McMullin Area
Groundwater Sustainability Agency

Groundwater Sustainability Plan

Revised and Adopted 07/06/2022

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Board of Directors

Brian Pacheco- County of Fresno
Jerry Rai- Raisin City Water District
Don Cameron- Raisin City Water District
Jeevan Singh- Mid-Valley Water District
Matt Abercrombie- Landowner

General Manager

Matt Hurley

County of Fresno Staff

Bernard Jimenez
Glenn Allen
Roy Jimenez

Landowner Representatives

Ryan Porto
Michael Naito
Jerry Radinoff

Outreach

Cristel Tufenkjian- Kings River Conservation District
Rebecca Quist- Kings River Conservation District

Provost & Pritchard Consulting Group

Lynn Groundwater
Randy Hopkins
Owen Kubit
Shay Overton
Sean Smith
Shawn Vaughn
Katie Durham
Taylor Muell
Eric Abrahamsen
Gavin O'Leary
Laurie Sales
Michele Calvert
Charis Calvert

LIMITATION

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

Section 3 of this Plan, Basin Setting, was prepared in general conformance with section 354.12 of the water code either by and /or under the direct supervision of the appropriate professional as indicated herein.

Per Regulation Requirements:

> **§354.12** Introduction to Basin Setting
> 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.
>
> Note: Authority cited: Section 10733.2, Water Code.
> Reference: Section 10733.2, Water Code.

REGISTERED PROFESSIONAL ENGINEER
LYNN GROUNDWATER
No. 84,134
Civil
STATE OF CALIFORNIA

Lynn Groundwater Moeller

DATE SIGNED 07/06/2022

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

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

Prepared by:

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Table of Contents

Executive Summary ES-1
1 Introduction 1-1
1.1 Purpose of Groundwater Sustainability Plan 1-1
1.2 Sustainability Goal 1-1
1.3 Coordination Agreements 1-1
1.4 Inter-basin Agreements 1-3
1.5 Agency Information 1-3
1.5.1 Organization and Management Structure of the GSA 1-3
1.5.2 Legal Authority of the GSA 1-4
2 Plan Area 2-1
2.1 Summary of Jurisdictional Areas and Other Features 2-13
2.1.1 Groundwater Basin Boundaries 2-13
2.1.2 Groundwater Sustainability Plan Area 2-13
2.1.3 Kings River Conservation District 2-17
2.1.4 Kings River Water Association 2-17
2.2 Water Resources Monitoring and Management Programs 2-17
2.2.1 Monitoring and Management Programs 2-17
2.2.2 Impacts to Operational Flexibility 2-21
2.2.3 Conjunctive Use Programs 2-28
2.3 Relation to General Plans 2-28
2.3.1 Summary of General Plans/Other Land Use Plans 2-28
2.3.2 Impact of GSP on Water Demands 2-28
2.3.3 Impact of GSP on Land Use Plan Assumptions 2-29
2.3.4 Permitting New or Replacement Wells 2-29
2.3.5 Land Use Plans Outside the Basin 2-30
2.4 Additional GSP Components 2-32
2.4.1 Saline Water Intrusion 2-32
2.4.2 Wellhead Protection 2-32
2.4.3 Migration of Contaminated Groundwater 2-33
2.4.4 Well Abandonment/Well Destruction Program 2-35
2.4.5 Replenishment of Groundwater Extractions 2-35
2.4.6 Well Construction Policies 2-35
2.4.7 Groundwater Projects 2-36

2.4.8 Efficient Water Management Practices 2-36
2.4.9 Relationships with State and Federal Agencies 2-36
2.4.10 Land-Use Planning 2-37
2.4.11 Impacts on Groundwater Dependent Ecosystems 2-37
2.5 Notice and Communication 2-37
2.5.1 Description of Beneficial Uses and Users 2-37
2.5.2 Decision-Making Process 2-42
2.5.3 Public Engagement / Public Outreach Plan 2-45
2.5.4 Encouraging Active Involvement 2-47
3 Basin Setting 3-1
3.1 Hydrogeologic Conceptual Model 3-1
3.1.1 Introduction 3-1
3.1.2 Lateral Basin Boundaries 3-1
3.1.3 Regional Geologic and Structural Setting 3-5
3.1.4 Topographic Information 3-8
3.1.5 Surficial Geology 3-11
3.1.6 Soil Characteristics 3-13
3.1.7 Cross-sections 3-15
3.1.8 Aquifer System 3-22
3.1.9 General Groundwater Quality 3-35
3.1.10 Surface Water Features 3-36
3.1.11 Source and Point of Delivery of Imported Water 3-39
3.1.12 Recharge and Discharge Areas 3-40
3.2 Current and Historical Groundwater Conditions 3-45
3.2.1 Groundwater Level Data 3-45
3.2.2 Groundwater Movement 3-73
3.2.3 Estimate of Groundwater Storage 3-76
3.2.4 Seawater Intrusion 3-79
3.2.5 Groundwater Quality Issues 3-79
3.2.6 Land Subsidence Conditions 3-95
3.2.7 Surface Water and Groundwater Interconnections 3-108
3.2.8 Groundwater Dependent Ecosystems 3-114
3.3 Water Budget Information 3-117
3.3.1 Introduction 3-117
3.3.2 Best Available Information 3-119

3.3.3 Description of Water Budget 3-120
3.3.4 Surface Water Entering and Leaving 3-123
3.3.5 Inflows to the Groundwater System 3-124
3.3.6 Outflows from Groundwater System 3-127
3.3.7 Change in Groundwater Storage 3-130
3.3.8 Historical Water Budget 3-131
3.3.9 Current Water Budget 3-134
3.3.10 Projected Water Budget 3-137
3.3.11 Quantification of Overdraft 3-144
3.3.12 Water Year Type Associated with Water Budget Components 3-144
3.3.13 Estimate of Sustainable Yield for the Basin 3-144
3.3.14 Management Areas 3-145
3.4 Water Supply 3-146
3.4.1 Water Rights 3-146
3.4.2 Kings River Supplies 3-146
3.4.3 Central Valley Project Supplies 3-149
3.4.4 State Water Project Supplies 3-151
4 Sustainable Management Criteria 4-1
4.1 Sustainability Goal 4-2
4.2 Groundwater Levels 4-3
4.2.1 Undesirable Results 4-3
4.2.2 Minimum Thresholds 4-7
4.2.3 Measurable Objectives 4-14
4.3 Groundwater Storage 4-17
4.3.1 Undesirable Results 4-18
4.3.2 Minimum Thresholds 4-19
4.3.3 Measurable Objectives 4-22
4.4 Seawater Intrusion 4-24
4.5 Groundwater Quality 4-24
4.5.1 Undesirable Results 4-25
4.5.2 Minimum Thresholds 4-28
4.5.3 Measurable Objectives 4-27
4.6 Land Subsidence 4-28
4.6.1 Undesirable Results 4-29
4.6.2 Minimum Thresholds 4-33

4.6.3 Measurable Objectives 4-41
4.7 Interconnected Groundwater Surface Water Systems 4-43
5 Monitoring Network 5-1
5.1 Introduction 5-2
5.1.1 Monitoring Network Objectives 5-2
5.1.2 Network Development Process 5-2
5.2 Groundwater Levels 5-3
5.2.1 Description of Monitoring Network 5-3
5.2.2 Adequacy of Monitoring Network 5-6
5.2.3 Density of Monitoring Sites and Frequency of Measurements 5-10
5.2.4 Monitoring Network Information 5-10
5.2.5 Monitoring Locations 5-12
5.2.6 Monitoring Protocols 5-12
5.2.7 Representative Monitoring 5-13
5.2.8 Assessment and Improvement of Monitoring Network 5-13
5.3 Groundwater Storage 5-16
5.3.1 Description of Monitoring Network 5-16
5.3.2 Adequacy of Monitoring Network 5-17
5.3.3 Density of Monitoring Sites and Frequency of Measurements 5-17
5.3.4 Monitoring Network Information 5-17
5.3.5 Monitoring Locations 5-18
5.3.6 Monitoring Protocols 5-19
5.3.7 Representative Monitoring 5-19
5.3.8 Assessment and Improvement of Monitoring Network 5-20
5.4 Seawater Intrusion 5-21
5.5 Water Quality 5-22
5.5.1 Description of Monitoring Network 5-22
5.5.2 Adequacy of Monitoring Network 5-24
5.5.3 Density of Monitoring Sites and Frequency of Measurements 5-24
5.5.4 Monitoring Network Information 5-25
5.5.5 Monitoring Locations 5-26
5.5.6 Monitoring Protocols 5-26
5.5.7 Representative Monitoring 5-27
5.5.8 Assessment and Improvement of Monitoring Network 5-28
5.6 Land Subsidence 5-29

5.6.1 Description of Monitoring Network 5-29
5.6.2 Adequacy of Monitoring Network 5-37
5.6.3 Density of Monitoring Sites and Frequency of Measurements 5-37
5.6.4 Monitoring Network Information 5-38
5.6.5 Monitoring Locations 5-39
5.6.6 Monitoring Protocols 5-39
5.6.7 Representative Monitoring 5-40
5.6.8 Assessment and Improvement of Monitoring Network 5-40
5.7 Depletion of Interconnected Surface Water 5-42
5.7.1 Description of Monitoring Network 5-42
5.7.2 Adequacy of Monitoring Network 5-43
5.7.3 Density of Monitoring Sites and Frequency of Measurements 5-44
5.7.4 Monitoring Network Information 5-44
5.7.5 Monitoring Locations 5-45
5.7.6 Monitoring Protocols 5-47
5.7.7 Representative Monitoring 5-47
5.7.8 Assessment and Improvement of Monitoring Network 5-48
5.8 Reporting Monitoring Data to the Department 5-49
6 Projects and Management Actions to Achieve Sustainability 6-1
6.1 Introduction 6-1
6.1.1 Public Notification 6-2
6.2 Projects 6-5
6.2.1 Fresno City Wastewater Treatment Plant Recharge Basins, FID Houghton Canal System 6-5
6.2.2 Fresno City Wastewater Treatment Plant Recharge Basin, FID Lower Dry Creek System 6-14
6.2.3 Southwest Groundwater Banking 6-20
6.2.4 Lassen Avenue Reverse Flow and Recharge 6-26
6.2.5 MAGSA Groundwater Banking Program 6-33
6.2.6 McMullin On-Farm Flood Capture Phase 2 Expansion 6-39
6.2.7 Houghton Wasteway Expansion 6-47
6.2.8 South Sandridge Canal Water Supply & Recharge 6-53
6.2.9 Stinson North Canal Water Supply and Recharge 6-59
6.2.10 Grantland Area Recharge 6-65
6.2.11 Consolidated ID Wristen Ditch Intertie 6-73
6.2.12 Upgradient Recharge Programs 6-81

6.2.13 Land Subsidence Data Gap Analysis 6-83
6.2.14 Surface Water-Groundwater Interconnection Data Gap Analysis 6-86
6.2.15 Domestic Well Mitigation Program 6-89
6.2.16 Project Ranking 6-93
6.3 Management Actions 6-97
6.3.1 Education and Outreach Management Actions 6-99
6.3.2 Well Head Requirements Management Actions 6-102
6.3.3 Groundwater Allocation Management Actions 6-106
6.3.4 Groundwater Marketing and Trading Management Actions 6-109
6.3.5 Fees and Incentives Management Actions 6-114
6.3.6 Groundwater Pumping Restrictions Management Actions 6-118
7 Plan Implementation 7-1
7.1 Estimate of GSP Implementation Costs 7-1
7.2 Identify Funding Alternatives 7-8
7.3 Schedule for Implementation 7-8
7.3.1 MAGSA Plan Implementation Schedule: 7-8
7.3.2 Schedule for Project Implementation 7-10
7.3.3 Schedule for Management Actions Implementation 7-12
7.4 Data Management System 7-13
7.5 Annual Reporting 7-15
7.6 Periodic Evaluations 7-17
8 References 8-1

List of Tables

Table ES-1 Water Uses and Water Sources ES-5
Table ES-2 Mid-Valley Water District History of Water Deliveries ES-5
Table ES-3 Terranova Ranch History of Water Deliveries ES-6
Table ES-4 Water Budgets ES-8
Table ES-5 Monitoring Requirements ES-9
Table ES-6 Groundwater Level Sustainable Management Criteria ES-11
Table ES-7 Chemicals of Concern and California MCLs ES-12
Table ES-10 Project Cost & Yield Summary ES-24

Table 2-1 Land-Use in McMullin Area GSA 2-5
Table 2-2 Water Uses and Water Sources 2-7
Table 2-3 Mid-Valley Water District History of Water Deliveries 2-7
Table 2-4 Terranova Ranch History of Water Deliveries 2-8
Table 2-5 From a well about one mile away from the Surfluh Lease 2-23
Table 2-6 From a well adjacent to the Surfluh Lease 2-23

Table 2-7 James Irrigation District Surface and Groundwater Use (2000-2009) 2-26
Table 2-8 Public Meetings (Plan Discussed) 2-41
Table 2-9 MAGSA Board of Directors 2-43
Table 2-10 Voting Thresholds for Specific Board Actions 2-45
Table 2-11 Informational Stakeholder Briefings 2-49
Table 2-12 Informational Stakeholder Briefings - Kings Subbasin 2-50
Table 2-13 Informational Stakeholder Briefings - Inter-basin Coordination 2-50
Table 2-14 Technical Meetings – Inter-basin Coordination 2-50
Table 2-15 Direct Mail 2-52
Table 2-16 Email Updates to Interested Persons 2-54
Table 3-1 Water Year Types 3-121
Table 3-2 Kings River Year Types based on Diversions into Kings Subbasin 3-122
Table 3-3 Estimated Seepage Rates for Hydrologic Soil Groups 3-126
Table 3-4 Kings Basin Historical Water Budget 3-131
Table 3-5 MAGSA Average Annual Historic Water Budget for WY 1997-2011 3-133
Table 3-6 Kings Basin Current Water Budget (2016-2017) 3-134
Table 3-7 McMullin Area GSA Current Demands Water Budget 3-136
Table 3-8 Kings Basin Projected Water Budget (2040) 3-142
Table 3-9 Near Future (2040) Projected Water Budget Including Projects and Management Actions 3-143
Table 3-10 Floodwater Discharge at James Bypass Gaging Station Since the Construction of Pine Flat Dam (1954/55 – 2015/16) 3-147
Table 3-11 Historic Friant CVP Water Supply Availability and Allocation by Year 3-150
Table 4-1 Monitoring Requirements 4-1
Table 4-2 Overdraft Mitigation Schedule 4-3
Table 4-3 Groundwater Level Minimum Thresholds 4-9
Table 4-4 Water Level Mitigation Rate 4-15
Table 4-5 Groundwater Level Interim Milestones and Measurable Objectives 4-16
Table 4-6 Estimate of Groundwater in Storage between Measurable Objective and Minimum Threshold . 4-17
Table 4-7 Estimate of Groundwater in Storage between Minimum Threshold and Measurable Objective Milestones 4-23
Table 4-8 Chemicals of Concern and California MCLs 4-27
Table 4-9 Selected Representative Wells and Monitored Chemicals of Concern 4-5
Table 4-10 Historical Total Land Subsidence in MAGSA 4-35
Table 4-11 Historical Land Subsidence Rates in MAGSA 4-35
Table 4-12 Measurable Objective for Land Subsidence 4-41
Table 4-13 Interconnected Surface Water Monitoring Network Wells 4-45
Table 5-1 Monitoring Requirements 5-1
Table 5-2 Monitoring Wells 5-26
Table 6-1 Recharge Basins for Houghton Canal 6-7
Table 6-2 Flow Rates Based on Assumed Infiltration Rates when Maximum Flows Available 6-8
Table 6-3 Summary of Maximum and Typical Recharge Volume 6-11
Table 6-4 Summary of Probable Construction Cost for Houghton Canal 6-12
Table 6-5 Summary of Cost per AF for Houghton Canal 6-13
Table 6-6 Recharge Basins for Lower Dry Creek Canal 6-16
Table 6-7 Flow Rates Based on Assumed Infiltration Rates when Maximum Flows Available 6-16
Table 6-8 Summary of Maximum and Typical Recharge Volume 6-18
Table 6-9 Summary of Probable Construction Costs for Lower Dry Creek 6-19
Table 6-10 Summary of Cost per AF for Lower Dry Creek 6-19
Table 6-11 Summary of Construction Costs for Southwest Banking Project 6-25
Table 6-12 Summary of Cost per AF for Southwest Banking Project 6-25
Table 6-13 Summary of Probable Construction Costs for the Lassen Avenue Reverse Flow and Recharge Project 6-31

Table 6-14 Summary of Cost per AF for the Lassen Avenue Reverse Flow and Recharge Project 6-32
Table 6-15 Summary of Probable Construction Costs for MAGSA Groundwater Banking Program 6-37
Table 6-16 Summary of Cost per AF for MAGSA Groundwater Banking Program 6-38
Table 6-17 Summary of Probable Construction Costs for Phase 2 6-45
Table 6-18 Summary of Probable Construction Costs for Phase 3 6-45
Table 6-19 Summary of Cost per AF for Entire McMullin Phase 2 and 3 6-45
Table 6-20 Summary of Cost per AF for McMullin Phase 2 and 3 in RCWD 6-46
Table 6-21 Summary of Probable Construction Costs for Houghton Wasteway Expansion Project 6-52
Table 6-22 Summary of Cost per AF for Houghton Wasteway Expansion Project 6-52
Table 6-23 Summary of Probable Construction Costs for South Sandridge Canal Water Supply & Recharge Project 6-58
Table 6-24 Summary of Cost per AF for South Sandridge Project 6-58
Table 6-25 Summary of Probable Construction Costs for Stinson North Canal 6-64
Table 6-26 Summary of Cost per AF for Stinson North Canal 6-64
Table 6-27 Summary of Probable Construction Costs for Grantland 6-72
Table 6-28 Summary of Cost per AF for Grantland Area Recharge Project 6-72
Table 6-29 Estimated Recharge Demand for the Wristen Ditch 6-74
Table 6-30 Summary of Probable Construction Cost for Wristen Ditch Intertie 6-80
Table 6-31 Summary of Cost per AF for Wristen Ditch Intertie 6-80
Table 6-32 Summary of Cost per AF for Upgradient Out-of-Area Recharge Project 6-82
Table 6-33 Project Cost & Yield Summary 6-94
Table 6-34 Project Ranking and Scoring Criteria 6-96
Table 6-35 Example Groundwater Allocation "Ramp Down" 6-106
Table 7-1 Estimated Administrative Costs 7-2
Table 7-2 Estimated MAGSA Project Costs 7-3
Table 7-3 Estimated Costs for Implementing Management Actions 7-4
Table 7-4 Pre-GSP Proposition 218 Election Draft 5-Year Budget 7-6
Table 7-5 DMS Annual Reporting Requirements 7-15

List of Figures

Figure ES-1 Groundwater Subbasins ES-2
Figure ES-2 Groundwater Sustainability Agencies within the Kings Subbasin ES-3
Figure ES-3 Participants in MAGSA Groundwater Sustainability Plan ES-4
Figure ES-4 Water Budget Schematic ES-7
Figure ES-5 Water Level Monitoring Network ES-15
Figure ES-6 Water Quality Monitoring Network ES-16
Figure ES-7 KRCD Land Subsidence Monitoring Locations Map ES-18
Figure ES-8 NASA Land Subsidence Monitoring Map ES-19
Figure ES 9 USBR San Joaquin River Restoration Project Monitoring Wells ES-20
Figure ES-10 MAGSA Projects for Groundwater Sustainability (Northwesterly Area) ES-22
Figure ES-11 MAGSA Projects for Groundwater Sustainability (Southeasterly Area) ES-23

Figure 1-1 GSAs in the Basin 1-2
Figure 2-1 Groundwater Subbasins 2-2
Figure 2-2 Groundwater Sustainability Agencies within the Kings Subbasin 2-3
Figure 2-3 Participants in MAGSA Groundwater Sustainability Plan 2-4
Figure 2-4 Cropping Map covering MAGSA using 2014 DWR Land Use Data 2-6
Figure 2-5 Well Density by Sections 2-9
Figure 2-6 Agricultural Well Density by Sections 2-10

Figure 2-7 Domestic Well Density by Sections 2-11
Figure 2-8 Municipal and Industrial Well Density by Sections 2-12
Figure 2-9 Jurisdiction Map 2-16
Figure 2-10 Impacts to Operational Flexibility 2-21
Figure 2-11 DOGGR Oil & Gas Wells (District 5) 2-24
Figure 2-12 Groundwater Contours Map (DWR 2017) 2-25
Figure 2-13 Disadvantaged Communities 2-39
Figure 2-14 DAC/SDAC Census Tracts 2-40
Figure 2-15 MAGSA Decision-Making Flow Chart 2-44
Figure 2-16 Website Views 2-53
Figure 3-1 Kings Groundwater Subbasin, Groundwater Sustainability Agencies 3-3
Figure 3-2 Groundwater elevation map 3-4
Figure 3-3 Base of Aquifer – Kings Subbasin 3-6
Figure 3-4 Isometric Block Diagram of the Fresno Area 3-7
Figure 3-5 Surficial Deposits and Geomorphic Features 3-9
Figure 3-6 Topography 3-10
Figure 3-7 Surficial Deposits – Kings Subbasin 3-12
Figure 3-8 Soil Texture and Saturated Hydraulic Conductivity 3-14
Figure 3-9 Regional Cross-Section A-A' – Kings Subbasin 3-16
Figure 3-10 Regional Cross-Section B-B' - Kings Subbasin 3-17
Figure 3-11 Regional Cross-Section C-C' - Kings Subbasin 3-18
Figure 3-12 Regional Cross-Section D-D' - Kings Subbasin 3-19
Figure 3-13 Regional Cross-Section E-E' - Kings Subbasin 3-20
Figure 3-14 Regional Cross-Section F-F' - Kings Subbasin 3-21
Figure 3-15 Kings Groundwater Subbasin Conceptual Cross-Section 3-23
Figure 3-16 Kings Groundwater Subbasin Conceptual Cross-Section 3-24
Figure 3-17 Lacustrine Clays in the McMullin Area GSA 3-26
Figure 3-18 Base of Unconfined Groundwater 3-29
Figure 3-19 Base of Aquifer 3-30
Figure 3-20 Recommended Specific Yield and Transmissivities 3-31
Figure 3-21 Areas of Flowing Wells in 1906 3-33
Figure 3-22 Pre-Development and Post-Development Regional Groundwater Flow Patterns 3-34
Figure 3-23 Surface Water Features Significant to the Management of the McMullin GSA Basin 3-38
Figure 3-24 Geologic Facies Conducive to Groundwater Recharge 3-42
Figure 3-25 Modified Soil Agricultural Groundwater Banking Index (SAGBI) Rating 3-43
Figure 3-26 Wetlands Map 3-44
Figure 3-27 Kings Subbasin Base of Unconfined Groundwater 3-48
Figure 3-28 Kings Subbasin Current (Spring 2017) Groundwater Level Elevations 3-49
Figure 3-29 Kings Subbasin Current (Fall 2017) Groundwater Level Elevations 3-50
Figure 3-30 Wells with Historical Water Level Data 3-52
Figure 3-31 Average Fall Groundwater Levels Hydrograph 3-54
Figure 3-32 Average Spring Groundwater Levels Hydrograph 3-55
Figure 3-33 1997 MAGSA Groundwater Contour Map 3-57
Figure 3-34 2013 MAGSA Groundwater Contour Map with Cross Sections 3-58
Figure 3-35 WSE Cross Section A from MAGSA (1995-1998) 3-60
Figure 3-36 WSE Cross Section B from MAGSA (1995-1998) 3-61
Figure 3-37 WSE Cross Section A from MAGSA (2012-2015) 3-62
Figure 3-38 WSE Cross Section B from MAGSA (2012-2015) 3-63
Figure 3-39 Well Hydrograph 1 3-65
Figure 3-40 Well Hydrograph 2 3-66
Figure 3-41 Well Hydrograph 3 3-67
Figure 3-42 Well Hydrograph 4 3-68

Figure 3-43 Well Hydrograph 5 3-69
Figure 3-44 Well Hydrograph 6 3-70
Figure 3-45 Well Hydrograph 7 3-71
Figure 3-46 Well Hydrograph 8 3-72
Figure 3-47 Groundwater Flow 3-75
Figure 3-48 Graph of Storage Change, Seasonal High/Low WY, GW Pumped 3-78
Figure 3-49 Public Water System Monitoring Wells and Selected American Ave. Landfill Monitoring Wells 3-80
Figure 3-50 MAGSA Constituents Map Arsenic (As) 3-81
Figure 3-51 MAGSA Constituents Map Chloride (CI-) 3-82
Figure 3-52 MAGSA Constituents Map Dibromochloropropane (DBCP) 3-83
Figure 3-53 MAGSA Constituents Map Manganese (Mn) 3-84
Figure 3-54 MAGSA Constituents Map-Nitrates (NO_3) 3-85
Figure 3-55 MAGSA Constituents Map Sodium (Na) 3-86
Figure 3-56 MAGSA Constituents Map Total Dissolved Solids (TDS) 3-87
Figure 3-57 MAGSA Constituents Map-1,2,3-Trichloropropane (123 TCP) 3-88
Figure 3-58 MAGSA Constituents Map-Uranium (U) 3-89
Figure 3-59 Oilfield Map 3-92
Figure 3-60 Coalition Boundary 3-94
Figure 3-61 Aquifer compaction due to groundwater pumping as identified by USGS (https://ca.water.usgs.gov/land_subsidence/california-subsidence-cause-effect.htm) 3-96
Figure 3-62 Kings Subbasin USBR SJRRP Land Subsidence Map 3-100
Figure 3-63 Kings Subbasin KRCD Land Subsidence Map 3-101
Figure 3-64 Kings Subbasin NASA INSAR Land Subsidence Map 3-102
Figure 3-65 Kings Subbasin DWR Land Subsidence Map 3-103
Figure 3-66 Land Subsidence from 1926 to 1972 3-104
Figure 3-67 USBR Land Subsidence Data (2011-2016) 3-105
Figure 3-68 KRCD Land Subsidence Data (2013-2016) 3-106
Figure 3-69 NASA InSAR Land Subsidence Data (2015-2016) 3-107
Figure 3-70 Monitoring Well locations along the San Joaquin River 3-109
Figure 3-71 Hydrograph for Well MW-09-39B, SJRRP 3-110
Figure 3-72 San Joaquin River Average Daily Flow Below Bifurcation Structure 3-111
Figure 3-73 USGS Scientific Investigations Report 2014-5148- Depth to Water Table Along San Joaquin River, Fall 1988 3-112
Figure 3-74 USGS Scientific Investigations Report 2014-5148 - Depth to Water Table Along San Joaquin River, Fall 2006 3-113
Figure 3-75 Map of Vegetative Groundwater Dependent Ecosystems 3-115
Figure 3-76 Map of Wetland Groundwater Dependent Ecosystems 3-116
Figure 3-77 Water Budget Schematic 3-117
Figure 3-78 Water Budgets Evaluated 3-119
Figure 3-79 Variables Impacting Projected Water Budget 3-137
Figure 3-80 Estimated Projected Kings River Inflow to Pine Flat Reservoir 3-138
Figure 3-81 50-year Monthly Average Precipitation Climate Change Factor 3-140
Figure 3-82 50-year Monthly Average ET Climate Change Factor 3-141
Figure 4-1 Groundwater Level- Sustainability Management 4-6
Figure 4-2 Post 1990 MT DeeperThan10 Ft Above MAGSA 4-13
Figure 4-3 Selected Groundwater Quality Monitoring Wells 4-4
Figure 4-4 Kings Basin Land Subsidence 4-31
Figure 4-5 KRCD Land Subsidence Map 4-36
Figure 4-6 DWR Land Subsidence Map 4-37
Figure 4-7 NASA Land Subsidence Map 4-40
Figure 4-8 Kings Subbasin Surface Water Features 4-47

Figure 4-9 Interconnected Surface Water Monitoring Network 4-48
Figure 5-1 Kings Basin Monitoring Network 5-5
Figure 5-2 Existing Monitored Wells Map 5-8
Figure 5-3 Proposed Monitoring Wells 5-9
Figure 5-4 Groundwater Quality Monitoring Wells 5-23
Figure 5-5 Kings Basin KRCD Land Subsidence Monitoring 5-31
Figure 5-6 Kings Basin NASA InSAR Land Subsidence Monitoring 5-32
Figure 5-7 Corcoran Clay Extent Within MAGSA 5-33
Figure 5-8 KRCD Land Subsidence Monitoring Locations Map 5-34
Figure 5-9 NASA Land Subsidence Monitoring Map 5-35
Figure 5-10 San Joaquin River Average Daily Flow Below Bifurcation Structure 5-43
Figure 5-11 USBR San Joaquin River Restoration Project Monitoring Wells 5-46
Figure 6-1 MAGSA Projects for Groundwater Sustainability (Northwesterly Area) 6-3
Figure 6-2 MAGSA Projects for Groundwater Sustainability (Southeasterly Area) 6-4
Figure 6-3 Houghton Canal Project Location & Facilities 6-6
Figure 6-4 Houghton Canal Lift Station (Conceptual) 6-9
Figure 6-5 RWTF Turnout for Basins 38-44 6-10
Figure 6-6 Aerial Photograph of Lower Dry Creek Project and Existing Site 6-15
Figure 6-7 Lower Dry Creek Canal Lift Station (Conceptual) 6-17
Figure 6-8 Southwest Banking Project Location and Facilities 6-22
Figure 6-9 SAGBI Rating Soils near the Southwest Banking Project 6-23
Figure 6-10 Lassen Avenue Reverse Flow and Recharge Project Location and Facilities 6-28
Figure 6-11 SAGBI Soils for the Lassen Avenue Reverse Flow and Recharge Project 6-30
Figure 6-12 MAGSA Groundwater Banking Program Location and Facilities 6-34
Figure 6-13 SAGBI Soils for MAGSA Groundwater Banking Program 6-36
Figure 6-14 McMullin On-Farm Flood Capture Expansion Project Location, Phases, & Facilities 6-41
Figure 6-15 SAGBI Rating Soils near the McMullin On-Farm Flood Capture Expansion Project 6-43
Figure 6-16 Houghton Wasteway Expansion Project Location and Facilities 6-48
Figure 6-17 SAGBI Rating Soils near the Houghton Wasteway Expansion Project 6-50
Figure 6-18 South Sandridge Canal Water Supply & Recharge Project Location and Facilities 6-54
Figure 6-19 SAGBI Rating Soils near the South Sandridge Canal Water Supply & Recharge Project 6-56
Figure 6-20 Stinson North Canal Project Location & Facilities 6-60
Figure 6-21 SAGBI Rating Soils near the Stinson North Canal Project 6-62
Figure 6-22 Grantland Area Recharge Project Location & Facilities 6-66
Figure 6-23 SAGBI Rating Soils near the Grantland Area Recharge Project 6-68
Figure 6-24 Channel Capacity Improvements Highlighted in LMC Hydraulic Analysis Summary 6-70
Figure 6-25 Wristen Ditch Intertie Project Location & Facilities 6-75
Figure 6-26 SAGBI Rating Soils near the Wristen Ditch Project 6-77
Figure 7-1 MAGSA Plan Implementation 7-9
Figure 7-2 Estimated Project Implementation Schedule 7-10
Figure 7-3 Estimated Management Actions Implementation Schedule 7-12
Figure 7-4 Kings Subbasin Data Management System Screenshot 7-14

Appendices

Appendix 1-A Kings Basin Coordination Agreement
Appendix 1-B GSP Checklist
Appendix 2-A MAGSA Joint Powers Agreement
Appendix 2-B Outreach Strategy
Appendix 2-C GSP Public Comments Table
Appendix 3-A Kings Subbasin GSA Coordination Efforts Technical Memoranda 1-6
Appendix 4-A Hydrographs
Appendix 4-B Groundwater Storage Calculations
Appendix 5-A Table of Monitoring Site Attributes
Appendix 5-B Data Management Standards
Appendix 5-C Best Management Practices for Monitoring Protocols, Standards, and Sites

Abbreviations

AF	Acre-Foot
AF/YR	Acre-Foot Per Year
AS	Arsenic
BGS	Below Ground Surface
BPA	Basin Plan Amendment
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
Caltrans	California Department of Transportation
CASGEM	California Statewide Groundwater Elevation Monitoring
CCR	California Code of Regulations
CDFW	California Department of Fish and Wildlife
CDP	Census Designated Place
CEQA	California Environmental Quality Act
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFS	Cubic Feet Per Second
CGPS	Continuous Global Positioning System
CID	Consolidated Irrigation District
CIMIS	California Irrigation Management Information System
City	City of Fresno
Cl	Chloride
Coalition	Kings River Water Quality Coalition
COC	Constituents of Concern
CSA	Community Service Area
CVHM	Central Valley Hydrologic Model
CVP	Central Valley Project
CVPDMC	Central Valley Project Delta Mendota Canal
CV-SALTS	Central Valley Salinity Alternatives for Long-term Sustainability
CWC	California Water Code
DAC	Disadvantaged Community
DBCP	1, 2-Dibromo-3-chloropropane
DDW	Division of Drinking Water
DHS	Department of Health Services
District	Consolidated Irrigation District
DMC	Delta-Mendota Canal
DMS	Data Management Systems

DQO ..... Data Quality Objective
DTSC ..... Department of Toxic Substance Control
DWR, CDWR ..... Department of Water Resources
DWSAP ..... Drinking Water Source Assessment and Protection
E-Clay ..... Corcoran Clay
EDB ..... Ethylene-Dibromide
EO ..... Education and Outreach
EPA ..... Environmental Protection Agency
ET ..... Evapotranspiration
ETAW ..... Evapotranspiration of applied water
FCEHD ..... Fresno County Environmental Health Department
FI ..... Fees and Incentives
FID ..... Fresno Irrigation District
FNF ..... Full Natural Flow
FWUA ..... Friant Water Users Authority
GA ..... Groundwater Allocations
GAMA ..... Groundwater Ambient Monitoring and Assessment
GAR ..... Groundwater Assessment Report
GDE ..... Groundwater Dependent Ecosystem
GIS ..... Geographical Information Systems
GMT ..... Groundwater Marketing and Trading
GP ..... Groundwater Pumping
GPS ..... Global Positioning System
GPD/FT ..... Gallons Per Day Per Foot
GSA ..... Groundwater Sustainability Agency
GSP ..... Groundwater Sustainability Plan
HCM ..... Hydrogeological Conceptual Model
HS ..... Health and Safety
ICM ..... Initial Conceptual Model
ID ..... Irrigation District
ILRP ..... Irrigated Lands Regulatory Program
InSAR ..... Interferometric Synthetic Aperture Radar
IRWM ..... Integrated Regional Water Management
ITF ..... Interagency Task Force
JID ..... James Irrigation District

JPA ..... Joint Powers Agreement
KDSA ..... Kenneth D. Schmidt and Associates
kg/mi²/qtr ..... kilograms per square mile per quarter
KRCD ..... Kings River Conservation District
KRWA ..... Kings River Water Association
KRWQC ..... Kings River Water Quality Coalition
Ksat ..... Saturated Hydraulic Conductivity
LAFCO ..... Local Agency Formation Commission
LDC ..... Lower Dry Creek
LDCE ..... Lower Dry Creek Extension
LID ..... Laguna Irrigation District
LiDAR ..... Light Detection and Ranging
LMC ..... Liberty Millrace Canal
LU ..... Land Use
MAGSA ..... McMullin Area Groundwater Sustainability Agency
MCL ..... Maximum Contaminant Level
mg/L ..... milligrams per liter
M&I ..... Municipal & Industrial
Mn ..... Manganese
MO ..... Measurable Objective
MPG ..... Mendota Pool Group
MSL ..... Mean Sea Level
MT ..... Minimum Threshold
MVWD ..... Mid-Valley Water District
Na ..... Sodium
NASA ..... National Aeronautics and Space Administration
NC Dataset Viewer ..... Nature Conservancy's Natural Communities Dataset Viewer
NGS ..... National Geodetic Survey
NO_3 ..... Nitrate
NO_3-N ..... Nitrogen
NOV ..... Notice of Violation
NRCS ..... Natural Resource Conservation Service
NRDC ..... Natural Resources Defense Council
PAC ..... Public Advisory Committee
PAH ..... Polynuclear Aromatic Hydrocarbons

PBO.....Plate Boundary Observatory
pCi/L..... picocuries per liter
PG&E.....Pacific Gas & Electric Company
Program.....Domestic Well Mitigation Program
Qb.....Flood-basin Deposits
Qoao.....Quaternary Older Alluvium
Qsd.....Quaternary Sand Dunes
Qya.....Quaternary Younger Alluvium
RC.....Resource Conservation
RCPP.....Regional Conservation Partnership Program
RCRA.....Resource Conservation and Recovery Act
RCWD.....Raisin City Water District
RP.....Reference Point
RWQCB.....Regional Water Quality Control Board
RWTF.....Regional Wastewater Treatment Facility
SAGBI.....Soil Agricultural Groundwater Banking Index
SDAC.....Severely Disadvantaged Community
Semitropic.....Semitropic Water Storage District
SGMA.....Sustainable Groundwater Management
SIR.....Scientific Investigations Reports
SJR.....San Joaquin River
SJRRP.....San Joaquin River Restoration Project
SJRRPGW.....San Joaquin River Restoration Project Groundwater Report
SJVAPCD.....San Joaquin Valley Air Pollution Control District
SLDMWA.....San Luis Delta Mendota Water Authority
SMC.....Sustainable Management Criteria
SMCL.....Secondary Maximum Contaminant Level
SNMP.....Salt and Nutrient Management Plan
SOI.....Sphere of Influence
SOPAC.....Scripps Orbit and Permanent Array Center
SWGP.....Stormwater Grant Program
SWP.....State Water Project
SWPPP.....Stormwater Pollution Prevention Plan
SWRCB, State Board.....State of California Water Resources Control Board
TCP.....1, 2, 3 -Trichloropropane

TDS ..... Total Dissolved Solids
U ..... Uranium
URF ..... Unreleased Restoration Flow
USACE ..... US Army Corps of Engineers
USBR ..... United States Burau of Reclamation
uS/cm ..... MilliSiemens per centimeter
USDA ..... United States Department of Agriculture
USGS ..... United States Geological Survey
VOC ..... Volatile Organic Compound
VFD ..... Variable Frequency Drive
WARMF ..... Watershed Analysis Risk Management Framework
WDR ..... Waste Discharge Requirements
WH ..... Well Head
WHPA ..... Wellhead Protection Area
WSE ..... Water Surface Elevation
WSIP ..... Water Storage Investment Program
WSP ..... Water Supply Paper
WRIME ..... Water Resources and Information Management Engineering
WWTP ..... Wastewater Treatment Plant
WY ..... Water Year
µg/L ..... micrograms per liter

Executive Summary

Chapter 1 - Introduction

On September 16, 2014, Governor Edmund G. Brown, Jr. signed into law a three-bill legislative package, composed of AB 1739 (Dickinson), SB 1168 (Pavley), and SB 1319 (Pavley), collectively known as the Sustainable Groundwater Management Act (SGMA) which was passed in 2014 and is codified in Section 10720 et seq. of the California Water Code. This legislation created a statutory framework for groundwater management that can be sustained during planning and implementation without causing undesirable results.

SGMA requires governments and water agencies of high- and medium-priority basins to halt overdraft and bring groundwater basins into balanced levels of pumping and recharge. Under SGMA, these basins should reach sustainability within 20 years of implementing their sustainability plans. For critically over-drafted basins, including the Kings Subbasin that the McMullin Area Groundwater Sustainability Agency (MAGSA) area is part of, the deadline for achieving sustainability is 2040.

In his signing statement, Governor Brown emphasized that "groundwater management in California is best accomplished locally." With ongoing financial and technical assistance from the Department of Water Resources (DWR) and substantial financial and practical involvement from its stakeholders and landowners, MAGSA is working to achieve basin-wide collaboration between neighboring groundwater sustainability agencies and helping to achieve groundwater sustainability within its local area of responsibility and the subbasin as a whole.

Chapter 2 - Plan Area

The Kings Groundwater Subbasin (Kings Subbasin) is part of the San Joaquin Valley Groundwater Basin. It is bordered by five groundwater subbasins which include the Madera, Kaweah, Tulare Lake, Westside, and Delta-Mendota Subbasins, shown in **Figure ES-1.** The San Joaquin River and the Kings River are the two principal rivers within or bordering the subbasin. Likewise, the San Joaquin River and the James Bypass segment of the Kings River form part of the northern and western boundary of the MAGSA. The Fresno Slough and James Bypass are along the western edge of the subbasin and connect the Kings River to the San Joaquin River system.

MAGSA is one of seven Groundwater Sustainability Agencies (GSAs) within the Kings Subbasin, shown in **Figure ES-2**. There is no overlap among the GSAs and there are no adjudicated areas in the groundwater subbasin.

The only state lands within the MAGSA area are the ecological reserve properties acquired and managed by California Department of Fish and Wildlife (CDFW). There are no tribal or federal lands located within the Plan area. Mid-Valley Water District (MVWD), Raisin City Water District (RCWD), and Fresno County are the three local entities participating in the MAGSA Groundwater Sustainability Plan (GSP) and are shown in **Figure ES 3**.

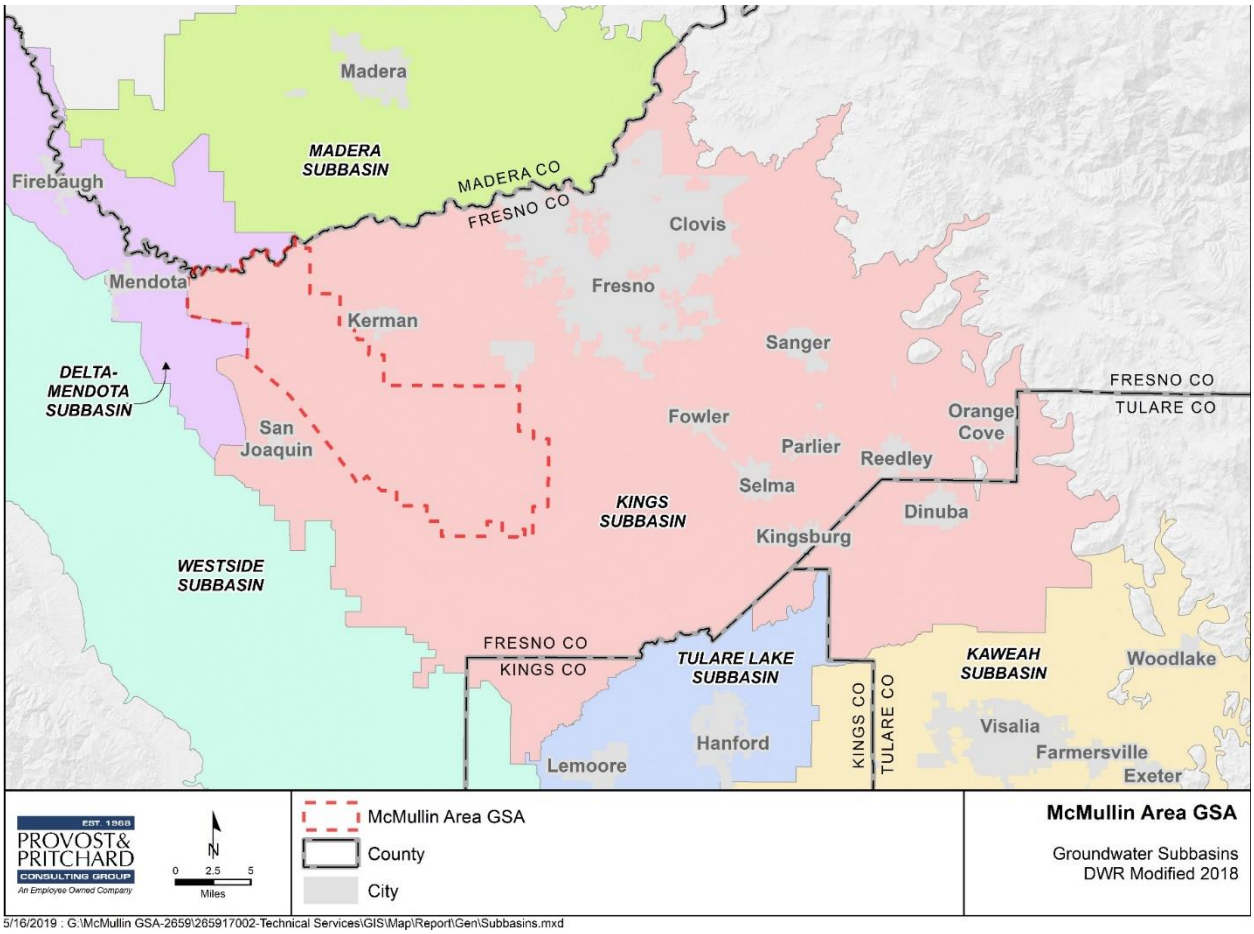


Figure ES-1 Groundwater Subbasins

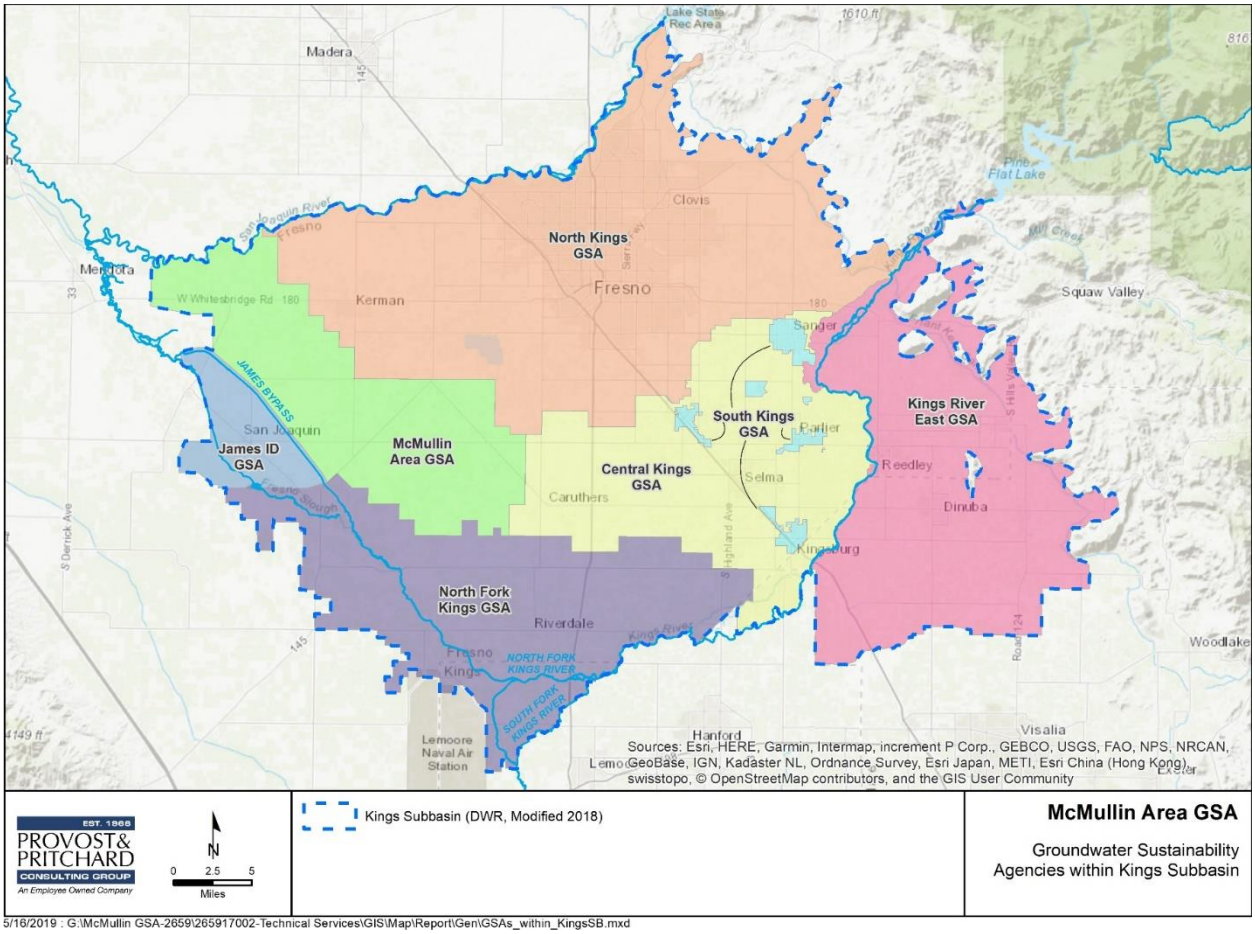


Figure ES-2 Groundwater Sustainability Agencies within the Kings Subbasin

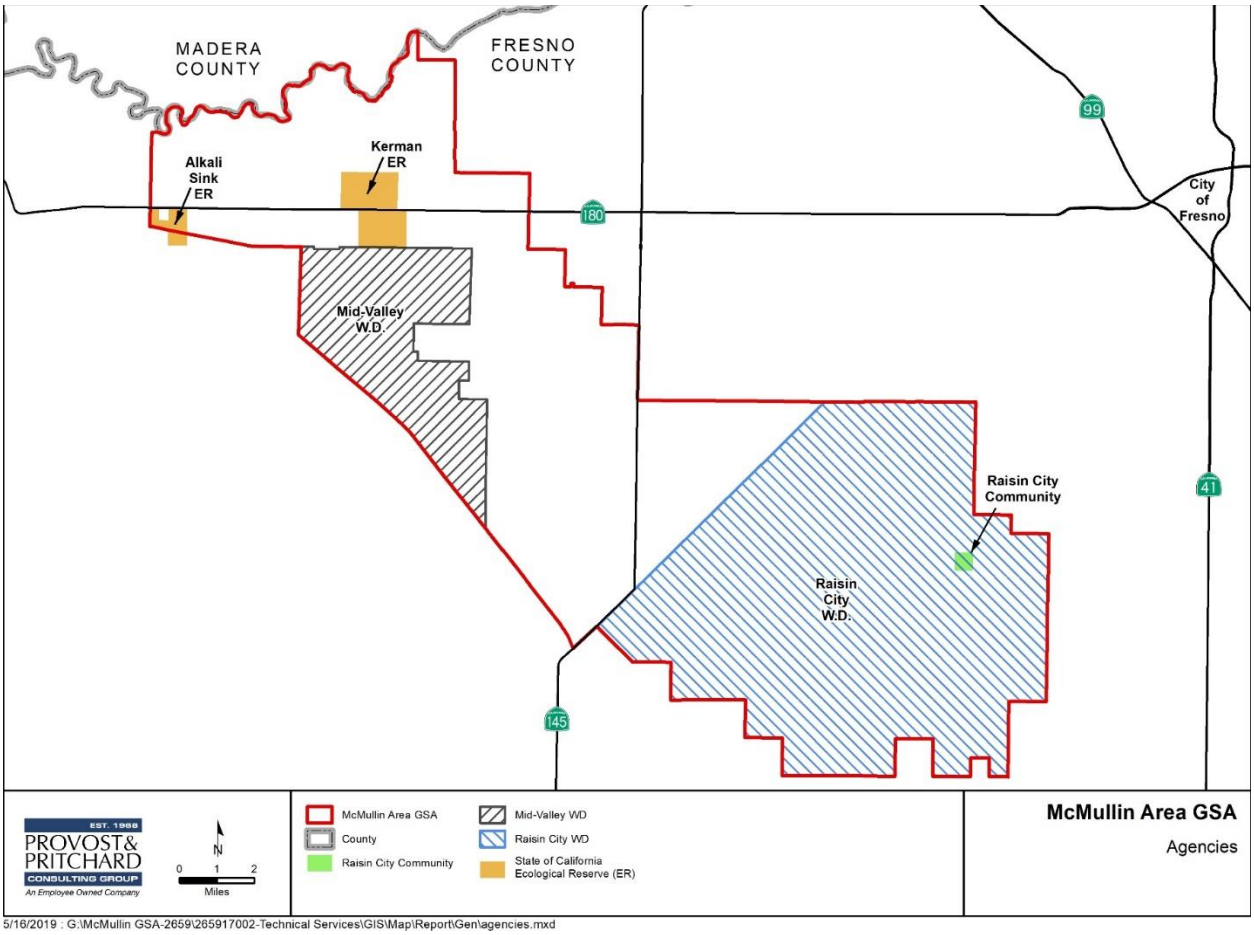


Figure ES-3 Participants in MAGSA Groundwater Sustainability Plan

Predominant water use and water source types for each of the plan's participants are shown in **Table ES-1**. The only community water system within MAGSA is for Raisin City, known as Fresno County Service Area #43 (water system #1000551). There are other public water systems in the MAGSA, but they are associated with industrial/commercial businesses (mainly around dairies, poultry farms and food processing plants). All the agencies and public water systems use groundwater.

Table ES-1 Water Uses and Water Sources

Agency / Water Company	Water Use	Water Source
County of Fresno	Agricultural Residential	Groundwater
Raisin City Water District	Agricultural	Groundwater Surface (Flood water)
Mid Valley Water District	Agricultural	Groundwater Surface (Flood water)

MVWD and Terranova Ranch located within the MAGSA service area also receive small quantities of available flood water, on occasion, from the north fork of the Kings River and/or the James Bypass segment of the Kings River that is diverted and conveyed toward the Terranova Ranch or the Gilmore Ranch which is a landowner within MVWD. MVWD may also receive United States Bureau of Reclamation (USBR) 215 Water when it is available. **Table ES-2** summarizes the volumes of flood water in acre feet (AF) diverted by MVWD since 1986. **Table ES-3** summarizes the volume of flood water (in AF) that Terranova Ranch estimates it has diverted.

Table ES-2 Mid-Valley Water District History of Water Deliveries

Date	Kings Floodwater AF	USBR Section 215 AF
1986	0	0
1987	0	0
1994	0	0
1995	4,983	0
1997	0	0
1998	7,757	0
1999	0	0
2000	0	0
2002	0	0
2003	0	368
2005	0	849
2006	3,648	268
2017	7,889	0

Table ES-3 Terranova Ranch History of Water Deliveries

Date	Kings Floodwater AF
1986	0
1987	0
1994	0
1995	4,500
1997	0
1998	4,500
1999	0
2000	0
2002	0
2003	0
2005	0
2006	4,500
2017	4,500

Chapter 3 - Basin Setting

Hydrogeologic Conceptual Model

The Hydrogeologic Conceptual Model (HCM) has been prepared to provide an easy-to-understand description of the general physical characteristics of the regional hydrology, land use, geology, geologic structure, water quality, principal aquifers, and principle aquitards in the study area.

It should be kept in mind that an HCM is not a numerical groundwater model or a water budget model. However, an HCM is useful in providing the context to develop water budgets, monitoring networks, and identification of data gaps. Refer to **Section 3.3** for information on the GSA's water budget.

This HCM was prepared following the requirements set forth in the California Code of Regulations, Title 23, Division 2, Chapter 1.5, Subchapter 2, Article 5, Sub article 2 (§354.14). Many topics discussed in this HCM, such as groundwater quality and groundwater flow, are discussed in greater detail in the Groundwater Conditions and Water Budget chapters.

The narrative HCM description is accompanied by graphical representations of the MAGSA portion of the Kings Subbasin that have attempted to clearly portray the geographic setting, regional geology, basin geometry, and general water quality. The HCM has been prepared utilizing existing qualified published studies and resources and will be periodically updated as data gaps are populated and other new information becomes available.

Current and Historical Groundwater Conditions

This section includes a description of important current and historical groundwater conditions within the MAGSA based on the best available data. Groundwater conditions described in Section 3.2 include groundwater levels, groundwater storage, groundwater quality, land subsidence, and surface water and groundwater interconnections. The section provides historical monitoring data collected by various agencies including DWR, Kings River Conservation District (KRCD), National Aeronautics and Space Administration

(NASA), and others. Refer to Chapter 5 – Monitoring Networks for descriptions of the monitoring programs that will continue to be used to collect data for implementation.

Water Budget

A water budget is an accounting of all the water that flows into and out of a specified area and describes the various components of the hydrologic cycle. A water budget includes all the water supplies, demands, modes of groundwater recharge, and non-recoverable losses, making it possible to identify how much water is stored in a system and changes to groundwater storage during a given period. Aggregated water budgets have been prepared for the entire Kings Subbasin as well as detailed water budgets for the MAGSA. A schematic diagram of a water budget indicating the primary inflows and outflows and impacts on the groundwater system is shown in **Figure ES-4** below:

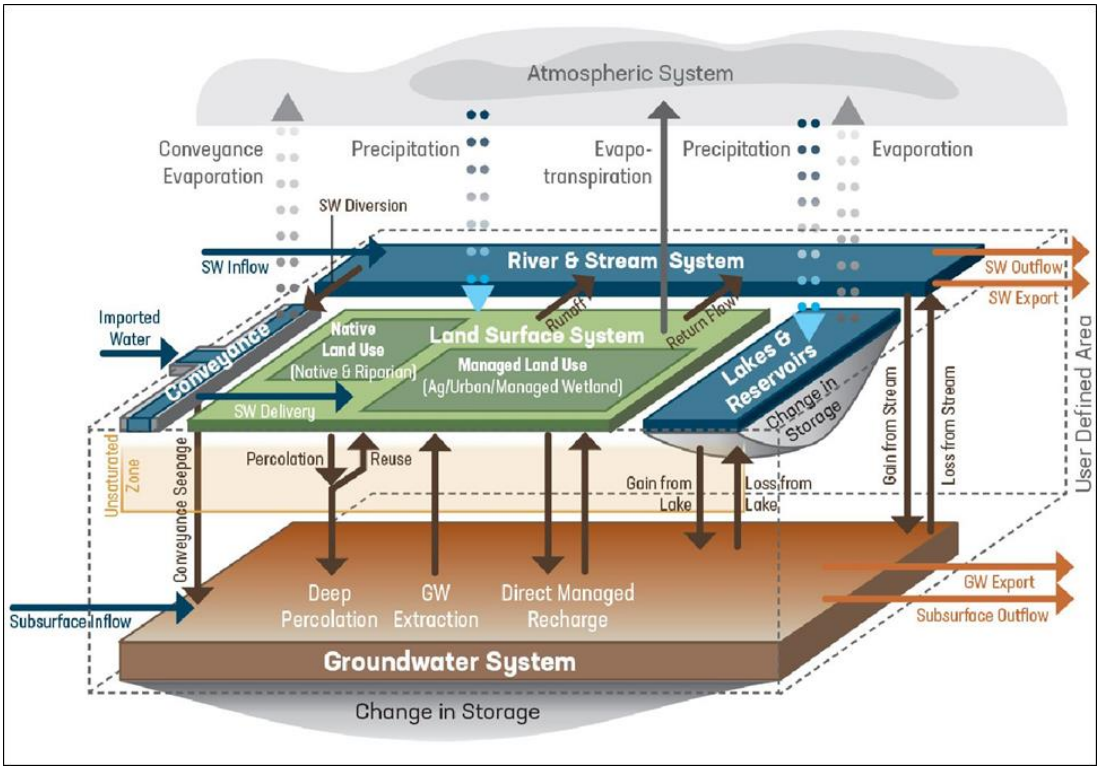


Figure ES-4 Water Budget Schematic

Purpose of Water Budget

Water budgets quantify the components of water supply, water use, and change to groundwater storage. The water budgets can be used as tools in numerous aspects of groundwater sustainability management including:

- Determining sustainable yield
- Identifying overdraft
- Identifying beneficial groundwater uses
- Identifying data uncertainties and monitoring needs
- Quantifying the effects of proposed projects and management actions
- Supporting the development of sustainable management criteria

The results of the MAGSA water budgets are shown in **Table ES-4**.

Table ES-4 Water Budgets

Description	MAGSA Annual Change in Groundwater Storage	
	Method 1	Method 2
Historical (1997-2011)	(61,600)	(18,000)
Current (2016-2017)	(69,400)	(18,000)
Future (2040)	0	0
Future (2070)	-	

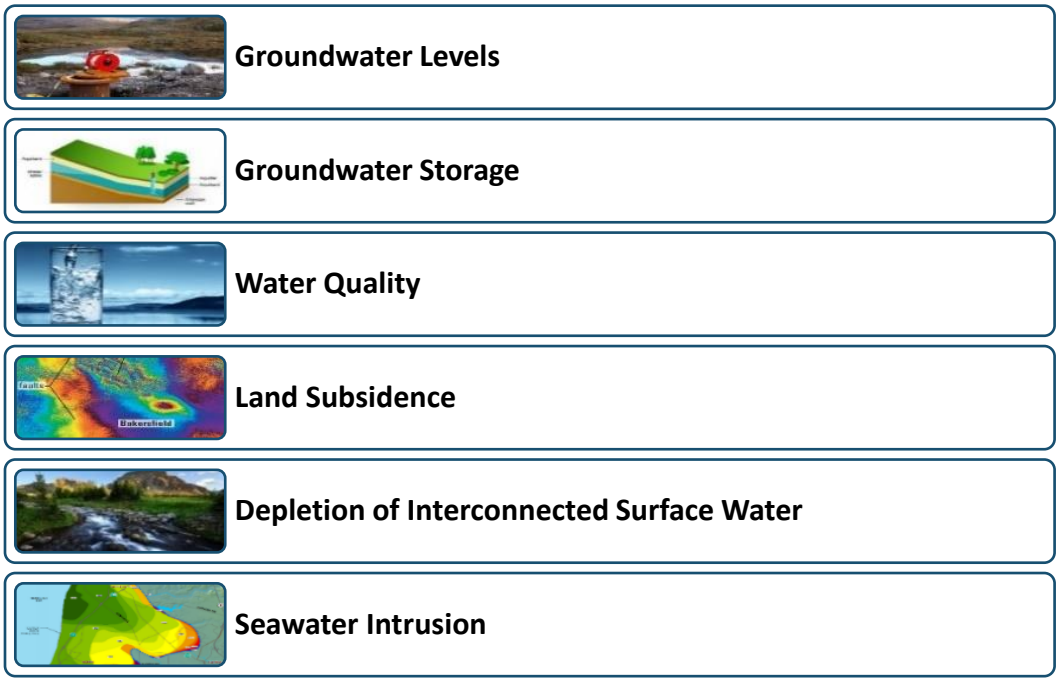
Based upon the foregoing and historical groundwater it is estimated that the sustainable yield for the subbasin is 1,140,000 AF/yr.

Chapter 4 - Sustainable Management Criteria

SGMA defines sustainable groundwater management as the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results. The avoidance of undesirable results is important to the success of the GSP. Several requirements from GSP regulations have been grouped together under the heading of Sustainable Management Criteria, including a Sustainability Goal, Undesirable Results, Minimum Thresholds, and Measurable Objectives for various indicators of groundwater conditions. Development of these Sustainable Management Criteria is dependent on basin information developed and presented in the hydrogeologic conceptual model, groundwater conditions, and water budget chapters of the MAGSA plan (DWR, 2017).

Indicators for the sustainable management of groundwater were determined by SGMA based on those items that are most important to the health and general well-being of the public. There are six indicators that must be monitored throughout the planning and implementation period of the GSP and identified in **Table ES-5**. This chapter will describe the indicators and why they are significant and will define the management thresholds.

Table ES-5 Monitoring Requirements



The sustainability goal of the Kings Subbasin and this GSA is "to ensure that, by no later than 2040, the basin is being operated to maintain a reliable water supply for current and future beneficial uses without experiencing undesirable results." This goal will be met by balancing water demand with available water supply to stabilize declining groundwater levels without significantly and unreasonably impacting water quality, land subsidence or interconnected surface water. The goal of the Kings Subbasin is to correct and end the long-term trend of a declining water table understanding that water levels will fluctuate based on the season, hydrologic cycle and changing groundwater demands within the basin and its proximity.

The conditions with the basin and this GSA will be considered sustainable when:

- The basin is managed within its sustainable yield.
- The current rate of decline of the groundwater table within the basin monitoring network indicator wells has been corrected and the multi-year trend of water elevations in these wells has been stabilized.
- Groundwater levels are maintained at a level that prevents Undesirable Results for the applicable sustainability indicators.

The seven GSAs within the Kings Subbasin have been coordinating within the basin for several years on how to reach and maintain sustainability within the Subbasin. As described in the Section 3 - Basin Setting, the Kings Basin includes significant and varied geologic conditions, water supply and land use that lead to differing conditions and obligations within each GSA. The basin setting describes the trend of declining groundwater levels within the basin and the GSAs. The degree of decline varies by location due primarily to type of land use and availability of surface water supplies. The Basin setting information, including historic groundwater conditions, surface supply, groundwater flows, land use and other information were used to establish the water budget, initial estimates of overdraft within each GSA and sustainable yield. The coordination effort among the GSAs has resulted in agreed upon estimated initial overdraft quantity reductions for each GSA to correct in order to reach interim milestones and sustainability in 2040. These quantities and each GSA's respective obligation will continue to be monitored and evaluated as additional information is gathered.

Each GSA in the Kings Subbasin is responsible for implementing projects and management actions intended to enhance its ability to reach sustainability and meet its initial mitigation requirements for overdraft. Examples of the types of measures that may be implemented to ensure the basin will be operated within the sustainable yield are identified in detail in Chapter 6 – Projects and Management Actions to Achieve Sustainability of the GSP for each GSA in the basin. Collectively, these projects and programs have been identified to ensure the basin reaches sustainability by 2040. The projects and programs include technical data and estimates of project benefit, and the sum of these benefits within the basin meet is believed to support the initial estimates for successfully achieving sustainability within the basin.

The Subbasin GSAs have agreed to a phased approach of increasing mitigation to achieve sustainability. Each of four (4) phases has set incremental targets and time periods for correcting the overdraft of 10% by 2025, 30% by 2030, 60% by 2035 and 100% by 2040 respectively. Each GSA in the Basin is planning to implement projects and management actions in accordance with the agreed mitigation targets. The GSAs will continue to confer regularly to review data to ensure all GSAs are meeting their milestones and progress is being made toward overall basin sustainability, in accordance with the Coordination Agreement.

Water Level

The GSAs within the Kings Basin have defined the Undesirable Result for groundwater levels as a result that would cause significant and undesirable reduction in the long-term viability of domestic, agricultural, municipal or environmental uses over the planning and implementation period of this GSP. Groundwater levels will continue to decline until the basin can reach sustainability. **Appendix 4-A** includes well hydrographs and the planned incremental overdraft mitigation to reach the Measurable Objective and sustainability in 2040. The Measurable Objective is the elevation at an Indicator Well that will be stabilized and maintained over time. This is the elevation at each Indicator Well that the GSAs will be managing the basin to maintain. A Minimum Threshold is the groundwater elevation at an Indicator Well that when exceeded in combination with minimum thresholds at other Indicator Wells, may cause an undesirable result in the basin. The Minimum Threshold elevations have been set based on 5-year drought conditions. The GSAs in the basin acknowledge that some shallow wells will go dry, so the GSAs will develop a shallow well mitigation program to help address the impacts to wells that are shallower than the minimum thresholds within the basin. A more detailed description of the proposed shallow well mitigation program is included in Chapter 6.

Current and historical information on water level is discussed in Section 3.2.1 and the water level monitoring network is discussed in section 5.2. Section 4.2 will discuss the Undesirable Result, Minimum Threshold, and Measurable Objective set for water levels. A summary of the Minimum Threshold and Measurable Objective for water levels can be seen in **Table ES-6**. The values in the table are the water surface elevation (WSE) for the Interim Milestones, Measurable Objective, and Minimum Threshold. More details and the methodology to set the criteria can be found in Section 4.2.

Table ES-6 Groundwater Level Sustainable Management Criteria

Monitor Well ID	Interim Milestones (WSE)				Measurable Objective	Minimum Threshold (WSE)
	2020	2025	2030	2035	2040 (WSE)	
13-1	54.1	44.2	35.9	30.4	28.6	-40.5
13-2	107.1	100.7	95.4	91.8	90.7	42.6
13-3	110.4	101.8	94.7	89.9	88.4	12.7
14-1	80.3	74.2	69.7	65.7	64.6	44.9
14-2	27.3	18.8	11.8	7.1	5.6	-53.1
14-3	62.4	56.3	51.2	47.8	46.7	24.1
14-4	81	69.5	59.9	53.5	51.5	14.7
14-5	19.2	13.7	9.1	6.1	5.1	-12.4
14-6	46.1	37.7	30.8	26.2	24.8	-23.2
15-1	11.2	3.2	-3.5	-7.9	-9.3	-34.9
15-10	33.9	26.2	19.9	15.7	14.4	-9.9
15-2	-15.7	-27.1	-36.5	-42.8	-44.8	-81.1
15-3	79.4	74.1	69.8	66.9	66	21.1
15-4	88.2	83.3	79.3	76.5	75.7	43.2
15-5	-37.7	-44.4	-50	-53.7	-54.9	-135.7
15-6	-30.4	-41.1	-50	-55.9	-57.7	-91.9
15-7	74.5	68.9	64.2	61	60	28.4
15-8	-29.4	-43.5	-55.2	-63	-65.4	-110.4
15-9	-51.4	-63.9	-74.2	-81	-83.2	-122.8
16-1	-26.8	-39.1	-49.2	-56	-58.1	-97.3
16-2	-50.8	-70.3	-86.6	-97.4	-100.8	-163.3
16-3	-16.5	-25.6	-33.1	-38.1	-39.7	-80
16-4	39.4	27.5	17.5	10.9	8.8	-29.5

Storage Change

Current and historical information on storage change is discussed in Section 3.2.3 and the storage change monitoring network is discussed in section 5.3. Section 4.3 will discuss the Undesirable Result, Minimum Threshold, and Measurable Objective set for storage change.

As part of the coordination of GSAs within the Kings Subbasin, a common method was utilized to estimate the change in groundwater storage for the entire subbasin and within each GSA during the hydrologic average base period, which was identified as the 15-year period from October 1996 to September 2011 based on Kings River surface water diversion into the area. The calculation estimated storage change within the upper unconfined groundwater for the Kings Subbasin to be approximately -1.8 million acre-feet (MAF) during the hydrologic average base period from spring 1997 to spring 2012, or an average of about -122,000 AF/yr. Estimated storage change in the lower confined aquifer is not possible at this time due to limited or no data from confined wells in the area.

An undesirable result would occur if the change in the total amount of groundwater in storage resulted in an amount less than the estimated amount of total groundwater in storage above the Groundwater Level Minimum Thresholds for all GSAs.

Water Quality

Current and historical information on water quality is discussed in Section 3.2.5 and the water quality monitoring network is discussed in section 5.5. Section 4.5 will discuss the Undesirable Result, Minimum Threshold, and Measurable Objective set for water quality. A summary of the Minimum Threshold for water quality can be seen in **Table ES-7**. The criteria to define minimum thresholds will be based around the maximum contaminant level (MCL) values of the chemicals of concern discussed in the Groundwater Conditions chapter, **Section 3.2.5** of this GSP. More details and the methodology to set the criteria can be found in Section 4.5.

Table ES-7 Chemicals of Concern and California MCLs

Chemical of Concern	California Primary MCL (mg/L unless otherwise shown)
Arsenic	0.01
Chloride	500**
Manganese	0.5*
Sodium	50.000
Uranium	20 (pCi/L)
Nitrate as NO3	45
Dibromo-Chloropropane (DBCP)	0.0002
1,2,3-Trichloropropane (TCP)	$5x10^{-6}$
Total Dissolved Solids (TDS)	1,000**

*=Notification Level, No MCL
**=Upper Secondary MCL

Undesirable results determinations will be based on the aggregated effect of: 1) the degradation of water quality to excess of MCLs (i.e. California potable water standards) where concentrations of chemicals of concern were historically below MCLs; and 2) for wells that have had recent historic concentrations of Chemicals of Concern above MCLs, the degradation of water quality to a level in excess of 20% greater than the recent historically high concentration of the Chemical of Concern in the well. The occurrence of an undesirable result will be defined as 15% of the monitoring indicator wells having reached either of these two criteria for two consecutive samples when shown to be altered by groundwater pumping or recharge activities.

Land Subsidence

According to the United States Geological Survey (USGS), land subsidence is a gradual settling or sudden sinking of the Earth's surface owing to subsurface movement of earth materials. The main form of subsidence in the MAGSA area is deep subsidence from declining confined aquifer groundwater levels. Current and historical information on land subsidence is discussed in Section 3.2.6 and the land subsidence monitoring network is discussed in section 5.6. Section 4.6 will discuss the Undesirable Result, Minimum Threshold, and Measurable Objective set for land subsidence.

The undesirable result for land subsidence as that which causes significant and unreasonable interference with surface land uses. The primary concern related to interference with surface land uses in the Kings Basin is subsidence reducing the capacity of gravity flow water conveyance facilities such as canals or river channels, thereby restricting or preventing delivery of irrigation water to agricultural land or conveyance of flood water. The GSAs within the basin have defined the Undesirable Result of land subsidence as significant and unreasonable if loss of conveyance capacity of the river channels or existing irrigation canals has occurred as a result of land subsidence.

The sustainability goal for the basin with 20 years of Plan implementation is to eliminate land subsidence that is caused by actions within the GSA's control. The measurable objective for annual land subsidence will be 1 inch/year, to allow for the error of the Interferometric Synthetic Aperture Radar (InSAR) data. A cumulative subsidence amount of 3 feet was identified as the minimum threshold, however to address subsidence before reaching the minimum threshold, subsidence of one foot within a 36 square mile area in the GSA would trigger management actions.

Surface Water Groundwater Interconnection

The San Joaquin River is the only surface water body of significance within the MAGSA. Information to evaluate the presence of interconnected surface water systems in the MAGSA in a few locations along the San Joaquin River is available through the USBR's San Joaquin River Restoration Project (SJRRP), a USGS groundwater flow model documentation report (USGS SIR 2014-5148, 2014), and Friant Water Users Authority and Natural Resources Defense Council (FWUA and NRDC, 2002). Based on the model reports and regional studies, it appears that there may be intermittent seasonal connections between surface water and groundwater in at least a limited number of locations along the San Joaquin River in the MAGSA. The San Joaquin River Restoration Program could mitigate for any surface water depletion from well pumping. Nevertheless, more information is needed to fully understand the interconnection between surface water and groundwater in MAGSA. As a result, a detailed data gap study will be performed to identify interconnected sections, evaluate if wells are impacting surface water, and whether those impacts require development of sustainable management criteria. In the interim, groundwater levels near the river system will be used as a proxy for surface water depletion from rivers. This method will use the Measurable Objectives (MO) and Minimum Thresholds (MT) of representative wells, located within 2 miles of the Kings River and San Joaquin River, as proxies for surface water depletion. This is an interim measure that will be updated once the data gap study is completed in 2025.

Chapter 5 - Monitoring Network

This chapter describes the monitoring network being developed by the MAGSA that will be utilized to collect critical data to determine short-term, seasonal, and long-term trends in groundwater and related surface conditions. This data will yield vital information necessary to support: 1) implementation of this Plan, 2) evaluation of the effectiveness of this Plan, and 3) informed decision making by the MAGSA management. The chapter describes current and future monitoring programs. The data from historical monitoring efforts can be found in Section 3.2 – Current and Historical Groundwater Conditions. The Monitoring Network chapter describes the current and proposed monitoring programs, identifies data gaps, and describes the plans to fill data gaps for each sustainability indicator.

Water Level

The majority of MAGSA members are agricultural producers and/or landowners. In general, groundwater levels in these members' wells have not been measured on a regular basis. A small number of private wells have been monitored consistently and have detailed temporal groundwater elevation data; however, most landowners have not performed measurements at all or, at best, they have monitored wells on a sporadic "as needed" basis, and the timing of fall and spring measurements has not been consistent. In the future, the agency will monitor groundwater levels every March and October to provide consistency in the measurements. The water level monitoring network is shown in **Figure ES-5**

Storage Change

Groundwater storage capacity will be calculated using local groundwater levels and specific yield values. This methodology has proven to be adequate in estimating annual change in groundwater storage in other regions of the Kings Subbasin. Specific yield values for various depths have been determined through an extensive literature search. Groundwater storage calculations are largely dependent on the groundwater level monitoring network, which is being expanded for SGMA. Collection of well attribute information described above will also benefit groundwater storage monitoring.

Water Quality

Groundwater quality in the MAGSA is generally well suited for irrigation and domestic use, although groundwater issues for drinking water may exist in localized areas within the GSA. While some of these chemical concerns are caused by humans, others are naturally occurring. Groundwater pollution characterization and mitigation are typically enforced by other local agencies and state level programs.

The GSA will review and analyze publicly available routine groundwater monitoring data reported by the community and non-community public supply wells and data from the Groundwater Ambient Monitoring and Assessment Program (GAMA) monitoring wells around the American Avenue Landfill in order to understand how and if groundwater pumping is exacerbating groundwater quality concerns and where to enforce pumping restrictions or other mitigation measures should it become necessary.

Groundwater quality concerns within the MAGSA have been identified in this GSP's Groundwater Conditions Chapter (**Section 3.2**). Groundwater monitoring and reporting by community water systems and non-community public supply wells is a requirement of California Code of Regulations (CCR) Title 22. Community and other public supply wells within the MAGSA monitoring network area already being routinely monitored for a wide range of contaminants, including the chemicals of concern, by the water purveyors under Title 22. The publicly available groundwater quality data reported by GAMA from selected wells (public supply wells and monitoring wells associated with the American Avenue Landfill) will be obtained annually and evaluated against sustainable management criteria.

Selected public supply wells and American Avenue Landfill monitoring wells, will form the basis of the monitoring wells for groundwater quality are shown on **Figure ES-6**. The groundwater quality monitoring network will be evaluated and revised if needed in subsequent GSP 5-year revisions.

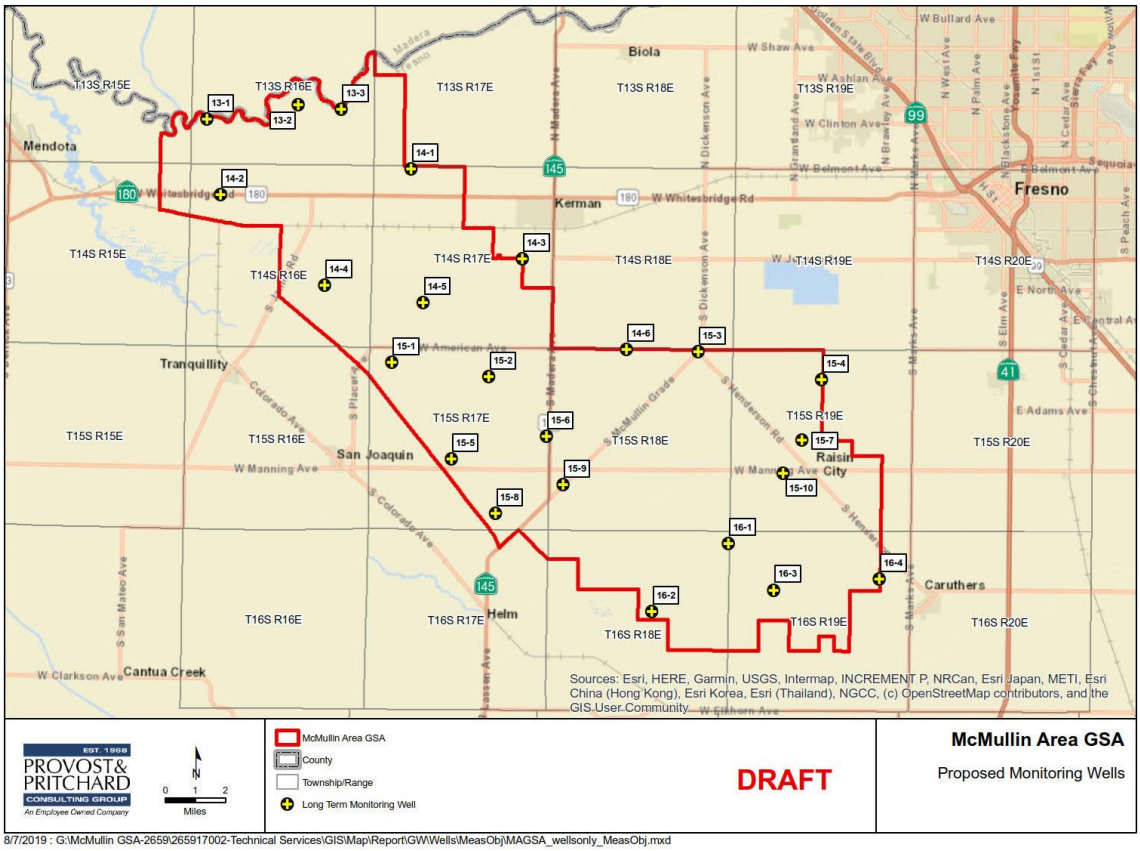


Figure ES-5 Water Level Monitoring Network

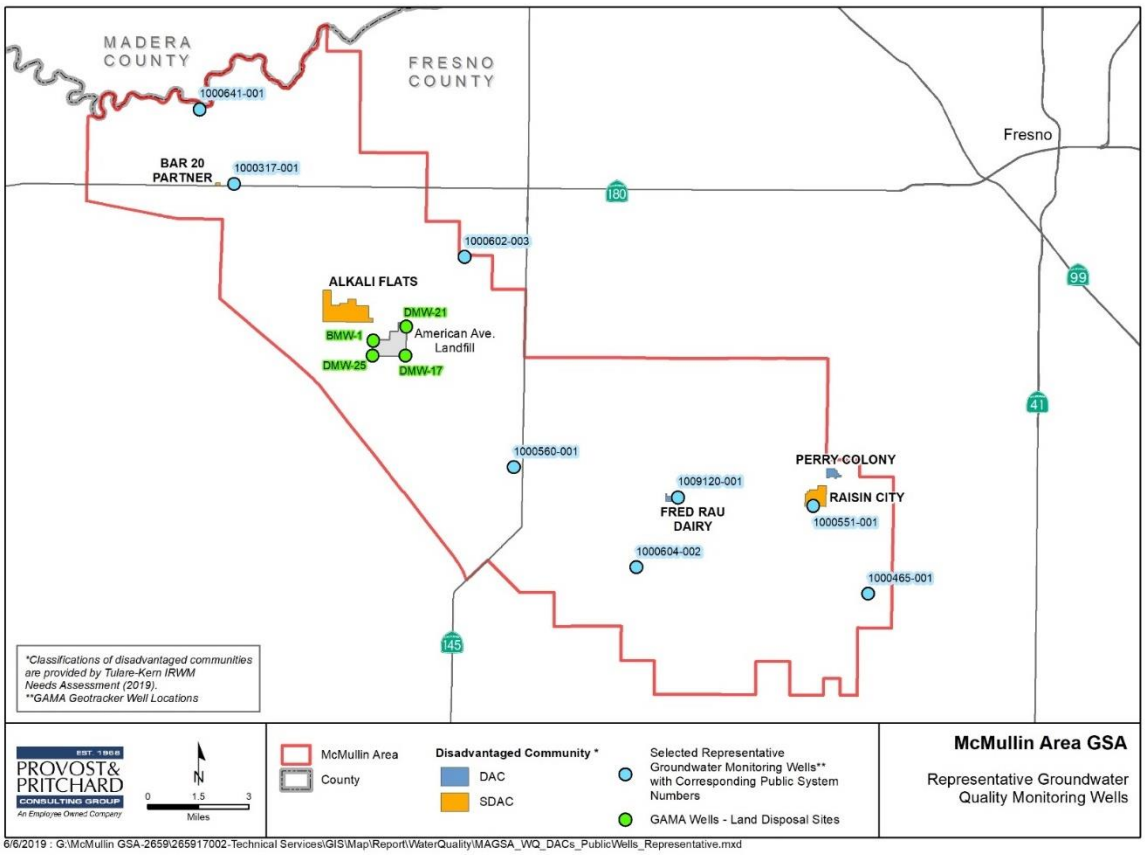


Figure ES-6 Water Quality Monitoring Network

Land Subsidence

While some local agencies in the San Joaquin Valley monitor for land subsidence, the majority rely on monitoring performed by regional water agencies or the State and Federal government. Measurement and monitoring for land subsidence are performed by a variety of agencies including USGS, USBR, the United States Army Corps of Engineers (USACE), University NAVSTAR (Navigation Satellite Timing and Ranging) Consortium (UNAVCO), and various private contractors. Interagency efforts between the USGS, USBR, the U.S. Coast and Geodetic Survey (now the National Geodetic Survey), and DWR resulted in an intensive series of investigations that identified and characterized subsidence in the San Joaquin Valley. NASA also measures subsidence in the Central Valley and has maps on their websites that show the subsidence for a defined period (https://earthobservatory.nasa.gov/IOTD/view.php?id=89761&eocn=image&eoci=related_image). The MAGSA monitoring network will utilize land subsidence data collected by MAGSA **Table ES-7**, and use the NASA InSAR data, **Figure ES-8,** to verify the areas of subsidence.

Surface Water Groundwater Interconnections

There is a current monitoring network established by the SJRRP that consistently collects groundwater elevation data along the San Joaquin River (SJR) on an annual basis. This data is collected in a joint effort between the SJRRP and the USBR. The USBR monitoring wells are located along the SJR and can be seen in **Figure ES 9.** Regional groundwater data provided by the USBR and the SJRRP as well as the USGS Flow Model (USGS SIR 2014-5148, 2014) indicate that at various times of the calendar year, the incessant flow of the SJR has run dry below Gravelly Ford. Additionally, in 2006 a considerably wet year, the USGS Scientific Investigations Report (SIR) indicated that the estimated depth to water table along the portion of the San Joaquin River adjacent to MAGSA was approximately 20 feet. This, therefore, identifies that the groundwater and surface water systems are not continuously interconnected. MAGSA will continue to monitor the annual data collected from the USBR and will discuss any changes to the monitoring network if necessary due to new reports or findings from the future USGS flow models.

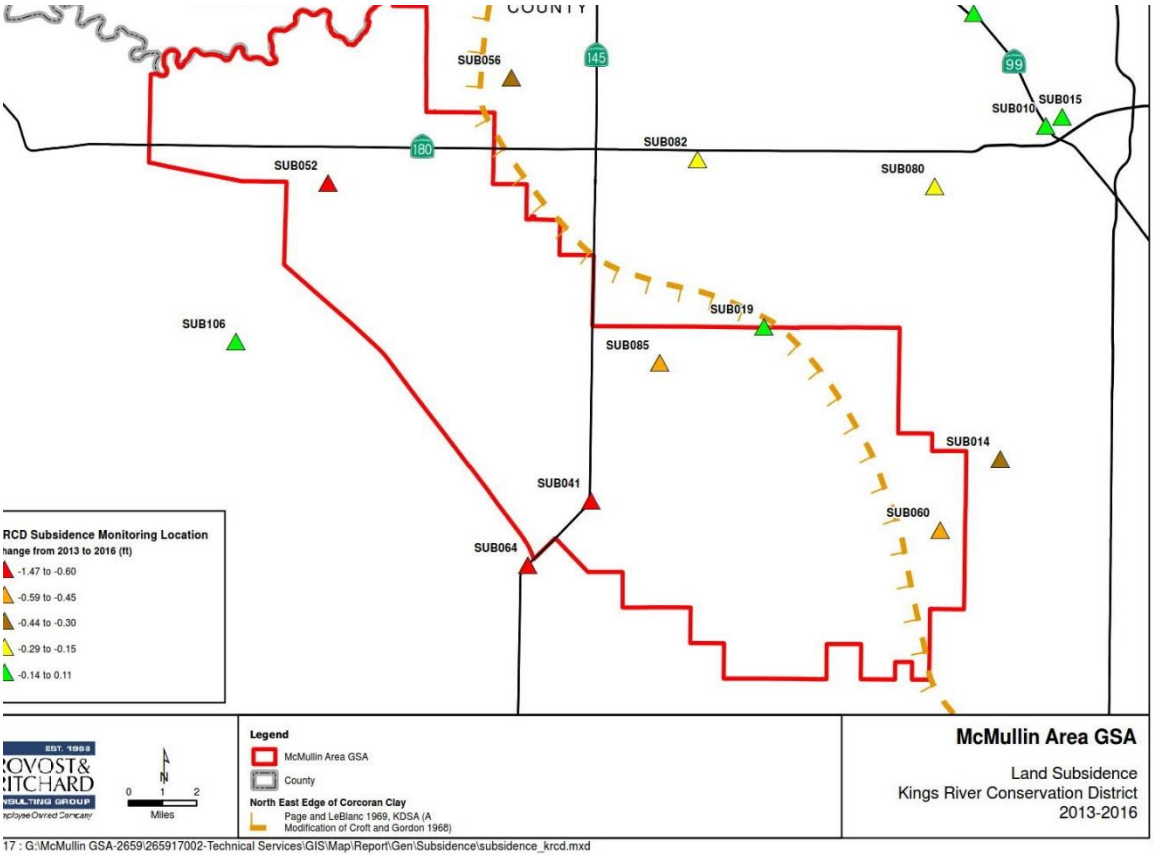


Figure ES-7 KRCD Land Subsidence Monitoring Locations Map

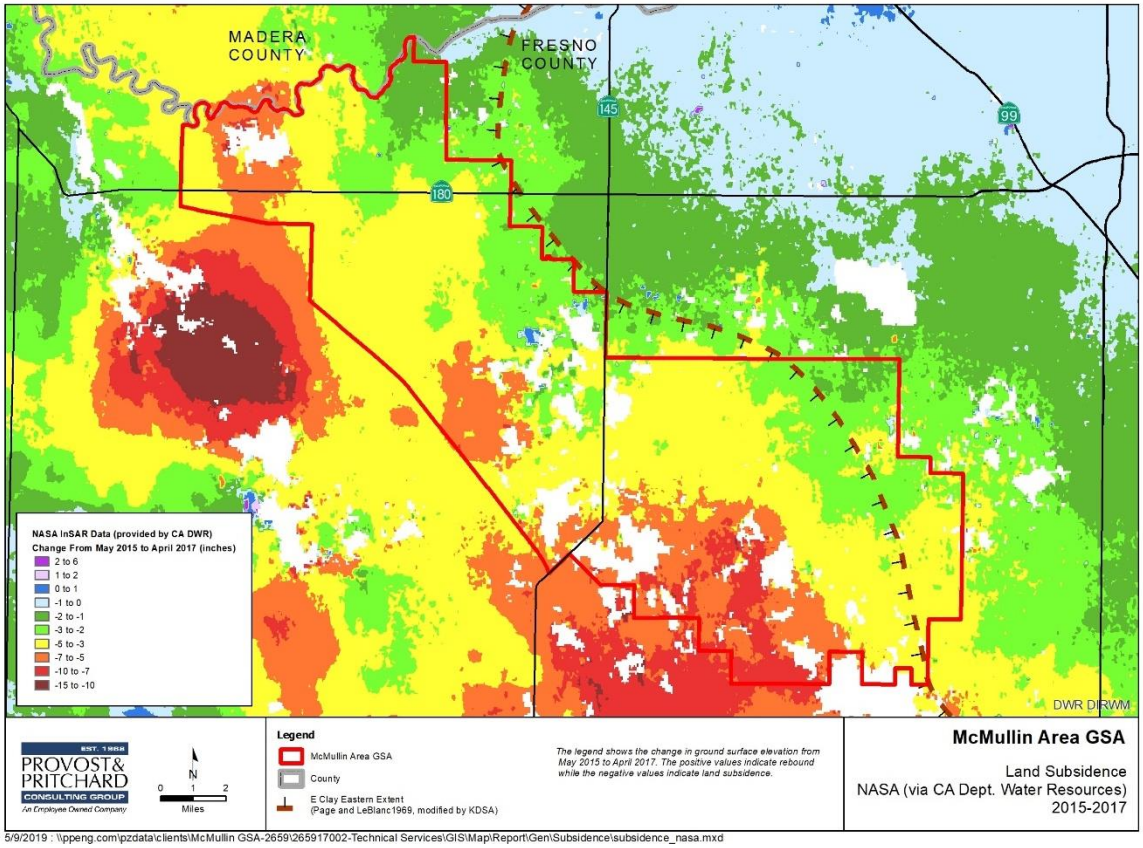


Figure ES-8 NASA Land Subsidence Monitoring Map

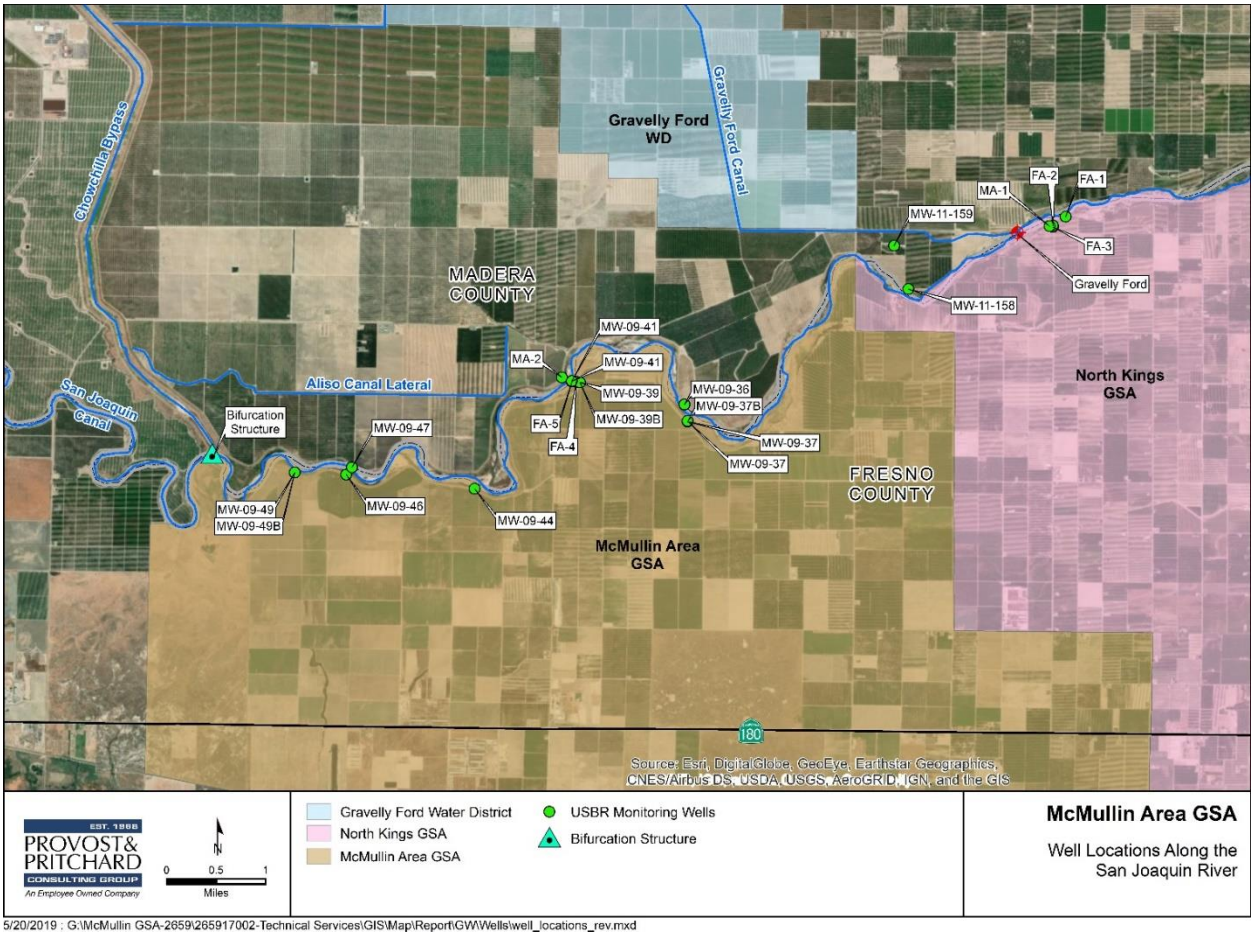


Figure ES 9 USBR San Joaquin River Restoration Project Monitoring Wells

Chapter 6 - Projects and Management Actions

Projects

Each of the following projects are in various stages of development, ranging from conceptual, to projects that have been constructed. Thus, each of the following projects have had a different level of investigation that has been completed, from projects with limited information, to a feasibility level, to field surveys for a channel capacity study, or recently constructed. The agency will maintain a list of proposed projects and their characteristics, along with their development status, and will use this list to prioritize and secure funding as opportunities may become available. Projects discussed in this Plan will remain a part of the potential projects that the GSA may choose to implement; however, other projects may come up with higher yield or lower cost and will be considered. The projects that are currently being considered are shown on **Figure ES-10** and **Figure ES-11.** They have been prioritized based on a cost-benefit matrix and are listed in order as follows:

1. Fresno City Wastewater Treatment Plant Recharge Basin, Fresno Irrigation District (FID) Houghton Canal System
2. Fresno City Wastewater Treatment Plant Recharge Basin, FID Lower Dry Creek System
3. Southwest Groundwater Banking
4. Lassen Avenue Reverse Flow & Recharge
5. MAGSA Groundwater Banking Program
6. McMullin On-Farm Flood Capture, Phase 2 Expansion
7. Houghton Wasteway Expansion
8. South Sandridge Canal Water Supply & Recharge
9. Stinson North Canal Water Supply & Recharge
10. Grantland Area Recharge
11. Consolidated Irrigation District (ID) Wristen Ditch Intertie
12. Upgradient Recharge Programs
13. Land Subsidence Data Gap Analysis
14. Surface Water- Groundwater Interconnection Data Gap Analysis
15. Domestic Well Mitigation Program

The process being used for project implementation has generally been as follows:

1. Identify potential projects
2. Prepare conceptual level feasibility study and cost estimate
3. Prioritize potential projects
4. Obtain agreement with project partner(s)
5. Secure funding
6. Prepare environmental documents and obtain permit and regulatory approvals
7. Design and prepare construction documents
8. Implement project construction
9. Operate and maintain the project for sustainability

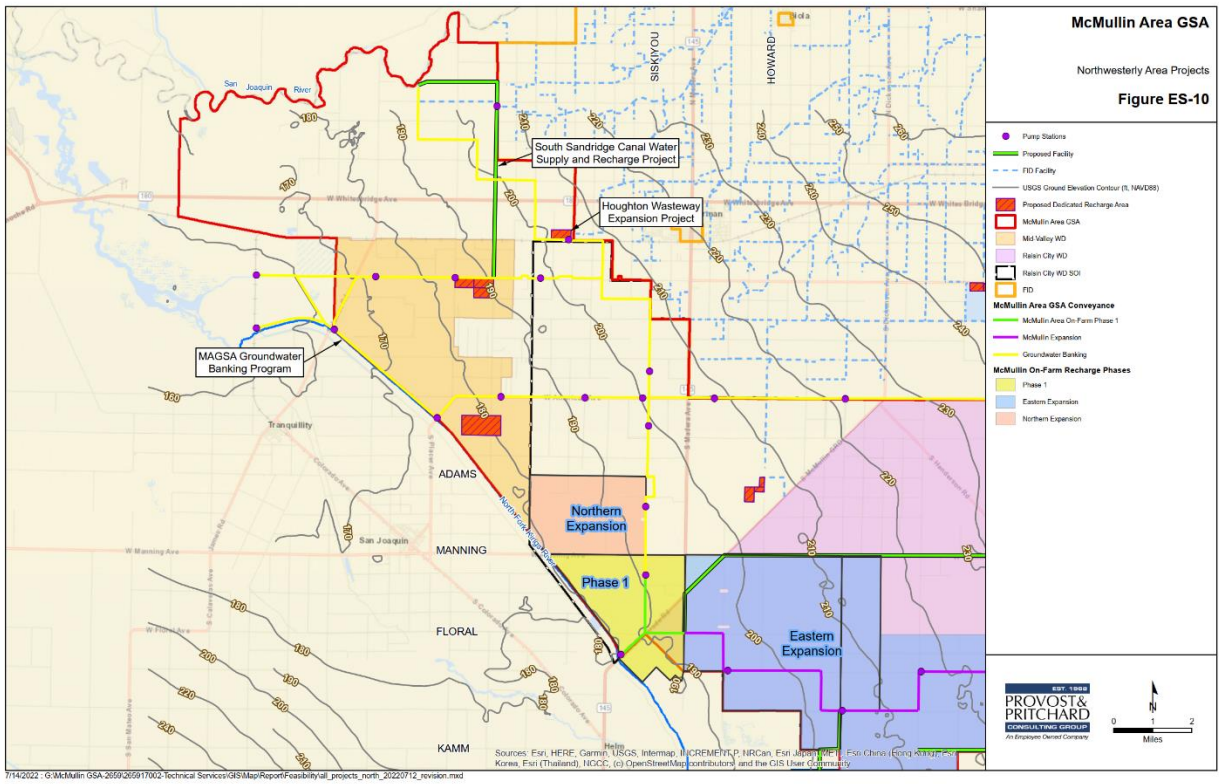


Figure ES-10 MAGSA Projects for Groundwater Sustainability (Northwesterly Area)

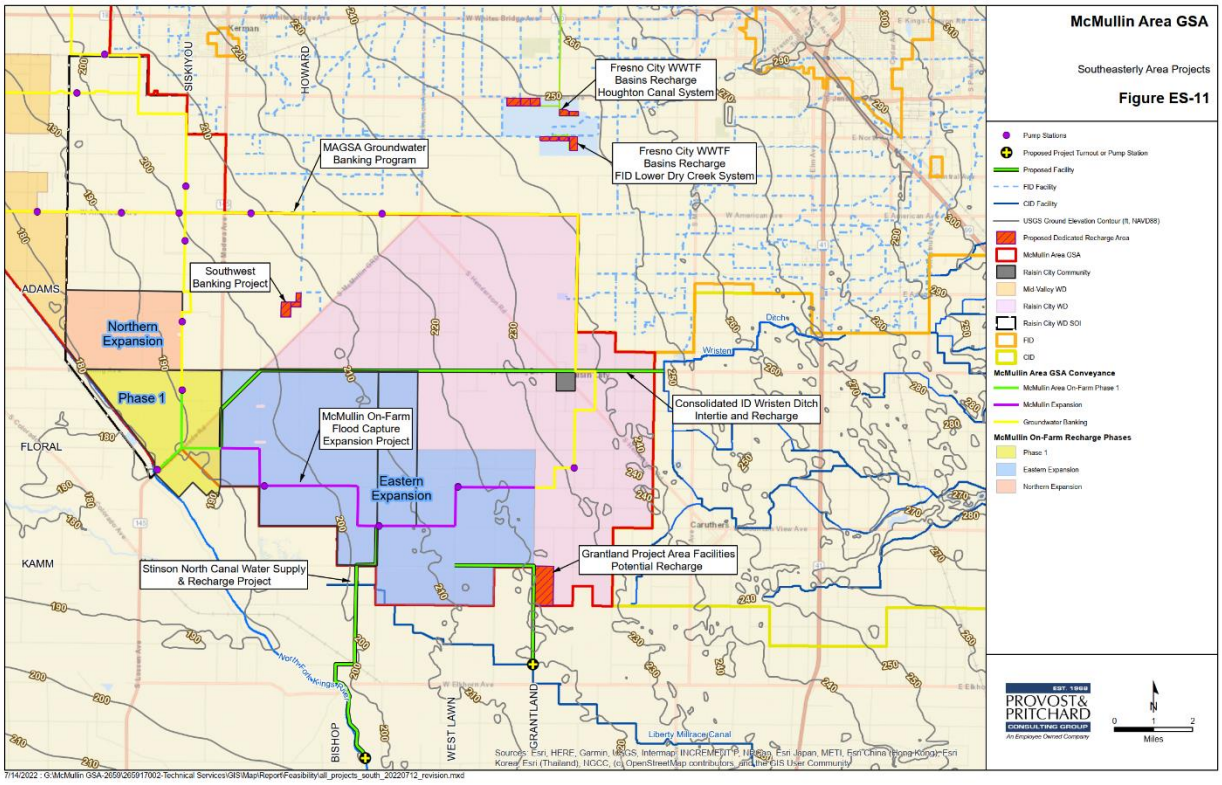


Figure ES-11 MAGSA Projects for Groundwater Sustainability (Southeasterly Area)

For each project, the conceptual costs were annualized over a 30-year period assuming a 5% interest rate to estimate an annual repayment cost. The portion of the water cost due to capital expenditures, on an average annual basis was calculated, all of which is summarized together in one location for all the projects investigated in **Table ES-8**. The two data gap analysis projects and the domestic well mitigation projects are not discussed below since they do not provide a new water yield and are not comparable.

Table ES-8 Project Cost & Yield Summary

Rank	Projects	Capital Cost	Annual Capital Payment	Average Annual Yield (AF)	Annualized Cost Per AF
1	Fresno City Wastewater Treatment Plant Recharge Basins, FID Houghton Canal System	$3,537,000	$230,000	6,745	$41
2	Fresno City Wastewater Treatment Plant Recharge Basins, Lower Dry Creek System	$2,223,000	$145,000	4,385	$41
3	Southwest Groundwater Banking	$6,221,000	$405,000	2,625	$154
4	Lassen Avenue Reverse Flow & Recharge	$3,263,000	$212,000	3,000	$71
5	MAGSA Groundwater Banking Program	$777,156,000	$50,555,000	208,000	$2,454.13
6	McMullin On-Farm Flood Capture, Phase 2 Expansion	$61,911,000	$4,027,000	27,120	$148.49
7	Houghton Wasteway Expansion	$4,922,000	$320,000	2,190	$146
8	South Sandridge Canal Water Supply & Recharge	$8,736,000	$568,000	4,800	$119
9	Stinson North Canal Water Supply & Recharge	$61,114,000	$3,976,000	39,670	$100
10	Grantland Area Recharge	$22,043,000	$1,434,000	7,920	$181
11	CID Wristen Ditch Intertie	$13,420,000	$873,000	3,175	$275
12	Upgradient Recharge Program	$42,464,000	$2,762,000	15,360	$180

Notes:
1. Assumes 5% interest rate loan annualized over a 30-year period.
2. No operations or maintenance costs are included, except on City of Fresno projects.
3. Water purchase costs will be an additional cost.

The costs and yields are based on very broad assumptions and include a thirty percent contingency. Actual water costs will be greater than estimated as none of the project include the actual water supply purchase cost which is yet to be negotiated with the organization with the water supply. Also, if the water is recharged, there is still the cost to recover the supply as groundwater.

Management Actions

GSAs have a variety of tools which can be used to achieve sustainable groundwater management. The projects primarily focus on the capture, use, recharge, and increase of surface water supplies within the GSA and surrounding areas. Alternatively, there are other management actions which primarily focus on the reduction of groundwater demand. These could be accomplished through increasing data collection, education and outreach, regulatory policies, incentive-based programs, and enforcement actions.

Section 6.3 will discuss a suite of management action options the GSA may consider during the GSP implementation. The menu of management actions discussed may not be implemented in a strictly linear fashion, as numbered in the GSP, and specific actions may not be implemented if sustainability is achieved through projects or other actions. It is expected that the GSA will further develop and craft management actions in response to stakeholder input on parallel timelines and adapt to the estimated schedules according to the best available information and best available science at any given time in accordance with, *354,44(c).*

The GSA understands there are various levels of uncertainty with project and program implementation per, *344.44.(d).* It is not unusual for project and program implementation to take longer than originally estimated. In addition, the accrual of expected benefits may take multiple years to be individually realized and vary substantially year to year. Depending upon the success or failure of the initial GSP project and management action efforts to increase water supplies, reduce groundwater demands, and improve data collection, the various implementation timelines may fluctuate over time.

This chapter is not a comprehensive list of management actions and future additions and revisions may be enforced by the GSA as needed to achieve sustainability. The management action categories identified in this GSP include:

1. Education and Outreach
2. Well Head Requirements
3. Groundwater Allocation
4. Groundwater Marketing and Trading
5. Fees and Incentives
6. Groundwater Pumping Restrictions

It is the mission of this GSP to promote responsible water resource management, while effectively enforcing the policies and standards set in place by the McMullin Area Groundwater Sustainability Agency to conserve and protect the region's water resources for future generations to come.

Chapter 7 - Plan Implementation

The adoption of the GSP will be the official start of the Plan Implementation for MAGSA. The GSA will continue its efforts to engage the public and secure the necessary funding to successfully monitor and manage groundwater resources within the McMullin Area in a sustainable manner. While the GSP is being reviewed by DWR, the GSA will coordinate with various stakeholders and beneficial users to improve the monitoring network and begin the implementation of both projects and management actions.

The proposed estimated budgets and implementation timelines for the suggested projects and management actions of the MAGSA GSP can be found in Chapter 7. All the projects discussed have been evaluated as potential investments that would assist in achieving the long-term goals of the GSA. Of the projects, McMullin's On-Farm Flood Capture project has already begun construction. The potential schedules and budgets outlined in sections 7.1 and section 7.3, are purely estimates and may be adapted or eliminated should the GSA board deem it necessary.

1 Introduction

1.1 Purpose of Groundwater Sustainability Plan

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

SGMA requires governments and water agencies of high and medium priority basins to halt groundwater overdraft and bring groundwater basins into balanced levels of pumping and recharge. Under SGMA, these basins should reach sustainability within 20 years of implementing their sustainability plans. For critically over-drafted basins, including the Kings Subbasin, the deadline for achieving sustainability is 2040.

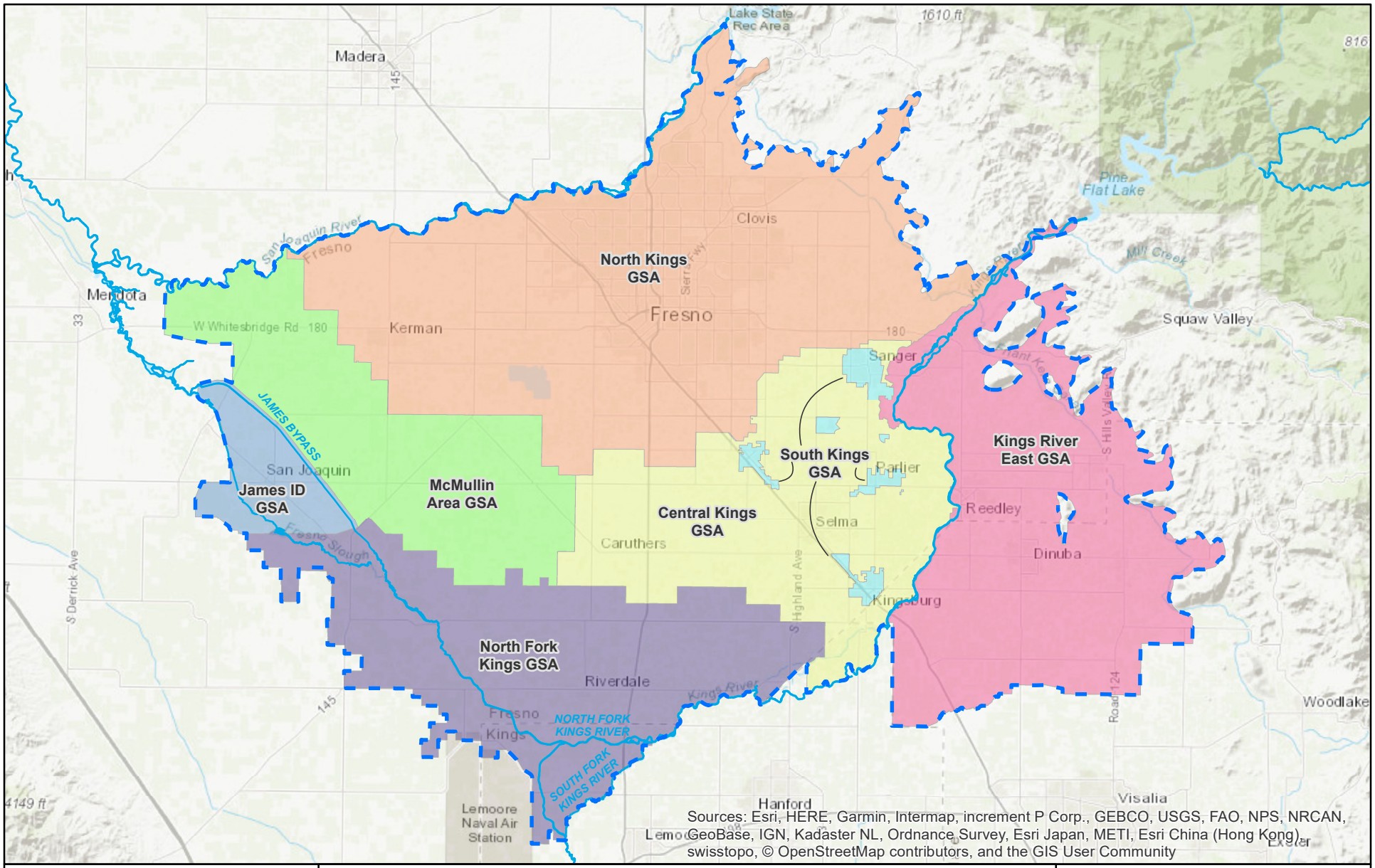
In his signing statement, Governor Brown emphasized that "groundwater management in California is best accomplished locally." The GSAs within the Kings Subbasin are working to achieve basin-wide sustainability through local efforts and cooperation.

1.2 Sustainability Goal

The sustainability goal of the Kings Basin and this GSA is to ensure that by 2040 the basin is being operated to maintain a reliable water supply for current and future beneficial uses without experiencing undesirable results. A more detailed description of the Sustainability Goal for the subbasin and Sustainable Management Criteria for the subbasin and this GSA, are included in **Chapter 4**

1.3 Coordination Agreements

The Kings Subbasin has seven GSAs, all of whom are preparing individual GSPs (see **Figure 1-1).** The seven GSAs have worked cooperatively since 2016 to coordinate the formation of the GSAs and developed other coordination elements of the GSPs. The GSAs have entered into a cooperative Memorandum of Understanding for development of the GSPs and grant funding. The GSAs also have developed a Coordination Agreement to facilitate future coordination efforts in accordance with section 357.4 of the Regulations. The formalized coordination agreement will help to ensure that: (a) the GSPs have been developed utilizing the similar data and methodologies; and (b) elements of the GSPs necessary to achieve the sustainability goal for the basin are based upon consistent interpretations of the basin setting. This approach has assured common assumptions and development of water budgets, monitoring network, sustainable management criteria, and data management system. **Appendix 2-C** includes a copy of the Kings Subbasin Coordination Agreement.



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Kings Subbasin (DWR, Modified 2018)

McMullin Area GSA

Groundwater Sustainability Agencies within Kings Subbasin

Figure 1-1

5/30/2019 : G:\McMullin GSA-2659\265917002-Technical Services\GIS\Map\Report\Gen\GSAs_within_KingsSB.mxd

1.4 Inter-basin Agreements

There are currently no agreements between the Kings Subbasin and its neighboring basins. Rather the GSAs that neighbor other subbasins have coordinated directly with those neighboring basins and GSAs. GSA discussions with neighboring agencies have been reported back to the other GSAs within the Kings Subbasin.

As shown in **Figure 2-1,** the MAGSA borders the Madera Subbasin and the Delta-Mendota Subbasin.

1.5 Agency Information

Legal Requirements:

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

McMullin Area Groundwater Sustainability Agency
275 S. Madera Avenue, Suite 301
Kerman, CA 93630
Attention: Matt Hurley

1.5.1 Organization and Management Structure of the GSA

Legal Requirements:

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

MAGSA was formed as a Joint Powers Authority that is comprised of the County of Fresno, the Raisin City Water District, and the Mid-Valley Water District. A copy of the Joint Powers Agreement is available on the GSA's website (https://www.mcmullinarea.org/). The County of Fresno has land use authority of the portion of the basin that MAGSA intends to manage. The Mid-Valley and Raisin City Water Districts are California Water Districts formed under the provisions of Water Code sections 34000-38500 with the ability to acquire, plan, construct, maintain, improve, operate and keep in repair the necessary works for production, storage, transmission, and distribution of water for irrigation, domestic, industrial, and municipal purposes.

To fulfill the mission of the GSA, the Board of Directors appoints standing committees and ad hoc committees as it deems necessary. The Board establishes the membership of all standing committees and invites the public and other interested parties to participate. The GSA has an ad hoc Technical Subcommittee that is tasked with development of the Groundwater Sustainability Plan. The Technical Subcommittee is comprised of a varied group of stakeholders including agency staff, private landowners, growers and community members. The GSA also has an ad hoc Outreach Subcommittee. The GSA has a General Manager responsible for day-to-day management authority.

Person with authority to implement Plan: Matt Hurley

Plan manager:
Matt Hurley
McMullin Area Groundwater Sustainability Agency
275 S. Madera Avenue, Suite 301
Kerman, CA 93630
mhurley@mcmullinarea.org
(559) 515-3339

1.5.2 Legal Authority of the GSA

Legal Requirements:

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

MAGSA is a Joint Powers Authority created by the McMullin Area Groundwater Sustainability Agency Joint Powers Agreement (JPA) comprised of the County of Fresno, the Raisin City Water District and the Mid-Valley Water District. The JPA gives MAGSA the authority to fulfill the role of GSA for the McMullin area and to develop, adopt and implement a GSP. Mid Valley Water District and Raisin City Water District are local public agencies. The Districts were organized on September 27, 1984 and May 21, 1962, respectively, under the California Water District Law, Section 34000 *et seq.* of the California Water Code (CWC) of the State of California. The three member agencies to the JPA do not have sufficient staff or resources to otherwise form a GSA independently from the MAGSA Joint Powers Authority, and have therefore agreed that the interests of the McMullin area are best served by having a single Joint Powers Authority dedicated to the management of groundwater resources.

The MAGSA Joint Powers Authority provided notice to DWR as required by Water Code section 10723.8, establishing MAGSA as the exclusive GSA pursuant to Water Code section 10723.8(c) for purposes of managing groundwater under Water Code sections 10720 *et seq.* (SGMA) for the portion of the Kings Subbasin that lies within the boundaries of the GSA, seen in **Figure 1-1 GSAs in the Basin**. The JPA, through reference to and incorporation of SGMA, empowers MAGSA to develop and implement a GSP to achieve sustainable groundwater management within its boundaries, in compliance with the mandates and timelines contained in SGMA.

Accordingly, through the SGMA notification process, MAGSA has been deemed the exclusive GSA within the designated territory empowered to sustainably manage the McMullin area of the Kings Subbasin in compliance with SGMA.

Estimated MAGSA Budget

On April 11, 2018, the MAGSA Board of Directors adopted a five-year budget and rate analysis, which set forth an assessment rate to fund the preparation and initial implementation costs for the MAGSA GSP. At that same meeting, the Board of Directors approved beginning the process to collect the fee in accordance with California Constitution Article XIII D, Section 6. On June 6, 2018, the Board of Directors conducted a public hearing and adopted the proposed fee. The proposed five-year budget table drafted to cover the implementation of SGMA, for the pre-GSP Proposition 218 Election can be found in **Section 7.1.**

The estimated administrative budget for MAGSA beginning in 2020 upon the implementation of the GSP is found in **Table 7-1**. These operational expenses are based off the Pre-GSP Proposition 218 Budget found in **Table 7-4**. The Board of Directors may adjust line items in the budget if deemed necessary to address MAGSA's ongoing operational expenses, as long as the adjusted budget does not require increasing the fee.

MAGSA has budgeted $1,255,800 annually to fund the implementation of SGMA, and to investigate projects. Project implementation is not included in the budget and will be dependent on Board approval, future benefit assessments and may reference the Project Ranking structure seen in **Section 7.1**. It is recognized that this approval assumes that no grants or other outside funding will be available and so results in the highest estimations. However, moving forward the GSA may look to explore the possibility of applying for and obtaining grants if deemed necessary.

The GSPs within the King Subbasin have agreed to utilize the same GSP outline structure and format, with only minor differences in some lower-level subheadings. This GSP is organized in a manner consistent with the GSP Emergency Regulations (i.e. California Code of Regulations section on Groundwater Sustainability Plans) in a format similar to that of the outline provided by DWR. Following is a brief summary of each GSP section. The complete checklist is included in **Appendix 1-B.**

- **Executive Summary** provides a summary of what will be included in the GSP.
- **Section 1 - Introduction** describes the Introduction, including the purpose of the GSP, sustainability goal, agency information, and GSP organization.
- **Section 2 - Plan Area** describes the geographic setting; existing water resources planning and programs; relationship of the GSP to other general plan documents within the Agency boundary and additional GSP components.
- **Section 3 – Basin Setting** includes a detailed discussion of the hydrogeologic conceptual model used to prepare the GSP, current and historical groundwater conditions, a discussion of the area groundwater budget, and a description of the special management areas created within the overall boundary.
- **Section 4 – Sustainable Management Criteria** sets forth the Agency's adopted sustainability goals, addresses the mandated Undesirable Results, defines Minimum Thresholds for each Undesirable Result and sets Measurable Objectives for both intermediate plan years (Interim Milestones) and for the Plan's complete implementation.
- **Section 5 – Monitoring Network** describes the network of monitoring wells and other facilities adopted by the Agency to measure Plan outcomes and assesses the need for improvements to the network in order to provide fully representative data. Monitoring protocols and data analysis techniques are also addressed.
- **Section 6 – Projects and Management Actions to Achieve Sustainability** lists and describes each project and management action that will be evaluated and may be adopted by the Agency in pursuit of sustainability. The section includes such project details as Measurable Objectives, required permits, anticipated benefits, project capital and operations/maintenance costs, project schedule, and required ongoing management operations, along with management actions that may be implemented.
- **Section 7 – Plan Implementation** describes the Plan implementation process, including estimated costs, sources of funding, an overall preliminary schedule through full implementation, description of the required data management system, methodology for annual reporting, and how progress evaluations will be made over time.
- **Section 8 – References and Technical Studies** summarizes the references and sources used to prepare and document this Plan.

2 Plan Area

Regulation Requirements:

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

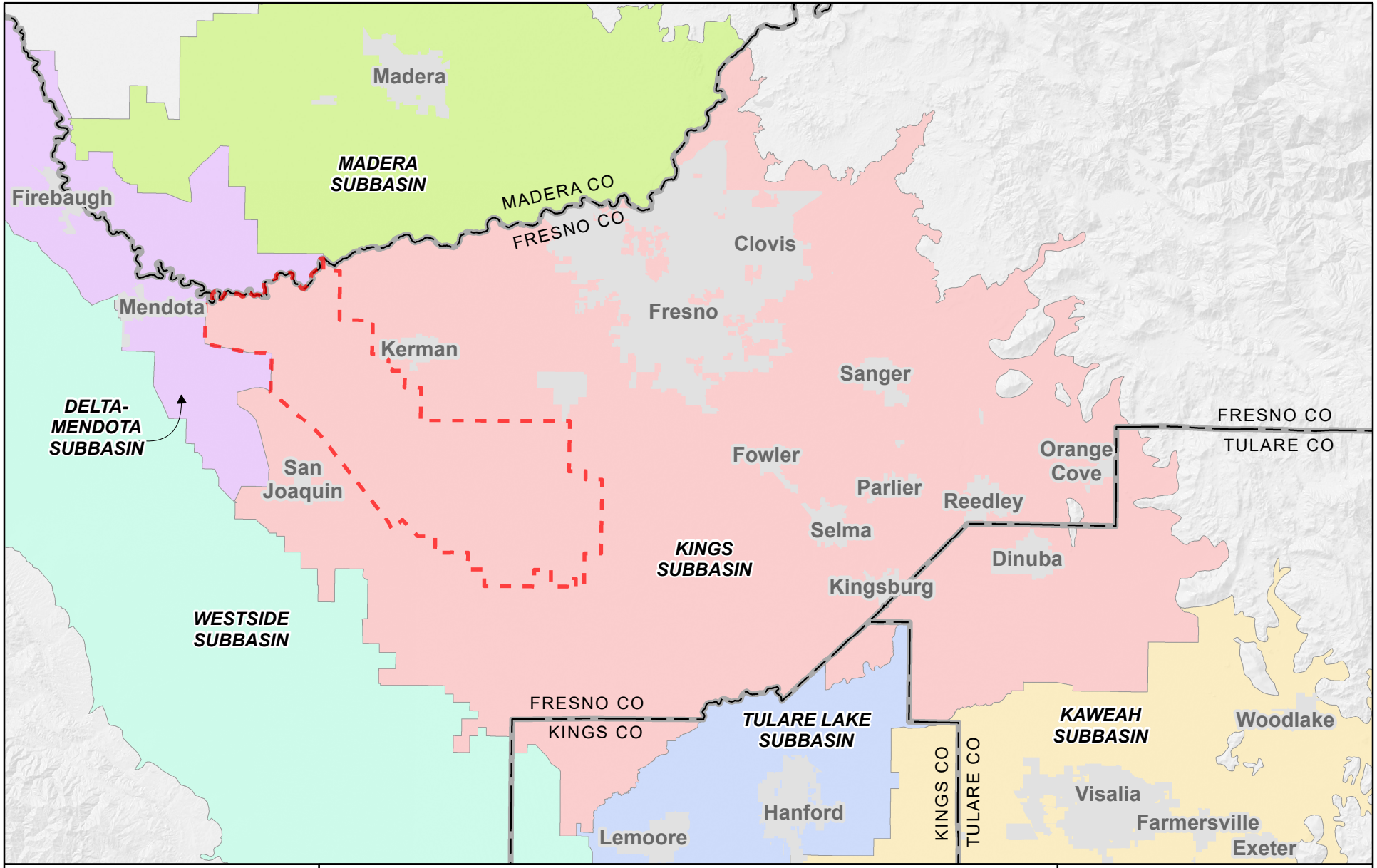
(a) One or more maps of the basin that depict the following, as applicable:

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

The Kings Subbasin is part of the San Joaquin Valley Groundwater Basin. It is bordered by five groundwater subbasins including the Madera, Kaweah, Tulare Lake, Westside, and Delta- Mendota Subbasins, shown in **Figure 2-1.** The San Joaquin and Kings Rivers are the two principal rivers within or bordering the subbasin. The Fresno Slough and James Bypass are along the western edge of the subbasin and connect the Kings River with the San Joaquin River.

MAGSA is one of seven GSAs within the Kings Subbasin, shown in **Figure 2-2**. There is no overlap among the GSAs and there are no adjudicated areas in the groundwater subbasin.

The only state lands within the MAGSA area are the ecological reserve properties acquired and managed by CDFW. There are no tribal or federal lands located within the Plan area. MVWD, RCWD, and Fresno County are the three local entities participating in the MAGSA GSP and are shown in **Figure 2-3**.



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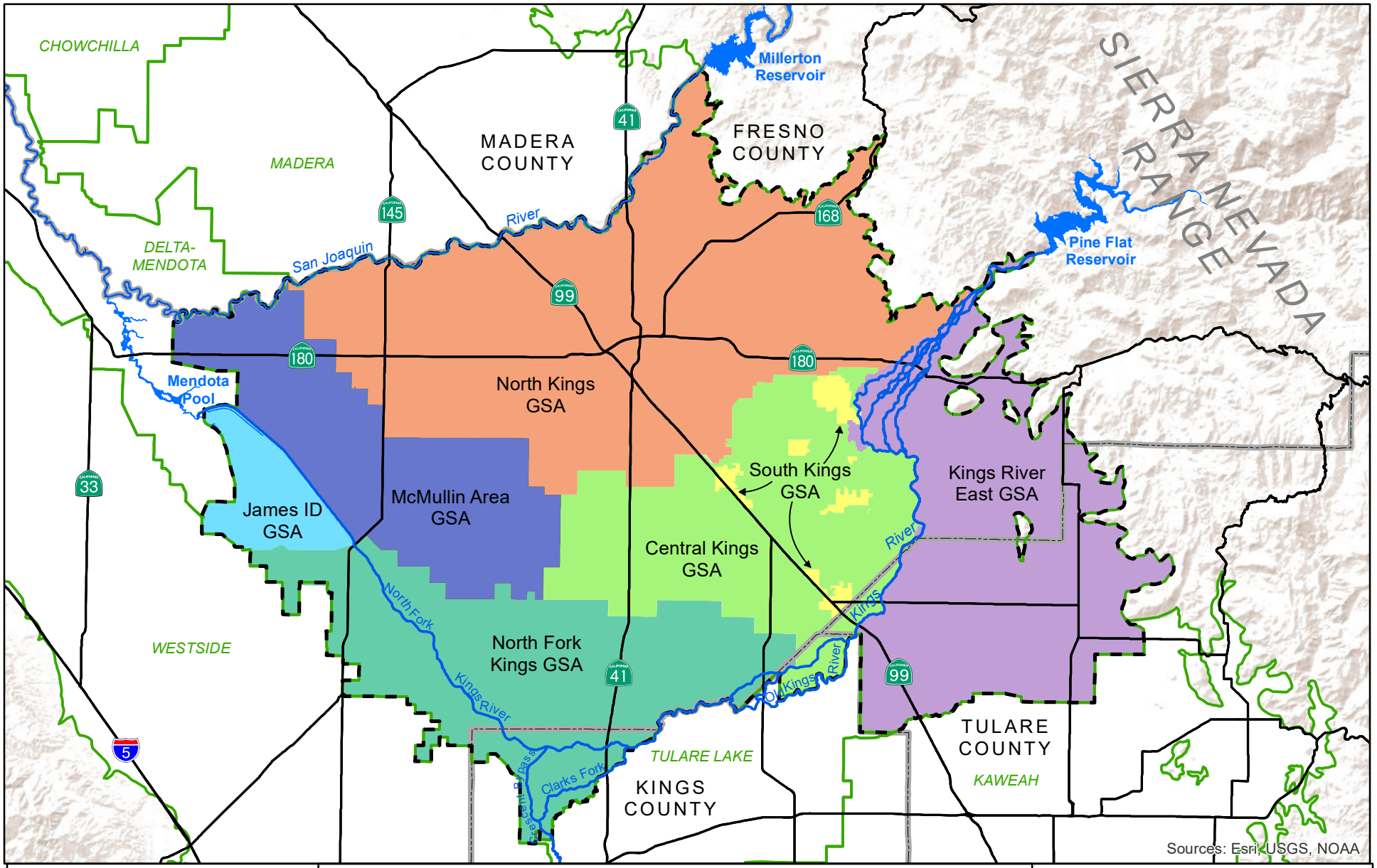

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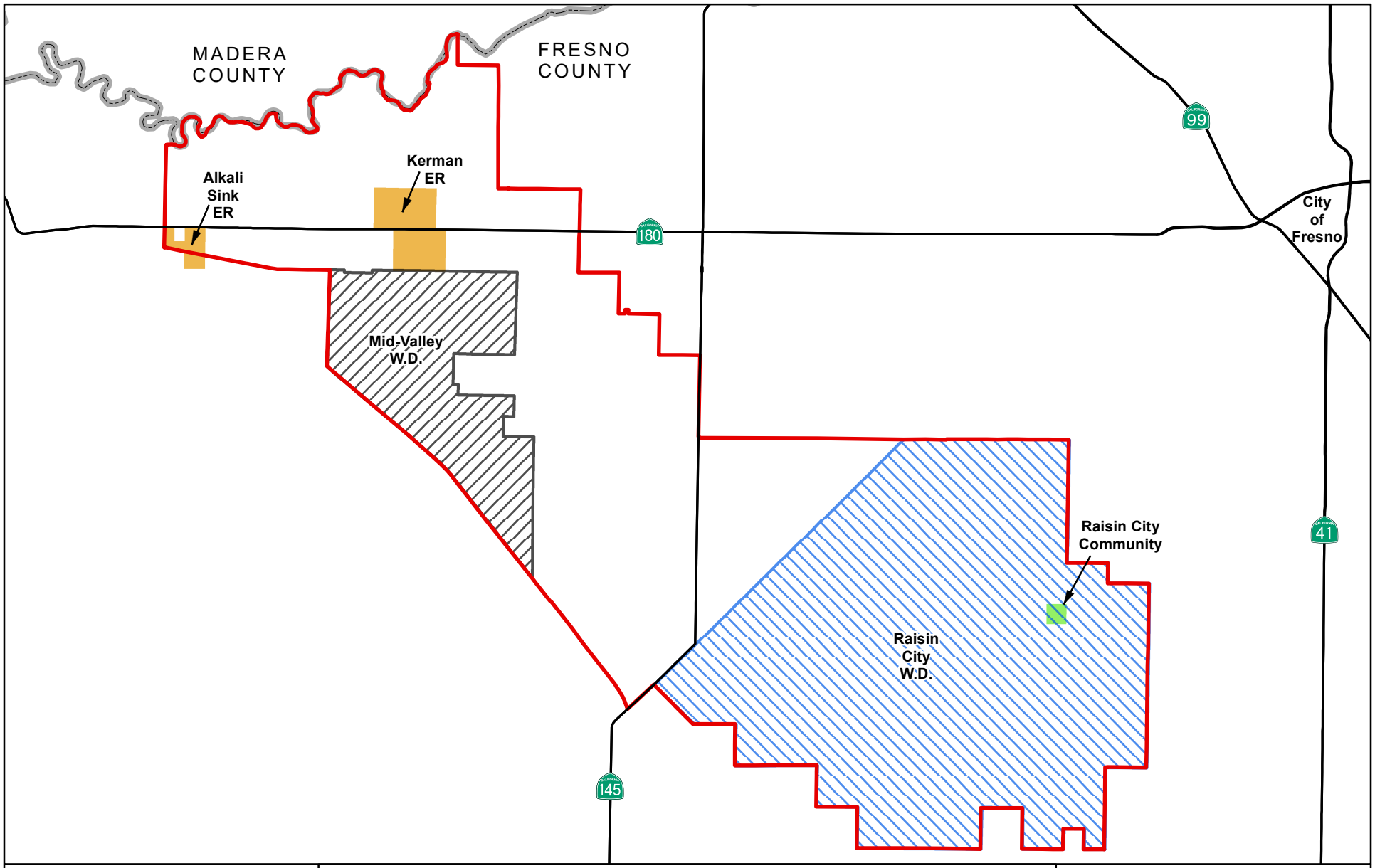
- Kings Groundwater Subbasin (DWR 2018)
- Other Groundwater Subbasins (DWR 2018)
- County

McMullin Area GSA

Kings Groundwater Subbasin
Groundwater Sustainability Agencies

Figure 2-2

12/16/2019 : G:\McMullin GSA-2659\265917002-Technical Services\GIS\Map\Report\HCM\subbasin_gsa.mxd



McMullin Area GSA

Agencies

Figure 2-3

5/30/2019 : G:\McMullin GSA-2659\265917002-Technical Services\GIS\Map\Report\Gen\agencies.mxd

The area consists of a combination of large and small farming operations that generally host permanent crops and annual row crops. Farmed agricultural land represents a large majority of the total area. DWR has updated statewide land use cropping maps in 2014 using Land IQ satellite imagery. **Figure 2-4** displays the cropping data for MAGSA using DWR data to provide a general idea of local land uses. Farm operations within the area generally include vineyards, almonds, alfalfa, dairy farms, poultry farms, and various row crops. **Table 2-1**, below, summarizes the land-use data based on percentage of total area within the GSA.

Table 2-1 Land-Use in McMullin Area GSA

Land-Use Classification	Percent of Total Area
Agricultural Lands	**92%**
Agricultural: Grains, Pasture and Field Crops	20%
Agricultural: Truck Crops	3%
Agricultural: Permanent Crops	64%
Agricultural: Idle Land	2%
Agricultural: Farmsteads and Others	3%
Native and Riparian vegetation	**5%**
Water Features	**< 1%**
Residential	**1%**
Urban Lands	**< 1%**
Industrial	**< 1%**

Residential area is dominated by single rural family dwellings that occupy only about 1 percent of the total area. There are few industrial units which comprise mainly manufacturing assembly processing units and storage and distribution units.

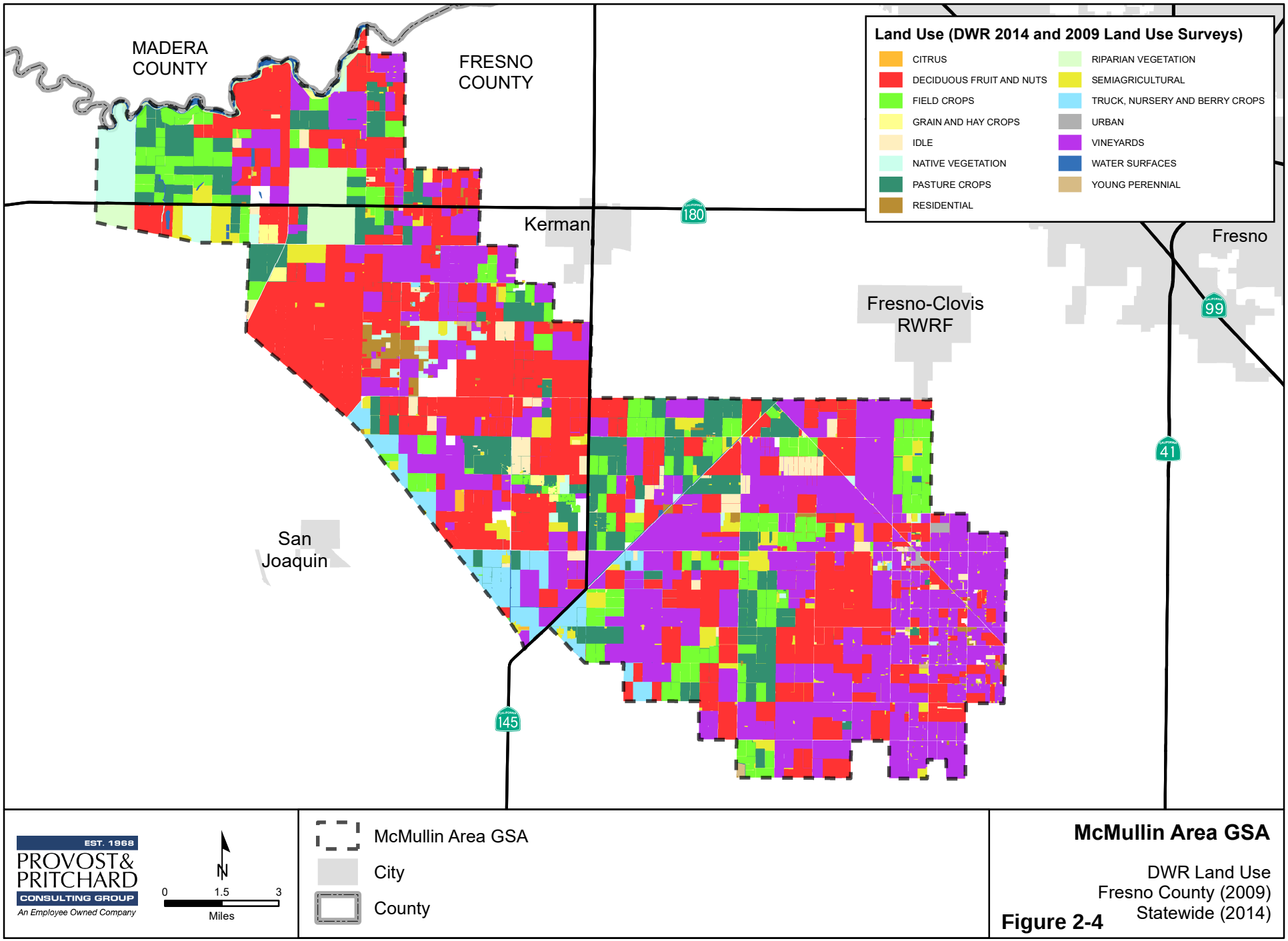


Figure 2-4

5/30/2019 : G:\McMullin GSA-2659\265917002-Technical Services\GIS\Map\Report\Gen\LandUse_2014.mxd

Water use and water source type for each of the plan's participants are shown in **Table 2-2.** The only community water system within MAGSA is for Raisin City, known as Fresno County Service Area #43 (water system #1000551). There are other public water systems in MAGSA, but they are associated with industrial/commercial businesses (mainly around dairies, poultry farms and food processing plants). All the agencies and public water systems use groundwater.

Table 2-2 Water Uses and Water Sources

Agency / Water Company	Water Use	Water Source
County of Fresno	Agricultural Residential	Groundwater
Raisin City Water District	Agricultural	Groundwater Surface (Flood water)
Mid Valley Water District	Agricultural	Groundwater Surface (Flood water)

MVWD and Terranova Ranch located within the MAGSA service area also receive small quantities of available flood water, on occasion, from the north fork of the Kings River and/or the James Bypass segment of the Kings River that is diverted and conveyed toward the Terranova Ranch or the Gilmore Ranch which is a landowner within MVWD. MVWD may also receive USBR 215 Water when it is available. **Table 2-3** summarizes the volumes of flood water in AF diverted by MVWD since 1986. **Table 2-4** summarizes the volume of flood water (in AF) Terranova Ranch estimates it has diverted.

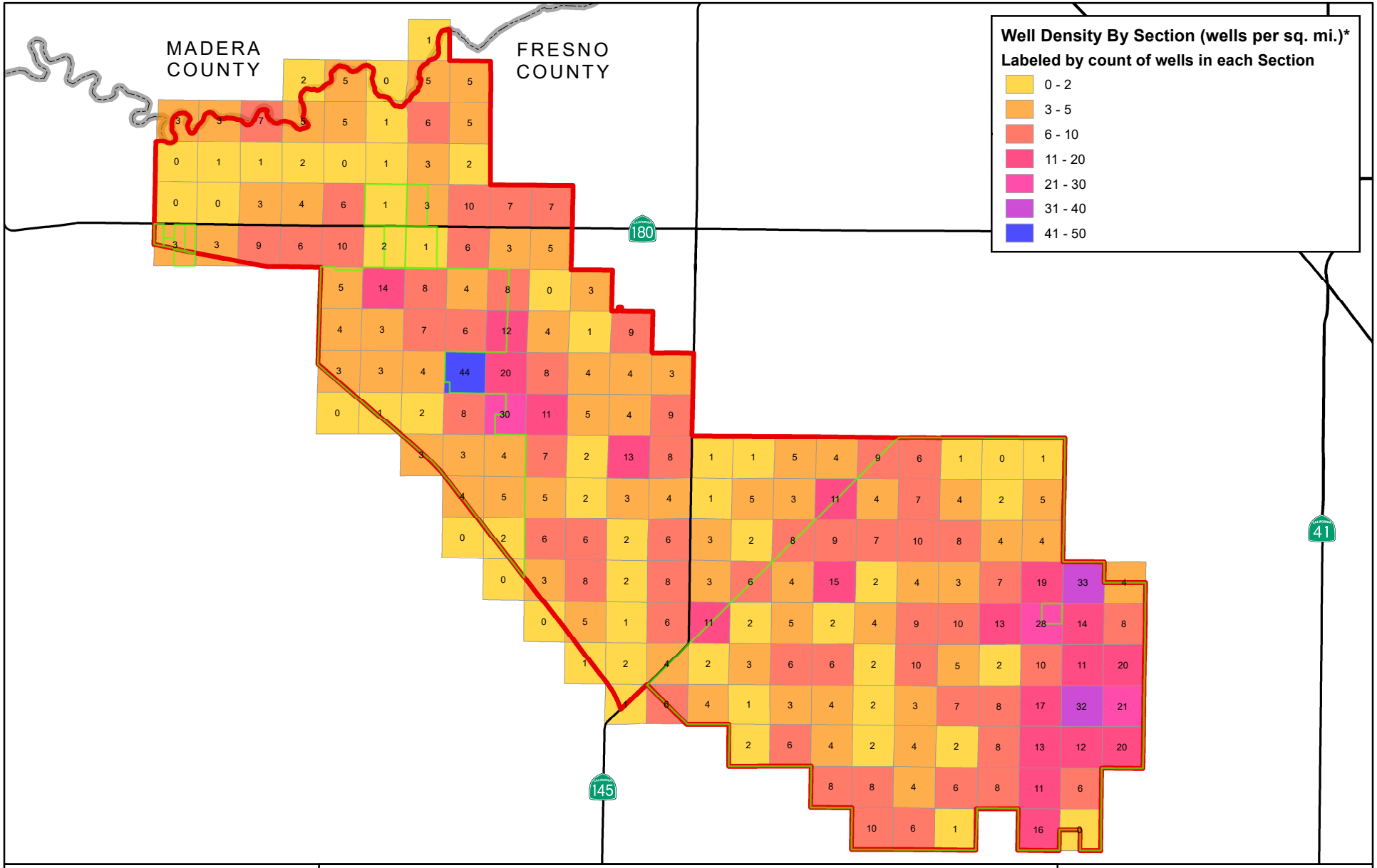
Table 2-3 Mid-Valley Water District History of Water Deliveries

Date	Kings Floodwater AF	USBR Section 215 AF
1986	0	0
1987	0	0
1994	0	0
1995	4,983	0
1997	0	0
1998	7,757	0
1999	0	0
2000	0	0
2002	0	0
2003	0	368
2005	0	849
2006	3,648	0268
2017	7,889	0

Table 2-4 Terranova Ranch History of Water Deliveries

Date	Kings Floodwater AF
1986	0
1987	0
1994	0
1995	4,500
1997	0
1998	4,500
1999	0
2000	0
2002	0
2003	0
2005	0
2006	4,500
2017	4,500

Figure 2-5 is a map of well density within the GSA area. There are an estimated 1,202 active wells in the MAGSA area. The map shown, is based on best available data including known well locations for each water agency and private well locations provided by Fresno County. The map excludes monitoring and test wells. The private wells were mapped by assuming that all wells constructed since 1975 remain active, unless a County permit authorizes their destruction. If a well was destroyed without issuance of a County permit, then it will show up on the map as still active. Fresno County did not have information readily available to sort the wells based off of domestic or irrigated use. The map does not necessarily show where pumping is concentrated since there is no differentiation between the different well uses. An approximation of the well distribution by type of usage using DWR's land-use survey shows that the domestic wells are clustered around dairies, poultry farms, and single-family dwellings. **Figure 2-6**, **Figure 2-7**, and **Figure 2-8** show the well density for agricultural, domestic, and municipal as identified on the DWR well completion reports. The domestic well density map, **Figure 2-7** generally indicates high well densities for the outskirts of the residential areas, which are likely in rural residential areas where each household has its own well.



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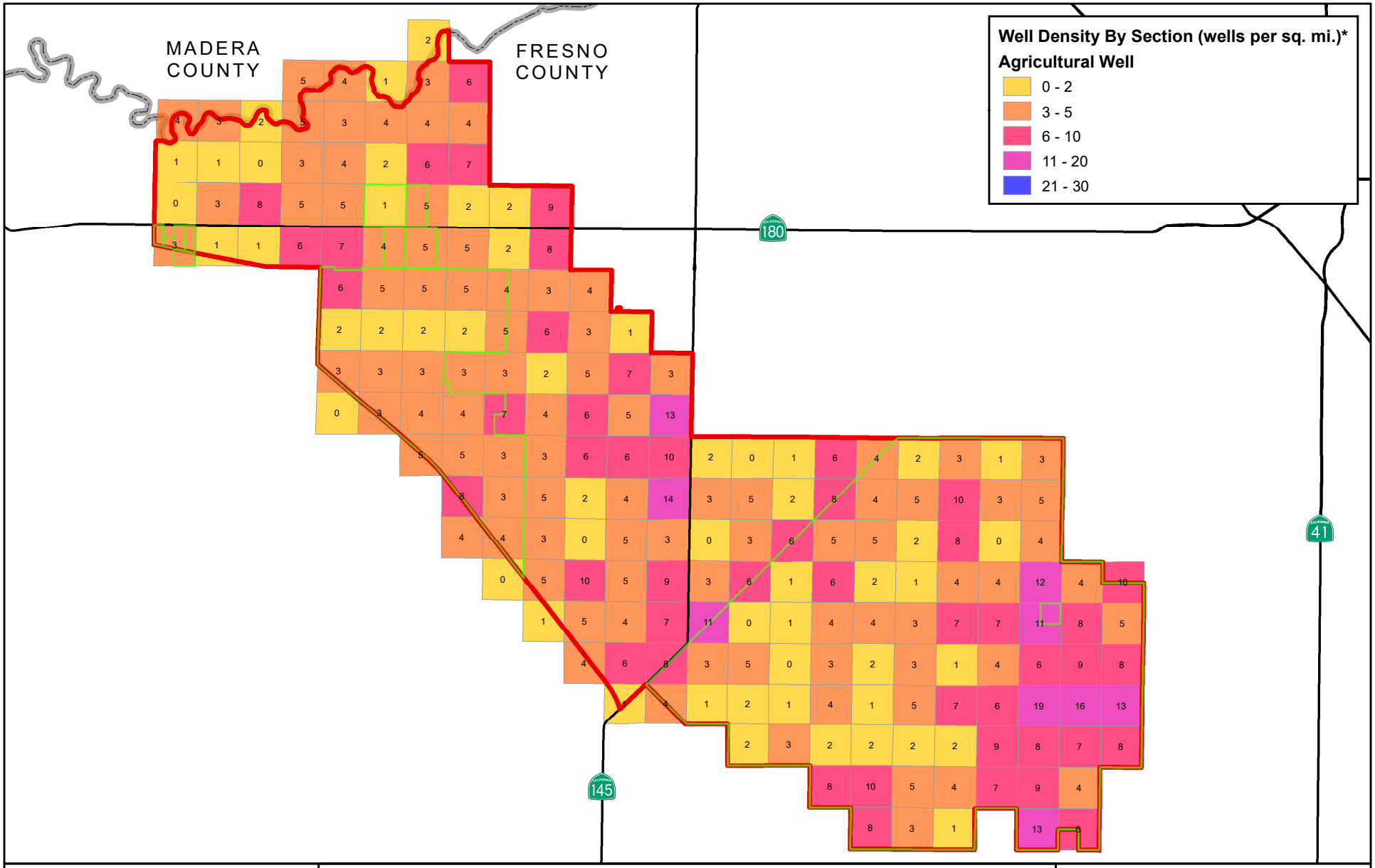
*Well density data created from datasets provided by Fresno County for active wells permitted by Fresno County Dept. of Health.

McMullin Area GSA

Well Density By Sections

Figure 2-5

5/30/2019 : G:\McMullin GSA-2659\265917002-Technical Services\GIS\Map\Report\GW\Wells\wells_density.mxd



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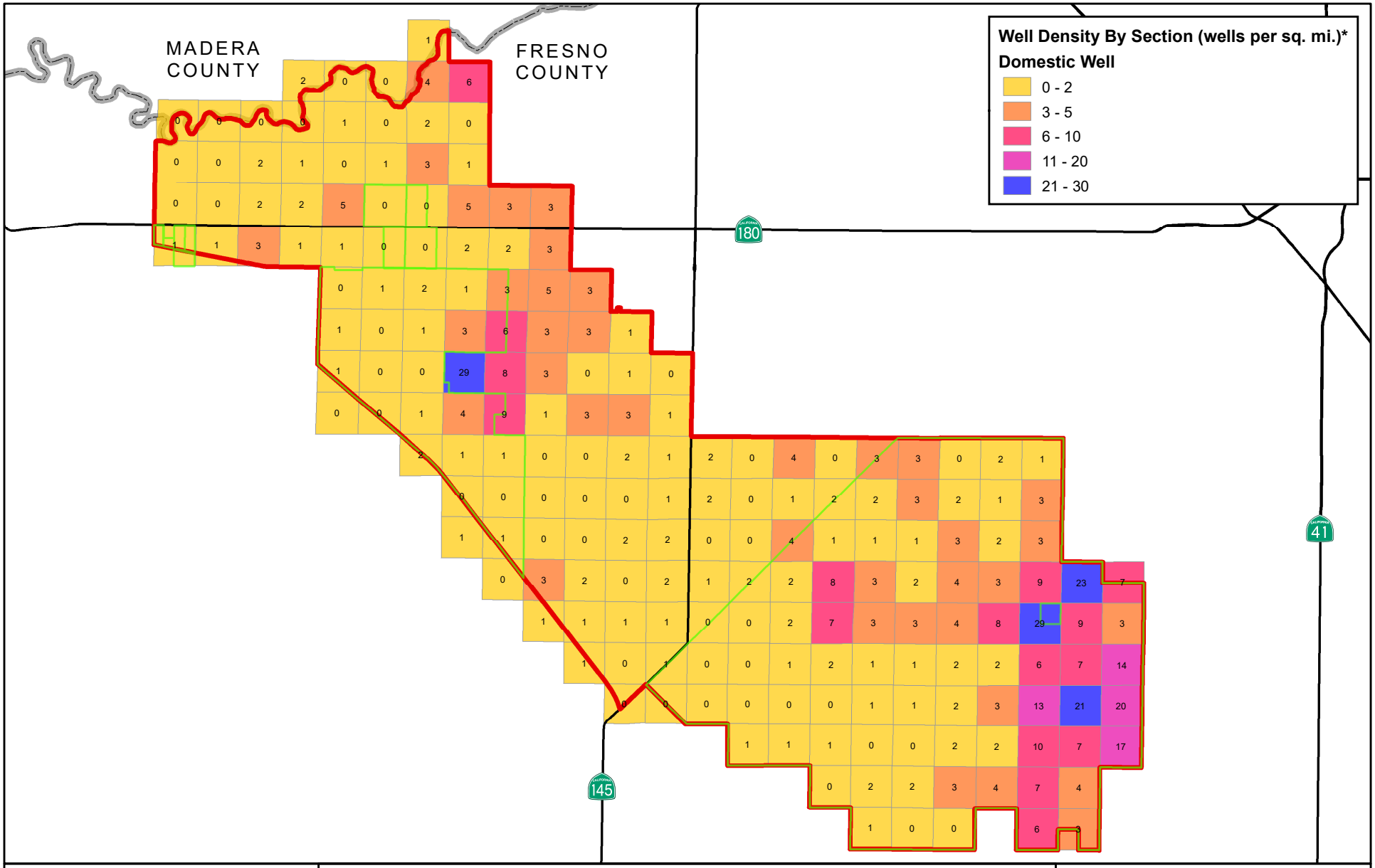

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*Well density data provided by Department of Water Resources.

McMullin Area GSA

Domestic Well Density

Figure 2-7

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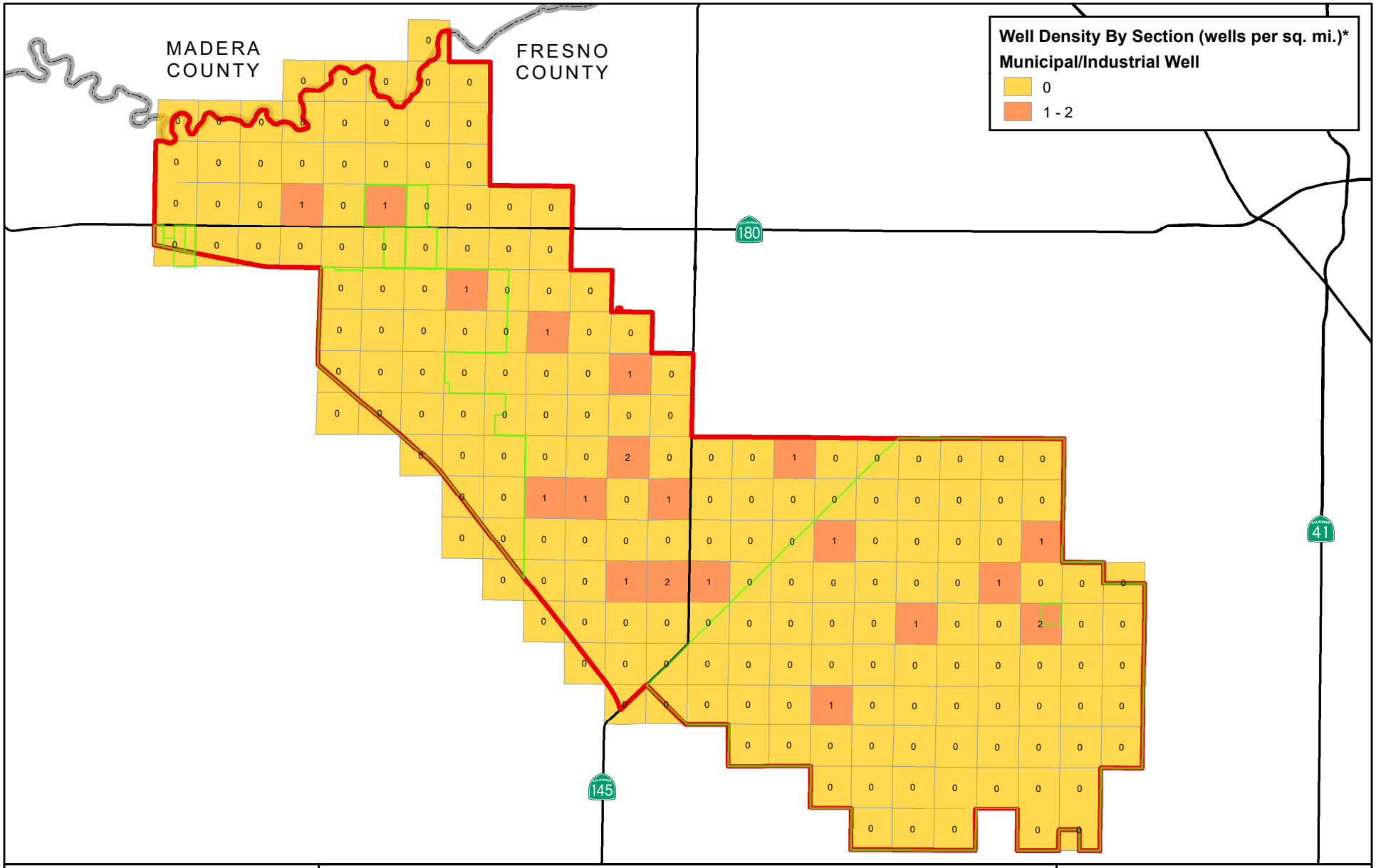

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Participating Agency

*Well density data provided by Department of Water Resources.

McMullin Area GSA

Municipal/Industrial Well Density

Figure 2-8

12/20/2019 : G:\McMullin GSA-2659\265917002-Technical Services\GIS\Map\Report\GW\Wells\well_density_Municipal-Industrial.mxd

2.1 Summary of Jurisdictional Areas and Other Features

Regulation Requirements:

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

2.1.1 Groundwater Basin Boundaries

The Kings Subbasin is located within the southern part of the San Joaquin Valley Basin in the Central Valley of California. The groundwater subbasin boundary as defined in the DWR Bulletin 118 (2003) is shown in **Figure 2-1**. The groundwater basin covers an area of 1,530 square miles. DWR estimates that the groundwater storage for the entire Kings Subbasin is about 93 million AF to a depth of more than 1,000 feet. The Upper Kings Subbasin has a total groundwater storage capacity of 35 million AF to an average depth of about 500 feet. The groundwater storage in the Lower Kings Subbasin is estimated to be about 44 million AF to an average depth of about 1,000 feet. The Upper Kings Subbasin refers to approximately the northeastern two-thirds of the subbasin, and the Lower Kings Subbasin refers to the southwestern one-third which includes MAGSA.

2.1.2 Groundwater Sustainability Plan Area

The MAGSA Groundwater Sustainability Plan Area is identified in **Figure 2-3**. The plan area is located within Fresno County and covers around 120,635 acres. It is comprised of 3 participating agencies, which are described below. CDFW and James Irrigation District (JID) are positioned as interested parties within the plan area but have no jurisdictional presence (**Figure 2-9**). Refer to **Table 2-2** for water use and water source for each agency. In addition, many private domestic and community wells are used in rural and semi-rural areas throughout the GSA.

COUNTY OF FRESNO

Fresno County was formed in 1856. The county has a total area of 6,011 square miles of which 5,958 square miles is land and 53 square miles (0.9%) is water. Major watercourses are the San Joaquin River, Kings River, Delta-Mendota Canal, Big Creek, and Friant-Kern Canal. It is bordered on the west by the Coast Range and on the east by the Sierra Nevada. It is the center of a large agricultural area. The Coast Range, which forms the county's western boundary, reaches a height of over 4,000 feet west of Coalinga while some peaks along the crest of the Sierra Nevada, the county's eastern boundary, exceed 14,000 feet. The San Joaquin Valley floor, between the two ranges, is fifty to sixty miles wide and has an elevation near the City of Fresno of about 325 feet above mean sea level. The current boundaries of the County were established in 1909. Fresno County is one of the largest, fastest growing, and most diverse counties in the state of California. The 2010 United States Census reported that Fresno County had a population of 930,450. Fresno County is home to 15 incorporated communities, all located on the Valley floor. Over 60% of the County's total population resides in the Fresno and Clovis metropolitan area. Within the MAGSA, about 53,386 acres (approximately 44.3% of the GSA area) are located outside of the water districts' service areas and constitute the County's "white spaces" area (*Sustainable Groundwater Management Act [SGMA] legislation addresses unmanaged areas or "white spaces" within a groundwater basin through the presumption that the overlying county(s) will become the responsible for these areas (Water Code §10724(a))*). They rely solely on private groundwater wells. Domestic water demands are met by private domestic and community wells.

RAISIN CITY WATER DISTRICT

RCWD is in central Fresno County, three miles southwest of the City of Fresno, three miles south of Kerman, and just northwest of the community of Caruthers. The community of Raisin City is located within the District. The District was formed on May 21, 1962. It serves an area of approximately 51,719 acres and is generally bounded by American Avenue to the north, S. McMullin Grade to the west, Conejo Avenue to the

south, and Brawley Avenue to the east. Local Agency Formation Commission's (LAFCO) adopted Sphere of Influence (SOI) extends northwest to Jensen Avenue and west to Lake Avenue. Total acreage within the District's SOI amounts to approximately 80,125 acres including the District's service area.

Surface water is not available for irrigation purposes within the District. No direct services to farming operations are currently being provided. The District plans for the construction of water storage basins and related infrastructure and pipelines to convey water within the District. Farmers in the area utilize groundwater for their various farming operations. The District is governed by a five-member, locally-elected Board of Directors. The District does not own any public facilities or infrastructure. The District's best opportunity is to share facilities with neighboring agencies. The neighboring agencies with surface water infrastructure or access to surface water include JID, Consolidated Irrigation District (CID), FID, MVWD, Laguna Irrigation District (LID), KRCD, and Kings River Water Association (KRWA). The District is a member of the Kings Basin Water Authority, a group of 60 public and private organizations dedicated to the preservation and implementation of the Kings Basin Integrated Regional Water Management Plan. The District is also part of the McMullin Recharge Group, formed in 1999 to address the long-term water supply imbalance in the Raisin City area.

MID VALLEY WATER DISTRICT

MVWD is in northwestern Fresno County, north of the community of Tranquility and the City of San Joaquin. The District encompasses approximately 13,678 acres (21.37 square miles). The District's SOI encompasses approximately 42,552 acres (66.49 square miles). The District was formed to obtain a contract for surface water supply from the United States Bureau of Reclamation's then proposed Mid-Valley Canal Unit of the Central Valley Project. The District has not been able to provide consistent water deliveries to its customers. Between 2002 and 2006, the District's annual water delivery ranged from zero AF in 2002 and 2004 to a high of 3,916 AF in 2006. **Table ES-2** summarizes the MVWD history of water deliveries between 1986 and 2017 through privately developed infrastructure. The District has no infrastructure and funding is very limited. The District has waived land valuation assessments since 2001. The District is governed by a five-member, locally elected Board of Directors. The District has no employees and contracts for services as needed.

RAISIN CITY COMMUNITY (CSA-43W)

The unincorporated community of Raisin City is located within Raisin City Water District's service area boundaries. The community is located near the intersection of W. Bowles Avenue and S. Ormus Avenue and contains most of the rural residential homes and small commercial establishments located within RCWD service area. The U.S. Census Bureau recognizes the unincorporated community of Raisin City as a census-designated place (CDP) located within central Fresno County. The community has a population of approximately 380, with a housing stock of 85 housing units, and a standing vacancy of 13 units. Of the 72 occupied housing units, 24 housing units were owner-occupied and the remaining 48 housing units were renter-occupied as of February 2015. The unincorporated community of Raisin City is served with domestic water services by County Service Area (CSA) No. 43 (Raisin City). The CSA is a dependent local agency governed by the Fresno County Board of Supervisors. The Fresno County Department of Public Works maintains the community water system. The service area for CSA No. 43 is largely developed and population growth is limited. Because the unincorporated community of Raisin City has historically experienced slow growth, it's anticipated that CSA No. 43 (Raisin City) would continue to provide municipal services to residents in the community. Raisin City Elementary School District is a one-school district located approximately 15 miles southwest of Fresno within RCWD service boundaries. It receives its water services from County Service Area No. 43 (Raisin City).

CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE

KERMAN ECOLOGICAL RESERVE

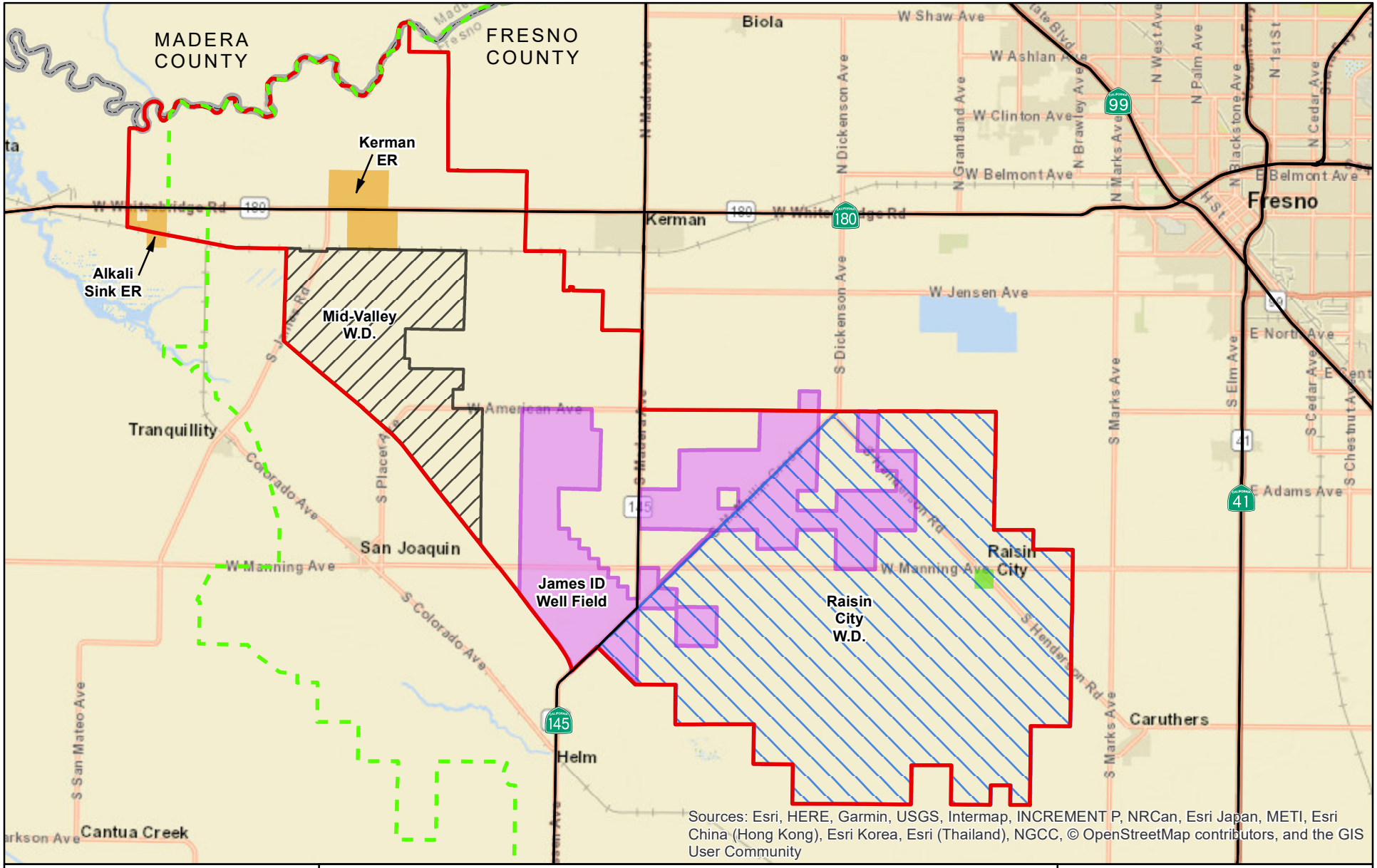
Kerman Ecological Reserve is approximately 1,800 acres. The principal habitat type is annual grassland, though northern clay-pan vernal pool and alkali desert scrub habitats also occur on this site. Animal species known or suspected to occur at the reserve include waterfowl, shorebirds, raptors, lizards, snakes, hare, coyote, badger, and ground squirrel. The property was designated an ecological reserve by the Fish and Game Commission in 1990. The purpose of the acquisition was to protect annual grasslands. Past land uses include cattle grazing and management as a waterfowl hunting area. In addition, drainage water from adjacent agricultural operations was historically spilled onto and across the reserve. This land was formerly the property of Mendota Irrigation District, which permitted relatively unrestricted public use of the land.

ALKALI SINK ECOLOGICAL RESERVE

The 930-acre Alkali Sink Ecological Reserve includes alkali sink scrub and annual grassland habitats. Migratory birds, particularly sand hill cranes, make seasonal use of the ground for foraging and resting. Wintering waterfowl utilize the flooded vernal pools, and some limited waterfowl nesting may take place on the annual grasslands. Raptors forage for rodents, rabbits, hares, small birds, and reptiles in the ecological reserve. The property was acquired to preserve remaining Alkali Sink Scrub habitat and was designated an ecological reserve by the Fish and Game Commission in 1979. Prior to acquisition, this area had been heavily grazed by livestock. In addition, much of the area was previously managed as private waterfowl hunting clubs; although there was little "development" of waterfowl hunting ponds, members hunted over flooded vernal pools.

JAMES IRRIGATION DISTRICT WELL FIELD

In 1920, following the formation of the JID, numerous shallower wells (200 to 600 feet deep) were drilled on land then owned by the San Joaquin Valley Farm Lands Company east of the James Bypass. The McMullin Grade Canal and the Lassen Avenue Canal were simultaneously built to transport that water to lands west of the Bypass. The San Joaquin Valley Farmlands Company sold James Irrigation District an easement to pump groundwater from beneath those lands east of the Bypass, up to 200 cfs in capacity from approximately 18,130 acres for irrigation purposes inside the JID. JID operates about 35 wells that are east of the JID boundary within their deeded groundwater easement area which lays within the MAGSA area. The well yields range from 950 to 3,400 gpm with an average of about 1,500 gpm.



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- McMullin Area GSA
- Mid-Valley WD
- Raisin City WD
- James ID Well Field
- Kings River Water Quality Coalition
- Raisin City Community
- State of California Ecological Reserve (ER)
- County

McMullin Area GSA

Jurisdiction Map

Figure 2-9

5/30/2019 : G:\McMullin GSA-2659\265917002-Technical Services\GIS\Map\Report\Gen\Jurisdictional_boundaries_KRWQC.mxd

2.1.3 Kings River Conservation District

KRCD is a legislatively defined special district that supports local interests in water planning and management, develops projects, collects groundwater data, and prepares an annual report of groundwater conditions; however, KRCD does not have the legislative authority to manage groundwater. There are six divisions within KRCD. MAGSA is located within KRCD Division 4 and it is part of the Lower King's Subbasin planning area.

2.1.4 Kings River Water Association

The history of water management on the Kings River is marked by numerous disputes over water rights. These disputes eventually led to the formation of the KRWA to solve disputes and to coordinate water management along the river. Under a series of complex agreements and water schedules, KRWA serves as the Watermaster to manage the Kings River flow and the conserved storage in Pine Flat Reservoir. KRWA is comprised of 28-member agencies that have rights for the 1,006,000 AF of conserved storage in Pine Flat Reservoir. The boundaries of KRWA define the Place-of-Use for the Kings River water rights held by KRWA in trust for the individual members. The Place-of-Use must be defined in the water rights permits issued by the State Water Resources Control Board (SWRCB). The areas outside of the KRWA boundaries that do not have surface water rights to the Kings River or Central Valley Project (CVP) supplies are reliant on groundwater. Under KRWA policies, surface water can be transferred between KRWA members within the adopted KRWA place of use. Through KRWA, members pay for irrigation storage benefits on the Pine Flat Dam and for retirement of the bonds and obligations to the federal government.

2.2 Water Resources Monitoring and Management Programs

Regulation Requirements:

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

2.2.1 Monitoring and Management Programs

Groundwater Level Monitoring

The Kings Subbasin has an extensive monitoring network. KRCD obtains water levels from about 1,100 wells in the region based on monitoring records from 19 local agencies to develop regional groundwater contour maps that cover the entire Kings Subbasin. Since 2003, KRCD has published an annual groundwater report that includes regional groundwater contours and maps showing annual change in groundwater levels. KRCD monitors groundwater levels in only a few wells within the MAGSA. KRCD's groundwater level monitoring program within MAGSA ceased in 2022. Beginning in 2022 MAGSA has assumed responsibility for groundwater level monitoring in the GSA.

Groundwater Extraction Monitoring

Most wells are not metered, and the volume pumped is not precisely known. To approach the volume pumped, the estimation will be based on unit water demand associated with a land use type. Unit water demand or annual water duty is defined as the amount of water used per acre, per year. This results in groundwater extraction estimates with varying levels of accuracy. Potential future groundwater metering policies are discussed in Section 5 – Monitoring Network.

Groundwater Quality Monitoring

Most of the wells in MAGSA are used for agricultural purposes. These wells have been monitored by the well operators to ensure crop productivity. These monitoring records are typically kept private and are not public information. Water quality monitoring of drinking water sources has been performed by domestic water purveyors as required by the Division of Drinking Water (DDW). The requirements for testing are based on the size of the community system. Additional testing may be done if a site has specific constituents of concern that need to be monitored. Some limited data is available in smaller communities that include clusters of domestic wells. The current level of water quality monitoring needs to be enhanced by a network of dedicated monitoring wells to track regional trends and to serve as a warning system for changes in water quality. More details on the monitoring network will be provided in **Section 5.5**.

Irrigated Lands Regulatory Program

The Irrigated Lands Regulatory Program (ILRP) addresses discharge of wastes (e.g., sediments, pesticides, nitrates) from commercial irrigated lands. These wastes can harm aquatic life or make water unusable for drinking water or agricultural uses. The goal of the ILRP is to protect surface water and groundwater quality and to reduce impacts of irrigated agricultural discharges to waters of the State. In 1999, the California Legislature passed Senate Bill 390, which eliminated a blanket waiver for agricultural waste discharges. The Bill required the Water Boards to develop a program to regulate agricultural lands under the Porter-Cologne Water Quality Control Act. In 2003, the Central Valley Water Board adopted a conditional Waiver of Waste Discharge Requirements (WDRs) to regulate agricultural discharges to surface waters. In December 2012, the Central Valley Water Board started adopting WDRs that address discharges to both surface water and groundwater, thus requiring ILRP enrollment for all commercially irrigated agricultural operations. Surface water quality has been monitored for several years and, in the future, groundwater quality will be monitored. Based on information in the workplan documents and additional information provided by the Kings River Water Quality Coalition (KRWQC, Coalition), annual groundwater monitoring under the IRLP program is anticipated to commence during the Fall of 2018; however, at the time of writing, discussions are underway to adapt annual groundwater monitoring to a spring schedule due to several factors related to the fall harvest season.

Under the ILRP rules, growers may form "third party" coalitions to assist with required monitoring, reporting, and education requirements for irrigated agriculture. The Coalition was established in 2009 as a Joint Powers Agency to pool resources and combine regional efforts to comply with the regulatory requirements of the ILRP. All properties within MAGSA also fall within the boundary served by the Coalition. Growers also have the option to complete regulatory requirements independently of the Coalition, but this is not recommended due to the high cost and complexity of performing required studies. Therefore, most growers have opted to join the Coalition. Additional information on the Coalition is located on their website at http://www.kingsriverwqc.org/. The Coalition area and supplemental areas cover the Plan area. Regional information on surface and groundwater quality is available from the Coalition.

As one of the mandatory requirements under the ILRP WDRs, the Kings Coalition prepared a Groundwater Assessment Report (GAR), which is an analysis of the risks to groundwater from salts and nitrates as the primary constituents of concern (COCs) that may originate from irrigated agriculture within that coalition area. Both the vadose zone and aquifer have nitrates and salts in storage that are the result of past land use practices, representing a reservoir of impacts that will continue to migrate over time.

CV SALTS

The Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS) began in 2006 and is a collaborative, stakeholder driven and managed program to develop sustainable salinity and nitrate management planning for the Central Valley. SWRCB requires the CV-SALTS program so that scientific and regulatory tools may be developed and implemented in order to address salinity levels and manage various nutrient concerns. CV-SALTS will then use these tools to prepare a Basin Plan Amendment (BPA)

with the Regional Water Quality Control Board (RWQCB) changing the objectives and implementation program for salt and nutrient management. To date, six technical project areas have been developed and can be reviewed at https://www.cvsalinity.org/technical-projects-index.html.

Each of these project areas has provided information for the Salt and Nutrient Management Plan (SNMP) for the entire Central Valley which was submitted to the RWQCB in December 2016 and subsequently released for comment. Once finalized, the SNMP will be utilized to prepare the BPA. Moving forward, future expansion will include additional management practice development, the BPA, implementation, monitoring and reporting, and a Phase II SNMP.

GAMA

The GAMA Program is California's comprehensive groundwater quality monitoring program that was designed to help better understand and identify risks to groundwater resources. GAMA was created by the State Water Resources Control Board in 2000. It was later expanded by Assembly Bill 599 - the Groundwater Quality Monitoring Act of 2001. AB 599 required that the State Water Resources Control Board, in coordination with an Interagency Task Force (ITF) and Public Advisory Committee (PAC) proceed towards integrating existing monitoring programs and designing new program elements as deemed necessary, which would result in a publicly accepted plan to monitor and assess groundwater quality in basins that account for 95% of the state's groundwater use. The GAMA Program is based on interagency collaboration with the State and Regional Water Boards, Department of Water Resources, Department of Pesticide Regulations, U.S. Geological Survey, and Lawrence Livermore National Laboratory, and cooperation with local water agencies and well owners.

The main goals of GAMA are to:

- Improve statewide comprehensive groundwater monitoring.
- Increase the availability to the public of groundwater quality and contamination information.
- Establish ambient groundwater quality on a basin-wide scale.
- Continue periodic groundwater sampling and groundwater quality studies in order to characterize various chemicals of concern and identify trends in groundwater quality.
- Centralize the availability of groundwater information to the public and decision makers to better protect our groundwater resources.

Groundwater Quality Protection

The existence and continued implementation of the above-described CV-SALTS and ILRP programs serve to protect groundwater directly by bringing attention to and monitoring groundwater quality, while improving management practices, to reduce impacts from nitrate, pesticides, and salinity. Additionally, the Integrated Regional Water Management (IRWM) agreements provide protection through cooperative water quality programs and management.

Several State of California online databases provide more indirect protection, by tracking information and data regarding known groundwater contamination, planned and current corrective actions, investigations into groundwater contamination, and groundwater quality from select water supply and monitoring wells. These databases are useful for finding and tracking groundwater quality issues and on-going remediation activities. Each database has interactive mapping functions to easily identify locations of known water quality issues, often by specific constituent. The extensive datasets are quite significant and are best accessed online at each individual site. Each program is discussed below:

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

The Department of Toxic Substance Control
The State of California Department of Toxic Substance 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. The online database can be accessed at http://www.envirostor.dtsc.ca.gov.

Groundwater Ambient Monitoring and Assessment Program
The SWRCB GAMA program collects data by testing untreated raw water for naturally occurring and man-made chemicals and compiles all the data into a publicly accessible online database. The online database can be accessed at http://geotracker.waterboards.ca.gov/gama/.

Land Subsidence Monitoring

Land subsidence can result from the compaction of underlying formations that are negatively affected by water level decline. Land subsidence is well documented in areas west of the Lower Kings Subbasin. The extent of subsidence in MAGSA has been minimal, and as such, land subsidence is not actively monitored in the MAGSA. While some local agencies in the San Joaquin Valley monitor for land subsidence, the majority rely on monitoring performed by regional water agencies or the State and Federal government. A Global Positioning System (GPS) control network has been established throughout the subbasin area. This control network can be utilized to survey existing benchmarks to monitor subsidence. Currently, USBR, in conjunction with DWR, USGS, and USACE, obtains subsidence data twice yearly in December and July and publishes maps of the results as part of the SJRRP. The subsidence areas shown in these maps cover the majority of the MAGSA area. USGS, NASA, and MAGSA also measure subsidence in the GSA. USGS and NASA have maps on their websites that show the subsidence for a defined period. MAGSA has a 7-mile grid that monitors new and existing benchmarks for land subsidence.

Surface Water Monitoring

Surface water in the area is monitored by numerous agencies. KRWA monitors surface water in the Kings River and its watershed including snowpack, reservoir stage, reservoir inflow and outflow, Kings River flows, and Kings River diversions. The Friant Water Authority monitors SJR water delivered through the Friant-Kern Canal and Madera Canal. The San Luis Delta Mendota Water Authority (SLDMWA) monitors flow in the Delta Mendota Pool daily, including stage measurements at Mendota Dam. The Mendota Pool Group (MPG) use daily records of inflows to and outflows from the Pool provided by the SLDMWA to calculate a detailed water budget for the portion of the Fresno Slough south of the Firebaugh Intake Canal. This analysis is conducted at the end of each year.

GSP Monitoring and Management Plans

The individual agencies located within the Plan area will be responsible for collecting data for any monitoring or management plan for which they are already collecting data. As needed, the agencies will report the water quality and water supply data to the GSA. The monitoring program is described later in this GSP in the Monitoring Network - **Chapter 5**.

2.2.2 Impacts to Operational Flexibility

Regulation Requirements:

§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 presence of different existing water management programs constitutes various constraints that will impact operational flexibility and water operations for the MAGSA. These programs are illustrated in **Figure 2-10** below, followed by a description of each program and possible measures to adapt to them.

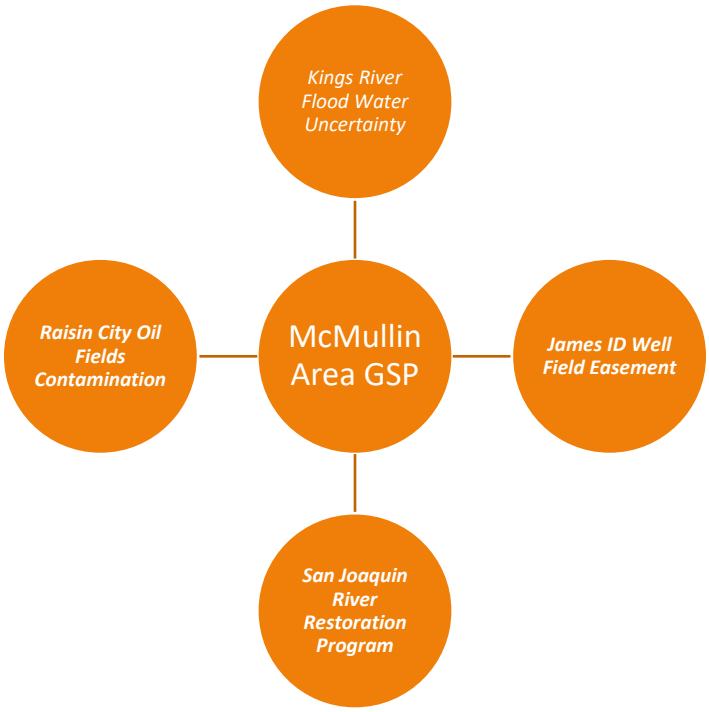


Figure 2-10 Impacts to Operational Flexibility

2.2.2.1 Kings River Flood Water Uncertainty

Kings River flows are regulated by Pine Flat Dam, completed in 1954 for flood control, recreation, irrigation, and hydroelectric purposes. Pine Flat Reservoir has a storage capacity of approximately one million acre-feet. The flood control functions of the facility are managed by the USACE, while the releases for irrigation diversion and water rights are managed by the KRWA. The additional reservoirs upstream of Pine Flat that are owned and operated by Pacific Gas and Electric for hydroelectric power generation have a combined storage capacity of about 252,000 AF. Two uncontrolled creeks, Hughes Creek and Mill Creek, flow into the Kings River below Pine Flat Dam. Pine Flat Reservoir has adequate storage capacity to avoid emergency releases in most storm events, but these downstream creeks can add significant flow to the river.

Since the construction of Pine Flat Dam, the North Fork of the Kings River downstream of Stinson Weir with the continuation of flows through the James Bypass and Fresno Slough to the San Joaquin River has normally been dry except during flood events. KRWA member units James and Tranquillity Irrigation Districts (James/Tranquillity) transferred their Kings River Water to other KRWA members due to the high losses that would occur by running them in the river and have relied on Central Valley Project supplies and groundwater. However, with the expiration in December 2015 of the James/Tranquillity agreement to sell

their water to the Lower River Units, the James/Tranquillity non-floodwater Kings River supplies could be run down the river to these two irrigation districts.

Based on the KRWA published data of flood releases from Pine Flat Reservoir for years 1954 to 2006, the water lost to the service area on the North Fork has occurred about every 2.4 years. Since the chart was generated, flood flows leaving the service area have also occurred in 2006, 2011, and 2017. For the fifty-one years of data from 1954 to 2006 the following information is obtained regarding the water leaving the northerly service area:

- The average annual flood duration was 39 days with a volume of 206,000 AF.
- The average flood event was 95 days and 500,000 AF for the 21 events.
- The flood period earliest start was October 1st, latest start was May 11th, and average start was April 30th for the 21 events.
- The flood period earliest end was December 16th, latest end was September 30th, and average end was June 17th for the 21 events.

The MAGSA area is not located within the Kings River Service Area or the place of use for the water rights held in trust by the Kings River Water Association for their member units. These water rights include floodwaters, various appropriated rights, and pre-1914 rights. The MVWD and Terranova Ranch have diverted water from the North Fork or James Bypass in high flow years on the Kings River. Any Kings River flows are the primary surface water supply that would be available to MAGSA.

Fresno, Alta, and Consolidated Irrigation Districts together filed an application to modify the Place of Use for the Kings River service area and appropriate Kings River high flows on May 9, 2017, to protect the local water rights. The application included several projects within MAGSA among others. By changing the Place of Use and identifying the specific projects Kings River waters, besides pre-1914 water, could potentially go to the MAGSA projects if the water rights application is approved. In addition to flows that could be available directly off the Kings River, Kings River water could be diverted from other facilities owned by KRWA member units such as the Liberty Millrace Canal if water above the member unit's need was available. However, Semitropic Water Storage District (Semitropic) in Kern County also filed an application to appropriate water from the Kings River on May 25, 2017, along with a petition for reconsideration of the fully appropriated stream status of the Kings River. The State Board could consider the fully appropriated status at a State Board hearing at some point in the future. Semitropic proposes to use all flood flows in excess of 100 cfs, up to 2,200 cfs, that leave the Kings River service area through the North Fork of the Kings River. Because of the uncertainty of utilizing high flow water from the Kings River, MAGSA plans to collaborate with water agencies that have access to other surface water resources as well as develop management actions identified in Chapter 6.

2.2.2.2 Raisin City Oil Fields Contamination

Oil-field-produced water can contain elevated concentrations of general minerals (especially total dissolved solids and chloride), metals (i.e., arsenic), trace elements (i.e., boron, strontium, thallium, lithium, etc.), petroleum hydrocarbons, polynuclear aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs, i.e., benzene, toluene, ethylbenzene, and xylenes [BTEX]), and radionuclides. The unauthorized discharge of waste containing oil field waste constituents to ground and/or groundwater creates, or threatens to create, a condition of pollution in groundwater and may result in the degradation of water quality. Oil field wastewater constituents could impair the groundwater for municipal and domestic supply, and agricultural supply uses. Based on Ayers and Westcott (1979), irrigation water with a chloride concentration above 350 milligrams per liter (mg/L) can cause severe crop problems. Boron toxicity can occur on sensitive crops at concentrations less than 1 mg/L in irrigation water.

The Longview Production Company operates a petroleum production and petroleum wastewater discharge facility at its Surfluh Lease in the Raisin City Oil Field (Surfluh Lease). The Surfluh Lease is one of 44 active

fields within Raisin City oil field. **Figure 2-11** shows the location of the oil field within MAGSA. The Surfluh Lease contains two wastewater injection wells and one pond to which wastewater is periodically released. Wastewater is separated from the extracted crude oil and discharged to the injection well and can flow to the unlined pond for percolation and evaporation. Groundwater samples were obtained from the wells from 1955 to 1973. Chemical analysis of those samples showed the following constituents at the indicated values:

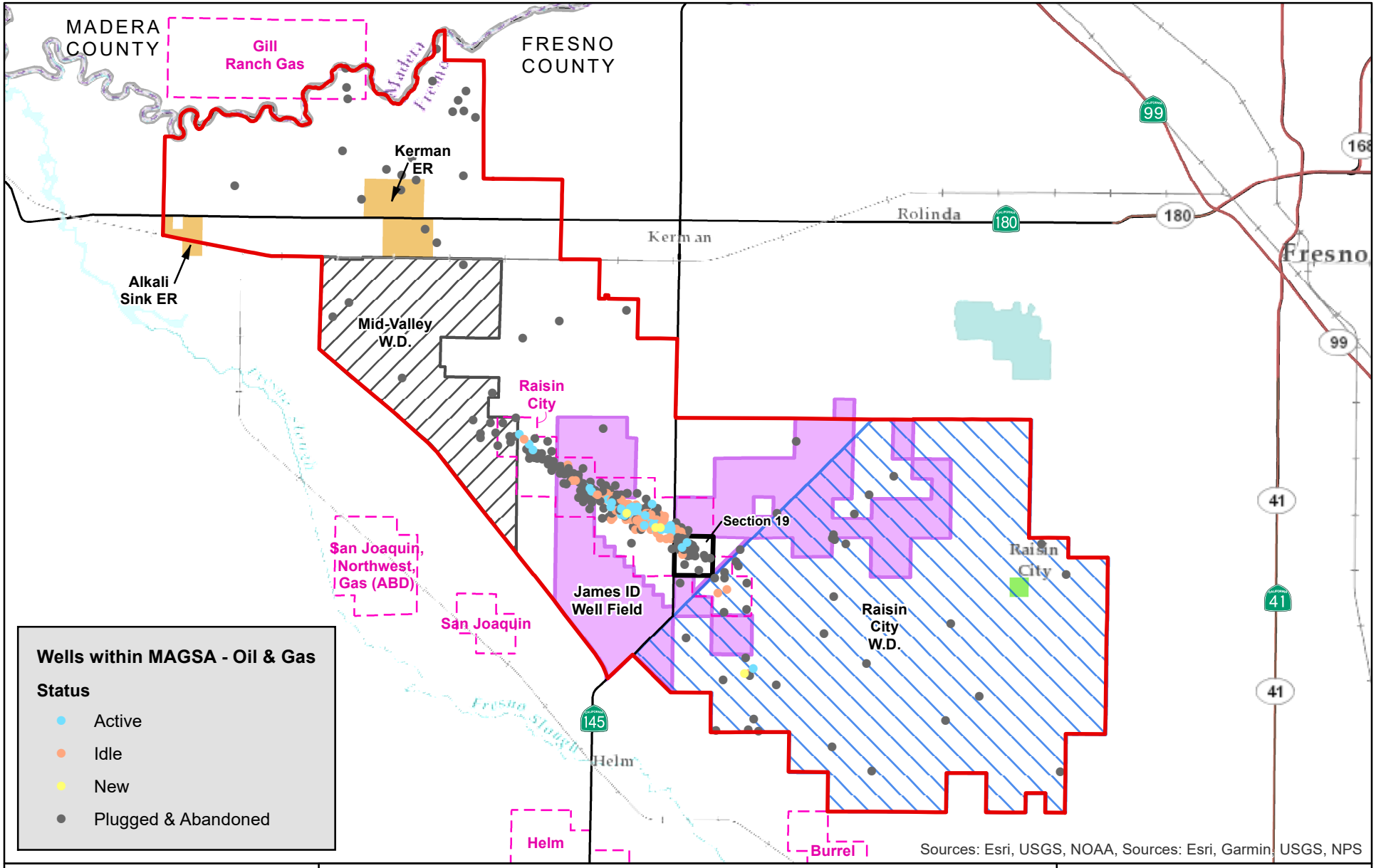
Table 2-5 From a well about one mile away from the Surfluh Lease

	Units	Measured Value Range
Specific EC	micromhos per centimeter (µmhos/cm)	482 – 491
Chloride	milligrams per liter (mg/l)	82 - 86
Boron	mg/l	None Detected – 0.12

Table 2-6 From a well adjacent to the Surfluh Lease

	Units	Measured Value Range
Specific EC	µmhos/cm	9,000
Chloride	mg/l	115
Boron	mg/l	4.5

On 27 March 2015, the Central Valley Water Board issued a Notice of Violation (NOV) to the Discharger, Longview Production Company. The NOV alleged that the discharge was in violation of Section 13260 of the California Water Code for failure to submit a Report of Waste Discharge before discharging waste that could affect the quality of waters of the State and that the Discharger was discharging wastewater more than the numerical limitations specified in the Basin Plan, which is causing or is threatening to cause a condition of pollution, contamination, or nuisance.



McMullin Area GSA

DOGGR Oil & Gas Wells
District 5

Figure 2-11

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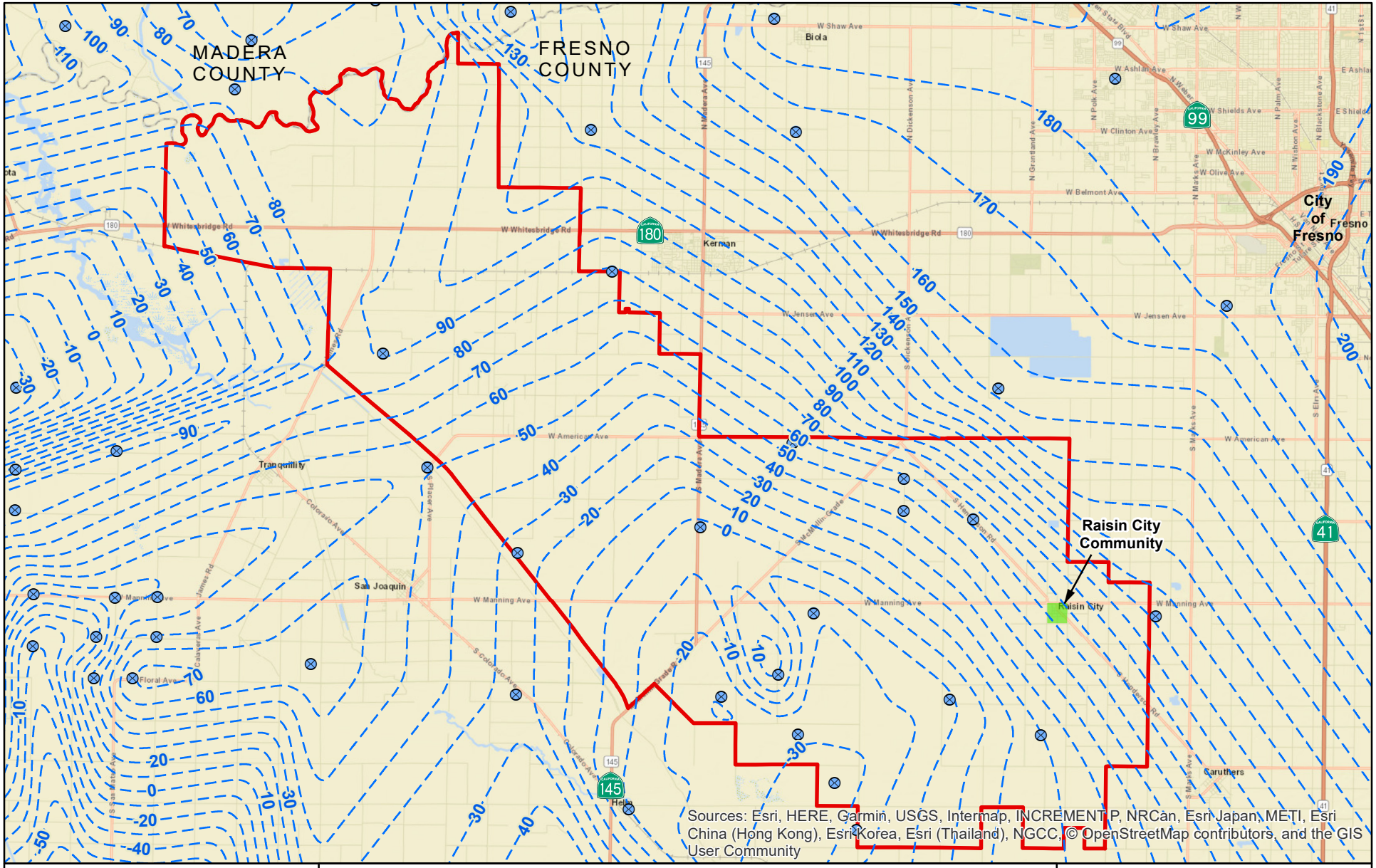


EST. 1968
PROVOST& PRITCHARD
CONSULTING GROUP
An Employee Owned Company

N
0 1 2
Miles

McMullin Area GSA
Raisin City Community
Water Surface Elevation in Feet
Well Used for Contouring

Disclaimer: The GIC point data is sparse for contouring

McMullin Area GSA

Groundwater Contours
Unconfined Aquifer
2017 DWR GIC
Figure 2-12

5/30/2019 : G:\McMullin GSA-2659\265917002-Technical Services\GIS\Map\Report\GW\2017_Unconfined_WSE_Contour_DWR.mxd

2.2.2.3 James Irrigation District Well Field Easement

In 1920, The San Joaquin Valley Farm Lands Company deeded facilities and easements to JID with the extraction not to exceed a total of 200 cfs at any time of fresh subterranean water (groundwater) from approximately 18,130 acres for irrigation purposes inside the JID. The entire area is located within MAGSA. The canals and wells are limited to specific strips of land, which primarily are located along the alignments of McMullin Grade and Lassen Avenue, where the groundwater easement is over a much larger area. JID has about 35 of about 63 total wells that are in the wellfield easement area (Page 4, James ID, 2010 Groundwater Management Plan). The average yield of the wells is about 1,500 gpm.

Table 2-7 shows the surface and groundwater use in JID from 2000 to 2009. Therefore, for the average groundwater use of 40,300 AF for the years 2000 to 2009, the wellfield use would be estimated to be on average about 22,568 AF/year or about 1.25 AF/acre over the 18,130 acres of groundwater easement area held by JID. MAGSA plans to work collaboratively with JID regarding the Projects and Management Actions identified in Chapter 6 that would help improve the operational flexibility for the basin related to the wellfield operations.

Table 2-7 James Irrigation District Surface and Groundwater Use (2000-2009)

Year	Surface Water		Groundwater		
	Volume (AF)	% supply	Volume (AF)	% supply	Wellfield yield of 56% (AF)
2009	15,900	22	55,100	78	30,856
2008	21,300	27	56,900	73	31,864
2007	34,300	42	48,200	58	26,992
2006	67,400	91	6,300	9	3,528
2005	50,300	69	22,500	31	12,600
2004	38,600	47	43,000	53	24,080
2003	39,000	51	37,400	49	20,944
2002	37,400	43	48,700	57	27,272
2001	26,400	35	48,600	65	27,216
2000	35,400	49	36,400	51	20,384
Average	36,600	48	40,300	52	22,568

Source: Table 7.1, James ID, 2010 Groundwater Management Plan

2.2.2.4 San Joaquin River Restoration Program

The San Joaquin River Restoration Act, included in Public Law 111-11 and signed into law on March 30, 2009, authorizes and directs the Secretary of the Interior to implement the Settlement between Natural Resources Defense Council (NRDC), Friant Water Authority, and the U.S. Departments of the Interior and Commerce. The Settlement establishes two primary goals:

- Restoration Goal – To restore and maintain fish populations in "good condition" in the main stem San Joaquin River below Friant Dam to the confluence of the Merced River, including naturally reproducing and self-sustaining populations of salmon and other fish.
- Water Management Goal – To reduce or avoid adverse water supply impacts on all the Friant Division long-term contractors that may result from the Interim and Restoration flows provided for in the Settlement.

To achieve the Restoration Goal, the Settlement requires releases of water from Friant Dam to the confluence of the Merced River (referred to as Restoration Flows). Restoration Flows vary by hydrologic year type and through the year in support of fish life-stage requirements.

Estimated water supply reductions to all Friant Division contractors resulting from the Restoration Flows under the SJRRP are about 200,000 AF/year (Imported Water Availability Projections for Tulare ID, Impacts of San Joaquin River Restoration, Provost & Pritchard, May 15, 2017). The stipulated Restoration Flows for each year type represents the total release from Friant Dam required to satisfy SJRRP Restoration Flows, riparian diversions between Friant Dam and Gravelly Ford Water District, and to maintain a minimum 5 cfs of flow at the Gravelly Ford gage station. The Settlement also stipulates that an additional buffer flow of up to 10 percent of the Restoration Flows could be made for: releases to the river, releases to address unexpected seepage losses, flushing flows to enhance gravel conditions for spawning during wet and normal-wet years, and riparian recruitment flows.

The July 2015 SJRRP Revised Framework for Implementation updated the US Bureau of Reclamation's 2012 framework, which established a schedule for implementation of the Restoration Program. The schedule for the SJRRP is important since it will determine when full Restoration Flows will be needed in the River. Full Restoration Flow amounts are being made available to the SJRRP but are currently not being used in the River until certain facilities and river modifications are complete. This creates Unreleased Restoration Flows (URFs) that have the same impact to historic contract deliveries, but the URFs are available for sale back to Friant contractors at premium prices (and potentially to others). The URFs will cease when river modifications allow full Restoration Flows in the River, which is estimated to be sometime between 2025 and 2029.

The SJRRP is currently behind schedule, underfunded, and is anticipated to be funding constrained into the future. SJRRP activities will be subject to available funding. Current funding needs are estimated at about $1.7 billion with approximately $780 million in anticipated funding.

Until the restoration program is complete, there are possible flows that may be available in the San Joaquin River that are available for purchase from the Restoration Program. With increased flows in the San Joaquin River due to the Restoration program, there is also increased seepage to the local groundwater aquifer that will occur, that would not have been occurring prior to the SJRRP implementation.

The availability of "Other" San Joaquin River water supplies (Section 215 and other surplus water) is estimated to decline from 127,000 AF/year to 61,000 – 68,000 AF/year for Friant Division contractors (Imported Water Availability Projections for Tulare ID, Impacts of San Joaquin River Restoration, Provost & Pritchard, May 15, 2017). If the availability of these supplies decreases for Friant Division contractors, they will also decrease the availability for those that might be able to obtain these supplies off the San Joaquin River, such as those agencies or properties within MAGSA that border the San Joaquin River.

However, the Unreleased Restoration Flows will potentially be for sale to others located on the San Joaquin River until 2025 to 2029 when the full Restoration Flows are anticipated to occur in the River.

2.2.3 Conjunctive Use Programs

Regulation Requirements:

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

Conjunctive use is the coordinated and planned management of both surface and groundwater resources in order to maximize their efficient use. Conjunctive use is utilized to improve water supply reliability and environmental conditions, reduce groundwater overdraft and land subsidence, and protect water quality.

Conjunctive use can include using surface water when it is available and relying on groundwater when surface water supplies run out in the late summer or are limited during droughts. Conjunctive use also includes cyclic storage where surplus surface waters are recharged during wet years and groundwater is pumped during dry periods. Conjunctive use should also include a robust monitoring program to help prevent negative impacts and verify the quantity of water in storage. For the GSAs that have surface water in the Kings Basin, they recharge surface water to offset the groundwater pumping. They also deliver surface water to growers who buy the water to use instead of using groundwater to irrigate the crops.

Conjunctive use of water relates to the combined use of ground and surface water. Due to the augmented water source, higher water reliability can be achieved. Conjunctive use therefore functions as a buffer for periods of water scarcity. The idea of this management approach is to use surface water when available in lieu of groundwater. Surface water is also used for groundwater banking (recharge) in areas that allow surface water to be stored in the aquifer for use later. This might be especially important as a buffer function for mitigating impacts of groundwater overdraft. The MAGSA users rely exclusively on groundwater for their needs and do not have a reliable access to surface water. MVWD and RCWD have pursued opportunities for diverting flood water to supplement their water demand.

2.3 Relation to General Plans

2.3.1 Summary of General Plans/Other Land Use Plans

Regulation Requirements:

§354.8(f) A plain language description of the land use elements or topic categories of applicable general plans that include the following:

1) A summary of general plans and other land use plans governing the basin.

California Government Code (§65350-65362) requires that each county and city in the state develop and adopt a general plan. The General Plan is a comprehensive, long-term framework for the enhanced protection of agricultural, natural, and cultural resources and for development within the county or city. Designed to meet state general plan requirements, it outlines policies, standards, and programs and sets out plan proposals to guide day-to-day decisions concerning a county's or city's future. Each general plan must include the vision, goals, and objectives of the city or county in terms of planning and development within eight different "elements" defined by the state as: land use, housing, circulation, conservation, noise, safety, open space, and environmental justice. The General Plan may be adopted in any form deemed appropriate or convenient by the legislative body of the county or city, including the combining of elements. Fresno County is the only agency within the plan area that has a general plan: Fresno County - 2000 General Plan.

2.3.2 Impact of GSP on Water Demands

Regulation Requirements:

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

The Fresno County General Plan was adopted prior to the development of the GSA and this GSP, and the General Plan did not consider the impacts of this plan's implementation. This GSP uses the same land use change assumptions identified in the general plan for forecasting the anticipated water budget, described later in this GSP in **Section 3.3**.

2.3.3 Impact of GSP on Land Use Plan Assumptions

Regulation Requirements:

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

As mentioned above, there is only one General Plan within the Plan area and it was developed prior to the development of the GSP. The General Plan sections that cover water supply are summarized below.

Fresno County General Plan - Fresno County development is dependent on a complex network of public facilities and services. Each type of service has a unique set of constraints and issues and must adapt to growth and change differently. The General Plan sets out policies and implementation programs to respond to this variety of issues and constraints. The Public Facilities and Services Element is organized accordingly into Public Facilities and Services; Funding; Water Supply and Delivery; Wastewater Collection, Treatment, and Disposal; Storm Drainage and Flood Control; and numerous other services. 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 decline 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.

2.3.4 Permitting New or Replacement Wells

Regulation Requirements:

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

Within MAGSA, well permitting and approval is managed by Fresno County Environmental Health Division (FCEHD). The FCEHD issues permits to construct new water wells; reconstruct, repair or deepen existing wells; and destroy abandoned wells to properly licensed water well drilling contractors in unincorporated Fresno County. Fresno County Department of Public Health, Environmental Health Division enforces the provisions of the California Well Standards Ordinance and the construction standards set forth in the California Well Standards, Bulletins 74-81 and 74-90. Only persons who possess an active C-57 Water Well Contractors License may perform construction, reconstruction, or destruction work on wells. In order to obtain a permit to drill a well, properly licensed contractors submit a completed Water Well Permit Form, along with applicable permit fees, to the FCEHD office. The over-the-counter permit is a ministerial process, not requiring discretionary action or California Environmental Quality Act (CEQA) action. The application is reviewed, and if found acceptable, will usually be approved within two working days. Once the permit application is approved, a well permit number is assigned, and drilling may commence. The permit is valid for 180 days.

The California Well Standards Ordinance requires contractors, as part of the well construction process, to install an annular seal of at least twenty (20) feet in depth (fifty [50] feet for public water system wells or industrial wells) to help protect the well from contamination. The California Well Standards Ordinance also requires contractors to notify the FCEHD office at least twenty-four (24) hours in advance of the scheduled time to install the annular seal so that Environmental Health staff can arrange to inspect the seal installation process. This inspection helps to ensure that the seal is installed in an approved manner to help prevent contamination of the well water.

More information can be found at the FCEHD Water Well Permitting Program website https://www.co.fresno.ca.us/departments/public-health/environmental-health/water-surveillance-program/water-well-permitting-program

Information requested on well permit applications as required by the State are as follows:

1. A map of the desired well location (distance from streets, global positioning coordinates, ground elevation)
2. Depth of well
3. Estimated pumping rate, schedule, and annual extraction volume
4. Water table depth, location to flood plain
5. Distance from potential pollution sources onsite or on adjacent properties
6. Distance from ponds, lakes, or streams
7. Any existing wells on the property including use, depth, and estimated extraction volume
8. The size in acres to be served by the well
9. Planned category use, such as irrigation, stock, domestic, municipal, or industrial

Existing well permitting programs may need to be expanded and adequately funded to ensure that location, well depth, water quality, and production information is collected, and well construction specifications and well abandonment standards are enforced.

New well permits could be conditioned upon receiving a water availability determination. New development projects could be required to secure "will serve" letters from local water agencies, and larger projects could be subject to water availability determinations to show that sufficient water is available as part of the land-use approval process. These requirements could also be expanded. Land-use agencies could be required to consider protection of prime groundwater recharge areas and consult groundwater management agencies regarding any significant groundwater-dependent development, including new permanent crop plantings to obtain "will serve" letters and water availability determinations.

2.3.5 Land Use Plans Outside the Basin

Regulation Requirements:

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

The relevant land-use plans located outside MAGSA include the City of Kerman General Plan, Madera County General Plan, and the City of Fresno General Plan. To MAGSA benefit, all nearby General Plans contain similar policies promoting water conservation, sustainable development, above ground storage, and recycled water. All nearby General Plans are upgradient of MAGSA (refer to **Figure 2-12**). All upgradient basin recharge, water recycling, and use of surface water in-lieu of groundwater pumping will improve the ability of MAGSA to achieve sustainable groundwater management. In addition, the up-gradient policies regarding water quality and contamination prevention combat the potential of contaminant plumes from migrating into MAGSA.

City of Kerman General Plan - Chapter 4 of the Kerman General Plan (conservation, open space, parks and recreation), discusses the conservation, development, and utilization of natural resources, including water, forests, soils, rivers and other waters, wildlife, and other natural resources. The relevant policies are listed below:

- Policy 3 (page 4-18) - Allow for adequate groundwater recharge by developing storm ponding and retention basins where feasible. In some areas, these ponds or basins can be incorporated into a recreational area or used as a wildlife habitat area.
- Policy 4 (page 4-19) - The City should develop a secondary water source system ("purple pipe system") that can be incorporated into new development to use less potable water for the irrigation of parks, schools, and public landscaping.

Madera County General Plan - Public Facilities and Services, Section 3 of the Madera County General Plan, discusses water supplies, water quality, and groundwater use. The goal for water supply and delivery is to ensure the availability of an adequate and safe water supply and the maintenance of high-quality water in water bodies and aquifers used as sources of domestic and agricultural water supply. The goal of Water Resources, Section 5C, is to protect and enhance the natural qualities of Madera County's streams, creeks, and groundwater. The relevant polices are listed below:

- Policy 3.C.1 - The County shall approve new development only if an adequate water supply to serve such development is demonstrated.
- Policy 3.C.7- The County shall promote the use of reclaimed wastewater to offset the demand for new water supplies.
- Policy 3.C.8 - The County shall support opportunities for groundwater users in problem areas to convert to surface water supplies.
- Policy 3.C.12- The County shall support programs for the agricultural re-use of reclaimed water.
- Policy 5.C.8 - The County shall protect groundwater resources from contamination and further overdraft by encouraging water conservation efforts and supporting the use of surface water for urban and agricultural uses whenever feasible.

City of Fresno General Plan - Public Utilities and Services, Chapter 6 of the Fresno General Plan, discusses the planning, provision, and maintenance of water, wastewater, solid waste systems, and other facilities operated by the City. The objective of Section 6.4 is to "manage and develop the City's water facilities on a strategic timeline basis that recognizes the long-life cycle of the assets, and the duration of the resources, to ensure a safe, economical, and reliable water supply for existing customers, planned urban development and economic diversification." The relevant policies are listed below:

- PU-7-c- Wastewater Recycling. Pursue the development of a recycled water system and the expansion of beneficial wastewater recycling opportunities, including a timely technical, practicable, and institutional evaluation of treatment, facility siting, and water exchange elements.
- PU-8-b- Water Supply. Prepare for provision of increased potable water capacity (including surface water treatment capacity) in a timely manner to facilitate planned urban development consistent with the General Plan.
- PU-8-f- Water Quality. Continue to evaluate and implement measures determined to be appropriate and consistent with water system policies, including prioritizing the use of groundwater, installing wellhead treatment facilities, construction of above-ground storage and surface water treatment facilities, and enhancing transmission grid mains to promote adequate water quality and quantity.
- PU-8-g- Review Project Impact on Supply. Mitigate the effects of development and capital improvement projects on the long-range water budget to ensure an adequate water supply for current and future uses.

2.4 Additional GSP Components

Regulation Requirements:

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

2.4.1 Saline Water Intrusion

Saltwater intrusion is a major concern commonly found in coastal aquifers around the world. Saltwater intrusion is the flow of seawater into freshwater aquifers primarily caused by groundwater development near the coast. Where groundwater is being pumped from aquifers that are in hydraulic connection with the sea, gradients may cause the migration of saltwater from the sea toward a well, making the freshwater well unusable. Given the distance separating McMullin area from the Pacific Ocean, saltwater intrusion from the ocean into the freshwater aquifer is not a concern for the area. However, groundwater with naturally occurring elevated concentrations of salts exist at depth in the local aquifers. The interface between the freshwater zone and the saline water zone represents a flow divide and defines the bottom of the fresh groundwater flow system. Below this depth, driving forces are not strong enough to counteract buoyancy and viscosity forces such that there is little mixing of modern groundwater recharge with formation waters. By determining the depth of this mixing zone throughout the study area, a physically based bottom boundary can be represented (base of freshwater system). The base of freshwater, or the depth at which elevated specific conductance is encountered, has been characterized as the boundary where the concentration of specific conductance is over 3,000 μS/cm (Page, 1973). The base of freshwater varies throughout the GSP area and is discussed in detail in Section 3.1 – Hydrogeologic Conceptual Model. As wells are drilled deeper, pumping can cause upcoming (i.e., upward vertical migration) of saline water thus increasing salinity in the freshwater aquifer. The MAGSA plan participants strive to prevent the importation of saline surface waters that could ultimately degrade the groundwater. When alternative water sources are available for importation, the plan participants consider not only the cost but also the quality, including salinity, of the water. MAGSA will monitor water quality in a manner that provides management information about salinity in the area.

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." 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.

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

The 1996 federal Safe Drinking Water Act amendments require each state to develop and implement a Source Water Assessment Program. Section 11672.60 of the California Health and Safety Code requires the Department of Health Services (DHS, the precursor to the California Department of Public Health) to develop and implement a program to protect sources of drinking water, specifying that the program must include both a source water assessment program and a wellhead protection program. In response to both legal mandates, DHS developed the Drinking Water Source Assessment and Protection (DWSAP) Program. California's DWSAP Program addresses both groundwater and surface water sources. The groundwater portion of the DWSAP Program serves as the state's wellhead protection program. DHS submitted the

DWSAP Program in January 1999. The United States Environmental Protection Agency (EPA) approved the DWSAP as California's wellhead protection program in January 1999. In November 1999, EPA gave final approval of the DWSAP Program as California's source water assessment and protection program. DHS was responsible for the completion of all assessments by May 2003. Wellhead Protection Programs are not regulatory in nature, nor do they address specific sources. They are designed to focus on the management of the resource rather than control a limited set of activities or contaminant sources.

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. Therefore, essential elements to any wellhead protection program are 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 member agencies are designed and constructed in accordance with DWR Bulletin 74-81 and 74-90. A permit is needed from the county to construct a new well. In addition, the member agencies encourage landowners to follow the same standard for privately owned wells. DWR Bulletins 74-81 and 74-90 provide specifications pertaining to wellhead protection, including:

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

2.4.3 Migration of Contaminated Groundwater

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

Just as groundwater generally moves slowly, so do contaminants in groundwater. Because of this slow movement, contaminants tend to remain concentrated in the form of a plume that flows along the same path as the groundwater. The size and speed of the plume depends on the amount and type of contaminant, its solubility and density, and the velocity of the surrounding groundwater. Contaminants can also move into the groundwater system through macro-pores—root systems, animal burrows, abandoned wells, and other systems of holes and cracks that supply pathways for contaminants. In areas surrounding pumping wells, the potential for contamination increases because water from the zone of contribution, a land area larger than the

original recharge area, is drawn into the well and the surrounding aquifer. Under certain conditions, pumping can also cause the groundwater (and associated contaminants) from another aquifer to enter the initial water source being pumped. This phenomenon is called inter-aquifer leakage. Thus, properly identifying and protecting the areas affected by well pumping is an important strategy to maintaining groundwater quality.

Groundwater within the GSA Area is generally of good quality for agricultural use. However, serious water quality problems in certain areas exist due to high concentrations of certain constituents. Information on existing contaminant plumes is limited. Therefore, specific information on the plumes is not provided here. However, some of the main constituents of concern include nitrate, Dibromo-Chloropropane (DBCP), Ethylene-Dibromide (EDB), 1,2,3-Trichloropropane (TCP) and petroleum hydrocarbons. Contamination of groundwater can result in poor drinking water quality, loss of water supply, degraded surface water systems, high cleanup costs, high costs for alternative water supplies, and/or potential health problems. Several federal laws help protect groundwater quality. The Safe Drinking Water Act established three drinking water source protection programs:

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

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

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

The Department of Toxic Substance Control - The 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 DTSCs oversight. The online database can be accessed at http://www.envirostor.dtsc.ca.gov.

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

2.4.4 Well Abandonment/Well Destruction Program

Well abandonment generally includes the proper capping and locking of a well that has not been used in over a year. Well destruction includes completely filling in a well in accordance with standard procedures. 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 state legislature. Fresno 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. Enforcement is the responsibility of local authorities.

MAGSA's member agencies have and will continue to properly destroy any of their wells that are no longer used and will additionally enforce proper well destruction procedures for private wells. In addition, the member agencies will encourage landowners and developers to convert unusable wells into monitor wells, rather than destroying them, so that they can become a part of the region's groundwater monitoring program.

2.4.5 Replenishment of Groundwater Extractions

Groundwater replenishment happens through direct recharge and in-lieu recharge. Water used for direct recharge most often comes from flood flows, water conservation, recycled water, desalination, and water transfers, according to DWR. During the hydrologic cycle, replenishment occurs naturally when rain, stormwater, and the flow from rivers, streams and creeks seep into an aquifer. Water also gets into ground as farmers irrigate fields and orchards. Replenishment within the context of groundwater management is accomplished through recharge at a rate that exceeds baseline conditions, maintaining or improving groundwater elevation levels. Two recharge methods are used: direct spreading and aquifer injection. There is also in-lieu recharge in which an alternative source is provided to users who would normally use groundwater, thereby leaving groundwater in place for later use and increasing the potential to improve groundwater levels.

In the McMullin area, the primary local water sources for groundwater replenishment include precipitation and San Joaquin and Kings River flood flows. The neighboring agencies with surface water infrastructure or access to surface water include JID, CID, FID, LID, Mutual Water Companies, KRCD, and KRWA. For more information, refer to the Conjunctive Use Programs section. Refer to Water Budget Information section in the Basin Setting chapter for discussions on how groundwater recharge is credited to different agencies.

2.4.6 Well Construction Policies

Proper well construction is important to ensure reliability, longevity, and protection of groundwater resources from contamination. All the member agencies follow State standards (DWR Bulletins 74-81 and 74-90) when constructing municipal and agricultural wells. Fresno County has adopted a well construction permitting program consistent with State Well Standards to help ensure proper construction of private wells. The County maintains records of all wells drilled in the Plan area. As of 2017, there were no limits on well construction, which may be revisited in the future. Private domestic or agricultural wells can be drilled with a county permit. State well standards address annular seals, surface features, well development, water quality testing, and various other topics. Refer to DWR Bulletins 74-81 and 74-90 for more details on State law. The GSA may decide to enforce more stringent well construction policies for keeping track of construction and water level measurement data. They would need to enter into an agreement with the County of Fresno to make any changes to permitting operations. More information on potential additional well construction policies can be found in **Section 6.3**.

2.4.7 Groundwater Projects

All the member agencies share responsibility for development and operation of recharge, storage, conservation, water recycling, and extraction projects. The member agencies in general develop their own projects to help meet their water demands and will continue to develop additional future projects to meet sustainability. Developing more groundwater recharge and water banking projects is considered key in stabilizing groundwater levels. **Chapter 6** provides descriptions, estimated costs, and estimated yield for numerous proposed projects.

The role of the MAGSA is to promote cooperation and sharing of information and ideas between the agencies. The MAGSA will also support measures to identify funding and implement regional projects that help the region achieve groundwater sustainability. This can include recharge projects that take advantage of areas conducive to recharge and areas where recharge provides the most benefits, thereby reducing the burden on certain agencies from having to recharge in their boundaries if they do not have suitable land or soils.

There are several proposed recharge projects to improve groundwater conditions in the area, which are generally favorable for artificial recharge. For more detailed information on potential projects, refer to **Chapter 6**.

2.4.8 Efficient Water Management Practices

Water management is an important element of irrigated crop production. Efficient irrigation systems and water management practices can help maintain farm profitability in an era of limited, higher-cost water supplies. Efficient water management may also reduce the impact of irrigated production on offsite water quantity and quality. As is often the case, technology is not the whole solution anywhere, but part of the solution almost everywhere. 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. Since groundwater is currently the only source of water for the farmers and other users within MAGSA, there is a clear awareness of the importance of water conservation and a renewed focus on developing recharge and surface water deliveries projects. Four components are being considered. These are direct groundwater recharge, dormant flooding, in-lieu surface water deliveries, and groundwater banking. The intent of these options is to capture floodwater from the Kings and San Joaquin Rivers, when available, and to provide the facilities with which the water districts could participate in transfers or exchanges that would net water for the growers – either groundwater or surface water – and help move the plan area towards sustainability. Continuing some of these conservation efforts will be necessary to achieve groundwater sustainability. Recycled water use is considered an important beneficial use of water but is unavailable in this area. There may be future purchases of recycled water from other agencies outside of MAGSA with potential projects discussed in **Section 6.2**. Future efforts will include an increased focusing on elevating awareness on groundwater overdraft and land subsidence and explaining the requirements of SGMA.

2.4.9 Relationships with State and Federal Agencies

From a regulatory standpoint, the plan members have numerous relationships with State and Federal agencies related to flood water supply, water quality, and water management. Those relationships that are common to all water agencies, such as regulation of municipal water by the California Division of Drinking Water, are not discussed here. Relationships unique to the plan area are briefly summarized below.

Kings River Flood Water. - The Kings River could provide a significant amount of the surface water to be used in the area. Kings River water is impounded by Pine Flat Dam, which is owned and operated by the USACE. The water rights permits were obtained from the State Water Resources Control Board, although allocation and management of water is largely handled by the Kings River Water Association. The local

agencies have on occasion diverted King's River flood water through agreements with the KRWA and continue to explore possibilities for future flood water diversions.

San Joaquin River Water. - MVWD receives on occasion San Joaquin River Section 215 water from the Friant Division of the Central Valley Project. The Friant Dam is owned and operated by USBR). The USBR is also the lead agency for the San Joaquin River Restoration, which has resulted in significant delivery curtailments to Friant contractors. RCWD and MVWD are working toward developing programs that will allow them to take the Friant division flood water either directly from the Bureau or via other CVP contractors like FID.

California Department of Fish and Wildlife. - The alkali sinks ecological reserve property, around 930 acres, was acquired to preserve remaining Alkali Sink Scrub habitat and was designated an ecological reserve by the Fish and Game Commission in 1979. The Kerman ecological reserve property covers 1,800 acres and was designated an ecological reserve by the Fish and Game Commission in 1990. Both properties are within McMullin GSA area, and they are both owned and managed by the CDFW.

MAGSA members are also eligible to receive grants from various agencies for water-related projects. Grants are obtained from DWR, SWRCB, USGS, the United States Department of Agriculture (USDA), and others. The member agencies work closely with these state and federal agencies to track grant programs and administer and implement grant contracts.

2.4.10 Land-Use Planning

Apart from the Ecologic Reserves land that is owned and managed by the CDFW, Fresno County is the only member agency with direct land-use planning authority. However, all the member agencies have an interest in land-use planning policies and how it will impact their continued development and water supplies. **Figure 2-4** is a map showing land use in the MAGSA area, including areas that are developed for urban and agricultural use.

Land-use policies are documented in various reports such as General Plans, Specific Plans, and plans for proposed developments. Updating some of these plans is a multi-year process and not all could be fully updated concurrently with the GSP development. These plans are expected to be modified gradually over time to be consistent with the goals and objectives of this GSP. Some smaller communities have no formal land-use policies or rely on county policies. These smaller communities will need to develop new policies and long-term plans as part of the SGMA process.

2.4.11 Impacts on Groundwater Dependent Ecosystems

Groundwater dependent ecosystems (GDE) are not prevalent in MAGSA due to heavy historical pumping causing groundwater levels to fall dramatically combined with a lack of surface water inflow. The impact of this GSP on GDEs will be further discussed in **Section 3.2**.

2.5 Notice and Communication

2.5.1 Description of Beneficial Uses and Users

Regulation Requirements:

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

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

Agricultural Users – Most of MAGSA's area is composed of agricultural users. Agricultural users are represented on the MAGSA Board of Directors through the member agencies. The MAGSA has developed and continues to improve blanket mailing lists which were used to notice several landowner outreach events. These lists, as well as email lists, will continue to be expanded and maintained leading into the development and through implementation of a GSP to ensure overlying users stay informed and have a reasonable opportunity to participate in the process. As JID has a deed to extract groundwater from the MAGSA service area, an invitation letter was sent by MAGSA to JID inviting them to participate as an Interested Party.

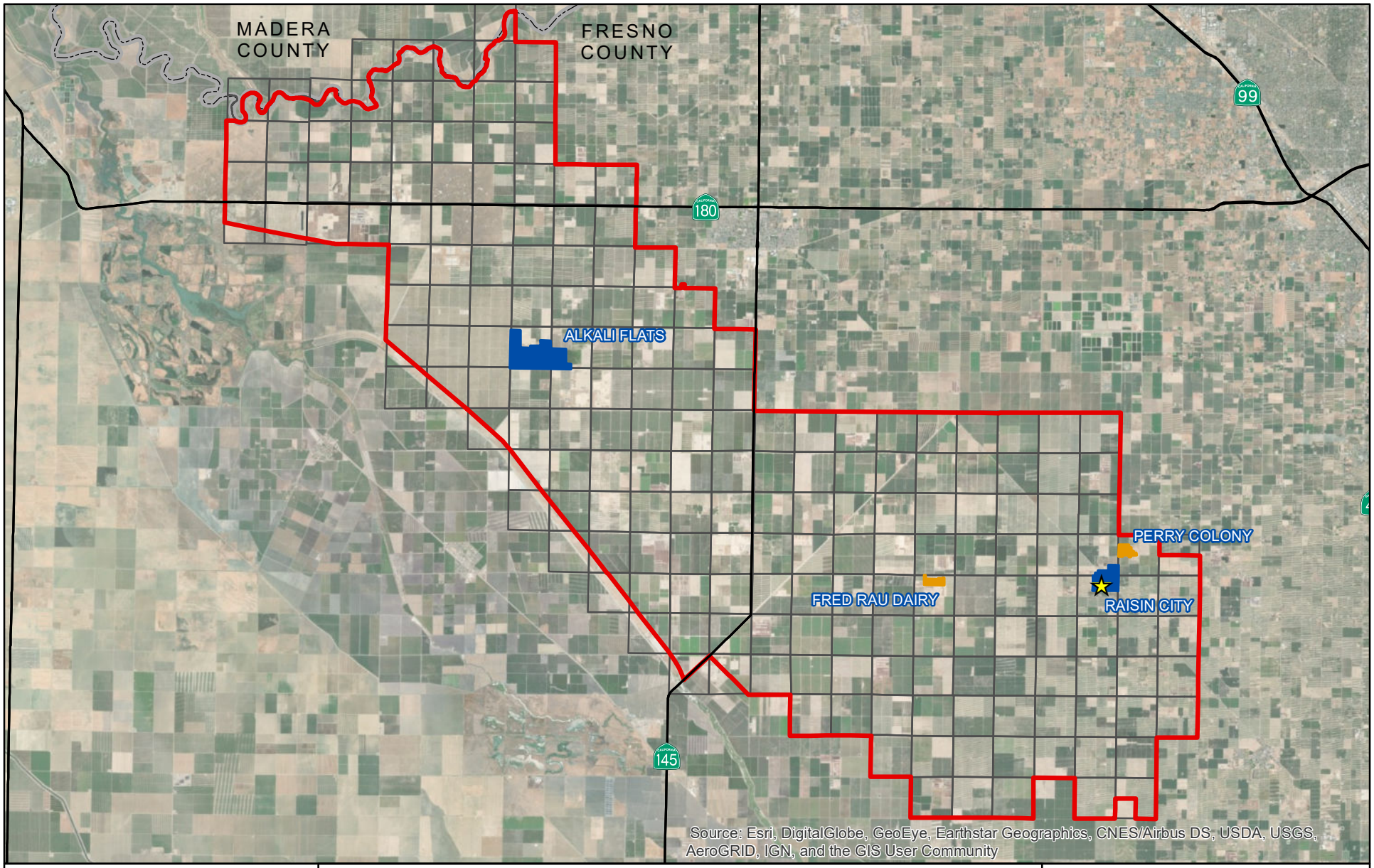
Domestic Well Users - Rural residents within the GSA boundaries are reliant upon groundwater to meet their domestic needs. MAGSA will reach out to rural residents through direct communications and will afford rural residents every opportunity to engage in any groundwater planning and management efforts that may have an impact on their domestic wells.

Municipal Well Operators - There are no municipal well operators within the boundaries of MAGSA.

Public Water Systems - The County of Fresno operates a public water system within the unincorporated community of Raisin City. The County is a participating member with representation on the MAGSA Board of Directors.

Local Land-Use Planning Agencies - The County of Fresno is the overlying land-use planning agency within the boundaries of MAGSA. The County is a participating member with representation on the MAGSA Board of Directors.

Environmental Users of Groundwater - The State of California owns land within and adjacent to the GSA boundary. The lands are managed by the CDFW. Much of lands are within the Delta-Mendota Subbasin and outside of the Kings Subbasin. The MAGSA will consult with CDFW on any groundwater management efforts that may have an impact on their environmental uses. An invitation letter was sent by MAGSA to CDFW inviting them to participate as an Interested Party.



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An Employee Owned Company

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Legend

- McMullin Area GSA
- County

Community

- Disadvantaged
- Severely Disadvantaged
- Raisin City Elementary

McMullin Area GSA

Disadvantaged Communities

Figure 2-13

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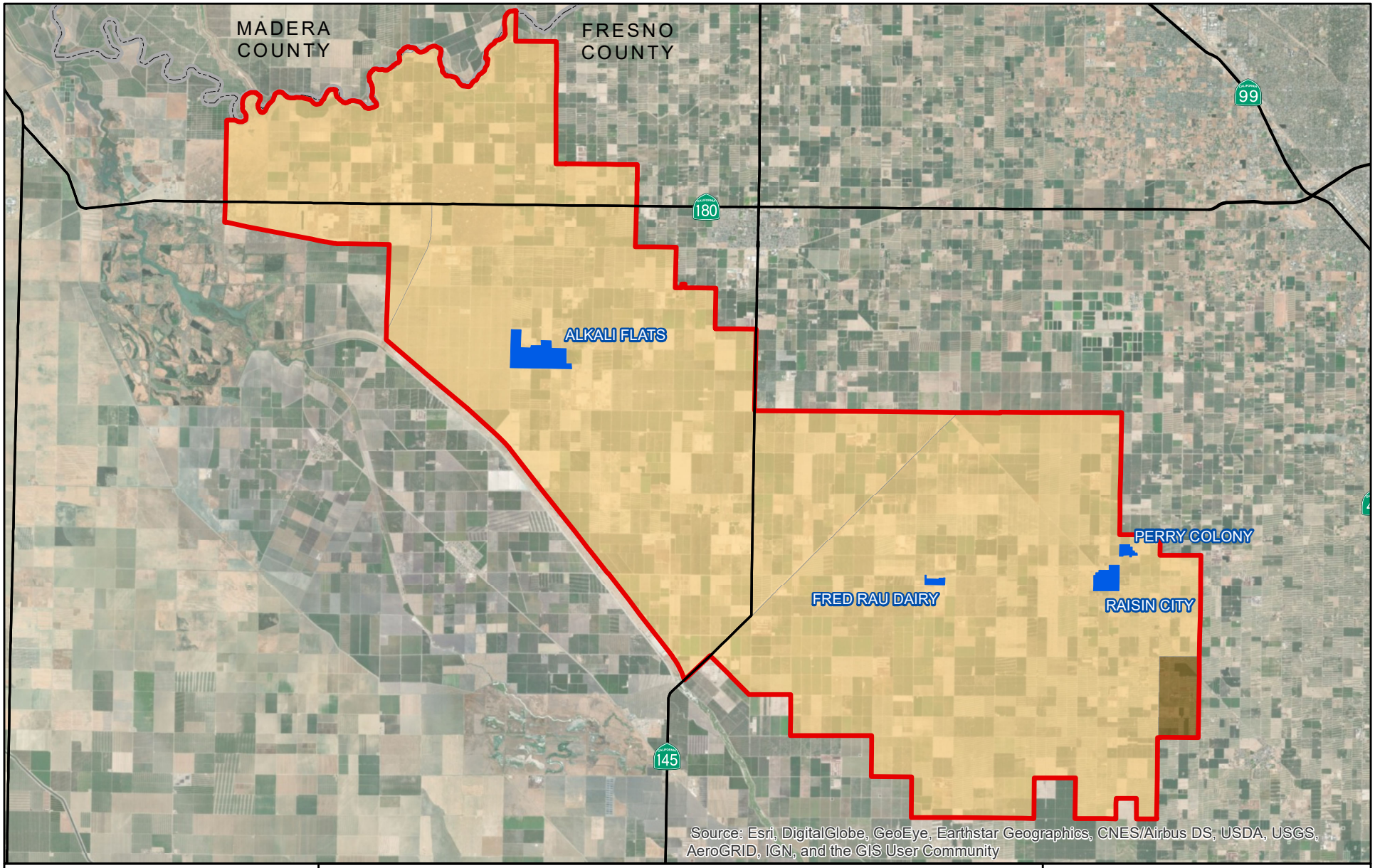

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Legend

- Community
- McMullin Area GSA
- County

Census Tract*

- Disadvantaged Community (DAC)
- Severly Disadvantaged Community (SDAC)

*ACS 2012-2016 CA DWR

McMullin Area GSA

DAC/SDAC Census Tracts

Figure 2-14

11/19/2018 : G:\McMullin GSA-2659\265917002-Technical Services\GIS\Map\Report\Gen\DAC_SDAC_tracts.mxd

Federal Government - The MAGSA is not aware of any federal government lands within the GSA area. There are no military facilities in the vicinity of the GSA area. There may be Waters of the United States within or adjoining the GSA area.

California Native American Tribes - The MAGSA is unaware of any lands within its territory that fit this category. On March 1, 2017, a Sacred Lands File and Native American Contacts List Request was submitted to the Native American Heritage Commission. A response to the request has not been received. MAGSA will ensure there is a means for tribes to participate should the response received indicate there is a need.

Disadvantaged Communities - The most recent Census tract data and Disadvantaged Community (DAC) pilot studies conducted by the Kings Basin Water Authority and County of Tulare indicate that most of the service area meets the California Water Code definition of a DAC. The MAGSA will continue to work towards identifying and addressing the interests of private domestic well owners.

Agencies - Entities are listed in Water Code section 10927 that are monitoring and reporting groundwater elevations in all or a part of a groundwater basin to be managed by the MAGSA. KRCD serves as the California Statewide Groundwater Elevation Monitoring (CASGEM) entity monitoring groundwater elevations in the Kings Subbasin. The County will continue to coordinate its groundwater monitoring activities with the KRCD and will support the KRCD in its role as the CASGEM entity monitoring groundwater elevations in the Kings Subbasin.

Regulation Requirements:

§354.10 Each plan shall include a summary of information relating to notification and communication by the Agency with other agencies and interested parties including the following:

(b) A list of public meetings at which the Plan was discussed or considered by the Agency.

Table 2-8 Public Meetings (Plan Discussed)

Public Meetings (Plan Discussed)		
Year	Date	Type of Meeting/Location
2017	Monthly	Board Meeting, Kerman
	6/14/2017	Landowner meeting, Kerman
	6/22/2017	Landowner meeting, webinar
	6/29/2017	Landowner meeting, Raisin City
2018	Monthly	Board Meeting, Kerman
	5/9/2018	Prop 218 Workshop, Kerman
	5/16/2018	Prop 218 Workshop, webinar
	5/23/2018	Prop 218 Workshop, Raisin City
	Monthly	Board Meeting, Kerman
	4/19/2019	GSP Progress Update, Kerman
	5/1/2019	GSP Progress Update, Kerman
	5/13/2019	MAGSA Open House, Kerman
	5/29/2019	Board GSP Workshop, Kerman
	6/5/2019	GSP Progress Update, Kerman
	8/13/2019	GSP Public Workshop, Kerman
	8/15/2019	GSP Webinar, online

Public Meetings (Plan Discussed)		
Year	**Date**	**Type of Meeting/Location**
2019	9/18/2019	GSP "Office Hours" Chat, Kerman and online
	10/16/2019	GSP Public Hearing
2020	Monthly	Board Meeting, Kerman (online during COVID-19 emergency)
	7/29/2020	Water Market Study Workshop, online
	10/21/2020	Water Market Study Workshop #2, online
	10/29/2020	Water Bank Tour, MAGSA service area
2021	Monthly	Board Meeting, Kerman (hybrid post-COVID-19 emergency)
	1/20/2021	2021 Vision Event, online
	1/27/2021	Water Market Workshop, online
	6/30/2021	OFR Public Scoping Session, online
	7/22/2021	OFR Webinar: Pecans & Other Nuts, online
	11/10/2021	Aquaterra Public Scoping Session, online
2022	Monthly	Board Meeting, Kerman (hybrid)
	1/26/2022	2022 Vision Event, online
	4/27/2022	Aquaterra Landowner Meeting, Kerman
	4/28/2022	Aquaterra Landowner Meeting, Kerman

Regulation Requirements:

§354.10 Each plan shall include a summary of information relating to notification and communication by the Agency with other agencies and interested parties including the following:

(c) Comments regarding the Plan received by the Agency and a summary of any responses by the Agency.

Public Comment and Response Management - A system for managing public comments and responses was developed to help track all comments received and status of comments. The public has the opportunity to submit comments through both in-person and online platforms. The system chapters and section to help track all feedback received. A tracking document is maintained by MAGSA staff to ensure all comments are recorded.

2.5.2 Decision-Making Process

Regulation Requirements:

§354.10 (d) A communication section of the Plan that includes the following:

1) An explanation of the Agency's decision-making process.

The MAGSA was formed by a JPA between the Mid-Valley Water District, the Raisin City Water District and the County of Fresno. Refer to **Appendix 2-A** for the JPA Agreement. The governing body of the JPA consists of a five-member Board of Directors, with each seat selected by the respective board of each Member as identified in **Table 2-9**.

Table 2-9 MAGSA Board of Directors

Seat	Assignment
1	Raisin City Water District
2	Raisin City Water District
3	Mid-Valley Water District
4	County of Fresno
5	'White Area' landowner appointed by the County of Fresno

The MAGSA Board is the governing and legislative body for the McMullin Area Groundwater Sustainability Area. Two members represent the RCWD area. One member represents the MVWD area. One member represents the Fresno County, and one member is a landowner representative. Seat 5 shall be an individual, or authorized representative of an entity, that owns land that is: (1) within the boundaries of the Authority and (2) outside the service area of MVWD or RCWD. Each Director representing a Member on the Board of Directors of the Authority may identify up to two alternates to serve on the Member's behalf. Unlike Directors, Alternates need not be elected officials.

When the Board is deciding on matters related to implementing SGMA, they review reports provided by either staff and/or ad hoc committees. The reports can provide recommendations or different options on how the Board can proceed. In addition to reports from staff and ad hoc committees, the Board may take into consideration the input of stakeholders. All Board meetings are open to the public, except in special cases when confidential information, as permitted by law, requires a closed session.

The MAGSA decision-making process is a bottom-up process in which stakeholders take part in the planning, implementation, monitoring, and evaluation of MAGSA's projects and programs. Stakeholder involvement is encouraged and sought not only through workshops and direct communications but also through the structure of the two-stage decision-making procedure.

1) The ad hoc committees, each led by assigned Board members, convene as needed to work on administration of the GSA and GSP development and implementation.
2) Outcomes from the ad hoc committees will be added to the publicly noticed MAGSA Board agendas for discussion or as action items.

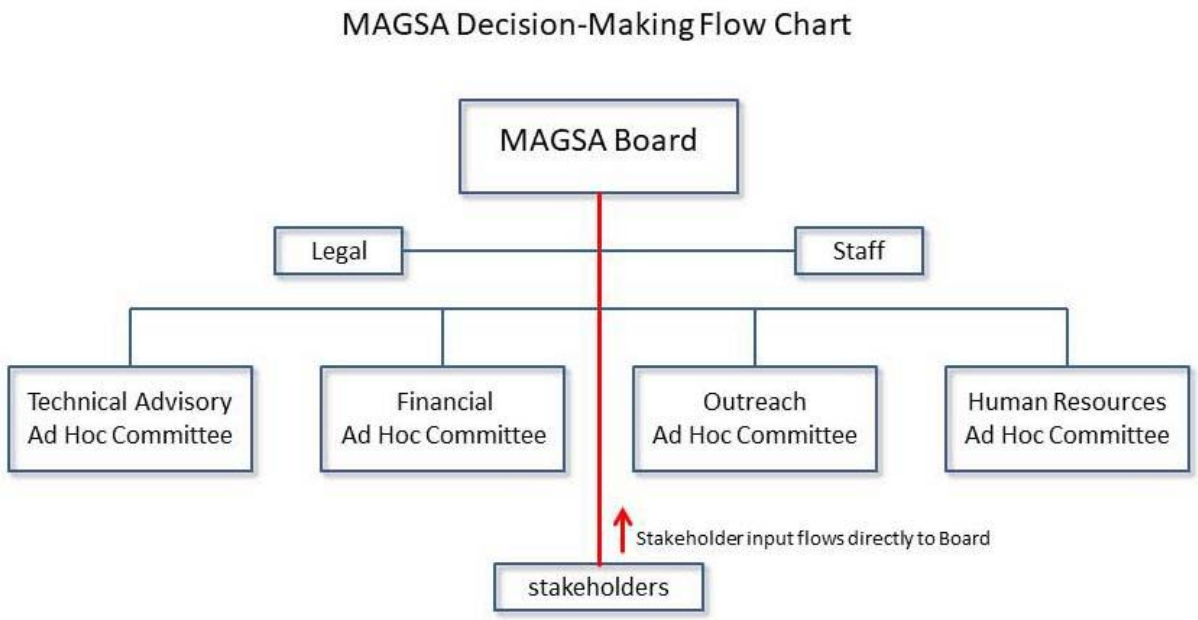


Figure 2-15 MAGSA Decision-Making Flow Chart

All board actions require a majority vote of the Board of Directors, except the following nine (9) board actions:

Table 2-10 Voting Thresholds for Specific Board Actions

	Board Action	Voting Threshold
1.	Adoption of or amendment to a GSP	Unanimous vote of all Directors
2.	To incur debts, liabilities or obligations on behalf of the Authority	Unanimous vote of all Directors
3.	Adoption of or revisions to policies of the Authority	Unanimous vote of all Directors
4.	GSA Enforcement	Three affirmative votes by Directors
5.	Authorization to participate in litigation, or other legal proceedings	Unanimous vote of all Directors
6.	Amendment of the Joint Powers Agreement	Unanimous vote of all Directors, subject to ratification by all Members
7.	Any assessment or fee levied or imposed by the GSA	Unanimous vote of all Directors
8.	Budget allocation among Members for GSA operations after initial GSP	Unanimous vote by all Directors
9.	Removal of a Member from the GSA	Three affirmative votes by Directors

2.5.3 Public Engagement / Public Outreach Plan

Regulation Requirements:

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

The MAGSA at their April 2017 Board meeting approved the decision to file paperwork with the State declaring the agency's intent to be the exclusive GSA for a portion of the Kings Subbasin. The Board also approved at their April 2017 meeting an outreach strategy to stakeholders.

The development of the MAGSA GSP is an inclusive, transparent effort requiring ongoing engagement with a variety of stakeholders to allow public input and response during various stages of development. The purpose of the communication plan is to guide MAGSA's stakeholder involvement efforts. This plan is intended to be flexible and adaptive in order to reflect stakeholders' needs and to identify the best practices for stakeholder involvement.

This plan is intended to be flexible and adaptive to reflect stakeholder needs and best practices for stakeholder involvement. Outreach strategies and campaigns supporting planned implementation activities are presented at MAGSA board meetings and the Outreach Ad Hoc Committee is available for further oversight and input. This public review of the outreach strategy will allow for public recommendations on best methods for communicating and informing stakeholders.
Engagement with groundwater users occurs in the following phases of the development and implementation of the GSP:

1. Formation of the GSA
2. Development of the Draft GSP
3. Finalization of the GSP
4. Implementation of the GSP

The plan's overarching goal is to inform, engage, and build stakeholder support for MAGSA's GSP metrics and thresholds and ultimately for those of the Kings Subbasin service area. A diverse, active, engaged public will help better identify issues, form solutions, and create a partnership between the MAGSA Board and stakeholders.

Specific goals that the communication plan seeks to accomplish include the following:

- Build stakeholder and broader public understanding of SGMA including purpose, timeline, and requirements
- Inform and raise awareness about MAGSA, including governance structure and powers
- Provide accurate, easy-to-understand, and timely information on ongoing Board activities and GSP development and implementation activities
- Promote communication between stakeholders and the MAGSA Board
- Describe how MAGSA relates to the broad sustainability goals of the Kings Subbasin
- Encourage and solicit public comments before key decision points of GSP development
- Demonstrate willingness to incorporate public input received in decisions
- Implement the SGMA requirements in a transparent manner

Key Messages - MAGSA incorporated and will continue to incorporate key messages in all its communications and engagement activities to help foster clear and accurate communication. This will ensure a level of consistency across all outreach efforts, instill stakeholder trust, and provide the opportunity for MAGSA staff to engage with stakeholders and communicate a common message. Messages will continue to be developed as GSP development and implementation progresses. Current key messages include:

- SGMA was written to allow local agencies to manage groundwater; however, there are requirements in the law that allow the State to intervene if they are not met.
- The Kings Subbasin must become sustainable by 2040.
    - The Kings Subbasin has been divided into seven separate Groundwater Sustainability Agencies that must come together to make the subbasin sustainable. The McMullin Area GSA is one of the seven.
- MAGSA is a Joint Powers Authority that includes the boundaries of three agencies
    - Your representation on the Board depends on your location in the McMullin Area.
- A GSP has specific requirements under SGMA.
    - MAGSA is responsible for developing and implementing a GSP that fits into the other six GSPs to achieve subbasin sustainability.
    - While these requirements are similar for all GSAs, the McMullin Area's issues and solutions will be very specific.
- Development of a GSP will require the services of technical consultants, lawyers, and other costs.
    - It is estimated that GSP development alone can cost up to $1,000,000.
    - SGMA is an unfunded mandate from the State that can have severe consequences for landowners if the requirements are not met.
    - The Kings Subbasin GSAs are submitting a grant application for up to $1.5 million that will be equally split between seven GSAs reducing the cost of GSP development.
    - MAGSA is utilizing member agency staff and public agency support to minimize expenses and provide efficiencies in the process.
    - MAGSA will assess landowners to cover the costs of implementing SGMA.
    - The alternative to a GSP is to have State intervention that includes State-mandated requirements and a high fee structure.
- Many decisions affecting groundwater use will be made as the GSP is developed and implemented.
    - MAGSA has unique groundwater management challenges.
    - The goal of the MAGSA Board is to develop a GSP that will allow as much flexibility as possible in supply- and demand-side solutions for sustainability.

- The MAGSA Board seeks landowner involvement.
- MAGSA will be asking for stakeholder input during key decision points and milestones upon GSP development and implementation.

- MAGSA is committed to securing a sustainable groundwater supply through collaboration with stakeholders.
  - Landowner involvement and collaboration in the GSP implementation process is essential to securing a sustainable groundwater supply for generations to come.

Growers are now taking responsibility for reaching groundwater sustainability. As growers start to be better land use planners and use water resources thoughtfully and responsibly, they are playing an important role in efforts toward sustaining regional groundwater resources.

Future outreach messaging will be developed for implementation and policy development.

Accountability and Transparency - Being open and involving stakeholders creates a democratic process that will produce a more qualified outcome. Accountability and transparency are important to the success of implementing SGMA within the McMullin Area. MAGSA will adhere to the following practices to help ensure accountability and transparency:

- Advanced notifications of meeting times, locations, and agendas
- Web posting of MAGSA materials
- Solicitation of input from stakeholders and good faith effort to incorporate stakeholder interests

Communication Plan Oversight - Oversight of the communication plan implementation will be provided by the MAGSA Board. All campaigns and strategies developed to implement MAGSA's Communication Plan are presented at MAGSA board meetings. The Ad Hoc Outreach Committee is also available for oversight and input. To measure the effectiveness and success of the outreach strategies, a set of quantitative metrics will be used. The metrics can also be used to track progress of the plan's goals. Some metrics that will be used include number of stakeholder meetings held, frequency of communications to Interested Persons, and website visits. Changes will be made to the plan as needed to ensure achievement of the plan's goals, while adhering to the principles outlined in the plan.

Public Input - The MAGSA Board is committed to transparency in public-decision processes and to stakeholder participation and dialogue with the goal of enabling beneficial users and stakeholders to access information and to increase collaboration. MAGSA seeks to have stakeholders contribute their own knowledge and experience in ways that can broaden and strengthen the outcomes of the process. Partnering with the public and responding to their input will ensure the development of the best possible solutions.

2.5.4 Encouraging Active Involvement

Regulation Requirements:

§354.10 (d)

3) A description of how the Agency encourages the active involvement of diverse social, cultural, and economic elements of population within the basin.

4) The method the Agency shall follow to inform the public about progress implementing the Plan, including the status of projects and actions.

See **Appendix 2-B** for stakeholder outreach strategy documents.

There are multiple stakeholders who have a personal or professional stake in the MAGSA Board decisions and associated GSP implementation. MAGSA will implement the plan in a coordinated effort that engages these multiple audiences throughout various outreach and involvement activities. Stakeholders will be

interested in both program-level and project-specific activities. Stakeholders will be asked to contribute their knowledge and voice their opinions at key decision points.

MAGSA will initiate many outreach activities and produce outreach materials to encourage active engagement by all stakeholders in GSP development. This Plan will guide the Ad Hoc Outreach Committee to implement consistent and coordinated public involvement and outreach. MAGSA seeks to actively solicit information, feedback, and opinions from stakeholders and beneficial users to inform on program implementation decisions. To meet this objective, MAGSA will engage with stakeholders in new and existing venues.

Strategies for Engagement - SGMA requires the GSA to consider the interests of all beneficial uses and users of groundwater and encourage involvement of diverse social, cultural, and economic elements of the population within the Basin during GSP preparation and implementation. MAGSA will provide opportunities for the public to participate in the planning and implementation process of the GSP. Some of the strategies of engagement include field briefings, one-on-one meetings, community meetings, industry/association briefings, newsletters, landowner/webinar workshops, and dedicated office hours.

Interested Person's List - MAGSA has been developing an Interested Person's list since early 2015. The list is used to notify and encourage stakeholders and beneficial users to get involved in Board meetings and attend outreach events and workshops. The list will also be used to provide updates after each Board meeting and notices of informational workshops and meetings. This list will also allow for tracking of stakeholder engagement. Expansion of the Interested Persons list is ongoing.

Informational Briefings Through Existing Stakeholder Engagement Venues - MAGSA will use outreach opportunities to open lines of communication with interested and affected stakeholders about the program, let them know the future opportunities for input, establish communication channels, and receive feedback on the process. A list of possible venues at which to provide informational briefings is shown below. Venues will be selected based on efficiency and effectiveness in reaching out to stakeholder populations and beneficial users.

- Fresno County Board of Supervisor meetings
- Farm Bureau meetings
- Lion's and Rotary Club meetings
- LAFCO meetings
- School District meetings
- Kerman Ag Expo

Informational Briefings with Local Governments and Agencies - MAGSA will reach out to local government and agency staff to inform them and receive input on MAGSA activities, to better understand their interests and concerns, and to coordinate with local planning activities.

Informational Briefings with Landowners and Other Interested Parties - MAGSA will hold informal informational briefings targeted to landowners, community residents, and other local interested parties to share information, build relationships, provide program updates, educate, and solicit input. MAGSA will make use of existing venues where landowners and other local stakeholders typically meet as well as new venues to conduct in-the-field briefings.

Table 2-11 Informational Stakeholder Briefings

INFORMATIONAL STAKEHOLDER BRIEFINGS			
Year	**Date**	**Type of Meeting/Location**	**Attendance**
2015	8/5/2015	Raisin City Water District Grower Meeting	40
	8/20/2015	SGMA Public Agency Workshop	12
2016	3/31/2016	Raisin City/Perry Colony Community Meeting	20
	8/24/2016	Fresno County/KRCD White Area Meeting	60
	9/21/2016	Ag Commodies Group Update	8
	9/2/2016	Fresno County/KRCD McMullin White Area Meeting	50
2017	2/17/2017	2017 World Ag Expo "SGMA Local Plans Update"	N/A
	6/14/2017	Landowner Meeting, Kerman	30
	6/22/2017	Landowner Webinar	8
	6/29/2017	Landowner meeting, Raisin City	30
	9/15/2017	SGMA Roundtable for schools, Kings & Tulare Counties	N/A
	10/25/2017	Kerman Ag Expo	100
2018	5/9/2018	Prop 218 Workshop, Kerman	5
	5/16/2018	Prop 218 Workshop, Webinar	4
	5/23/2018	Prop 218 Workshop, Raisin City	17
2019	4/19/2019	GSP Progress Update, Kerman	15
	5/1/2019	GSP Progress Update, Kerman	15
	5/13/2019	MAGSA Office Open House	14
	5/23/2019	News broadcast - FOX26 Town Hall: Sustainable Groundwater Management Act, Fresno	N/A
	6/5/2019	GSP Progress Update, Kerman	15
	8/13/2019	GSP Public Workshop, Kerman	31
	8/15/2019	GSP Webinar, online	17
	9/18/2019	GSP "Office Hours" Chat, Kerman and online	5
2020	7/29/2020	Water Market Study Workshop, online	35
	10/21/2020	Water Market Study Workshop #2, online	25
	10/29/2020	Water Bank Tour, MAGSA Service Area	16
2021	1/20/2021	2021 Vision Event, online	48
	1/27/2021	Water Market Workshop, online	43
	6/30/2021	OFR Public Scoping Session, online	30
	7/22/2021	OFR Webinar: Pecans & Other Nuts	79
	11/10/2021	Aquaterra Public Scoping Session	32
2022	1/26/2022	2022 Vision Event	57
	4/27/2022	Aquaterra Landowner Meeting, Kerman	16
	4/28/2022	Aquaterra Landowner Meeting, Kerman	12

Table 2-12 Informational Stakeholder Briefings - Kings Subbasin

INFORMATIONAL STAKEHOLDER BRIEFINGS - KINGS SUBBASIN			
Year	Date	Type of Meeting/Location	Attendance
2019	4/26/2019	Kings Subbasin Watershed Tour	45
	6/10/2019	Kings Subbasin Community Discussion on Groundwater, Riverdale	24
	8/26/2019	Kings Subbasin Community Discussion on Groundwater, Dinuba	22
2020	2/24/2020	GSP Implementation and Coordination Workshop, Easton	30

Table 2-13 Informational Stakeholder Briefings - Inter-basin Coordination

INFORMATIONAL STAKEHOLDER BRIEFINGS - INTER-BASIN COORDINATION		
Date	Type of Meeting/Location	Attendance
7/22/2016	SGMA Practitioners Roundtable 1, Tulare	55
3/17/2017	SGMA Practitioners Roundtable 2, Tulare	51
10/20/2017	SGMA Practitioners Roundtable 3, Tulare	57
12/18/2018	SGMA Practitioners Roundtable 4, Tulare	60

Table 2-14 Technical Meetings – Inter-basin Coordination

TECHNICAL MEETINGS - INTER-BASIN COORDINATION	
Date	Type of Meeting/Location
10/9/2019	MAGSA and Delta-Mendota Subbasin Groups

Stakeholder Committee

MAGSA actively involves representatives of diverse stakeholder groups through the Stakeholder Committee. The member structure of the Stakeholder Committee includes representatives of all stakeholder groups within the MAGSA boundaries: two general agricultural representatives, one permanent crop agricultural representative, one dairy agricultural representative, a domestic user representative, a DAC representative, an environmental representative, two governmental representatives including County and State, and one local agency representative. The Stakeholder Committee meets regularly and is an advisory group to the MAGSA Board. The Stakeholder Committee will have the opportunity to provide input throughout GSP implementation on policies, management actions, and projects that may be considered by the MAGSA Board. It is the role of Committee members to act as a liaison between MAGSA and the public, as well as serve as a resource to the broader community. Information on the Stakeholder Committee is updated on MAGSA's website.

DAC Community Engagement – MAGSA encourages the involvement of diverse stakeholder groups through targeted outreach efforts in Disadvantaged Communities. MAGSA partnered with the California State University, Fresno, California Water Institute to engage residents in the DACs in Perry Colony and Alkali Flats. The objective of the community engagement effort was to meet one-on-one with residents of the Perry Colony community and Alkali Flats community to discuss groundwater conditions (quality and quantity), and to advise residents about the opportunity to participate in the development of a groundwater sustainability plan for MAGSA A representative from the Leadership Counsel for Justice and Accountability trained student volunteers on how to conduct successful SGMA door-to-door outreach. Door-to-door outreach was conducted in both Perry Colony and Alkali Flats; volunteers engaged residents with educational

materials and a survey in a full faith effort to achieve 100% coverage of the communities. A technical memorandum summarizing the efforts is included in **Appendix 2-B**. MAGSA will continue efforts to engage the Disadvantaged Communities within the area it serves.

Outreach Content and Materials - MAGSA will develop and disseminate outreach materials that meet the needs of various stakeholders depending on their interest and involvement and their preferred ways of receiving information. MAGSA will develop clear, consistent, and timely informational materials. These materials will help develop public understanding of MAGSA; communicate information about GSP development and implementation and how these relate to stakeholder interests; inform the public on how to get involved; and motivate stakeholders to contribute to and support GSP development and implementation. Outreach materials will be easy-to-understanding and visually appealing.

Based on the specific outreach purpose, written materials will include fact sheets, FAQs, presentations, talking points, maps, and graphics. Outreach materials will be available in printed and website-appropriate form and will be posted to the project website, emailed, and distributed at meetings, workshops, and outreach events. Some of the materials developed to date are:

- MAGSA/SGMA Overview
- SGMA FAQ
- Kings Subbasin/MAGSA Boundary Maps
- Prop 218 FAQ
- Prop 218 Educational Mailer (English/Spanish)
- MAGSA versus State Fee Comparison
- Periodic Email Newsletter
- Presentations
- Sustainability Indicator Infographics (English/Spanish)
- GSP Community Letter and Educational Handout (English/Spanish)
- GSP Educational Mailer (English/Spanish)
- GSP Postcard Mailer (English/Spanish)
- Stakeholder Survey
- Videos
- Project-specific brochures, maps, and briefing documents
- Direct mail newsletters

Examples of handout materials that have been made available are included **in Appendix 2-B**

Local Office – MAGSA has an office in Kerman which is the largest town close to the MAGSA border. There is a full-time general manager of MAGSA at the office who is available to talk to the public and answer questions regarding the MAGSA GSP.

Educational Webinars – MAGSA is dedicated to reaching its landowners and stakeholders through a wide array of channels, including online webinars to provide maximum flexibility for engagement. Webinars are used as a tool to educate and/or inform landowners and the public on topics pertinent to MAGSA's sustainability efforts, including updates on projects and management actions. Webinars are recorded and available on MAGSA's website and YouTube channel for future reference.

Social Media – MAGSA shares agency updates with the public and engages with stakeholders through posts on Twitter and LinkedIn.

Direct Mail Outreach – When pertinent and timely, MAGSA will utilize direct mail to reach all parcel owners within agency boundaries. Communication pieces developed will include messaging that

communicates information about MAGSA and updates stakeholders on recent activities. MAGSA contact and website information will be included on direct mail pieces. When feasible, translation of direct mail communication pieces will be made available. Communications may include newsletters, postcards, flyers, or additional direct mail formats appropriate for campaign and outreach goals. Communication pieces mailed to date include:

Table 2-15 Direct Mail

DIRECT MAIL			
Date	**Title**	**Audience**	**Quantity**
April 2018	Proposition 218 Election education and workshop promo	Landowners	1,155
April 2018	Proposition 218 Election education and workshop promo (Spanish)	Landowners/Communities	online
October 2018	Fall 2018 Newsletter: Prop 218 Election Results and GSP Update	Landowners	1,155
October 2018	Fall 2018 Newsletter: Prop 218 Election Results and GSP Update (Spanish)	Landowners/Communities	online
May 2019	YETI Incentives contact form mailer; GM welcome letter	Landowners	1,155
July 2019	GSP Postcard - workshop promo	Landowners	749
July 2019	GSP Postcard - workshop promo (Spanish)	Landowners/Communities	online
August 2019	GSP Newsletter - how to comment, workshop promo	Landowners	749
August 2019	GSP Newsletter - how to comment, workshop promo	Landowners/Communities	online
May 2020	Board Policy Outreach; GSP Submitted, Water Market Strategy Begins	Landowners	752
June 2021	GSP Newsletter – MAGSA Groundwater Updates	Landowners	832
June 2021	Public Scoping Session mailer	Agencies	50
October 2021	Well Registration Letter and Form Mailing Package	Landowners	838
November 2021	Well Registration Postcard	Landowners	838
February 2022	Well Registration Thank You & Grace Period Letter	Landowners	1,604
April 2022	Aquaterra Landowner Meeting Invitations	Landowners	110
June 2022	Domestic Well Owner: Dry Well Postcard	Landowners (10 acres or less)	543

Examples of direct mailings are included in **Appendix 2-B**.

Website - MAGSA launched its website, www.mcmullinarea.org, in April 2017. MAGSA's website is one of its most important outreach tools and the most important for communicating with the public; it provides an opportunity to share information and dialogue to those who are interested in MAGSA. To ensure effective and current communications with interested and involved stakeholders, project-specific content for the website, including written text, graphics, and maps, have been developed. A Google translation tool is available on all website pages with translation capabilities in 19 languages. MAGSA will ensure its website remains up-to-date and contains timely information about:

- Status of GSP development
- Project and Management Action updates and information
- Informational and educational blog posts and agency updates
- Notices of meetings and outreach events
- Public opportunities to learn more or provide input
- Key outreach opportunities
- Links to key documents

A list of website articles is included in **Appendix 2-B**.

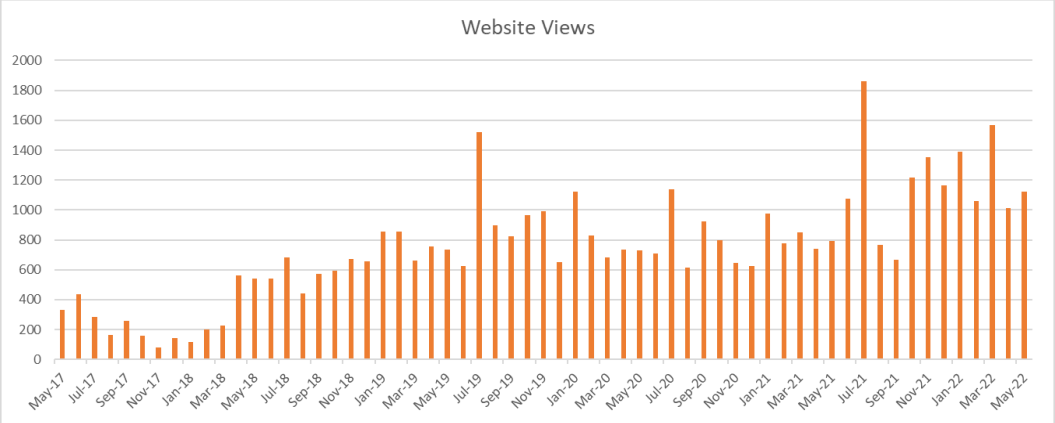


Figure 2-16 Website Views

YouTube Channel - Videos have become one of the most popular means to obtain information and therefore are one of the most effective ways to engage stakeholders. MAGSA created a YouTube Channel at https://www.youtube.com/channel/UCCO_FugOC6kOcVY0Oah5YjA for posting videos of outreach events and in-house produced educational videos on MAGSA and SGMA. Videos developed to date include:

- McMullin Area GSA SGMA Update, Landowner Meetings June 2017
- McMullin Area Prop 218 Workshop
- McMullin Area GSP Workshop Sessions
- "The GSP is in.... what's next for MAGSA?"
- "3 Reasons to Engage with MAGSA in 2020"
- "One way to help shape MAGSA's future"
- Water Market Study Technical Workshops
- "The Road to Groundwater Sustainability"
- MAGSA Vision Events
- McMullin On Farm Flood Capture Expansion Project: Scoping Session Webinar
- On-Farm Recharge Webinar: Pecans & Other Nuts
- Aquaterra Water Bank Public Scoping Webinar

MAGSA Electronic Updates - One of the methods used to keep stakeholders informed on MAGSA activities is the regularly scheduled McMullin Area Electronic Update. The updates are distributed to the Interested Persons list via e-mail on a regular basis. They provide highlights of Board meetings and information on upcoming events and meetings. To support transparency, website articles are written and sent to the Interested Person's email list after Board meetings to highlight important topics. Topics covered include:

- Status of GSP development
- Proposition 218 election notices and updates
- Projects and management actions
- Funding and grant opportunities
- Sustainable Management Criteria
- Well Monitoring Network, well canvass effort
- Stakeholder Alerts for Board Policy drafts and adoption
- Board meeting actions and updates

- Event and webinar invitations and notices

A list of email updates sent to the Interested Persons list is shown below.

Table 2-16 Email Updates to Interested Persons

EMAIL UPDATES TO INTERESTED PERSONS				
Date	Email Topic	# of recipients	Open Rate	Click-thru rate
5/15/2017	Outreach event calendar	11	72%	38%
6/16/2017	Engineering firm selected, budget	52	63%	10%
6/29/2017	Landowner meetings posted	54	61%	48%
8/7/2017	Board meeting highlights, ad hoc committees formed	63	66%	15%
10/5/2017	Update on GSP, groundwater conditions	68	63%	9%
11/2/2017	Technical consultant working on GSP, upcoming events	69	54%	0%
12/11/2017	Ad hoc tech committee highlights, GSP chapters	69	59%	46%
2/15/2018	Technical report on land subsidence	-	61%	47%
4/6/2018	Special board meeting, fee rate adoption	79	60%	44%
4/10/2018	Board Agenda	78	53%	53%
4/13/2018	218 Election, rate study approved	81	65%	35%
4/29/2018	Board Agenda	84	54%	46%
5/2/2018	MAGSA Prop 218 workshops (Fresno County Farm Bureau)	N/A	-	-
5/16/2018	Technical updates on projects, Prop 218 workshop info, public hearing reminder	101	66%	37%
5/23/2018	Prop 218 workshop reminder	101	59%	9%
6/1/2018	Board meeting, public hearing agenda posted	110	53%	29%
6/7/2018	Prop 218 Election passes, tech GSP update, workshop materials	111	63%	32%
6/22/2018	GSA seeking letters of support for grant	114	61%	23%
7/9/2018	Board Agenda	119	57%	41%
7/12/2018	GSA seeking letters of support for grant	122	64%	32%
7/23/2018	Groundwater credit system, grant application submitted	130	66%	33%
8/1/2018	Board Agenda	130	46%	35%
8/3/2018	DWR funding for TSS, Chair and Vice Chair reappointed	129	64%	24%
8/31/2018	Board Agenda	132	44%	26%
9/5/2018	Meeting location change	131	50%	0%
9/14/2018	Regional monitoring efforts, ethics policy, conflict code	132	62%	32%
9/29/2018	Board Agenda	133	47%	29%
10/5/2018	Federal grant awarded, Board joins regional water authority, stakeholder survey	136	59%	38%
11/2/2018	Board Agenda	146	52%	29%
11/20/2018	Project list, well canvass update, overdraft number, water budget video	152	61%	52%
12/3/2018	Board Agenda	155	55%	46%
12/2/2018	Special Board Agenda	155	63%	47%

EMAIL UPDATES TO INTERESTED PERSONS				
Date	Email Topic	# of recipients	Open Rate	Click-thru rate
12/17/2018	Special Meeting agenda/notice	157	57%	52%
12/20/2018	Water quality criteria, GSP Updates, stakeholder survey	157	56%	43%
12/28/2018	Board meeting rescheduled	158	56%	0%
1/3/2019	Lawrence Berkely Lab survey	159	64%	18%
1/8/2019	Board Agenda	159	57%	42%
1/10/2019	General Manager hired	175	63%	10%
1/11/2019	Sustainable Management Criteria survey	161	55%	46%
1/17/2019	Stakeholders can impact GSP with survey participation	165	60%	31%
2/1/2019	Board Agenda	165	53%	32%
2/20/2019	Groundwater level metrics, Board adopts IRWMP, Sustainable Management Criteria Survey	169	59%	39%
2/27/2019	Final call to take Sustainable Management Criteria Survey	168	49%	18%
3/5/2019	Board Agenda	169	54%	53%
4/1/2019	April Board Meeting postponed	178	49%	3%
4/2/2019	Pace of sustainability, undesirable results survey concludes, water quality infographic	178	55%	37%
4/8/2019	Board Agenda	178	49%	32%
4/23/2019	MAGSA water budget, water budget video, open house invitation	181	55%	36%
4/26/2019	Board Agenda	182	41%	27%
5/6/2019	CA Water Commission meeting in Kerman	184	52%	31%
5/8/2019	Open House invitation	184	59%	9%
5/13/2019	Open House reminder	185	42%	3%
5/15/2019	CA Water Commission Terranova tour	185	56%	14%
5/21/2019	FOX25 Town Hall event	213	46%	7%
5/28/2019	CA Water Commission Terranova tour, MAGSA open house and YETI raffle	225	54%	34%
5/31/2019	Board Agenda	224	41%	16%
6/4/2019	Kings Subbasin Workshop	224	47%	15%
6/10/2019	Water Quality objective, GSP in July, groundwater storage infographic	226	51%	24%
6/11/2019	Meeting date change	226	44%	1%
7/1/2019	Meeting change notice	227	44%	8%
7/8/2019	Board Agenda	228	50%	35%
7/10/2019	GSP Public Comment and Review, GSP download link, workshop info	228	52%	41%
7/15/2019	GSP first released in Kings Subbasin, GSP board presentation slides	230	44%	31%
7/22/2019	PRESS RELEASE: MAGSA first to release GSP in Kings Subbasin	16	54%	14%
7/22/2019	Notice of press release and the GSP to Legislative Staff	39	22%	14%

EMAIL UPDATES TO INTERESTED PERSONS				
Date	Email Topic	# of recipients	Open Rate	Click-thru rate
7/31/2019	Upcoming GSP events	233	50%	11%
8/2/2019	Board Agenda	235	44%	29%
8/12/2019	GSP Workshop and webinar reminder	237	46%	23%
8/26/2019	Kings Subbasin community discussion on groundwater	236	46%	14%
8/30/2019	Board Meeting cancellation notice	237	42%	11%
9/11/2019	Office Hours chat promo	238	43%	10%
9/16/2019	GSP Office Hours promo 2, GSP workshop materials and videos	239	41%	14%
9/18/2019	GSP Office Hours promo 3, now live and online at the office	239	40%	7%
9/20/2019	Board Agenda	240	46%	42%
1/3/2020	Board Agenda	252	49%	31%
1/30/2020	MAGA fully empowered, RFP submitted	252	43%	29%
1/31/2020	Board Agenda	252	36%	29%
2/10/2020	Regional Workshop in Easton	252	48%	17%
2/28/2020	MAGSA Board Cancellation Notice	253	39%	6%
3/3/2020	Reminder: Board Meeting Cancelled	253	38%	5%
3/9/2020	Board Agenda	253	48%	40%
3/18/2020	MAGSA Will respond and adapt to COVID-19	254	46%	11%
3/27/2020	MAGSA awards Geosyntec contract	254	40%	41%
3/30/2020	Board Meeting Cancelled	254	40%	3%
4/15/2020	Next Board Meeting Scheduled for May 13	254	40%	3%
4/29/2020	Groundwater conditions improve overall in the Kings Subbasin in water year 2019	256	51%	23%
5/8/2020	May 13 Board Agenda Available	264	50%	32%
5/14/2020	Stakeholder Alter: Board Policies	269	56%	21%
5/31/2020	June 3rd Board Agenda Available	270	34%	29%
6/10/2020	Meet MAGSA's Water Market Study Team	272	50%	33%
6/29/2020	July 1 Board Meeting Cancelled	273	32%	6%
6/30/2020	Online Water Marketing Strategy Technical Workshop July 29	273	32%	6%
7/11/2020	July 15 Board Agenda: 2020-2021 Budget, Marketing Grant Report	275	46%	42%
7/16/2020	Stakeholder Alert: Board Policy Draft	273	49%	25%
7/17/2020	July 21 Special Board Meeting: Existing and Anticipated Litigation	273	44%	32%
7/20/2020	MAGSA Water Market Reminder	273	44%	12%
7/23/2020	Board approves $19 fee rate, keeps eye on grant funding opportunities	274	43%	20%
7/27/2020	Online Water Marketing Strategy Technical Workshop (RSVPs)	38	71%	44%
7/28/2020	Online Water Marketing Strategy Technical Workshop (All)	276	41%	35%

EMAIL UPDATES TO INTERESTED PERSONS				
Date	Email Topic	# of recipients	Open Rate	Click-thru rate
7/30/2020	Water Market Technical Workshop Video and Presentation Now Available	275	38%	16%
7/31/2020	August 5 Board Meeting Cancelled	274	32%	4%
8/28/2020	September 2 Board Agenda: Groundwater Data, Export, Banking Policy	278	37%	26%
9/8/2020	Stakeholder Alter: Board Policy Draft	288	51%	30%
9/14/2020	Two draft policies released, water market study update, Groundwater Data Policy adopted	288	51%	30%
9/28/2020	Water Market Technical Workshop #2 Save the Date	288	38%	21%
10/2/2020	Board Agenda	291	44%	27%
10/7/2020	Board Meeting Postponed	291	36%	4%
10/16/2020	Water Market Workshop #2 Final Reminder	292	42%	27%
10/26/2020	E-Update: Water Market Technical Workshop #2 Video and Presentation	293	39%	17%
10/30/2020	November 4 Board Agenda	294	32%	26%
11/5/2020	Stakeholder Alert: Board Policy	292	50%	22%
11/23/2020	E-Update: MAGSA Video Provides Narrative for Achieving Sustainability	293	46%	29%
11/30/2020	Board Meeting Notice	295	32%	1%
12/2/2020	Save the Date: Online Water Marketing Workshop	293	34%	18%
12/4/2020	Board Agenda	294	46%	32%
12/11/2020	Vision Event Promo	294	39%	31%
12/22/2020	E-Update: Policies adopted, water market workshop, vision event	294	39%	22%
1/1/2021	Board Agenda	295	46%	37%
1/7/22021	Stakeholder Alert: Board Policies	297	47%	32%
1/20/2021	MAGSA Vision Event Reminder	297	37%	26%
1/25/2021	Water Market Workshop Reminder	296	42%	25%
1/29/2021	January E-Update: Vision Event recap	296	35%	17%
1/29/2021	Board Agenda	296	40%	21%
2/17/2021	MAGSA awarded $10 million grant to expand innovative OnFarm Recharge project	297	49%	25%
2/26/2021	March 3 Board Meeting Agenda Available	298	30%	29%
4/2/2021	April 7 Board Meeting Agenda Available	299	44%	34%
4/12/2021	School Webinar	299	40%	6%
4/28/2021	Groundwater in MAGSA: Annual Report Update	301	43%	24%
4/30/2021	May 5, 2021 Board Meeting Agenda Available	301	46%	41%
6/1/2021	June Board Meeting	303	38%	7%
6/4/2021	June 9 Board Meeting Agenda	305	33%	30%
6/17/2021	OFR Public Scoping Meeting Webinar	306	38%	18%
6/21/2021	OFR Public Scoping Meeting Webinar: PRESS RELEASE	10	29%	0%

EMAIL UPDATES TO INTERESTED PERSONS				
Date	Email Topic	# of recipients	Open Rate	Click-thru rate
6/24/2021	Public Scoping Meeting Next Wednesday	310	36%	14%
6/28/2021	Learn More About the McMullin On-Farm Flood Capture Expansion Project	312	33%	13%
6/28/2021	On-Farm Recharge Webinar for Nut Crops July 22 (to GSA Leads)	110	19%	21%
6/29/2021	On-Farm Recharge Webinar for Nut Crops July 22 (press release)	14	25%	67%
6/30/20201	TODAY @ 6 PM: OFR Public Scoping Meeting Webinar	316	36%	23%
7/1/2021	On-Farm Recharge Webinar for Nut Crops July 22	315	37%	9%
7/2/2021	July 7, 2021 Board Meeting Agenda Available	316	32%	20%
7/6/2021	OFR Public Scoping Meeting Webinar Recording	316	35%	22%
7/8/2021	STAKEHOLDER ALERT: BOARD POLICY	315	50%	29%
7/12/2021	Nut Crops On-Farm Recharge Webinar July 22 @ 11:30 am	839	35%	6%
7/14/2021	Nut Crops On-Farm Recharge Webinar July 22 @ 11:30 am	1008	35%	8%
7/20/2021	Zoom link for On-Farm Recharge Webinar this Thursday @ 11:30 AM	73	47%	29%
7/21/2021	Tomorrow: Nut Crops On-Farm Recharge Webinar	1012	28%	6%
7/22/2021	TODAY at 11:30! On-Farm Recharge Webinar	1013	25%	13%
7/23/2021	Recording Available for On-Farm Recharge Webinar: Pecans & Other Nuts	1041	38%	11%
8/4/2021	August 4 MAGSA Agenda	331	39%	39%
8/11/2021	In case you missed it (E-Update)	331	43%	17%
8/27/2021	Cancellation Notice	331	34%	14%
9/17/2021	Sept Special Board Meeting Agenda	330	47%	18%
10/1/2021	Oct Board Meeting Agenda #1	330	35%	7%
10/1/2021	Oct Board Meeting Agenda #2 (Corrected Location)	330	42%	10%
10/15/2021	Oct 21 Special Board Meeting Agenda	331	46%	18%
10/25/2021	Well Registration Requirement	330	55%	15%
10/28/2021	Aquaterra Public Scoping Webinar	330	9%	42%
10/29/2021	Nov 3 2021 Board Meeting Agenda	331	44%	15%
11/1/2021	Well Registration Requirement #2	333	45%	7%
11/2/2021	Kings Subbasin Builds for Drought Resilience at Record Pace	334	45%	6%
11/3/2021	Aquaterra Public Scoping Webinar #2	332	42%	4%
11/9/2021	Aquaterra Public Scoping Webinar #3	334	37%	3%
11/10/2021	Aquaterra Public Scoping Webinar #4	335	36%	6%
11/11/2021	Aquaterra Public Scoping Webinar Recording & Slides	337	47%	13%
12/3/2021	December 8 Board Agenda	341	49%	16%
12/6/2021	Well Registration Reminder	341	49%	8%

EMAIL UPDATES TO INTERESTED PERSONS				
Date	Email Topic	# of recipients	Open Rate	Click-thru rate
12/20/2021	Well Registration Reminder#2	342	42%	5%
12/29/2021	Well Registration Reminder #3	345	42%	3%
12/30/2021	January 5 Board Agenda	343	44%	13%
1/11/2022	MAGSA 2022 Vision Event	344	47%	7%
1/17/2022	Register Today: MAGSA 2022 Vision Event	344	38%	4%
1/20/2022	Exciting things are happening in MAGSA	344	43%	5%
1/24/2022	This Wednesday: MAGSA 2022 Vision Event	345	42%	5%
1/25/2022	Raisin City Water District & Mid Valley Water District Annexation Workshop	345	46%	13%
1/26/2022	Today's Webinar Link: MAGSA 2022 Vision Event	352	45%	16%
1/27/2022	Vision Event Recording & Well Registration Grace Period	354	39%	4%
1/30/2022	MAGSA February 2 Board Meeting Agenda	346	38%	10%
2/4/2022	Well Registration Update & Grace Period Announcement	345	44%	1%
2/25/2022	Well Registration Grace Period Reminder	348	42%	3%
3/4/2022	March 9 Board Agenda	349	47%	15%
3/10/2022	Groundwater Awareness Week	381	44%	3%
3/16/2022	March Board Meeting E-Update	351	52%	8%
4/2/2022	April 6 Board Agenda	351	53%	16%
4/11/2022	April Updates	351	51%	13%
4/11/2022	Stakeholder Alert" Rules & Regulations	352	56%	10%
4/14/2022	Memo on Executive Order	373	54%	20%
4/18/2022	Aquaterra Landowner Meetings	37	59%	14%
4/21/2022	Aquaterra Landowner Meetings: Updated Times	70	63%	24%
4/25/2022	Aquaterra Landowner Meetings: Final Reminder	64	65%	13%
4/25/2022	Aquaterra Landowner Meetings: RECAP	87	65%	13%
5/6/2022	May Board Meeting Cancellation Notice	352	43%	2%
5/27/2022	June 1 Board Agenda	355	44%	9%

Example email updates that have been sent out are included in **Appendix 2-B**.

Stakeholder Survey – To better understand the priorities of stakeholders in the McMullin Area service area, MAGSA is conducting a stakeholder survey. The survey provides an opportunity for stakeholders to identify their interest in groundwater management and identifies their level of involvement and knowledge related to groundwater and the SGMA implementation process. A blank copy of the survey and aggregated responses are included in **Appendix 2-B**. The survey is ongoing.

Sustainable Management Criteria Stakeholder Survey
MAGSA conducted a Sustainable Management Criteria survey from January-February 2019 during GSP development. The survey was conducted in an effort to identify and prioritize stakeholder concerns relating to potential impacts that may result from groundwater conditions. The survey was segmented into 5

geographically outlined areas within MAGSA's boundaries to help identify potential area-specific concerns. The survey was conducted via an online form available at MAGSA's website. Responses were received from 31 stakeholders. A copy of the survey is included in **Appendix 2-B**.

Media Outreach - MAGSA staff will identify the preferred media outlets to provide information regarding public meetings, landowner communications, and other issues. Materials include news/press releases, newspaper articles, and media briefings. Media outreach will seek to maximize public understanding through these channels and identify alternative sources through which to convey educational and news items. News releases will announce major project milestones and engagement opportunities.

MAGSA will maintain a list of regional media, like the Kerman News and Fresno Bee, along with state and specialized media, as well as organizational newsletters. Specialized media and newsletters include publications such as:

- County Farm Bureau publications
- Water agency/organization publications
- Environmental publications
- Industry association publications

3 Basin Setting

3.1 Hydrogeologic Conceptual Model

3.1.1 Introduction

Regulation Requirements:

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

This HCM has been prepared to provide an easy-to-understand description of the general physical characteristics of the regional hydrology, land use, geology, geologic structure, water quality, principal aquifers, and principal aquitards in the study area. Once developed, an HCM is useful in providing the context to develop water budgets, monitoring networks, and identification of data gaps.

An HCM is not a numerical groundwater model or a water budget model. An HCM is rather a written and graphical description of the hydrologic and hydrogeologic conditions that lay the foundation for future water budget models. In addition, this HCM supports and provides the hydrogeologic setting to support the Groundwater Conditions (**Section 3.2**) and Water Budget (**Section 3.3**) of this GSP.

This HCM was prepared following the requirements set forth in the California Code of Regulations, Title 23, Division 2, Chapter 1.5, Subchapter 2, Article 5, Subarticle 2 (§354.14). Many topics discussed in this HCM, such as groundwater quality and groundwater flow, are discussed in greater detail in the Groundwater Conditions (**Section 3.2)** and Water Budget (**Section 3.3**) chapters.

The narrative HCM description provided in this chapter is accompanied by graphical representations of the MAGSA portion of the Kings Subbasin that have attempted to clearly portray the geographic setting, regional geology, basin geometry, and general water quality of MAGSA's service area. This HCM has been prepared utilizing existing qualified published studies and resources and will be periodically updated as data gaps are addressed, and new information becomes available.

3.1.2 Lateral Basin Boundaries

Regulation Requirements:

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

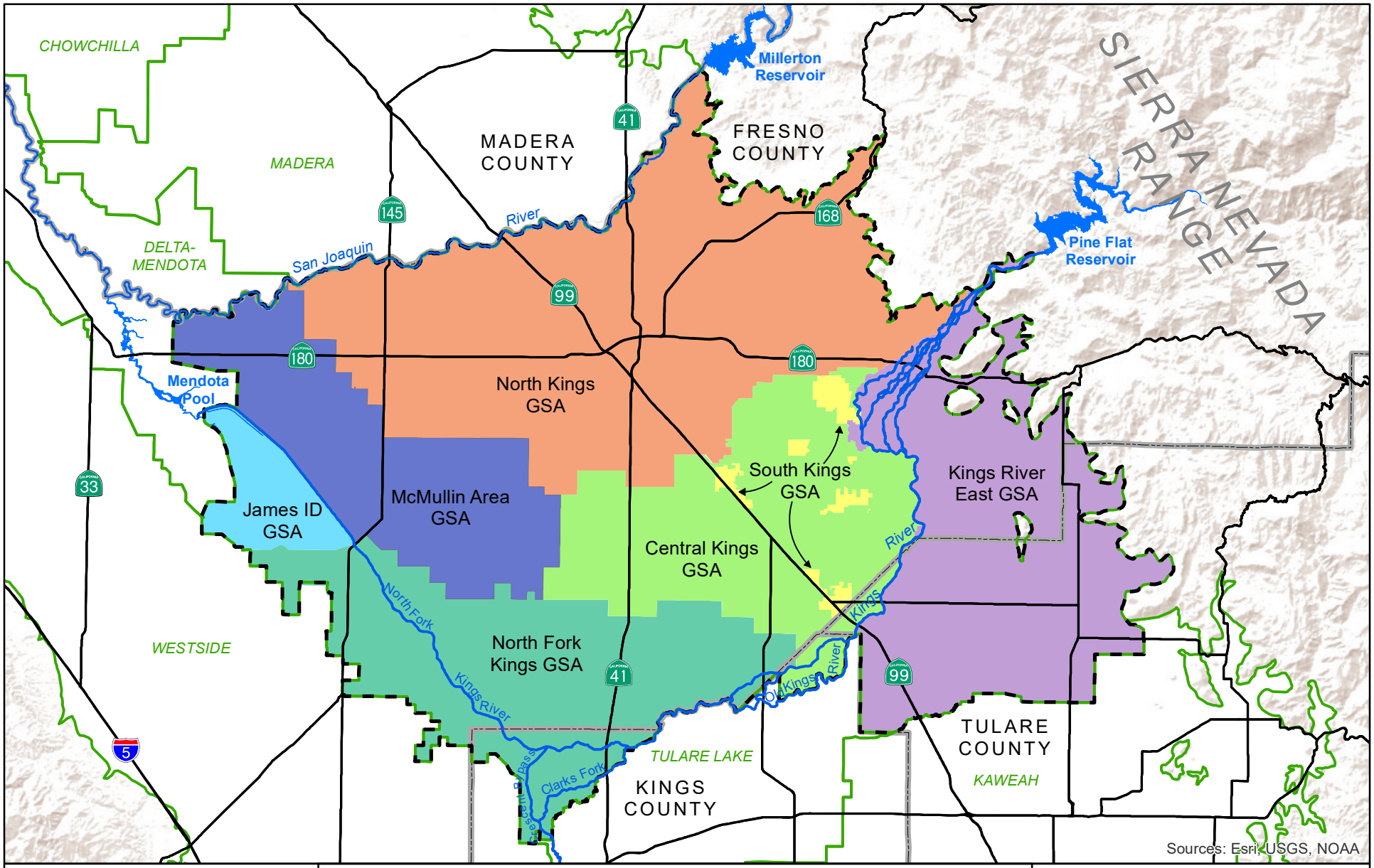
To the east, the Kings Subbasin is bounded by the Sierra Nevada foothills. To the west the subbasin is bounded by the Delta Mendota and Westside Subbasins. Starting in the southwest corner the Kings Subbasin shares a common border for a mile with the Westside Subbasin, then the border runs easterly along the northern boundary of the South Fork Kings GSA, the south fork of the Kings River, the southern boundary of Laguna Irrigation District, the northern boundary of the Kings County Water District, the southern boundaries of the Consolidated and Alta Irrigation Districts, and the western boundary of Stone Corral Irrigation District. To the north it is bounded by the San Joaquin River and the northwest corner of the subbasin is formed by the intersection of the east line of the Farmers Water District with the San Joaquin River (CDWR, 2006). A more detailed description for the GSA is included below.

As shown in **Figure 3-1,** the MAGSA area is bounded to the north by the SJR. The remaining boundaries of the MAGSA area and its underlying aquifer system are defined by political boundaries that generally follow existing irrigation district boundaries to the south and the east and the edge of the Kings Subbasin to the

west. To the southwest it is bounded by the JID GSA along the James Bypass, to the south by the North Fork Kings GSA, to the east by the Central Kings GSA, and to the northeast by the North Kings GSA.

The major features that affect groundwater flow are the SJR to the north, neighboring irrigation districts, and the Corcoran Clay member of the Tulare Formation, a well-known aquitard that underlies the majority of the MAGSA area. The Corcoran Clay and its effect on the movement of groundwater are discussed in further detail later in this HCM.

Significant amounts of surface water are lost to seepage along the SJR where it borders MAGSA. These losses are gains to the area's groundwater aquifers. As shown in **Figure 3-2**, seepage from the SJR and the recharge ridge associated with seepage loss from the river induce groundwater to flow away from the river to the southwest. Further south, groundwater in MAGSA flows to the southwestern area of the GSA towards a groundwater depression near the McMullin Grade.



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Kings Groundwater Subbasin (DWR 2018)
Other Groundwater Subbasins (DWR 2018)
County

McMullin Area GSA

Kings Groundwater Subbasin
Groundwater Sustainability Agencies

Figure 3-1

12/16/2019 : G:\McMullin GSA-2659\265917002-Technical Services\GIS\Map\Report\HCM\subbasin_gsa.mxd

McMullin Area GSA

Groundwater Elevation Contours
Spring 2016
Figure 3-2

MADERA CO.
FRESNO CO.
SAN JOAQUIN RIVER
MADERA
FRESNO
Biola
Mendota
Kerman
Tranquillity
San Joaquin
Raisin City
Caruthers
Cantua Creek
Old Fig Garden
Mayfair
Fresno
West Park
Calwa
Easton
JAMES BYPASS
FRESNO SLOUGH
Kearney Park
Speedway Park
145
180
41

McMullin Area GSA
Kings Subbasin (DWR, Modified 2018)
Mid-Valley WD
Raisin City WD
State of California Ecological Reserve
Raisin City Community
City/Town
Generalized Groundwater Flow Direction
Water Surface Elevation (10ft interval)*

**Contours created for Kings Subbasin Coordinated Effort, KDSA.*

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), swisstopo, © OpenStreetMap contributors, and the GIS User Community

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3.1.3 Regional Geologic and Structural Setting

Regulation Requirements:

§354.14(b)(1) The hydrogeologic conceptual model shall be summarized in a written description that includes the regional geologic and structural setting of the basin including the immediate surrounding area, as necessary for geologic consistency.
§354.14(b)(3) The hydrogeologic conceptual model shall be summarized in a written description that includes the definable bottom of the basin.

The Kings Subbasin is centrally located within the San Joaquin Valley, which represents the southern portion of the Great Central Valley of California. The San Joaquin Valley is a structural trough up to 200 miles long and 70 miles wide. It is filled with up to 32,000 feet of marine and continental sediments deposited during periodic inundation by the Pacific Ocean and by erosion of the surrounding mountains, respectively. Continental deposits shed from the surrounding mountains form an alluvial wedge that thickens from the valley edges toward the axis of the structural trough. This depositional axis is slightly west of the series of rivers, lakes, sloughs, and marshes, which mark the current and historic axis of surface drainage in the San Joaquin Valley (CDWR, 2006).

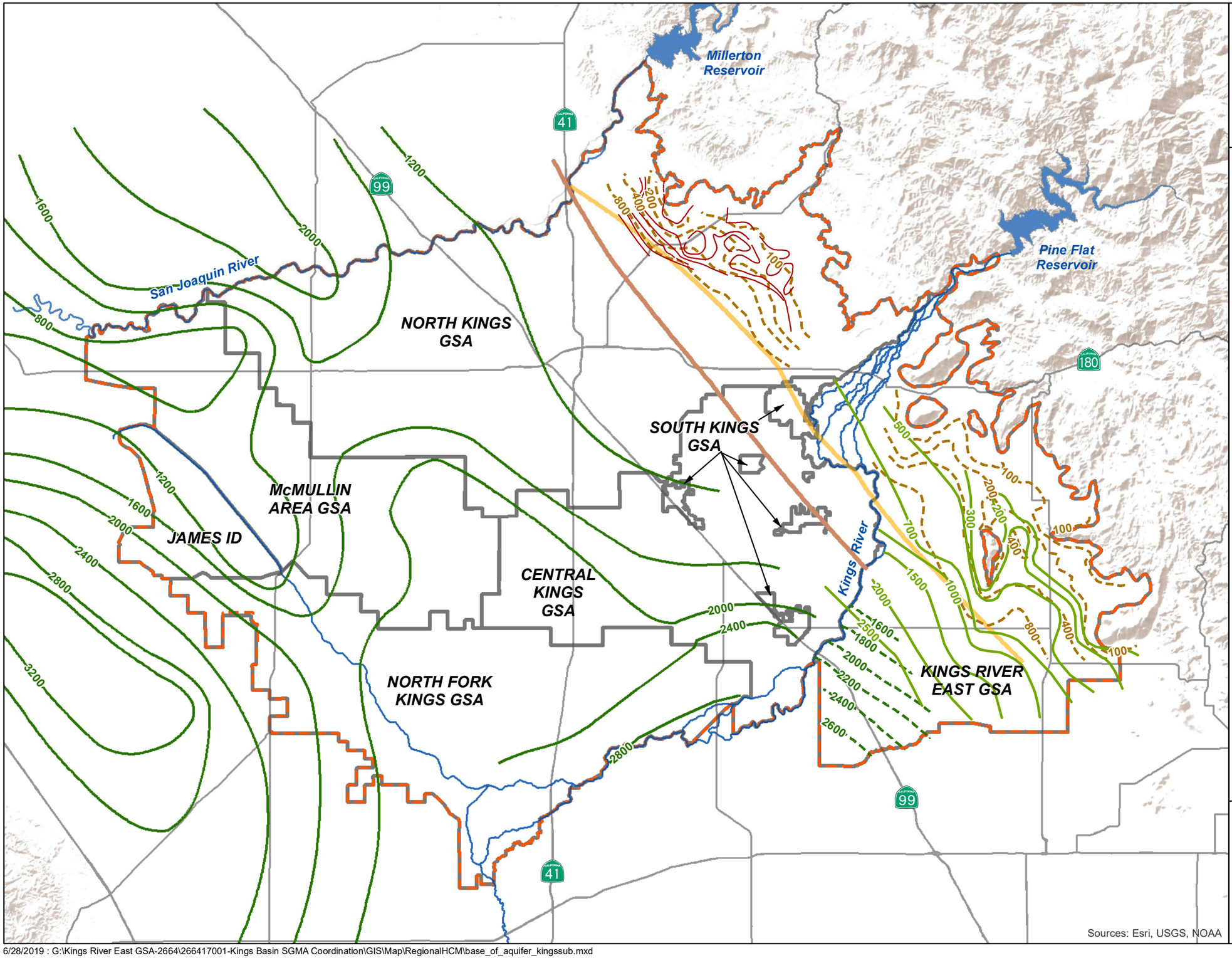
In the east, the geologic structure of the Kings Subbasin can be divided into two categories, a basement complex (i.e., bedrock) and overlying sedimentary rocks and deposits (Page and LeBlanc, 1969). Despite being faulted and jointed, the regional structure of the basement complex is formed from the western slope of the southwest tilted Sierra Nevada (Smith, 1964). For the purposes of this HCM, the basement complex is the definable bottom of the Kings Subbasin. The definable bottom of the basin is the base of the aquifer on the east side of the basin east of the interface between the depth to bedrock and further west and southwest the definable base of the aquifer is the depth to connate water (**Figure 3-3**). East of the approximate edge of connate water or where freshwater extends to bedrock, the base of the aquifer is the same as the base of the basin. West of the interface between connate water and bedrock, the depth to bedrock is deeper than the base of freshwater or depth to connate water. Some of the sedimentary deposits overlaying the basement complex have also been folded and/or faulted, but the overriding structure of the sedimentary deposits are homoclinal (i.e., sedimentary deposits that dip uniformly in one direction). The dip of the homoclines is controlled by the back slope of the Sierra Nevada and the age of the deposits (i.e., older sediments are more steeply dipping than younger sediments). Similarly, to the west, the general orientation of sediments originating from the Coast Ranges is dipping east toward the valley trough. A more detailed description of the GSA is included below.

The regional structural setting described above can be seen in the isometric block diagram of the Central Valley (not to scale) presented as **Figure 3-4**. The Sierra Nevada Mountain Range and its foothills are located east of the basin and erosion of these mountains and hills have formed alluvial deposits that slope generally southwest to west toward the axis of the San Joaquin Valley. Deep marine sediments, which are shown on **Figure 3-4** as occurring below the alluvial fan deposits, do not yield water to wells (Page and LeBlanc, 1969), and are therefore not discussed further in this HCM.

Kings Subbasin

Base of Aquifer

Figure 3-3



Legend

- Kings Subbasin GSAs
- Kings Subbasin (2019)
- Highway
- Waterway
- Calculated Depth to Basement Complex (ft)*
- Calculated Depth to Base of Fresh Water (ft)*
- Approximate Depth to Connate Water (ft)**, KDSA (2010)
- Approximate East Edge of Connate Water, KDSA (2010)
- Approximate East Edge of Connate Water, Page & LeBlanc (1969)
- Depth to Bedrock (P&P and KDSA, 1995)
- Depth to Bedrock, Alta ID (KDSA, 2019)

*Depth to Basement Complex and Depth to Base of Fresh Water contours calculated from Page and LeBlanc (1969) basement complex elevation contours/contours on approximate base of fresh water and USGS ground elevation (USGS DEM, NAVD88, ft).

**Connate water is where Total Dissolved Solids approach 2,000 mg/L.

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Sources: Esri, USGS, NOAA

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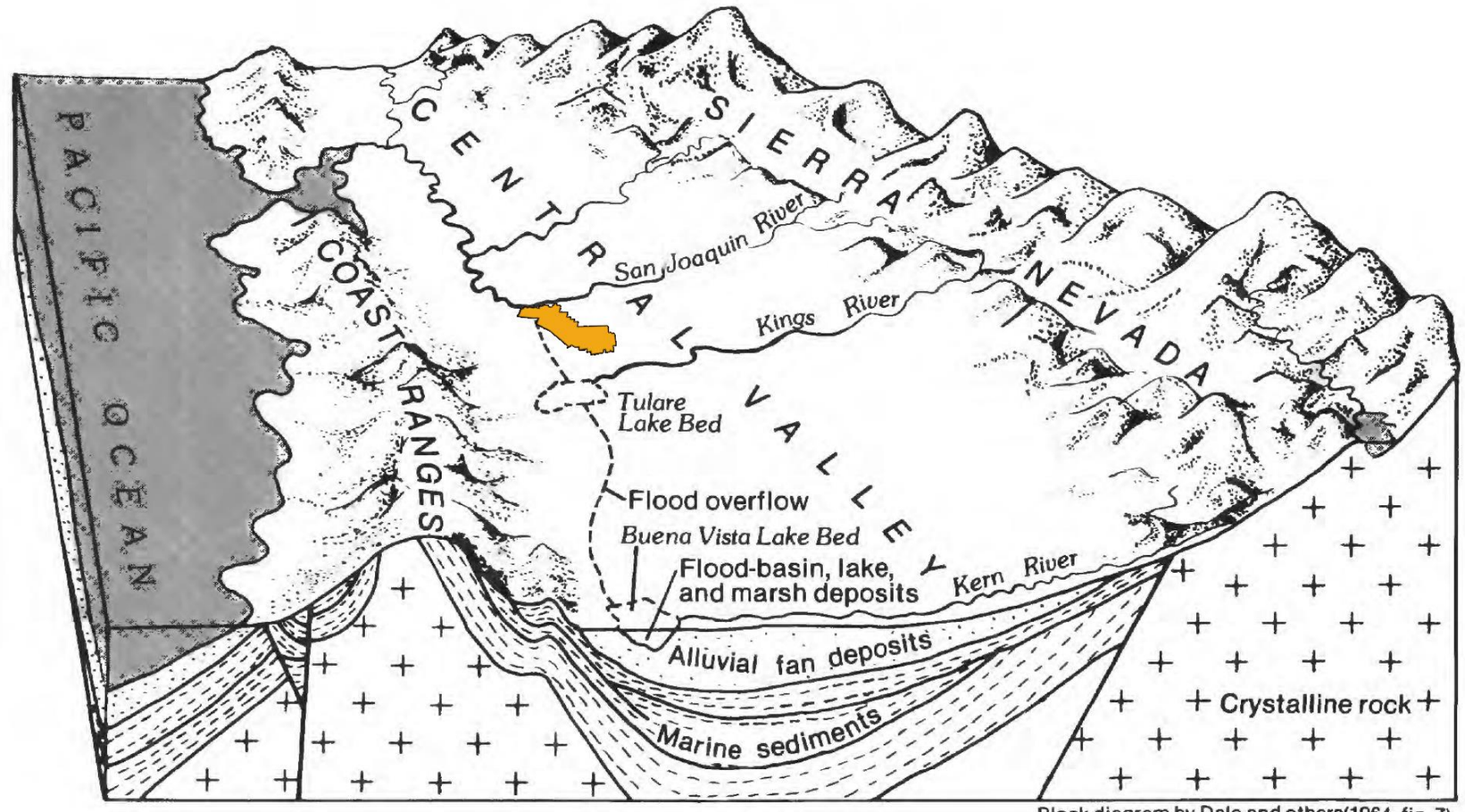


Figure 3-4 Isometric Block Diagram of the Fresno Area

3.1.4 Topographic Information

Regulation Requirements:

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

The geomorphology of the Kings Subbasin is dominated by a series of overlapping alluvial fans originating from the Sierra Nevada foothills and the San Joaquin and Kings Rivers. A relatively large area of sand dune deposits is located within the eastern central middle of the basin. Surface elevations in the subbasin range from approximately 700 feet above mean sea level (MSL) in the east to as low as approximately 160 feet in the west. Relatively steep slopes exist in the areas adjacent to the Sierra Nevada foothills, however the overall topography of the subbasin slopes gently to the southwest. Additional description of this GSA is included below.

Page and LeBlanc (1969) mapped the geomorphic features of the MAGSA area and surrounding areas in the Kings Subbasin. As shown in **Figure 3-5**, the landscape of the northern MAGSA area is dominated by the alluvial fans of the San Joaquin River. Alluvial fans are fan or cone-shaped deposits of sediment built by streams. Alluvial fans are narrower at the head than at the toe and slope with decreasing gradient from head to toe. The landscape to the south is dominated by sand dunes.

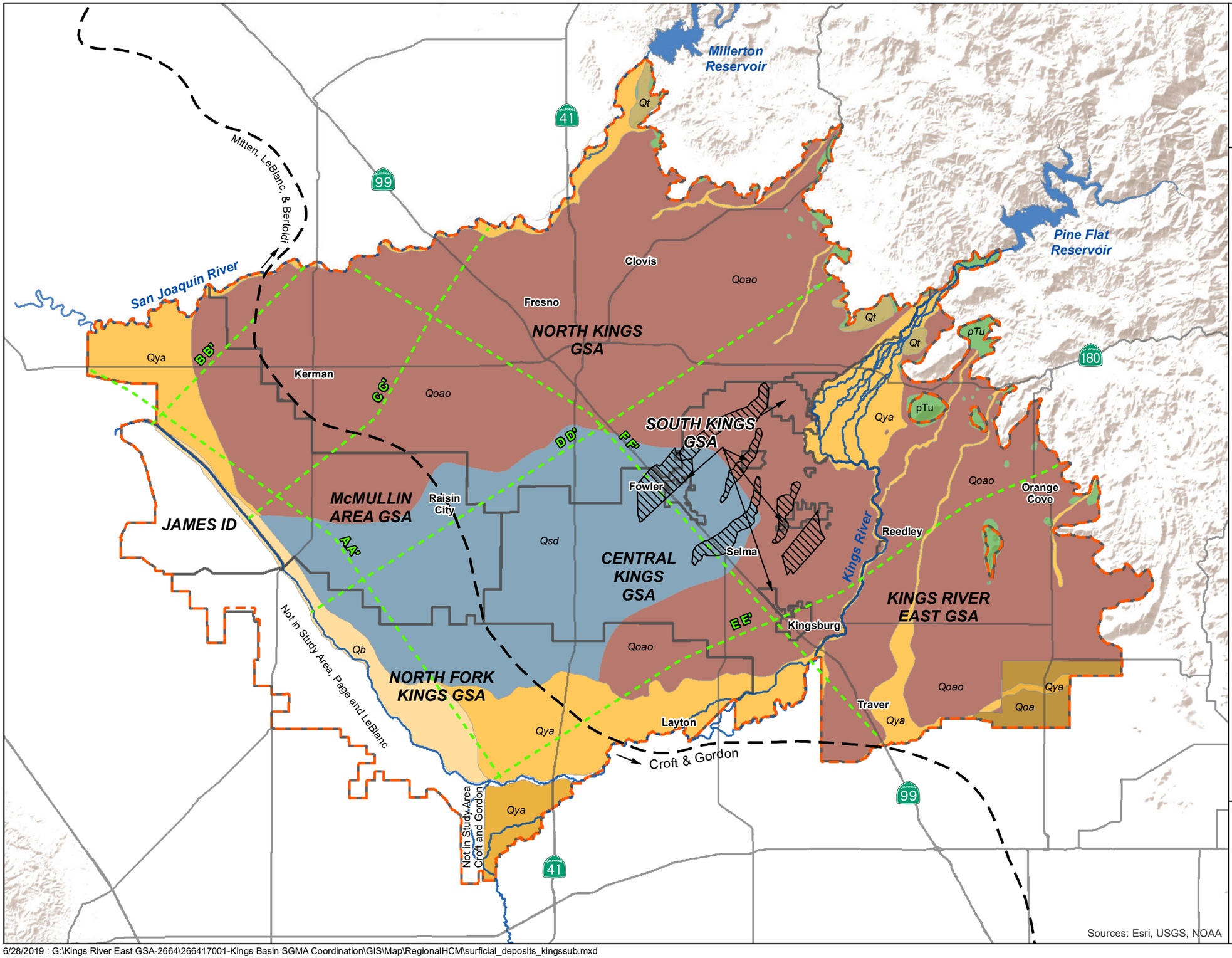
At flood stage, the Kings River has historically inundated areas along either side of Fresno Slough and the Fresno Slough bypass, which has created a long, narrow, low-lying plain along the western edge of the area. Davis et al. (1959) has labeled this area as "overflow lands."

A topographic map of the Kings Subbasin is presented as **Figure 3-6.** In general, the surface of the MAGSA area slopes gently toward the southwest. Elevation ranges from about 240 feet above MSL in the southeast portion of the GSA to about 170 feet msl in the northwest.

Kings Subbasin

Surficial Deposits

Figure 3-5



Legend

- Kings Subbasin GSAs
- Kings Subbasin (2019)
- Highway
- Waterway

Geologic Deposits
Page and LeBlanc, 1969

- Basement Complex (Consolidated) (pTu)
- Flood Basin Deposits (Unconsolidated) (Qb)
- Older Alluvium (Unconsolidated) (Qoao)
- Sand Dunes (Unconsolidated) (Qsd)
- Terrace Deposits (Unconsolidated) (Qt)
- Younger Alluvium (Unconsolidated) (Qya)
- Geologic Cross Section

Geologic Deposits
Croft and Gorden, 1968

- Older Alluvium (Qoa)
- Younger Alluvium (Qya)

Subsurface Geologic Features

- Eastern Extent of E-Clay (Corcoran Clay) (Page and LeBlanc, 1969 (Modified by KDSA))*
- Incised Valley Fill (Weissmann et al, 2002 and Cehrs et al, 1980)

*Extent of E-Clay references differ outside of the Kings Subbasin.
- North of the San Joaquin River: Mitten, LeBlanc, & Bertoldi (1970)
- South of the Kings River: Croft & Gordon (1968)

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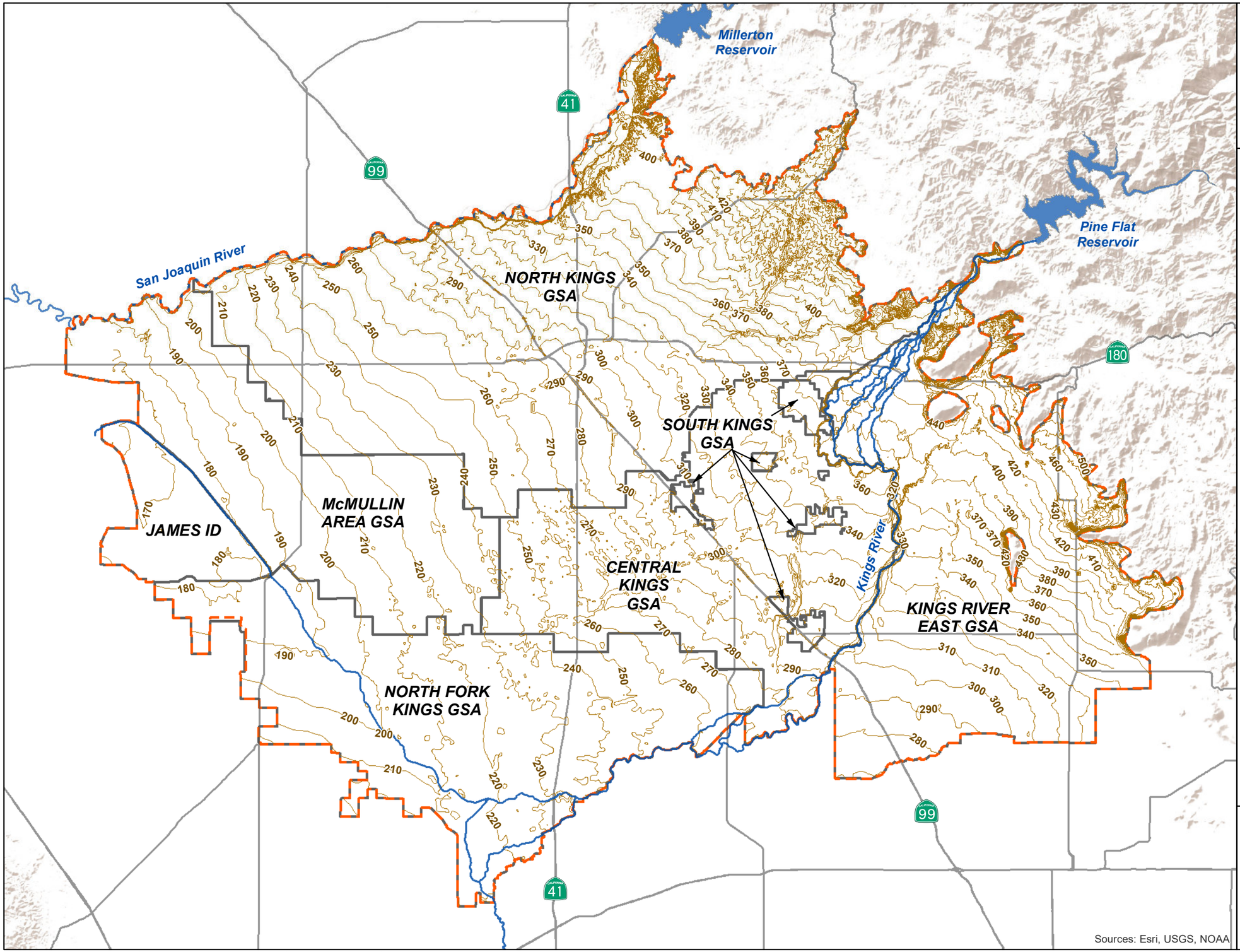

Kings Subbasin

Topography

Figure 3-6

Legend

- Kings Subbasin GSAs
- Kings Subbasin (2019)
- Highway
- Waterway
- USGS Ground Elevation (USGS DEM, NAVD88, 10ft interval)

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3.1.5 Surficial Geology

Regulation Requirements:

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

Surficial geologic materials in the Kings Subbasin consist of consolidated rocks and unconsolidated deposits. The consolidated rocks are comprised of a pre-Tertiary age basement complex, and marine and continental sedimentary rocks of Cretaceous (145 to 66 million years ago) and Tertiary age (66 to 2.6 million years ago). The basement complex comprises a large portion of the Sierra Nevada and other regional mountain ranges that is composed of a mass of plutonic and metamorphic rocks commonly referred to as the Sierra Nevada batholith. The basement complex surface slopes gently to the southwest from the foothills to beneath the valley floor. The unconsolidated deposits are of both Tertiary and Quaternary age (2.6 million years ago to the present) and are generally comprised of alluvial material from the nearby foothills.

Quaternary age (2.6 million years ago to the present) deposits dominate the Kings Subbasin surface. These deposits have been categorized by Page and LeBlanc (1969) as Quaternary Older Alluvium (Qoao), Quaternary Younger Alluvium (Qya), and Quaternary Sand Dunes (Qsd). Qoao deposits are the most prominent and cover most of the subbasin. A large swath of Qsd is located in the south-central portion of the subbasin and Qya can generally be found along the banks and alluvial fans of rivers and intermittent streams. Quaternary Flood-basin deposits (Qb) are found along the western boundary of the subbasin between the San Joaquin and the Kings Rivers. Several relatively small outcroppings of basement complex (pTu) are located along the subbasin western edge. **Figure 3-7** is a map depicting surficial deposits in Kings Subbasin. More detailed descriptions of this GSA are included below.

Surficial geologic units in the region consist of unconsolidated Quaternary age (2.6 million years ago to the present) deposits. As shown on **Figure 3-7**, within the MAGSA, surface materials have been categorized by Page and LeBlanc (1969) as Qoao, Qya, Qsd, or Qb. Quaternary alluvium within the MAGSA is a result of erosion of the Sierra Nevada range to the east and subsequent deposition on the valley floor.

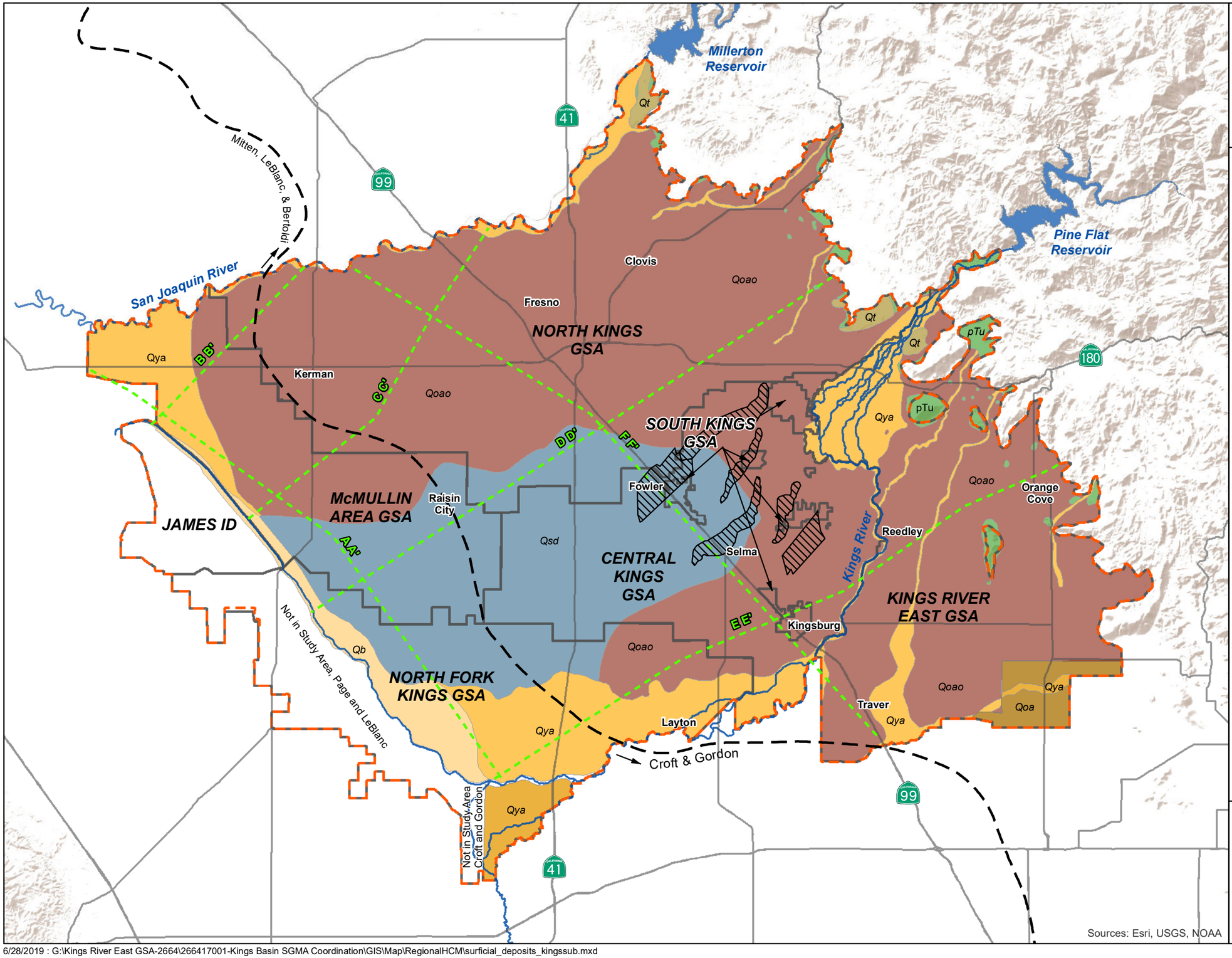
Surface geology in the MAGSA is closely tied to the geomorphic features in the area. Qya is mapped in the northwest part of the GSA along the modern-day San Joaquin River stream channel and southward, covering an area roughly contiguous with the Low Alluvial Fan of the San Joaquin River. A relatively large area of Qsd is located in the southern part of MAGSA in an area mapped as Dune Sands by Page and Leblanc (1969). Old Alluvium, as mapped, corresponds to the High Alluvial Fans of the Kings and San Joaquin Rivers. Qb lay along the western margin of MAGSA nearer to the depocenter of the valley defined locally by the Fresno Slough in an area mapped by Page and Leblanc (1969) as Over Flow Lands.

Cross-section locations are shown on **Figure 3-9** through **Figure 3-14**. Cross-sections are described later in this document.

Kings Subbasin

Surficial Deposits

Figure 3-7



Legend

- Kings Subbasin GSAs
- Kings Subbasin (2019)
- Highway
- Waterway

Geologic Deposits
Page and LeBlanc, 1969

- Basement Complex (Consolidated) (pTu)
- Flood Basin Deposits (Unconsolidated) (Qb)
- Older Alluvium (Unconsolidated) (Qoao)
- Sand Dunes (Unconsolidated) (Qsd)
- Terrace Deposits (Unconsolidated) (Qt)
- Younger Alluvium (Unconsolidated) (Qya)
- Geologic Cross Section

Geologic Deposits
Croft and Gorden, 1968

- Older Alluvium (Qoa)
- Younger Alluvium (Qya)

Subsurface Geologic Features

- Eastern Extent of E-Clay (Corcoran Clay) (Page and LeBlanc, 1969 (Modified by KDSA))*
- Incised Valley Fill (Weissmann et al, 2002 and Cehrs et al, 1980)

*Extent of E-Clay references differ outside of the Kings Subbasin.
- North of the San Joaquin River: Mitten, LeBlanc, & Bertoldi (1970)
- South of the Kings River: Croft & Gordon (1968)

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3.1.6 Soil Characteristics

Regulation Requirements:

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

Soils within the Kings Subbasin can vary significantly. In general, coarser grained soils are found along the eastern portions of the subbasin and adjacent to the SJR and Kings River, as well as areas associated with recent alluvial deposition along intermittent streams. Finer grained soils are typically found in the area of the compound fan created by intermittent streams in the east and are also found in the western areas of the Subbasin near the Fresno Slough. Soil maps and a more detailed description of this GSA are included below.

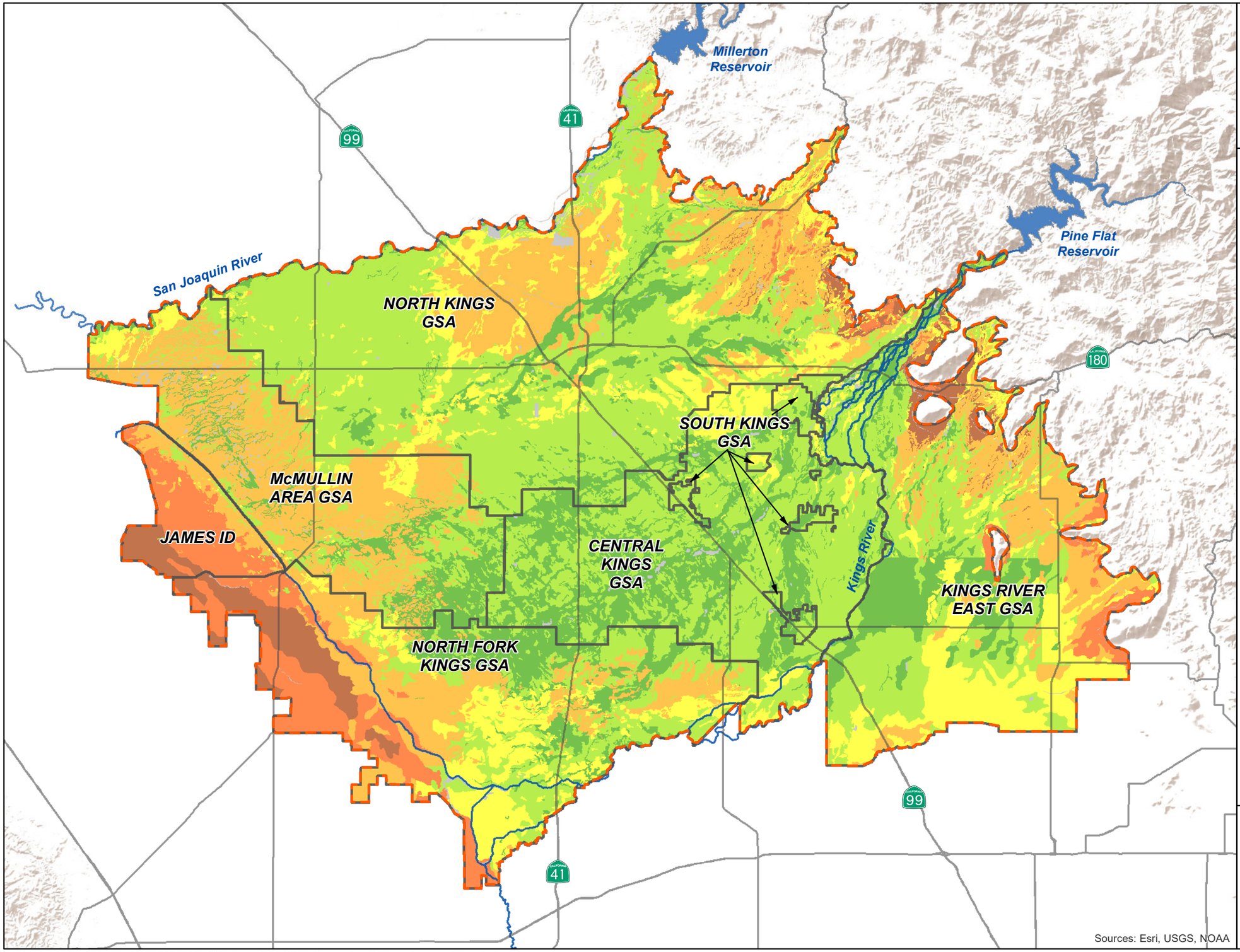
Top soils within the MAGSA have been mapped and described by the Natural Resource Conservation Service (NRCS). For the MAGSA area, the NRCS has generally described soils to depths of 5 to 7 feet. A map of NRCS soil textural classes is presented as **Figure 3-8**. On this map, soil textural classes have additionally been related to Saturated Hydraulic Conductivity (Ksat or hydraulic conductivity) based on NRCS general categories. The hydraulic conductivity values shown on the map are expressed in general terms ranging from relatively rapid for coarse grained top soils to relatively slow for fine and very fine-grained top soils.

As shown in **Figure 3-8**, the dominant soil textural class in the MAGSA is moderately fine. Moderately coarse soils exist along the margins of the MAGSA in the north, east, and west. At the southern end of the MAGSA the soil textural class is a mixture of coarse and moderately coarse. Intermittent stringers of coarse soils exist within the central portion of the MAGSA and along the boundary of the MAGSA and the San Joaquin River. In agreement with Surficial Geology and Geomorphic Features **(Figure 3-5**), those areas with rapid Ksat are found mostly in the Dune Sand deposits, and areas with restrictive layers are found in the Old Alluvium or the high alluvial fans of the major rivers.

Kings Subbasin

Soil Texture and Relative Saturated Hydraulic Conductivity

Figure 3-8



Legend

- Kings Subbasin GSAs
- Kings Subbasin (2019)
- Highway
- Waterway

USDA Soil Texture Class in Relation to Relative Saturated Hydraulic Conductivity (Ksat)

RAPID

- Coarse (Sands)
- Moderately Coarse (Sandy Loam)
- Medium (Very Fine Sandy Loam)
- Moderately Fine (Clay Loam)
- Fine and Very Fine (Sandy Clay)
- Impermeable (Restrictive Layers/Clays)
- No Rating

SLOW

Note: Soils data from USDA Soil Conservation Service.

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Sources: Esri, USGS, NOAA

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3.1.7 Cross-sections

Regulation Requirements:

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

Geologic cross section from Page and LeBlanc (1969) that transverse the Kings Subbasin are presented as **Figure 3-9** through **Figure 3-14**. Geologic cross section locations are shown on the Surficial Geology Map (**Figure 3-7**). They include two geologic cross sections roughly parallel to and four cross sections perpendicular to the structural trough of the San Joaquin Valley. These cross sections have been updated to show more recent interpretations of the depth to connate water and better vertical control of the depth to bedrock in a few locations near the foothills from technical studies done for the City of Clovis and the Kings River East GSA (KDSA (2010), KDSA (2019), Provost & Pritchard and KDSA (1995). As well these geologic cross sections are updated to show the boundaries of the Kings Subbasin GSAs. More detailed discussions of the portions of the geologic cross sections for MAGSA are included below.

Regional cross section A-A' traverses northwest-southeast through the MAGSA and is shown in **Figure 3-9**. Regional cross-sections B-B', C-C', and D-D' transverse northeast-southwest through the MAGSA area, are perpendicular to A-A', and are shown in Figure **3-10** through **Figure 3-12**, respectively.

The Quaternary Older Alluvium (Qoao & Qoa) is inferred to begin at the ground surface in the east or within 50 feet of the ground surface in the northwestern, western, and southern sections of the MAGSA. It reaches depths between approximately 700 to 1000 feet below the ground surface. Below the Qoa are Quaternary to Tertiary age continental deposits, which extend to depths of at least 1800 feet below ground surface across the entire MAGSA.

Three different laterally extensive clays within the Qoa are indicated as appearing in the MAGSA on cross sections. The oldest and most laterally extensive of these is the E-clay. It occurs at depths of approximately 500 feet in the north and west and at depths of approximately 400 feet in the south. It is present in all four cross sections. South of B-B' it is indicated that the lower bed of the E-clay is also present, commonly referred to in these areas as the bifurcated E-clay. Cross sections A-A' and B-B' indicate the presence of the C-clay in the northwestern area of the MAGSA occurring at a depth of approximately 300 feet. The A-clay is common in the western part of the area, appearing at shallow depths in cross sections A-A', B-B', and D-D'. Qya occurs at shallow depths in the western portion of the GSA, appearing in A-A', B-B', and C-C', in the vicinity of the San Joaquin River and the Fresno Slough. In the south, across the eastern two thirds of the transverse of D-D', the area is covered at shallow depths by Qsd.

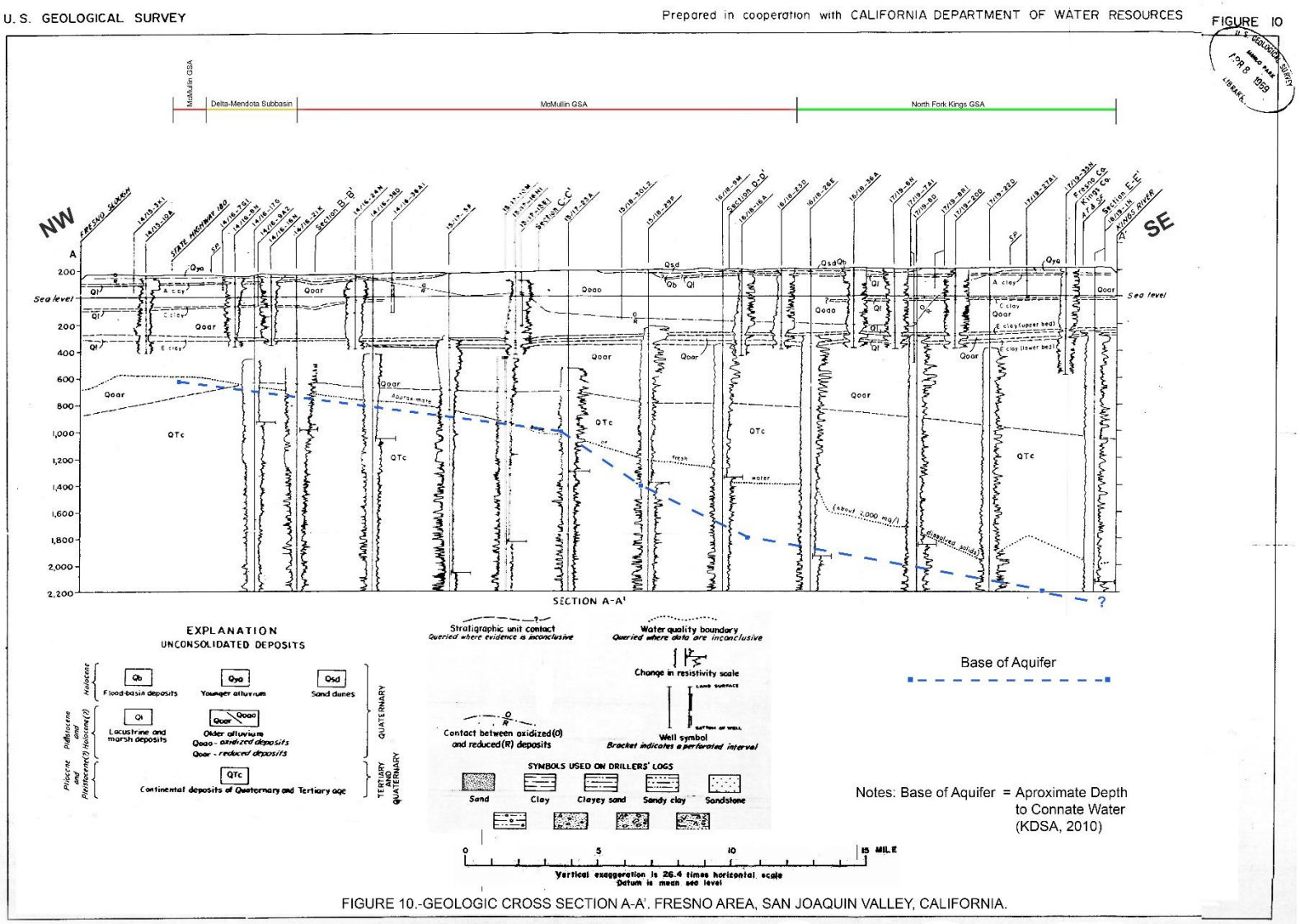

FIGURE 10.-GEOLOGIC CROSS SECTION A-A'. FRESNO AREA, SAN JOAQUIN VALLEY, CALIFORNIA.

Figure 3-9 Regional Cross-Section A-A' – Kings Subbasin

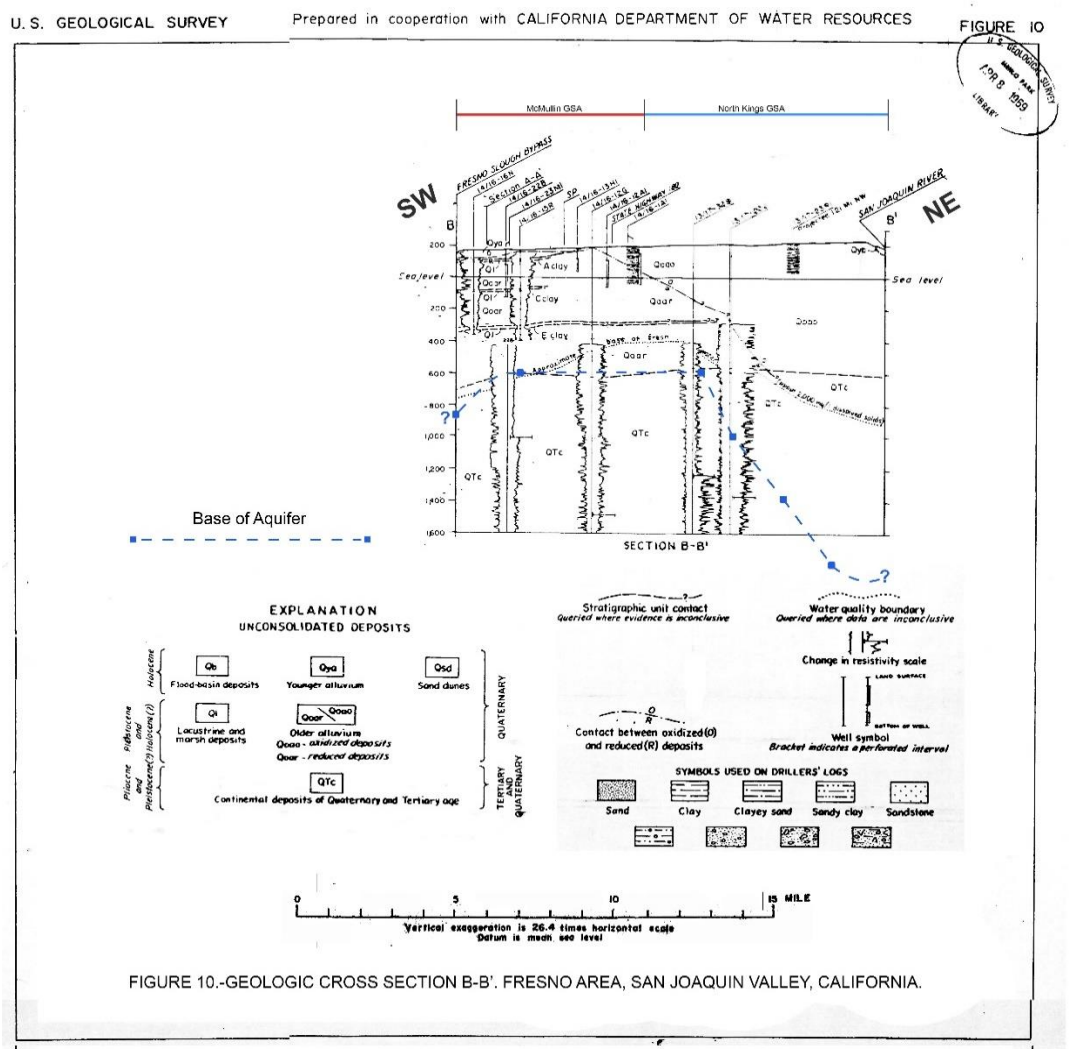

FIGURE 10.-GEOLOGIC CROSS SECTION B-B'. FRESNO AREA, SAN JOAQUIN VALLEY, CALIFORNIA.

Figure 3-10 Regional Cross-Section B-B' - Kings Subbasin

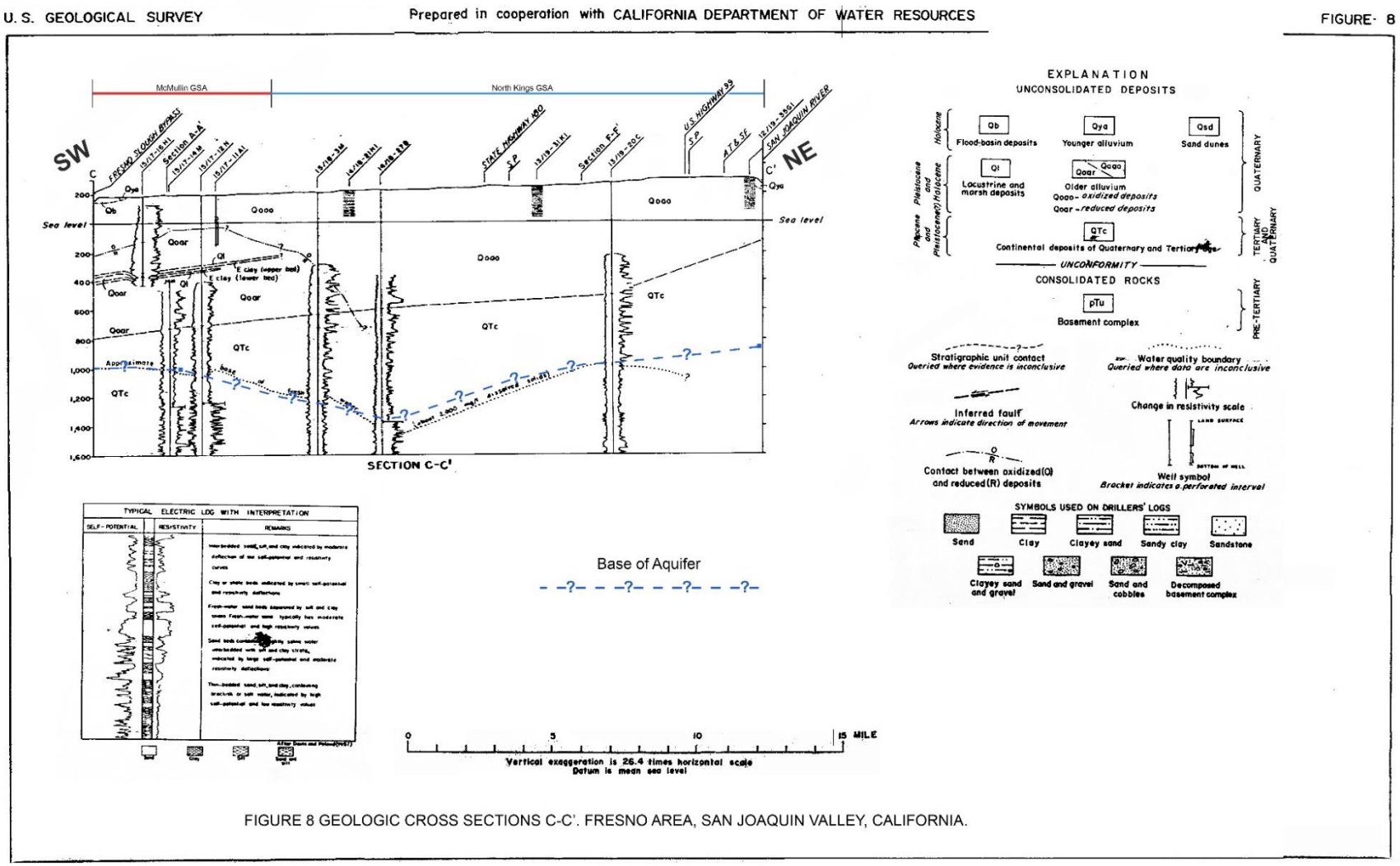

Figure 3-11 Regional Cross-Section C-C' - Kings Subbasin

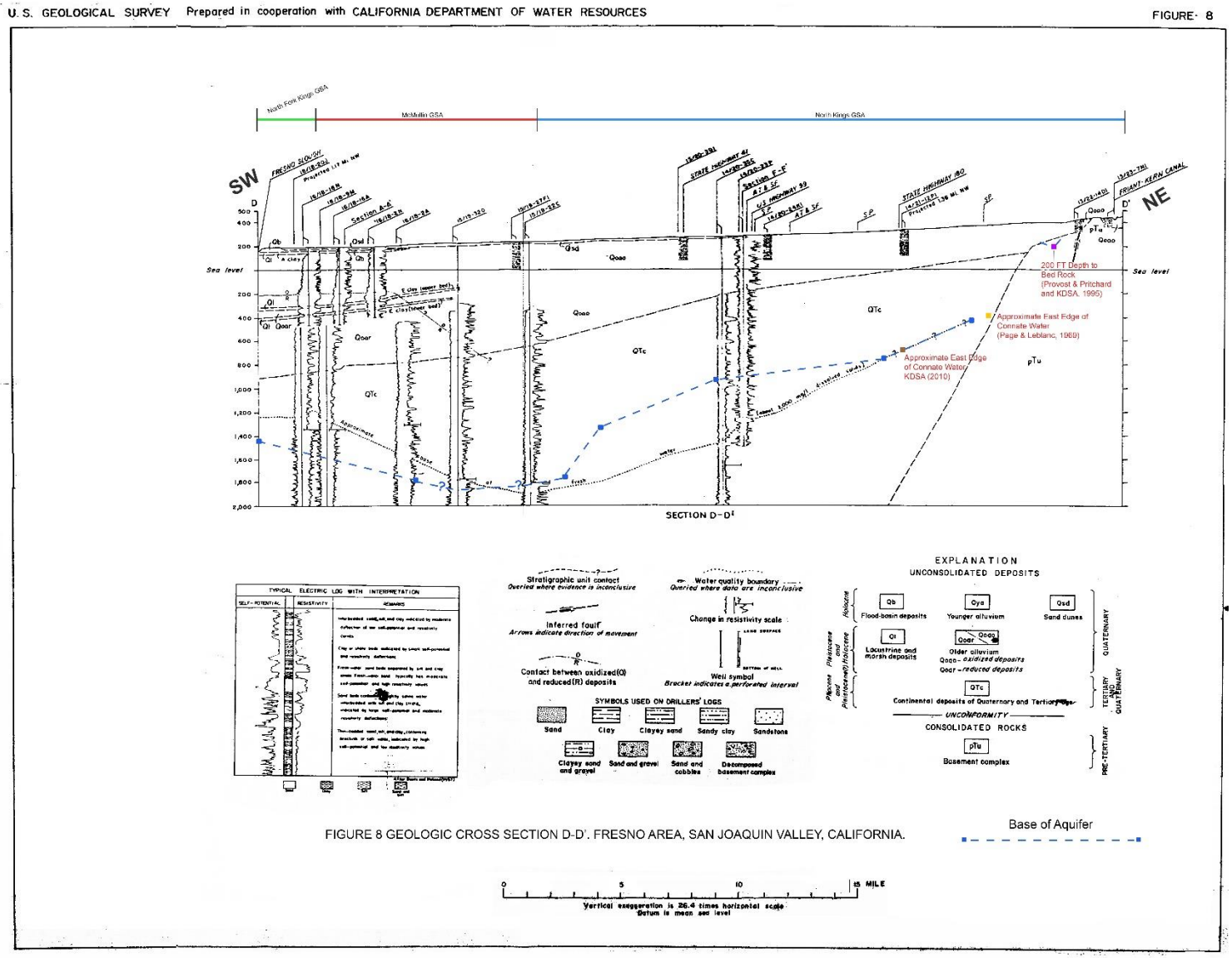

FIGURE 8 GEOLOGIC CROSS SECTION D-D'. FRESNO AREA, SAN JOAQUIN VALLEY, CALIFORNIA.

Figure 3-12 Regional Cross-Section D-D' - Kings Subbasin

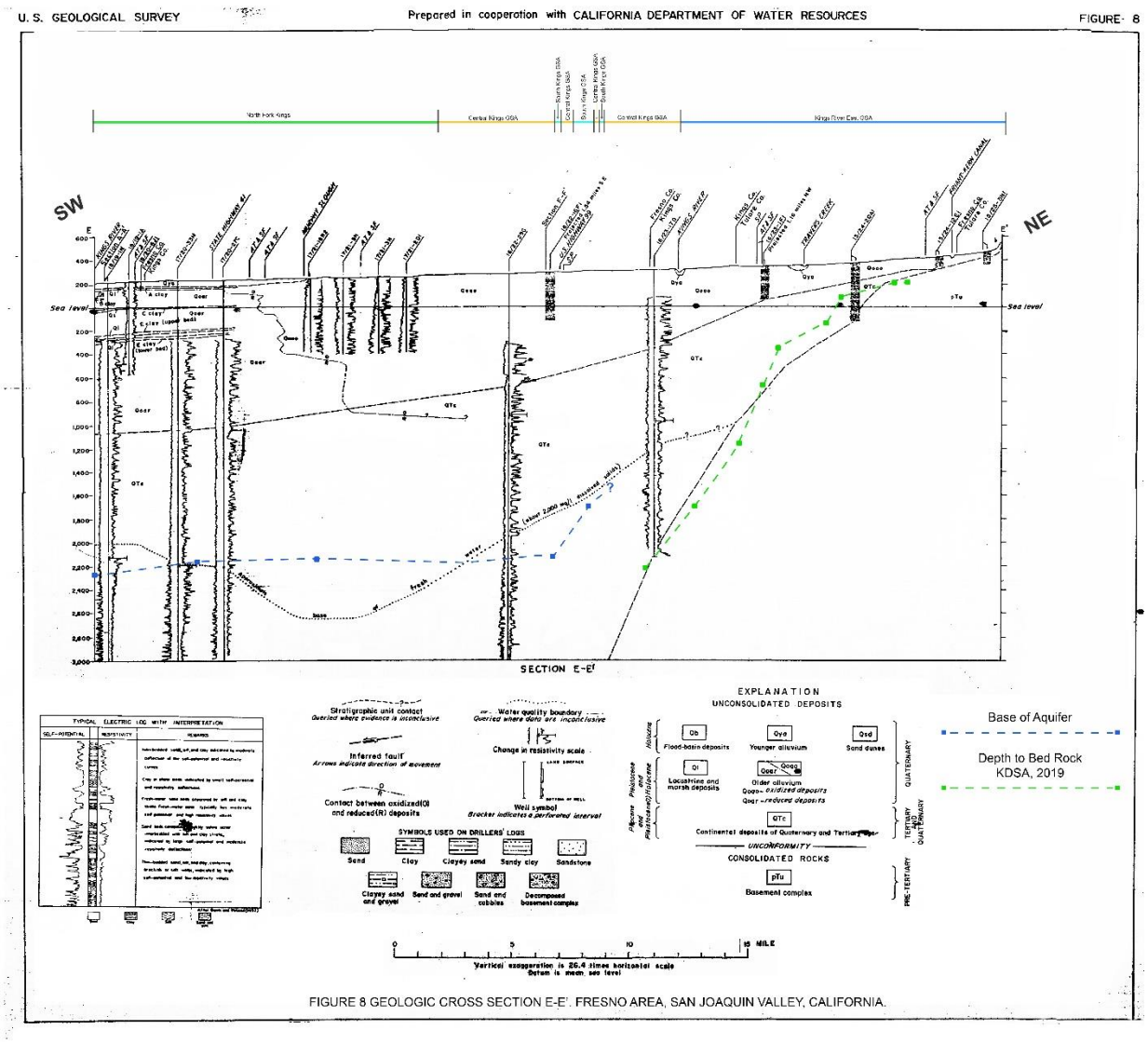

Figure 3-13 Regional Cross-Section E-E' - Kings Subbasin

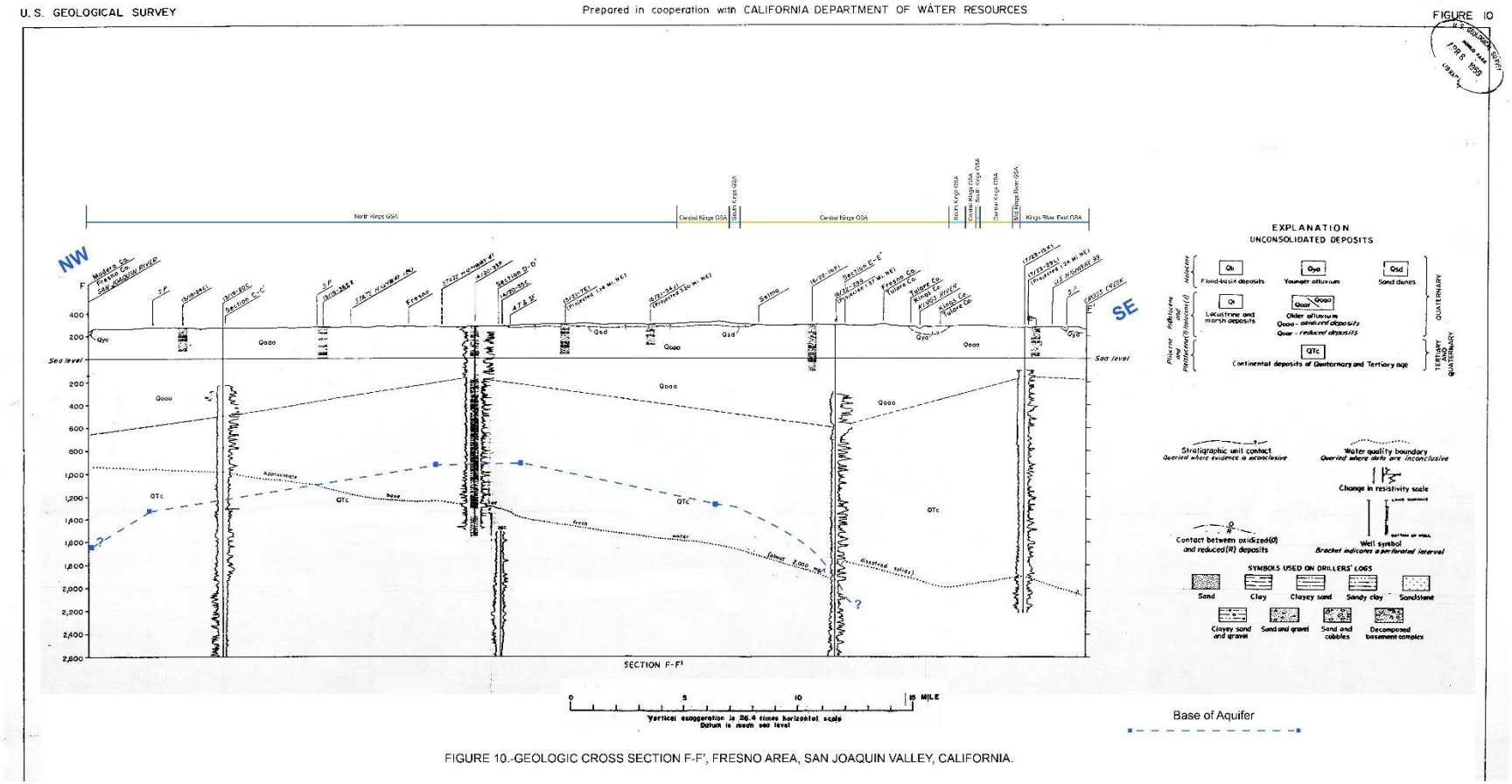

FIGURE 10.-GEOLOGIC CROSS SECTION F-F', FRESNO AREA, SAN JOAQUIN VALLEY, CALIFORNIA.

Figure 3-14 Regional Cross-Section F-F' - Kings Subbasin

n

3.1.8 Aquifer System

Regulation Requirements:

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

3.1.8.1 Geologic Formations

Regulation Requirements:

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

Geologists studying the lithology of the San Joaquin Valley in different areas have used different formation names over the years to describe the same lithologic units. As a result, the nomenclature used to describe the geologic formations within the Kings Subbasin can be confusing. A summary of the formations present in the Kings Subbasin is shown in **Figure 3-15** and **Figure 3-16** below, which are conceptual hydrogeologic cross sections. These conceptual hydrogeologic cross sections are included here as they show the vertical and horizontal stratigraphic relationships of the various geologic formations in the Kings Subbasin as interpreted by Brown & Caldwell and Water Resources and Information Management Engineering (WRIME) (2006).

The major stratigraphic and structural features such as the confining A-Clay, C-Clay, and E-clay (lacustrine deposits) that exist in the western portion of the subbasin are clearly identified. Likewise, the structural basement complex can be seen sloping to the southwest away from the foothills to beneath the valley floor, while the valley floor itself is primarily composed of alluvial deposits. Scaled geologic cross sections for the GSA were discussed above in Section 3.1.7, and more details regarding geologic formations in the MAGSA are provided below.

In the MAGSA area the surficial geology (Surficial Geology section of this HCM), soils (Soil Characteristics section of this HCM), and the subsurface geology (Cross-Sections section of this HCM) have been grouped into the Post-Modesto Formation, Modesto Formation, Riverbank Formation, Tulare Formation, and Turlock Lake Formation (Croft, 1972; Muir, 1977; Lettis, 1982; Page and LeBlanc, 1969; Cehrs, et al. 1980; Wiseman, et. al, 2002).

In the MAGSA area the Post-Modesto and Modesto Formation are the youngest mapped formations. These sediments form a 10-to-30-foot-thick veneer of materials composed primarily of granitic and metamorphic alluvium. The Riverbank Formation, stratigraphically below the Modesto Formation, is between 15-to-30 feet thick and is similar to the Modesto Formation in mineralogy. The Riverbank Formation contains an extensive iron-silica hardpan horizon present at the surface and in the subsurface. This hardpan horizon is the first impediment to groundwater percolation in the MAGSA and as such is an important consideration for recharge. The Tulare Formation and its associated aquitard E-Clay is stratigraphically below the Riverbank Formation. The Turlock Lake Formation lays below the Tulare Formation.

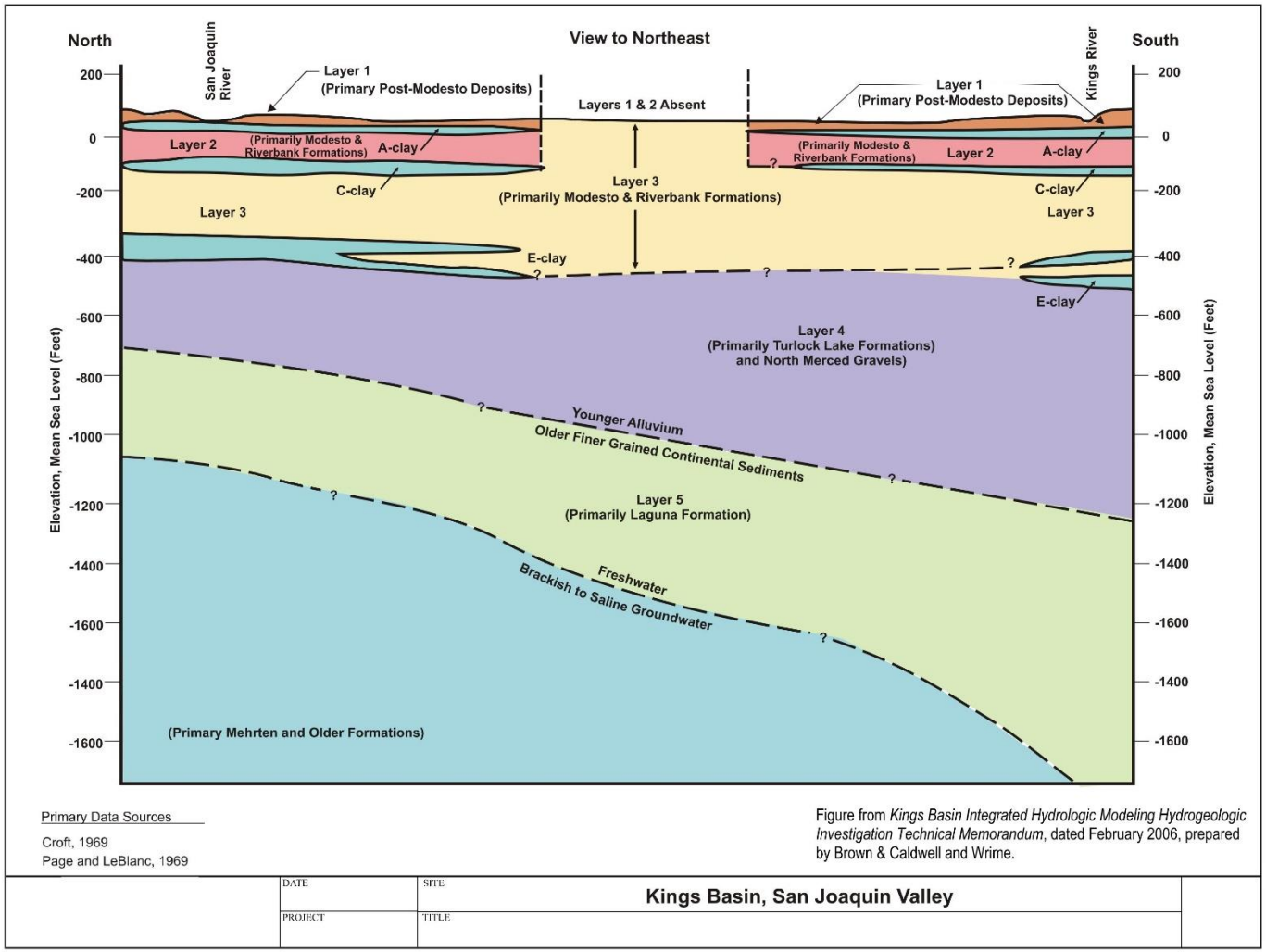

Figure 3-15 Kings Groundwater Subbasin Conceptual Cross-Section

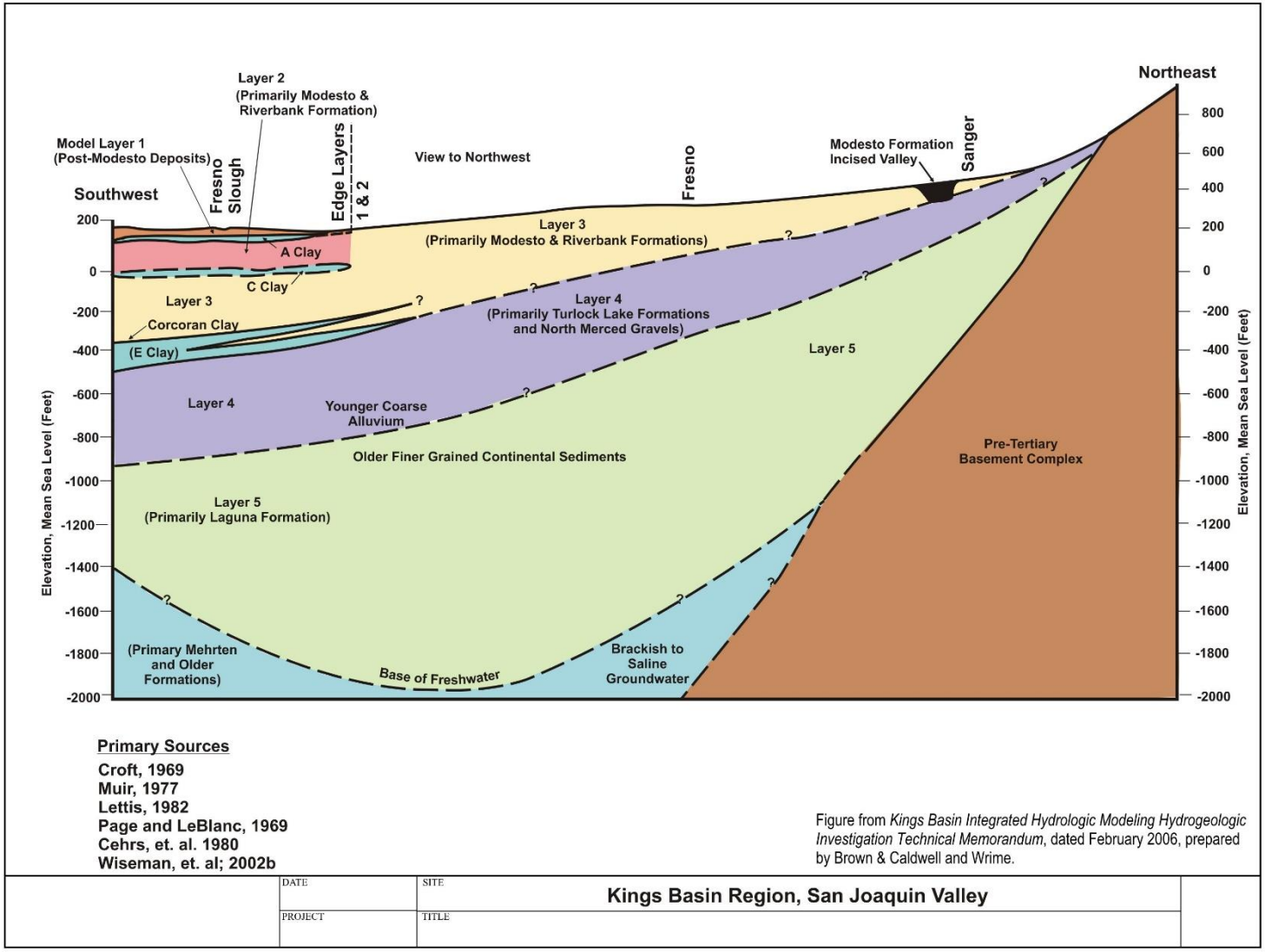

Figure 3-16 Kings Groundwater Subbasin Conceptual Cross-Section

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

The Kings Subbasin groundwater aquifer system consists of unconsolidated continental deposits. These deposits are an older series of Tertiary (66 to 2.6 million years ago) and Quaternary (2.6 million years ago to the present) age sediments overlain by a younger series of deposits of Quaternary age. The Quaternary age deposits are divided into older alluvium, lacustrine (lake) and marsh deposits, younger alluvium, and flood-basin deposits (Page and LeBlanc, 1969). Lacustrine and marsh deposits, known as E-Clay or Corcoran Clay, tend to lie in western portions of the subbasin and contain the major aquitards in the area that separate the unconfined aquifer system above and from confined aquifer system below, as shown on Geologic Cross Sections above.

The older alluvium, which is the most important aquifer in the area, consists mostly of interbedded layers of silts, silty/sandy clays, clay lenses, clayey and silty sands, sands, gravels, cobbles, and boulders (Page and LeBlanc, 1969). The younger alluvium is a sedimentary deposit of fluvial arkosic beds that overlies the older alluvium and is interbedded with the flood-basin deposits. Its lithology is similar to the underlying older alluvium. Beneath river channels, the younger alluvium is highly permeable (Page and LeBlanc, 1969). The older alluvium extends to depths of approximately 800 to 1100 feet beneath the MAGSA (**Figure 3-9 – Figure 3-12**). It hosts an unconfined aquifer and confined aquifers.

Interbedded within the older alluvium are lacustrine and marsh deposits that have been identified as the A-, C-, and E clays (Croft, 1972). These clays are highly impermeable and restrict the vertical movement of water between more permeable beds wherever they occur. As shown in **Figure 3-17** below, the E-clay, commonly known as the Corcoran Clay, is found beneath most of the MAGSA at depths of approximately 400 to 500 feet (**Figure 3-9 – Figure 3-12**). It is bifurcated across much of this expanse, meaning there are two lenses, an upper and lower lens. The Corcoran Clay is known to have confined groundwater conditions beneath it (Page and LeBlanc, 1969).

The A-clay occurs at shallow depths of approximately 50 feet below the surface in the western part of the MAGSA (**Figure 3-17**). The C-clay is present in the northwestern portion of the MAGSA at depths of approximately 300 feet below the surface (**Figure 3-9** & **Figure 3-10**). These lacustrine deposits, along with reduced facies of the older alluvium, coarsen laterally from west to east and as the depths of the deposits decrease. The coarser facies they grade into are associated with oxidized deposits of the older alluvium (Page and LeBlanc, 1969). Within the MAGSA the aquifer thickness is limited by relatively shallow saline water, which may exist as little as 600 feet beneath ground surface in the northern part of the area (**Figure 3-9** & **Figure 3-10**). As discussed below, Kenneth D. Schmidt and Associates (KDSA) 2010 estimated the base of fresh water in MAGSA at its shallowest to be about 800 feet deep.

The younger alluvium is lithologically similar to the underlying older alluvium (Page and LeBlanc, 1969). It is principally found in proximity to natural waterways and is interbedded with flood-basin deposits. Beneath river channels it is highly permeable but beneath flood plains it may be poorly permeable. In general, the younger alluvium is not vertically extensive enough to contain a large percentage of the area's groundwater. Well data in other parts of the Kings Groundwater Basin indicate that confined groundwater conditions exist between the C-clay and E-clay where their boundaries overlap. At the time of writing this HCM, insufficient data was available to verify if confined groundwater conditions exist between the C-clay and E-Clay within the MAGSA; however, based on the available data from nearby areas, it is assumed that confined groundwater conditions exist between the two in the MAGSA. This is still being investigated by the Kings Basin Coordination Efforts

McMullin Area GSA

Extent of Lacustrine Clays
Figure 3-17

MADERA CO.

FRESNO CO.

SAN JOAQUIN RIVER

MADERA

FRESNO

Biola

Kerman

W Whitesbridge Rd

239 ft

Kearney Park

Fresno

W Herndon Ave

E Herndon Ave

Speedway

Tranquillity

FRESNO SLOUGH

JAMES BYPASS

San Joaquin

Raisin City

Caruthers

Helm

Cantua Creek

S Bryan Ave

99

145

180

41

- McMullin Area GSA
- Kings Subbasin (DWR, Modified 2018)
- A-Clay Extent (USGS 1958)
- C-clay Extent (USGS 1958)
- Corcoran Clay Extent (E-Clay, Page 1986)

North East Edge of Corcoran Clay

- Page and LeBlanc 1969, KDSA Modification

Note: A and C Clays found on hachured side of extent lines.

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), swisstopo, © OpenStreetMap contributors, and the GIS User Community

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3.1.8.2 Aquifer Characteristics and Properties

Regulation Requirements:

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

In general terms, the aquifer system in the Kings Subbasin extends vertically to the basement complex along the eastern margins of the subbasin and to the base of freshwater (connate water) in the other areas. For the purposes of this HCM, freshwater is defined as groundwater with total dissolved solids (TDS) content of 2,000 mg/L. Laterally, the aquifer system essentially underlies the entire subbasin. Specific yields, in the subbasin range from 0.2 percent to 36 percent (CDWR, 2006). Within the central valley, hydraulic conductivity values have been estimated to range between approximately 0.00053 feet per day (ft/day) for clays to 110 ft/day for sand and gravel aquifer materials (Williamson et al, 1989). More detailed discussion of the vertical extent, aquifer characteristics, specific yield of deposits, and hydraulic conductivity and transmissivity of this GSA are discussed below.

Vertical Extent

The lateral extent of the aquifer system within the Kings Subbasin is described in the Lateral Basin Boundaries section of this HCM. The vertical extent, i.e., depth, of the aquifer system is comprised of two separate boundary types, basement complex and depth to connate water, and has been mapped by Page and LeBlanc (1969) and KDSA (2010). The Kings Basin Coordination Efforts, Base of Unconfined Groundwater Map by KDSA is included in this HCM as **Figure 3-3**. As shown in this figure, along the central-eastern portions of the Kings Subbasin, the base of the unconfined aquifer is located at a depth of approximately 300 feet bgs. Further west within the Kings Subbasin and coinciding with the E-clay, the base of the unconfined aquifer drops to depths of 400 to 450 feet bgs.

For the purposes of this HCM the base of the fresh water is considered the base of the useable aquifer as MAGSA is not bounded to the east by the bedrock of the Sierra Nevada nor on the west by the bedrock of the Coast Range. In 2010 KDSA developed contours for the Kings Subbasin for the depth to connate water. The depth to connate water is the depth to the base of fresh water based on a TDS of 2,000 mg/L. or about 3,000 milliSiemens per centimeter (uS/cm) electrical conductivity (**Figure 3-19**). This map shows that the base of the aquifer, defined here as the base to fresh water (or depth to connate water), deepens southeastward across the MAGSA from about 800 feet to at least 2,400 feet. The southeastward deepening of the base of fresh water is in general agreement with the USGS developed base of fresh water as shown on the Geologic Cross sections above (**Figure 3-9** to **Figure 3-14**)

Aquifer Characteristics

The principle aquifer characteristics of importance to the MAGSA are transmissivity, hydraulic conductivity, and storativity. By definition, hydraulic conductivity is the rate at which water can move through a permeable medium, and the transmissivity is the amount of water that can be transmitted horizontally by the full saturated thickness of the aquifer under a hydraulic gradient of 1. These two properties are related in that transmissivity is the hydraulic conductivity multiplied by saturated aquifer thickness. Storativity relates to how much space is available in the aquifer system for storage and release of groundwater. More specifically, storativity is the volume of water that a permeable unit will absorb or expel from storage per unit surface area per unit change in head (Meinzer, 1932). In unconfined aquifers, the storativity is approximately equal to the specific yield. Therefore, as most of the published sources consulted for this HCM provide information on specific yield, this portion of the report discusses specific yield as a close approximation of storativity.
Specific Yield of the Deposits

Specific yield is defined as the ratio of the volume of water a rock or soil sample will yield by gravity drainage to the volume of rock or soil (Meinzer, 1932). In general, specific yield data derived from subsurface material textures are considered to be the most accurate obtainable values. As part of the Kings Basin Coordination Efforts, KDSA conducted a review of available published sources of specific yield data (KDSA, 2018b). Initial sources of specific yield values used in the evaluation included Davis et. al. (1959), Page and LeBlanc (1969), and Williamson et. al. (1989).

Within the MAGSA, additional evaluation of specific yield values was performed by KDSA as the values from Williamson et. al. (1989) were estimated over the entire saturated thickness of the aquifer, down to depths of several thousand feet (i.e., below the E-Clay). As documented by Page and Leblanc (1969), Quaternary and Tertiary age deep continental deposits are more finely grained than the overlying Quaternary age deposits. The deeper fine-grained deposits have lower specific yield; therefore, the overall specific yield based on the entire saturated thickness of the aquifer are lower than specific yield values in the unconfined aquifer above the E-Clay.

The additional KDSA evaluation for the MAGSA was based on electric logs, geologic logs, and DWR Well Completion Reports. The data were used to develop several subsurface geologic cross sections in the area. On the subsurface cross sections, three types of deposits--sand or coarser materials, clay or silt, and intermediate type materials, such as sandy clay--were shown. These deposit types were assigned specific yield values of 20 percent, 3 percent, and 8 percent, respectively. Specific yield was estimated from the Spring 2005 water table to the top of the Corcoran Clay.

Based on the review of published data and the additional evaluation for the MAGSA, KDSA compiled a map for the MAGSA showing the recommended specific yield values for use in calculating changes in storage. This map is presented in this HCM as **Figure 3-20**. As shown in **Figure 3-20**, recommended specific yield values for the MAGSA range from 10.2 % to 16 %.

Hydraulic Conductivity and Transmissivity

The hydraulic conductivity of a saturated, porous medium is the volume of water it will transmit in a unit time, through a cross-section of unit area, under a hydraulic gradient of a unit change in head, through a unit length of flow (Lohman, 1972). In USGS Professional Paper 1401-D, Williamson et. al. (1989) compiled hydraulic conductivity values estimated from more than 7,400 drillers' logs in the San Joaquin Valley and from power company pump-efficiency tests. Within the unconfined aquifer of the MAGSA, estimates of hydraulic conductivity range from a high of 15.3 feet/day (ft/d) in the northwest near the San Joaquin River to a low of 6.0 ft/d along the western margin in the area of the Fresno Slough.

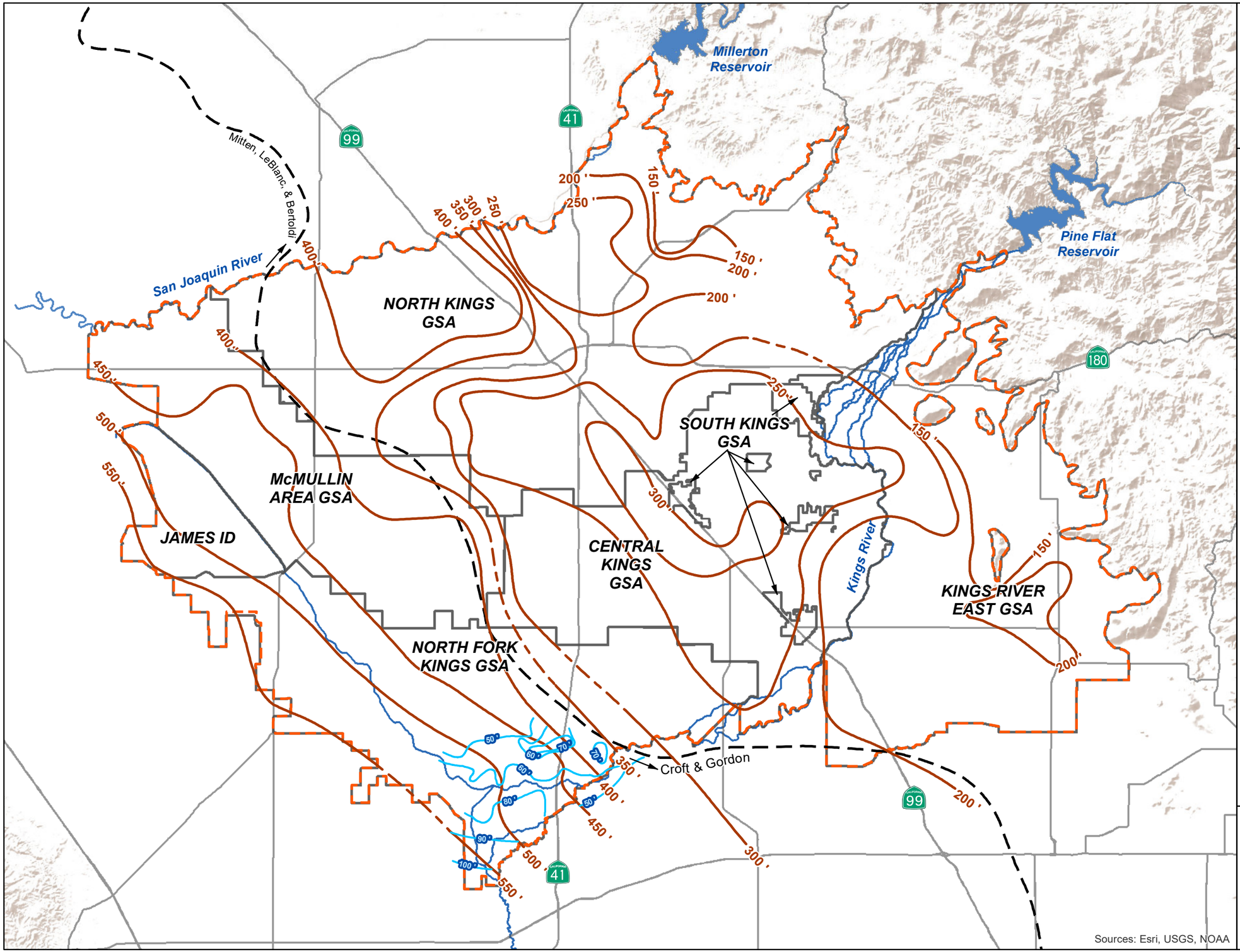
Transmissivity is the property of an aquifer that determines the ability of the aquifer to transmit groundwater flow laterally. It can be calculated by multiplying the thickness of the water producing strata by the hydraulic conductivity of the same strata. Typically, transmissivity values can readily be determined from the results of aquifer tests; however, when such information is not available, they can also be estimated from well specific capacity values. A conversion between specific capacity and transmissivity was developed by Thomasson et al. (1960) by which an estimate of transmissivity could be made by multiplying the specific capacity of a well by 1,500 for an unconfined aquifer or by 2,000 for a confined aquifer.

As part of the Kings Basin Coordination Efforts, KDSA compiled transmissivity values estimated from specific capacity compiled by Davis et el. (1964). The resulting transmissivity values were then refined where KDSA had aquifer test results and then used to estimate groundwater flows at MAGSA boundaries with other GSAs within the Kings Basin (2018c). Based on the KDSA evaluation, estimates of transmissivity along the border of the MAGSA range from a low of 75,000 gallons per day per foot (gpd/ft) in the south to a high of 133,500 gpd/ft in the northwest corner of the GSA near the San Joaquin River (**Figure 3-20**).

Kings Subbasin

Enhanced Concept of
Base of Unconfined Groundwater

Figure 3-18



Legend

- Kings Subbasin GSAs
- Kings Subbasin (2019)
- Highway
- Waterway
- Depth To A-Clay (Laguna
- Eastern Extent of E-Clay (Corcoran Clay) (Page and LeBlanc, 1969 (Modified by KDSA))

Depth to Base of Unconfined Groundwater

(KDSA, 2018)

- Defined
- Inferred

KDSA
Est. 1972

EST. 1968
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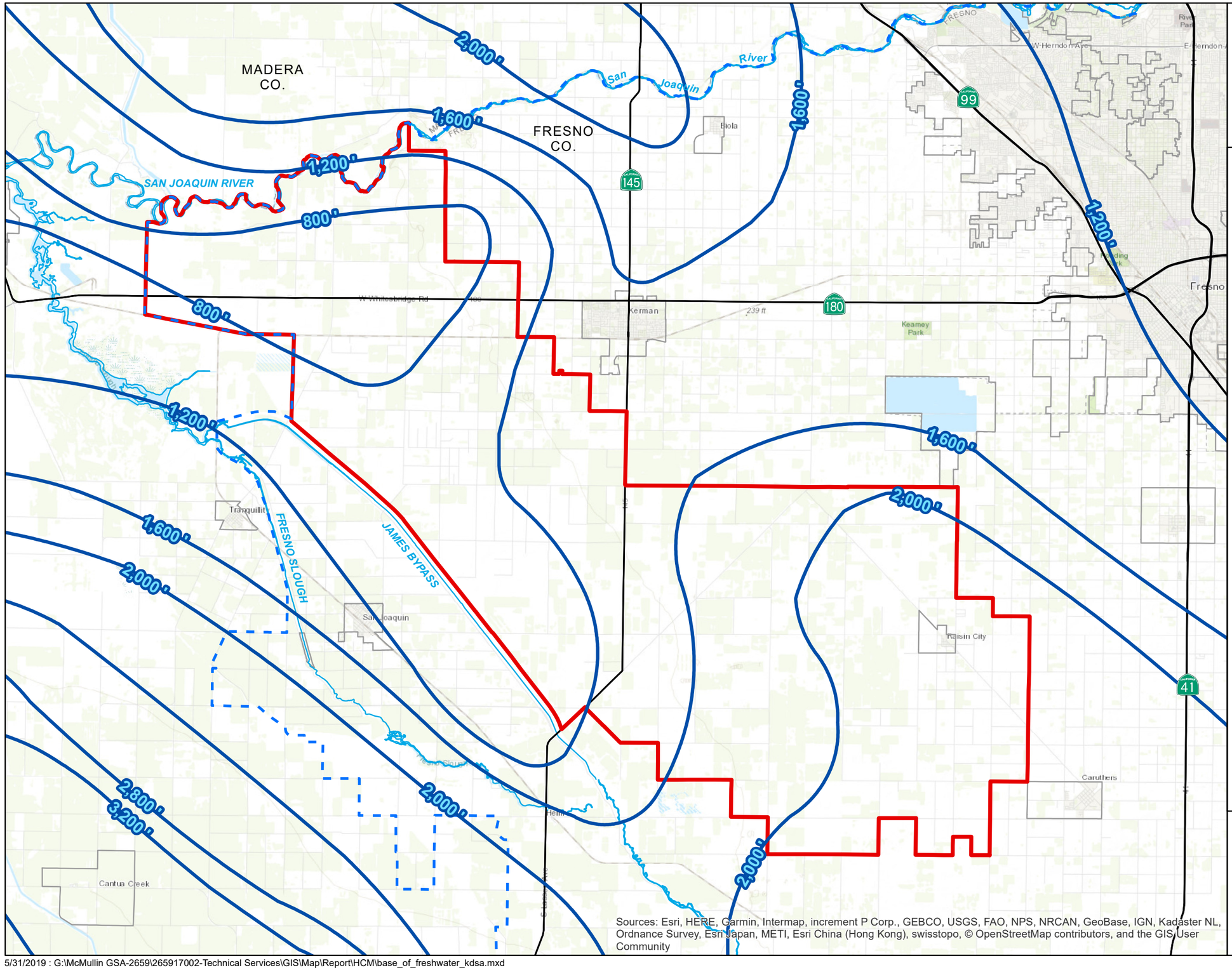
McMullin Area GSA

Base of Aquifer

Figure 3-19



McMullin Area GSA

Kings Subbasin (DWR, Modified 2018)

Approximate Depth to Connate Water (ft)**

Note: **Connate water is where Total Dissolved Solids approach 2,000 mg/L. KDSA 2010

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), swisstopo, © OpenStreetMap contributors, and the GIS User Community

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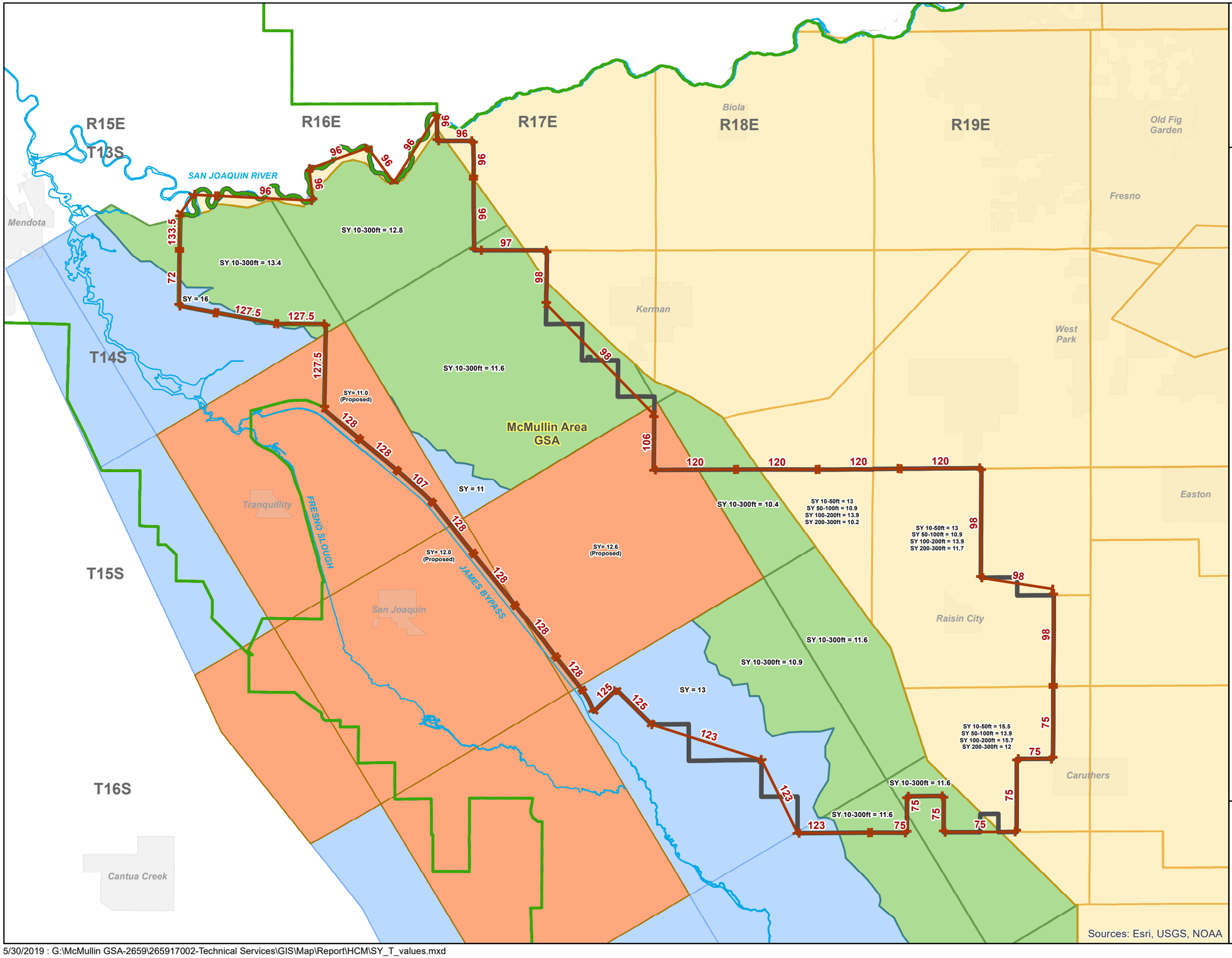
McMullin Area GSA

Data Sources Coverage,
Recomended Specific Yield and
Initial Estimated Transmissivity
Vallues (KDSA, 2018c)

Figure 3-20



McMullin Area GSA

Kings Subbasin (DWR 2018)

Groundwater Subbasins (DWR 2018)

City/Place

Boundary Flow Segment
(Transmissivity values shown as 1,000s)

Proposed SY Data Source Heirarchy

USGS WSP 1469 (1959)

Page and LeBlanc 1969 (1969)

USGS PP 1401-D (1989)

KDSA Evaluation
(From 2005 Water Level to
Base of Unconfined Aquifer)

Note: SY from 200-300ft from USGS OFR 1969. Map from Kings Subbasin Coordinated Effort Technical Memorandum #2 (SY) and Technical Memorandum #5 (T Values).

KDSA
Est. 1972

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Sources: Esri, USGS, NOAA

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Regional Groundwater Flow Patterns

Groundwater flow patterns in the upper (unconfined) and in lower confined aquifers (i.e., below the Corcoran Clay) under natural flow conditions in the MAGSA differed greatly before agricultural development of the area. Groundwater recharge to the area occurs primarily from run-off from the Coast Ranges to the west and from San Joaquin river seepage and groundwater percolation. Prior to development, waters from both east and west sources moved under the Corcoran Clay and into the valley trough where mixing, circulation, and upward movement through the Corcoran Clay occurred at very slow rates (**Figure 3-22, Inset B**). As a result, the potentiometric surface of the confined groundwater was higher than the land surface in the valley trough area and flowing artesian well conditions existed within the trough area (Bull and Miller, 1975). A map depicting areas of flowing artesian wells within the San Joaquin in 1906 from Mendenhall et. al. (1916) is included as **Figure 3-21**.

Large-scale agricultural pumping on the west side of the San Joaquin Valley has resulted in a change to the flow pattern of confined groundwater below the Corcoran Clay, as well as changed flow patterns in the aquifer above the Corcoran Clay (**Figure 3-22, Inset C**). As shown on **Figure 3-22**, from 1906 to 1966, the mixing point of the two distinct water sources in the confined aquifer moved west and the confined groundwater potentiometric surface became lower than the valley land surface (Bull and Miller, 1975). Currently, there are no known springs, seeps, or flowing wells within the MAGSA.

The potentiometric surface of unconfined groundwater has also been lowered considerably due to large-scale agricultural pumping, which, among other things, has led to the San Joaquin River transitioning from a predominantly gaining stream to a predominantly losing stream (**Figure 3-22, Insets B and C**).

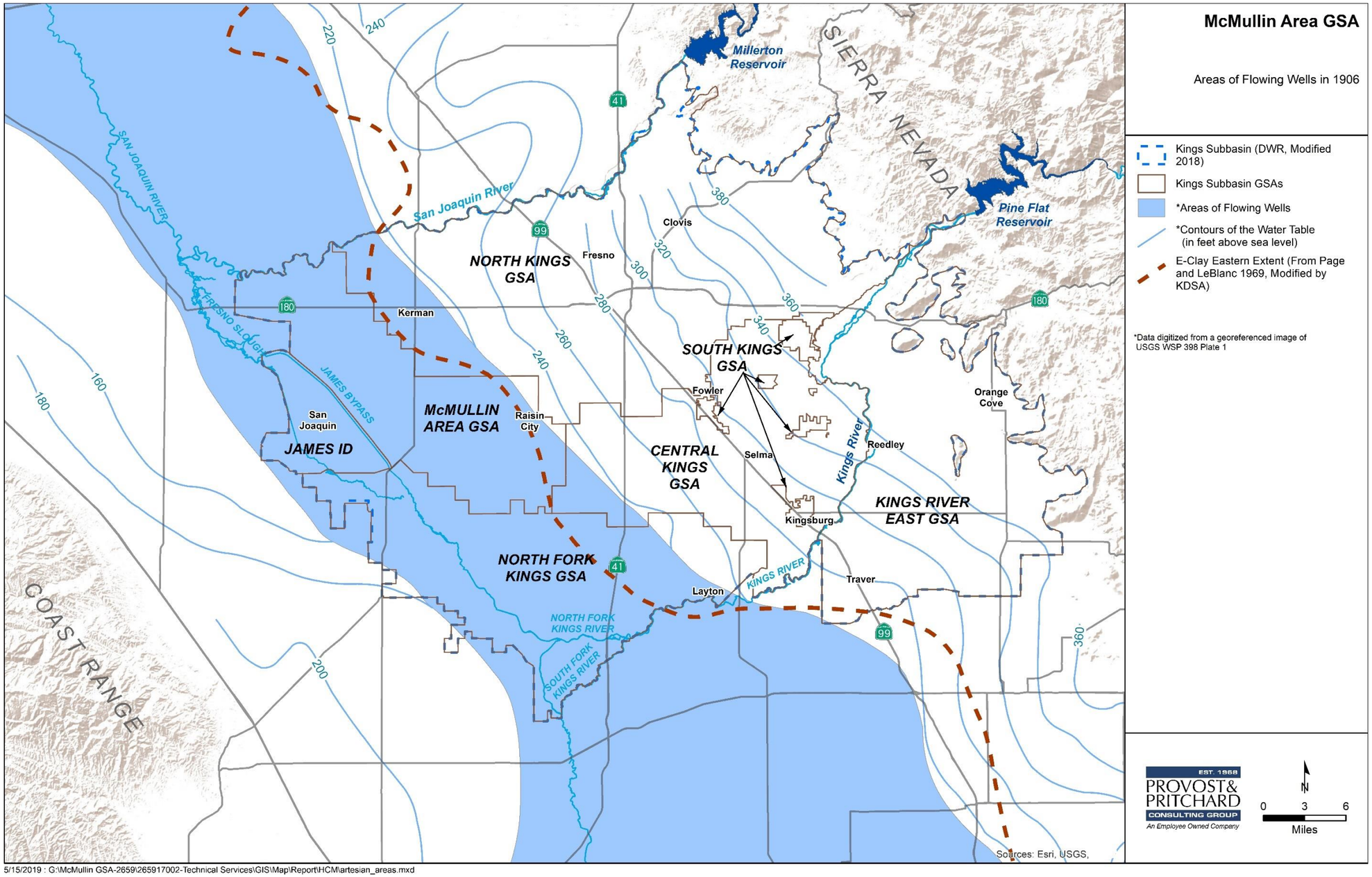

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Figure 3-21 Areas of Flowing Wells in 1906

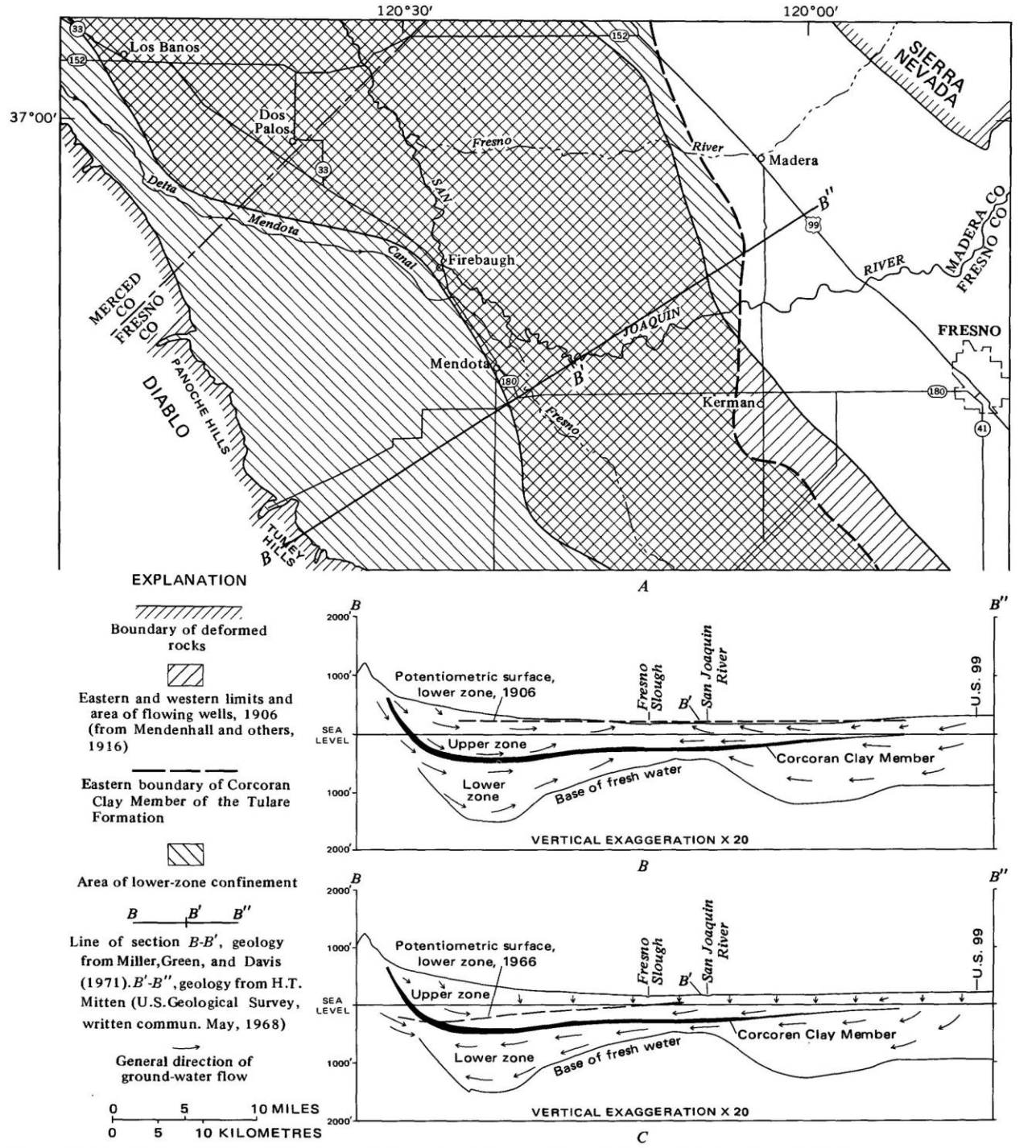

Figure 20 from Bull and Miller, 1975. Change in the natural-flow conditions in the central San Joaquin Valley. A, Extent of lower-zone unconfined. B, Flow conditions in 1900 (pre-development). C, Flow conditions in 1906 (post-development).

Figure 3-22 Pre-Development and Post-Development Regional Groundwater Flow Patterns

3.1.8.3 Aquifer Uses

Regulation Requirements:

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

Groundwater is pumped extensively for agricultural use within the Kings Subbasin, as it is in the San Joaquin Valley as a whole. Domestic and municipal use of groundwater is also significant within the subbasin. Domestics wells, in large part, draw water from the shallower aquifer zones. Historically agricultural wells drew water primarily from the unconfined portions of the aquifer although newer agricultural wells are often deeper and can draw water from multiple aquifer zones. Newer municipal wells are often sealed across shallow contaminated water and often tap the deeper confined portion of the aquifer. In addition, some municipal wells only draw water from a specific zone(s) of a given aquifer, usually below the base of the unconfined groundwater, in efforts to meet MCLs without the need for treatment. More detailed information for the GSA is presented below.

The aquifers in the MAGSA are used for domestic, irrigation, industrial, and municipal water supply purposes. Most of the groundwater pumped in MAGSA is from the unconfined and groundwater pumped from the confined aquifer is primarily used for agriculture. Groundwater pumping for municipal use occurs in the community of Raisin City but it is not metered. Other private domestic pumping within the area occurs for rural residential and private well systems, as well as agricultural industrial related pumping within some areas. Agricultural related pumping is the largest groundwater demand within the MAGSA. The estimated amounts of pumping are described in the Water Budget chapter of this plan.

3.1.9 General Groundwater Quality

Regulation Requirements:

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

According to CDWR Bulletin 118 (2006), groundwater in the Kings Subbasin is predominantly of sodium-bicarbonate type. The major cations are calcium, magnesium, and sodium. A typical range of groundwater quality in the basin is 200 to 700 mg/L. DH) data indicates an average TDS of 240 mg/L from 414 samples from Title 22 water supply wells. These samples ranged from 40 to 570 mg/L. DBCP, a soil fumigant nematicide, and nitrates can be found in groundwater along the eastern side of the subbasin. Shallow brackish groundwater can be found along the western portion of the subbasin. Elevated concentrations of fluoride, boron, and sodium can be found in localized areas of the subbasin. The discussion presented below is intended to present a generalized view of groundwater quality in this GSA. A more detailed discussion on groundwater quality is included in **Section 3.2.5**.

Groundwater quality of the MAGSA is discussed in general terms below. Further detailed groundwater quality discussions are included in the Groundwater Conditions Section. According to DWR Bulletin 118, groundwater in the Kings Basin is predominantly of sodium-bicarbonate type. The major cations are calcium, magnesium, and sodium. A typical range of groundwater quality in the basin is 200 to 700 mg/L. Department of Health Services (DHS) data indicates an average TDS of 240 mg/L from 414 samples from Title 22 water supply wells. These samples ranged from 40 to 570 mg/L. DBCP, a soil fumigant nematicide, and nitrates can be found in groundwater along the eastern side of the subbasin. Shallow brackish groundwater can be found along the western portion of the subbasin. Elevated concentrations of sodium can be found in localized areas of the subbasin.

Groundwater quality is generally excellent for agriculture and good in most areas for municipal use. However, there are water quality issues in some areas of the MAGSA. The primary constituents of concern include chloride, nitrate, and salinity (EC, TDS).

Known areas of groundwater impacts include elevated levels of chloride and salinity due to the Raisin City Oilfield and some nitrate and salinity exceedances attributed to agriculture per the Kings GAR. The MAGSA area is approximately the northern portion of the GAR-designated Lower Kings area.

Nitrate exceedances in any well with at least one measurement at or above the MCL of 10 mg/L are generally concentrated outside of urban areas. The GAR indicates that there are very few nitrate detections (2006 to 2014) in the MAGSA area, but many of those present are above the MCL of 10 mg/L. Few pesticide exceedances are present in the MAGSA.

The dominant source of impacted groundwater in the MAGSA has been identified as the Raisin City Oilfield. In 2017, KDSA prepared a review of the groundwater contamination due to the oilfield brine. The assessment focused on historical evaluations of the area by the California Division of Water Resources (now the Department of Water Resources) and the current Department of Water Resources. The KDSA review summarized the following findings.

> In the 1950s, DWR released a report on the Raisin City Oil Field estimating that as of 1953, approximately 730 acre-feet per year of wastewater was disposed of in the unlined sumps. This wastewater had concentrations of TDS at 34,000 to 44,000 mg/L, chloride (21,000 to 27,000 mg/L), and boron (6 to 20 mg/L). At the time, groundwater samples were used to determine that background chloride concentrations were about 20 to 65 mg/L and that wells obviously impacted by the wastewater had concentrations from approximately 150 to 2,700 mg/L. The Division of Water Resources suggested that unlined sumps no longer be used for wastewater disposal. After about 1959, the Raisin City Oil Field wastewater was to be injected into deep strata. The direction of groundwater flow in the early 1950's was to the southwest. By the mid 1960's, irrigation well pumping to the southeast of McMullin Grade had caused a cone of depression in the area, causing the Raisin City Oil Field groundwater to flow to the south.
>
> Using chloride as a marker constituent, the KDSA report indicates the largest number of impacted wells are located in Section 13 of Township 15 South, Range 23 East, with three secondary impact centers in adjacent sections to the west and southeast, and in Section 9. Given the location of these impacted areas, the former groundwater flow direction to the southwest, and the current groundwater flow direction to the south due to the groundwater depression, it can be expected that impacts will be seen to the southwest and south of the above-mentioned areas. The JID well field is located to the southwest and south of these plume centers so is likely to be impacted by the Raisin City oilfield plume currently and in the future.

More in-depth discussions of groundwater quality issues related to nitrates, chloride, and salinity and the locations of known groundwater contamination sites and plumes are presented in the Groundwater Conditions Chapter.

3.1.10 Surface Water Features

Regulation Requirements:

§354.14(d)(5) Physical characteristics of the basin shall be represented on one or more maps that depict surface water bodies that are significant to the management of the basin.

The most significant surface water features within the Kings Subbasin are the SJR and Kings River. More detailed information on the surface water features within the GSA is discussed below.

Surface water bodies that effect the management of the MAGSA area are shown on **Figure 3-23**. In general, there are few surface water bodies that are significant to the management of the basin. Lassen Canal and McMullin Canal are located in the central portion of the MAGSA. Both waterways are operated by JID, the

adjacent GSA to the west, for historical transport of groundwater pumped from the JID well field within the MAGSA to JID. One FID surface water basin is located within the mid-southern end of the MAGSA. This basin is fed by Dry Creek Canal when surface water is available and has recently been expanded under an agreement between FID and JID. This basin is now called the Southwest Flood Water Protection & Utilization Project, Phase 1. Also, when available, flood water is spread on two areas along the western boundary of the GSA adjacent to the James Bypass (**Figure 3-23**)

Seepage from the SJR provides some groundwater recharge benefit to the northern portion of the MAGSA. The Fresno Slough and the James Bypass delivers water to the SJR from the Kings River when the Kings River is flooding significantly. During these periods, seepage occurs along the western boundary of the MAGSA adjacent to the Fresno Slough overflow area.

Kings Subbasin

Surface Water Features Significant to the Management of the Kings Subbasin Source and Point of Delivery for Imported Water Supplies

Figure 3-23

Legend

- Kings Subbasin GSAs
- Kings Subbasin (2019)
- Highway
- Intermittent Stream
- Riparian Water Right Holders
- Weir (Divert Out of Subbasin)

Diversion Into Kings Subbasin

- From Friant-Kern Canal
- From Mendota Pool (CVP)
- From Kings River

Millerton Reservoir
Pine Flat Reservoir
San Joaquin River
Mendota Pool
Flow Direction
Flow Direction
Little Dry Creek
Dry Creek
Dry Creek
Dog Creek
Redbank Slough
Fancher Creek
Holland Creek
Hughes Creek
Mill Creek
Wahtoke Creek
Friant-Kern Canal
Wooten Creek
Kings River
Sand Creek
Cottonwood Creek
NORTH KINGS GSA
SOUTH KINGS GSA
JAMES ID
McMULLIN AREA GSA
CENTRAL KINGS GSA
NORTH FORK KINGS GSA
KINGS RIVER EAST GSA
41
99
180
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41

Sources: Esri, USGS, NOAA

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3.1.11 Source and Point of Delivery of Imported Water

Regulation Requirements:

§354.14(d)(6) Physical characteristics of the basin shall be represented on one or more maps that depict the source and point of delivery for imported water supplies.

The primary source of surface water occurs from diversions from the Kings River. Additional sources of surface water occur from diversions from the SJR via the Friant-Kern Canal, Mendota Pool, and from intermittent streams. Millerton and Pine Flat Reservoirs and Mendota Pool are the main locations for storage and regulation of surface water supplies for the Kings Subbasin. More detailed information on the surface water features within the GSA is discussed below.

Water users within the MAGSA not located adjacent to the SJR rely almost exclusively on pumped groundwater for agricultural, industrial, and municipal needs. When available, flood water is utilized in two areas along the western edge of the MAGSA adjacent to the James Bypass. One FID recharge basin is located within the MAGSA that receives flood water from Dry Creek Canal when flood water is available. This basin has been expanded under a joint agreement between FID and JID and is called the Southwest Flood Water & Utilization Project, Phase 1. The purpose of this basin is to recharge in the JID well field within the MAGSA. The project will leave behind a minimum of 10% of the total amount of water recharged to benefit the local aquifer. This 10% "leave behind" is a direct benefit to the MAGSA. The source of water for this project is Kings River flood water via FID and/or CVP water also through FID's canal system. Another project currently being developed in MAGSA is the McMullin On-Farm Flood Capture Project, Phase 1. This project will take Kings River flood waters from the James Bypass and deliver it to approximately 5,575 acres primarily located on the Terranova Ranch (Tetra Tech R&D, 2014). The water will be used as both direct recharge on farm fields and be delivered to farmers for direct use to effect in lieu recharge. The turn out from the James Bypass has a capacity of 500 cfs and was sized to accommodate enough flow to provide enough water at build out of Phases 2 & 3. These two points of delivery for imported surface water, one on Dry Creek Canal and two on the James Bypass are shown on **Figure 3-23**.

Significant groundwater importing programs do not currently exist within the MAGSA area. It can be assumed that property owners located along the boundaries of the MAGSA area may pump small amounts of groundwater from within the area to irrigate adjacent parcels located outside of the area. It is also assumed that the opposite is true resulting in small amounts of groundwater either imported in or exported from the MAGSA area. Riparian water right holders exist along the SJR. The amount of surface water imported into the area from riparian water right holders is not believed to be significant, although when flood water is available on the San Joaquin River, this can be locally significant to the point where wells in the area can be shut off for the irrigation season.

3.1.12 Recharge and Discharge Areas

Regulation Requirements:

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

The San Joaquin River, the Kings River, and numerous intermittent streams provide the most significant recharge in the Kings Subbasin. Numerous agencies engage in some form of recharge in the basin, which can range from seepage from unlined canals, reservoirs, stormwater basins, wastewater effluent ponds and recharge basins. More detailed information on recharge areas within the GSA is discussed below.

Existing and potential groundwater recharge areas and areas of groundwater discharge are presented in this section. Discussions herein are presented on a regional scale to provide a generalized assessment of the MAGSA's potential for recharge. This information would need to be supplemented with local information for developing site-specific groundwater recharge projects.

Existing Recharge Areas

The MAGSA includes few natural recharge areas and constructed recharge basins. In addition to the two projects described above, recharge occurs from seepage from the SJR and from the Fresno Slough and James Bypass at times when the Kings River is at flood stage. Seepage from unlined canals, stormwater basins, wastewater effluent ponds, and natural recharge from percolation of precipitation are considered minor. Deep percolation of over applied agricultural water also likely adds to groundwater recharge.

Potential Recharge Areas

Potential recharge areas have been identified using NRCS soil textural data and geologic facies favorable for groundwater as mapped by Page and LeBlanc (1969). The maps used in the below discussions of potential recharge areas provide a regional assessment of recharge potential and can be useful for initial screening. It is recognized that land availability is generally a limiting factor in the selection of recharge areas as is the availability of a water supply source.

Soils

A soils map based on NRCS soil textural classes related to Ksat is presented as **Figure 3-8**. This map generally represents soils in the upper 5 to 7 feet of the soil profile. The largest grouping of the most permeable soils tends to be found in the southeastern most portion of the MAGSA where coarse to moderately coarse soils are concentrated. Fingers of permeable soils, predominantly orientated in a southwest-northeast direction, appear within the central portion of the MAGSA. These fingers of more permeable soils are are likely recent streambed deposits. Additional permeable soils are shown in the MAGSA adjacent to the SJR. Refer to **Section 3.1.5** of this HCM for further discussions on the soils.

Geologic Facies

In addition to soils, deeper deposits (7 to 50 feet in depth) are also a vital component in evaluating recharge potential. **Figure 3-24** shows a map of geologic facies favorable for groundwater recharge as mapped by Page and LeBlanc (1969). Facies is a geologic term that means the appearance and characteristics of a sedimentary deposit that is used to distinguish a subsurface material from contiguous subsurface materials. The facies data is based on descriptions of texture to a depth of approximately 300 feet. Six facies categories were defined, including Facies A through Facies F. **Figure 3-24** shows only the facies within the MAGSA that are predominantly coarse-grained materials, thus favorable for groundwater recharge.

Soil Agricultural Groundwater Banking Index

The University of California, Davis, and the University of California Division of Agriculture and Natural Resources developed the Soil Agricultural Groundwater Banking Index (SAGBI). The Index is a composite evaluation of the feasibility of groundwater recharge on agricultural land (also called Irrigation Field Flooding). Irrigation Field Flooding could have significant potential for groundwater recharge due to the large areas of irrigated agriculture in the GSA. The following five parameters are incorporated into the Index:

1. Deep percolation is dependent upon the saturated hydraulic conductivity of the limiting layer.
2. Root zone residence time estimates drainage within the root zone shortly after water application.
3. Topography is scored according to slope classes based on ranges of slope percent.
4. Chemical limitations are quantified using the electrical conductivity (EC) of the soil.
5. Soil surface condition is identified by the soil erosion factor and the sodium adsorption ratio.

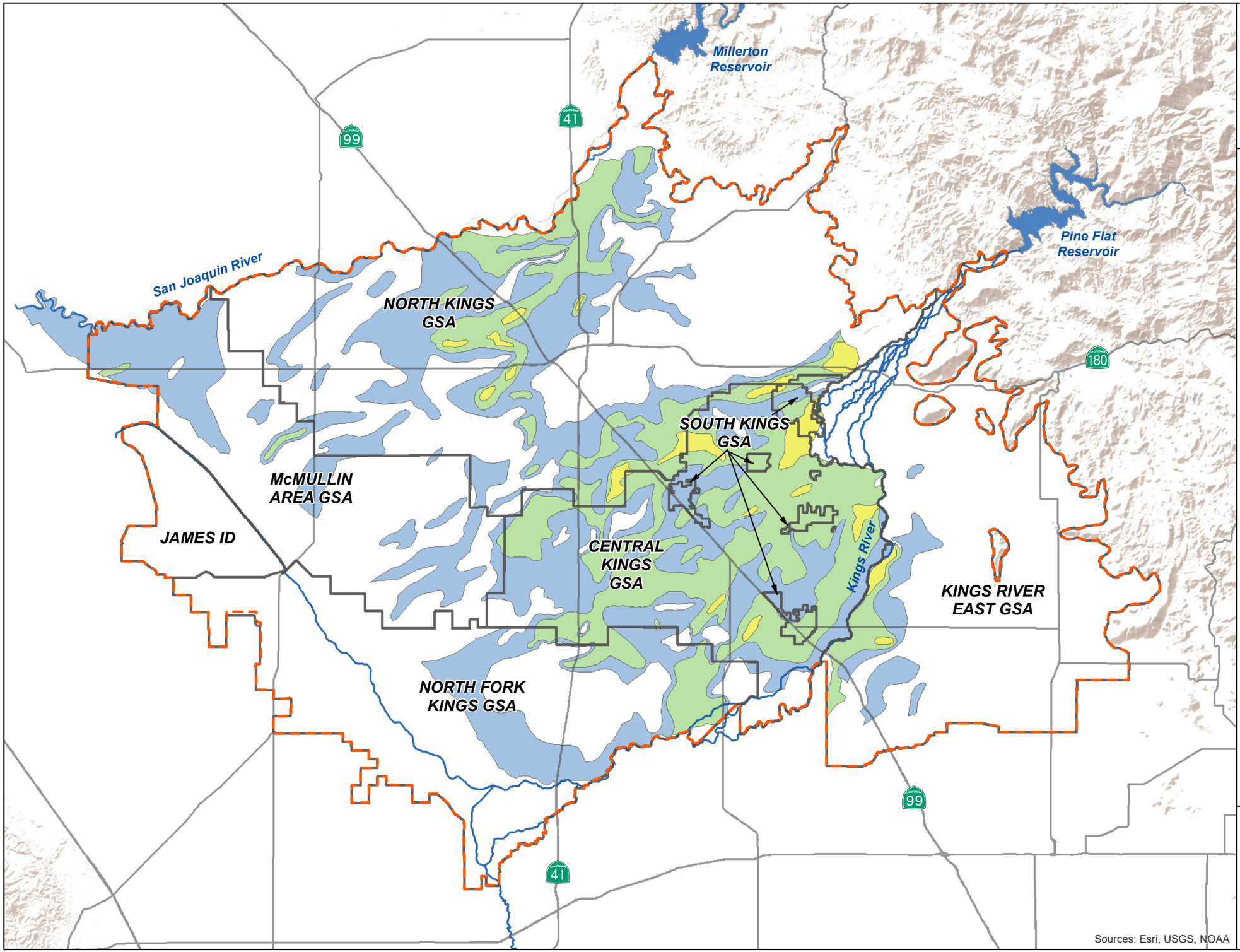
Proximity to a water conveyance system is not a factor considered in the SAGBI composite evaluation. Each factor is scored on a range and weighted according to significance. Adjustments are then made to reflect soil modification by deep tillage (i.e., shallow hard pan is assumed to have been ripped by historic farming activities). **Figure 3-25** illustrates the modified SAGBI Index for the MAGSA. Ultimately, SAGBI seeks to categorize recharge potential according to risk of crop damage at the recharge site. Usefulness of the index is diminished when evaluating locations for dedicated recharge basins. In these cases, a soil profile illustrating deep percolation potential may prove to be more useful. As is the case with any model, the SAGBI is best applied in conjunction with other available data and on-site evaluation.

Discharge Areas

Prior to development and under natural conditions, groundwater in the Fresno area moved southwestward from the Sierra Nevada and toward the center of the valley. During this time, artesian conditions caused some water to move upward from the confined aquifer toward the surface (Page & LeBlanc, 1969). Following development and significant pumping of groundwater, the occurrence of groundwater discharges (springs, seeps, etc.) were greatly reduced. Currently, no known springs, seeps, or artesian wells are in the MAGSA. Groundwater level maps are presented in the Groundwater Conditions Chapter.

Wetland Areas

Wetland areas within the MAGSA from the U.S. Forest Service's National Wetland Inventory are shown on **Figure 3-26**. In general, the MAGSA is devoid of wetlands except in areas adjacent to the SJR. Other features of note include the 1,800-acre Kerman Ecological Reserve located in the northern portion of the MAGSA on both sides of Highway 180 and the 930-acre Alkali Sink Ecological Reserve partially located within the MAGSA along its northwestern edge (**Figure 3-26**). Both ecological reserves contain annual grassland habitats and at times claypan vernal pool habitats. Retrieved from https://www.wildlife.ca.gov/Lands/Places-to-Visit/Kerman-ER#10742133-history and https://www.wildlife.ca.gov/Lands/Places-to-Visit/Alkali-Sink-ER.



Kings Subbasin

Geologic Facies Conducive to Groundwater Recharge

Figure 3-24

Legend

- Kings Subbasin GSAs
- Kings Subbasin (2019)
- Highway
- Waterway

Geologic Facies (Page and LeBlanc 1969)

Facies Code

- Facies - D: 50-66% Coarse grained material
- Facies - E: 66-80% Coarse grained material
- Facies - F: > 80% Coarse grained material

Note: This map only shows Facies that may be favorable for groundwater recharge. Facies A thru C have higher percentages of fine grain materials and are not shown.

Geologic Facies evaluated to a depth of 300 feet.

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Sources: Esri, USGS, NOAA

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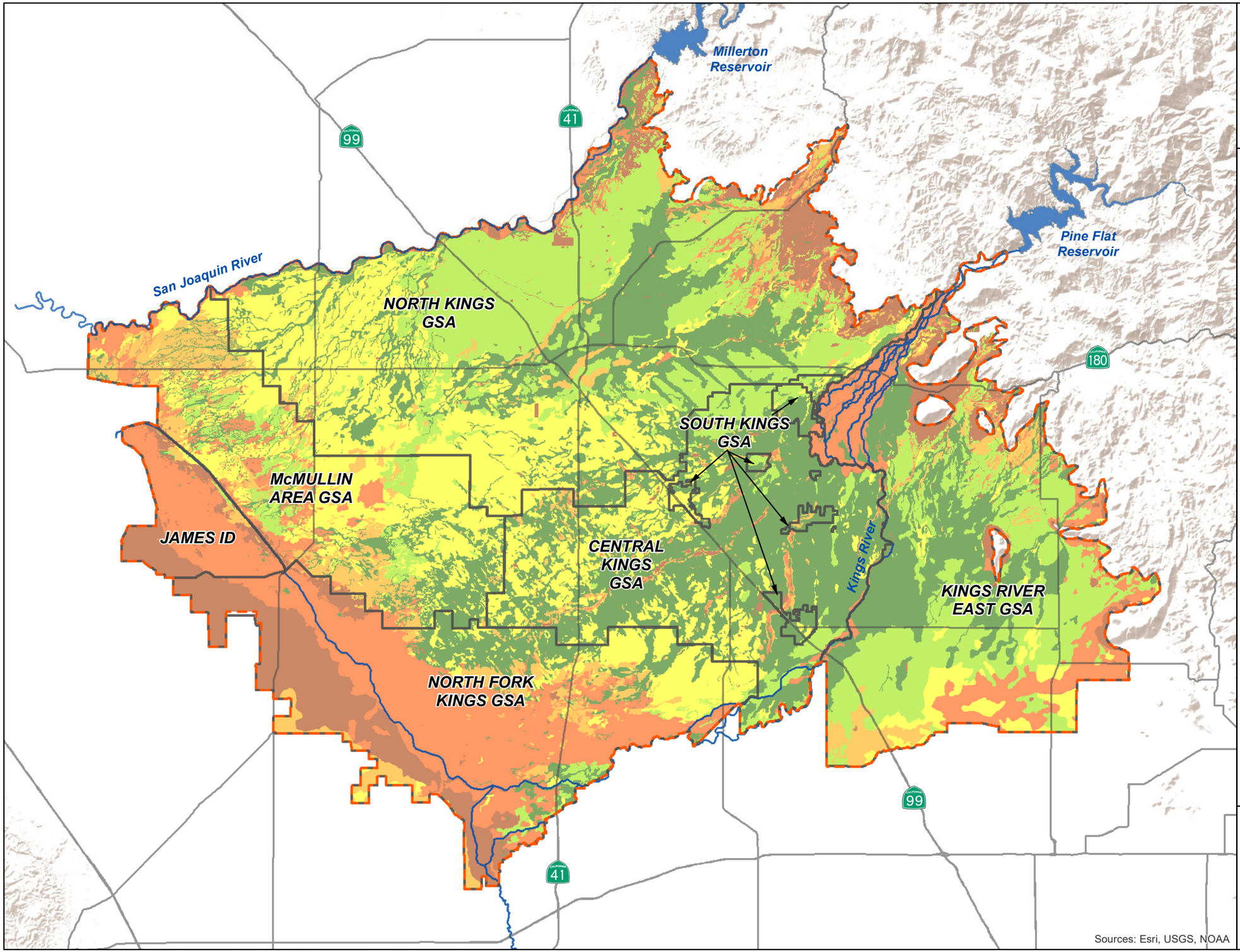

Kings Subbasin

Modified Soil Agricultural Groundwater Banking Index (SAGBI) Rating

Figure 3-25

Legend

- Kings Subbasin GSAs
- Kings Subbasin (2019)
- Highway
- Waterway

SAGBI Rating - Modified

- 0 -15 Very Poor
- 15 - 29 Poor
- 29 - 49 Moderately Poor
- 49 - 69 Moderately Good
- 69 - 85 Good
- 85 - 100 Excellent

Note: The SAGBI Index evaluates the feasibility of recharging water on already cropped land and considers criteria such as percolation rate, slopes, soil chemistry and other factors.

Modified SAGBI Rating assumes that lands planted with orchard or vineyard crops on soils that have a restrictive layer have been deep tilled.

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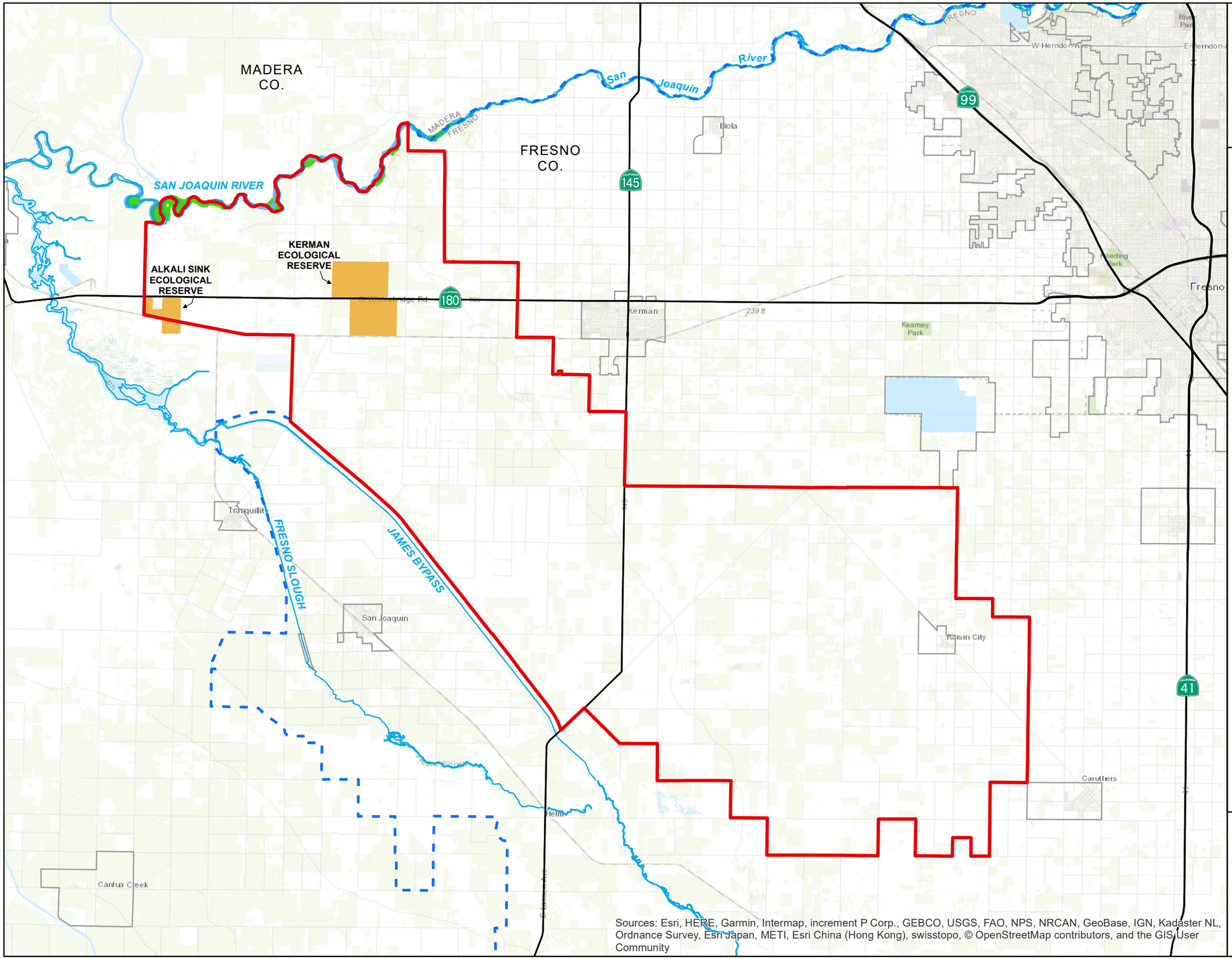
McMullin Area GSA

Wetlands

Figure 3-26



McMullin Area GSA

Kings Subbasin (DWR, Modified 2018)

State of California Ecological Reserve

Freshwater Forested/Shrub Wetland

Riverine

*Wetlands shown within the McMullin GSA area and up to 1 mile outside of the boundary.

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), swisstopo, © OpenStreetMap contributors, and the GIS User Community

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3.2 Current and Historical Groundwater Conditions

Regulation Requirements:

§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

General current and historical groundwater level trends and flow direction for the Kings Subbasin are discussed in this Section below. More in-depth discussions of groundwater conditions within the GSA, including groundwater levels, storage, and quality; land subsidence, surface water/groundwater interconnections, and groundwater dependent ecosystems, are discussed in the subsequent Subsections.

Unconfined groundwater conditions extend across essentially the entire Kings Subbasin. A map depicting the depth to the base of unconfined groundwater is shown in **Figure 3-27**. Within the western portions of the subbasin, lacustrine and marsh deposits including the well-known regional clays) interbed with more coarse-grained alluvium. Historically, confined groundwater conditions existed below these regional clays, which have been identified as the A, C, and E clays (USGS 1999-H, Croft, 1972). Currently, confined groundwater conditions still exist below the E and C clays. Groundwater below the A clay no longer appears to be confined. These clays are highly impermeable and restrict the vertical movement of water between more permeable beds wherever they occur. The most extensive and hydrologically important of these aquitards is the E-clay, commonly known as the Corcoran Clay. As shown in **Figure 3-27**, the Corcoran Clay, is present beneath the approximate western third of the Kings Subbasin, where the depth to the top of the Corcoran Clay ranges from approximately 350 to 550 feet.

This chapter includes a description of important current and historical groundwater conditions within the MAGSA based on the best available data. Groundwater conditions described in this chapter include groundwater levels, groundwater storage, groundwater quality, land subsidence, and surface water and groundwater interconnections. This chapter provides historical monitoring data collected by various agencies including DWR, KRCD, NASA, and others. Refer to **Chapter 5** for descriptions of the monitoring programs that will continue to be used to collect data for implementation.

3.2.1 Groundwater Level Data

Regulation Requirements:

§354.16(a) Groundwater elevation data demonstrating flow directions, lateral and vertical gradients, and regional pumping patterns, including:

1. Groundwater elevation contour maps depicting the groundwater table or potentiometric surface associated with the current seasonal high and seasonal low for each principal aquifer within the basin.
2. Hydrographs depicting long-term groundwater elevations, historical highs and lows, and hydraulic gradients between principal aquifers.

Figure 3-28 shows the current (Spring 2017) groundwater surface elevation contours and general direction of unconfined groundwater flow in the Kings Subbasin for the seasonal high condition. In general, groundwater flow is to the southwest within nearly the entire subbasin with a few notable exceptions where municipal and irrigation pumping in parts of the Kings Subbasin have influenced the direction of groundwater flow or the influence of recharge from basins and the major rivers can be seen. **Figure 3-29** shows the current (Fall 2017) groundwater elevation contours. The overall direction of groundwater flow in Fall 2017 is similar to the Spring 2017 groundwater flow directions. In a typical or near normal water year the fall groundwater elevation contours would represent the seasonal low point in the hydrologic cycle, however the 2016/2017 water year, at 241% of normal, was a significantly wetter year than normal and, in general, groundwater levels rose in Central Kings GSA, Kings River East GSA, South Kings GSA, the western and northeast portions of North Kings GSA. Groundwater levels also rose in portions of North Fork Kings GSA near the Kings River and along the border with Westside Subbasin. The northern and southern portion of JID GSA also had

increases in water levels. Groundwater levels generally fell in MAGSA but did rise near the border with JID GSA and in area near the intersection of T15S R18E, T15S R19E, 1T6S R18E, and T16S19E.

Several areas show the results of groundwater recharge occurring in 2017. The FID Waldron and Boswell banking facilities show more pronounced groundwater mounds, as well there is a groundwater ridge evident on the Fall 2017 groundwater elevation contour map in Central Kings GSA in an area with favorable geology for recharge and numerous recharge sites that trend southwest through the central portions of that GSA. It is estimated Central Kings GSA recharged on the order of 150,000 to 200,000 AF that year. The Fall 2017 map highlights the importance of surface water supplies in Kings Subbasin. The general increase in groundwater levels in parts of the Subbasin from spring to fall of 2017 show how conjunctive use of groundwater and surface water in years when surface water supplies are plentiful can be managed to positively affect groundwater levels. This also indicates that recharge projects of various types, including reduced pumping in years with plentiful surface water supplies, are likely to be successful and will be significant to the Subbasin reaching sustainability.

The discussion that follows uses the Spring 2017 groundwater elevation map (**Figure 3-28**). In the Fresno-Clovis metropolitan area, an urban cone of depression is located north-northeast of the intersection of Highways 180 and 41 and has caused changes in the generally southwesterly groundwater flow direction as groundwater now moves toward the cone of depression under the urban area. In the area between southwest Fresno and the Fresno-Clovis Regional Waste-Water Treatment Facility, there is little change in groundwater elevation. In the northeast portion of the Fresno-Clovis urban area, roughly between Highway 168 and Shepherd Avenue and southwest of Big Dry Creek reservoir, groundwater gradient steepens appreciably due to deepening groundwater levels in the greater Fresno area and due to the poorer water bearing properties of subsurface materials in this area associated with the finer-grained deposits in the interfan area between the Kings and San Joaquin Rivers. There is also a general increase in groundwater gradient apparently associated with the finer grained deposits of the compound fan of intermittent streams south of the Kings River in the eastern portion of the Kings River East GSA.

In the west-southwest part of the subbasin, the lack of surface water supply combined with decades of agricultural pumping has influenced the natural direction of groundwater flow and created a cone of depression southwest of Raisin City. The cone of depression extends southeast through the middle portion of MAGSA and the central portions of North Fork Kings GSA. The cone of depression has caused changes in the general flow direction and gradients as unconfined groundwater now moves toward the cone of depression from adjacent areas west of the Subbasin and southeast through MAGSA. Groundwater east of the Kings River in the Kings River East GSA flows southwesterly near the mountains and to the south-southeast near the Kings River.

Under natural flow conditions, the dominant flow direction in the Kings Subbasin was southwest, roughly perpendicular to the Sierra Nevada and towards the trough of the valley. The San Joaquin and Kings Rivers were historically locations of groundwater discharge and within about 2 to 4 miles of them groundwater flow deviated from the regional southwest direction and flowed towards them. The rivers and Fresno Slough being areas of groundwater discharge were thus gaining streams. Once pumping lowered water levels sufficiently, the San Joaquin and Kings Rivers, for the most part, became losing streams and groundwater started flowing away them. Today groundwater forms ridges beneath both rivers which indicates both rivers are predominantly losing steams (**Figure 3-28**). A groundwater ridge along the San Joaquin River can be seen in **Figure 3-28** extending approximately the length of the North Kings GSA area. Starting on the northwest corner of the North Kings GSA area, groundwater (seepage) from the SJR flows southerly to southwesterly towards the McMullin GSA.

Historical Groundwater Conditions

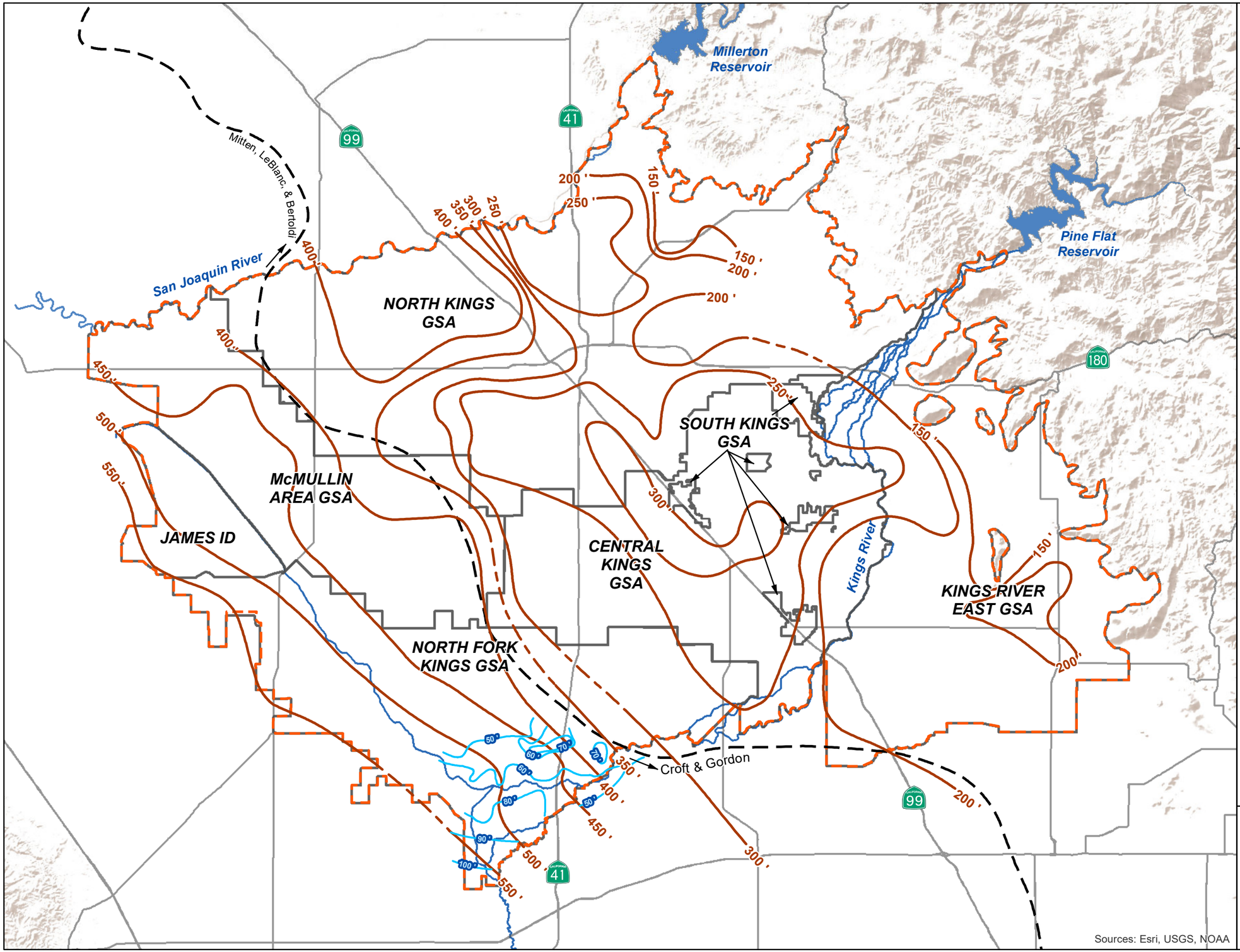
Groundwater flow patterns in the upper (unconfined) and in lower confined aquifers (i.e., below the Corcoran Clay) under natural flow conditions in the western area of the Kings Subbasin differed before extensive development of groundwater resources in the valley. Groundwater recharge to the area occurs primarily from run-off from the Coast Ranges to the west and from SJR seepage and groundwater percolation. Prior to development, groundwater flowed from areas of recharge along the flanks of the valley, from both the east and west, towards the axis of the valley where it recharged both the unconfined and confined portions of the aquifer. Groundwater from both sources flowed under the Corcoran Clay to the valley trough where mixing, circulation, and upward movement through the Corcoran Clay occurred at very slow rates (**Figure 3-22, Inset B**). As a result, the potentiometric surface of the confined groundwater was higher than the land surface in the valley trough area and flowing artesian well conditions existed within the trough area (Bull and Miller, 1975). The upward welling of groundwater and discharge at land surface supported extensive wetlands in the Fresno Slough area of the Kings Subbasin. A map depicting areas of flowing artesian wells within the San Joaquin in 1906 from Mendenhall et. al. (1916) is included as **Figure 3-21**. Large-scale agricultural pumping in the San Joaquin Valley has resulted in a change to the flow pattern, as well as an overall lowering of groundwater levels, of the confined groundwater below the Corcoran Clay, as well as changed flow patterns in the aquifer above the Corcoran Clay (**Figure 3-22, Inset C**). As shown on **Figure 3-22**, from 1906 to 1966, the mixing point of the two distinct water sources (Sierran and Coast Ranges) in the confined aquifer moved west, indicating confined flow to areas west of the Kings Subbasin, and the confined groundwater potentiometric surface became lower than the valley land surface (Bull and Miller, 1975). Currently, there are no known springs, seeps, or flowing wells within the Kings Subbasin.

The potentiometric surface of unconfined groundwater having been lowered considerably due to large-scale agricultural pumping, which, among other things, led to the San Joaquin and Kings Rivers transitioning over most of their reaches in the Kings Subbasin from predominantly gaining streams to predominantly losing streams. **Figure 3-22, Insets B and C** illustrate this changed flow pattern near the SJR.

Kings Subbasin

Base of Unconfined Groundwater

Figure 3-27



Legend

- Kings Subbasin GSAs
- Kings Subbasin (2019)
- Highway
- Waterway
- Depth To A-Clay (Laguna
- Eastern Extent of E-Clay (Corcoran Clay) (Page and LeBlanc, 1969 (Modified by KDSA))

Depth to Base of Unconfined Groundwater (KDSA, 2018)

- Defined
- Inferred

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Kings Subbasin
Coordinated Effort

Kings Coordinated Effort GSAs

Spring 2017
Groundwater Elevation Contours

Figure 3-28

Legend

- Kings Subbasin GSAs
- Township/Range
- Well - Data Used
- Well - Data Not Used
- Generalized GW Flow Direction

Water Level Contours

- Line of Equal Elevation (10ft interval)

T11S
T12S
T13S
T14S
T15S
T16S
T17S

R16E R17E R18E R19E R20E R21E R22E R23E R24E R25E

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

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Kings Subbasin
Coordinated Effort

Kings Coordinated Effort GSAs

Fall 2017
Groundwater Elevation Contours

Figure 3-29

Legend

- Kings Subbasin GSAs
- Township/Range
- Well - Data Used
- Well - Data Not Used

Water Level Contours

- Line of Equal Elevation (10ft interval)

T11S
T12S
T13S
T14S
T15S
T16S
T17S

R16E R17E R18E R19E R20E R21E R22E R23E R24E R25E

Madera, Chowchilla, Fresno, Clovis, Sanger, Reedley, Dinuba, Selma, Kingsburg, Biola, Kerman, Tranquillity, San Joaquin, Cantua Creek, Five Points, Riverdale, Laton, Lemoore, Lemoore Naval Air Station, Hanford, Armona, Visalia, Farmersville, Exeter, Ivanhoe, Squaw Valley

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

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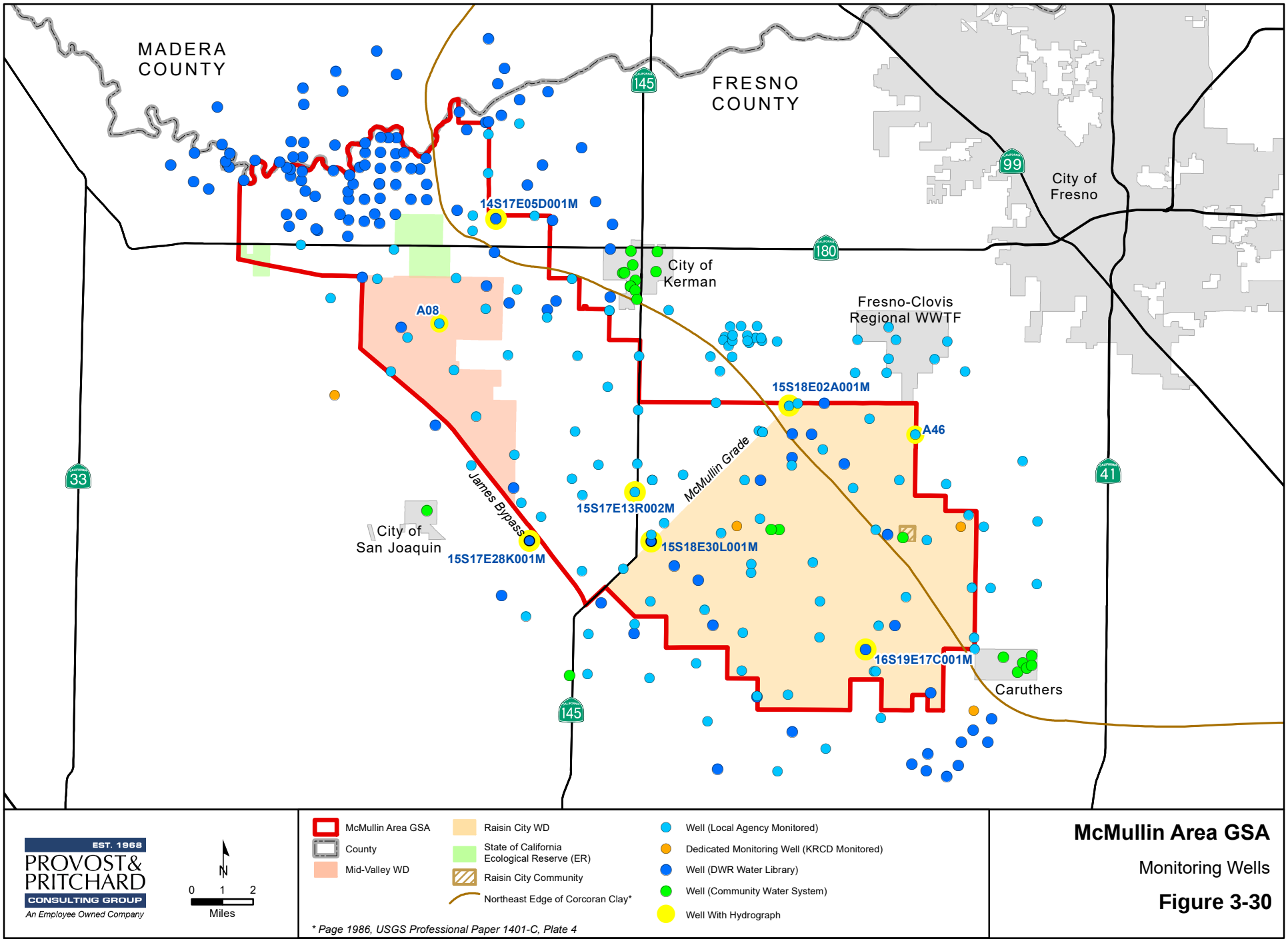
In MAGSA, aquifers occur in unconfined, semiconfined, and confined states. Water levels in an unconfined aquifer system coincide with the top of the zone of saturation, where hydrostatic pressure is equal to atmospheric pressure. Seasonal water level variations in such systems are typically subdued. In confined aquifers, water bearing materials are completely saturated and overlain by confining materials of low permeability, such as clay or fine silt. Water level within the aquifer is reflected by the height above the confining stratum to which water will rise in a well drilled into the aquifer. Groundwater is generally unconfined within the alluvial fan deposits (older and younger alluvium). Groundwater in the deeper continental deposits is unconfined to semiconfined with the degree of confinement generally increasing with depth. Groundwater is generally unconfined to semiconfined above and east of the Corcoran Clay Layer and generally confined below the Corcoran Clay Layer. Groundwater conditions at specific locations vary from regional patterns because of localized hydrogeologic conditions and groundwater pumping.

Since 1989, KRCD has used groundwater level data, both from their monitoring efforts and from DWR, to produce annual groundwater reports. These reports include regional water level maps showing historical and existing groundwater levels. For the purposes of this chapter, a subset of wells was chosen to spatially reflect the historical groundwater conditions within MAGSA. **Figure 3-30** shows the location of wells analyzed to describe historical groundwater level conditions. The periods of record for these wells extended from anywhere between the 1920s to present. The map shows 152 wells within the GSA, and 129 wells outside GSA borders, for a total of 281 wells. Wells outside of the border help to identify boundary conditions. A set of 8 wells with consistent historical data were chosen to graphically display the groundwater conditions representative of the GSA and are highlighted in the figure. It is the intention of the GSA that some of these 8 wells and more will be used in the monitoring network and for setting sustainable management criteria.



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Groundwater levels have historically fluctuated seasonally and in response to wet or dry periods; however, the long-term trend is decreasing water levels. **Figure 3-31** and **Figure 3-32**, below, show the average groundwater level hydrographs from the 8 highlighted wells within MAGSA as identified in **Figure 3-30.** The hydrographs are used to show the predominant trends in the groundwater system since the early 1920s. Average depth to groundwater in MAGSA increases from about 7 feet in 1921 to about 155 feet below the ground surface in 2016. The average annual groundwater level decline, based on the trend line, is about 1.7 feet/year; however, rate of decline has increased from a rate of about 1 foot/year between 1955 and 1998 to a rate of about 2 feet/year between 1998 and 2016.

There was a reduction in the rate of groundwater level decline after the construction of Pine Flat Dam in 1964, but it did not successfully halt the groundwater overdraft. Groundwater levels are responsive to flow conditions in the Kings River and the overall hydrology of the basin. The sharp decline in groundwater levels slows down around the year 2000 when the groundwater conditions in MAGSA registered an improvement, potentially linked to the impact from the successive years with high precipitation records between 1995 and 1998. After the rebound, the groundwater levels trend continued to decline reaching lower groundwater depths over the recent drought period with low points around years 2015 at about 160 feet below ground surface. The declining water level indicates that groundwater is pumped at a rate faster than the naturally occurring groundwater recharge rate. It can be interpreted from the groundwater level trend lines that groundwater levels will continue to decline into the future should there be no changes in current operation.

To put it into some perspective, production wells within MAGSA vary in depth from as shallow as 75 feet all the way to 700-800 feet in the area around McMullin Grade and along James Bypass border. Average well depths vary between 300 and 500 feet for most parts of the GSA.

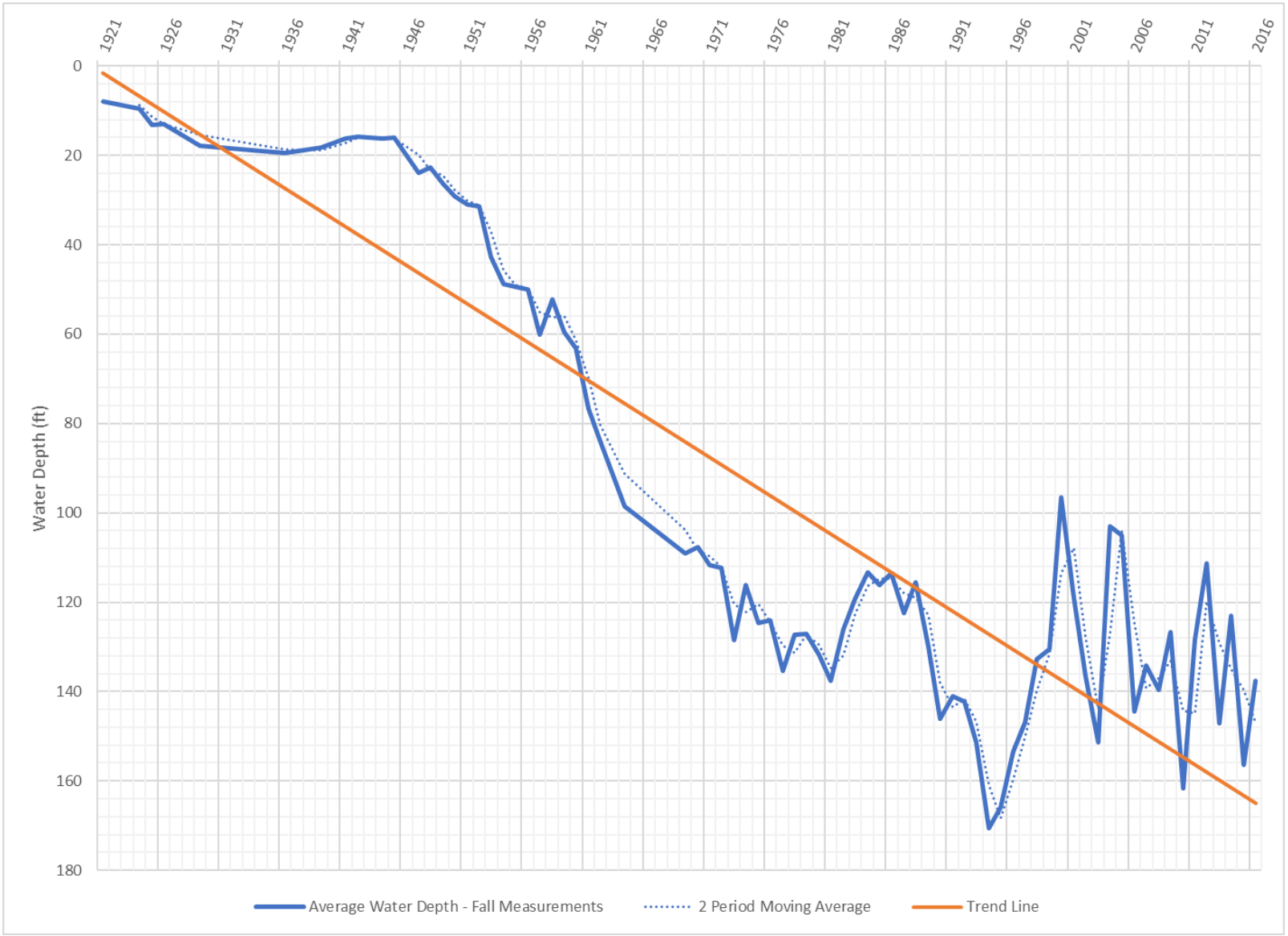


Figure 3-31 Average Fall Groundwater Levels Hydrograph

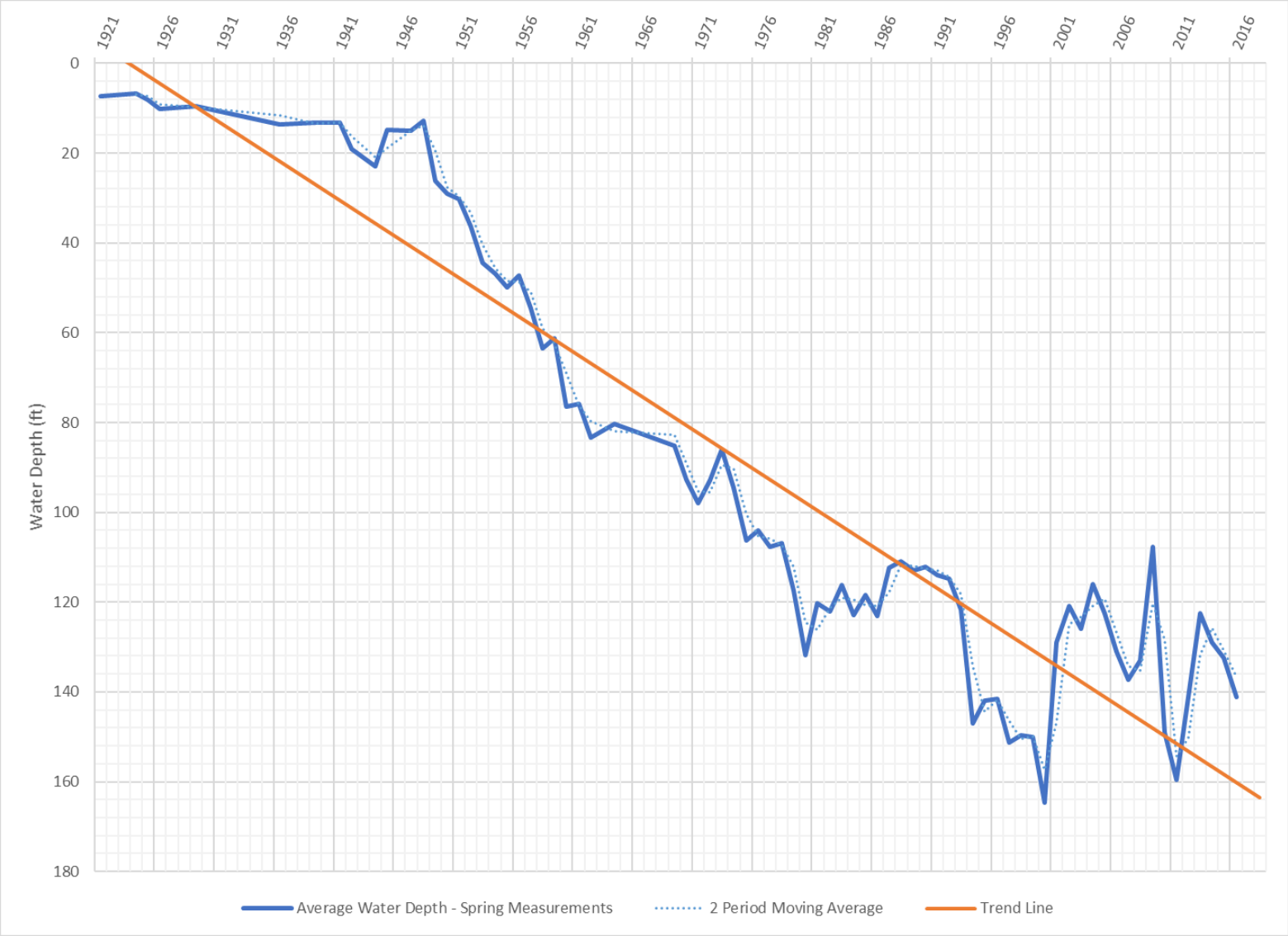
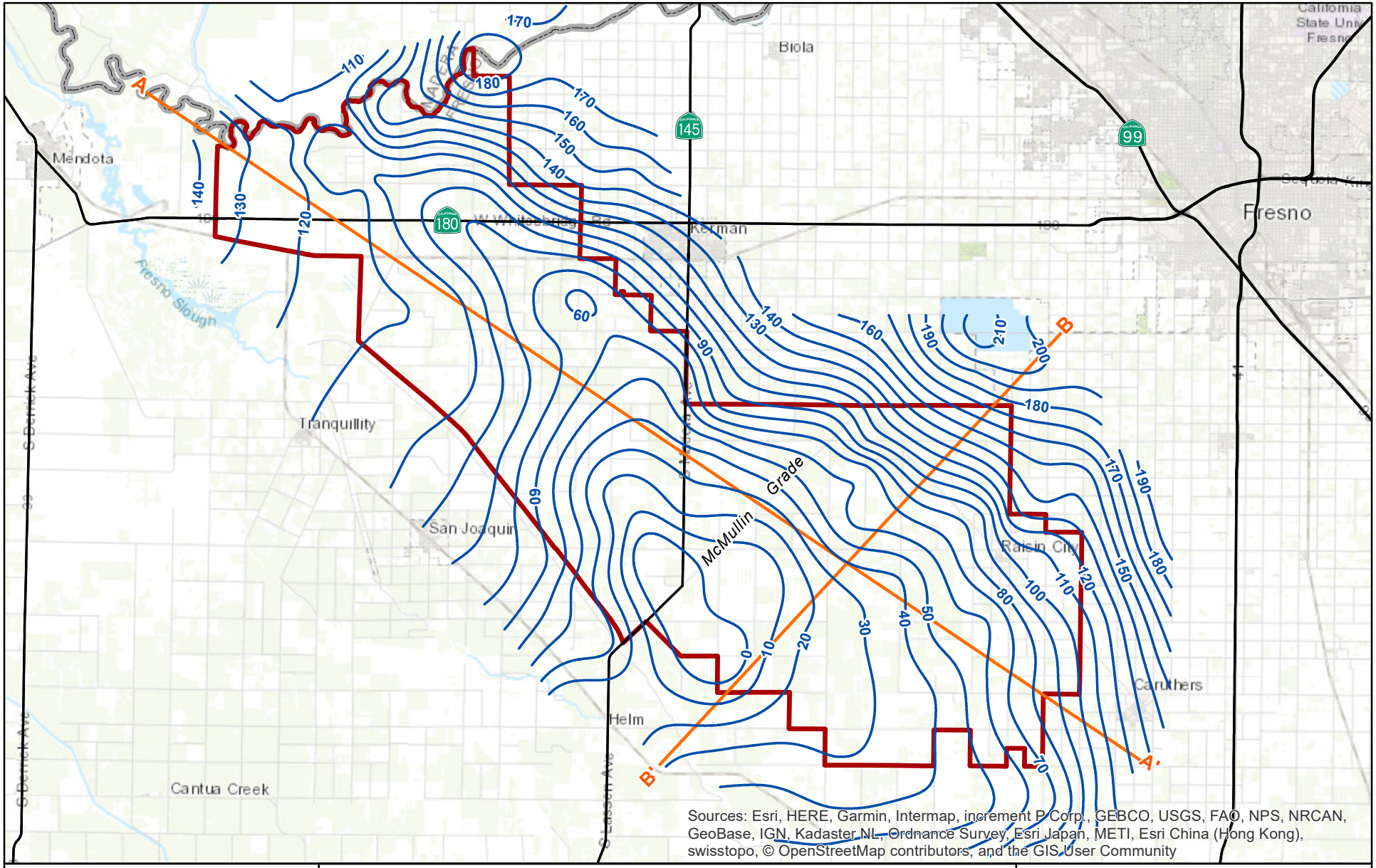


Figure 3-32 Average Spring Groundwater Levels Hydrograph

Seasonal high and low water level conditions in MAGSA are also presented in a series of groundwater elevation contour maps for the beginning and end of the base period (water years 1997-2011). Data to develop groundwater related contours were obtained from California Water Data Library. Spring 1997 groundwater contours can be seen in **Figure 3-33** below, while **Figure 3-34** displays groundwater contours for Spring 2013 to give a general idea of the current direction of groundwater movement. Note the general similarity in groundwater contour shape and flow direction between the beginning and end of the period of study. This indicates that historically established pumping trends have continued over time. A large groundwater depression occurs in the southwest corner of the southeast portion of the GSA (southwest of Raisin City) from 1997 to present. Water surface elevation (WSE) varies greatly in the GSA with values that range between approximately 150 feet above MSL all the way to 30 feet below MSL. This causes a steep hydraulic gradient to exist, with large volumes of groundwater movement into GSA boundaries.



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Legend

- McMullin Area GSA
- County
- Cross Section

Water Surface Elevation - Spring 1997

- Contour of Equal Elevation (ft)

McMullin Area GSA

Cross Sections:
1997 Water Surface Elevation

Figure 3-33

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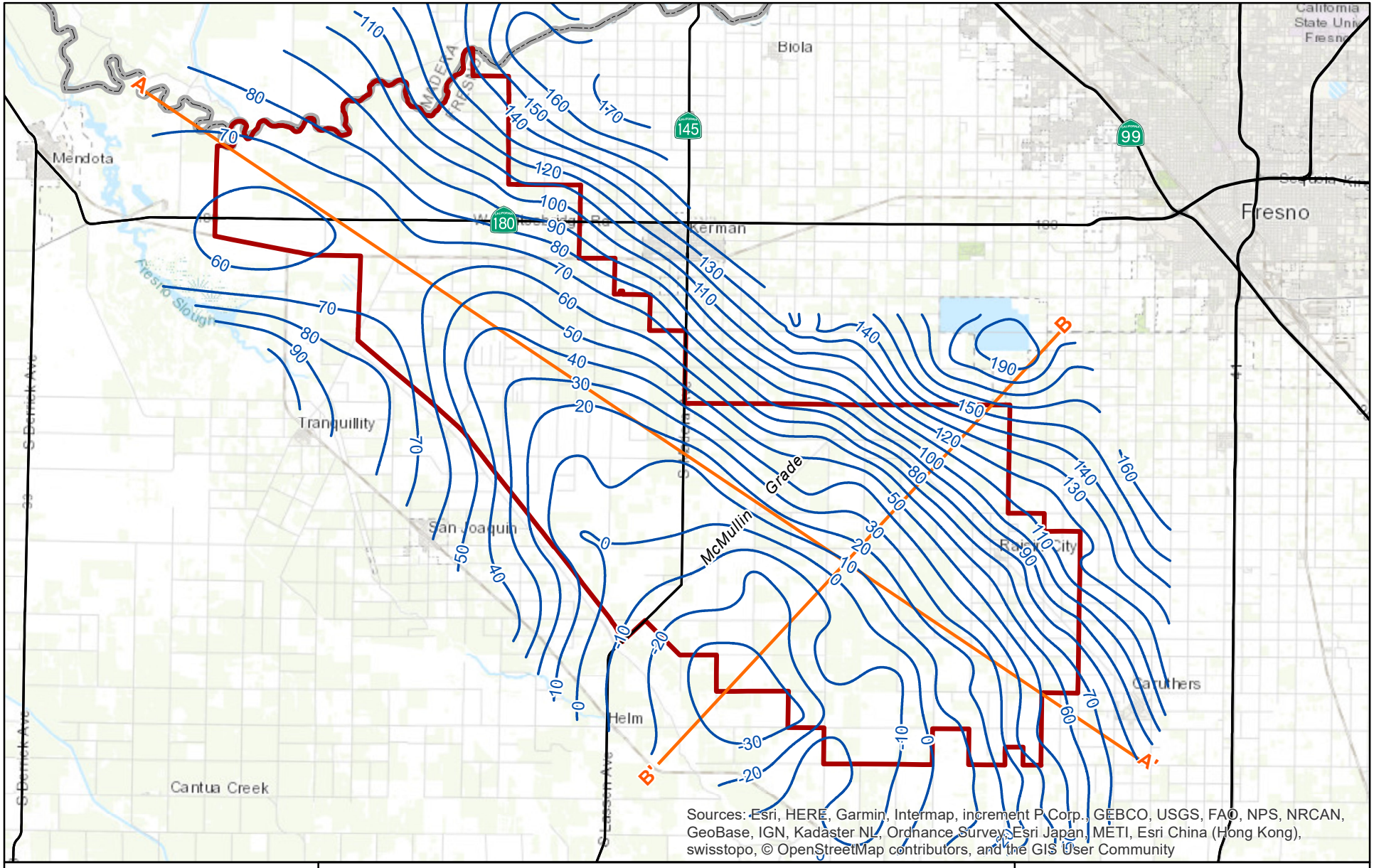

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- County
- Cross Section

Water Surface Elevation - Spring 2013

- Contour of Equal Elevation (ft)

McMullin Area GSA

Cross Sections:
2013 Water Surface Elevation
Figure 3-34

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Cross sections were cut through contour surfaces for MAGSA in the direction of northwest to southeast (A – A') and northeast to southwest (B – B'); the locations of which are shown in Figure 4 above. Graphs of the WSE for the cross sections were created for two sets of years in order to visually present the spatial change in water levels over time (**Figure 3-35** through **Figure 3-38**).

Groundwater elevation in MAGSA generally increases to the North and to the West of the GSA. The groundwater depression in the southern portion of the GSA, near the McMullin Grade, can clearly be seen on each of the four graphs. **Figure 3-36** and **Figure 3-38** display the extremely steep hydraulic gradient that runs along the B cross section, starting with a WSE of about 150 feet, dropping to a WSE of about -30 feet over the course of 11 miles. The low point within cross section B is generally between Manning Avenue and Nebraska Avenue. The A cross section doesn't have quite as large of a drop with the largest range in WSE being about 60 feet of difference. The general low points in Cross Section A are between Hwy 145 and the cross-section B location. It may be noted when looking at **Figure 3-35** and **Figure 3-36**, on a year to year comparative basis, groundwater levels seemingly do not change much; however, when comparing them to **Figure 3-37** and **Figure 3-38**, levels jump down from a minimum of about 20 feet above MSL to about 20 feet below MSL. In part, this could be attributed to the fact that 1996-1998 were wetter than average years while 2012-2015 were considered drought years, causing an increase in agricultural water demand. Overall, the groundwater elevation along the cross sections has decreased from 1995 to 2015, but the general shape of the curves looks the same, which is reflected in the groundwater contour maps.

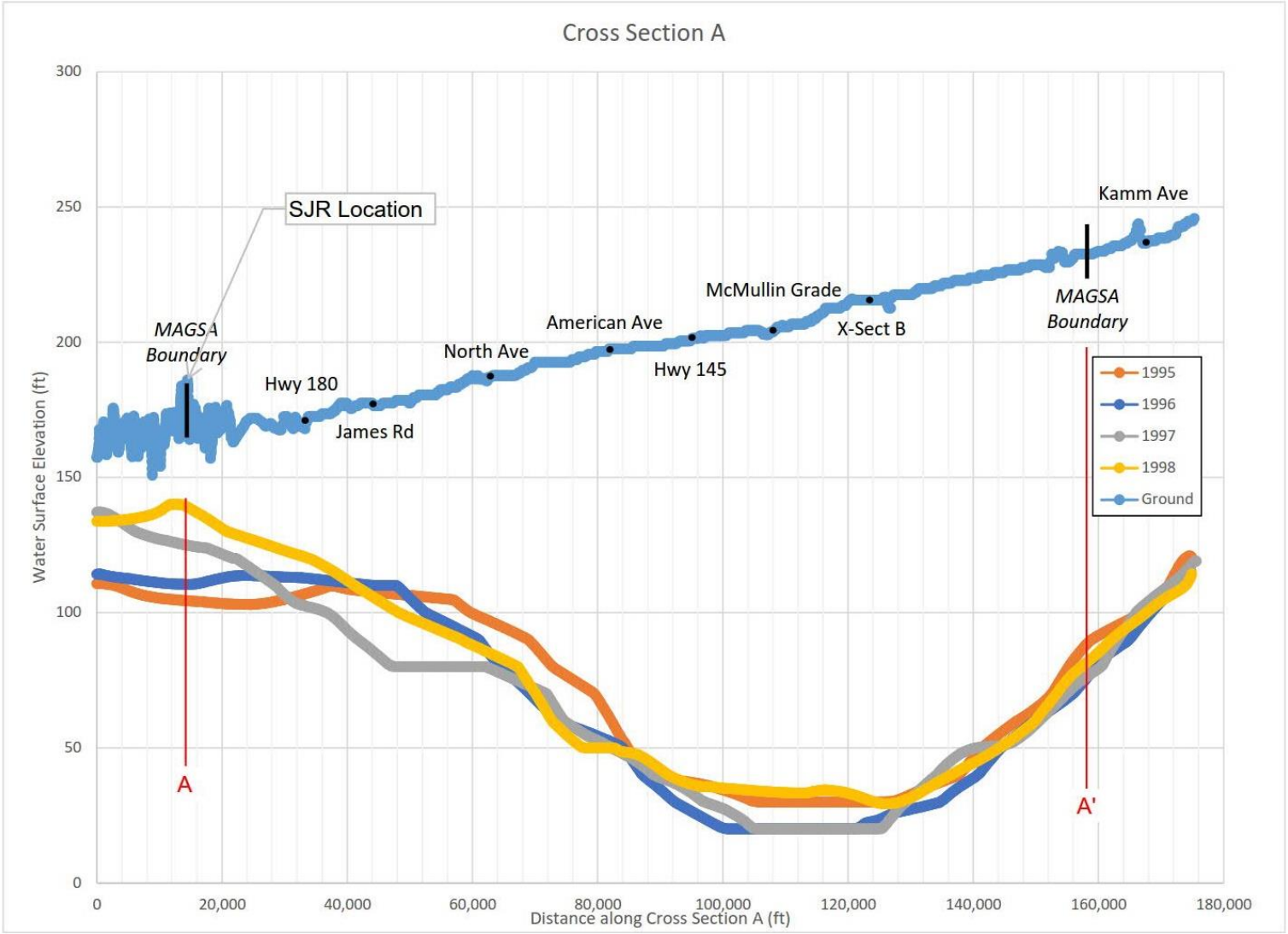


Figure 3-35 WSE Cross Section A from MAGSA (1995-1998)

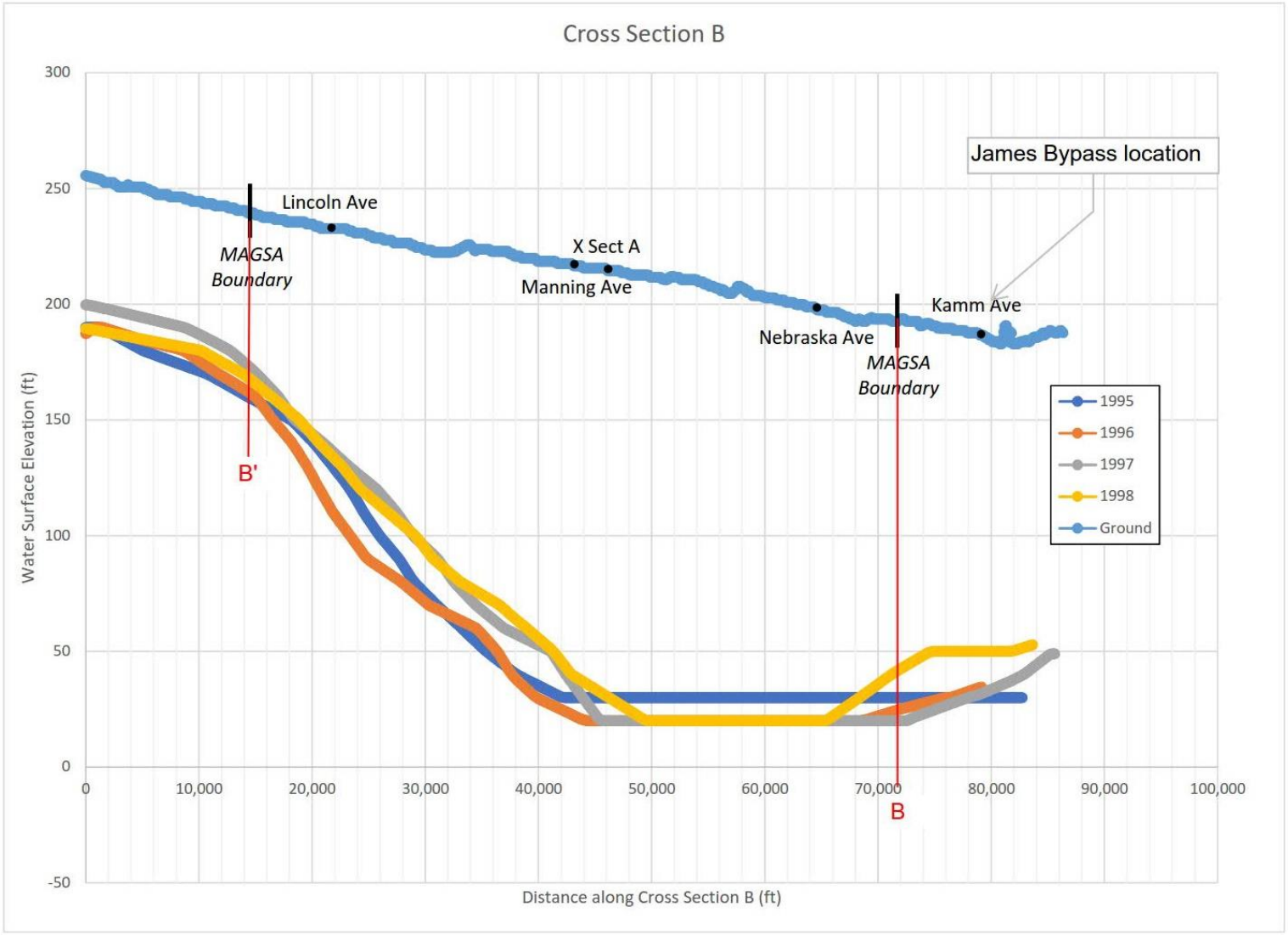


Figure 3-36 WSE Cross Section B from MAGSA (1995-1998)

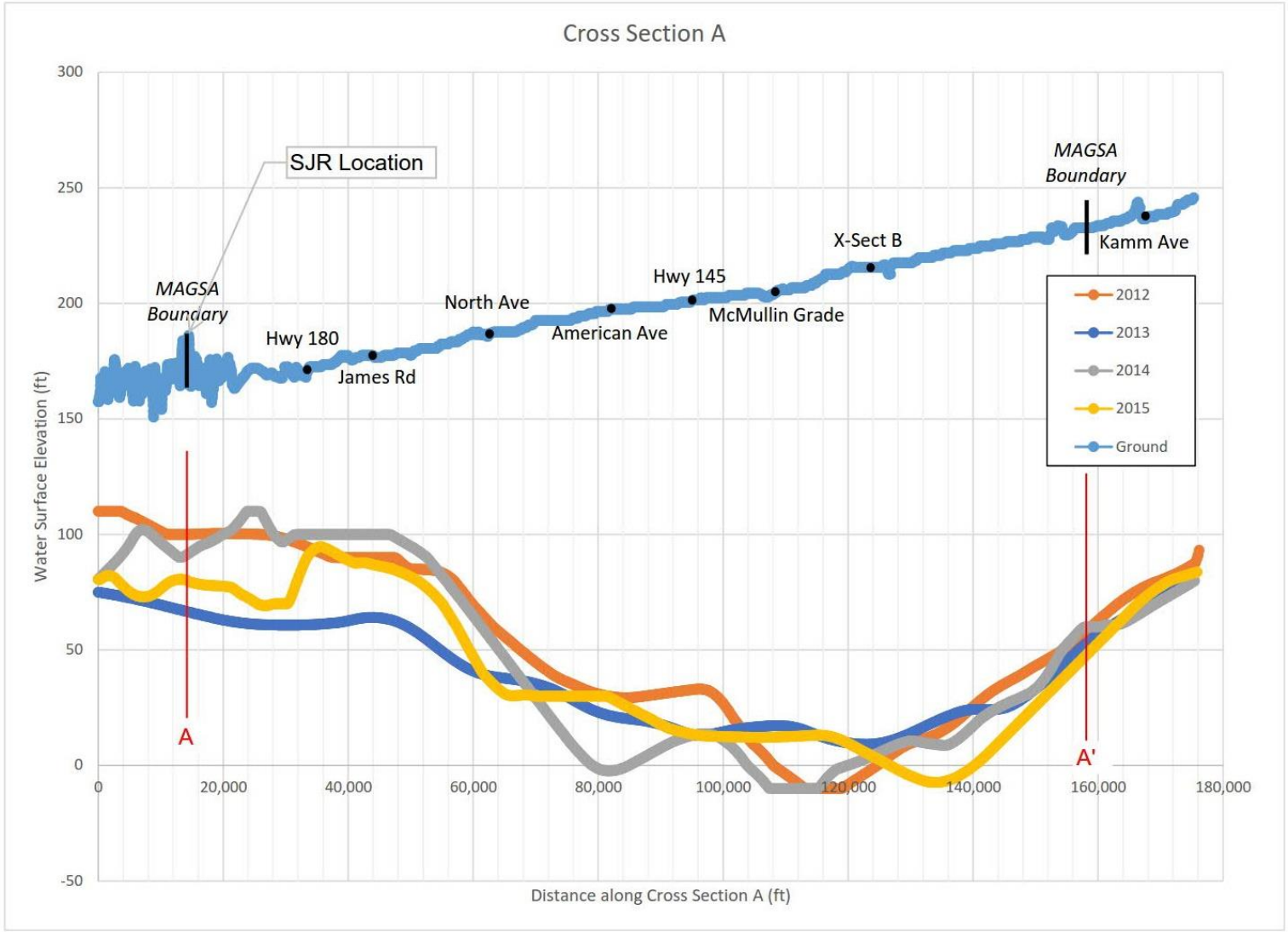


Figure 3-37 WSE Cross Section A from MAGSA (2012-2015)

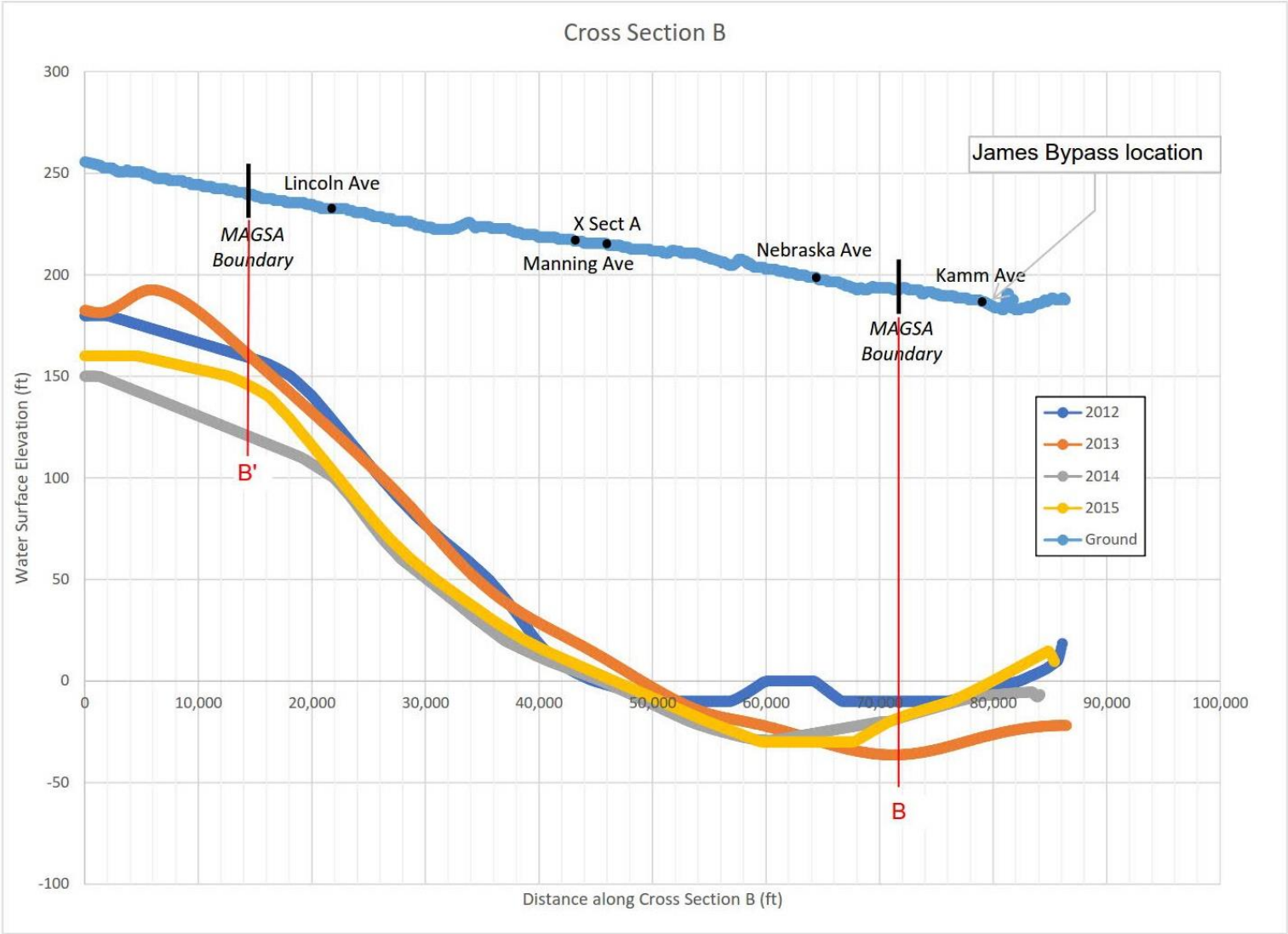


Figure 3-38 WSE Cross Section B from MAGSA (2012-2015)

During the base period, there is a characteristic pattern to the water level hydrographs in MAGSA. For the most part, water levels in the plan area from 1955 to 2015 reflect a general decline that may be interrupted by seasonal fluctuations. **Figure 3-39** through **Figure 3-46** reflect these patterns and represent water level fluctuations in typical wells representing the aquifer system in MAGSA. The hydrographs have relatively long periods of record (several of them starting in the 1920s, and others from the 1950s and 1960s), are regularly measured, and are geographically distributed across the area. The hydrographs show annual and cyclic fluctuations in groundwater levels, reflecting climatic conditions and magnitude of replenishment-extractions cycles of groundwater. The locations of the wells for each of the hydrographs are displayed on **Figure 3-30**. It is the intent of MAGSA that these wells will be used in setting sustainable management criteria and will be monitored in the future, remaining key components of the monitoring network.

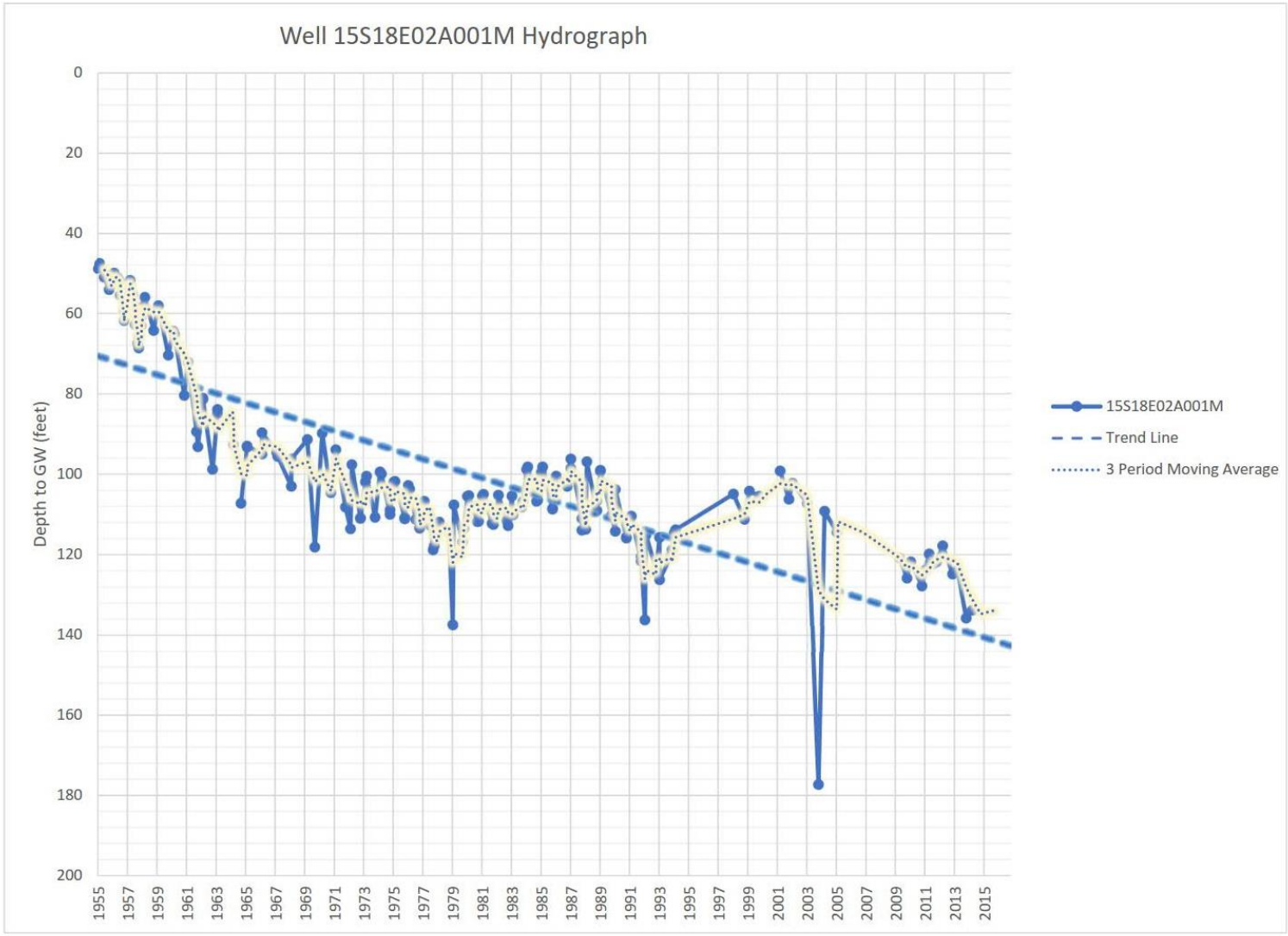


Figure 3-39 Well Hydrograph 1

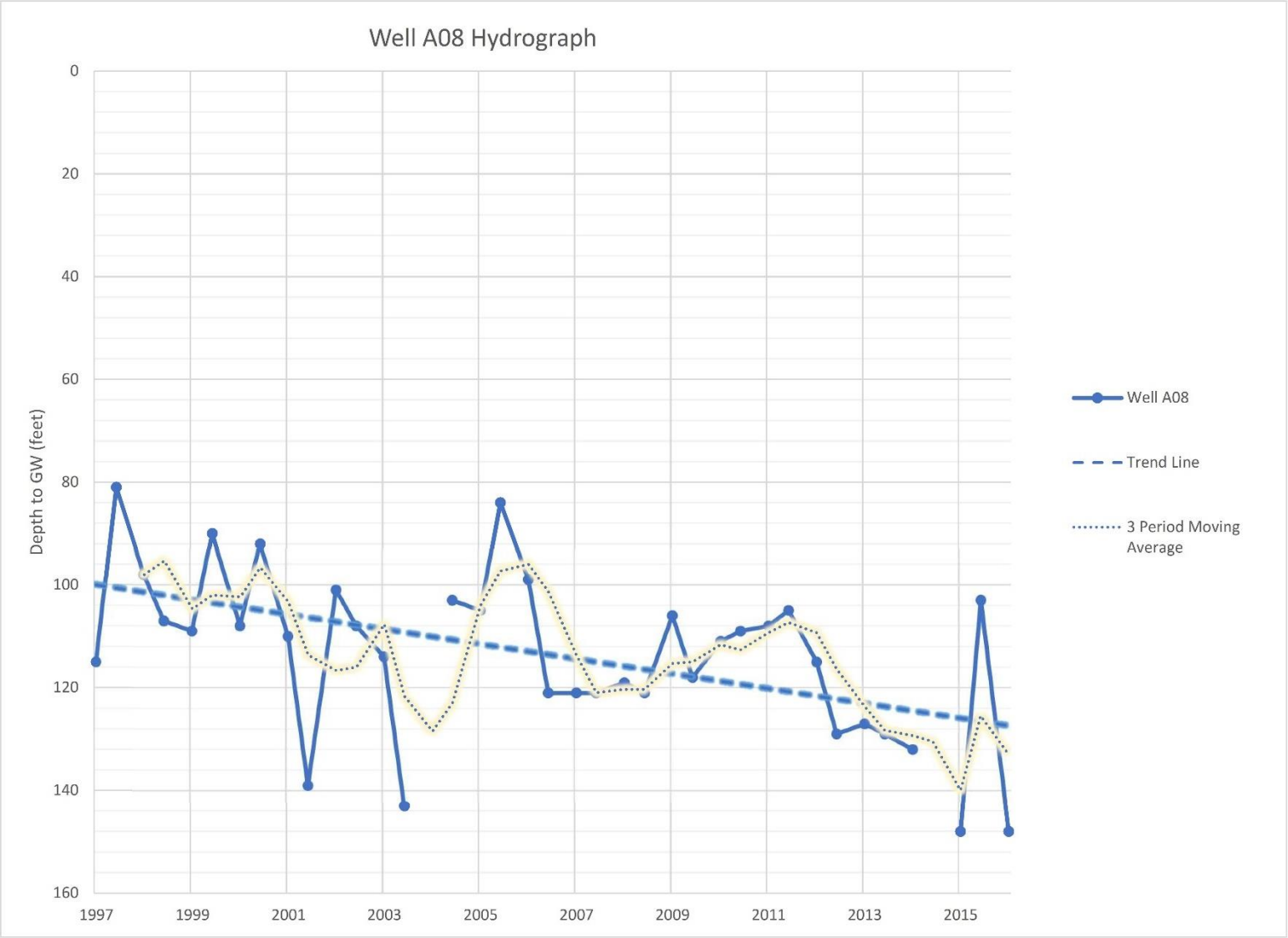


Figure 3-40 Well Hydrograph 2

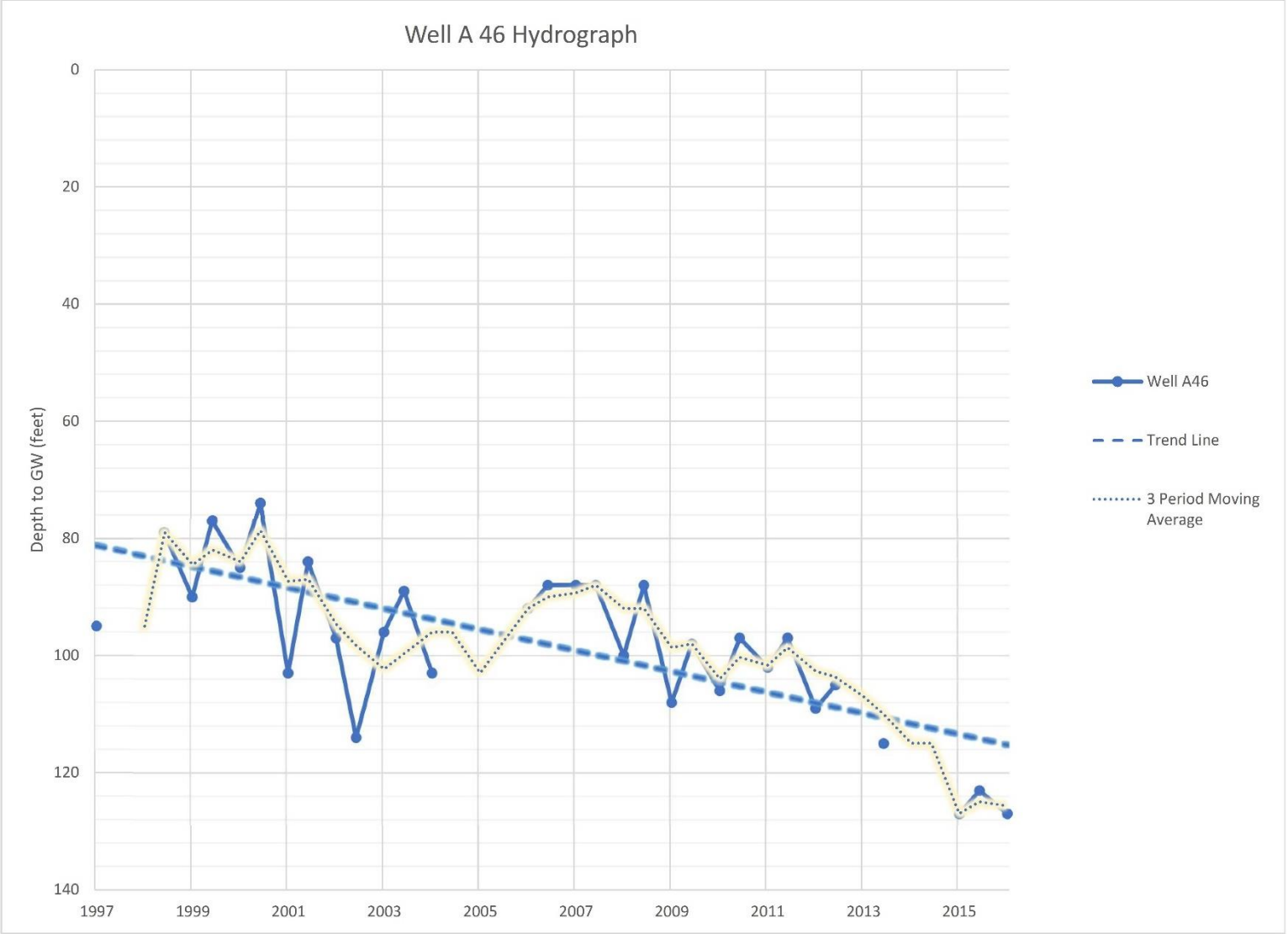


Figure 3-41 Well Hydrograph 3

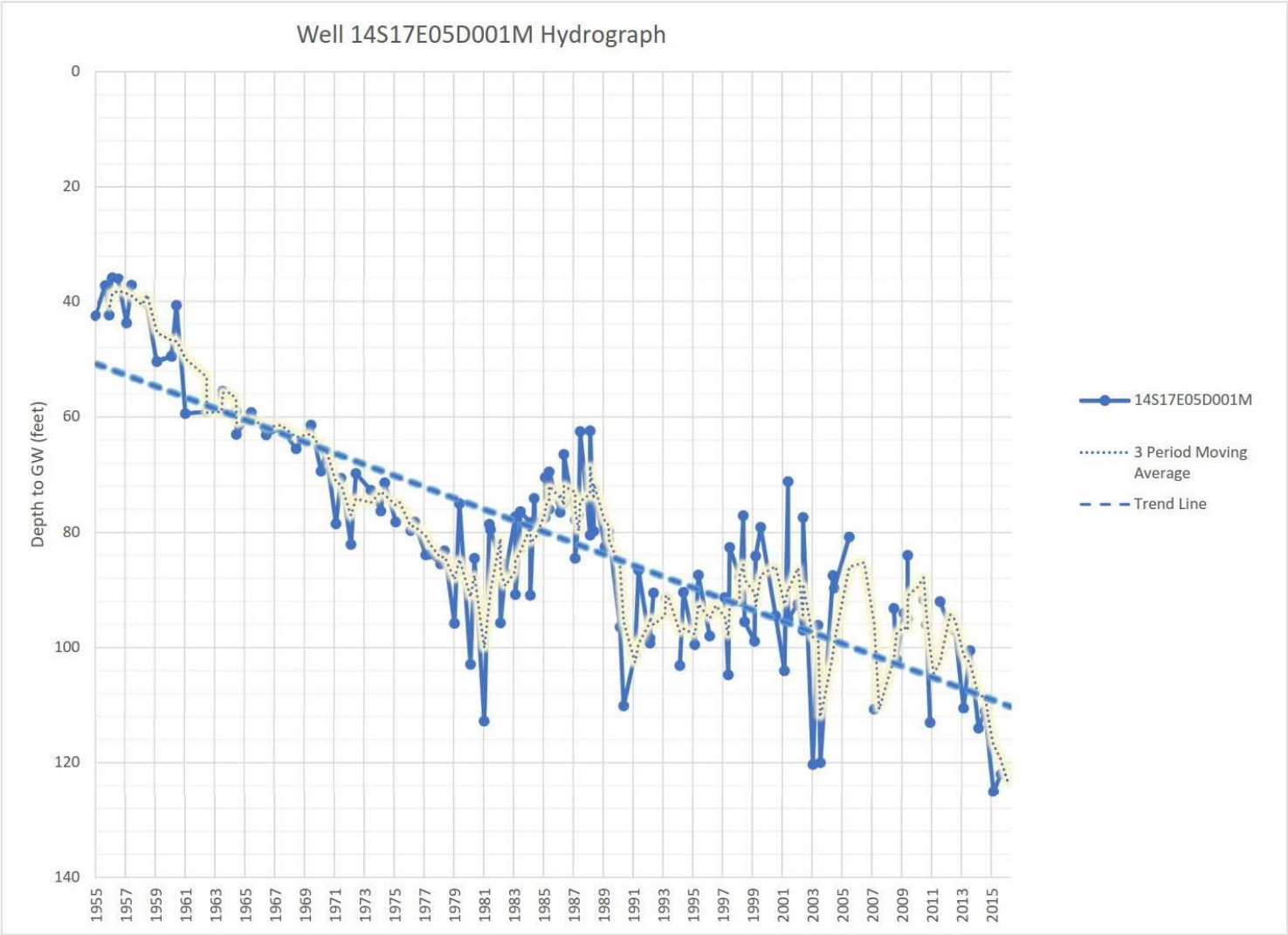


Figure 3-42 Well Hydrograph 4

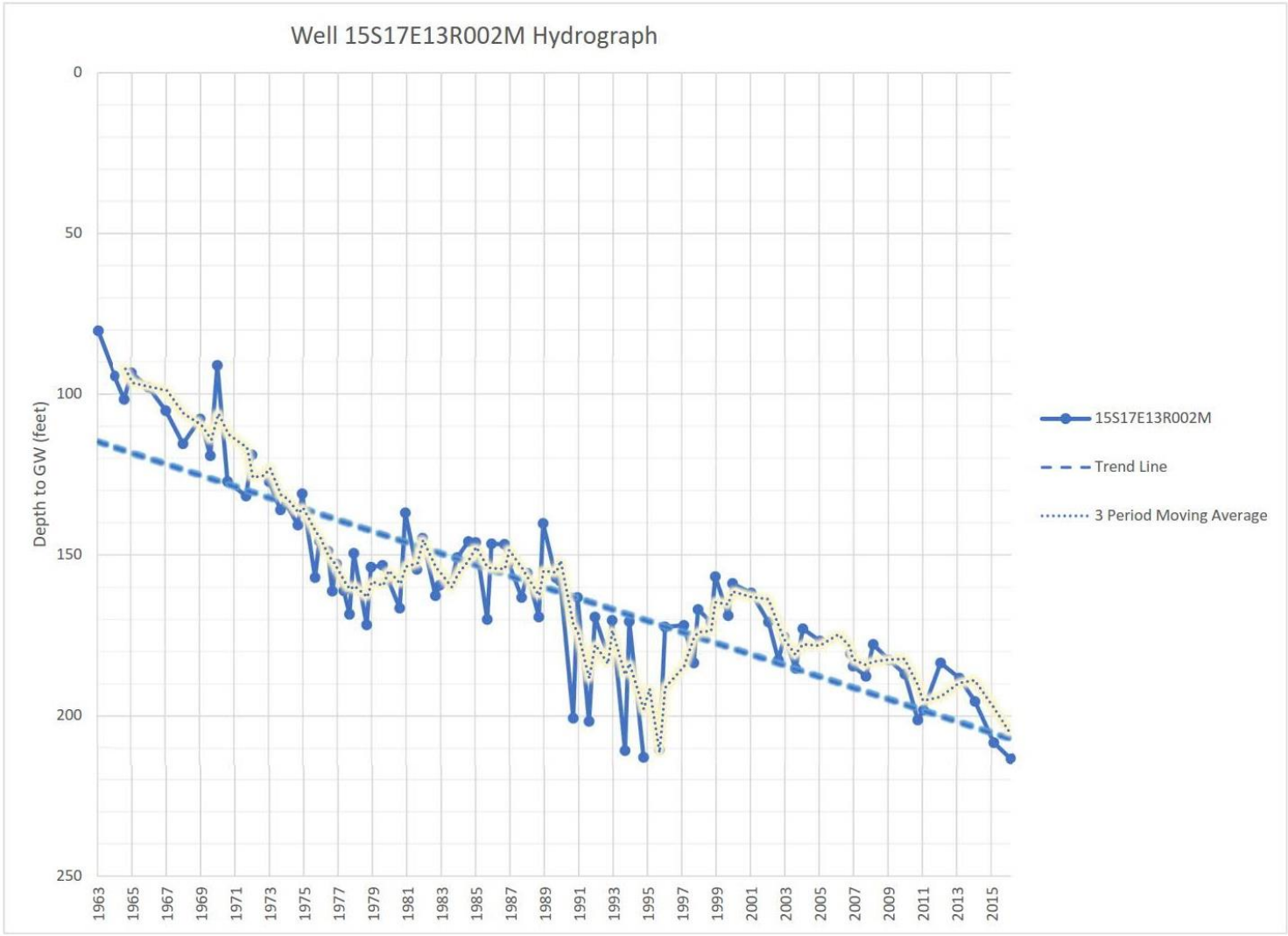


Figure 3-43 Well Hydrograph 5

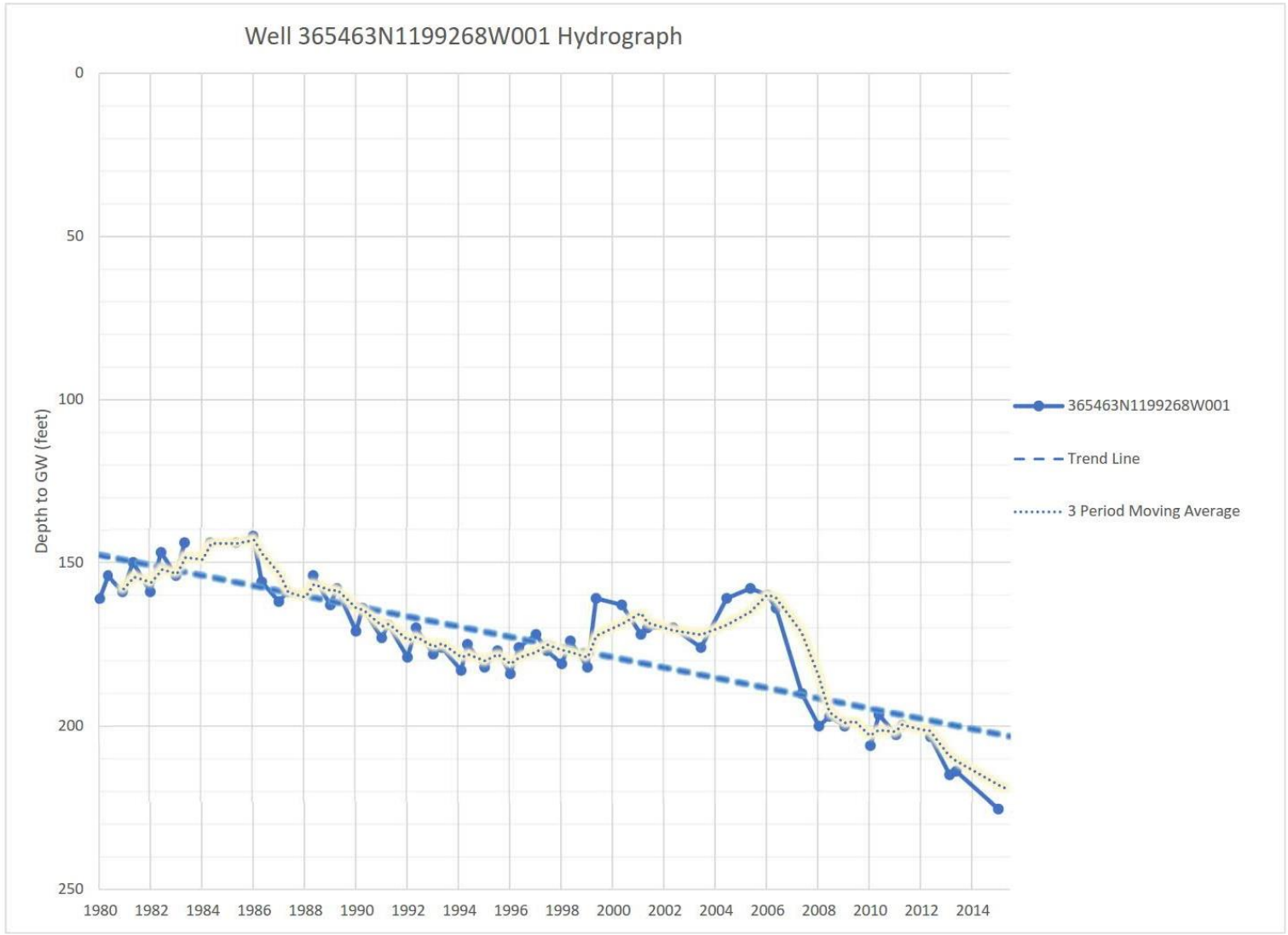


Figure 3-44 Well Hydrograph 6

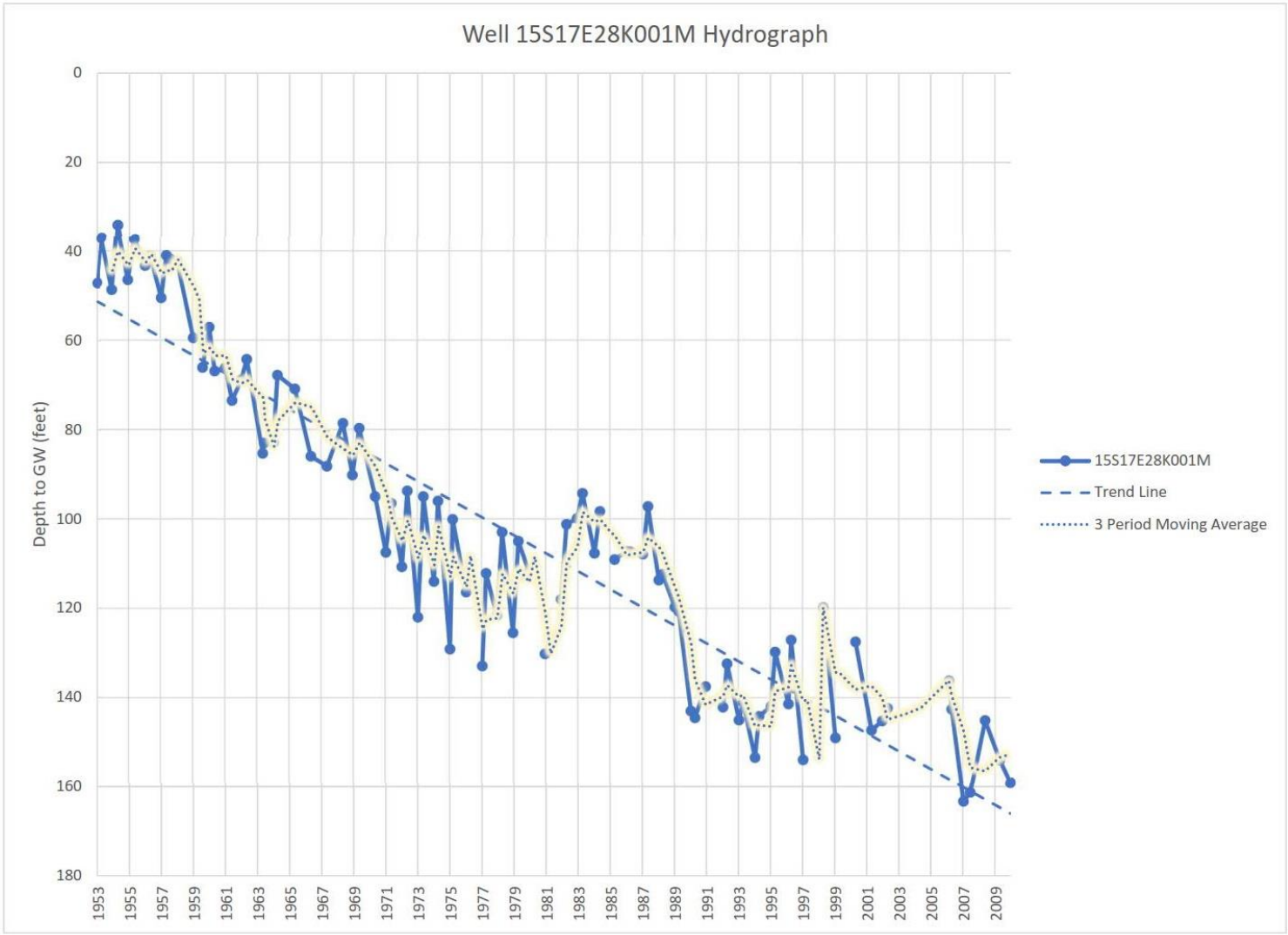


Figure 3-45 Well Hydrograph 7

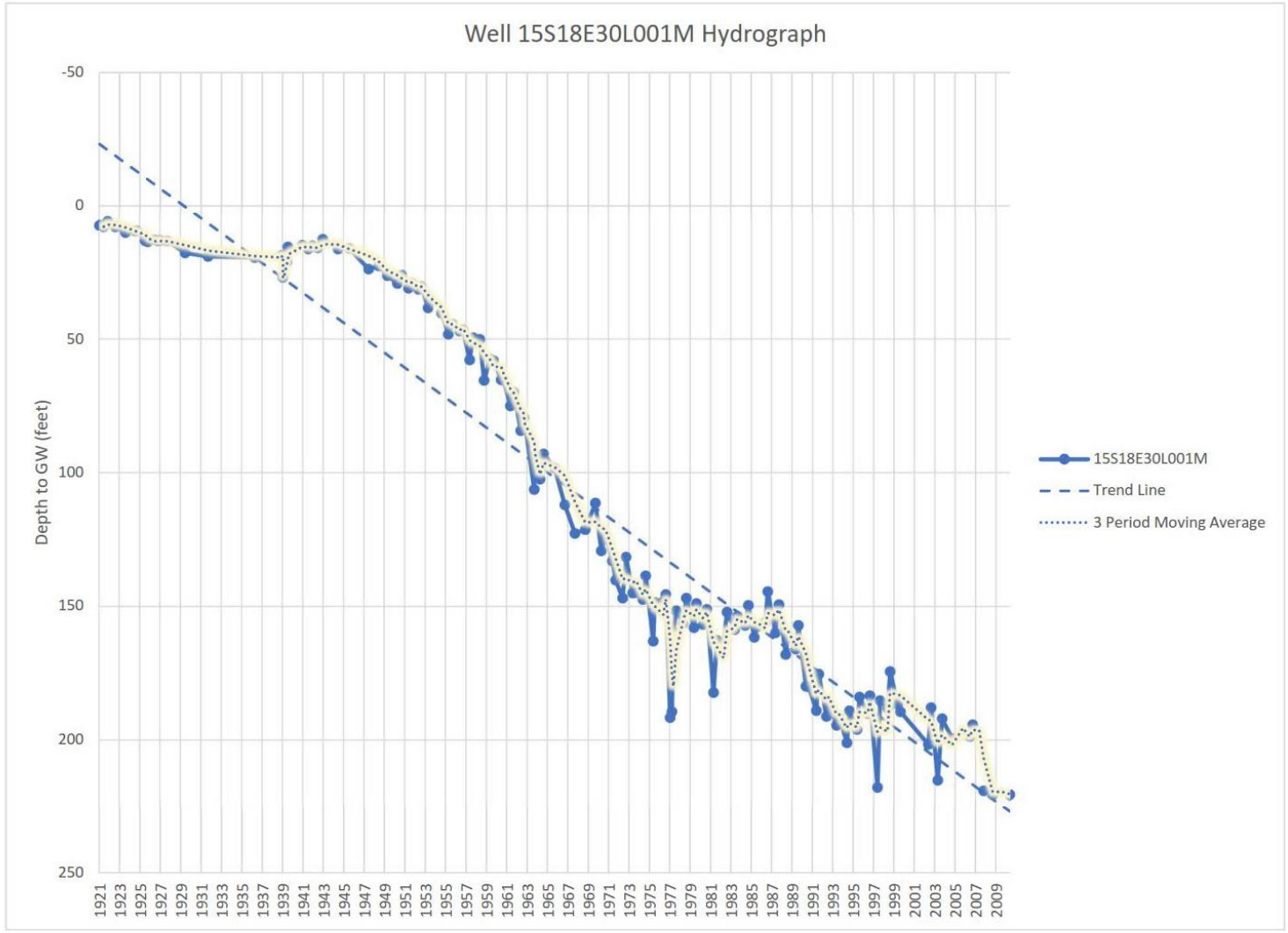


Figure 3-46 Well Hydrograph 8

3.2.2 Groundwater Movement

Groundwater moves in a manner similar to anything else, from areas of high-pressure, such as recharge zones, to areas of low pressure, such as sources of discharge and/or withdrawal. **Figure 3-47** shows that the regional groundwater flow pattern is flowing from every direction toward the Southeast border of the GSA. The highest groundwater elevations are located along the MAGSA boundaries while the lowest groundwater elevations are located at the center of the cone of depression near the Southeastern border of MAGSA.

The lack of surface water supply combined with agricultural pumping in the area has influenced the natural groundwater flow. The cone of depression has caused changes in the general flow direction as groundwater now moves toward the cone of depression from neighboring GSAs. The general pattern of groundwater movement in MAGSA reflects recharge entering the plan area from surface water stream (SJR) to the north. The flow pattern is generally in the same direction for different hydrologic years. Significant alternations of this pattern are apparent in pumping depressions in and about RCWD. The size and configuration of the pumping depression are variable over the base period and clearly reflect the magnitude of groundwater extractions. The groundwater gradient steepens towards the groundwater depression near Highway 145 and McMullin Grade. To the Northwest, along the SJR, groundwater flows southerly to southeasterly, due to higher groundwater levels from seepage.

Vertical Gradients
Historically vertical gradients in the unconfined and confined portions of the aquifer had an upward component of vertical flow near the trough of the valley where the potentiometric surface of confined groundwater was very similar, i.e., slightly higher, than the unconfined or water table aquifer. Large scale development of groundwater resources caused a change to this historic condition. As well, since development thousands of wells perforated in aquifers above and below the Corcoran clay have increased the hydraulic connection between these aquifers and substantially increased equivalent vertical hydraulic conductivity of the aquifer system (Faunt C.C, ed. 2009). The dramatic lowering of hydraulic heads in the confined parts of the aquifer has resulted in a large net downward movement of water through bore holes. This vertical flow occurs in both pumped and un-pumped wells, and increases during the growing season (Faunt, CC. ed. 2009). Most data available, with a few exceptions, to evaluate the vertical gradient is hydraulic head. These sources of data provide some indication of head differences between the lower aquifer and unconfined aquifer zones. At this time, there is insufficient data to prepare confined groundwater maps for the Kings Subbasin.

Currently, readily available information for differences in hydraulic head between confined groundwater and unconfined groundwater in the Kings Subbasin indicates hydraulic head in confined groundwater is usually less than hydraulic head in unconfined groundwater. Information on hydraulic head differences is available for the Fresno Irrigation District groundwater banking facilities, four relatively new wells installed near the border between North Fork Kings GSA and the Westside Subbasin, the regional wastewater treatment facility, and from three As-built diagrams of nested wells installed by the City of Fresno near city wells. This discussion mainly focuses on hydraulic head differences between unconfined and confined groundwater. The difference in hydraulic head between unconfined and confined groundwater is one component of estimating vertical gradients and the other is the thickness of the intervening aquitard or the difference in elevation between perforated intervals in a well tapping confined strata and a shallow well tapping unconfined strata. A positive vertical gradient value represents downward flow; thus, the unconfined aquifer is potentially recharging the confined aquifer, primarily the current condition. Negative vertical gradients represent an upward flow, indicating that the confined aquifer is potentially discharging to the overlying unconfined aquifer, the historical condition.

Page and LeBlanc, 1969, calculated vertical gradients in two locations west of MAGSA in 14S15E25H and 13S15E35E. The differences in water levels (hydraulic head) at that time were 70 to 90 feet and 70 to 110 feet, and the calculated vertical gradients ranged from 0.12 to 0.22. This indicates at the time vertical gradients

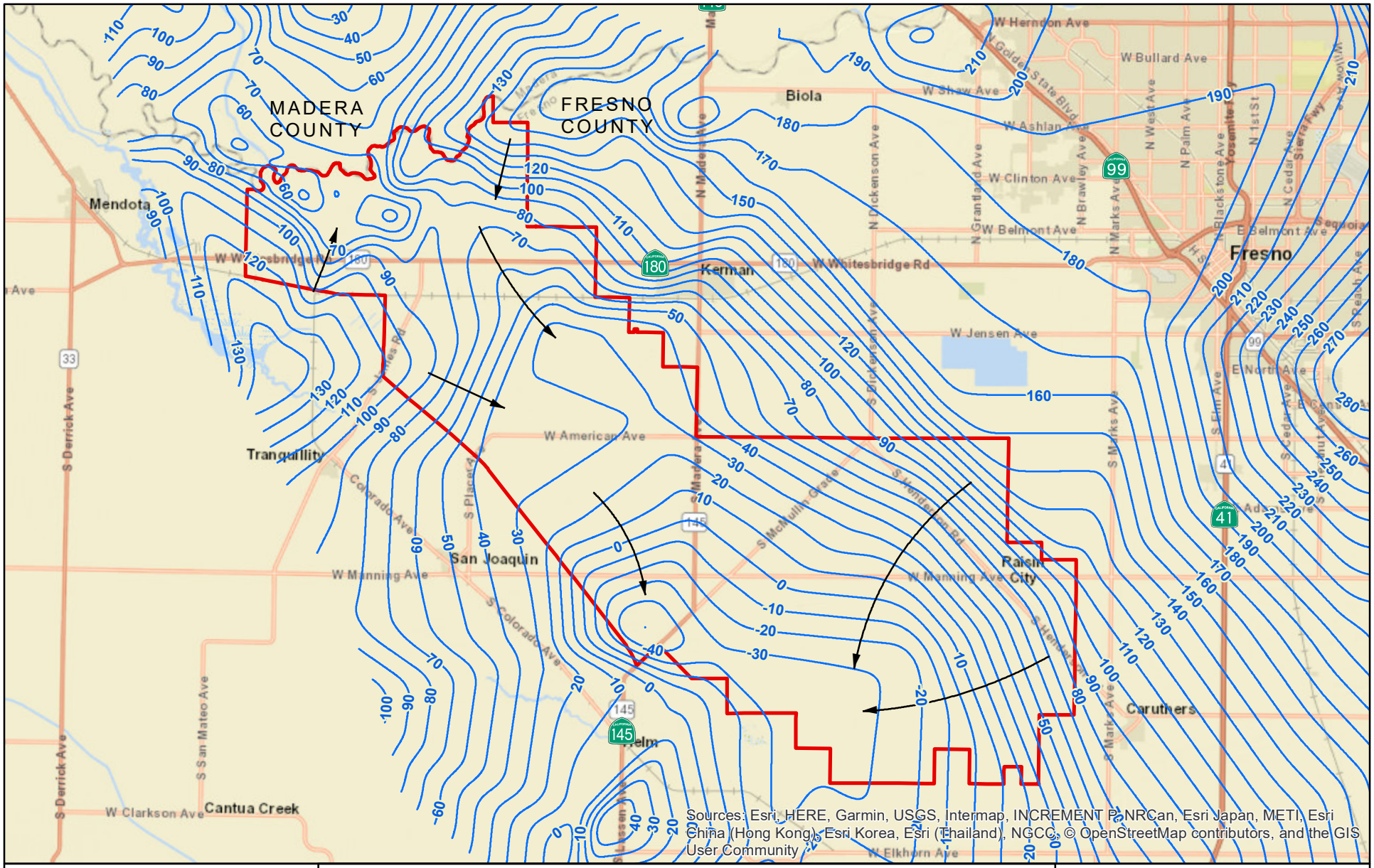
were positive and unconfined groundwater water was potentially recharging the confined aquifer (a change from the historical conditions).

Upper and Lower aquifer zone groundwater elevation maps prepared for the City of Fresno, Metropolitan Water Resources Plan Update, 2007 provide some general information on vertical heads differences, on a regional scale, in spring 2006 for the Fresno area (KDSA, 2006). In general, head differences between the upper and lower aquifer zones were greatest in the east and north parts of the metropolitan area. At that time, head differences appear to be mostly positive except for the central portions of the metropolitan area, where both maps have closed 190 ft elevation contours, the head differences between confined and unconfined groundwater appear minimal. Near the San Joaquin River head differences were about 5 feet, in the south part of the study area head differences were from about 0 to 10 feet, at the regional wastewater treatment facility head differences were about 10 feet. The greatest head differences between unconfined and confined groundwater occurred east of the Fresno Air Terminal where it was as much as 50 feet. In north Fresno, in the Fort Washington area, head differences were about 30 to 35 feet. In June 1995, KDSA indicates water levels across a confining bed which underlies the regional wastewater treatment facility were about 11 feet, and that at time there was not much water being pumped from deeper groundwater below a depth of about 450 feet. As-built diagrams for nested monitoring wells at City of Fresno well sites No. 362, No. 359 and No. 318, have one-time data available for when the monitoring wells were built. This information indicates head differences were 7.7 feet near Maple and Perrin Avenues, and 40 near Belmont and Armstrong Avenues, and 45.7 feet near California and Temperance Avenues.

Data on vertical gradients, again mainly head differences between unconfined and confined groundwater, is available at the FID Boswell and Waldron Water Banks. Data from a leaky aquifer test in late September/early October 2017, from a shallow and a deep monitor well at the FID-Empire banking facility indicates the difference in static water levels between a shallow monitor well and a deeper monitor well was about 9 feet. The area is underlain by a 55 feet thick aquitard, and the estimated vertical gradient was about 0.16, which is in the range estimated by Page and LeBlanc, 1969. Data from the Waldron facility between shallow monitor wells and deeper monitor or recovery wells indicates that vertical head differences vary from about 5 to 8 feet under static conditions and can be as high as about 40 feet when the recovery wells are pumping. At the Empire site vertical head differences are typically between about 3 to 8 feet, and when the recovery wells pump the head difference can be as high as 55 feet. At the Lambrecht facility vertical head differences are greater and can vary from about 8 to 30 feet under static conditions and are about 50 feet when the recovery wells are pumping. At the Boswell site vertical head differences under static conditions can be from about 8 feet to as much as 40 feet and appear to be about 80 feet when the Recovery well is pumping. These data also show that vertical gradients tend to be less during the winter and early spring and increase during the summer months presumably due to increased groundwater pumpage.

Water levels are available from four nested monitor wells installed near the boundary between the North Fork Kings GSA and the Westside Subbasin under a DWR DAC grant. These wells have casings perforated above and below the Corcoran clay. Water elevation differences between unconfined and confined groundwater at the sites collected from May 31 to June 1, 2018, after the wells were developed, varied from about 25 to 70 feet. The greatest difference was in FC-1 near Yuba and Kamm Avenues and the least amount of head differential was in FC-3 near Golden Rod and Mt. Whitney Avenues.

In general, these data discussed above indicate that vertical gradients vary considerably in the Subbasin. Vertical gradients can vary through time, as water levels change relatively quickly in confined groundwater due to pumpage compared to water level changes in unconfined groundwater. Vertical gradient information will continue to be developed as additional information becomes available for well construction, as well as for specific projects where vertical gradient information is needed.



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3.2.3 Estimate of Groundwater Storage

Regulation Requirements:

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

As part of the coordination of GSAs within the Kings Subbasin, a common method was utilized to estimate the change in groundwater storage for the entire subbasin and within each GSA during the hydrologic average base period. This method estimated storage within the upper unconfined groundwater aquifer. Estimated storage change in the lower confined aquifer is not possible at this time due to limited or no data from confined wells throughout the GSA. Refer to Section 3.1 – Hydrogeologic Conceptual Model for more details on the different aquifers in the GSA.

Storage change was estimated for the Kings Subbasin in Technical Memorandum 4 (**Appendix 3-A**). to be approximately -1.8 MAF during the hydrologic average base period from spring 1997 to spring 2012, or about -122,000 AF/yr. Estimates of year to year storage change (annual storage change), cumulative change in storage, percent of normal water year and estimated groundwater use between the springs of years in the hydrologic base period, based on data, are shown on **Figure 3-48**, below, for the Kings Subbasin. The methods for estimating storage change are detailed in Technical Memorandum 4 (**Appendix 3-A**). The overall trend in storage change, based on groundwater elevation contours generated from water level data, from year to year generally tracks with the preceding water year type. For example, storage change is positive in 1998, 1999, 2006, 2011, and 2012 which follow above normal water years. The years 2000 to 2004 are years of near normal to below normal water years, and storage change was negative. It is interesting to note that 2001 was a 100 percent water year and the storage change in that year of 135,565 AF is reasonably close to the long-term storage change estimated for the hydrologic base period years. A similar trend also exists between change in storage and estimated groundwater use. Positive storage change is estimated in 1998, 1999, 2006, 2011 and 2012 which are years of relatively lower estimated groundwater use. Decreases in storage are also linked to increased groundwater use as illustrated by the years 2002 and 2008 which are both years when the previous year's estimated groundwater use were greater than normal. There are inconsistencies in some of the groundwater elevation contours for the years in the base period due to several factors including a general lack of well construction data in the basin, historical data being collected at different times by different agencies and possibly from different wells, lack of data in some areas in some years, and potentially inconsistencies in measurement point elevations. Groundwater elevation contours were not constructed for spring 2010 due a lack of data in Central Kings GSA, therefore storage change for 2010 was averaged between 2009 and 2011. It is likely that the storage change from 2009-2010 was negative as it follows an 83 percent water year. The groundwater contour maps used in this evaluation will continue to be refined, especially as additional well construction data is collected, and annual and cumulative estimates of storage change will be adjusted.

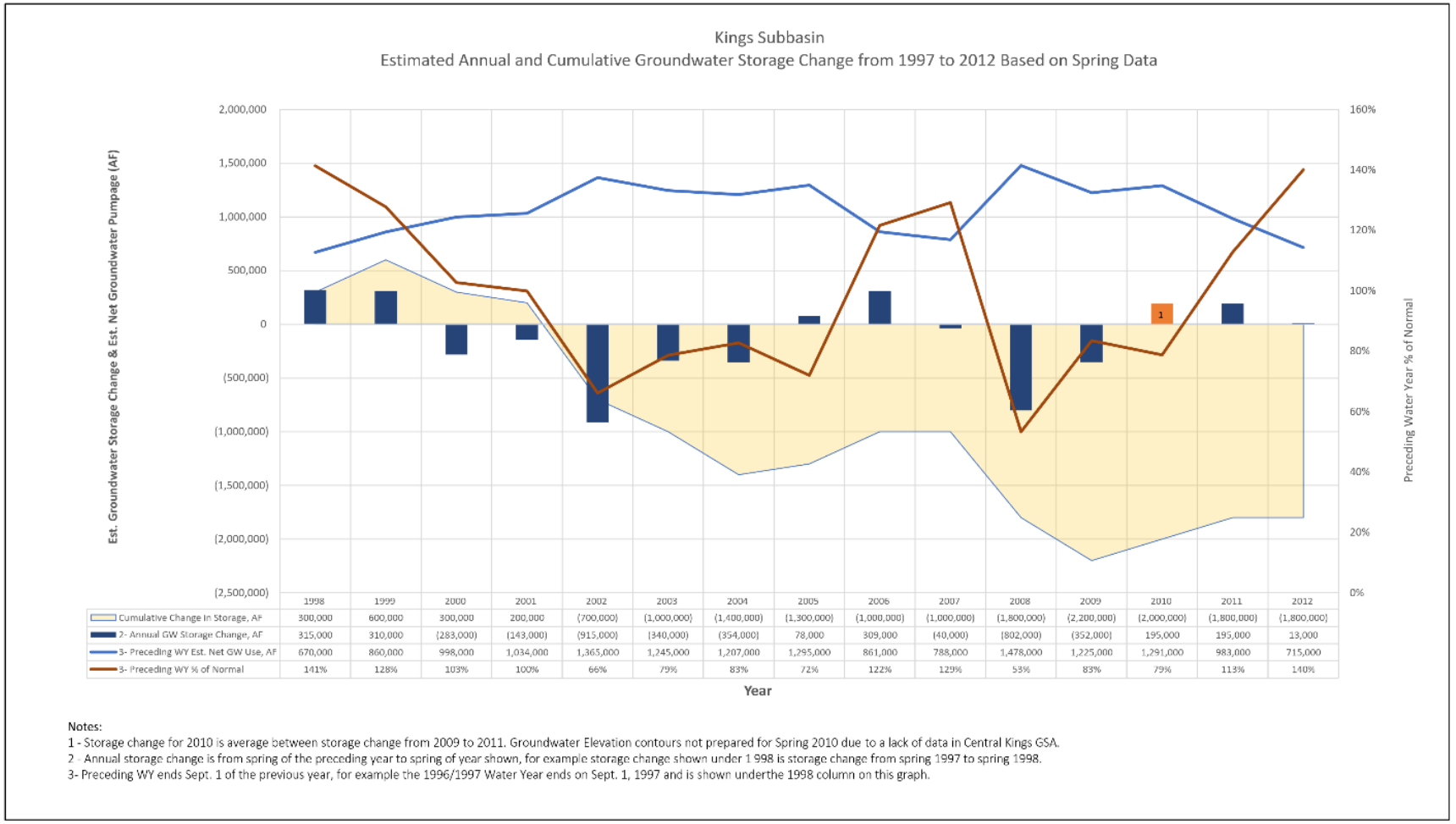
The purpose for determining the change in groundwater storage was to provide a baseline condition for the groundwater system and to provide design targets for future groundwater recharge projects. A common method was utilized to estimate change in groundwater storage for the entire subbasin and within each GSA as part of the coordination efforts within the Kings Subbasin. Technical Memorandum 2 (**Appendix 3-A**), identified the basis for assumptions of specific yield values utilized throughout the basin including MAGSA. Specific yields for each subarea (predominantly by Township) were identified for varying depths of 0-50 feet, 50-100 feet, 100-200 feet, and 200-300 feet below ground surface. **Figure 3-20** displays the specific yield values by Township, depth, and data source. USGS Water Supply Paper (WSP) No. 1469 dated 1959 was a source used, and other sources include USGS WSP 1401-D (1989), Page & LeBlanc (1969), and a technical memorandum prepared by KDSA documenting estimates of specific yield.

Once specific yield values have been determined, the coordination effort process for calculating storage change follows Technical Memorandum 4 (KDSA, 2018c) and includes the following steps:

1. Determine the base of the unconfined groundwater (TM-1, **Appendix 3-A**)
2. Calculate average depth to groundwater for each subarea based on the well data collected.
3. Multiply the thickness of saturated alluvium within each depth zone by the specific yield for that depth zone (TM-2) and by the area of that subarea within the Plan area.
4. Sum the total storage capacity for all subareas.
5. Then compare the storage from one year to the next, the difference equals the storage change.

Using the above method, average annual storage change for the hydrologic base period of 1997-2011 was estimated to be approximately -16,000 AF/year.

A similar storage-change calculation has been performed in MAGSA as part of the KRCD Groundwater Management Plan Update performed by WRIME in 2006. The WRIME Study estimated that over 1.8 million acre-feet of groundwater has been taken from storage and not replenished in Water Management Area A, and that the average annual rate of groundwater overdraft in the Water Management Area A is 34,000 AF/year.



Notes:
1 - Storage change for 2010 is average between storage change from 2009 to 2011. Groundwater Elevation contours not prepared for Spring 2010 due to a lack of data in Central Kings GSA.
2 - Annual storage change is from spring of the preceding year to spring of year shown, for example storage change shown under 1 998 is storage change from spring 1997 to spring 1998.
3- Preceding WY ends Sept. 1 of the previous year, for example the 1996/1997 Water Year ends on Sept. 1, 1997 and is shown underthe 1998 column on this graph.

Figure 3-48 Graph of Storage Change, Seasonal High/Low WY, GW Pumped

3.2.4 Seawater Intrusion

Regulation Requirements:

§354.16(c) Seawater intrusion conditions in the basin, including maps and cross-sections of the seawater intrusion front for each principal aquifer.

Not applicable for the area.

3.2.5 Groundwater Quality Issues

Regulation Requirements:

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

3.2.5.1 Kings Sub Basin Groundwater Quality Conditions

Groundwater quality is generally excellent for agriculture, and good in most areas for municipal use. However, there are possible water quality concerns in some areas. According to DWR Bulletin 118, groundwater in the Kings Subbasin is predominantly of sodium-bicarbonate type. The major cations are calcium, magnesium, and sodium. A typical range of groundwater quality in the basin is 200 to 700 mg/L. DHS data indicates an average TDS of 240 mg/L from 414 samples from Title 22 water supply wells. These samples ranged from 40 to 570 mg/L. DBCP, a soil fumigant nematicide, and nitrates can be found in groundwater along the eastern side of the subbasin. Shallow brackish groundwater can be found along the Western portion of the subbasin. Elevated concentrations of sodium can be found in localized areas of the subbasin.

3.2.5.2 Current Groundwater Quality Conditions in McMullin Area GSA

Groundwater quality within the MAGSA area is generally of excellent quality for agricultural uses and good for municipal uses. Historically, the MAGSA area has identified eight possible constituents that have been present at inconsistent levels over the last several decades. A list of known constituents with possible, historically elevated levels include the following: Arsenic (AS), Chloride (CI-), 1,2 Dibromo-3-chloropropane (DBCP), Manganese (Mn), Nitrates (NO3), Sodium (Na), Total Dissolved Solids (TDS), 1,2,3 Trichloropropane (1,2,3 TCP), Uranium (U). Possible areas of concentration or boundaries that may require additional monitoring, would include the Raisin City Oil Field and the American Avenue Landfill site. Additionally, some nitrate and salinity exceedances can be attributed to agriculture per the State Board's GAR. Few pesticide exceedances are present. The Raisin City Oilfield groundwater quality impacts are described in detail below. In order to further examine these identified constituents in the MAGSA, the GSA plans to utilize public water supply monitoring well data as well as data from GAMA.

As previously mentioned, both existing public water supply monitoring wells as well as monitoring wells surrounding the American Ave Landfill were assessed and will continue to be the method that MAGSA utilizes to monitor any future water quality concerns. Throughout the MAGSA historical period, water quality data is relatively sparse, so groundwater quality data was assessed over the last three years, utilizing GAMA. While there were possible indications of brief historical MCL or secondary maximum contaminant level (SMCL) exceedances, there was no indication of trends that would cause significant concern to MAGSA water quality. Moving forward, the GSA will strive to maintain current levels and prevent the increase of any known constituent levels, while continuing to monitor for new future developments. Additionally, the American Ave Landfill, and Raisin City Oil Field, being possible areas of contamination, will be regularly monitored through the existing network for potential plume expansion or movement. Should the GSA board deem it necessary, the GSA will adopt policy to address any conceivable future water quality concerns and will enhance the groundwater monitoring system, as needed.

As referenced in the sections below, the term MCL is an acronym for Maximum Contaminant Level. This is a standard set by the EPA in order to monitor and regulate water quality. Additionally, the term SMCL is widely used throughout this section and refers to the EPA's term for suggested water quality standards. Lastly, the term constituent is also a widely used phrase for a chemical and is seen throughout this section to describe the specific chemical components found in the groundwater of various areas throughout the MAGSA.

Figure 3-49 shows the GSA boundary, with the groundwater quality monitoring wells, from which data will be collected for MAGSA groundwater quality monitoring. The chosen monitoring network is comprised of both monitoring wells surrounding the American Ave Landfill, which is a possible point of contamination, and groundwater monitoring wells from the public water system.

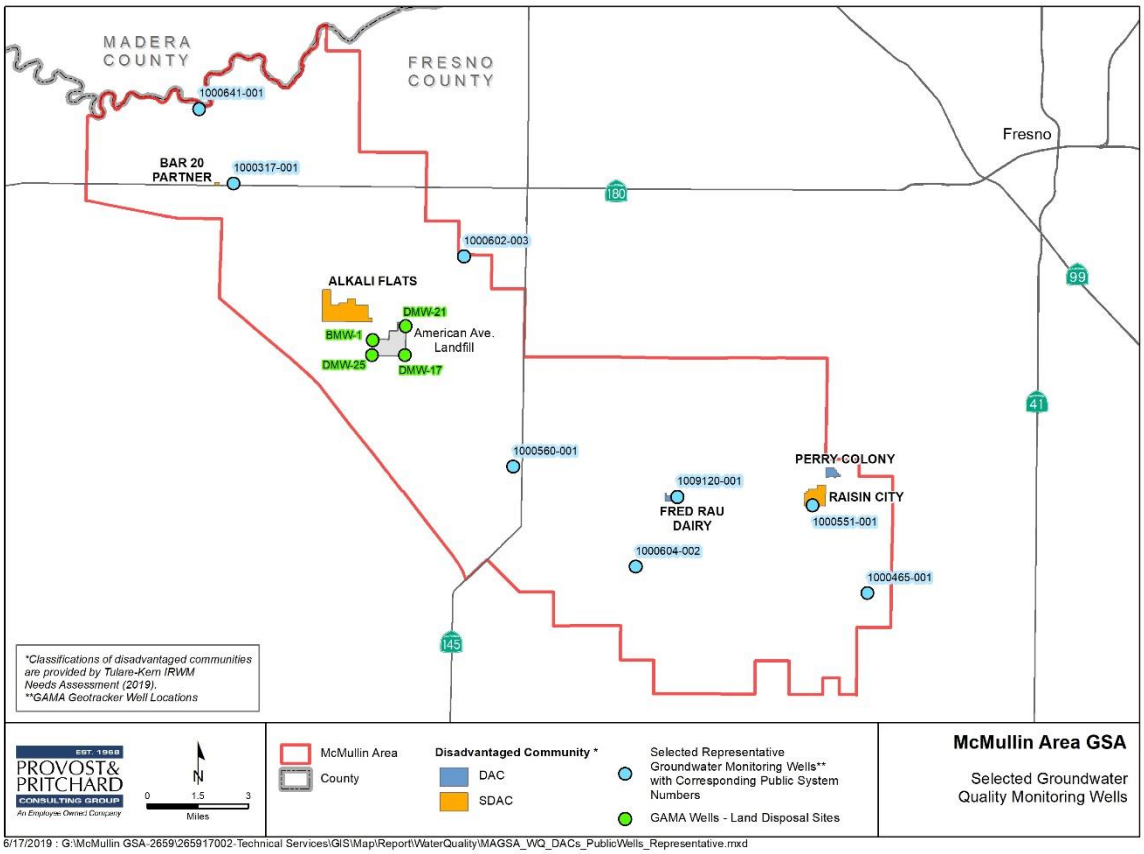


Figure 3-49 Public Water System Monitoring Wells and Selected American Ave. Landfill Monitoring Wells

The following will list the known constituents within the MAGSA boundary.

Arsenic (As)

Arsenic occurs in natural deposits and has an MCL of 10 micrograms per liter (µg/L). Within the MAGSA, Arsenic is seen at various locations throughout the GSA. In 2018 a municipal well southeast of Raisin City had a reported value of 38 µg/L while a municipal well, located northwest of the American Avenue Landfill with a total depth of 258 ft had a reported value of 17.7 in 2014. Although intermittent heightened levels of Arsenic can be found directly surrounding the Landfill, the trend is consistently reported levels well within the acceptable range of the MCL throughout the MAGSA boundary. As indicated below, in **Figure 3-50**, arsenic is not of considerable concern for MAGSA and while historic, sporadic heightened MCL exceedances may have been indicated, there is little indication to a consequential or continuous incline. Additionally, the GSA recognizes the possible presence of levels in exceedance of the MCL, located southwest of Raisin City, northeast of the American Ave Landfill and within the Landfill groundwater monitoring system. These groundwater monitoring wells will continue to be monitored by the GSA, and additional monitoring or policy development will be addressed by the GSA board as deemed necessary.

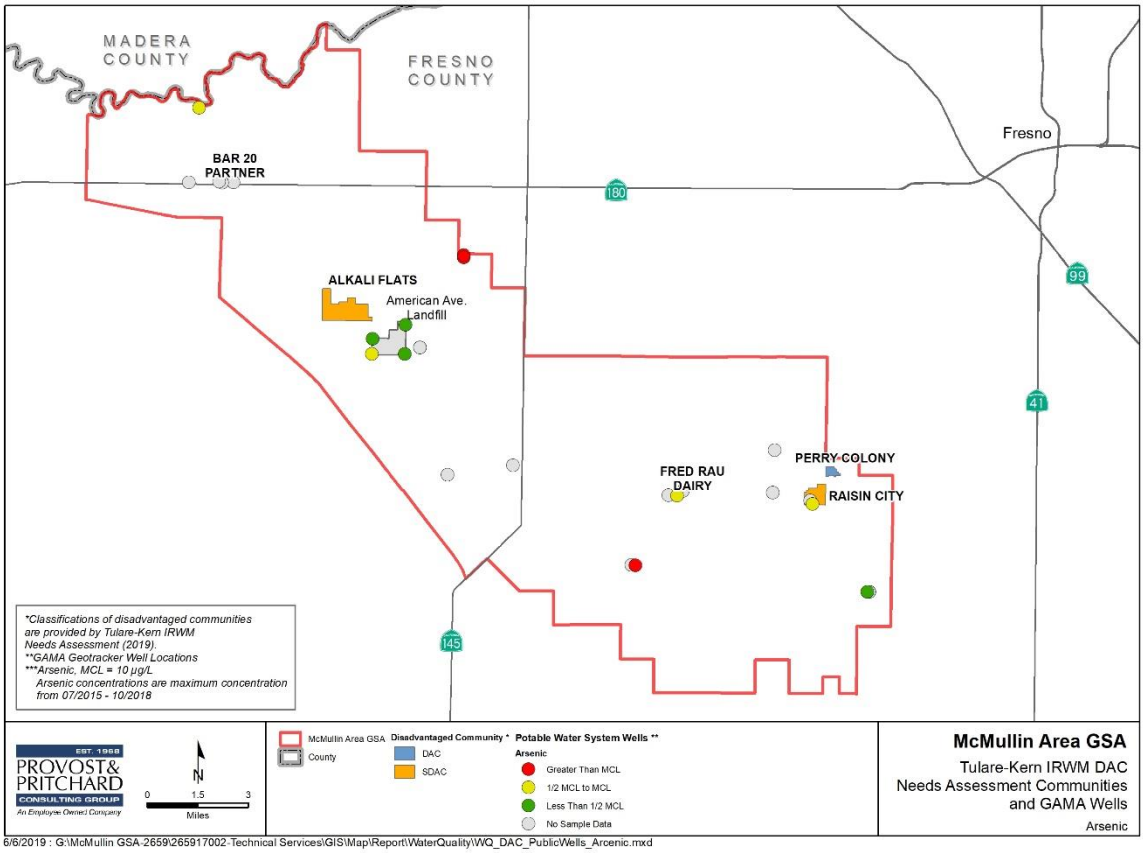


Figure 3-50 MAGSA Constituents Map Arsenic (As)

Chloride (Cl-)

Chloride is a common constituent to be identified in groundwater particularly in the Central Valley of California. Chloride has an SMCL of 500 mg/L. Chloride is present in monitoring wells and municipal wells of various depths throughout the MAGSA. As indicated in **Figure 3-51**, chloride is not of considerable concern for MAGSA and while historic, sporadic heightened MCL exceedances may have been indicated, there is little indication to a consequential or continuous incline. As mentioned previously, the American Ave Landfill is an area of possible contamination is regularly monitored and will continue to be through, GAMA data. The monitoring well located on the northeast corner of the Landfill (L10006109169-DMW-22), as historically seen values that have approached and even exceeded SMCL levels however these recorded values have been substantially irregular and in recent years have decreased below SMCL levels with a 460 mg/L in October of 2018. These groundwater monitoring wells will continue to be monitored by the GSA, and additional monitoring or policy development will be addressed by the GSA board as deemed necessary.

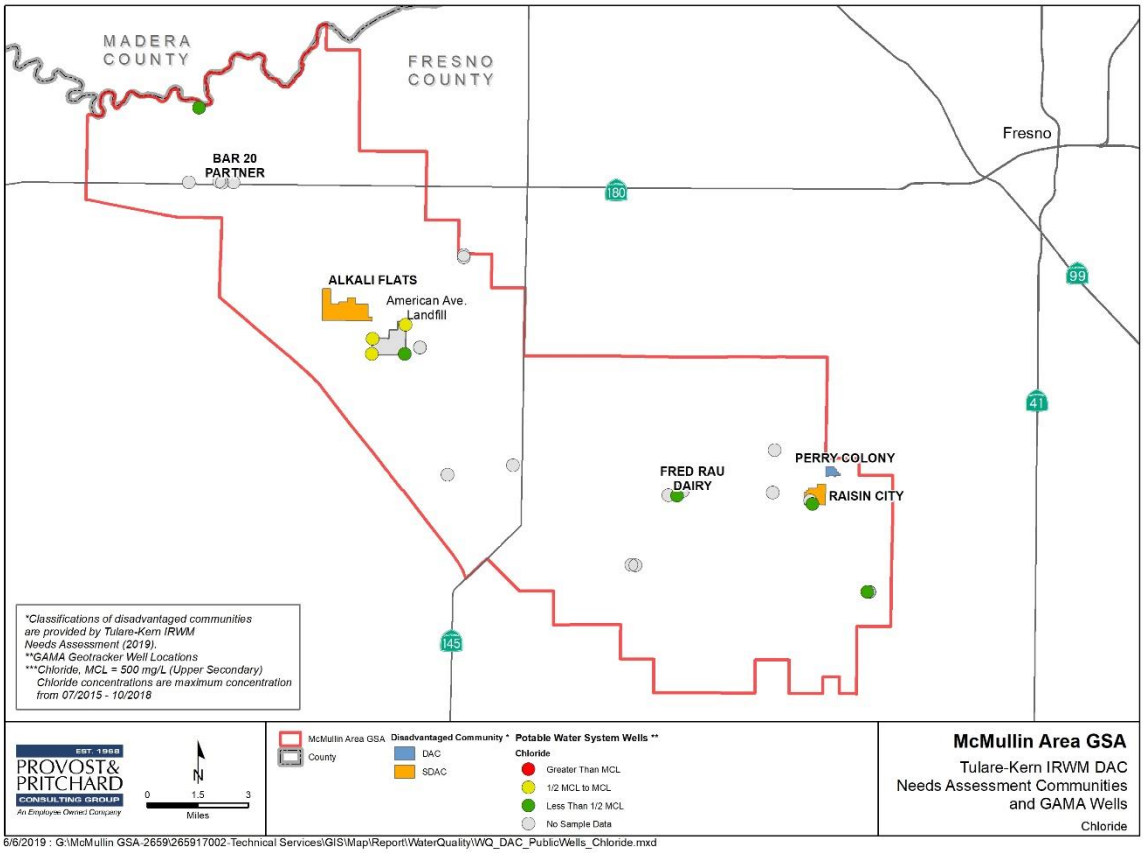


Figure 3-51 MAGSA Constituents Map Chloride (Cl-)

1,2-Dibromo-3-chloropropane (DBCP)

DBCP was used as a fumigant to kill nematodes in soil before planting and was widely used in California until 1977. The MCL is 0.2 µg/L. DBCP was used in vineyards and deciduous orchards where sandy soils were present. In 1993, an unspecified well with a total well depth of 233 ft, captured a value for DBCP of 2.5 µg/L. As indicated below, in **Figure 3-52**, DBCP is not of considerable concern for MAGSA and while historic, sporadic heightened MCL exceedances may have been indicated, there is little indication to a consequential or continuous incline. Additionally, the GSA recognizes the possible presence of constituent levels reported, southeast of Raisin City and will continue to monitor these values from the public water supply system. These groundwater monitoring wells will continue to be monitored by the GSA, and additional monitoring or policy development will be addressed by the GSA board as deemed necessary.

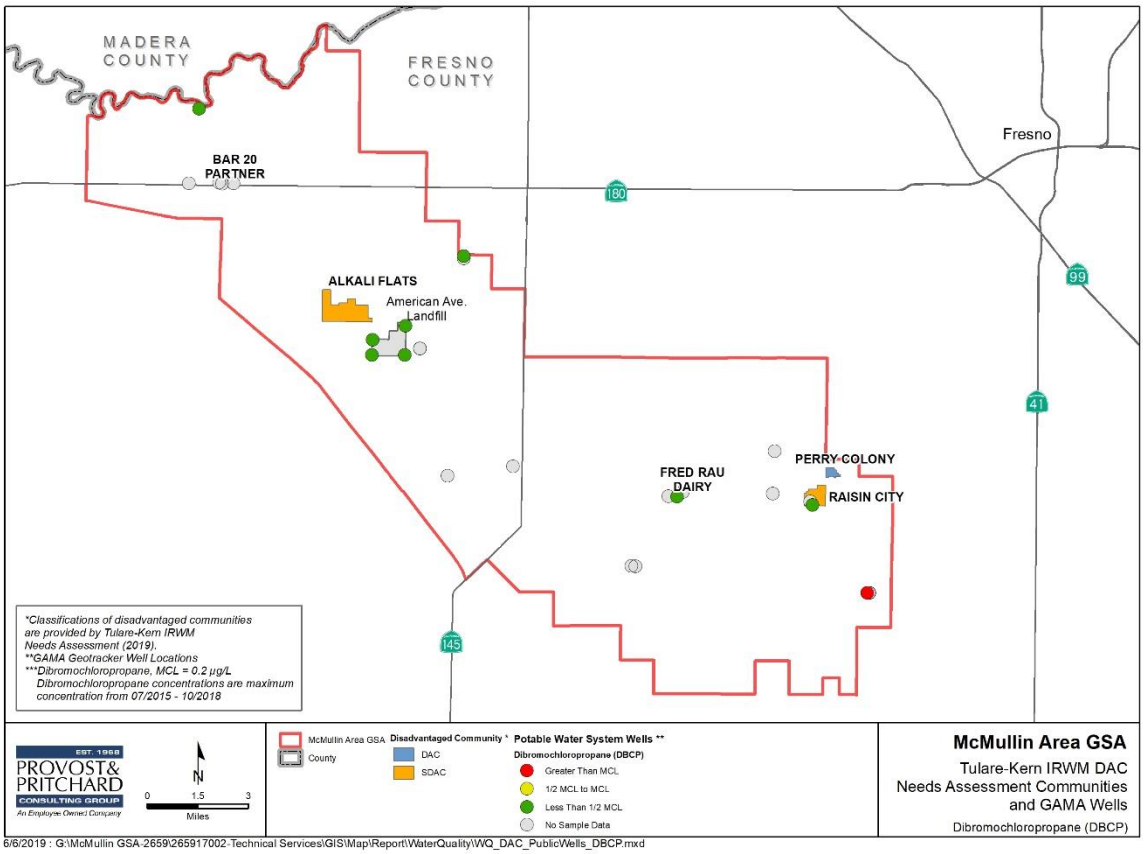


Figure 3-52 MAGSA Constituents Map Dibromochloropropane (DBCP)

Manganese (Mn)

Manganese can be found throughout the MAGSA boundary with higher levels recorded north of Highway 180, and southeast of the American Avenue Landfill. The SMCL for Manganese is 50 µg/L. As indicated below, in **Figure 3-53**, Manganese is not of considerable concern for MAGSA and while historic, sporadic heightened MCL exceedances may have been indicated, there is little indication to a consequential or continuous incline. The previously referenced monitoring well located on the northeastern corner of the landfill boundary (L10006109169-DMW-22) has registered a value of zero, for Mn since March of 2006. These groundwater monitoring wells will continue to be monitored by the GSA, and additional monitoring or policy development will be addressed by the GSA board as deemed necessary.

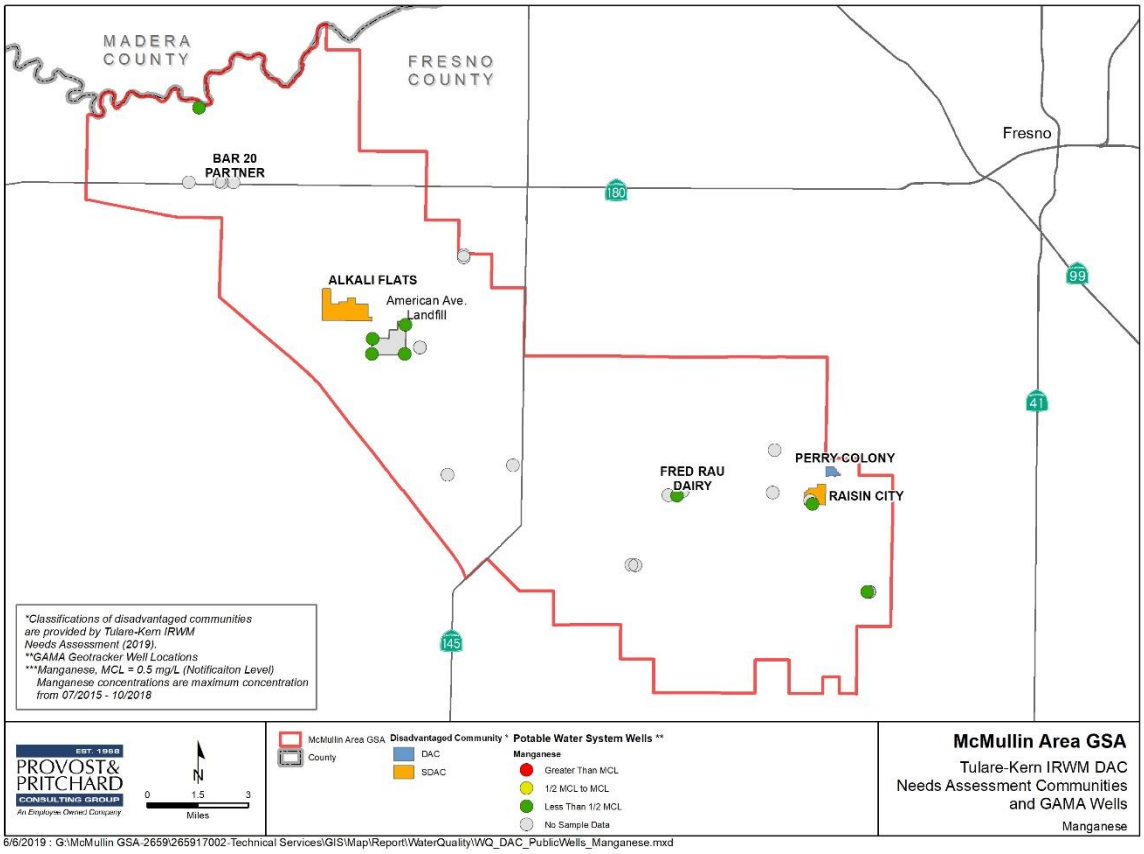


Figure 3-53 MAGSA Constituents Map Manganese (Mn)

Nitrate-Nitrogen (NO_3) -(NO_3-N)

Nitrate is commonly found in groundwater as a result of application of nitrogen fertilizers in irrigated agricultural and landscaped areas, seepage from feedlots and dairies, wastewater and food processing waste ponds, winery waste, sewage effluent, and leachate from septic system drain fields. The MCL for nitrate (NO_3) is 45 mg/L, and 10 mg/L for nitrate as nitrogen (NO_3-N). As mentioned above, GAMA data was evaluated over the last three years, 2015 to 2018 and trends indicated that there were no significant exceedances of NO_3 throughout the MAGSA area as seen is **Figure 3-54**. As indicated previously, the landfill is a possible contaminant concern and is currently monitored and will continued to be evaluated on a regular basis. In 2018 NO_3-N levels at the groundwater monitoring well located on the northwest corner of the landfill had a reported level of 20 mg/L (L10006109169-DMW-22). However historically, these values have ranged significantly lower and have little indication of a consequential or continuous incline. These values will continue to be monitored by the GSA, and additional monitoring or policy development will be addressed by the GSA board as deemed necessary.

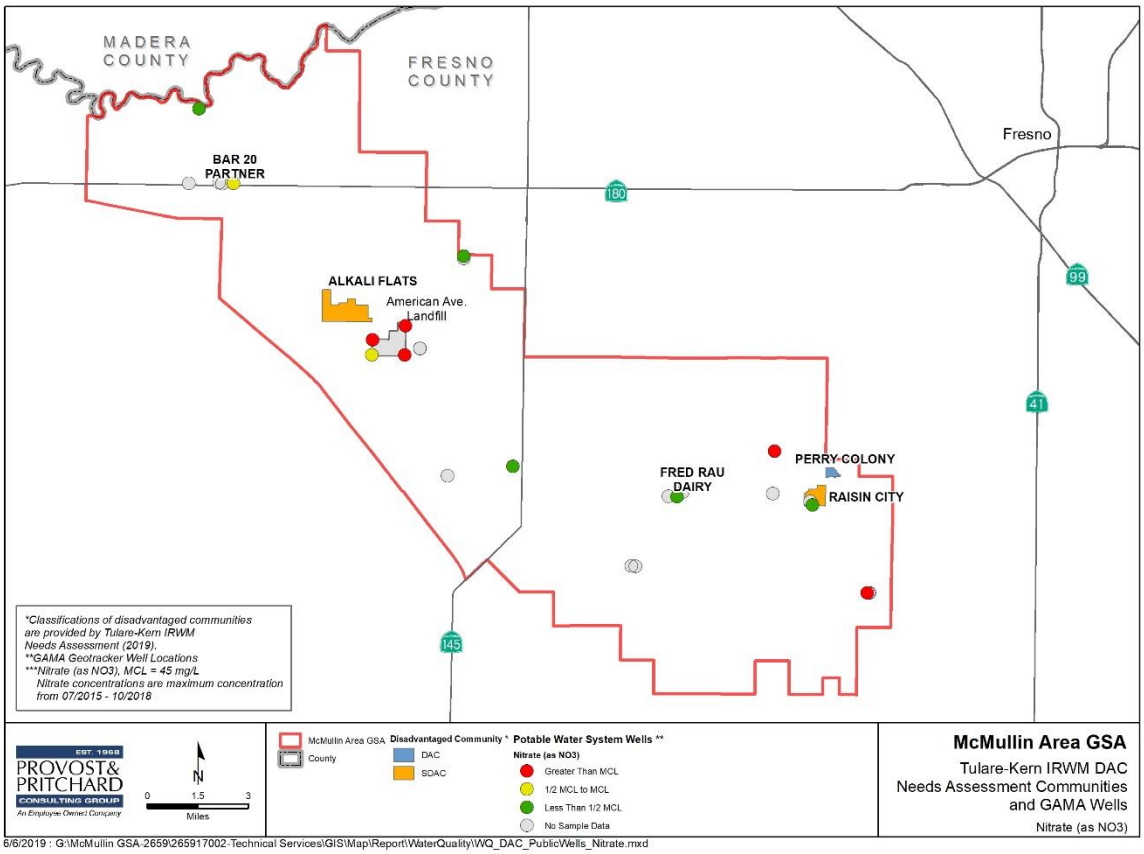


Figure 3-54 MAGSA Constituents Map-Nitrates (NO_3)

Sodium (Na)

Sodium is the predominant constituent in the MAGSA and maintains an Action Level of 50mg/l, higher levels are found surrounding the American Avenue Landfill as well as in various public water supply wells within MAGSA as shown below in **Figure 3-55**. In the past three years, Na has been detected surrounding the landfill. In October of 2018, a Na value of 240 mg/l was measured in the monitoring well located on the northeastern edge of the landfill (L10006109169-DMW-22). As mentioned previously the landfill is an area of possible contamination and is currently monitored and will continue to be monitored by MAGSA. While there is indication of elevated Na levels in areas of the MAGSA, there is little GAMA data to suggest a consequential or continuous incline. In 2017, the above referenced monitoring well had a reported Na value of 310 mg/l, while in October of 2018 the same well had report of 240 mg/L. These groundwater monitoring wells will continue to be monitored by the GSA, and additional monitoring or policy development will be addressed by the GSA board as deemed necessary to prevent future incline in Sodium values surrounding the American Ave Landfill as well as in public water supply wells both north of Alkali Flats, south of Raisin City and near the Fred Rau Dairy.

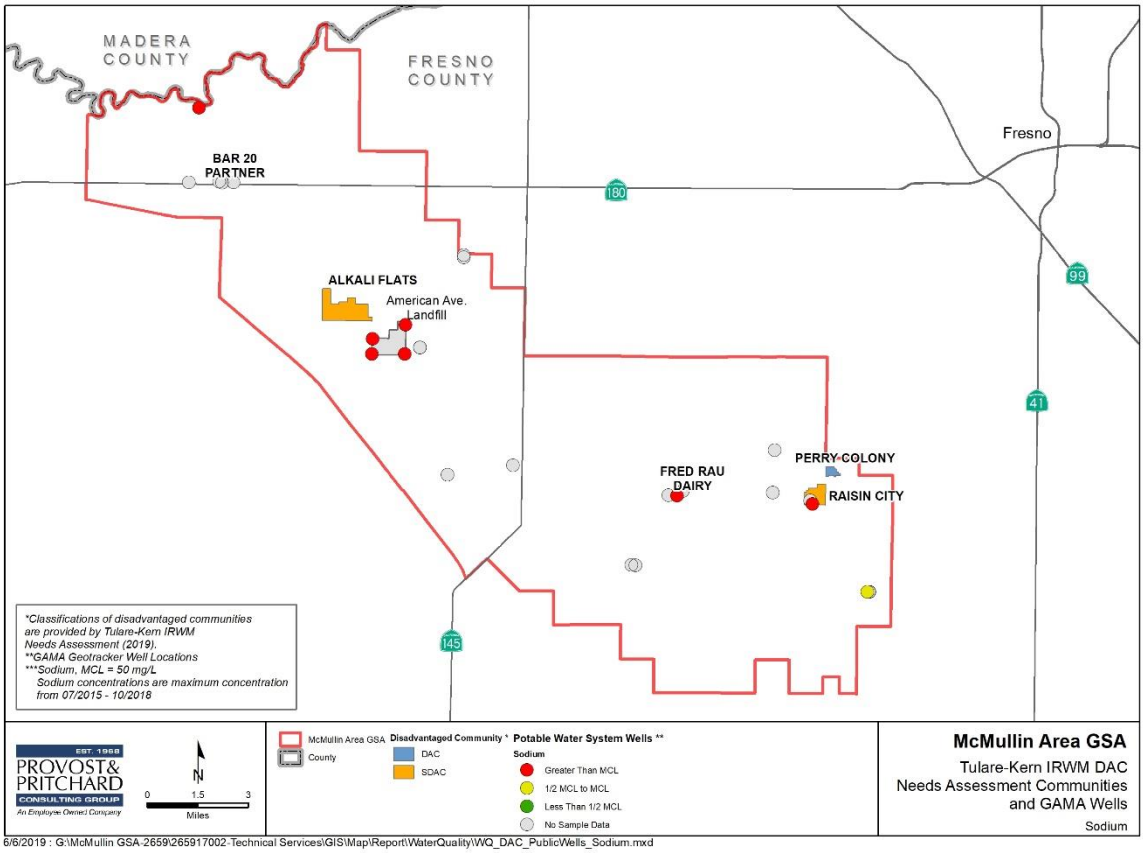


Figure 3-55 MAGSA Constituents Map Sodium (Na)

Total Dissolved Solids (TDS)

TDS has a recommended SMCL of 1000 mg/L. Throughout the MAGSA these values are present with little regularity or pattern, as shown in **Figure 3-56**. The presence of TDS is quite common as mainly this is representative of the existence of salts. While historical values for TDS have registered at levels greater than the SMCL, in recent years the previously described monitoring well located on the northeastern corner of the American Ave Landfill ((L10006109169-DMW-22) has seen a decline from a value of 2,400 mg/L in August of 2017 to 1,600 mg/L in October of 2018. These groundwater monitoring wells will continue to be monitored by the GSA, in order to prevent future development of heightened TDS levels throughout the MAGSA, and additional monitoring or policy development will be addressed by the GSA board as deemed necessary.

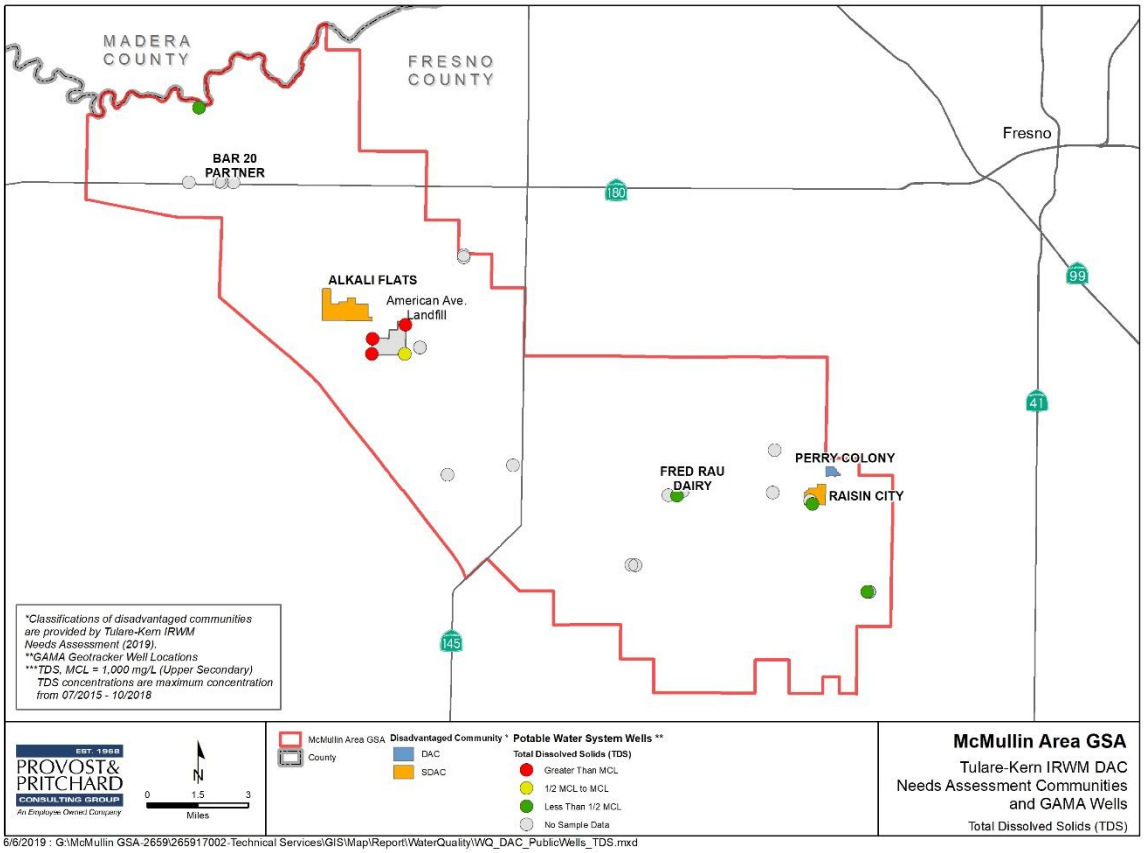


Figure 3-56 MAGSA Constituents Map Total Dissolved Solids (TDS)

1,2,3 Trichlopropane (1,2,3 TCP**)**

TCP is used industrially (paint and varnish remover as a cleaning and degreasing agent) and chemically (solvent and intermediate for pesticides). There is no current federal MCL; however, California has adopted its own drinking water standard of 5 parts per trillion which went into effect on January 1, 2018. As indicated below, in **Figure 3-57**, 1,2,3 TCP is not of considerable concern for MAGSA and while historic, sporadic heightened MCL exceedances may have been indicated, there is little indication to a consequential or continuous incline. Additionally, the GSA recognizes the possible presence of constituent levels reported, southeast of Raisin City and will continue to monitor these values from the public water supply system. These groundwater monitoring wells will continue to be monitored by the GSA, and additional monitoring or policy development will be addressed by the GSA board as deemed necessary.

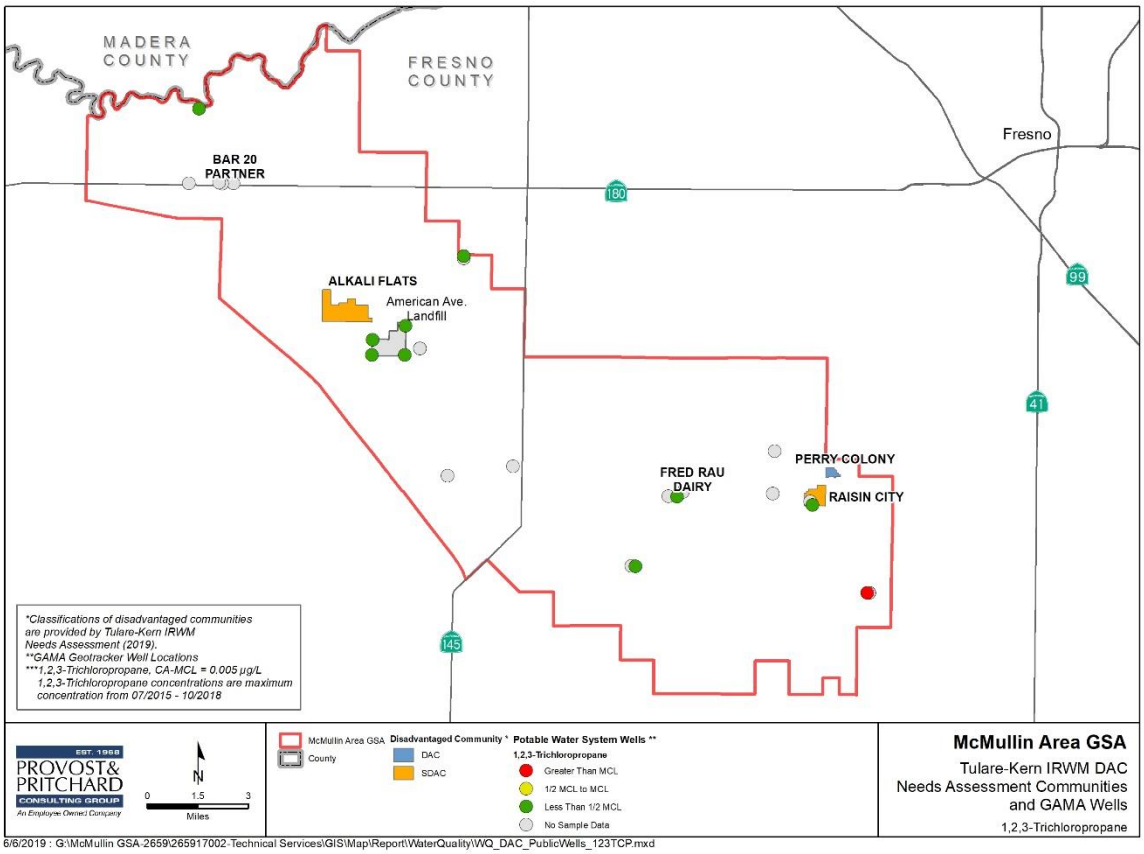


Figure 3-57 MAGSA Constituents Map-1,2,3-Trichloropropane (123 TCP)

Uranium (U)

Uranium occurs naturally in groundwater in parts of the GSA. Uranium is derived from Sierra Nevada granitics and will preferentially adhere to clays. There is potential for radon gas, formed by the decay of uranium, to pool in unventilated basements. Uranium is used in nuclear technology, as a colorant in uranium glass, for tinting in early photography, in the leather and wood industries for stains and dyes, and in the silk and wood industries. The MCL is 30 µg/L or 20 picocuries per liter (pCi/L). In contrast with the previously discussed constituents, Uranium is not present in the direct areas surrounding the American Avenue Landfill and has not been identified through GAMA data over the last three years, as shown in **Figure 3-58**. However, Uranium is tested for by public water supply systems as per California Title 22 Code of Regulations.

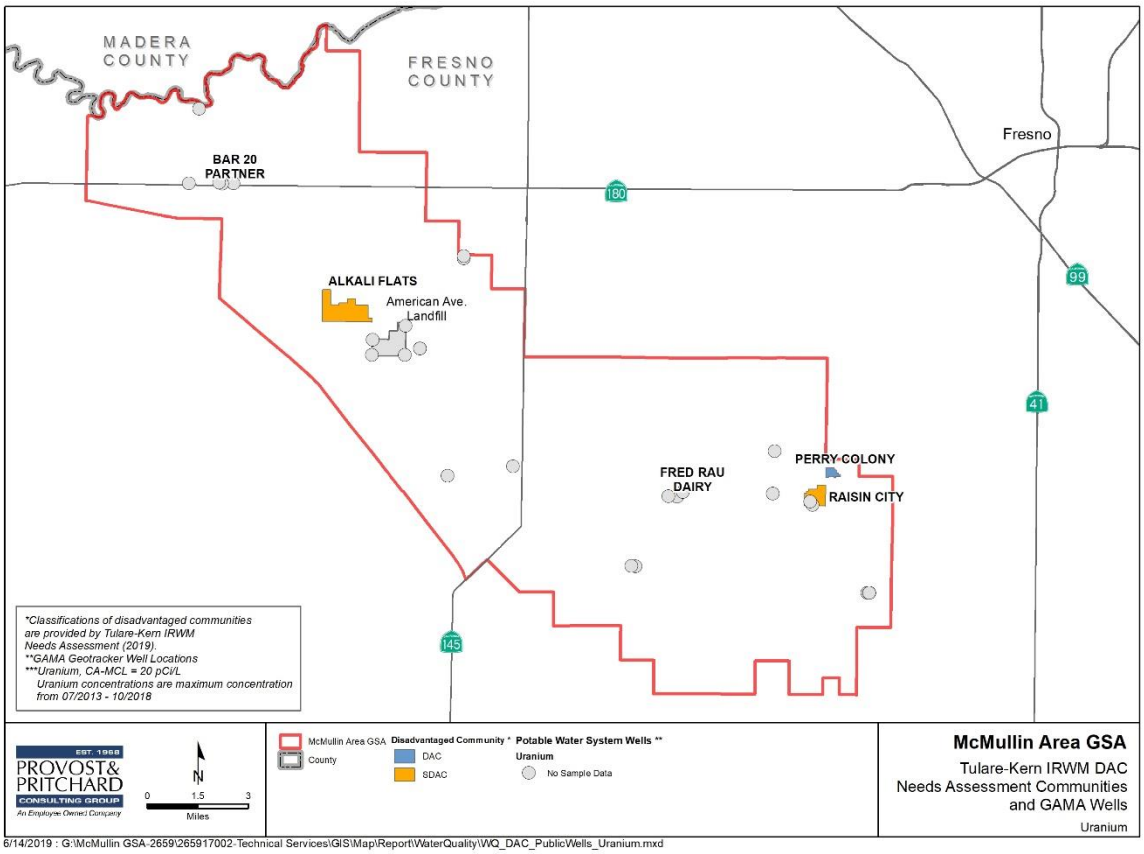


Figure 3-58 MAGSA Constituents Map-Uranium (U)

It can be reasonably concluded that the groundwater within the MAGSA boundary is of good quality. In order to prevent the development or expansion of the presence of known constituents, the GSA will continue to monitor existing groundwater monitoring wells. If ever deemed necessary, the GSA board may develop or implement policy in order to address future groundwater quality concerns within the MAGSA boundary.

3.2.5.3 Migration of Contaminated Groundwater

Raisin City Oilfield

The dominant source of impacted groundwater in MAGSA has been identified as the Raisin City Oilfield (**Figure 3-59**). In 2017, KDSA prepared a review of the groundwater contamination due to the oilfield brine. The assessment focuses on historical evaluations of the area by California Division of Water Resources and Department of Water Resources. The review is summarized below.

In the 1950s, DWR evaluated oilfield wastewater disposal activities in the San Joaquin Valley. Among others, DWR released a report on the Raisin City Oil Field, located within the MAGSA area. It estimated that, as of 1953, approximately 730 acre-feet per year of wastewater was disposed of in unlined sumps. The wastewater had exceedingly high concentrations of total dissolved solids (TDS) (34,000 to 44,000 mg/L) and chloride (21,000 to 27,000 mg/L).

At the time, groundwater samples were taken to determine that typical chloride concentrations were about 20 to 65 mg/L and that wells obviously impacted by the wastewater had concentrations from approximately 150 to 2,700 mg/L. DWR suggested that unlined sumps no longer be used for wastewater disposal. After about 1959, the Raisin City Oil Field wastewater was to be injected into deep strata.

The direction of groundwater flow in the early 1950's was to the southwest, which influenced the direction of contaminant flow. In 1967, the Central Valley RWQCB asked DWR to investigate a well contamination problem with extremely high EC and chloride concentrations. It was determined that an unlined sump approximately 150 yards from the well in question contained oil field wastewater, which had been discharged there due to emergency procedures. Further investigation indicated that other local sumps were not in use, but DWR still recommended changing emergency procedures. By the mid 1960's, irrigation well pumping to the southeast of McMullin Grade had caused a cone of depression in the area, causing the Raisin City Oil Field groundwater to flow south.

Section 19—the southeasternmost section of the oil field—had four irrigation wells by 2003. KDSA developed a trilinear diagram for three of the four wells to show the relation of anion equivalents compared to those for typical water and wastewater. It was determined that water from the wells was a mixture of the two water sources. KDSA also obtained records from JID for TDS concentrations from four of their wells just to the south of Section 19. The perforated intervals of each well were above the Corcoran Clay. The locations of the wells, coupled with each of their changes in TDS concentrations over time, confirmed the southerly flow of groundwater and the brine plume movement.

Using chloride as a marker constituent, the KDSA report indicated several impacted wells located in Section 13 of Township 15 South, Range 23 East, with three secondary impact centers in adjacent sections to the west and southeast, and in Section 9. Given the location of these impacted areas, the former groundwater flow direction to the southwest, and the current groundwater flow direction to the south due to the groundwater depression, it can be expected that impacts will be seen to the southwest and south of the above-mentioned areas. The ID well field is located to the southwest and south of these plume centers, so it is likely to be impacted by the Raisin City oilfield plume in the future if it is not already experiencing the effects.

If not already testing for chloride and TDS, JID should add these constituents to their on-going monitoring program. Contaminant plume movement will be monitored using wells located in the ongoing monitoring network, further discussed in Chapter 5.

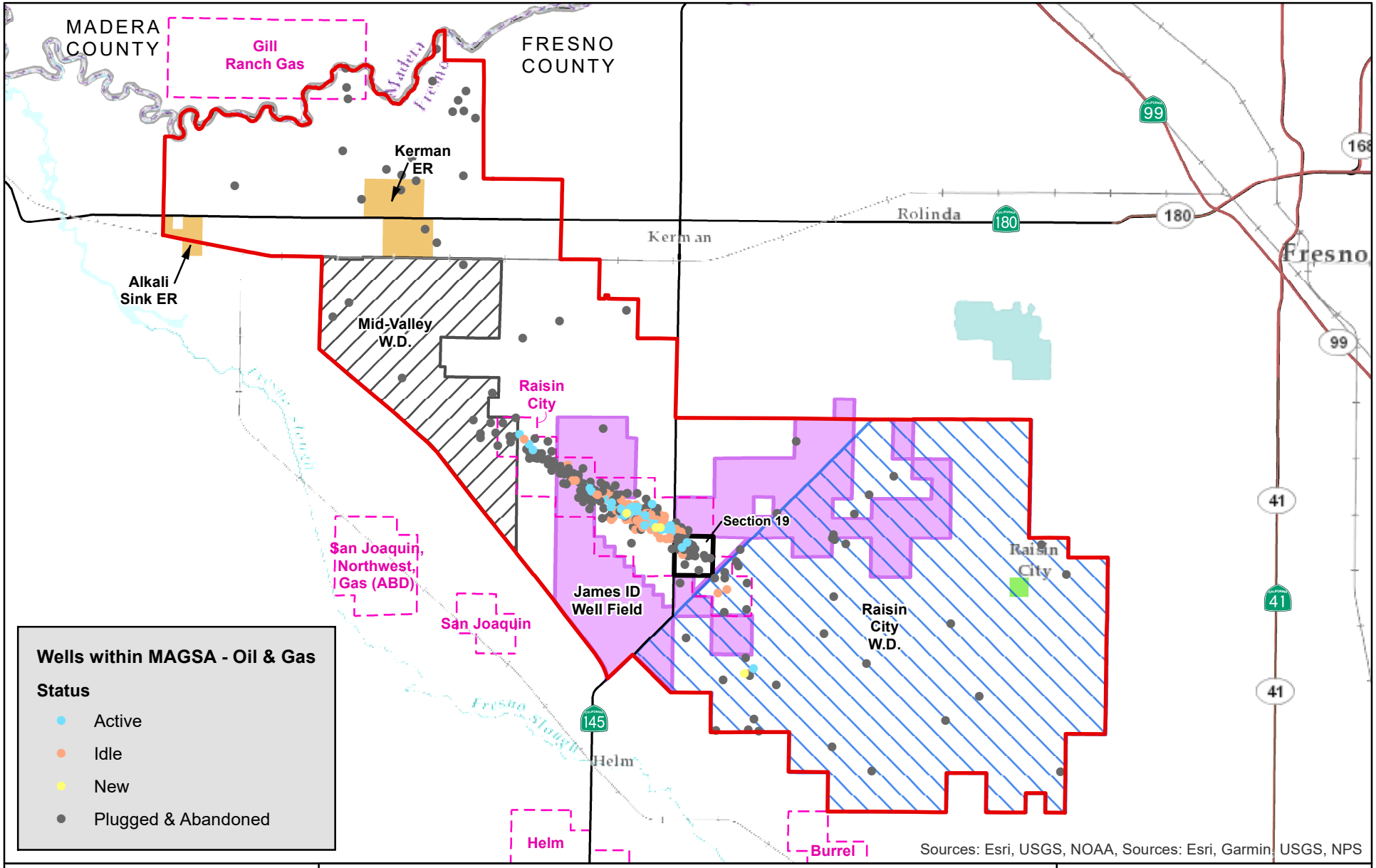
American Avenue Landfill

As indicated in the previous discussions, various known constituents have been detected in the groundwater surrounding the Landfill. These include, but are not limited to, Arsenic (As), Chloride (CI-), Nitrates (NO_3)-(NO_3-N), Sodium (Na), and Total Dissolved Solids (TDS). The groundwater surrounding the landfill is being monitored/remediated by SOMA under oversight by the RWQCB. This monitoring will continue as part of the MAGSA GSP.

Monitoring Resources

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

- California Water Resources Control Board: http://geotracker.waterboards.ca.gov
- The Department of Toxic Substance Control: http://www.envirostor.dtsc.ca.gov
- Groundwater Ambient Monitoring and Assessment Program: http://geotracker.waterboards.ca.gov/gama/



McMullin Area GSA

DOGGR Oil & Gas Wells
District 5

Figure 3-59

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Kerman

A secondary potential plume migration concern is located at the nearby town of Kerman. Two wells have multiple detected exceedances in groundwater of hexavalent chromium during the 2014 to 2017-time period. Kerman is located less than two miles northeast of the northern portion of the MAGSA area and is directly up-gradient. Wells located near the area should be tested for hexavalent chromium initially, then monitored according to the findings.

3.2.5.4 Groundwater Quality Management Programs in Place

3.2.5.4.1 - *Irrigated Lands Regulatory Program (ILRP) Groundwater Assessment Report (GAR)*

As one of the mandatory requirements under the ILRP WDRs, the Kings Coalition prepared a GAR, which is an analysis of the risks to groundwater from salts and nitrates as the primary COCs that may originate from irrigated agriculture within that coalition area. Both the vadose zone and aquifer have nitrates and salts in storage that are the result of past land use practices representing a reservoir of impacts that will continue to migrate over time.

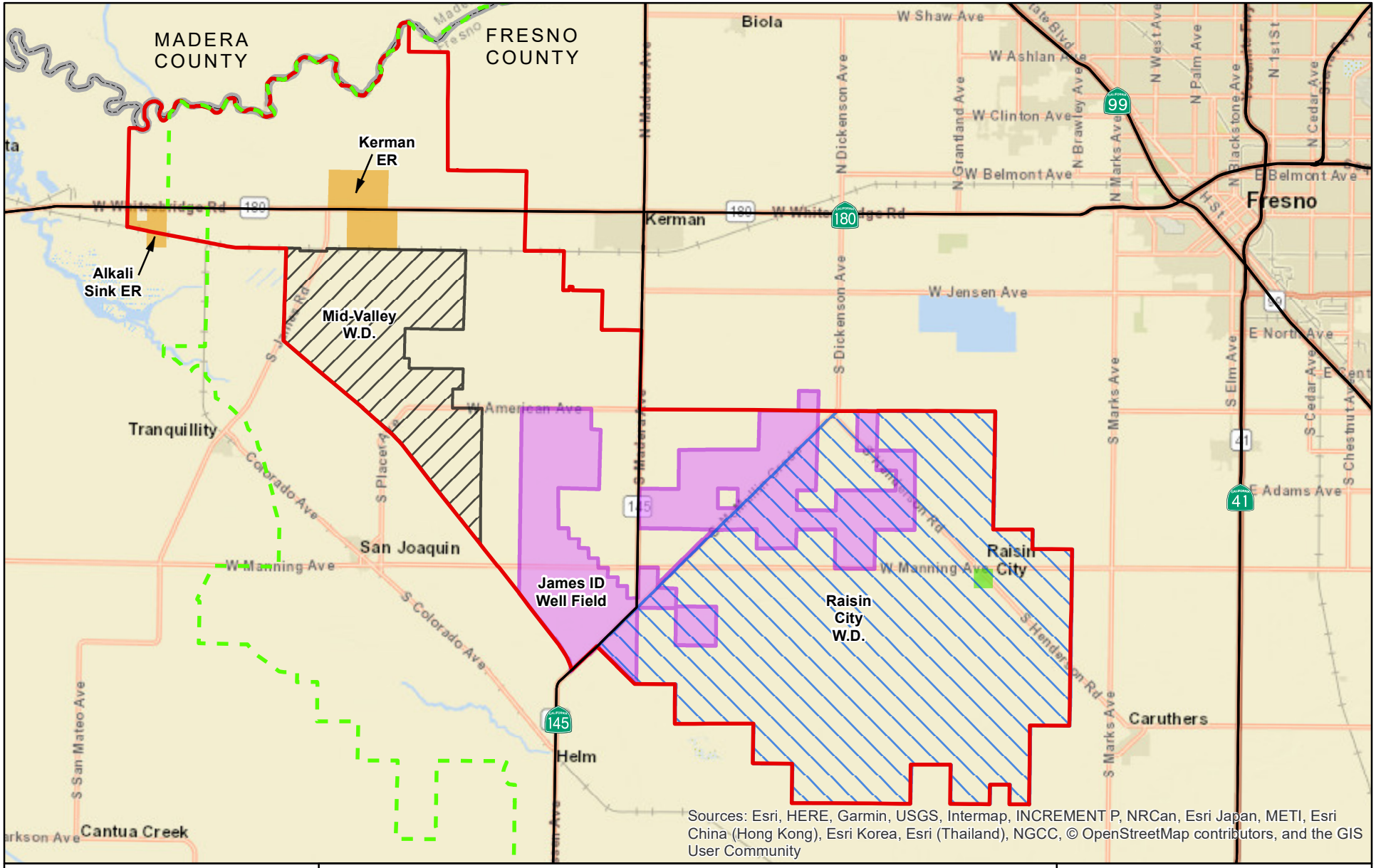
The MAGSA area is in the Northern portion of the GAR study area designated as the Lower Kings area (**Figure 3-60**). The Kings Study area is predominantly agricultural land use which is the largest potential source of nitrates (UC Davis, 2012). Salt originating from outside of the Kings Study area is in imported water from the Sacramento – San Joaquin Delta via the Central Valley Project Delta Mendota Canal (CVPDMC) or the State Water Project's (SWP) California Aqueduct.

Naturally occurring sources of salt include runoff from the Coastal Range, groundwater flows through the marine sediments from the Coastal Range, and residual salts that concentrate through evaporation of the runoff into poorly drained areas at the land surface (surface sinks). High TDS observed in groundwater is also the result of high groundwater tables overlying the clay layers and can be found naturally in the deeper part of the aquifer below the Corcoran clay, likely of marine origin. Irrigation can mobilize the naturally occurring salts resulting in discharge of the salts to groundwater or to surface water via agricultural drainage.

Nitrate exceedances in any well with at least one measurement at or above the maximum contaminant level (MCL) of 10 mg/L are generally concentrated outside of urban areas. The GAR indicates that there are very few nitrate detections (2006 to 2014) in the MAGSA area, but many of those detections are above the MCL of 10 mg/L. Increasing and decreasing nitrate trends are about equal in the Lower Kings subarea.

The GAR indicates that there are relatively few TDS detections (2006 to 2014) in MAGSA, but many of those present are above the primary drinking water standard of 1,000 mg/L. This area tends to have naturally-occurring saline soils with elevated TDS levels in much of the western side of the Coalition area due to saline and connate water found within the fresh water-bearing continental deposits. TDS concentrations are increasing in concentration in the Lower Kings subarea.

According to the GAR, there are very few pesticide exceedances in the Lower Kings area.



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3.2.5.4.2 - *CV SALTS*

CV-SALTS began in 2006 and is a collaborative stakeholder driven and managed program to develop sustainable salinity and nitrate management planning for the Central Valley.

As part of the first technical project, Conceptual Model Development, the Initial Conceptual Model (ICM) Technical Services Final Report dated December 2013 includes a salt and nitrate analysis for the Kings Subbasin (as a prototype area) covering the years 1983 to 2003. Watershed Analysis Risk Management Framework (WARMF) model results for both average NO_3-N and TDS mass loading to groundwater recharge were illustrated based on the Central Valley Hydrogeologic Model (CVHM) model grid. Average NO_3-N mass loading results in a range from 3 to 80 in kilograms per square mile per quarter (kg/mi^2/qtr) with the higher values located within the central portion of MAGSA, reducing in concentration towards the north and southeast (Fig. 9-23 of report). Average TDS mass loading results range from 113 to 3,600 kg/mi^2/qtr with the higher values covering most of the northern half of the MAGSA area, decreasing significantly to the southeast (Fig. 9-24 of report).

Ambient water quality zones for NO_3-N and TDS were then established based on well depth. Elevated zones of NO_3-N at any depth were found, however elevated zones of TDS up to 3,000 mg/L were noted in the northern third of the MAGSA area. The highest TDS levels were found to be in the shallowest layers (monitoring and shallow domestic wells), with the most widespread area noted at the deeper domestic well depth. Both concentration and areal extent of TDS detections decreased in the deepest municipal and agricultural well depth zone.

Additional analyses were performed based on average quarterly groundwater recharge volume and concentrations of NO_3-N and TDS. In general, concentrations of both NO_3-N and TDS were increasing significantly from 1984 to 2004 in the northeastern portion of MAGSA at the domestic well depth zone and decreasing in the central and south portions. The shallow monitoring well and deepest municipal well depth zones showed the least changes in NO_3-N and TDS concentrations. This northwestern-most area is coincident with the area of least recharge but highest recharge concentrations of NO_3-N and TDS.

It is noted in the ICM that considerable variability exists in the water quality (and therefore the assimilative capacity of that defined area) within the broader area based on the coarse analysis used. The results showed that there can be areas that have no assimilative capacity, while there may also be areas that have greater assimilative capacity compared to the entire area. The report recommends that in order to perform adequate salt and nutrient management at a practical (local) scale, public datasets should be supplemented with additional data that may not be readily available.

It is anticipated that, upon approval and adoption of the comprehensive SNMP, local-scale SNMPs may be developed and implemented by local and/or regional entities as needed. The Local SNMPs will be informed by prototype and archetype methods as well as the implementation measures recommended in the SNMP.

3.2.6 Land Subsidence Conditions

Regulation Requirements:

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

As shown in **Figure 3-61**, subsidence can either be elastic or inelastic. Elastic subsidence is recoverable if water levels rise, while inelastic subsidence is permanent. Elastic subsidence occurs in the coarse-grained portions of the aquifer where the materials generally do not get rearranged. While elastic subsidence is recoverable if groundwater levels are restored, the process can take many years. Although there are several causes of inelastic land subsidence, the compression of clay as a result of groundwater overdraft is the cause

of most subsidence documented in the San Joaquin Valley. This results in compaction of fine-grained sediments (clays) above and within the aquifer system as water is removed from pores between them. Over time, as water is removed (mined) from the compressible clay, the clay compresses, resulting in the lowering of the overlying land surface. The compressed clay cannot reabsorb water when the clays rearrange or compact, thus there is no opportunity to reverse the subsidence in these areas. This process is known as aquifer system compaction. The Corcoran Clay Member of the Tulare Formation has been mapped over much of the western side of the San Joaquin Valley and the aquifer beneath it is confined. Most of the permanent subsidence in the San Joaquin Valley has historically been correlated to overdraft in the confined aquifer below the Corcoran Clay. However, with increased reliance on groundwater to meet demands, land subsidence is currently occurring in areas outside of the Corcoran clay. Even though subsidence is now occurring in areas outside of the Corcoran clay, the relative amount is less than the historical subsidence in areas underlain by the Corcoran Clay.

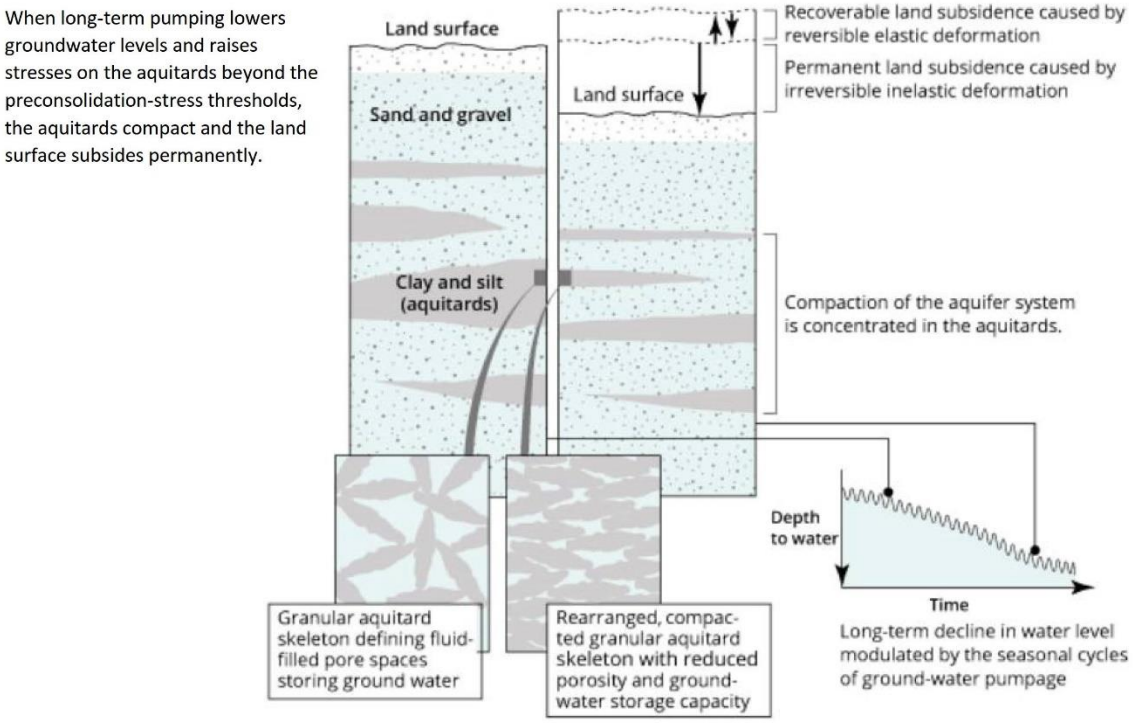

Figure 3-61 Aquifer compaction due to groundwater pumping as identified by USGS (https://ca.water.usgs.gov/land_subsidence/california-subsidence-cause-effect.htm)

Five types of subsidence have been found in California and the San Joaquin Valley: oxidation of peat deposits in river/delta areas; deep subsidence resulting from falling groundwater levels caused by overdraft; shallow subsidence caused by hydro-compaction of collapsible soil layers; tectonic subsidence resulting from earthquakes and ground deformation; and subsidence caused by fluid withdrawal from oil and gas fields. The main form of subsidence in the MAGSA area is presumed to be deep subsidence from declining groundwater levels. Excessive groundwater pumping can contribute to deep subsidence across a broad area, resulting in aquifer compaction, loss of storage capacity, and adverse effects to surface features such as canals, flood control systems, and water supply pipelines which rely on gravity flow.

3.2.6.1 Review of Existing Data

The effort included a review of the HCM, recorded subsidence, historic groundwater levels, historic infrastructure impacts, remote sensing data, and Continuous Global Positioning System stations. The results of existing data are described below.

Review of the HCM and understanding of grain-sized distributions and the potential for subsidence to occur. Review of any known regional or correlative geologic conditions where subsidence has been observed.
Most subsidence in the San Joaquin Valley has happened and is happening west of the MAGSA area over the axial trough of the Valley west and south of MAGSA as described above. Areas prone to subsidence, soil textures, clay mineralogy, and other geologic and geochemical properties were intensely studied by the USGS in a series of Professional Papers in the 1960's, 1970's, and 1980's. Regionally, the areas prone to subsidence were underlain by deposits where the clayey deposits are dominated by the clay mineral montmorillonite (USGS 497-C, Meade 1967). The historic subsidence map and the recent subsidence maps both show that generally subsidence increases westerly to southwesterly across MAGSA indicating that groundwater is likely increasingly confined to the west and there is likely a higher percentage of montmorillonite in the finer-grained sediments near the axis of the valley.

It should also be noted that historically, and currently, those areas with the most significant subsidence are underlain by the Corcoran clay member of the Tulare Formation. As shown on **Figure 3-67** the Corcoran Clay extends into the majority of the MAGSA area with only the very eastern portion outside of the Corcoran Clay boundary. In addition to the clay mineralogy, aquifer compaction and the resultant land subsidence are also dependent on over-extraction of groundwater from a confined aquifer.

Review of historic range of groundwater levels in the principal aquifers of the basin.
Groundwater elevation hydrographs from six wells in the MAGSA area were reviewed to evaluate historic groundwater levels. Their periods of record range from approximately 20 to 60 years, and they are geographically distributed across the MAGSA area. These hydrographs ultimately provide a basis to determine historic groundwater trends in the region. Naturally, groundwater levels in the MAGSA area fluctuate seasonally based on area precipitation. The long-term trend in the MAGSA area, however, is a relatively steady decline in water levels. The average rate of decline in water surface elevation across the six wells analyzed is 1.43 feet per year. The two wells with the oldest periods of record have the lowest rates of decline, indicating that rates of water level reduction have increased in recent decades. With one exception, the lowest groundwater elevations were reported over the recent drought period with low points around 2015 and 2016. One well had its lowest historic level in 2003.

Review of historic records of infrastructure impacts, including, but not limited to, damage to pipelines, canals, roadways, or bridges, or well collapse potentially associated with land surface elevation changes.
There are no known infrastructure impacts in the GSA area.

Review of remote sensing results such as InSAR or other land surface monitoring data.
A review of existing land subsidence data from remote sensing can be found below.

Review of existing CGPS surveys. Continuous Global Positioning Systems (CGPS) stations can be used to monitor land subsidence. CGPS stations are located in Mendota, Madera, and Coarsegold with no stations located within the MAGSA boundary.

3.2.6.2 Subsidence Monitoring Results

Land Subsidence in Kings Subbasin

Available land subsidence data was reviewed to assist in determining what information is available and in establishing a monitoring network. The effort included a review of the HCM, recorded subsidence, historic groundwater levels, historic infrastructure impacts, remote sensing data, and CGPS stations. A summary of existing data is provided below. Refer to Section 5.6.1 – Description of Monitoring Network for detailed discussions on the technologies available for monitoring subsidence and the existing monitoring programs in the region.

Historically, land subsidence has occurred on the west side of the San Joaquin Valley. Land subsidence was first monitored from the 1920s to 1970s when there was less access to surface water. During this timeframe, subsidence rates varied but were as high as one foot per year in some areas. Figure 2 from the USGS Professional Paper 437-I (1984) shows most subsidence occurring on the west side of the San Joaquin Valley as shown in **Figure 3-66**. Subsidence monitoring decreased after the 1970s when there was more access to surface water due to the canals and water storage projects built in California and less reliance on groundwater to meet demands.

Monitoring land subsidence increased again in the 2000s due to drought conditions, environmental regulations that resulted in lower surface water allocations, and increased local demand on groundwater. Furthermore, collapsed wells and subsidence impacts to canals were becoming more prevalent throughout the San Joaquin Valley. Data from 1949 to 2016 was used to evaluate the land subsidence in the Kings basin area. Historical data sources include USBR SJRRP, KRCD, DWR, and NASA InSAR data provided by DWR.

Following are maps, **Figure 3-62** through **Figure 3-65**, showing subsidence monitoring from four different sources. The majority of subsidence can be found west of the Corcoran Clay layer as shown in the historical DWR, KRCD, and NASA maps. The USBR SJRRP map does not cover the entire Kings Basin but provides data for NKGSA, MAGSA, and JID and shows subsidence increases to the west. A decline in land surface elevation is reported as a negative number, and a rise in land elevation is shown as a positive number. A rise in elevation can occur from a rebound of past subsidence. This is possible, especially in areas with elastic subsidence that have had groundwater levels restored. Each measurement method has accuracy limitations, so a reported rise may be the result of inaccuracies in the technology used.

Land Subsidence in MAGSA

While some local agencies in the San Joaquin Valley monitor for land subsidence, the majority rely on monitoring performed by regional water agencies or the State or Federal government. A GPS control network has been established throughout the plan area. This control network can be utilized to survey existing benchmarks to monitor subsidence. Currently, USBR in conjunction with DWR, USGS and USACE obtain subsidence data twice yearly in December and July and publish maps of the results as part of the SJRRP. The subsidence areas shown in these maps cover the majority of the MAGSA area. USGS, NASA, and KRCD also measure subsidence in the Central Valley. USGS and NASA have maps on their websites that show the subsidence for a defined period. KRCD has a 7-mile grid that monitors new and existing benchmarks for land subsidence. Data sources studied for this chapter include USBR SJRRP, KRCD, and NASA InSAR data provided by DWR.

Figure 3-67 shows the land subsidence, as measured for the USBR SJRRP, from December 2011 to December 2016. Overall, the MAGSA area has subsided approximately 0.3 feet over the 5-year period. There is only one monitoring point located within the MAGSA area. The figure shows less subsidence to the east of the MAGSA area at 0.08 ft (1 in) and greater subsidence to the west at 0.31 ft (3.7 in).

Figure 3-68 shows the KRCD land subsidence monitoring locations and results from 2013 to 2016. There are five monitoring locations within the MAGSA area with measurements ranging from uplift of 0.11 ft (1.3 inches) to subsidence of 1.47 ft (17.6 inches). There is one monitoring point with a range of 0.11 ft uplift to

0.14 ft subsidence, while there are two locations with subsidence between 0.45 ft and 0.59 ft and two points with subsidence from 0.60 ft to 1.47 ft. The monitoring locations showing greater subsidence are located along the west side of the MAGSA area.

Figure 3-69 shows NASA InSAR data, provided by DWR, from May 2015 to May 2016. Overall, there is minimal subsidence shown in the MAGSA area. The least amount of subsidence is in the southeast portion of the MAGSA area with subsidence increasing to the west. The eastern edge of the MAGSA area generally has less than 2 inches of subsidence. The western edge of the MAGSA area has up to 7 inches of subsidence.

Part of the subsidence located in the southwest portion of the GSA area, along highway 145, is within the JID well field. It should be noted, however, that there are no known infrastructure impacts to pipelines, canals, roadways, wells, etc. in the GSA area.

As shown in the figures mentioned above, there appears to be minimal to moderate subsidence occurring in the MAGSA area. The greatest subsidence in the plan area has been located along the western edge of the MAGSA boundary. Part of the subsidence located in the southwest portion of the GSA area, along highway 145, is within the JID well field. This eastern edge seems to correlate with the eastern edge of the Corcoran Clay, as shown in **Figure 3-67** through **Figure 3-69**. The areas with the most significant subsidence are underlain by the Corcoran clay member of the Tulare Formation.

Kings Subbasin
Coordinated Effort

Kings Coordinated Effort GSAs

Land Subsidence
U.S. Bureau of Reclamation
2011-2016

Figure 3-62

Legend

Kings Subbasin GSAs

Township/Range

E-Clay Eastern Extent

Page and LeBlanc1969, modified by KDSA

USBR Subsidence Data *

Change from Dec. 2011 to Dec. 2016

- Less than 0.15 feet
- -0.3 to -0.15
- -0.45 to -0.3
- -0.6 to -0.45
- -0.75 to -0.6

* Subsidence Monitoring Points labeled with Free Adjusted delta values from Dec. 2011 to Dec. 2016

Millerton Reservoir
Pine Flat Reservoir
San Joaquin River
Kings River
Clovis
Fresno
Kerman
Fowler
Orange Cove
Raisin City
San Joaquin
Selma
Reedley
Kingsburg
Layton
Traver

NORTH KINGS GSA
SOUTH KINGS GSA
McMULLIN AREA GSA
JAMES ID
CENTRAL KINGS GSA
KINGS RIVER EAST GSA
NORTH FORK KINGS GSA

T11S
T12S
T13S
T14S
T15S
T16S
T17S
T18S

R16E R17E R18E R19E R20E R21E R22E R23E R24E R25E

Sources: Esri, USGS, NOAA

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CONSULTING GROUP
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Kings Subbasin
Coordinated Effort

Kings Coordinated Effort GSAs

Land Subsidence
Kings River Conservation District
2013-2016

Figure 3-63

Legend

Kings Subbasin GSAs

Township/Range

E-Clay Eastern Extent

Page and LeBlanc 1969, modified by KDSA

KRCD Subsidence Monitoring Location

Change from 2013 to 2016 (ft)

- 0.01 to 0.12
- -0.24 to 0.00
- -0.49 to -0.25
- -0.99 to -0.50
- -1.49 to -1.00
- -1.99 to -1.50
- -2.49 to -2.00
- -3.91 to -2.50

Millerton Reservoir
Pine Flat Reservoir
San Joaquin River
Kings River

SUB020 SUB046 SUB045 SUB031 SUB048 SUB067 SUB075 SUB049 SUB044 SUB025 SUB100 SUB056 SUB051 SUB077 SUB015 SUB010 SUB079 SUB034 SUB082 SUB043 SUB103 SUB054 SUB052 SUB080 SUB033 SUB085 SUB058 SUB006 SUB009 SUB014 SUB041 SUB060 SUB088 SUB064 SUB072 SUB017 SUB035 SUB057 SUB097 SUB094 SUB005 SUB042 SUB013 SUB040 SUB039 SUB084 SUB021 SUB070 SUB092 SUB086 SUB029 SUB089 SUB105 SUB032 SUB016 SUB026 SUB022 SUB068 SUB036 SUB071 SUB028

Clovis
Fresno
Kerman
Fowler
Orange Cove
San Joaquin
Raisin City
Selma
Reedley
Kingsburg
Laton
Traver

NORTH KINGS GSA
SOUTH KINGS GSA
McMULLIN AREA GSA
JAMES ID
CENTRAL KINGS GSA
KINGS RIVER EAST GSA
NORTH FORK KINGS GSA

T11S T12S T13S T14S T15S T16S T17S T18S

R16E R17E R18E R19E R20E R21E R22E R23E R24E R25E

Sources: Esri, USGS, NOAA

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Kings Subbasin
Coordinated Effort

Kings Coordinated Effort GSAs

Land Subsidence
NASA (via CA Dept. Water Resources)
2015-2017

Figure 3-64

Legend

Kings Subbasin GSAs

Township/Range

E-Clay Eastern Extent

Page and LeBlanc 1969, modified by KDSA

NASA InSAR Data (provided by CA DWR) *

Change from May 2015 to April 2017 (inches)

- 2 to 6
- 1 to 2
- 0 to 1
- -1 to 0
- -2 to -1
- -3 to -2
- -5 to -3
- -7 to -5
- -10 to -7
- -15 to -10

* The legend shows the change in ground surface elevation from May 2015 to April 2017. The positive values indicate rebound while the negative values indicate land subsidence.

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DWR DIRWM, Sources: Esri, USGS, NOAA

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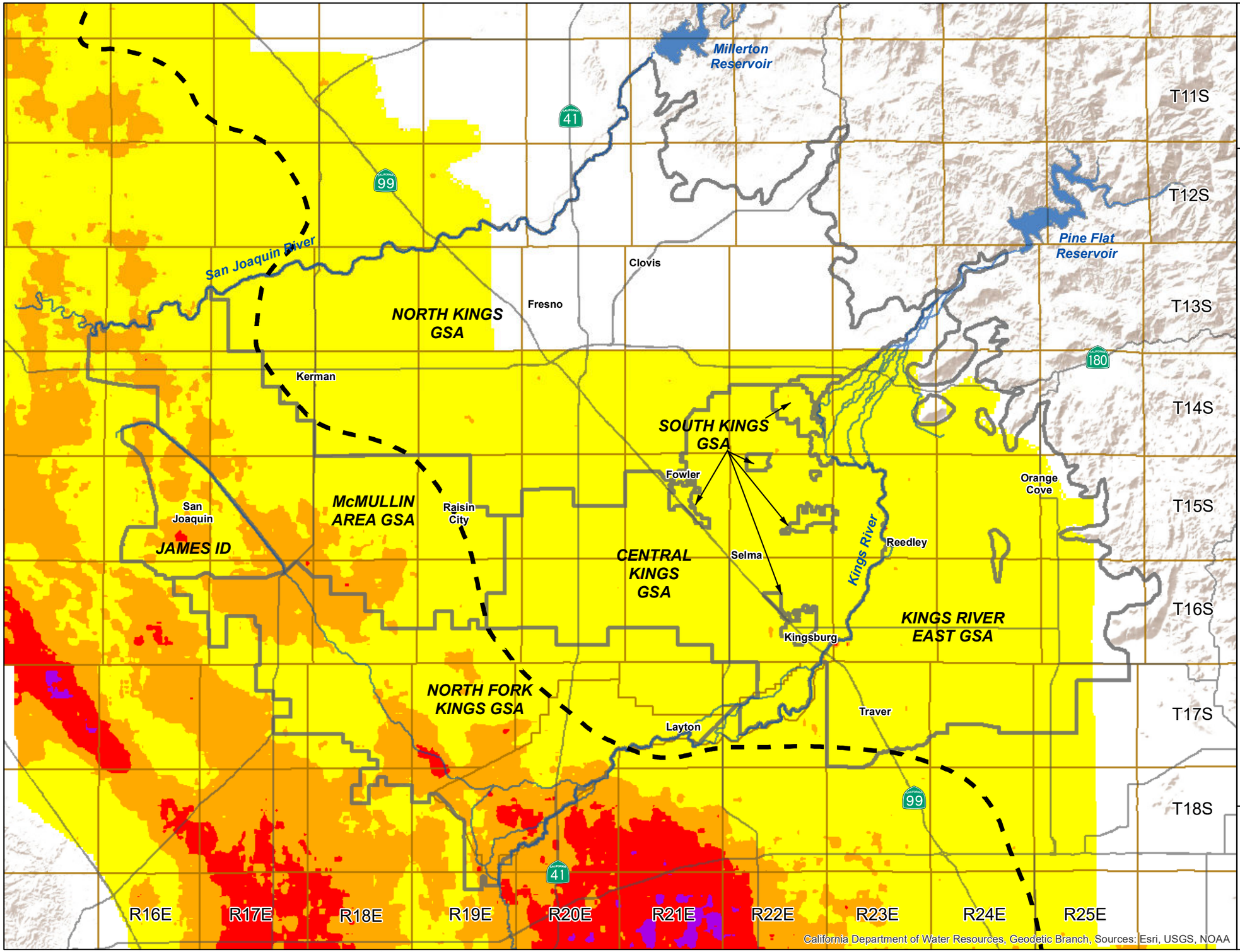
Kings Subbasin Coordinated Effort

Kings Coordinated Effort GSAs

DWR Analysis for 1949 - 2005*

Figure 3-65



Legend

- Kings Subbasin GSAs
- Township/Range

E-Clay Eastern Extent

- Page and LeBlanc 1969, Modified by KDSA

Vertical Displacement SJV * DWR 1949-2005 (ft)

- -30 to -25 (feet)
- -25 to -20 (feet)
- -20 to -15 (feet)
- -15 to -10 (feet)
- -10 to -5 (feet)
- -5 to 0 (feet)

* Source:
https://gis.water.ca.gov/arcgis/rest/services/Elevation/Vertical_Displacement_SJV_DWR_1949_to_2005/MapServer
or
https://data.cnra.ca.gov/dataset/vertical-displacement-sjv-1949-to-2005

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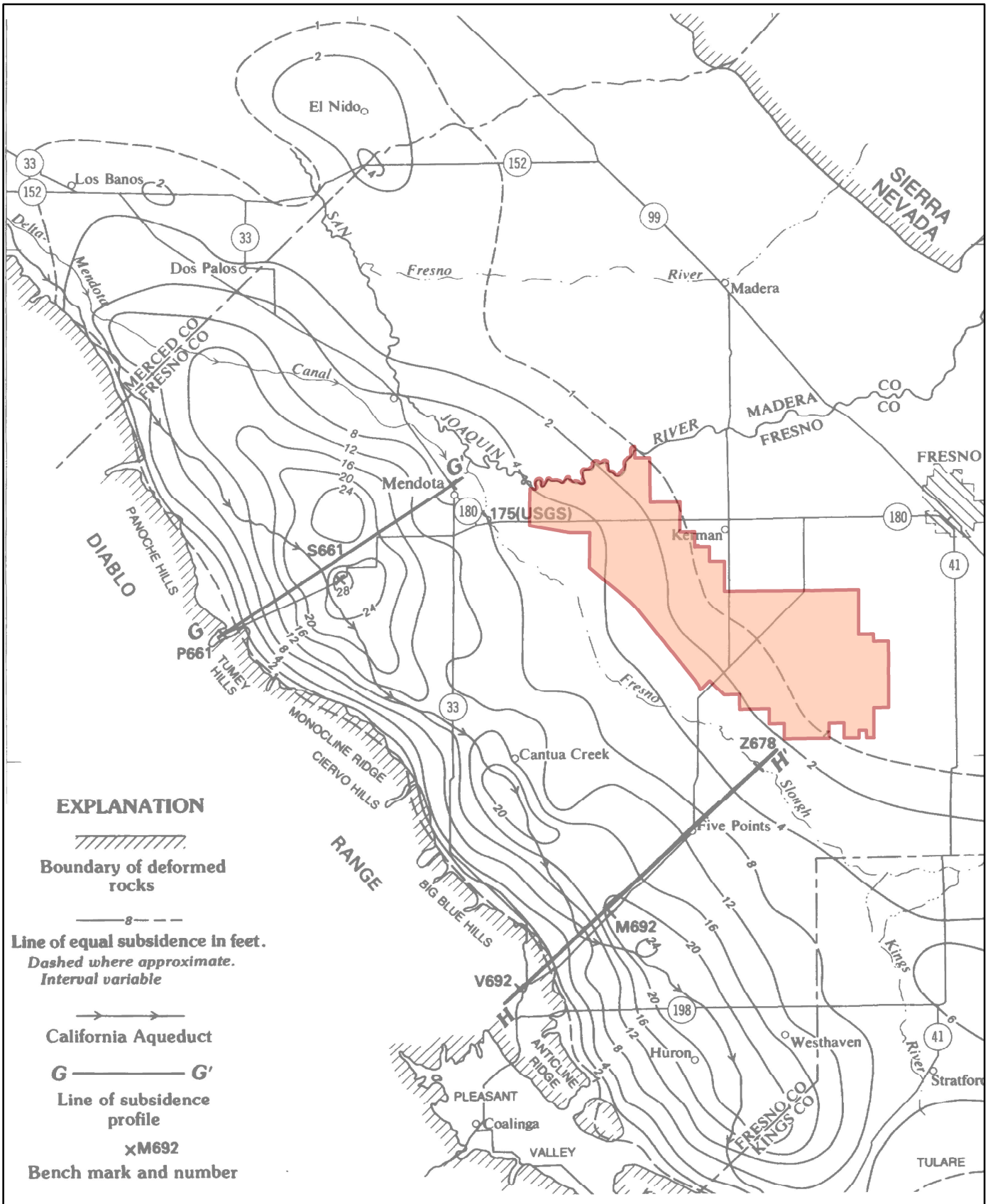

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Source: USGS PP 437-I, 1984, Land Subsidence in the San Joaquin Valley, California, as of 1980

McMullin Area GSA

Land Subsidence from 1926 to 1972

Figure 3-66

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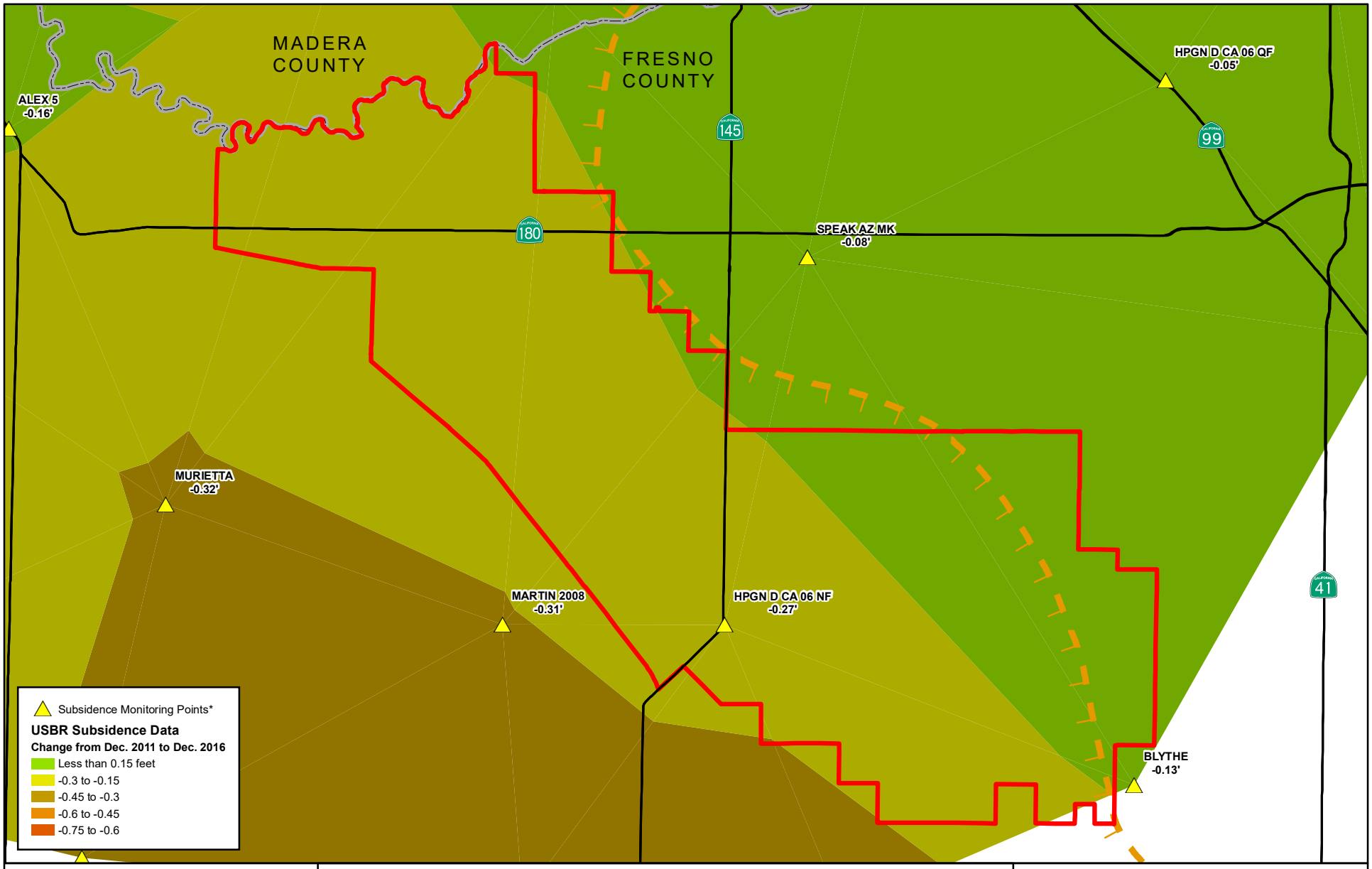

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McMullin Area GSA

County

North East Edge of Corcoran Clay

Page and LeBlanc 1969, KDSA Modification

**Subsidence Monitoring Points labeled with Free Adjusted delta values from Dec. 2011 to Dec. 2016*

McMullin Area GSA

Land Subsidence
U.S. Bureau of Reclamation
2011-2016

Figure 3-67

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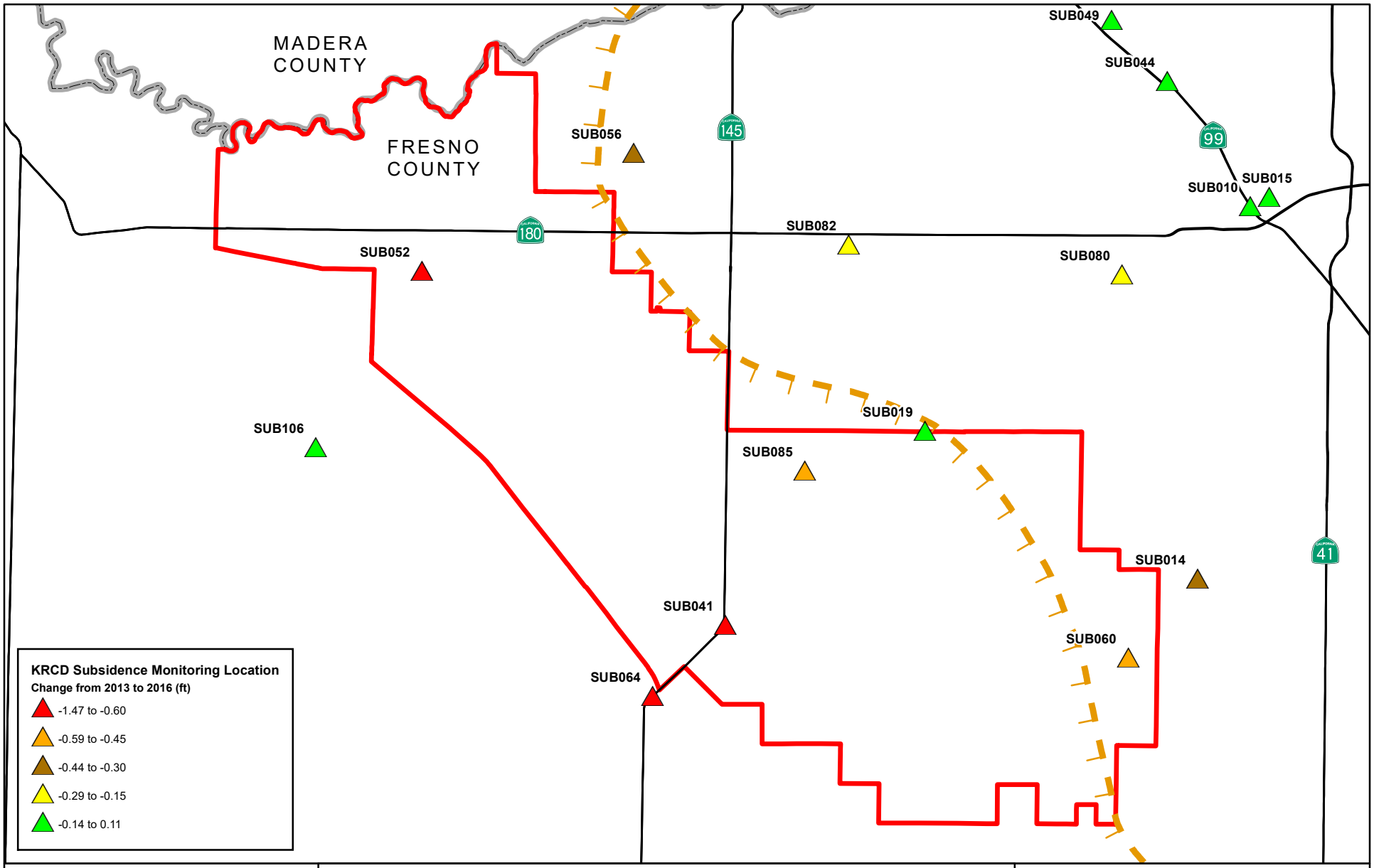

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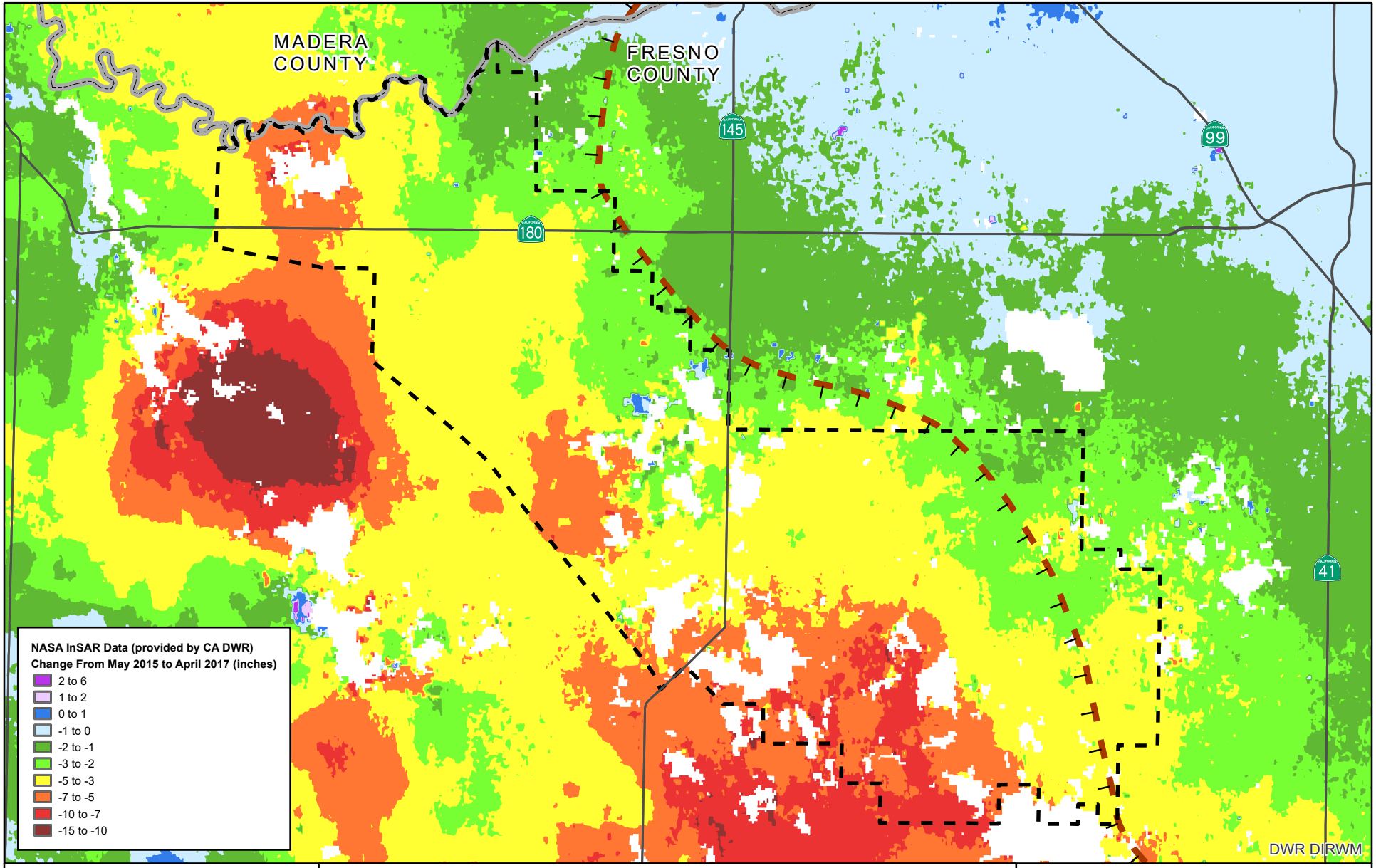

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McMullin Area GSA
County
E Clay Eastern Extent
(Page and LeBlanc1969, modified by KDSA)

The legend shows the change in ground surface elevation from May 2015 to April 2017. The positive values indicate rebound while the negative values indicate land subsidence.

McMullin Area GSA
Land Subsidence
NASA (via CA Dept. Water Resources)
2015-2017
Figure 3-69

5/30/2019 : G:\McMullin GSA-2659\265917002-Technical Services\GIS\Map\Report\Gen\Subsidence\subsidence_nasa.mxd

3.2.7 Surface Water and Groundwater Interconnections

Regulation Requirements:

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

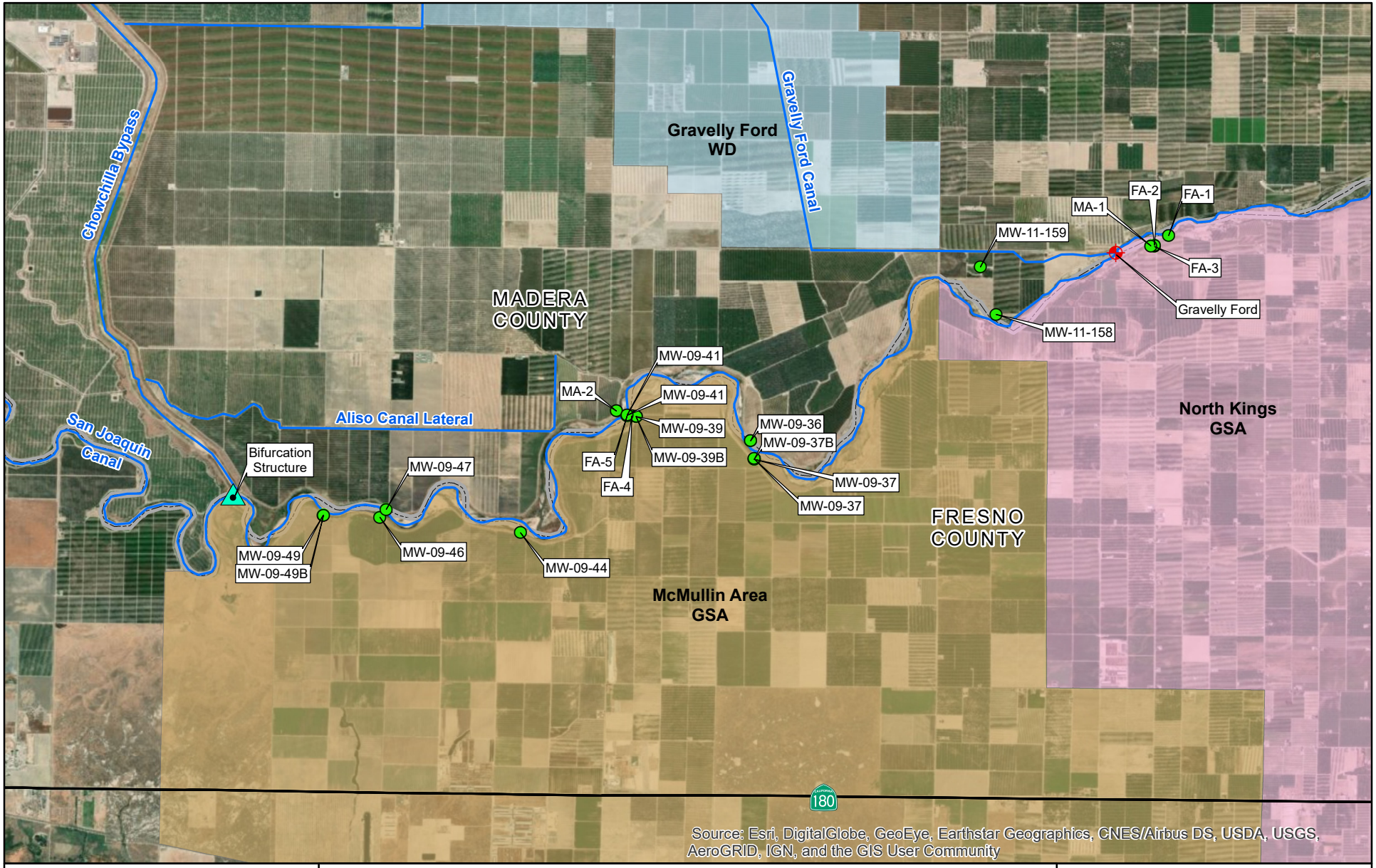
Interconnected surface water has been defined in the California Code of Regulations Title 23, Division 2, Chapter 1.5, Subchapter 2 as surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted. The major surface waters in the Kings Basin include the Kings River and the SJR. Both rivers are interconnected over discrete stretches, however due to existing river management programs, the river stretches that meet the definition of interconnected surface water are not likely to become depleted

The SJR is the only surface water body of significance within the MAGSA. The SWRCB depicts interconnected surface water as 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 (*Cal. Code Regs. Tit. 23 § 351 (o)*). It has been adequately determined that there is no evidence as to the presence of continuous interconnected surface water groundwater systems within the MAGSA along the San Joaquin River therefore this criterion is not applicable to the MAGSA. This may be concluded since at various times of the calendar year, the incessant flow of the SJR has run dry below Gravelly Ford therefore identifying that the systems are not continuously interconnected. There is significant and quantifying evidence brought forth by the USBR's SJRRP, a USGS Groundwater Flow Model Documentation Report (SJRRPGW) (USGS SIR 2014-5148, 2014), which documents the development and calibration of the SJRRPGW and simulates groundwater and surface flow. Additionally, the San Joaquin River Restoration Study Background Report (FWUA and NRDC, 2002) addresses regional groundwater monitoring data to further support the above claim. The following will discuss USBR regional groundwater monitoring data in conjunction with the USGS Flow Model and the FWUA/NRDC report findings, in order support the claim that the SJR is not continuously connected specifically in the portion of the river that boarders the northern boundary of the MAGSA, and therefore is not applicable to the SGMA interconnected surface water sustainable management criteria.

Regional Groundwater Monitoring Data

Regional groundwater monitoring data is available through the US Bureau of Reclamation as part of the SJRRP. These monitoring wells as shown in **Figure 3-70** provide limited data from piezometers along the portion of the SJR adjacent to the MAGSA and show a slight possible seasonal connection, however this data is inconclusive due to the lack of riverbed elevation data and the deficiency of nested wells to verify continuous saturation through time. The findings from this groundwater data indicate similar findings as the USGS Flow Model, and the FWUA/NRDC Background Report, that groundwater depths immediately adjacent to the SJR along the MAGSA ranged from approximately 5 to 25 feet below ground as seen in **Figure 3-71.**

In further support as previously stated, the San Joaquin River Restoration Background Report (FWUA and NRDC, 2002) also indicates groundwater depths of 20 to 30 feet below the riverbed throughout the portion of the SJR bordering the MAGSA for the year 1996.



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- Gravelly Ford Water District
- North Kings GSA
- McMullin Area GSA
- USBR Monitoring Wells
- Bifurcation Structure

McMullin Area GSA

Well Locations Along the San Joaquin River

Figure 3-70

5/30/2019 : G:\McMullin GSA-2659\265917002-Technical Services\GIS\Map\Report\GW\Wells\well_locations_rev.mxd

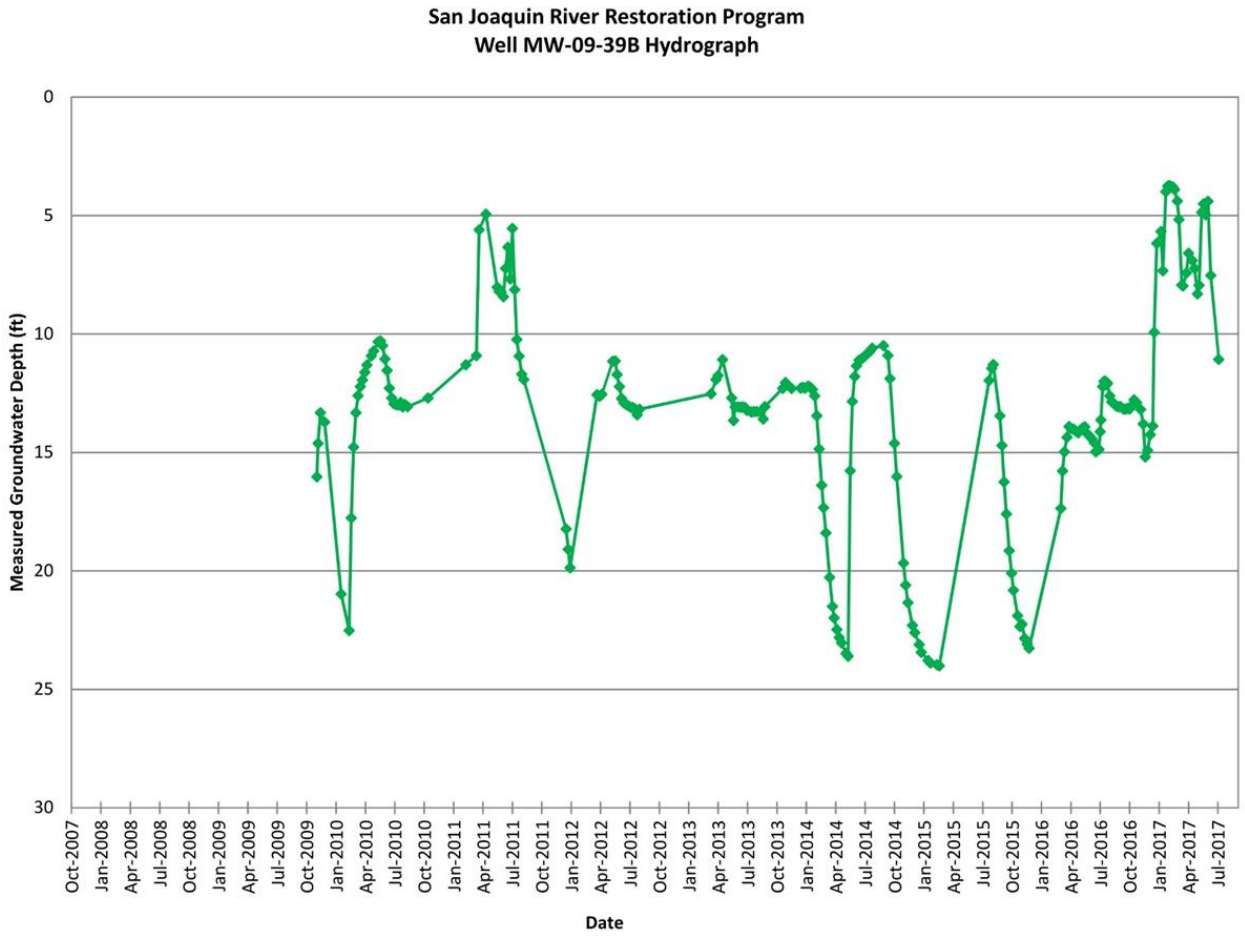


Figure 3-71 Hydrograph for Well MW-09-39B, SJRRP

San Joaquin River at Transect 8

Groundwater elevation data is available at this location from six monitoring wells; MW-09-39 (700 feet east of SJR), MW-09-39B (700 feet east of SJR) as seen in **Figure 3-71** FA-4 (500 feet east of SJR), FA-5 (300 feet east of SJR), MW-09-41 (300 feet east of SJR), and MA-2 (250 feet west of SJR). The channel bed elevation is approximately 170.3 feet. Groundwater elevations in the monitor wells increase when flows in the river increase and decrease when flows drop, however this remains to be discontinuous throughout the year thus indicating that the groundwater surface water systems are not interconnected.

SJR at Shield Avenue

Groundwater elevation data are available at this location from three monitor wells: MW-09-36 (300 feet north of SJR), MW-09-37 (400 feet south of SJR), and MW-09-37B (400 feet south of SJR). The channel bed elevation here is approximately 173 feet. Groundwater elevations in the monitor wells increase when flows in the river increase and decrease when flows drop. When river discharge is high, groundwater elevations in wells MW-09-36 and MW-09-37B are higher than the channel bed elevation, however this is not a continuous connection. When the river is flowing at low flow or base flow, the groundwater elevation is below the estimated channel elevation invert. This relationship indicates a lack of interconnection. Though they do respond to flows in the river, water elevations in MW-09-37 rarely exceed the elevation of the channel bed even during high flows.

Scientific Investigations Report 2014-5148

As described above the USGS Scientific Investigations Report is a groundwater flow model for the SJRRP and was prepared in cooperation with the USBR (USGS, 2014). Throughout the year at various instances the daily flow of the SJR located below the Bifurcation Structure below Gravelly Ford as shown in **Figure 3-72** can and does occasionally run dry. Therefore, the MAGSA groundwater surface water systems are not interconnected. Within the USGS Documentation of Groundwater Flow Model for the SJR (USGS SIR 2014-5148, 2014), it is indicated that during the Fall of 1988 (a dry year) the depth to groundwater is approximately as shallow as 25 feet below the ground at the portion of the MAGSA depicted in **Figure 3-73.** Additionally, during the Fall of 2006 (a wet year) depicted in **Figure 3-74** the measured approximate depth to groundwater on the same areas of the river was 20 feet. Similarly, in both considerably wet and dry years the system proved to not be interconnected. In further support as previously stated, the San Joaquin River Restoration Background Report (FWUA and NRDC, 2002) also indicates groundwater depths of 20 to 30 feet below the riverbed in the specific portion of the SJR bordering the MAGSA for the year 1996.

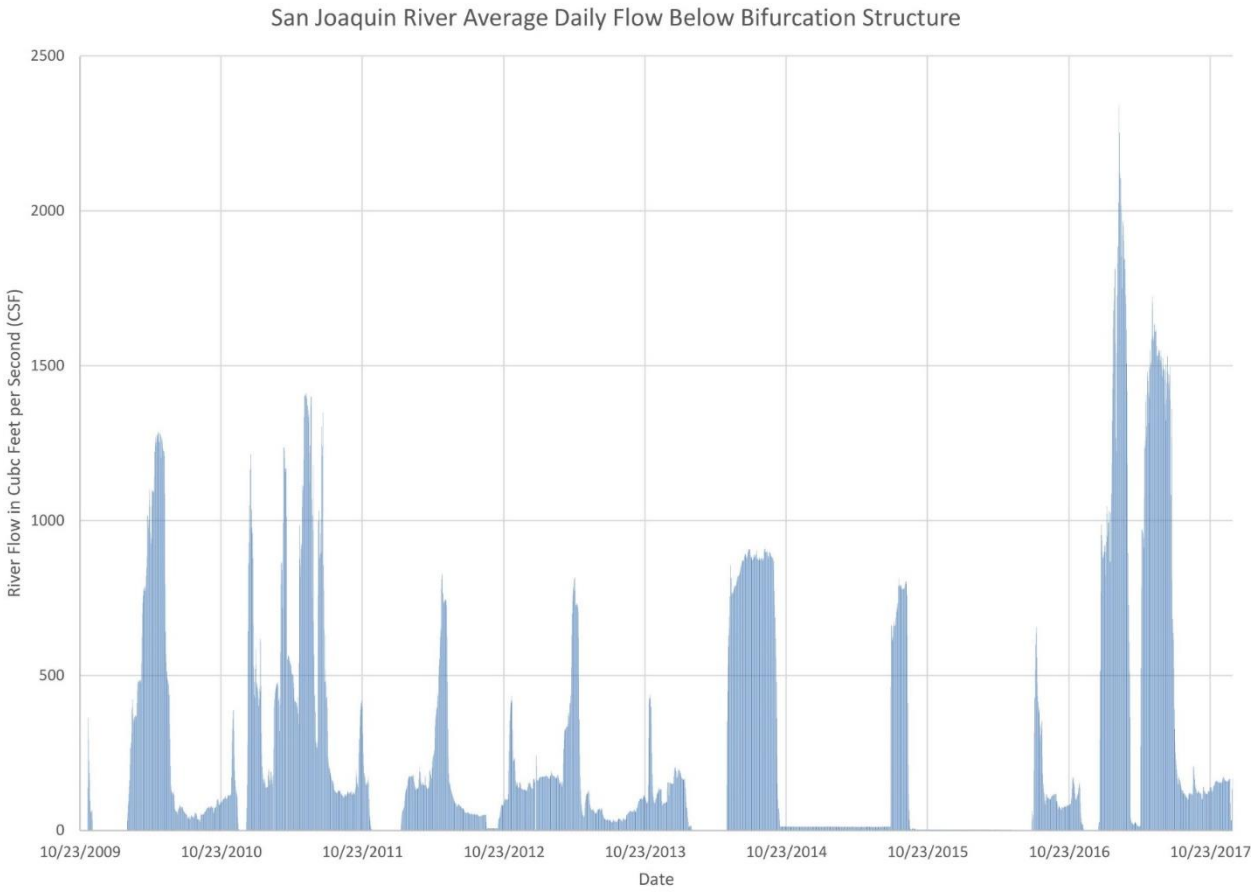


Figure 3-72 San Joaquin River Average Daily Flow Below Bifurcation Structure

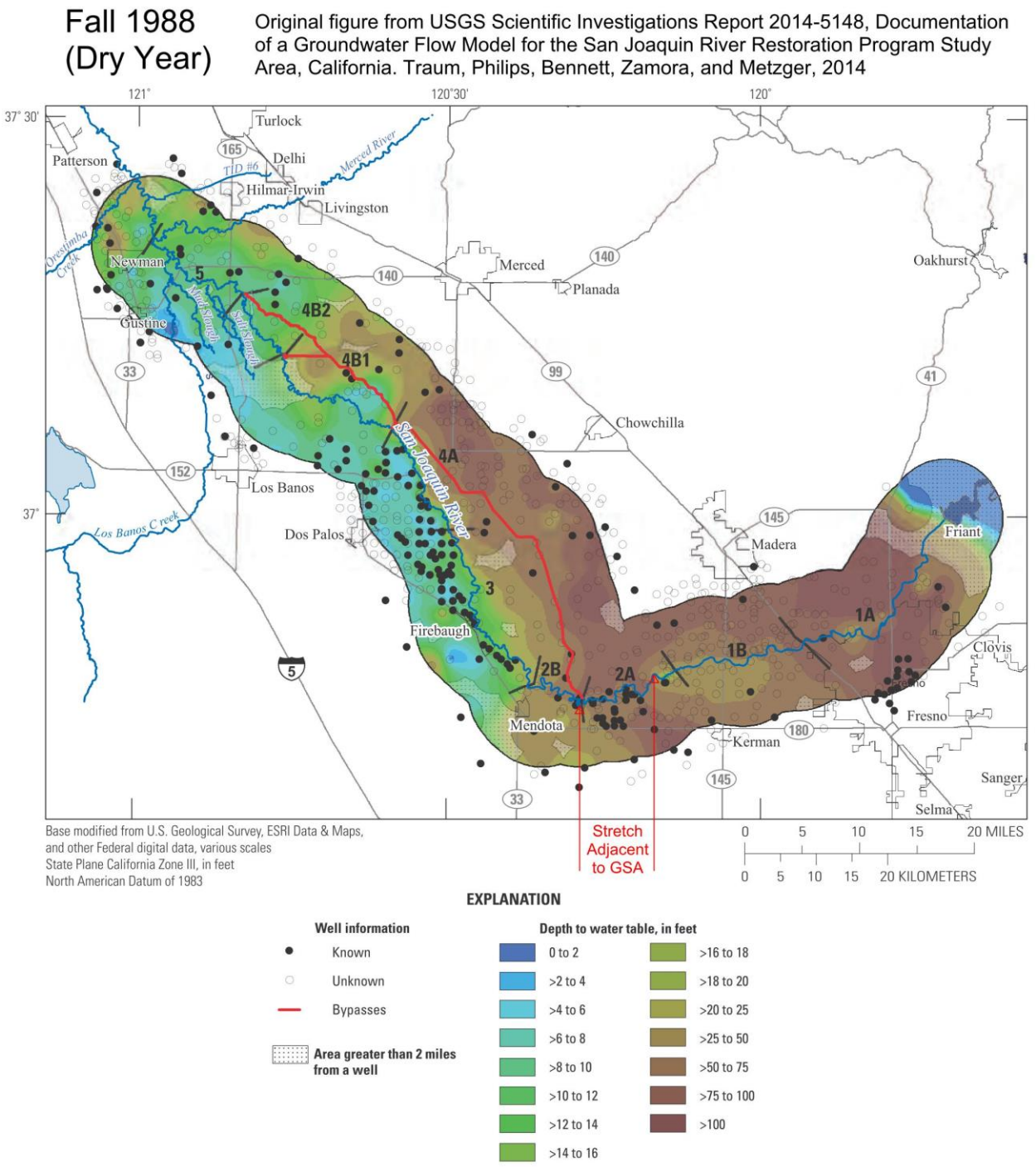


Figure 3-73 USGS Scientific Investigations Report 2014-5148- Depth to Water Table Along San Joaquin River, Fall 1988

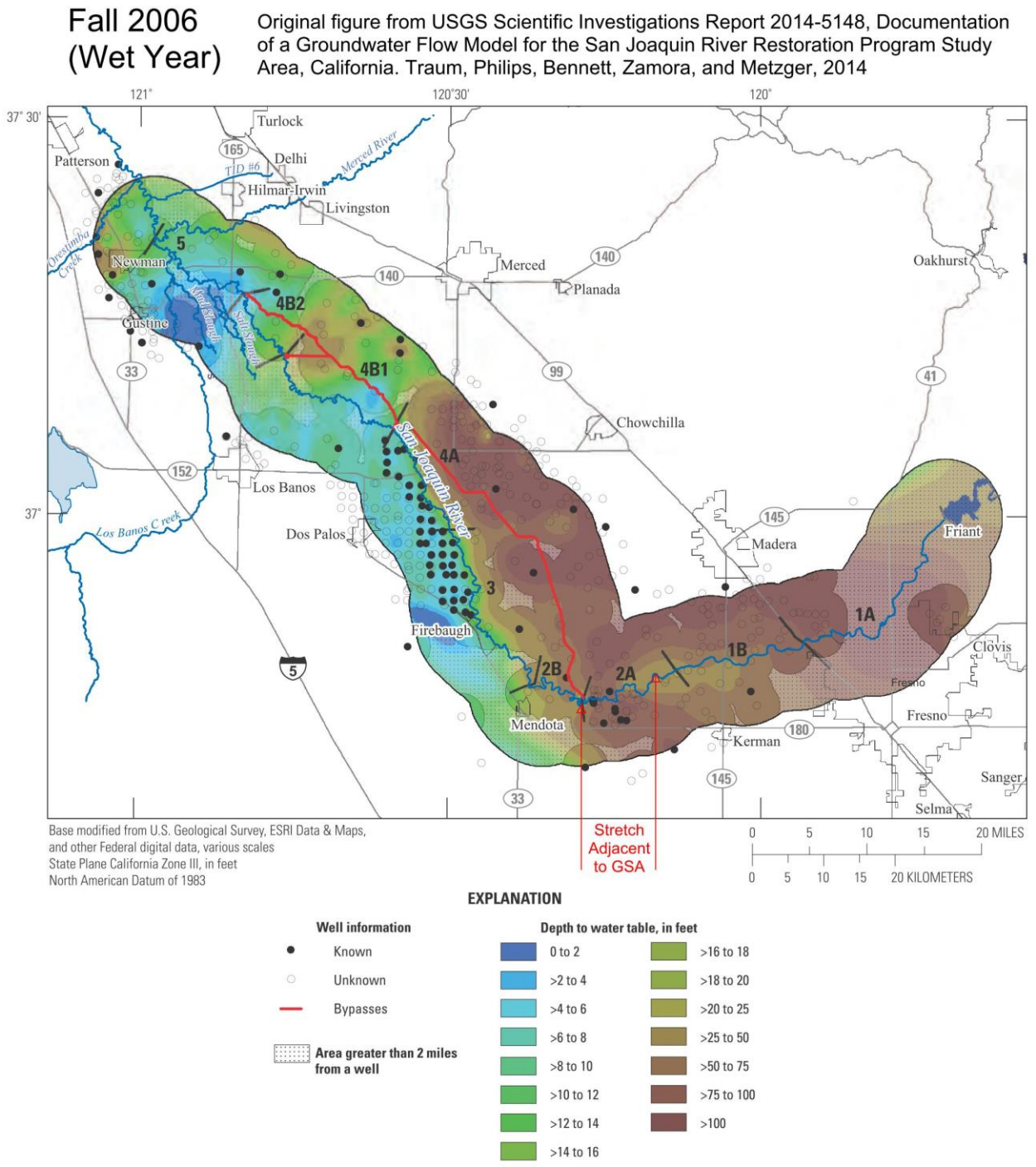


Figure 3-74 USGS Scientific Investigations Report 2014-5148 - Depth to Water Table Along San Joaquin River, Fall 2006

Interconnected surface water sustainable management criteria do not apply within the MAGSA reaches of the San Joaquin River but MAGSA will continue to review the annual near-river groundwater monitoring data that is collected on a regular basis by the USBR as part of the San Joaquin River Restoration Program. Additionally, there is no current evidence as to the connection of active wells along the river and increased seepage loss or negative impacts to downstream beneficial users. Any future complaints or developments in data supporting evidence of interconnected systems will be addressed and included in future GSP revisions as

deemed necessary. Additionally, it is presumed that an updated version of the USGS Groundwater Flow Model (USGS SIR 2014-5148, 2014) is set to be released in the late Fall of 2019. While it is presumed that there shall not be significant changes to the previously held opinions regarding interconnected surface water and the MAGSA portion of the SJR, necessary revisions to the GSP will be reviewed and applied if needed.

3.2.8 Groundwater Dependent Ecosystems

Regulation Requirements:

§354.16(g) Identification of groundwater dependent ecosystems within the basin, utilizing data available from the Department, as specified in Section 353.2, or best available information.

GDEs are defined under SGMA as "ecological communities of species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface" (23 CCR § 351(m)). While GDEs are not one of the six groundwater conditions that can lead to undesirable results, they can be related to sustainable management criteria identified in **Chapter 4**. The Nature Conservancy's Natural Communities Dataset Viewer (NC Dataset Viewer) Vegetative GDE map and Wetland GDE map with basin-wide marked revisions are provided below as **Figure 3-75** and **Figure 3-76.** Recognizing that much of the Kings Subbasin has a depth to groundwater greater than the deepest vegetative GDE rooting depth of thirty feet, many of the GDEs identified in the NC Dataset Viewer were mischaracterized.

Spring 2017 depth to groundwater contours and NC Dataset Viewer GDEs were overlaid to identify GDEs in areas with depth to groundwater greater than 30 feet. GDEs meeting this criterion were categorized as "Rejected GDE" and depicted in purple in **Figure 3-75** and **Figure 3-76**. Areas closer to the foothills require more depth to groundwater data to sufficiently validate the presence of GDEs; therefore, they are categorized as "Possible GDEs" for the 2020 GSP. The Kings Subbasin also categorized GDEs within 100-ft of the Kings River and the SJR as "Possible GDEs." This 100-ft buffer is based on a California Department of Transportation typical wetland setback (CDOT, 2019).

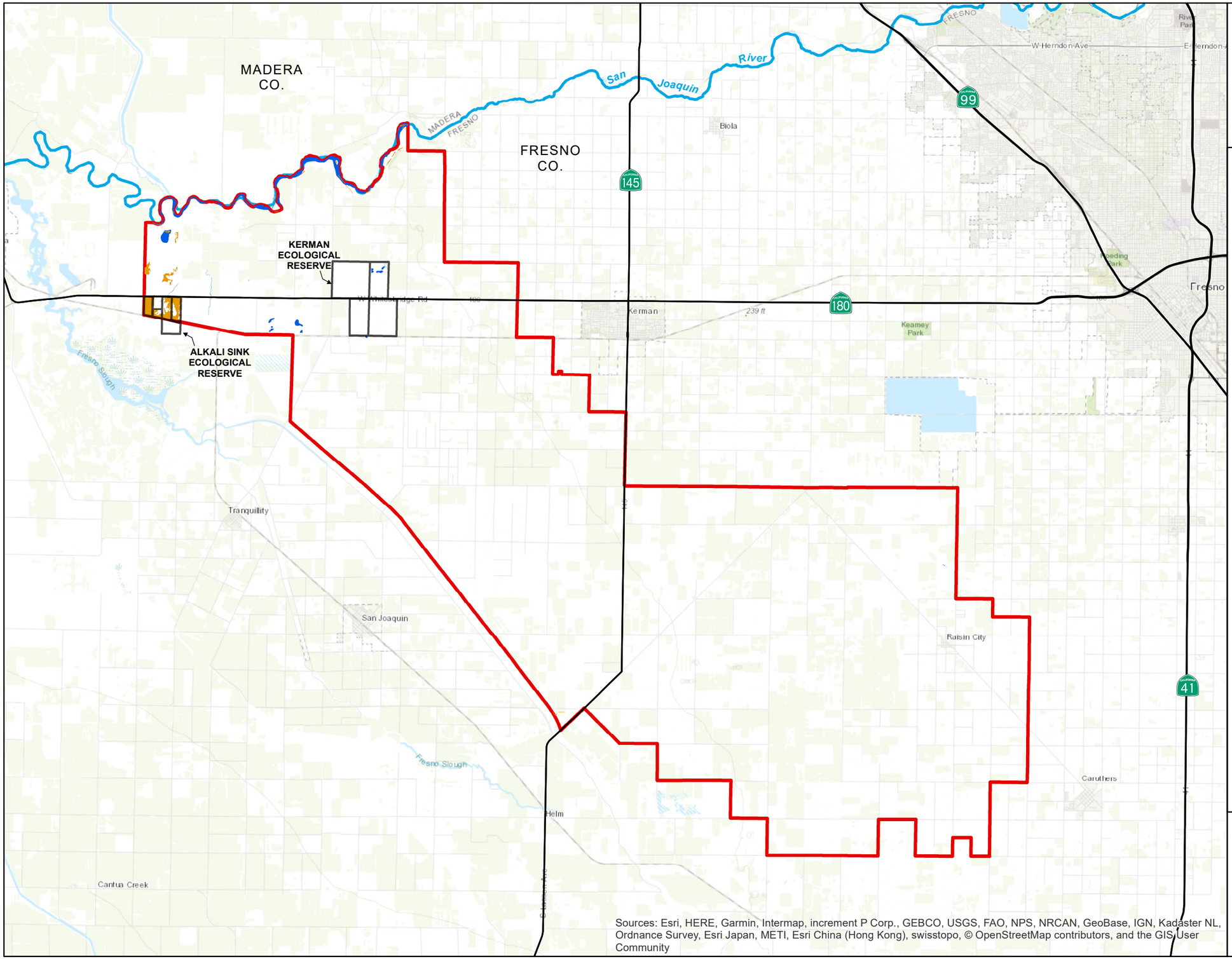
The Kings Subbasin will continue to evaluate the rejected and possible GDEs and their relationship to the groundwater conditions through monitoring efforts identified in Chapter 5 regarding groundwater level and interconnected surface water monitoring. If appropriate, revisions will be made in the future updates of the GSP.

As seen in **Figure 3-75** and **Figure 3-76**, groundwater elevations can be extremely low throughout MAGSA, indicating a lack of GDEs. A few potential spots are displayed to indicate the possibility of GDEs existing in those locations. However, water level data from wells in the northwest corner of the GSA indicate that the depth to water in the area can be between 100 and 150 feet deep. This is significantly deeper than the root zone for typical vegetation in the area, meaning that the likelihood of highlighted areas being GDEs is very low. There is a possibility of ecosystems occurring due to perched aquifer water, however this would have no effect on management of resources since pumping will not have a significant effect on perched systems. There is also a significant portion of the noted GDE indicators within managed land, therefore the ecosystem is already being protected. Any impacts this GSP will have on GDEs in MAGSA, if any, will be positive due to the nature of the projects and management actions that will be implemented. Recharge basins will help to mitigate the decline in water levels while programs will decrease the demand on water resources.

McMullin Area GSA

Groundwater Dependent Ecosystems

Figure 3-75



- McMullin Area GSA
- State of California Ecological Reserve
- Vegetation (Nature Conservancy iGDE)
- Wetlands (Nature Conservancy iGDE)

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), swisstopo, © OpenStreetMap contributors, and the GIS User Community

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McMullin Area GSA

Wetlands

Figure 3-76

MADERA CO.

FRESNO CO.

SAN JOAQUIN RIVER

San Joaquin River

MADERA

FRESNO

KERMAN ECOLOGICAL RESERVE

ALKALI SINK ECOLOGICAL RESERVE

W Whitesbridge Rd

239 ft

Biola

Kerman

Kearney Park

Fresno

W Herndon Ave

E Herndon Ave

Speedway

Tranquillity

FRESNO SLOUGH

JAMES BYPASS

San Joaquin

Helm

Cantua Creek

Raisin City

Caruthers

99

145

180

41

- McMullin Area GSA
- Kings Subbasin (DWR, Modified 2018)
- State of California Ecological Reserve
- Freshwater Forested/Shrub Wetland
- Riverine

*Wetlands shown within the McMullin GSA area and up to 1 mile outside of the boundary.

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), swisstopo, © OpenStreetMap contributors, and the GIS User Community

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3.3 Water Budget Information

3.3.1 Introduction

Regulation Requirements:

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

A water budget is an accounting of all the water that flows into and out of a specified area and describes the various components of the hydrologic cycle. A water budget includes all the water supplies, demands, modes of groundwater recharge, and non-recoverable losses, making it possible to identify how much water is stored in a system and changes in groundwater storage during a given period. An aggregated water budget has been prepared for the entire Kings Subbasin as well as detailed water budget for the MAGSA. A schematic diagram of a water budget indicating the primary inflows and outflows and impacts on the groundwater system is shown in **Figure 3-77** below:

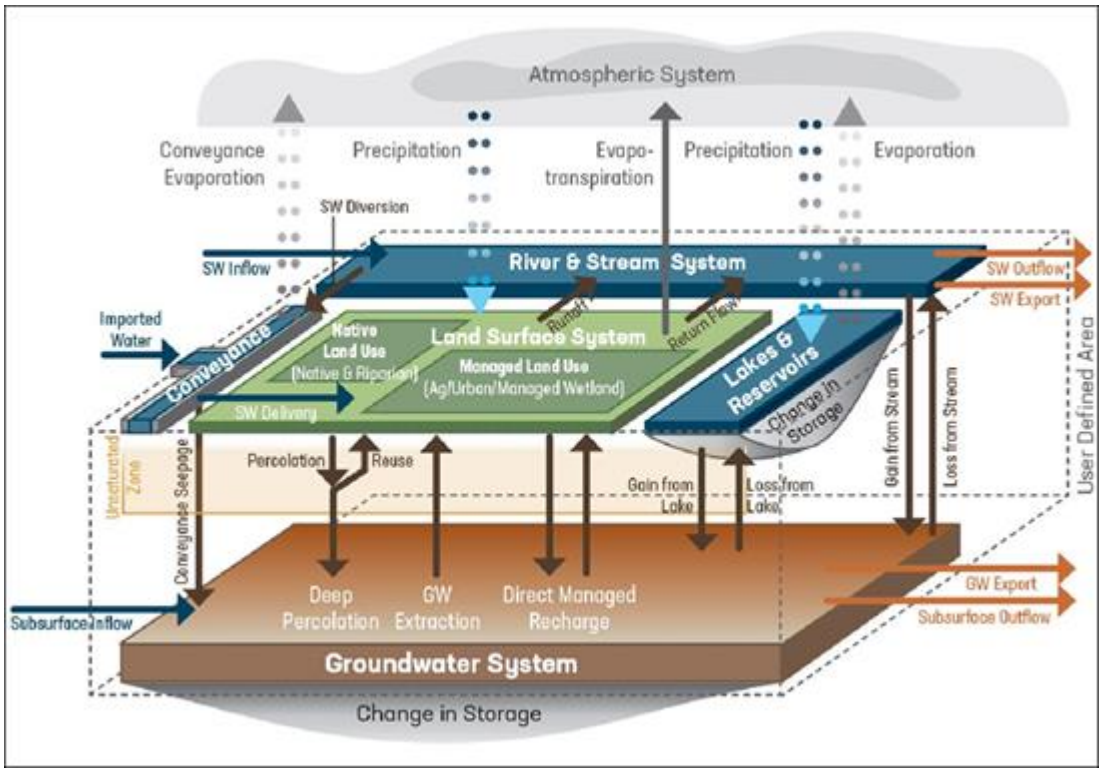


Figure 3-77 Water Budget Schematic

Purpose of Water Budget

Water budgets quantify the components of water supply, water use, and change in groundwater storage. The water budgets can be used as tools in numerous aspects of groundwater sustainability management including:

- Determining sustainable yield
- Identifying overdraft
- Identifying beneficial groundwater uses

- Identifying data uncertainties and monitoring needs
- Quantifying the effects of proposed projects and management actions
- Supporting the development of sustainable management criteria

Water Budget Methodology

The Kings Subbasin GSAs have regularly coordinated and used consistent methodologies for water budget development as captured in *Kings Subbasin GSA Coordination Efforts, Draft Technical Memos 1-6 (***Appendix 3-A***)*. The methods used in developing the water budgets are described generally below and may vary depending on what kind of water budget (historical, current or projected) is being discussed.

The historical, current and projected water budgets have been developed directly from measured and estimated data. A numerical model has not been used for development of the water budgets due to documented deficiencies with currently available groundwater models, including an existing numerical model of the Kings Subbasin, limited data availability for model development purposes, and limited time available for refinement, calibration and validation of a model. An analytical water budget (spreadsheet) approach has been used, which has the advantage of clearly showing the origin of data used for the water budget, as opposed to extracting disaggregated data from a numerical groundwater model that does not explicitly identify the data source or computation method. The GSAs in the Kings Subbasin mutually agreed that an analytical water budget would be a more practical and useful tool, and therefore offer greater value in managing groundwater. Ongoing use of an analytical water budget will be reviewed during the first five years of GSP implementation, and a decision will be made on the capability, data adequacy and usefulness of revising the existing Kings groundwater model for future GSP activities. The data developed as part of the analytical water budget will be used if the existing Kings groundwater model is updated in the future.

Water Budget Requirements

The coordinated water budgets quantify the following information in conformance with §354.18 (b) of the GSP requirements:

1. Total surface water entering or leaving the subbasin
2. Inflows to the groundwater system by water source type, including subsurface groundwater inflow and infiltration of precipitation, applied water, and surface water systems, such as lakes, streams, rivers, canals, springs and conveyance systems.
3. Outflows from the groundwater system by water use sector, including evapotranspiration, groundwater extraction, groundwater discharge to surface water sources, and subsurface groundwater outflow.
4. The change in the annual volume of groundwater in storage between seasonal high conditions.
5. Identification of overdraft over a period of years during which water year and water supply conditions approximate average conditions.
6. The water year type associated with the annual supply, demand, and change in groundwater stored
7. An estimate of sustainable yield for the basin.

Water Budget Periods

Water budgets were performed for historical, current and future periods, as shown in the following figure and described below:

Figure 3-78 Water Budgets Evaluated

Historical. A historical water budget was prepared covering Water Years 1996/97-2010/11 (1997-2011). This historical period was selected by the Kings Subbasin based on average surface water diversion amounts during the period compared to long-term records, since average surface water deliveries would equate to average groundwater pumping. This period had surface water diversions very similar to the last 50 years. While a more recent historical period would have been ideal, unfortunately extreme drought conditions between 2012 and 2016 would have made this impractical.

Current. A current water budget was prepared to represent recent conditions. This water budget includes water demands from 2016 to 2017, and long-term average supplies.

Future. Future water budgets were prepared for 2040, which is the year when the GSA must reach sustainability, and 2070, which represents a 50-year planning horizon. These water budgets include estimated changes in demands and impacts from climate change.

3.3.2 Best Available Information

GSP regulations stipulate the need to use the best available information and the best available science to quantify the water budget for the basin. Best available information is common terminology that is not defined under SGMA or the GSP Regulations. Best available science, as defined in the GSP Regulations, refers to the use of adequate and credible information and data, that is specific to the decision being made and the time frame available for making that decision, which is also consistent with scientific and engineering professional standards of practice. It is understood that initial steps to compile and quantify water budget components may be constrained by GSP timelines, limited data and limited funding, and may consequently need to rely on the best available information that is obtainable at the time the GSP is developed. The best available data for the water budget was often incomplete, had to be estimated, or was based on assumptions. The confidence intervals for each parameter vary from 5% to as high as 50%. As a result, the water budget presented herein is merely an approximation of the hydrologic system in the GSA.

3.3.3 Description of Water Budget

Regulation Requirements:

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

Historical water budgets were developed for each GSA in the Kings Subbasin and then rolled up together to obtain a water budget for the entire Kings Subbasin. The historical water budget does not include an annual accounting of conditions, rather average annual values over the study period (1997-2011) were identified and incorporated into an average-annual historical water budget.

As described subsequently, the historical water budget has been used as the basis for the current-level and projected water budgets, with appropriate adjustments for changes in demands, climate change impacts, etc.

Hydrologically Average Period
The historical water budget for the Kings Subbasin was developed for a base period of water-year 1997 through 2011 (October 1996 to September 1997). This hydrologic period was selected since it is a relatively long period during which "…*water supply conditions approximate average conditions*" as specified in DWR Groundwater Regulations at §354.18 (b) (5). The analysis of average conditions was based on Kings River surface water diversion amounts being approximately the same as the long-term average. Kings River surface water diversions were used since they are the largest source of water supplies to the Kings Subbasin, constituting nearly 90% of surface water used and more than 60% of the total water supply. Surface water diversions were used to select the hydrologic base period rather than Kings River runoff because they are more representative of average groundwater pumping conditions, since runoff water can be regulated in Pine Flat Reservoir from one year to the next.

The Kings Subbasin operates in a classical conjunctive use manner where groundwater pumping each year is used to supplement the surface water supply. Average Kings River surface water diversions to the Kings Subbasin since the construction of Pine Flat Dam (1955-2018) were 1,088,932 AF. Average diversions during the selected 1997-2011 historical analysis period were 1,081,700 AF, which is 99.3-percent of the long-term average. Kings River diversions during the 50-year period from 1968-2017 averaged 1,083,901 AF, which is also very similar.

A more recent historical analysis period was sought out, but due to the large number of exceptionally dry years between 2007 and 2015, any historical period including all of those years would have required an extended historical period going back to the 1980s to approximate average hydrologic conditions, and hence average groundwater pumping conditions. Such an extended historical period would have included periods with more questionable data and represented an older period that is not representative of more recent land use changes and water management practices. Due to these identified deficiencies, the 1997-2011 period was selected for the historical water budget even though it does not include more recent years.

Water Year Types
Water budgets were developed for dry, normal, and wet year water types. These water-year types were developed according to a water year classification based on water supply diversion information in the Kings

Subbasin. The water year on the Kings River is October through September. The water year types were developed due to the absence of DWR-developed water year types for the Kings River watershed and other watersheds in the Tulare Basin, and to account for actual surface water diversions rather than runoff.

The water year types were defined based on percentage of average Kings River diversions to the Kings Subbasin for a 50-year hydrologic period from 1968-2017. Year types were selected for Dry, Normal, and Wet conditions based on the historical diversions. A summary of the water year types is shown in **Table 3-1** below.

Table 3-1 Water Year Types

Water Year Type	Percent Historical Diversions
Dry	<75%
Normal	75% - 125%
Wet	>125%

A comparison of the Kings year type classifications was made to the DWR San Joaquin Valley water year hydrologic classification index. DWR classifies year types as critical, dry, below normal, above normal, and wet based on the San Joaquin Valley runoff hydrology. The Kings year type and the SJV Index year type generally match up very well except for a few years which were considered dry by DWR standards based on runoff but were considered normal based on Kings diversions. This is due to the operation of Pine Flat Reservoir and the ability to store water for the following year.

Table 3-2 Kings River Year Types based on Diversions into Kings Subbasin

Water Year	Pre-Project Piedra	% Water Year PPP	Headgate Diversions	% Average Diversions	Kings Year Type	*DWR SJV Index*	Water Year	Pre-Project Piedra	% Water Year PPP	Headgate Diversions	% Average Diversions	Kings Year Type	*DWR SJV Index*
1955	1,120,800	66.3%	803,079	73.7%	dry	*D*	**1987**	779,051	46.0%	830,511	76.3%	**normal**	*C*
1956	2,603,500	154.1%	1,691,879	155.4%	wet	*W*	**1988**	827,211	48.9%	620,703	57.0%	**dry**	*C*
1957	1,251,400	74.1%	952,292	87.5%	normal	*BN*	**1989**	905,624	53.6%	746,970	68.6%	**dry**	*C*
1958	2,533,200	149.9%	1,523,837	139.9%	wet	*W*	**1990**	662,989	40.5%	488,305	44.8%	**dry**	*C*
1959	818,000	48.4%	732,405	67.3%	dry	*D*	**1991**	1,075,608	63.7%	791,489	72.7%	**dry**	*C*
1960	719,400	42.6%	577,568	53.0%	dry	*C*	**1992**	705,247	41.7%	579,956	53.3%	**dry**	*C*
1961	571,800	33.8%	460,148	42.3%	dry	*C*	**1993**	2,553,114	151.1%	1,511,627	138.8%	**wet**	*W*
1962	1,879,300	111.2%	1,312,010	120.5%	normal	*BN*	**1994**	861,045	51.0%	845,093	77.6%	**normal**	*C*
1963	1,906,900	112.8%	1,328,459	122.0%	normal	*AN*	**1995**	3,460,047	204.8%	1,516,205	139.2%	**wet**	*W*
1964	882,100	52.2%	774,685	71.1%	dry	*D*	**1996**	2,095,921	124.0%	1,678,550	154.1%	**wet**	*W*
1965	1,986,200	117.5%	1,451,438	133.3%	wet	*W*	**1997**	2,652,070	156.9%	1,538,836	141.3%	**wet**	*W*
1966	1,219,100	72.1%	1,010,957	92.8%	normal	*BN*	**1998**	3,104,062	183.7%	1,390,921	127.7%	**wet**	*W*
1967	3,332,800	197.2%	1,774,026	162.9%	wet	*W*	**1999**	1,261,024	74.6%	1,118,240	102.7%	**normal**	*AN*
1968	843,204	49.9%	948,479	87.1%	**normal**	*D*	**2000**	1,534,654	90.8%	1,087,483	99.9%	**normal**	*AN*
1969	4,386,300	259.6%	1,700,665	156.2%	**wet**	*W*	**2001**	1,010,201	59.8%	720,077	66.1%	**dry**	*D*
1970	1,330,595	78.7%	1,332,285	122.3%	**normal**	*AN*	**2002**	1,141,149	67.5%	856,072	78.6%	**normal**	*D*
1971	1,174,952	69.5%	1,003,329	92.1%	**normal**	*BN*	**2003**	1,426,170	84.4%	901,133	82.8%	**normal**	*BN*
1972	859,583	50.8%	708,266	65.0%	**dry**	*D*	**2004**	1,050,714	62.2%	783,628	72.0%	**dry**	*D*
1973	2,135,442	126.4%	1,551,605	142.5%	**wet**	*AN*	**2005**	2,531,327	149.8%	1,324,132	121.6%	**normal**	*W*
1974	2,095,945	124.0%	1,522,343	139.8%	**wet**	*W*	**2006**	2,948,677	174.5%	1,406,012	129.1%	**wet**	*W*
1975	1,583,365	93.7%	1,205,401	110.7%	**normal**	*W*	**2007**	679,047	40.2%	580,345	53.3%	**dry**	*C*
1976	540,664	32.0%	418,674	38.4%	**dry**	*C*	**2008**	1,216,651	72.0%	908,837	83.5%	**normal**	*C*
1977	395,994	23.4%	331,187	30.4%	**dry**	*C*	**2009**	1,348,201	79.8%	857,132	78.7%	**normal**	*BN*
1978	3,453,853	204.4%	1,585,949	145.6%	**wet**	*W*	**2010**	2,062,001	122.0%	1,227,931	112.8%	**normal**	*AN*
1979	1,729,846	102.4%	1,643,166	150.9%	**wet**	*AN*	**2011**	3,319,830	196.5%	1,524,717	140.0%	**wet**	*W*
1980	3,046,952	180.3%	1,721,195	158.1%	**wet**	*W*	**2012**	825,683	48.9%	828,979	76.1%	**normal**	*D*
1981	1,040,415	61.6%	1,030,737	94.7%	**normal**	*D*	**2013**	691,301	40.9%	429,208	39.4%	**dry**	*C*
1982	3,111,011	184.1%	1,513,954	139.0%	**wet**	*W*	**2014**	536,924	31.8%	391,587	36.0%	**dry**	*C*
1983	4,476,391	264.9%	1,573,586	144.5%	**wet**	*W*	**2015**	360,979	21.4%	215,058	19.7%	**dry**	*C*
1984	1,971,145	116.7%	1,533,875	140.9%	**wet**	*AN*	**2016**	1,253,961	74.2%	811,025	74.5%	**dry**	*D*
1985	1,252,501	74.1%	1,074,064	98.6%	**normal**	*D*	**2017**	4,096,148	242.4%	1,725,612	158.5%	**wet**	*W*
1986	3,262,497	193.1%	1,559,911	143.3%	**wet**	*W*	2018	1,274,520	75.4%	1,080,371	99.2%	normal	*BN*

Notes: 1) Kings River diversion accounting was on a calendar year basis for the years 1955 through 1964 (9 mo). Accounting began on a waer year basis (Oct-Sep) in the 1964/65 year.

2) Kings Year Type classifications: Dry = <75% of average Kings Subbasin diversions; Normal = >75% and <125% of average; Wet = >125% of average Kings Subbasin diversions.

3) DWR SJV Index = CDEC Water Year Hydrologic Classification Indices for San Joaquin Valley. C = Critical; D = Dry; BN = Below Normal; AN = Above Normal; W = Wet.

4) 50-year hydrologic period (WY 1967/68 - 2016/17) shown in **bold**.

3.3.4 Surface Water Entering and Leaving

Regulation Requirements:

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

Quantities of water entering the Kings Subbasin at the surface, either as surface flows or precipitation, are described and quantified in this section using the procedures described below.

Surface Water Used For Irrigation
Kings River delivery data were acquired from KRWA Watermaster Reports for headgate diversions to each member unit (P&P, 2018b). SJR (Friant) delivery data were acquired directly from the local agencies or USBR reports. MAGSA does not have any rights to surface water diversions and has not historically purchased surface water from neighboring agencies, except in some flood years. Over the historical base period previously discussed, MAGSA has brought in approximately 1,900 AF per year on an average annual basis.

Riparian water use in the subbasin was estimated by assuming that all potential agricultural riparian lands with identified pumps that abut the Kings River divert surface water to meet their crop demands when water was available in that reach of the river. Average annual demands were assumed to be 3 acre-feet/acre and were divided into monthly values. Similarly, along the SJR, most lands designated as having Holding Contracts with the USBR were assumed to divert 3 acre-feet/acre/year. MAGSA was assumed to divert surface water only during periods with flood flows. The actual acreage of riparian and Holding Contract lands is unknown since it is not reported, so this value may be modified in the future.

Surface Water For M&I
Urban surface water delivery data were collected directly from local agencies. MAGSA only contains a rural residential population and does not have a surface water treatment plant and has no plans to use surface water for municipal and industrial use in the future.

Surface Water Use As Recharge
Surface water use for intentional recharge is based on measured deliveries to recharge basins. When recharge basins were not metered, the deliveries were estimated by the local agency using their own criteria and assumptions. MAGSA has not historically brought surface water into the area for intentional recharge.

Precipitation
Monthly precipitation data was collected from the National Oceanic and Atmospheric Administration Regional Climate Center's Applied Climate Information System for stations throughout the Kings Subbasin for the 20-year, 1996-2016 period. Annual precipitation contours were generated using the station coordinates and their respective annual precipitation. Using the contours, weighted average precipitation values were identified for each GSA within the Kings Subbasin for each year within the 20-year period. More specifically, MAGSA has an average annual precipitation of 8.8 inches over the hydrologic base period of 1997-2011.

Spill Inflows
This represents spills of surface water into an irrigation or water district, and therefore is a source of water. Data is based on measured spills, or estimates provided by the district. If the spills were unknown, and believed to be small, they were assumed to be zero.

Some FID facilities extend into the MAGSA area, such as the Houghton Wasteway Pipeline and the Lower Dry Creek Canal connecting to the Southwest Banking site. FID has historically had flood rights in these areas, and operational spills have occurred according to growers near the canals who divert water when available. It is estimated that approximately 2,000 AF of spills at the Lower Dry Creek Canal have occurred on an average annual basis for the historical water budget. With implementation of SGMA, this may change, and spills may become negligible.

3.3.5 Inflows to the Groundwater System

Quantities of water entering the groundwater body in the Kings Subbasin as forms of recharge, are described and quantified in this section using the procedures described below.

Groundwater Inflows
Unconfined groundwater flows were estimated for the historical period based on measured groundwater levels and transmissivities using Darcy's Law. For lateral groundwater flows, the equation used is:

$$Q = TIL$$

where: $Q\ is$ groundwater flow in gallons per day (gpd)

T: transmissivity in gallons per day/foot (gpd per foot)
I: hydraulic gradient (feet per mile)
L: width of flow (miles).

Transmissivity is a factor indicating the ability of the aquifer to transmit groundwater flow laterally. It is equal to the thickness of water-producing strata multiplied by the hydraulic conductivity of these strata. Transmissivity is best determined from the results of aquifer tests but is also commonly obtained from published data when available or estimated from specific capacity (pumping rate divided by drawdown) values when aquifer tests are not available. Both the hydraulic gradient, or water-level slope, and the width of flow are best determined from detailed (i.e., 10-foot or less contour interval) water-level elevation maps.

In estimating groundwater flow the following simplifying assumptions were made:

- Spring water levels represent the most static water level conditions and are the best levels for estimating groundwater flows,
- The aquifer is relatively homogenous and isotropic

In the Kings Basin, unconfined groundwater flows were estimated at each of the GSA boundaries. The analysis divided the GSA borders into flow segments. Average flow direction and gradients for each segment were determined from groundwater contour maps developed for the Kings Subbasin (P&P Technical Memorandum #4) (P&P, 2018b). Transmissivities were estimated from available aquifer tests when available. In areas with sparse aquifer tests, specific capacities from USGS reports were used. A more complete description of the calculations is presented in P&P Technical Memorandum #5 (P&P, 2018c).

Confined groundwater flows were roughly estimated based on calculated confined groundwater flows in other parts of the Kings Basin. In the MAGSA, subsurface outflows are estimated to be 153,000 AF/year, including 118,000 AF/year from the unconfined aquifer, and 35,000 AF/year from the confined aquifer.

Deep Percolation
Irrigation
Deep percolation was calculated by assuming that the amount of water applied above and beyond the evapotranspiration rate (due to irrigation inefficiencies) infiltrates past the root zone and into the groundwater system. As a result, the quantity of deep percolation of irrigation water is computed as a function of irrigation

efficiency. For example, in MAGSA, the irrigation efficiency is estimated to be 79%, then deep percolation of irrigation water would be 100% – 79% = 21% of the applied water.

Precipitation

Deep percolation of precipitation was estimated based on the following empirical formula:

DP = 0.64 x P – 6.2

Where:

DP = Deep percolation (inches)
P = Annual precipitation (inches)
Source: Williamson, Prudic and Swain, 1989

This empirical equation was developed for the San Joaquin Valley (Williamson, Prudic, & Swain, 1989) by estimating soil moisture budgets over a 50-year period. (Note, that if annual precipitation is less than 9.69 inches, then deep percolation will not occur.) The equation above was used to calculate the volume of recharge due to precipitation on an annual basis for each year over the hydrologic period from 1997-2011 and the values were averaged together to obtain deep percolation on an average annual basis.

This equation was only used in rural (agricultural, rangeland and rural residential areas) areas. Deep percolation of precipitation in urban areas is covered in Urban Stormwater Recharge; however, MAGSA is almost completely rural land and does not have urban stormwater recharge areas.

M&I

Deep percolation of Municipal & Industrial (M&I) water includes two components: 1) Indoor water usage sent to treatment plants and septic systems; and 2) Outdoor landscape water that percolates past the root zone.

When sewer flows are known the volume percolated is equal to the plant deliveries minus percolation pond evaporation. If some effluent is directly diverted for other purposes, such as irrigation of non-edible crops, that volume is subtracted. For rural populations, it is also assumed that 100 percent of indoor water use is percolated into the groundwater through septic systems and leach fields. Indoor water usage is assumed to be 35% of rural water demands based on experience with other San Joaquin Valley communities.

It is assumed that all outdoor water use is used for landscape irrigation. All water applied in excess of landscape irrigation demands is assumed to percolate past the root zone and eventually reach the water table. Landscape irrigation efficiency is assumed to be 75%, therefore, 25% of outdoor water usage is assumed to percolate.

Seepage

Channels and Pipelines

Channel seepage can be acquired using one of three methods:

1. Results of local seepage tests and seepage losses
2. Difference between diversions and water deliveries. This is only possible when headgate diversions and grower deliveries are accurately metered. Channel evaporation and spills also need to be subtracted.
3. Typical seepage rates for different soil types (see discussion below)

KRCD (1991) estimated seepage rates for different hydrologic soil groups in Alta Irrigation District. Since these were developed for general soil groups, rather than locally specific soil types, it is assumed they are applicable in other areas of the Kings Basin. These seepage rates are shown in **Table 3-3** below.

Table 3-3 Estimated Seepage Rates for Hydrologic Soil Groups

Hydrologic Soil Group	Estimated Infiltration Rates (feet/day)
A	1.0
A'	0.7
B	0.7
B'	0.5
C	0.5
C'	0.3
D	0.05

Pipeline seepage is based on data provided by local agencies, or standard values estimated using the AWWA Water Audit Loss Tool.

MAGSA does not have a surface water distribution system and losses associated with the distribution of groundwater for municipal purposes are considered negligible.

Reservoirs

Reservoirs seepage was based on the seepage rates for general hydrologic soils groups described above under Seepage of Channels & Pipelines. Annual seepage was calculated as the seepage rate multiplied by the time period the reservoir is typically filled with water. There are no designated storage reservoirs in MAGSA.

Stormwater Recharge

As previously mentioned, MAGSA does not have any developed urban areas; stormwater recharge was ignored.

Local Stream and River Recharge

Stream seepage occurs from three sources: Local Foothill Streams, SJR and the Kings River.

San Joaquin River

In the area of MAGSA, SJR flows only occurred during flood releases and very wet years during the hydrologic base period (1996-2011). The USGS (Traum, et. al., 2014) SJRRPGW estimated seepage at 41,000 AF/year for SJR Reach 2, or 2.6 cfs per river mile for 24.4 river miles, which would equate on average to modeled seepage losses of 1,680 AF/mile per year for the MAGSA area, which includes 11.9 miles along a portion of Reach 2.

Kings River

The Kings River is the main source of surface water that runs through the Kings Subbasin. Kings River seepage benefits each of the seven GSAs to a varying degree. KRWA Annual Watermaster Reports documents river losses along designated river reaches on a monthly basis. These comprise all river losses, including seepage, evaporation and riparian diversions. Riparian diversions were estimated as described under Surface Water for Irrigation with an estimated acreage in each GSA. Evaporation was based on the river width, a local reference evapotranspiration rate, and a riparian evapotranspiration constant (0.8). Losses were estimated for each GSA based on the distance the river traverses the GSA. It was assumed that seepage was equal on each side of the river. MAGSA benefits from Kings River seepage in wet years as well as when water is sent down the James Bypass.

3.3.6 Outflows from Groundwater System

The primary outflow from the groundwater body is groundwater pumping, which was estimated for agricultural and M&I purposes as described below.

Groundwater Pumping for Irrigation
Unmetered groundwater pumping is estimated based on crop evapotranspiration and other water budget variables. In groundwater only areas, the groundwater pumping is simply the crop evapotranspiration demand less effective precipitation, divided by an average irrigation efficiency.

When available, irrigation efficiencies were collected from local agency staff or Agricultural Water Management Plans. When no specific data was available, they were estimated based on the general crop types (USBR, July 2018). Field crops are assumed to use flood/furrow irrigation and have an efficiency of 70%. Trees and vines are assumed to use drip or micro-spray and have an irrigation efficiency of 85% (Thomas Harder and Co., 2017 and Davids Engineering, 2018).

In areas with surface water and groundwater, the groundwater pumping must be back-calculated using numerous water budget variables. In a simple situation, groundwater pumping equals crop applied water demands minus surface water deliveries. However, surface water deliveries to growers differ from headgate surface water diversions due to system losses and deliveries made for intentional recharge. In these situations, irrigation groundwater pumping is estimated using the following formula:

Private Irrigation Pumping = Crop applied water demands – Surface water deliveries to growers

where:

Surface Water Deliveries to Growers = Headgate diversions – System losses – Intentional recharge

and

System Losses = Channel evaporation + Channel seepage + Reservoir evaporation + Reservoir seepage + Operational Spills

As a result, private irrigation pumping can be calculated with the following formula:

Private Irrigation Pumping = (Crop evapotranspiration less effective precipitation) / Irrigation efficiency – Headgate diversions + Channel evaporation + Channel seepage + Reservoir evaporation + Reservoir seepage + Operational spills + Intentional recharge

Groundwater Pumping for M&I
M&I groundwater pumping by municipal water suppliers was collected directly from the local urban agencies.

Rural residential water demands include domestic well pumping at farmhouses and rural communities that are not served water from a City, County Service Area, Community Services District or other water utility. Rural residential water demands were estimated as the sum of indoor and outdoor water use. The water demands were estimated based on assumed per capita water use for indoor use and assumed use per acre for outdoor use. Population was estimated using 2010 US Census Block Groups. Block Groups did not always closely follow GSA boundaries. As a result, all block groups that were outside of designated urban areas and had most of their area inside a GSA were assumed to represent the local rural population.

Indoor use for rural areas was multiplied by 70 gallons/capita/day, based on the recent goal of 55 gallons per day from SB 606/AB 1668, which has likely been exceeded in the past. It was assumed that each parcel has 4

residents. Outdoor use was estimated by assuming that 0.65 AF/acre is used for landscape irrigation and other outdoor water uses. Estimates of aggregate outdoor water use were based on processing June 2016 multi-band satellite images to determine amount of irrigated vegetation in the North Kings GSA. Lacking data and a similar analysis elsewhere, the results were applied in a similar fashion by each Kings Basin GSA. The analysis determined that approximately 21 percent of the rural residential land area was vegetated, and 3 AF/acre water use was assumed to obtain 0.65 AF/acre aggregate water use over the GSA. The average parcel size was calculated as 2.5 acres using the satellite data.

Evapotranspiration of Applied Irrigation Water

This variable, also called crop water demand, represents crop evapotranspiration minus effective precipitation (ETAW). For the historical period, this variable was estimated using DWR Land Use data by County (Fresno – 1994, 2000 and 2009; Kings – 1996 and 2003; Tulare - 1999 and 2007) and annual crop evapotranspiration rates from the DWR (https://water.ca.gov/Programs/Water-Use-And-Efficiency/Land-And-Water-Use/Agricultural-Land-And-Water-Use-Estimates). The land use data for the water budget period was interpolated each year using the DWR data. Land use was assumed to remain constant prior to the first county data and after the last county data and was linearly interpolated between available years of county land use data. The two crops with the most acreage in MAGSA are vineyards and almonds consisting of approximately 38,000 acres and 25,500 acres, respectively. The DWR annual crop evapotranspiration rates were available on-line for 20 crops for the years 1998 through 2010. 2011 annual crop evapotranspiration rates were obtained directly from DWR and 1997 was taken to be equivalent to the average of the period 1998 through 2011.

The total crop evapotranspiration rates were generally computed as the product of the interpolated crop acreage for each crop times the annual crop evapotranspiration. The totals by crop were then aggregated to totals for each GSA. In addition to this normal computation, there was an adjustment for the acreage of newly planted orchards, which would not have the same rates as mature orchards. The adjustment for newly planted orchards assumes a four-year annual increase in evapotranspiration, going from 25% of the normal annual evapotranspiration rate in the first year to 100% of the normal rate in year four. In addition to the adjustment for newly planted acreage as represented in the crop acreage data, there was also an assumption that orchards would be replaced on a twenty-year basis which resulted in an additional 6.25% reduction to crop evapotranspiration rates for ongoing orchard acreage.

Evapotranspiration of Applied M&I Water

Evapotranspiration of M&I water primarily includes landscape irrigation demands. It is assumed that all outdoor water use is applied to landscape irrigation. First, the quantity of M&I water used outdoors needs to be determined. When total water deliveries and sewer flows are known, then outdoor water use is simply the difference between the two values. When total pumping or sewer records are not available, then outdoor water use is assumed to be 65% of total water demands. This is based on general experience with other municipalities in the San Joaquin Valley. Local landscape irrigation efficiencies are assumed to be 75% based on efficiencies in other areas of the San Joaquin Valley. Therefore, 75% of outdoor water use is assumed to be consumed through evapotranspiration.

Evapotranspiration of Effective Precipitation

Effective precipitation is the amount of rainfall beneficially used by crops, either directly as transpiration or through storage in the root zone and evapotranspiration in subsequent periods. Annual values of effective precipitation were obtained from DWR's Agricultural Land & Water Use Estimates website (https://water.ca.gov/Programs/Water-Use-And-Efficiency/Land-And-Water-Use/Agricultural-Land-And-Water-Use-Estimates). As with annual crop evapotranspiration rates, annual estimates of effective precipitation were available for individual Detailed Analysis Units for the period 1998 through 2010. 2011 estimates were obtained directly from DWR and 1997 was estimated as the average for the period 1998-2011. The unit effective precipitation rates were multiplied by interpolated acreages for the 1997-2011 period as described earlier to develop estimates of overall effective precipitation in the GSA.

Evaporation from Conveyance Channels
Detailed studies estimated channel evaporation and canal bank evapotranspiration (collectively called evaporation losses) to be 0.4% + 0.05% = 0.45% of flows in Consolidated Irrigation District (KRCD, 1993) and 0.75% + 0.25% = 1.0% of flows in Alta Irrigation District (KRCD, 1991). Due to the relatively small volume of water lost due to evaporation, rigorous analyses were not performed for other irrigation/water districts. Rather, channel evaporation losses were assumed to be the average of the two values reported above, or 0.7%; however, MAGSA does not currently have conveyance channels throughout the GSA.

Evaporation from Reservoirs and Recharge Basins
Long-term evaporation rates were collected from seven California Irrigation Management Information System (CIMIS) stations in and around the Kings Basin. These included Stations No. 2 – Five Points, 15 – Stratford, 39 – Parlier, 80 – Fresno State, 105 – Westlands, 142 – Westlands, 142 – Orange Cove and 190 – Five Points South West. Reservoir and basin evaporation estimates were based on actual evaporation rates during the study period for the closest CIMIS station, or a combination of CIMIS stations. MAGSA has not historically owned any reservoirs or recharge basins, therefore this parameter was not evaluated for the GSA.

Evaporation and Runoff of Precipitation
Evaporation and runoff of precipitation are a residual value in the water budget, and were calculated with the following formula:

> Evaporation and Runoff of Precipitation = Precipitation - Effective Precipitation - Deep Percolation of Precipitation

This represents a non-recoverable loss that does not impact either water supplies or demands.

Operational Spills
This represent spills of surface water outside of an irrigation or water district and is considered a non-recoverable loss to that district. They are based on measured spills, or estimates provided by the district. If the spills were unknown, and believed to be small, they were assumed to be zero.

Groundwater Exports
This represents the export of groundwater from one agency into another. It is based on metered well pumping. It can occur from water transfers, exchanges, or banking agreements. Groundwater exports by landowners that own adjacent properties on an agency boundary (one in the agency and one just outside) were neglected, since it was assumed that they are minor and tend to balance each other out.

Groundwater Outflow
Groundwater outflow was calculated the same way as inflow, but this time all the boundaries with negative flow were added together for each year and averaged to get an average annual value for groundwater outflow.

Other Consumptive Uses
Other consumptive uses include groundwater pumping from JID wells that is then delivered and used on JID lands.

3.3.7 Change in Groundwater Storage

Regulation Requirements:

§354.18(b) The water budget shall quantify the following, either through direct measurements or estimates based on data:
(4) The change in the annual volume of groundwater in storage between seasonal high conditions.
(5) If overdraft conditions occur, as defined in Bulletin 118, the water budget shall include a quantification of overdraft over a period of years during which water year and water supply conditions approximate average conditions.
(6) The water year type associated with the annual supply, demand, and change in groundwater stored.
(7) An estimate of sustainable yield for the basin.

3.3.7.1 Unconfined Groundwater Storage Change

Water storage change in the unconfined aquifer for the 1997-2011 hydrologic period was estimated based on measured groundwater levels. Water surface elevation contour maps were generated for Spring 1997 and Spring 2012 based on the available data from more than 900 wells within the Kings Subbasin. In preparing the contour maps, well levels that appeared inconsistent with the other wells in an area were not used. Wells with significantly different water levels could be erroneous or anomalous because they are: 1) composite wells pumping from two or more aquifers; 2) confined wells pumping from below the Corcoran Clay; 3) or for other reasons included errors in the data.

Specific yield is defined as the ratio of the volume of water that a given mass of saturated rock or soil will yield by gravity to the volume of that mass. Specific yield is represented as a percentage. Groundwater storage change can be estimated by multiplying the change in groundwater level by the specific yield. Specific yield values for use in the storage change calculation were estimated from USGS reports and other sources as documented in P&P Technical Memorandum #2 (TM2) (P&P, January 2018). Specific yield values also vary by depth and TM2 describes unique values at depth zones from 0'-50', 50'-100', 100'-200' and 200'-300'. The storage change was estimated based on the water above 300' below the groundwater surface.

Groundwater storage change for the range of years was computed using the procedure documented in P&P Technical Memorandum #4 (P&P, October 2018). For MAGSA, it is estimated that the average annual storage change between the years of 1997 and 2011 is approximately -16,000 AF per year.

3.3.7.2 Groundwater Released from Aquifer Compaction

Water release from aquitard compaction occurs when clay soils in confined aquifers collapse during land subsidence caused by groundwater over-pumping. This essentially squeezes water out of the clay and creates a new one-time water source that would otherwise not be available. Hence, the water is mined from the clay layers. It is assumed that 1-foot of land subsidence results in an equivalent 1-foot of new groundwater supply from the confined aquifer.

Subsidence data was not available for the entire hydrologic base period (1996 to 2011); data was only available during certain years from 2007 to 2017. However, it was assumed that no subsidence occurred from 1996 to 2006, due to more stable groundwater levels and a lack of physical observations indicating land subsidence. Most of the observed land subsidence occurred during the extended drought from 2012 to 2016. For recent years, NASA/Jet Propulsion Laboratory-processed satellite InSAR data of vertical ground surface displacement, which was available on DWR's website (DWR, 2018) for May 31, 2015, through April 30, 2017 (23 months). Subsidence was generally minimal before the most recent drought in 2012, except in JID, MAGSA and North Fork Kings GSA. Luhdorff and Scalmanini (2014) provided land subsidence data from March 2007 to March 2011, also using InSAR data. The subsidence in the three affected GSAs was estimated to be about 0.25 feet over the 50 months, or 0.72 inches/year, equating to 12,000 AF/year for the entire Kings Basin. For MAGSA, this results in an approximate increase of supply of 2,000 AF/year on an average annual basis.

3.3.8 Historical Water Budget

Regulation Requirements:

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

A historical water budget was prepared for the entire Kings Basin and for North Kings GSA. The water budget covers the hydrologically average period of 1997-2011 (see **Section 3.3.2** for discussion on the selection of this period). The water budget includes average-annual values over the entire time period. Hence a single water budget is presented rather than one showing values for each year from 1997-2011. An average-annual water budget is considered the most practical representation of the data.

Kings Basin Water Budget

Table 3-4 shows a water budget for the entire Kings Subbasin with the equivalent individual water budgets for the seven GSAs within the Kings Subbasin. The water budget for Central Kings GSA and South Kings GSA were combined into a single water budget. The inflows and outflows to the groundwater basin are used to estimate the change in groundwater storage based on the water budget components (Method 1), and this estimated change in storage is compared to the calculated change in groundwater storage from the groundwater level data (Method 2).

Table 3-4 Kings Basin Historical Water Budget

(all units in acre-feet)

Description	TOTAL	McMullin GSA	NFKings GSA	North Kings GSA	Central/South	Kings River East	James ID
Total Supply	***3,547,400***	**379,500**	***616,200***	***1,167,200***	**614,700**	***677,500***	***92,300***
Consumptive Use Subtotal	***2,094,600***	**296,000**	**399,100**	**544,500**	**358,000**	**428,400**	**68,600**
GW Recharge Subtotal	***1,362,500***	**239,800**	**202,300**	**460,900**	**216,100**	**210,400**	**33,000**
Nonrecoverable Subtotal	***631,200***	**31,900**	**65,500**	**325,000**	**110,400**	**76,300**	**22,100**
Method 1							
Estimated Annual Change in Groundwater Storage	***-198,200***	**-61,600**	**-91,500**	**-6,500**	**-10,500**	**-23,500**	**-4,600**
GW Recharge	1,362,500	239,800	202,300	460,900	216,100	210,400	33,000
GW Pumping	-1,341,800	-282,900	-277,600	-345,400	-191,200	-229,200	-15,500
GW Outflow	-200,400	0	-16,200	-122,000	-35,400	-4,700	-22,100
Other Change in GW Storage	-18,500	-18,500	0	0	0	0	0
Method 2							
Calculated Annual Change in Groundwater Storage (unconfined and confined)	***-134,000***	**-18,000**	**-59,000**	**-24,000**	**-17,000**	**-11,000**	**-5,000**

As shown in **Table 3-4**, the subbasin water budget indicates an annual decline in groundwater storage of 198,200 acre-feet, which is about 64,000 acre-feet higher than the estimate of 134,000 acre-feet decline in groundwater storage based on unconfined groundwater levels and estimated water released from the confined aquifer (Method 2). While not exactly matching, the two estimates of groundwater storage change are presumed satisfactory considering the uncertainty involved in both estimates. The difference in groundwater storage change estimate of 64,000 acre-feet is about 3% of the estimate of ETAW, which typically is considered to have a range of uncertainty of 10-15%. The estimate of groundwater storage change interpreted directly from measured water levels is itself subject to uncertainty of potentially 10-20%. Other components of the water budget are also subject to uncertainty, making the remaining residual difference between the water budget and the direct "measurement" of groundwater storage change adequate considering the currently available data. Generally, the estimated change in storage from unconfined groundwater levels and the estimate of water released from the confined aquifer (Method 2: 134,000 AF/year) is considered the more accurate value. The water budget helped to validate this number. On an average annual basis, the water budget for MAGSA shows an overdraft of approximately 61,600 AF, compared to a calculated overdraft of approximately 18,000 AF based on specific yield and groundwater levels.

McMullin Area GSA Historical Water Budget

The detailed historical water budget for the MAGSA is shown in **Table 3-5.** Water Budgets were developed for normal, wet and dry year scenarios. The wet and dry year water budgets are comparable with the normal year water budgets, with changes made for precipitation and surface water supplies. The normal year water budget reflects average conditions and is used for long-term planning. The wet and dry year water budgets essentially show bookend conditions, including significant overdraft in dry years and water surpluses in wet years.

An important component of the historical water budget is groundwater inflow from North Kings GSA and Central Kings GSA. Through coordinated meetings with all subbasin GSAs, it was determined that groundwater pumping and lack of surface water in MAGSA has additional groundwater flow out of other GSAs. Recent flows were compared to historical flows from the 1920s before there was considerable development. The comparison determined that MAGSA is inducing large volumes of groundwater flow. This value is included in the historical water budget but is removed in the future water budget discussed later, since it is anticipated that these groundwater flows will be mitigated through water supply and demand reduction projects.

Table 3-5 MAGSA Average Annual Historic Water Budget for WY 1997-2011

(all units in acre-feet)

Description	Irrigation Eff. Symbol	79% Volume (AF) Average Year	Wet Year	Dry Year
Supply				
1) Surface Water for Irrigation	Qirr	1,900	6,200	0
2) Surface Water for M&I	Qmi	0	0	0
3) Groundwater Pumping for Irrigation (Private Wells, calculated/estimated)	Gwirra	0	0	0
4) Groundwater Pumping for Irrigation (Private Wells, unknown)	Gwirrp	280,300	233,700	310,900
5) Groundwater Pumping for M&I (Agency Wells)	Gwmia	0	0	0
6) Groundwater Pumping for M&I (Private Wells)	Gwmip	2,600	2,600	2,600
7) Precipitation	P	92,700	131,098	65,901
8) Spill Inflows	Si	2,000	3,500	0
9) Other Supply:	Os	0	0	0
Total Supply		**379,500**	**377,098**	**379,401**
Demand				
Consumptive Use				
10) Evapotranspiration met by Applied Water	ETc	224,200	192,000	245,300
11) Evapotranspiration met by Effective Precipitation	ETp	52,000	84,200	30,900
12) Evapotranspiration of M&I	ETmi	1,300	1,300	1,300
13) Other Consumptive Use: JID Well Field Pumping	Od	18,500	1,497	27,598
Consumptive Subtotal		**296,000**	**278,997**	**305,098**
Groundwater Recharge				
14) Groundwater Inflow	GWi	153,000	153,000	153,000
15) Deep Percolation of Irrigation Water	PRCirr	59,600	51,038	65,206
16) Deep Percolation of Precipitation	PRCp	8,800	22,400	0
17) Deep Percolation of M&I Water	PRCmi	1,300	1,300	1,300
18) Seepage of Channels & Pipelines	Sch	0	0	0
19) Seepage - Reservoirs	Sr	400	400	400
20) Urban Stormwater - Recharge	Rus	0	0	0
21) Local Streams/Rivers - Recharge	Rst	16,700	12,000	25,000
22) Groundwater - Intentional Recharge	Rint	0	0	0
23) Other Recharge:	Or	0	0	0
GW Recharge Subtotal		**239,800**	**240,138**	**244,906**
Nonrecoverable Losses				
24) Groundwater - Outflow	GWo	0	0	0
25) Evaporation - Channels	Ech	0	0	0
26) Evaporation - Reservoirs & Recharge Basins	Er	0	0	0
27) Precipitation - Evaporation and Runoff	Ep	31,900	24,500	35,000
28) Operational Spills	S	0	0	0
29) Groundwater - Export	GE	0	0	0
30) Other Losses:	Ol	0	0	0
Nonrecoverable Subtotal		**31,900**	**24,500**	**35,000**
Estimated Annual Change in Groundwater Storage		**(61,600)**	**2,341**	**(96,192)**
GW Recharge - #14 thru #23	239,800		240,138	244,906
GW Pumping - #3 thru #6	(301,400)		(237,797)	(341,098)
GW Outflow - #24 and #29	0		0	0
Calculated Annual Change in Groundwater Storage		**(16,000)**		
Water Release from Aquitard Compaction		**(2,000)**		
	Total	**(18,000)**		
	Water balance closes within acceptable limit			

Uncertainty in Water Budgets

There is considerable uncertainty in many of the water budget parameters. The parameters with the least uncertainty, estimated as plus or minus 5%, are limited to surface water diversions which are directly measured. Most other water budget parameters are indirectly estimated. For example, precipitation is estimated based on a limited number of sparsely distributed precipitation stations. Water budget parameters

using precipitation (such as effective precipitation) start with the uncertainty of the precipitation value itself, which is increased by the need to estimate crop evapotranspiration, soil moisture storage and movement through the soil surface to provide recharge. The largest single component of water use, evapotranspiration of applied water, is estimated to have an accuracy of plus or minus 15%, with uncertainty resulting from infrequent surveys of cropping patterns, indirect estimates of unit evapotranspiration rates for crop types, and variations in agricultural management practices that result in variations in unit crop water use.

For the historical period, the estimated annual change in groundwater storage was 61,600 AF based on the water budget, which differs from the "direct" estimate of groundwater storage change of 16,000 AF. The "direct" estimate of groundwater storage change is based on specific yield estimates and water levels from groundwater contour maps. There is some uncertainty in the specific yields used for this estimate and water level changes map be questionable on a year-to-year basis. However, over a 15-year period like Water Year (WY) 1997-2011, the total change in groundwater levels should be relatively definite. With improved data collection, it is expected that this discrepancy could reduce over time and result in specific future refinements to the water budgets that achieve the same outcome. The water budget (including the historical, current and future versions) should therefore be considered an approximate model for the MAGSA hydrologic system, and the values should be used as guides rather than precise values.

3.3.9 Current Water Budget

Regulation Requirements:

§354.18
(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.
(d) The Agency shall utilize the following information provided, as available, by the Department pursuant to Section 353.2, or other data of comparable quality, to develop the water budget:
(2) Current water budget information for temperature, water year type, evapotranspiration, and land use.

Kings Basin Current Water Budget

Table 3-6 shows a current water budget (2016-2017) for the Kings Subbasin as a whole along with the equivalent individual water budgets for the seven GSAs within the Kings Subbasin.

Table 3-6 Kings Basin Current Water Budget (2016-2017)

(all units in acre-feet)

Description	TOTAL	McMullin GSA	NFKings GSA	North Kings GSA	Central/South	Kings River East	James ID
Total Supply	*3,490,400*	389,400	*621,300*	*1,110,300*	604,900	*671,500*	*93,000*
Consumptive Use Subtotal	*2,043,000*	303,800	403,200	493,600	350,300	424,600	67,500
GW Recharge Subtotal	*1,352,000*	241,900	203,300	449,400	215,700	208,400	33,300
Nonrecoverable Subtotal	*635,400*	31,900	65,500	330,400	109,200	76,300	22,100
Method 1							
Estimated Annual Change in Groundwater Storage	-119,400	-69,400	-63,100	39,200	-1,100	-19,500	-5,500
GW Recharge	1,352,000	241,900	203,300	449,400	215,700	208,400	33,300
GW Pumping	-1,285,000	-292,800	-282,700	-288,200	-181,400	-223,200	-16,700
GW Outflow	-200,400	0	-16,200	-122,000	-35,400	-4,700	-22,100
Other Change in GW Storage	14,000	-18,500	32,500	0	0	0	0

The water budget shows a change in groundwater storage of -119,400 AF/year, which is less than the -198,200 AF/year estimated for the historical period. This reduction is attributed to increased surface water use in some cities, water meter installations, and residual effects of conservation measures implemented during the 2012-2015 drought.

MAGSA Current Water Budget

A Current Water Budget was prepared for the GSA based on the following criteria:

1. Urban water demands were based on the average demands for 2016 and 2017. These represent a dry year and wet year, respectively. This period was selected since it best represented both current and average conditions. No recent single year was considered a better representation of current hydrology than these two years.

2. Agricultural demands were based on 2014 DWR land use maps, which are the most recent comprehensive land use maps for the area.

3. Surface water supplies were based on the long-term average supplies from the historical water budget, and not the actual supplies delivered in 2016 and 2017.

4. Other variables not described above were assumed to be the same as the historical water budget.

The MAGSA Current Water Budget is shown in **Table 3-7**. Wet and Dry Year water budgets, with variations in surface water supplies and precipitation based on the year type, are also shown in **Table 3-7**. Overall, the water budget shows a slightly higher demand on groundwater with an increase in ETAW of about 23,000 acre-feet.

The current water budget is a short snapshot of water conditions and not considered as accurate as a long-term average water budget. The water budget was not compared to changes in groundwater levels since it would be inaccurate due to time lags from various forms of recharge, and inaccuracies that tend to balance out over longer time periods. Lastly, some of the measures, such as water conservation, may not persist long-term. Nevertheless, this water budget is still the best representation of current water budget conditions available.

Table 3-7 McMullin Area GSA Current Demands Water Budget

(all units in acre-feet)

Description	Irrigation Eff. Symbol	79% Volume (AF)		
Supply		Average Year	Wet Year	Dry Year
1) Surface Water for Irrigation	Qirr	1,900	6,200	0
2) Surface Water for M&I	Qmi	0	0	0
3) Groundwater Pumping for Irrigation (Private Wells, calculated/estimated)	Gwirra	0	0	0
4) Groundwater Pumping for Irrigation (Private Wells, unknown)	Gwirrp	290,200	243,600	320,800
5) Groundwater Pumping for M&I (Agency Wells)	Gwmia	0	0	0
6) Groundwater Pumping for M&I (Private Wells)	Gwmip	2,600	2,600	2,600
7) Precipitation	P	92,700	131,098	65,901
8) Spill Inflows	Si	2,000	3,500	0
9) Other Supply:	Os	0	0	0
Total Supply		**389,400**	**386,998**	**389,301**
Demand				
Consumptive Use				
10) Evapotranspiration met by Applied Water	ETc	232,000	199,800	253,100
11) Evapotranspiration met by Effective Precipitation	ETp	52,000	84,200	30,900
12) Evapotranspiration of M&I	ETmi	1,300	1,300	1,300
13) Other Consumptive Use: JID Wellfield Pumping	Od	18,500	1,497	27,598
Consumptive Subtotal		**303,800**	**286,797**	**312,898**
Groundwater Recharge				
14) Groundwater Inflow	GWi	153,000	153,000	153,000
15) Deep Percolation of Irrigation Water	PRCirr	61,700	53,111	67,280
16) Deep Percolation of Precipitation	PRCp	8,800	22,400	0
17) Deep Percolation of M&I Water	PRCmi	1,300	1,300	1,300
18) Seepage of Channels & Pipelines	Sch	0	0	0
19) Seepage - Reservoirs	Sr	400	400	400
20) Urban Stormwater - Recharge	Rus	0	0	0
21) Local Streams/Rivers - Recharge	Rst	16,700	12,000	25,000
22) Groundwater - Intentional Recharge	Rint	0	0	0
23) Other Recharge:	Or	0	0	0
GW Recharge Subtotal		**241,900**	**242,211**	**246,980**
Nonrecoverable Losses				
24) Groundwater - Outflow	GWo	0	0	0
25) Evaporation - Channels	Ech	0	0	0
26) Evaporation - Reservoirs & Recharge Basins	Er	0	0	0
27) Precipitation - Evaporation and Runoff	Ep	31,900	24,500	35,000
28) Operational Spills	S	0	0	0
29) Groundwater - Export	GE	0	0	0
30) Other Losses:	Ol	0	0	0
Nonrecoverable Subtotal		**31,900**	**24,500**	**35,000**
Estimated Annual Change in Groundwater Storage		**(69,400)**	**(5,486)**	**(104,018)**
GW Recharge - #14 thru #23	241,900		242,211	246,980
GW Pumping - #3 thru #6	(311,300)		(247,697)	(350,998)
GW Outflow - #24 and #29	0		0	0
Calculated Annual Change in Groundwater Storage		**(16,000)**		
Water Release from Aquitard Compaction		**(2,000)**		
	Total	**(18,000)**		
	Water balance closes within acceptable limit			

3.3.10 Projected Water Budget

Regulation Requirements:

§354.18
(c) Each Plan shall quantify the current, historical, and projected water budget for the basin as follows:
(3) Projected water budgets shall be used to estimate future baseline conditions of supply, demand, and aquifer response to Plan implementation, and to identify the uncertainties of these projected water budget components. The projected water budget shall utilize the following methodologies and assumptions to estimate future baseline conditions concerning hydrology, water demand and surface water supply availability or reliability over the planning and implementation horizon:
(A) Projected hydrology shall utilize 50 years of historical precipitation, evapotranspiration, and streamflow information as the baseline condition for estimating future hydrology. The projected hydrology information shall also be applied as the baseline condition used to evaluate future scenarios of hydrologic uncertainty associated with projections of climate change and sea level rise.
(B) Projected water demand shall utilize the most recent land use, evapotranspiration, and crop coefficient information as the baseline condition for estimating future water demand. The projected water demand information shall also be applied as the baseline condition used to evaluate future scenarios of water demand uncertainty associated with projected changes in local land use planning, population growth, and climate.
(C) Projected surface water supply shall utilize the most recent water supply information as the baseline condition for estimating future surface water supply. The projected surface water supply shall also be applied as the baseline condition used to evaluate future scenarios of surface water supply availability and reliability as a function of the historical surface water supply identified in Section 354.18(c)(2)(A), and the projected changes in local land use planning, population growth, and climate.
(d) The Agency shall utilize the following information provided, as available, by the Department pursuant to Section 353.2, or other data of comparable quality, to develop the water budget:
(1) Historical water budget information for 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, and sea level rise.

Projected water budgets (future water budgets) have been developed for 2040 and 2070. The 2040 water budget is the focus of this analysis as it represents near term periods and requires less speculative estimates of projected future climate change impacts, population growth and land use change.

Projected water budgets are based initially on the Current water budget, with changes made to various variables, as shown in the Figure below.

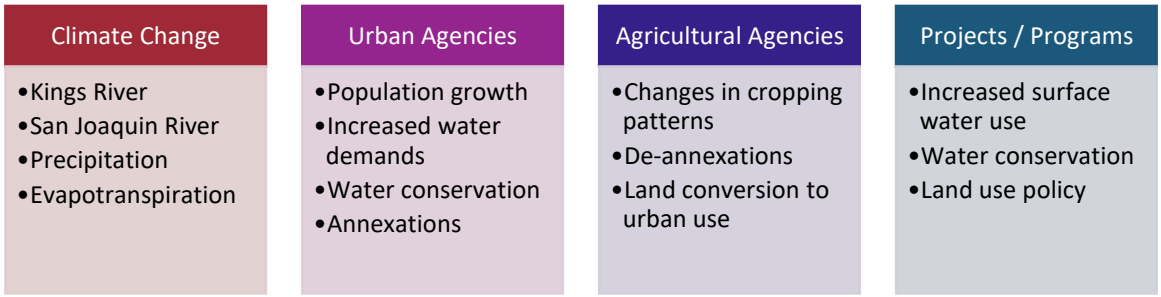


Figure 3-79 Variables Impacting Projected Water Budget

Climate Change

Climate change impacts were based on *Guidance for Climate Change Data Use during Groundwater Sustainability Plan Development* (DWR, 2018) and the related climate change website: https://data.cnra.ca.gov/dataset/sgma-climate-change-resources. This document provided estimates for 2030 and 2070. Since 2040 is the deadline for sustainability, and therefore the focus of the water budgets, impacts from 2040 were interpolated between the 2030 and 2070 results.

The DWR climate change datasets were developed for the California Water Commission's Water Storage Investment Program (WSIP). As described by DWR, the WSIP dataset is consistent with other DWR

programs, is based on best available science, builds on previous efforts, incorporates the latest advances in projections, and follows Climate Change Technical Advisory Group guidance. The available datasets include central tendency projections of ensembles of general circulation models for 2030 and 2070 levels. The datasets also include climatic bookends for 2070 conditions, with a drier, extreme warming scenario and a wetter, moderate warming scenario being provided. Only the central tendency simulations were used for preparing water budgets for the Kings Subbasin.

For the Kings Subbasin, three DWR datasets were used; namely, projected Kings River inflows to Pine Flat Dam, projected precipitation in the Kings Subbasin and projected evapotranspiration. In addition, projections for Friant-Kern Canal water supplies (San Joaquin River) were developed by the Friant Water Authority (2018) and are also based on WISP projections.

Kings River Flows

Kings River inflows for early future and late future conditions were analyzed based on the WSIP water supply projections. As shown in **Figure 3-80**, the central tendency projections for both 2030 and 2070 show a slight increase in projected Kings River inflows, however there was a major shift in timing of runoff.

The simple interpretation of this shift is that predicted warmer temperatures in the future will result in more precipitation in the Sierra Nevada occurring as rainfall and less as snowfall. Additionally, warmer temperatures mean that snowfall will tend to melt earlier that it would have melted historically.

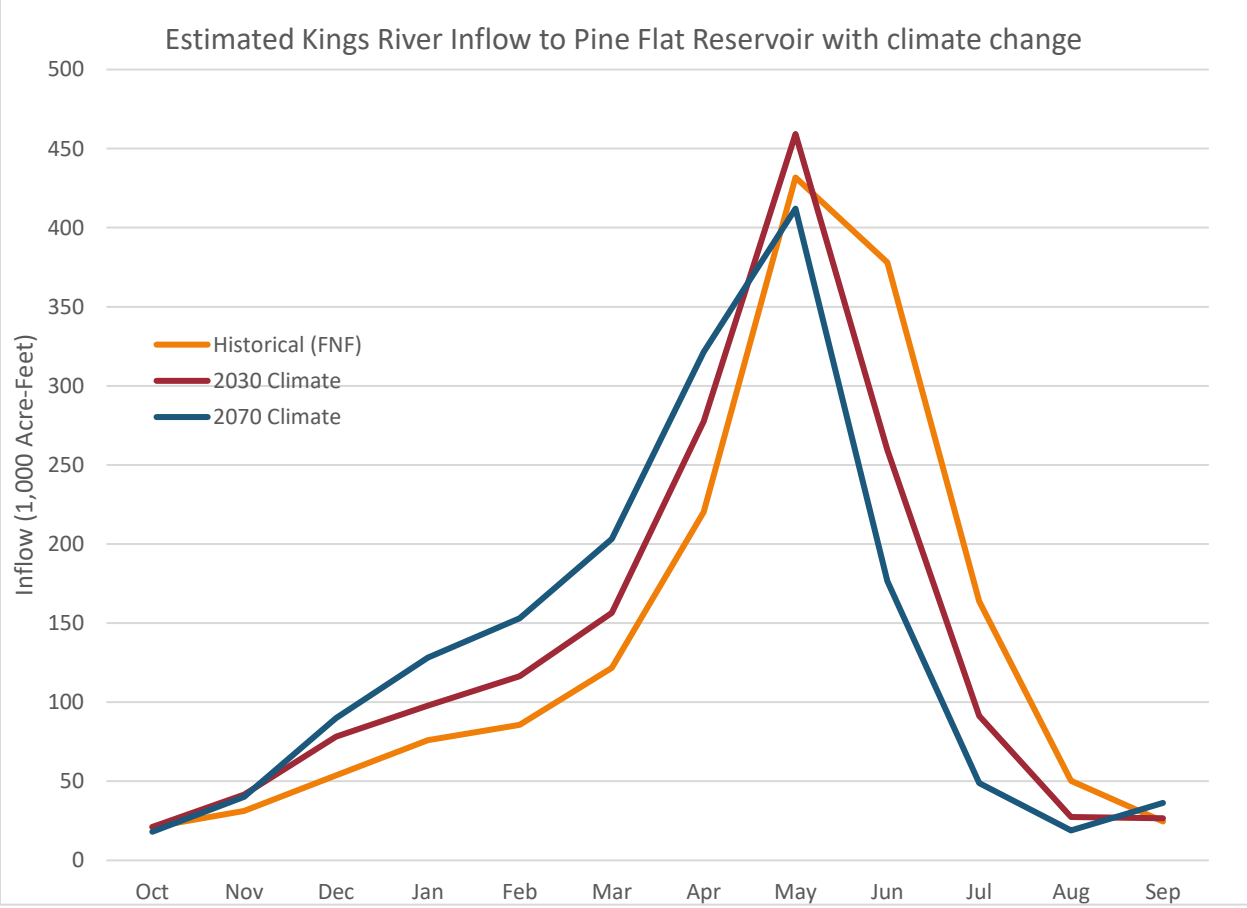


Figure 3-80 Estimated Projected Kings River Inflow to Pine Flat Reservoir

As noted earlier, the overall change in predicted Kings River inflows is a very slight increase. Inflows increased about 0.7% between historical and early future (2030) conditions and increased 0.3% between

historical and late future (2070) conditions. However, there were some major shifts in timing of runoff, with large drops in runoff occurring in the late spring/early summer months of June, July and August. Runoff during winter months tended to increase significantly for winter and early spring months. While the overall change in runoff is essentially negligible, there would be significant changes in water management based on the change in runoff patterns. Historically, significant amounts of Kings River runoff occurred during the irrigation season when inflows could be directly used for water deliveries without needing storage. In the future more of this runoff will now occur during non-irrigation or low-irrigation months. Maintaining the same level of water supply from the Kings River in the future will require modifications in water management practices including increased use of surface water storage, increased recharge during the non-irrigation and low-irrigation periods, and expansion of diversion facilities to accommodate higher peak flows in non-irrigation and low-irrigation periods. In addition to management changes by local water agencies, maintaining historical surface water supplies will also be affected by water rights allocations, which assign available water to local water agencies on defined schedules that vary by period.

Quantification of the impacts of predicted Kings River inflows on surface water supplies would require a sophisticated, theoretical operations model that considers inflow availability, water rights and management practices by local water agencies. No such operations model is available and development of such a model was not feasible during preparation of the current GSPs. Additionally, water management on the Kings River is based on numerous factors in addition to those that could be incorporated into a monthly operations model such as operational availability of facilities, cropping patterns, daily water supply allocations, availability of recharge facilities, management practices and other factors, which preclude the possibility of a simplified analysis. It is expected that future SGMA analyses will continue to consider the potential quantification of future water supply, however there is no certainty that such an analysis will be pursued or would improve predictive capability even if it was available.

Based on the uncertainty described above, the assumption was made that Kings River water supplies available to the Kings Subbasin water supplies will be managed in the future to maintain historical levels of water supplies. This assumption is based on the slight overall increase in runoff, flexibility of existing water management to absorb changed timing of inflows and projected changes in the timing of irrigation demands corresponding to warming.

Precipitation

The WSIP climate change datasets provided by DWR were reviewed for precipitation and evapotranspiration conditions. For precipitation, the interpolated dataset for 2040 and the dataset for 2070 generally showed minimal changes (**Figure 3-81**).

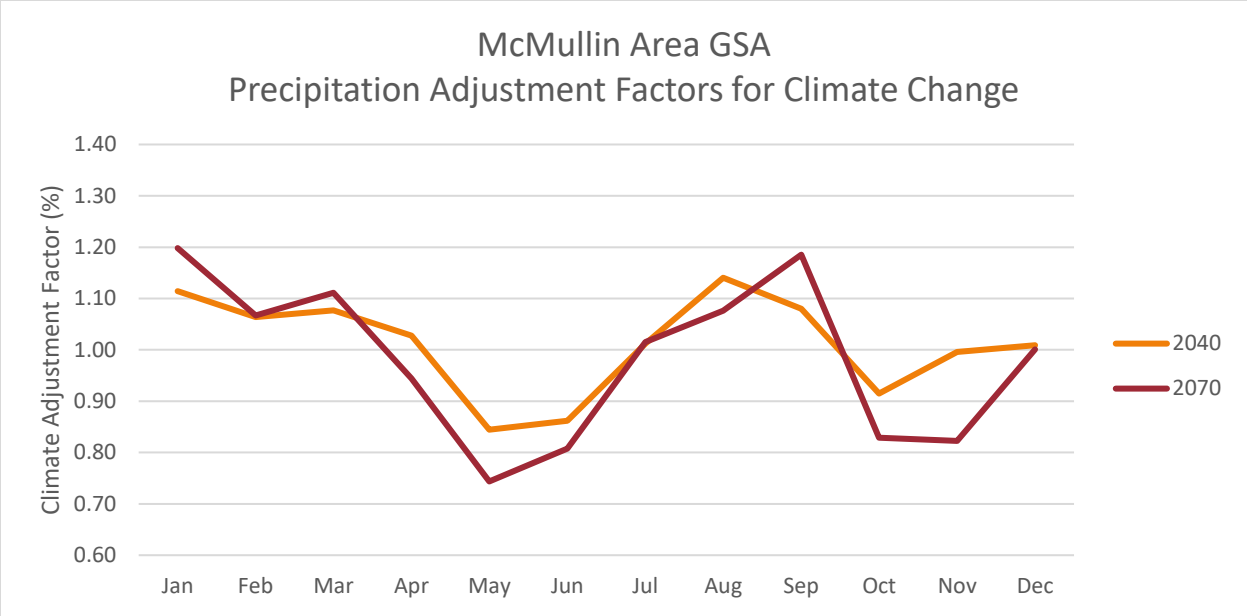


Figure 3-81 50-year Monthly Average Precipitation Climate Change Factor

The overall average precipitation change factors were projected to increase by 1.2% for early future (2040) conditions and to decrease by 1.7% for late future (2070) conditions. Moreover, the average monthly adjustment factors understate the effect on precipitation, as many of the months with projected decreases in precipitation (e.g., May, June and October) are low precipitation months while months indicated increased precipitation tend to be wetter (e.g., January and February). Adjusting for monthly average precipitation, the estimated total volume of precipitation for the MAGSA is estimated to increase by 2% for early future and 1% for late future conditions. Given the generally low amount of precipitation in the Kings Subbasin and the slight increase projected with climate change, a conservative assumption has been made that projected rainfall, and amounts available for water supply such as effective precipitation and recharge from precipitation, will remain the same for early future and late future projection as estimated for the historical period.

Evapotranspiration

The WSIP climate change projections provided by the DWR project consistently higher evapotranspiration rates for early future and late future conditions, as shown in **Figure 3-82**. For early future (2040) conditions, the projected adjustments indicate an average increase of 4.3% with little variation by month on average. For late future (2070) conditions, the projected adjustments indicate an average increase of 8%. Although the late future projections show slightly more variation by month, the outlier (higher) rates are in relatively low evapotranspiration months (e.g., November, December, and January) and relatively consistent during the irrigation season (April through September).

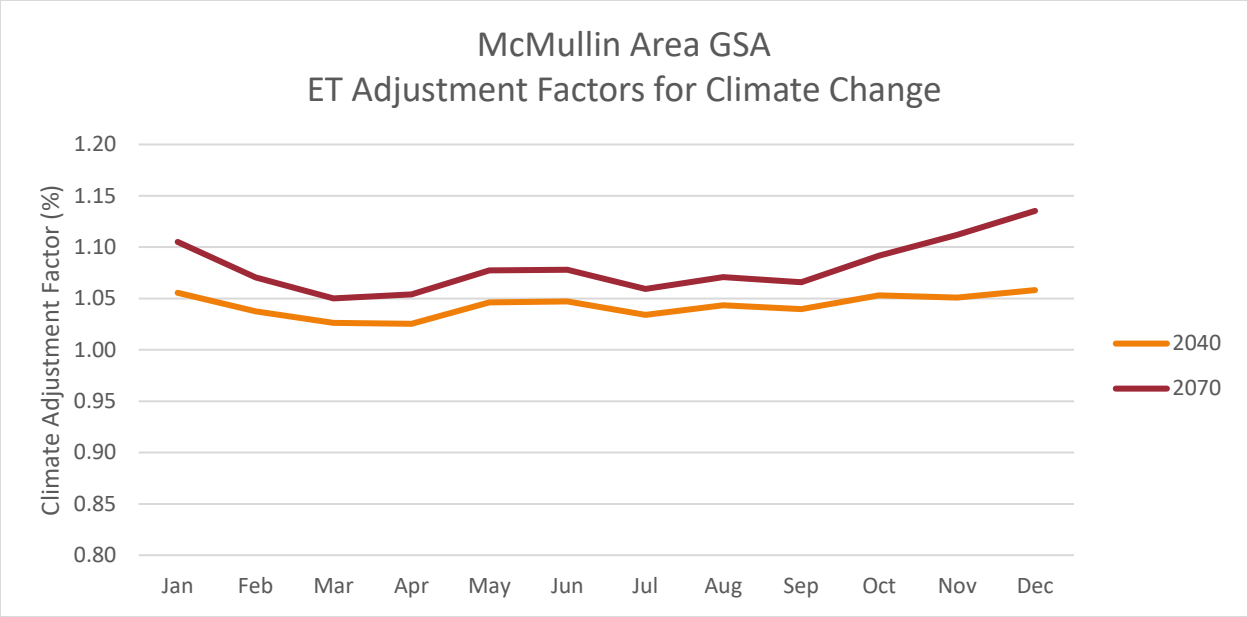


Figure 3-82 50-year Monthly Average ET Climate Change Factor

The effect of projected increased evapotranspiration rates on irrigated water use were reviewed, with reference to a U.S Bureau of Reclamation report on effects of climate change as follows:

> *"Annual crop ET is projected to increase for perennial crops, with smaller increases, and sometimes slight decreases, for annual crops. Perennial crop ET increases are due to longer growing seasons and increases in ETo. While annual crops also experience increased ET rates, earlier potential planting dates and reduced growing season due to increased temperatures and crop development sometimes result in decreased annual crop ET."* (USBR, 2015)

For the Kings Subbasin, evapotranspiration adjustment factors were applied based on the documentation in the USBR, 2015 report. For annual crops, unit water use was left at rates identified in the historical period. For perennial crops, unit water use was increased corresponding to the increasing projected for the early future (2040) and late future (2070) WSIP projections.

Future water use for municipal areas has been updated based on projected population rates and updated per capita water use. Where available, Urban Water Management Plans have been used as the source of population projections and per capita water use rates. MAGSA does not anticipate much growth in population over the implementation phase of the plan; therefore, municipal water demand remains unchanged from the current budget. The ratios of indoor use, outdoor use and resulting recharge were left as developed for the historical period. The higher anticipated evapotranspiration (ET) is not expected to impact urban water use through higher landscaping demands, since urban agencies are seeking per capita consumption goals.

In preparing the projected water budget, it was assumed that MAGSA will have completed enough projects to bring in or recharge approximately 41,000 AF on an average annual basis. The rest of the overdraft will have been mitigated through management action aimed at reducing demand.

Kings Basin Projected Water Budget

Table 3-8 shows a projected water budget for the Kings Subbasin as a whole along with the equivalent individual water budgets for the seven GSAs within the Kings Subbasin. The proposed mitigation measures are shown at the bottom of the table including water supply augmentation, demand reduction from project development (e.g. land taken out of agricultural production to build recharge basins), and management actions. These all result in net zero change in groundwater storage in 2040.

Table 3-8 Kings Basin Projected Water Budget (2040)

(all units in acre-feet)

Description	TOTAL	McMullin GSA	NFKings GSA	North Kings GSA	Central/South	Kings River East	James ID
Total Supply	*3,686,945*	*404,800*	*628,800*	*1,238,356*	*627,000*	*687,000*	*100,989*
Consumptive Use Subtotal	*2,139,841*	297,500	409,000	547,000	365,200	435,000	67,641
GW Recharge Subtotal	*1,434,453*	*245,100*	*205,000*	*518,400*	*219,500*	*213,100*	33,353
Nonrecoverable Subtotal	*645,541*	*50,400*	*65,500*	*336,100*	*113,500*	*76,400*	*22,141*
Method 1							
Estimated Annual Change in Groundwater Storage	0	0	0	0	0	0	0
GW Recharge	1,434,453	245,100	205,000	518,400	219,500	213,100	33,353
GW Pumping	-1,467,406	-308,200	-290,200	-412,200	-199,200	-239,700	-17,906
GW Outflow	-200,441	0	-16,200	-122,000	-35,400	-4,700	-22,141
Other Change in GW Storage	14,000	-18,500	32,500	0	0	0	0
Projects for Water Supply Augmentation	168,494	40,600	62,800	15,800	15,100	27,500	6,694
Demand Reduction from Project Development	7,500	800	2,900	0	0	3,800	0
Management Actions for Demand Reduction	43,400	40,200	3,200	0	0	0	0

MAGSA Projected 2040 Water Budget

The projected MAGSA water budgets for the early future (based on 2040 climate conditions) are shown in **Table 3-9**. The projected water budget includes the yield from anticipated future projects resulting in a net groundwater change of zero.

Table 3-9 Near Future (2040) Projected Water Budget Including Projects and Management Actions

(all units in acre-feet)

Description	Irrigation Eff. Symbol	79% Volume (AF)		
		Average Year	Wet Year	Dry Year
Supply				
1) Surface Water for Irrigation	Qirr	1,900	6,200	0
2) Surface Water for M&I	Qmi	0	0	0
3) Groundwater Pumping for Irrigation (Private Wells, calculated/estimated)	Gwirra	0	0	0
4) Groundwater Pumping for Irrigation (Private Wells, unknown)	Gwirrp	305,600	265,300	336,200
5) Groundwater Pumping for M&I (Agency Wells)	Gwmia	0	0	0
6) Groundwater Pumping for M&I (Private Wells)	Gwmip	2,600	2,600	2,600
7) Precipitation	P	92,700	131,098	65,901
8) Spill Inflows	Si	2,000	3,500	0
9) Other Supply:	Os	0	0	0
Total Supply		**404,800**	**408,698**	**404,701**
Demand				
Consumptive Use				
10) Evapotranspiration met by Applied Water	ETc	244,200	212,000	265,300
11) Evapotranspiration met by Effective Precipitation	ETp	52,000	84,200	30,900
12) Evapotranspiration of M&I	ETmi	1,300	1,300	1,300
13) Other Consumptive Use: JID Wellfield Pumping	Od	18,500	1,497	27,598
Consumptive Subtotal		**316,000**	**298,997**	**325,098**
Groundwater Recharge				
14) Groundwater Inflow	GWi	153,000	153,000	153,000
15) Deep Percolation of Irrigation Water	PRCirr	64,900	56,354	70,523
16) Deep Percolation of Precipitation	PRCp	8,800	22,400	0
17) Deep Percolation of M&I Water	PRCmi	1,300	1,300	1,300
18) Seepage of Channels & Pipelines	Sch	0	0	0
19) Seepage - Reservoirs	Sr	400	400	400
20) Urban Stormwater - Recharge	Rus	0	0	0
21) Local Streams/Rivers - Recharge	Rst	16,700	12,000	25,000
22) Groundwater - Intentional Recharge	Rint	0	6,200	0
23) Other Recharge:	Or	0	0	0
GW Recharge Subtotal		**245,100**	**251,654**	**250,223**
Nonrecoverable Losses				
24) Groundwater - Outflow	GWo	0	0	0
25) Evaporation - Channels	Ech	0	0	0
26) Evaporation - Reservoirs & Recharge Basins	Er	0	0	0
27) Precipitation - Evaporation and Runoff	Ep	31,900	24,500	35,000
28) Operational Spills	S	0	0	0
29) Groundwater - Export	GE	0	0	0
30) Other Losses:	Ol	0	0	0
Nonrecoverable Subtotal		**31,900**	**24,500**	**35,000**
Estimated Annual Change in Groundwater Storage		**0**	**63,857**	**(34,575)**
GW Recharge - #14 thru #23		245,100	251,654	250,223
GW Pumping - #3 thru #6		(326,700)	(269,397)	(366,398)
GW Outflow - #24 and #29		0	0	0
Projects for Water Supply Augmentation		**40,600**	**40,600**	**40,600**
Demand Reduction from Project Development		**800**	**800**	**800**
Management Actions for Demand Reduction		**40,200**	**40,200**	**40,200**

Projected water budget for late future (2070) is largely the same as the 2040 water budget with an adjustment to the anticipated ET demand for crops. Based on average DWR climate change factors for MAGSA, the ET for 2070 is anticipated to increase by approximately 8.1 percent from current values. Therefore, the expected ET demand would increase by about 10,700 AF from the 2040 budget. Due to the uncertainty in planning so far ahead, this potential increase in demand will be accounted for as data is updated and refined into the implementation phase of the plan.

3.3.11 Quantification of Overdraft

Regulation Requirements:

> **§354.18(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.

DWR Bulletin 118 defines the Kings Subbasin as being subject to critical overdraft. The existence of overdraft in the Kings Subbasin is documented by historical decline in groundwater levels and is confirmed by the historical water budget presented previously. The historical water budget for the period of Water Years 1996-97 through 2010-11 represents an average hydrological period on the Kings River. The estimated annual decline in groundwater storage for the MAGSA during this period, as "directly" estimated based on groundwater levels, specific yields and measured groundwater subsidence, is 18,000 AF/year. This result was corroborated by the computed water budget, which identified an estimated annual groundwater storage decrease of 61,600 AF/year. As described earlier, the level of uncertainty for components of the water budget is such that the two estimated changes in groundwater storage (18,000 AF and 61,6000 AF) are substantially similar when considering computational uncertainty. The value estimated based on groundwater contours is considered the more accurate values, since it was based primarily on measured data, whereas the water budget contains numerous assumptions and estimates.

The current overdraft, based in the Current Water Budget for 2016/2017, shows a decrease in groundwater storage of 69,400 AF/year. This is considered the best estimate of current conditions. The Current Water Budget is a short-term snapshot and may not necessarily represent long-term average conditions.

3.3.12 Water Year Type Associated with Water Budget Components

Regulation Requirements:

> **§354.18(b)** The water budget shall quantify the following, either through direct measurements or estimates based on data:
> **(6)** The water year type associated with the annual supply, demand, and change in groundwater stored.

Water year types were identified for the Kings Subbasin based on Kings River diversions, since the Kings River is the largest source of water supply to the Subbasin. Water types were identified for Wet, Normal and Dry Years, with Wet Years occurring when diversions are more than 125% of normal and Dry Years occurring when diversions are less than 75% of normal. In the 15-year Historical period of WYs 1997-2011, there were four wet years, three dry years and eight normal years.

3.3.13 Estimate of Sustainable Yield for the Basin

Regulation Requirements:

> **§354.18(b)** The water budget shall quantify the following, either through direct measurements or estimates based on data:
> **(7)** An estimate of sustainable yield for the basin.

The 'sustainable yield' is defined as the amount of groundwater pumping that can occur while maintaining groundwater at sustainable levels and avoiding undesirable results. The sustainable yield can be estimated as the Total Groundwater Recharge (from natural and artificial sources) minus the Groundwater Outflow. Using the Current Kings Basin Water Budget (**Table 3-6**), the sustainable yield is estimated to be:

1,370,000 AF – 200,000 AF = **1,170,000 AF/year**

Note: Values are rounded to the nearest 10,000 AF

Due to the numerous uncertainties, assumptions and estimates in the water budgets, the sustainable yield is considered approximate in nature, but gives a good general idea of the groundwater available. This sustainable yield value is based on long-term average supplies under current demand and development conditions. The sustainable yield can, and will likely, change over time due to increased surface usage, increases in demands, and climate change impacts. As a result, the sustainable yield may go up or down over time.

It should be noted that this is a basin-wide sustainable yield, and this value cannot be used to estimate sustainable yield in local areas. The effective sustainable yield on a per acre basis will be different for each GSA and may also vary in different parts of a GSA.

3.3.14 Management Areas

Regulation Requirements:

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

(b) A basin that includes one or more management areas shall describe the following in the Plan:

Since MAGSA is rather homogenized in terms of water supplies and land use, the GSA will be managed as a single management area. The associated measurable objectives, minimum thresholds, and monitoring will be described in Chapters 4 and 5.

3.4 Water Supply

Each potential project presented has a surface water supply that was identified as being more likely to be available. However, MAGSA nor the water districts within MAGSA have any surface water supply contracts and supplies will need to be developed for a successful project**. Section 3.4** identifies the supplies that could be available to projects and historical water supply availability. Due to the location of the projects, only certain surface water supplies may be available for purchase for any particular project.

3.4.1 Water Rights

In California, surface water cannot be owned by individuals, groups, businesses, or governmental agencies, but permits, licenses, and registrations give the right to beneficially use reasonable amounts of water within a specific area or Place of Use. Based on the location of MAGSA, it is located within the Place of Use for the USBR CVP but is not located within the Place of Use for the Kings River, called the Kings River Service Area or SWP. Therefore, entities could purchase surface water supplies from the CVP and use it for beneficial uses within the GSA after going through the various regulatory and environmental processes for a water transfer if there was a willing seller. New water rights are typically not being granted on either the SJR and the Kings River, as they are deemed fully appropriated upstream of Mendota Dam according to the California Division of Water Rights. However, existing CVP or SWP supplies held by others could be used by an agency by agreement. Similarly, MAGSA could develop an agreement to use appropriated pre-1914 water rights as pre-1914 supplies are not limited to a specific Place of Use.

3.4.2 Kings River Supplies

Since the construction of Pine Flat Dam, the North Fork of the Kings River downstream of Stinson Weir with continuation through the James Bypass and Fresno Slough to the SJR, has normally been dry except during flood events. In high flow events, floodwater in the North Fork is measured near the point that the water leaves the Kings River Service Area on the James Bypass at the gaging station just downstream of Placer Avenue. High flow water, or floodwater, from Pine Flat Reservoir has historically been available in the North Fork of the Kings River on average about every 3 years, 23 out of 64 years (for the years 1954/55 to 2017/18), as shown in **Table 3-10**. On an average annual basis, the historical record indicates that approximately 180,000 AF over about a 40-day period could have been available based on the record of flows leaving the Kings River service area. For the period 1954 to 2016, an average of approximately 504,000 AF per event over an average of 115 days occurred.

Table 3-10 Floodwater Discharge at James Bypass Gaging Station
Since the Construction of Pine Flat Dam (1954/55 – 2015/16)

Water Year	% of Avg.	Total (Acre-Feet)	Duration (Days)
1955-56	153%	91,205	46
1957-58	150%	212,797	109
1966-67	199%	484,870	113
1968-69	258%	1,551,343	205
1969-70	78%	62,173	44
1973-74	123%	86,353	63
1977-78	203%	551,189	138
1978-79	102%	11,763	46
1979-80	179%	579,581	192
1981-82	183%	452,756	122
1982-83	264%	2,309,290	332
1983-84	116%	568,609	169
1985-86	192%	667,750	130
1986-87	46%	1,347	22
1994-95	204%	586,510	149
1995-96	123%	74,542	38
1996-97	156%	437,113	103
1997-98	183%	986,453	166
1998-99	74%	20,043	29
2004-05	149%	63,194	36
2005-06	173%	612,148	84
2010-11	195%	503,465	150
2016-17	242%	688,812	164
Average		504,490	115

However, if the hydrology repeated itself, this historical amount of floodwater would likely not be available today because the Kings River water rights holders have constructed numerous groundwater recharge projects over the years that capture floodwater now that could not have been utilized previously. It is doubtful that any smaller volume flood releases will occur in the future because of the additional projects that have been built and future projects that are planned to be built by the water rights holders on the Kings River. If the smaller flood releases were removed from the historical record, then the frequency of occurrence of floodwater would be less. If for example, flood release volumes less than 100,000 AF were removed, the frequency would be approximately 1 out of 4 years and the duration about 35 days on an average annual basis. It is expected that the volume of available water during a flood release will be significantly less on average in the future because of the additional projects already and planned to be constructed by the water rights holders.

Furthermore, if the flood release volumes for the extremely wet years of 1968-69 and 1982-83 were removed based on the assumption that those years would not occur again, the frequency would be approximately 1 out of 3 years and the duration about 31 days on an average annual basis. If the flood release volumes for the extremely wet years of 1968-69 and 1982-83 were removed as well as those years with less those than 100,000 AF based on the assumption that these events would not occur again, the frequency would be approximately 1 out of 5 years and the duration about 28 days on an average annual basis.

Therefore, the volume of available water during a flood release may be less than the historical record indicates of frequency of about every 3 years for 40 days on an average annual basis but could be as low as every 1 out of 5 years with duration of about 28 days on an average annual basis. Even so, the duration and frequency of the historical record was used in the assumed water supply for those projects described herein with the potential for a Kings River water supply.

Possible Kings River Implications

MAGSA is not located within the Kings River Service Area and is outside the Place of Use for the water rights held in trust by the KRWA for their member units. These water rights include floodwaters and various other appropriated rights, including pre-1914 rights. The SWRCB DWR or State Board regulates the appropriation and beneficial use of water in California and has determined that the Kings River is fully appropriated, which means that the State Board is not accepting new applications to appropriate water from the Kings River unless a petition for reconsideration of the fully appropriated stream status is also submitted. However, with the water that has historically been lost to the service area in high flow events, there should still be water available for use in some years. The MVWD and Terranova Ranch have diverted some water from the North Fork of the Kings River or James Bypass in past high flow years on the Kings River through temporary floodwater agreements from KRWA.

Fresno, Alta and Consolidated Irrigation Districts together filed an application to modify the Place of Use for the Kings River service area and to appropriate Kings River high flows on May 9, 2017, to protect the local water rights. The application included several projects within MAGSA among others. By changing the Place of Use and identifying the specific projects, Kings River waters besides pre-1914 water could potentially go to the MAGSA projects if the water rights application is approved. In addition to flows that could be available directly off the Kings River, Kings River water could be diverted from other facilities owned by KRWA member units such as the Liberty Millrace Canal if water above the member unit need was available. However, Semitropic in Kern County also filed an application to appropriate water from the Kings River on May 25, 2017, along with a petition for reconsideration of the fully appropriated stream status of the Kings River. The State Board could consider the fully appropriated status at a State Board hearing at some point in the future. Semitropic proposes to use all flood flows in excess of 100 cfs, up to 2,200 cfs, that leaves the Kings River service area through the North Fork of the Kings River.

Water Rights Permit Process

If the State Board determines that adequate evidence exists for a public hearing to reconsider the fully appropriated stream status and if the fully appropriated stream status is revoked, then the two competing water rights applications would be considered before a water rights permit could be issued. A water rights permit must identify the amounts, conditions, and construction timetables for the proposed water project. Before the State Board issues a permit, it accounts for all prior rights and the availability of water in the basin. The State Board also considers the flows needed to preserve instream uses such as fish and wildlife habitat.

The State Board indicates that it has more than 500 pending water right applications, and even if all information needed is provided, they indicate it may take 3 to 4 years to obtain a permit. If others protest the project or the project has the capacity to harm threatened or endangered species, it could take even longer to get a permit. The process of the State Board reviewing the fully appropriated stream status will likely increase the time required due to the public review. The fact that there are two competing water rights applications will also lengthen the time before any permit could be issued.

Therefore, the availability of Kings River supplies from flood releases on a reliable basis will likely be five or more years before any determination is made.

3.4.3 Central Valley Project Supplies

For those projects with a connection to FID or Mendota Pool, CVP Friant Division Section 215 water or contracted CVP supplies could be available as MAGSA is located within the CVP Place of Use, and therefore additional CVP Class I or Class II supplies that might be available for purchase could be permitted and brought to the District, or any pre-1914 supplies that might be available for purchase off the Friant system that could be wheeled to Mendota Pool or through Fresno ID.

Quantifying the water that might be available presumes that historical hydrology will repeat itself, but this will not occur because predicting future availability is unknown. The most likely CVP water that could be available is Section 215 water, a high flow federal designation for floodwater. Section 215 of the Reclamation Reform Act, Public Law 97-293 authorizes the Bureau of Reclamation to provide temporary water service contracts for non-storable flood flows as a result of either an unusually large water supply not otherwise storable for project purposes or infrequent and otherwise unmanaged flood flows of short duration. General assumptions can be made about the frequency of available floodwater based on limited historical records provided by the Friant Water Authority and USBR. Section 215 water is available when conditions cause Millerton Lake (on the San Joaquin River) to rise to the point that flood control releases are necessary, as mandated by the U.S. Army Corps of Engineers flood control criteria. Priority allocation for Section 215 water is made available to the Friant Division Long-Term and Cross Valley Canal Contractors. Section 215 water can then also be made available to other parties (Non-Long-Term Contractors) in accordance with Reclamation law and contractual requirements, normally on a temporary one-year basis.

Section 215 water has typically occurred between December and July, with historical data showing the most prolific months being March, April, May, June, and July. The various historical records obtained were combined into **Table 3-11** and averaged. Section 215 water is estimated to have been available over the past 52 years (1966-2017) about 46 percent of the time, which is approximately every other year. When Section 215 flows have occurred, the average duration was for about 5 months (about 140 days). However, on an average annual basis, the duration is about 2 months (60 days). The table shows that since 1966 Section 215 water is available every 2-3 years out of every 5 years.

Table 3-11 Historic Friant CVP Water Supply Availability and Allocation by Year

USBR Water Year	Water Year Type [1]	CLASS I Allocation	CLASS II Allocation	Section 215 Available (months)	
1966 [2]	Below Normal	100	23	N	
1967	Wet	100	100	Y	(3)
1968	Dry	92	0	N	
1969	Wet	100	100	Y	(7)
1970	Above Normal	100	29	N	
1971	Below Normal	100	35	N	
1972	Dry	100	4	N	
1973	Above Normal	100	77	Y	(2)
1974	Wet	100	82	Y	(1)
1975	Wet	100	60	N	
1976	Critical	75	0	N	
1977	Critical	25	0	N	
1978	Wet	100	100	Y	(4)
1979	Above Normal	100	63	Y	(4)
1980	Wet	100	100	Y	(5)
1981	Dry	100	22	N	
1982	Wet	100	100	Y	(7)
1983	Wet	100	100	Y	(9)
1984	Above Normal	100	50	N	
1985	Dry	100	14	N	
1986	Wet	100	100	Y	(6)
1987	Critical	91	0	N	
1988	Critical	78	0	N	
1989	Critical	98	0	N	
1990	Critical	68	0	N	
1991	Critical	100	0	N	
1992	Critical	83	0	N	
1993	Wet	100	90	Y	(5)
1994	Critical	80	0	N	
1995	Wet	100	100	Y	(6)
1996	Wet	100	58	Y	(5)
1997	Wet	100	55	Y	(2)
1998	Wet	100	50	Y	(5)
1999 [3]	Above Normal	100	55	Y	(2)
2000	Above Normal	100	60	Y	(2)
2001	Dry	100	5	N	
2002	Dry	100	8	N	
2003	Below Normal	100	8	Y	(3)
2004	Dry	100	18	N	
2005	Wet	100	10	Y	(5)
2006	Wet	100	10	Y	(6)
2007	Critical	65	0	N	
2008	Critical	100	5	N	
2009	Below Normal	85	10	N	
2010	Above Normal	100	10	Y	-
2011	Wet	100	5	Y	(5)
2012	Dry	57	0	N	
2013	Critical	62	0	N	
2014	Critical	0	0	N	
2015	Critical	0	0	N	
2016	Dry	100	Unc. Sea.	Y	-
2017	Wet	100	Unc. Sea.	Y	(7)
AVERAGE		90	34	46%	(5)

Notes:

[1] San Joaquin Valley Hydrological Classification from http://cdec.water.ca.gov/cgi-progs/iodir/WSIHIST

[2] For years 1966 to 1998, Section 215 availability estimated from San Joaquin River flow data at Friant Dam, when releases exceeded 500 cfs.

[3] For years 1999 to 2011, Section 215 availability from Friant Water Authority data of contractors taking water off the Friant Kern Canal. For 2012 to 2017, data was obtained from USBR.

[4] The available duration was unknown for 2010 and 2016.

It should be noted that the SJRRP can be expected to utilize flood releases when available prior to be water being designated as Section 215 water. This has the likely effect of decreasing the amount of water available for use or recharge when Section 215 water does become available. Another option, but costlier alterative for MAGSA would be to purchase Class 1 or Class 2 supplies which is far more reliable compared to Section 215 water.

3.4.4 State Water Project Supplies

SWP supplies could physically be delivered to Mendota Pool by way of the Delta-Mendota Canal (DMC). However, SWP supplies are probably one of the more expensive water sources due to the multiple municipal water agencies that might purchase said water if it was available. Also, SWP floodwater (Article 21) has been unreliable in recent years due to the difficulty of operating the pumps at full capacity in the Sacramento-San Joaquin Delta because of regulatory constraints. Therefore, SWP sources were excluded from being considered a viable water supply source for the projects being considered, as well as MAGSA not being in the Place of Use for the SWP.

Appendix 3-A Kings Subbasin GSA Coordination Efforts Technical Memoranda 1-6

4 Sustainable Management Criteria

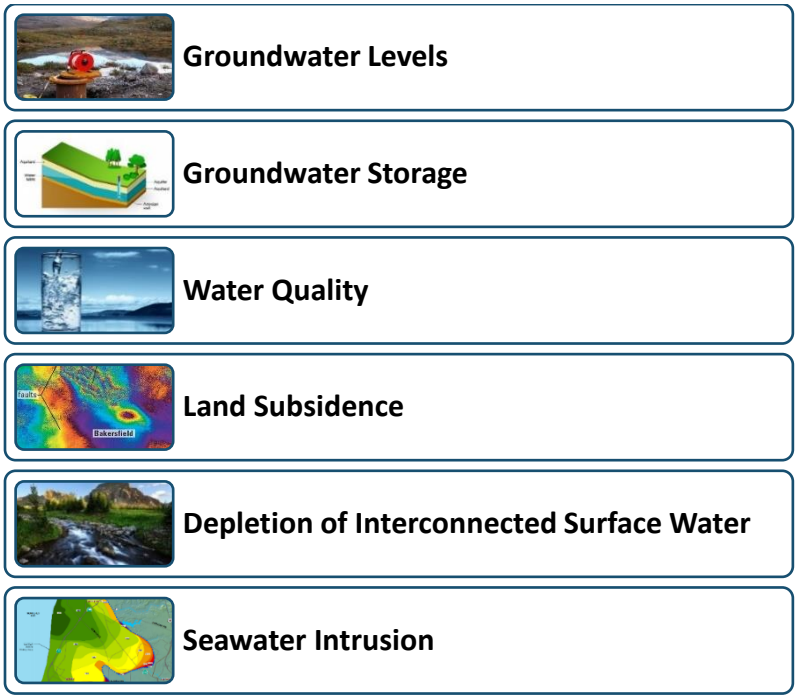
Regulation Requirements:

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

SGMA defines sustainable groundwater management as the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results. The avoidance of undesirable results is important to the success of the GSP. Several requirements from GSP regulations have been grouped together under the heading of Sustainable Management Criteria, including a Sustainability Goal, Undesirable Results, Minimum Thresholds, and Measurable Objectives for various indicators of groundwater conditions. Development of these Sustainable Management Criteria is dependent on basin information developed and presented in the hydrogeologic conceptual model, groundwater conditions, and water budget chapters of the MAGSA plan (DWR, 2017).

Indicators for the sustainable management of groundwater were determined by SGMA based on that are important to the health and general well-being of the public. There are six indicators that must be monitored throughout the planning and implementation period of the GSP and identified in **Table 4-1**. This chapter will describe the indicators and why they are significant and will define the management thresholds.

Table 4-1 Monitoring Requirements



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

4.1 Sustainability Goal

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

The sustainability goal of the Kings Subbasin and this GSA 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 water demand with available water supply to stabilize declining groundwater levels without significantly and unreasonably impacting water quality, land subsidence or interconnected surface water. The goal of the Basin is to correct and end the long-term trend of a declining water table understanding that water levels will fluctuate based on the season, hydrologic cycle and changing groundwater demands within the basin and its proximity.

The conditions with the basin and this GSA will be considered sustainable when:

- The basin is managed within its sustainable yield.
- The current rate of decline of the groundwater table within the basin monitoring network indicator wells has been corrected and the multi-year trend of water elevations in these wells has been stabilized.
- Groundwater management activities prevent undesirable results to groundwater levels, groundwater storage, groundwater quality, land subsidence and interconnected surface water.

The seven GSAs within the Kings Basin have been coordinating within the basin for several years on how to reach and maintain sustainability within the Basin. As described in **Chapter 2.5**, the Kings Basin includes significantly varied geologic conditions, water supplies and land uses that lead to different conditions and obligations within each GSA. The basin setting describes the trend of declining groundwater levels within the basin and this GSA. The degree of decline varies by location based primarily on land use and available surface water supplies. The Basin setting information, including historic groundwater conditions, surface supplies, groundwater flows, land use and other information were used to establish the water budget, estimates of overdraft within each GSA and sustainable yield. The coordination efforts between the GSAs have resulted in agreed to initial quantities for each GSA to correct in order to correct current and future conditions. For the MAGSA, this is 91,100 AF per year. These quantities and each GSAs respective obligation will continue to be monitored and evaluated as additional information is gathered.

Each GSA in the Kings Basin is responsible for implementing projects and management actions required to reach sustainability and meet their initial mitigation requirements for overdraft. The measures that will be implemented to ensure the basin will be operated within the sustainable yield are identified in detail in Section 6 – Projects and Management Actions to Achieve Sustainability of the GSP for each GSA in the basin. Collectively, these projects and programs have been identified to ensure the basin reaches sustainability by 2040. The projects and programs include technical data and estimates of project benefit, and the total of these benefits within the basin meet the initial estimates for reaching sustainability within the basin.

The basin has agreed to a phased approach of increasing mitigation to achieve sustainability. The proposed mitigation schedule is shown in **Table 4-2**.

Table 4-2 Overdraft Mitigation Schedule

Period	Percent of Overdraft Mitigated	Cumulative Mitigation
2020-2025	10%	10%
2025-2030	20%	30%
2030-2035	30%	60%
2035-2040	40%	100%

Note that these are minimum goals and progress may be faster than described. A phased approach with gradually increasing progress was selected since time will be necessary to secure funding, plan, design and build projects, and finalize water transfer deals. Furthermore, if recharge or banking projects are developed, a wet period will be needed before projects are realized. Consequently, efforts will be consistent throughout the 20-year period, but many benefits will not be seen until the latter years. Each GSA in the basin is planning to implement projects and management actions in accordance with the agreed mitigation targets. The GSAs will continue to meet regularly to review data to ensure all GSAs are meeting their milestones and progress is being made toward sustainability.

4.2 Groundwater Levels

4.2.1 Undesirable Results

4.2.1.1 Criteria to Define Undesirable Results

Regulation Requirements:

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

The SGMA regulations define Undesirable Results for groundwater levels as:

> *"Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon. Overdraft during a period of drought is not sufficient to establish a chronic lowering of groundwater levels if extractions and groundwater recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods."* [CWC §10721(x)(1)]

The undesirable result for chronic lowering of groundwater levels is a result that would cause significant and undesirable reduction in the long-term viability of domestic, agricultural, municipal or environmental uses over the planning and implementation period of this GSP. The terms "significant and unreasonable" are not defined by regulations, rather the conditions leading to this classification are determined by the GSA, beneficial users, and the basin they are a part of. The process used to develop criteria for determining undesirable results began with discussions with stakeholders and landowners. Primary concerns related to Undesirable Results for groundwater levels were:

- Groundwater levels declining in dry periods to a point that they will not likely recover during normal/wet periods
- A significant and unreasonable number of shallow domestic wells going dry

Identification of Undesirable Results is based on the monitoring network of Indicator Wells described in Section 5. The GSAs in the Kings Basin have defined the Undesirable Result as occurring when 15% of the Indicator Wells have exceeded the Minimum Threshold during a single monitoring event. This value was chosen to provide a balance between unanticipated hydrology, potentially erroneous data, and coverage of a significant area within the GSA. Exceedance of a Minimum Threshold at a single Indicator Well is not necessarily sufficient to indicate GSA-wide conditions are causing undesirable results.

The sustainability goal and the undesirable results provide the qualitative basis for the quantitative sustainable management criteria described below:

- **Measurable Objective** is the quantitative goal that will allow the basin to achieve its sustainability goal within the 20-year planning period. More specifically, the measurable objective is the elevation at an Indicator Well that will be stabilized and maintained over time. The measurable objective has been set such that there is a reasonable margin of operational flexibility that will accommodate droughts, climate change, and conjunctive use operations. The GSAs in the basin will manage the basin to the measurable objectives using adaptive management and implementing the projects and management actions described in Section 6 when needed to ensure sustainability will be achieved.

  The basin is currently not in a sustainable condition, and GSAs recognize that it will take several years to reach sustainability. The measurable objective was set based on the decline in each Indicator Well within the monitoring network during a recent period of average surface water deliveries within the basin from 1997 to 2012, and an incremental mitigation correction planned to reach sustainable water levels during the planning period. Hence, the Measurable Objective is based on what is considered a reasonable level of continued decline, since halting the overdraft before 2040 would not be practical or even feasible given the current and anticipated future water supply conditions. A more detailed description of the measurable objective is included later in this section.
- **Interim Milestones** are 5-year target groundwater levels at each Indicator Well that have been set for the basin to reach sustainability over the 20-year planning period. The interim milestones have been set based on the long-term average hydrologic conditions and the planned projects and management actions the GSAs will use to make incremental improvement toward sustainability over the 20-year planning period. The GSAs will manage the basin to these Interim Milestones during the planning period by comparing hydrologic conditions to historic average conditions and implementing management actions if needed to maintain a path to sustainability.
- **Minimum Threshold** is the groundwater elevation at an Indicator Well that when exceeded in combination with minimum thresholds at other Indicator Wells, may cause an undesirable result in the basin. More specifically for groundwater levels, the minimum threshold is the groundwater elevation below which significant and unreasonable impacts to beneficial users occurs. As noted previously, the primary concerns for groundwater users and uses were groundwater levels declining to a point that would not recover to sustainable levels, or declining to levels that would cause a significant and unreasonable number of shallow wells to go dry. Although the undesirable result (as defined) may not occur until water levels are below the minimum threshold, the basin will use the 5-year milestones and minimum threshold levels as trigger for operational change.

  The Kings Basin GSAs recognize that some wells will go dry, and the GSAs have indicated that it is not significant and unreasonable impacts if less than 15% of the shallow wells in the basin go dry. However, DWR has indicated through public comment and direct consultation with the basin that GSAs need to demonstrate how an impact to even just one single well is not significant and unreasonable. The shallowest wells in the basin are typically private domestic wells. Using the shallowest wells within the basin as a control to maintain water levels is impractical considering well construction has varied significantly and many wells may have been constructed too shallow, not considering or having been approved for sustainable or planned groundwater elevations.

Agricultural uses are the largest groundwater user within the basin and agriculture production is the primary economic driver for the region. Setting minimum thresholds to maintain water levels to the shallowest well in an area would cause a significant and unreasonable economic impact to the basin' s varied groundwater users, including agriculture users and the many communities that are solely groundwater dependent because of the significant demand reduction it would require for all users. This is especially true when considering that suitable wells can be constructed deeper within the basin. The Kings Basin has a very large aquifer with existing water levels well above the base of the unconfined aquifer, and as shown in Chapter 2 – Basin Setting, recent water levels are several hundred feet above the base of the aquifer in much of the basin. Because the aquifer is so significant and of such good quality in most of the basin, a productive well of suitable quality can still be constructed as water levels continue to decline until sustainability is reached.

Considering the economic, social and environmental impacts to domestic, agricultural, municipal and other groundwater users as well as the correlation to other sustainable management criteria, the basin plans to have groundwater levels continue to decline until sustainability can be reached within the planning period, but develop a program to address shallow well impacts. The Minimum Thresholds have been set below the measurable objective based on the needed operational flexibility to accommodate dry hydrologic conditions. Operational flexibility is the elevation difference between the Measurable Objective and the Minimum Threshold. During dry periods, more groundwater pumping will occur causing groundwater levels to decline below measurable objective levels. This Operational Flexibility is based on a five-year drought period. This amount of Operational Flexibility is consistent with other GSPs in the State that were approved. A more detailed description of the minimum threshold is included later in this chapter.

The GSAs in the basin acknowledge that some shallow wells will go dry, so the GSAs will develop a shallow well mitigation program to help address the impacts to wells that are shallower than the minimum thresholds within the basin. A more detailed description of the proposed shallow well mitigation program is included in Chapter 6. At the time of the initial GSP submittal in January of 2020, not all of the GSPs in the Kings Basin included an analysis of the potential shallow well impacts. Each GSA now includes an analysis of the potential number of shallow wells impacted by the Minimum Thresholds.

These terms are illustrated in **Figure 4-1**.

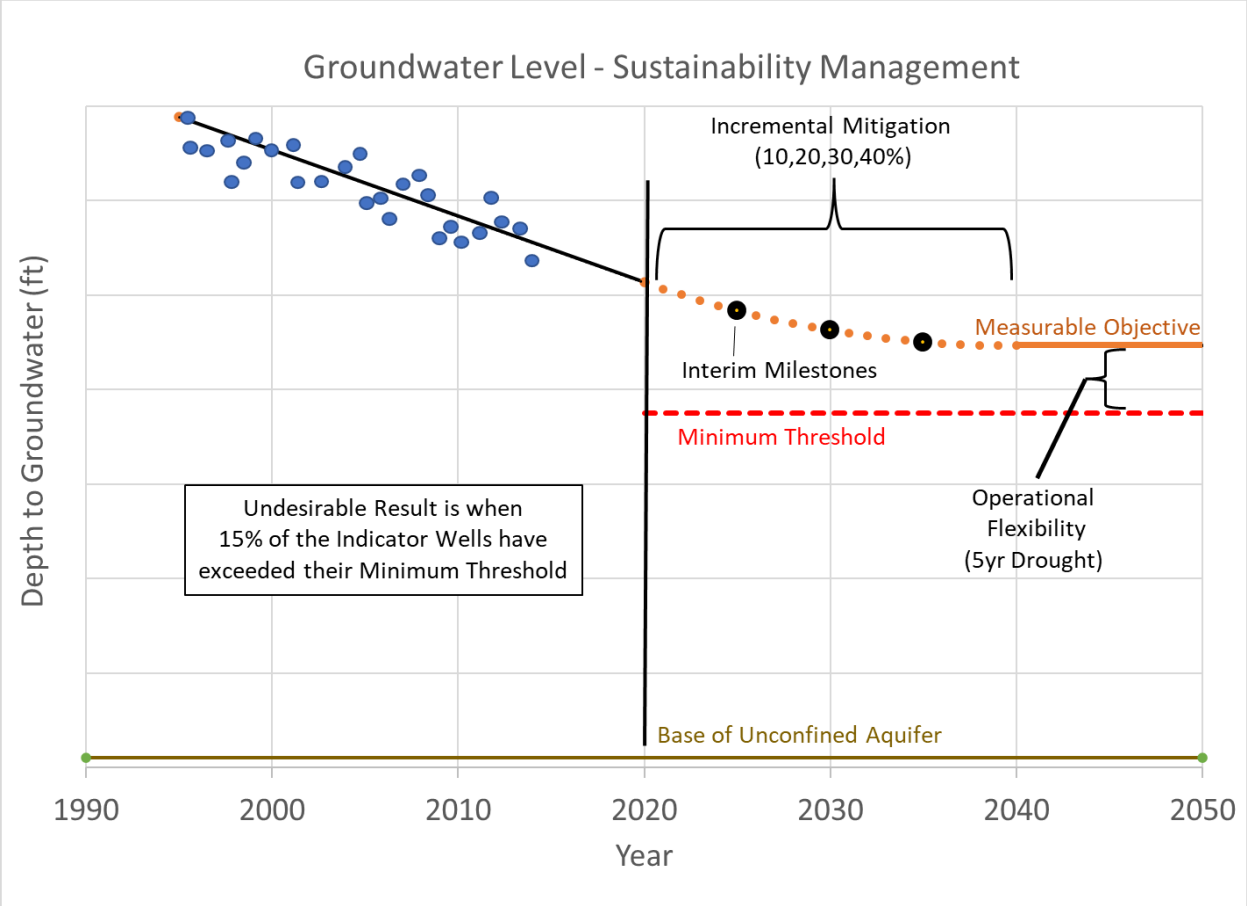


Figure 4-1 Groundwater Level- Sustainability Management

4.2.1.2 Causes of Groundwater Conditions That Could Lead to Undesirable Results

Regulation Requirements:

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

Each Indicator Well has a unique Minimum Threshold elevation, so the elevation at which an undesirable result occurs varies throughout the basin and each GSA. The continued decline of water levels below the minimum threshold would be the undesired result. The decline of the water table below minimum threshold levels could be caused by:

- GSAs not correcting the overdraft at the basin-agreed incremental mitigation rates described later in this section.
- Hydrologic cycle significantly drier than historic average conditions.
- Extended or worse drought conditions than the historic 2012-16 drought.
- Neighboring GSAs and Basins not correcting boundary flow losses to the Kings Basin and its GSAs.
- Increased demand and pumping beyond what are planned for in the water budget

- Reduction of long-standing surface water supplies as a result of State or Federal regulations leading to the need for increased groundwater pumping in the Kings Basin or neighboring basins.

As noted above, for much of the basin there will still be a significant amount of suitable water supply well below the minimum threshold and above the point at which a productive well of suitable water quality could no longer be constructed.

Regulation Requirements:

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

The GSAs in the Kings Basin have defined the Undesirable Result as occurring when 15% of the Indicator Wells in a GSA have exceeded the Minimum Threshold during a single monitoring event (spring or fall). For MAGSA, that is 3 of the 23 Indicator Wells listed in the monitoring network discussion. The 15% was chosen to provide a balance between unanticipated hydrology, potentially erroneous data, and coverage of a significant area within the GSA.

Regulation Requirements:

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

The primary effect of the chronic lowering of the groundwater table has caused wells to be drilled deeper and deeper to maintain productivity. Without correcting the basin to sustainability and stabilizing the water table, the decades long trend of drilling deeper and deeper wells would continue causing increased financial burden on stakeholders. In the easternmost portion of the basin, bedrock is shallow and the availability of supply above the bedrock could be diminished such that productive wells could not be constructed if water levels are not stabilized above these levels. In some portions of the basin, as water levels decline, the water quality changes are significant enough to require additional treatment. Stabilizing the water table will reduce the changing conditions and provide for more sustainable long-term conditions within the basin. The development of shallow well mitigation program described in Chapter 6 will help to address some of the potential effects to shallow well owners.

4.2.1.3 Evaluation of Multiple Minimum Thresholds

Regulation Requirements:

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

The GSA, in coordination with the other GSAs in the basin will utilize multiple wells to monitor and manage the GSA and basin. Indicator wells of approximately two per township (with more where necessary and available) have been identified, and Measurable Objectives and Minimum Thresholds will be set at each of these wells. As described previously, the exceedance of the minimum threshold at 15% of the Indicator Wells in the GSA is significant and will trigger further investigation and action by the GSA. A detailed description of the GSA's monitoring network is included in **Chapter 5** of this GSP.

4.2.2 Minimum Thresholds

Regulation Requirements:

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

The GSA, in coordination with the other GSAs in the Basin, has established a monitoring network with multiple Indicator Wells. A Measurable Objective and Minimum Threshold for groundwater levels have been determined at each of these Indicator Wells for the unconfined aquifer. The minimum threshold was set at an elevation to allow operational flexibility of the anticipated water level decline during a 5-year drought. For most Indicator Wells in the network, the operational flexibility below the measurable objective was set based on the actual decline during the historic 2012-2016 drought and increased by 20% to estimate the impacts of a five-year drought. The Operational Flexibility was used because of changing hydrologic conditions and concerns for extended periods of drought in the future. This amount of Operational Flexibility is consistent with methods used in other GSPs approved by the State. The minimum thresholds were set by adding that distance below the measurable objective for each Indicator Well in the network. As additional data and understanding is gained during the planning period, it is recognized that the Minimum Threshold elevations may be updated. A more detailed description is provided later in this section.

Regulation Requirements:

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

Groundwater elevation will be used as the indicator for the chronic lowering of groundwater levels. The minimum thresholds used for groundwater levels will set the overall groundwater storage volume desired to be maintained below the groundwater levels.

4.2.2.1 Criteria to Define Minimum Thresholds

Regulation Requirements:

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

§354.28 (c) Minimum thresholds for each sustainability indicator shall be defined as follows:
(1) Chronic Lowering of Groundwater Levels. The minimum threshold for chronic lowering of groundwater levels shall be the groundwater elevation indicating a depletion of supply at a given location that may lead to undesirable results. Minimum thresholds for chronic lowering of groundwater levels shall be supported by the following:
(A) The rate of groundwater elevation decline based on historical trends, water year type, and projected water use in the basin.

As required by the regulation, the Minimum Thresholds for chronic lowering of groundwater levels were established based on the rate of groundwater elevation decline considering historic trends, water year types and projected water use in the basin. As mentioned previously, the minimum thresholds have been set below the shallowest wells in the basin in some areas, but the GSAs are planning a shallow well mitigation program to help address these impacts.

As shown in above, the minimum threshold is the elevation below the measurable objective that provides the operational flexibility to allow for periods of increased groundwater pumping during dry periods. As mentioned, the minimum threshold was set at an elevation to allow operational flexibility of the anticipated water level decline during a 5-year drought. For most Indicator Wells in the network, the actual decline during the historic 2012-2016 drought was determined at each Indicator Well in the monitoring network and increased by 20%. That amount of decline was then used to determine the Minimum Threshold by deducting that amount from the elevation set for the Measurable Objective at that Indicator Well. At 11 of the Indicator wells, there is incomplete or inconsistent water level readings during the drought period. For those wells, the average rate of decline was multiplied by 15 (three times the standard rate of decline for 5 years) to

determine the total depth of decline for operational flexibility. The rate of decline during the 2012-2016 drought was observed to be roughly three times the average rate of decline.

The establishment of the minimum threshold was based on actual water level readings at each of the wells chosen to be Indicator Wells in the Monitoring Network. A hydrograph was generated for each well and the historic rate of decline identified for each well individually. The trendline was developed using the recent water level reading from the 1990s to the end of the Basin base period (2012). This considers recent base period conditions for the basin which factors in recent land use changes, different water year types and the water use within the basin. The amount of decline during the recent drought (2012-2016) was also determined. A table listing the minimum threshold for each Indicator Well is included as **Table 4-3** and a hydrograph for each Indicator Well showing the Minimum Threshold is included as **Appendix 4-A**. In addition to the Minimum Thresholds, the hydrographs include the rate of decline of each specific well, and the Measurable Objective elevation based on the incremental rate of mitigation. Water Surface Elevation and Depth-to-Water minimum threshold contour maps for the entire Kings Subbasin were developed using the minimum thresholds from each GSP in the Kings Basin. These contour maps are included in **Appendix 4-B**. As with all sustainable management criteria, it is recognized that future data may allow for refinement of these thresholds.

Table 4-3 Groundwater Level Minimum Thresholds

Well ID	Minimum Threshold (WSE)
13-1	-40.50
13-2	42.60
13-3	12.70
14-1	44.90
14-2	-53.10
14-3	24.10
14-4	14.70
14-5	-12.40
14-6	-23.20
15-1	-34.90
15-10	-9.90
15-2	-81.10
15-3	21.10
15-4	43.20
15-5	-135.70
15-6	-91.90
15-7	28.40
15-8	-110.40
15-9	-122.80
16-1	-97.30
16-2	-163.30

Well ID	Minimum Threshold (WSE)
16-3	-80.00
16-4	-29.50

4.2.2.2 Relationships Between Minimum Thresholds and Sustainability Indicators

Regulation Requirements:

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

§354.28 **(c)** Minimum thresholds for each sustainability indicator shall be defined as follows:
(1) Chronic Lowering of Groundwater Levels. The minimum threshold for chronic lowering of groundwater levels shall be the groundwater elevation indicating a depletion of supply at a given location that may lead to undesirable results. Minimum thresholds for chronic lowering of groundwater levels shall be supported by the following:
(B) Potential effects on other sustainability indicators.

The following provides an explanation of the relationship between the water level minimum thresholds and the other sustainability indicators and how the GSA determined that the minimum thresholds will avoid undesirable results for each Indicator:

- Groundwater Storage. The minimum thresholds used for groundwater levels determine the desired minimum groundwater storage volume to be maintained. As mentioned in much of the GSA and the basin, there will remain a very significant amount of groundwater below the minimum threshold elevations. The sustainable management criteria (SMC) section on Groundwater Storage describes this further.
- Sea Water Intrusion. This indicator is not applicable to this basin.
- Groundwater Quality. Changing groundwater levels can affect groundwater constituent concentrations positively and negatively. The minimum thresholds were compared with known contaminants of concern where data and quality information by elevation was available. Groundwater levels are not used as proxy for groundwater quality conditions. GSA has set separate groundwater quality Sustainable Management Criteria and will monitor water quality condition changes as water levels change and reach sustainability.
- Land Subsidence. The GSA has not experienced significant subsidence. Water levels, and primarily pumping from beneath clay layers, can cause land subsidence. The majority of pumping in the GSA is from others above or outside of clay layer areas encountering subsidence. The water level minimum thresholds have been established based on historic rates of decline that have not caused land subsidence of significance.
- Interconnected Surface Water. The GSAs of the basin have identified Interconnected Surface Water as a data gap and will be investigating this further over the next few years.

4.2.2.3 Minimum Thresholds in Relation to Adjacent Basins

Regulation Requirements:

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

The minimum thresholds established are based on implementation of incremental correction of the historic decline starting immediately and reaching stabilization by 2040. This approach is believed to be conservative and correct the trend of existing groundwater decline. The Kings Basin is primarily negatively impacted by

surrounding basin pumping as adjacent basins with limited surface water supplies have caused declining groundwater conditions that negatively impact the Kings basin by increasing groundwater flows across basin boundaries. As described in **Chapter 2.5**, these flows have increased overtime compared to historical flows prior to significant development in the valley of groundwater as a resource. Groundwater pumping in the confined aquifer in adjacent basins has also impacted the Kings Basin as the confined aquifer is primarily fed by the groundwater upgradient in the Kings Basin.

As a basin, the various Kings GSAs have met with their neighboring GSAs outside of the Kings Basin to discuss how thresholds have been established and potential impacts. At the time of the preparation of this GSP, criteria from the neighboring basin was not available. However, it is understood that minimum threshold elevations along the boundaries will not match exactly as the basins and GSAs have likely taken different approaches to establishing thresholds. Basin representatives have met with other basin representatives to begin discussions on inter-basin concerns, but additional discussion and determinations are needed. Once the neighboring basin GSP is completed, the MAGSA will evaluate the potential differences between thresholds and work to coordinate needed resolutions and clarifications.

4.2.2.4 Impact of Minimum Thresholds on Beneficial Uses and Users

Regulation Requirements:

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

Stabilizing the groundwater levels will provide more certainty of the long-term availability of groundwater supply for all beneficial uses and users. Property values have always been influenced by the presence and depth of a useable well. Minimum Thresholds may affect those property values with existing wells with depths shallower than the Minimum Threshold. Changes in demands will be required to mitigate for future impacts to maintain water levels above the minimum thresholds. The GSAs in the basin recognize that water levels will continue to decline until the overdraft within the basin, and the impact of pumping from neighboring basins, has been corrected. .

The GSA recognizes that some shallow wells will likely go dry until water levels have been stabilized. Without SGMA and the proposed incremental mitigation by the GSA, the shallow wells would have gone dry sooner, requiring the landowners to deepen these existing wells. However, the GSAs will develop a well mitigation program to help address impacts to shallow wells that may go dry above the minimum threshold. A more detailed description of the minimum threshold is included later in this chapter, and a description the proposed mitigation program is included in Chapter 6.

An analysis was performed to estimate the number of domestic wells that may potentially go dry at the minimum threshold elevations. Utilizing the minimum threshold elevation at each of the water level monitoring well sites, a groundwater level contour surface was generated for the entire GSA utilizing geographic information system (GIS) software. From this surface, the estimated average depth to groundwater in each Section (one-square mile) was obtained which provides an estimate of the depth to groundwater at the minimum threshold. The depth to water at the minimum threshold in each section was compared to the well completion report records available from DWR. DWR's well completion reports are grouped by section, but locations within each section are not known. It is important to note the inaccuracies of the well record data, including inaccurate locations and construction information, no consideration of abandoned or inactive wells, no consideration of well modifications, and may not include all recent well information. For this comparison, all domestic wells were selected from the DWR records. The perforation interval of the well was considered if included in the well completion report, otherwise the total depth of the well was considered. For every domestic well in each section in the GSA, the minimum threshold depth was compared to ten feet above the bottom of perforation interval (if known) or ten feet above the total depth of the well. Sections that are entirely contained within the boundaries of a community water system (City of

Fresno, Clovis, etc.) were removed from the comparison, but if only a portion of the section was within the water system service area or within the GSA's exterior boundary, all of the wells in the section were included in the analysis since the exact location of the wells in a section is not included in the available data. In an effort to remove wells that have been abandoned or already gone dry, wells with depths or perforations shallower than the fall 2017 groundwater surface contours were removed for this analysis.

Since the first comparison to minimum thresholds included all wells regardless of age, and many of those wells have likely been abandoned or failed, a second comparison was performed for wells constructed after 1990. 1990 was chosen as a comparison to provide a range of the estimated impact to wells that will be up to 50 years old in 2040. Using this period for the analysis is also consistent with SWRCB comments and studies performed by UCDavis. The results of this analysis are shown in **Figure 4-2**,which shows the number of wells in each section that may be impacted.

The number of domestic wells shallower than the minimum threshold were totaled and compared to the total number of domestic well records. As mentioned previously, the total number of domestic wells used in these calculations is based on DWR records, and may include abandoned, destroyed, or inactive wells. In addition, due to the unique geology within the GSA there may be wells included that draw from shallow perched groundwater and will not go dry, or may only be dry for short periods of time. Utilizing all well data and all wells in a section that is only partially outside a community water system is very conservative considering the data includes many wells that are no longer active or are nearing the end of their usable life. For these reasons, it is anticipated that the number of impacted wells is lower than what is shown. These numbers may be refined as the GSP is implemented and more information becomes available.

Kings Subbasin Coordinated Effort

Per Section
Review of DWR WCR Data
Domestic Wells, Post 1990

McMullin Area GSA

Figure 4-2

Community Water Systems

Domestic Wells Where MT is Deeper than 10' Above the Total Depth or Bottom of Perforation

- 0
- 1 - 3
- 4 - 7
- 8 - 10
- 11 - 14
- No SMC Depth For This Section
- No Wells Constructed Post 1990

N

0 1 2
Miles

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

Fresno County Dept. PWP, Bureau of Land Management, Esri, HERE, Garmin, USGS, NGA, EPA, USDA, NPS

5/24/2022 : G:\Kings River East GSA-2664\266417001-Kings Basin SGMA Coordination\GIS\Map\Wells\MonitorNetwork\MeasObjectives\WCR Review\KingsSubbasinMtMoStats\2022_KingsSubbasinMtMoStats\2022_KingsSubbasinMtMoStats.aprx

4.2.2.5 Current Standards Relevant to Sustainability Indicator

Regulation Requirements:

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

There are currently no state, federal, or local regulatory standards applicable to groundwater levels. This GSP will become the basis for local regulatory standards.

4.2.2.6 Measurement of Minimum Thresholds

Regulation Requirements:

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

Groundwater level readings will be made at Indicator Wells in accordance with water level measurement protocols described in **Chapter 5** of this GSP.

4.2.3 Measurable Objectives

4.2.3.1 Description of Measurable Objectives

Regulation Requirements:

> §354.30 **(a)** Each Agency shall establish measurable objectives, including interim milestones in increments of five years, to achieve the sustainability goal for the basin with 20 years of Plan implementation and to continue to sustainably manage the groundwater basin over the planning and implementation horizon.
> **(b)** Measurable objectives shall be established for each sustainability indicator, based on quantitative values using the same metrics and monitoring sites as are used to define the minimum thresholds.

The Measurable Objective is the quantitative goal that will allow the basin to achieve its sustainability goal within the 20-year planning period. More specifically, the measurable objective is the elevation at an Indicator Well that will be stabilized and maintained over time. The measurable objective has been set such that there is a reasonable margin of operational flexibility that will accommodate droughts, climate change, and conjunctive use operations. The GSAs in the basin will manage the basin to the measurable objectives using the projects and management actions described in **Section 6**.

The establishment of the Measurable Objective was based on actual water level readings at each of the wells chosen to be Indicator Wells in the Monitoring Network. The Monitoring Network is described in detail in **Chapter 5** of this GSP. A hydrograph was generated for each well and the historic rate of decline identified for each well individually. The trendline was developed using the available water level readings from 1997 to 2012 which corresponds to the hydrologic base period for the basin. Use of this historic data considers recent base period conditions for the basin which factors in recent land use changes, different water year types and the water use within the basin. The rate of decline was then projected from the more recently measured fall water level to year 2020 for each well. The basin wide agreed incremental mitigation rate for correction (shown in **Table 4-4**) was applied to each well's hydrograph. The incremental correction provides the calculation of the anticipated water level at 2040. By 2040, there should no longer be a long-term average decline, therefore, the water level estimated for 2040 becomes the measurable objective. A table listing the minimum threshold for each Indicator Well is included as **Table 4-3** and a hydrograph for each Indicator Well showing the Measurable Objective is included as **Appendix 4-A**. In addition to the Measurable Objective, the hydrographs include the rate of decline of each specific well, and the Minimum Threshold elevation based on the desired Operational Flexibility to maintain during a 5-year drought.

Table 4-4 Water Level Mitigation Rate

Year	Correction	Cumulative % Correction
2025	10%	10%
2030	20%	30%
2035	30%	60%
2040	40%	100%

The incremental mitigation for correction was selected based on the understanding that correcting decades of overdraft will take many years and implementation is dependent on many factors, including development of funding, project development, environmental and permit compliance, correction by neighboring GSAs and basins that impact the Kings Basin.

Water Surface Elevation and Depth-to-Water Measurable Objective contour maps for the entire Kings Subbasin were developed using the Measurable Objectives from each GSP in the Kings Basin. These contour maps are included in **Appendix 4-B**.

4.2.3.2 Operational Flexibility

Regulation Requirements:

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

A margin of operational flexibility, or margin of safety, allows for variation in groundwater levels due to historical water budgets, seasonal and yearly variations, drought and also takes into consideration levels of uncertainty. Drought years may cause pumping to increase, but wet years may provide enough opportunity for surface water recharge to offset drought years. The operational flexibility for each well in the GSA will vary based on current groundwater levels and rate of decline. As shown in , the Operational Flexibility is the difference in groundwater levels between the Measurable Objective and Minimum Threshold, and represents the amount of allowable decline in groundwater levels below the Measurable Objective. The Measurable Objective was established using the basin base period which represents recent average hydrologic conditions and water uses with recent land uses and demands. As mentioned, the Minimum Threshold was set at an elevation to allow operational flexibility of the anticipated water level decline during a 5-year drought, and was based on the recent historic drought of 2012-2016.

4.2.3.3 Representative Monitoring

Regulation Requirements:

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

The GSA is not proposing to use representative Measurable Objectives. Indicator wells are being used to establish measurable objectives and minimum thresholds.

4.2.3.4 Path to Achieve Measurable Objectives

Regulation Requirements:

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

The MAGSA and the other GSAs in the basin will implement projects and programs to correct the declining groundwater levels and reach sustainability. The MAGSA projects and programs are described in Section 6 of this GSP and implementation discussed in **Chapter 7** of the GSP. The interim milestones for water level correction are unique to each Indicator Well, but follow the same basin wide agreed incremental mitigation rate for correction (shown in **Table 4-4**). The 5-year milestones to achieve measurable objectives are shown in **Table 4-5**. The Measurable Objective water levels have been used to determine the estimated volume of overdraft correction that is required within this GSA and the entire basin. The MAGSA has identified the schedule for implementation of each project and management action as well as that project's anticipated benefit or yield. The combined benefit of each project and management action at each milestone shows that the GSA has identified projects and management actions to correct the total overdraft by 2040. Future projects and management actions are included in the anticipated reduction in demand and overdraft.

Although the undesirable result (as defined) may not occur until water levels are below the minimum threshold, the basin will use the 5-year milestones and minimum threshold levels as trigger for operational change. The GSAs will manage the basin to these Interim Milestones during the planning period by comparing hydrologic conditions to historic average conditions and implementing management actions if needed to maintain a path to sustainability.

The GSA has identified the schedule for implementation of each project and management action as well as that project's anticipated benefit or yield. The combined benefit of each project and management action at each milestone shows that the GSA has identified projects to achieve sustainability by 2040. Other future projects and management actions would be included in the anticipated reduction in demand and overdraft.

Table 4-5 Groundwater Level Interim Milestones and Measurable Objectives

ID	Interim Milestones (WSE)				Measurable Objective (WSE)
	2020	2025	2030	2035	2040
13-1	54.1	44.2	35.9	30.4	28.6
13-2	107.1	100.7	95.4	91.8	90.7
13-3	110.4	101.8	94.7	89.9	88.4
14-1	80.3	74.2	69.7	65.7	64.6
14-2	27.3	18.8	11.8	7.1	5.6
14-3	62.4	56.3	51.2	47.8	46.7
14-4	81	69.5	59.9	53.5	51.5
14-5	19.2	13.7	9.1	6.1	5.1
14-6	46.1	37.7	30.8	26.2	24.8
15-1	11.2	3.2	-3.5	-7.9	-9.3
15-10	33.9	26.2	19.9	15.7	14.4
15-2	-15.7	-27.1	-36.5	-42.8	-44.8
15-3	79.4	74.1	69.8	66.9	66
15-4	88.2	83.3	79.3	76.5	75.7
15-5	-37.7	-44.4	-50	-53.7	-54.9
15-6	-30.4	-41.1	-50	-55.9	-57.7

15-7	74.5	68.9	64.2	61	60
15-8	-29.4	-43.5	-55.2	-63	-65.4
15-9	-51.4	-63.9	-74.2	-81	-83.2
16-1	-26.8	-39.1	-49.2	-56	-58.1
16-2	-50.8	-70.3	-86.6	-97.4	-100.8
16-3	-16.5	-25.6	-33.1	-38.1	-39.7
16-4	39.4	27.5	17.5	10.9	8.8

4.3 Groundwater Storage

Groundwater storage is directly linked to groundwater levels, and the measurable objective and minimum threshold for groundwater levels dictate the amount of groundwater in storage available for cyclic use once the Subbasin reaches sustainability. The criteria used to determine water level undesirable results, measurable objectives and minimum thresholds dictate groundwater storage items. As described in **Section 3.2.3**, the estimation of the amount of groundwater storage change is dependent on water level elevation changes from multiple wells and the depth of groundwater at the beginning and end of the period for which storage change is estimated multiplied by specific yield values in the interval in which the water level is fluctuating. The amount of groundwater storage change over time is estimated from these groundwater contoured surfaces from the beginning and end of the period in question. Once the subbasin reaches sustainability, the estimated volume of groundwater between the measurable objective and the minimum threshold levels provides the operational flexibility. Estimates of these volumes for the subbasin GSAs are included in **Table 4-6**.

Table 4-6 Estimate of Groundwater in Storage between Measurable Objective and Minimum Threshold

GSA	Volume (Acre-Feet)
Central	680,000
James	110,000
Kings River East	620,000
McMullin	570,000
North Fork Kings	940,000
North Kings	1,070,000
South Kings	42,000
Total for Subbasin	**4,032,000**

See **Table 4-7** for Estimated Groundwater Storage Milestones.

Since the groundwater level measurable objectives are lower than current water levels, the amount of groundwater in storage between current groundwater levels and the minimum thresholds is considerably more than the estimate of groundwater in storage between the ultimate measurable objectives and minimum thresholds, however once the subbasin reaches sustainability, the long-term volume of groundwater in storage between the measurable objective and minimum threshold levels is the critical storage volume and, as mentioned above, is the groundwater storage operational flexibility.

Storage change in the confined aquifer was not estimated since actual changes are considered small to negligible as long as that portion of the aquifer remains fully saturated. Changes in the potentiometric surface only impact the compressibility of the mineral skeleton and pore water, which have a very small impact on the total volume of storage change. Furthermore, when pumping occurs from the confined aquifer, it ultimately impacts the unconfined aquifer by inducing groundwater flows into the confined portion of the aquifer through downward seepage through confining layers and wells screened across multiple aquifer zones.

4.3.1 Undesirable Results

4.3.1.1 Criteria to Define Undesirable Results

Regulation Requirements:

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

The Groundwater Level Minimum Threshold elevations across the GSA and Subbasin were used to estimate the amount of groundwater in storage from the Minimum Threshold to the interim milestones and measurable objective. An undesirable result would occur if the total amount of water in storage was less than the estimated amount of groundwater in storage below the Minimum Thresholds. Since the Subbasin plans to maintain water levels above the minimum threshold and only periodically use the storage between the minimum threshold and measurable objective, the total amount of groundwater in storage below the minimum threshold was not calculated.

4.3.1.2 Causes of Groundwater Conditions That Could Lead to Undesirable Results

Regulation Requirements:

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

Since the amount of groundwater storage change is based on water levels, the causes for Undesirable Results in Groundwater Storage are the same as causes for Undesirable Results listed under **Section 4.2** for Water Levels. The reasons for chronic lowering of water levels include:

- GSAs not correcting the overdraft at the basin-agreed incremental mitigation rates described later in this section.
- Hydrologic cycle significantly drier than historic average conditions.
- Extended or worse drought conditions than the historic 2012-16 drought.
- Neighboring GSAs and Basins not correcting boundary flow losses to the Kings Basin and its GSAs.
- Increased demand and pumping beyond what are planned for in the water budget

As previously stated, for much of the basin there will still be a significant amount of suitable water supply well below the minimum threshold and above the point at which a productive well of suitable water quality could no longer be constructed.

Regulation Requirements:

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

The criteria for Undesirable Results for Water Levels are also used for Groundwater Storage as they define the Minimum Threshold elevations below which an undesirable result would occur for storage volume.

Regulation Requirements:

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

The effects of Undesirable Results for Water Levels described in **Section 4.2.1.2** are the same for Groundwater Storage. The primary effect of the chronic lowering of the groundwater table has caused wells

to be drilled deeper and deeper to maintain productivity. Without correcting the Subbasin to sustainability and stabilizing the water table, the decades long trend of drilling deeper and deeper wells would continue causing increased financial burden on stakeholders. In some areas of the Subbasin, bedrock is shallow and the availability of supply above the bedrock could be diminished such that productive wells could not be constructed if water levels are not stabilized above these levels. In some portions of the Subbasin, as water levels decline, the groundwater quality changes could potentially be significant enough to require additional treatment, but ongoing evaluation of groundwater quality data is needed to understand these potential changes. Stabilizing the water table should reduce changing conditions potentially associated with declining groundwater levels and provide for more sustainable long-term conditions within the Subbasin.

4.3.1.3 Evaluation of Multiple Minimum Thresholds

Regulation Requirements:

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

The GSA, in coordination with the other GSAs in the Subbasin, utilized multiple wells to develop groundwater contours and estimate the change in groundwater storage. The amount of groundwater in storage (or change over time) was estimated from these contoured surfaces. A water level surface was created from the minimum threshold, interim milestone and measurable objective water level elevations at the monitor wells. The amount of groundwater in storage above the minimum thresholds to the measurable objective, as well as to each of the interim milestones, was estimated using the process described in **Section 3.2.3**.

4.3.2 Minimum Thresholds

Regulation Requirements:

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

The groundwater storage minimum threshold is based on the groundwater level minimum thresholds (described previously) as the basis for the estimation of groundwater in storage above those water levels to the measurable objective and the interim milestones. Water levels are not used as a proxy, but the water levels determine the water level surface that is used to calculate the volume in storage between those levels. Utilizing the process for groundwater storage calculation described in **Section 3.2.3**, the groundwater in storage between the measurable objective and minimum threshold was estimated and shown in **Table 4-6**.

Regulation Requirements:

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

The minimum thresholds used for groundwater levels will set the overall groundwater storage volume desired to be maintained below the groundwater levels.

4.3.2.1 Criteria to Define Minimum Thresholds

Regulation Requirements:

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

§354.28 **(c)** Minimum thresholds for each sustainability indicator shall be defined as follows:
(1) Chronic Lowering of Groundwater Levels. The minimum threshold for chronic lowering of groundwater levels shall be the groundwater elevation indicating a depletion of supply at a given location that may lead to undesirable results. Minimum thresholds for chronic lowering of groundwater levels shall be supported by the following:
(A) The rate of groundwater elevation decline based on historical trends, water year type, and projected water use in the basin.

The criteria for minimum thresholds for water levels are also used for groundwater storage as they define the elevations that are used to estimate the volume of groundwater in storage from the water level minimum thresholds to the measurable objective and interim milestones. The criteria for water level minimum thresholds are described in **Section 4.2.2.1.** The minimum threshold for groundwater storage is the minimum threshold water surface for water level at all the monitored wells. An exceedance for water level may not cause an exceedance for groundwater storage.

4.3.2.2 Relationships Between Minimum Thresholds and Sustainability Indicators

Regulation Requirements:

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

§354.28 **(c)** Minimum thresholds for each sustainability indicator shall be defined as follows:
(2) Reduction of Groundwater Storage. The minimum threshold for reduction of groundwater storage shall be a total volume of groundwater that can be withdrawn from the basin without causing conditions that may lead to undesirable results. Minimum thresholds for reduction of groundwater storage shall be supported by the sustainable yield of the basin, calculated based on historical trends, water year type, and projected water use in the basin.

The minimum thresholds used for groundwater levels will set the overall groundwater storage volume desired to be maintained above the measurable objective and the interim milestones at five-year increments. The exceedance of a single water level minimum threshold does not necessarily mean there has been an exceedance of the groundwater storage minimum threshold. As mentioned in much of the GSA and the Subbasin, there will remain a very significant amount of groundwater below the minimum threshold elevations but again it should be noted that the critical storage volume is the volume between the minimum threshold and the measurable objective, i.e., the operational flexibility.

4.3.2.3 Minimum Thresholds in Relation to Adjacent Basins

Regulation Requirements:

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

It is understood that the minimum threshold elevations along the MAGSA boundaries will not match exactly as the neighboring basins as the neighboring basins have likely taken different approaches to establishing minimum thresholds. Once the neighboring basins GSPs are completed, the MAGSA will evaluate the potential differences between thresholds and work to coordinate needed resolutions and clarifications.

4.3.2.4 Impact of Minimum Thresholds on Beneficial Uses and Users

Regulation Requirements:

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

The minimum threshold for groundwater storage is based on the water level minimum thresholds which have been established based on historic rates of decline, the proposed mitigation rate and enough operational flexibility to maintain beneficial use in the Subbasin during a five-year drought. As described in **Section 4.2.2.4,** the minimum thresholds have been determined based on the plan to correct the existing overdraft

with an incremental approach intended to result in stabilized groundwater levels by 2040. The minimum thresholds have been established to allow for continued beneficial use within the GSA and provide improved long-term certainty of groundwater levels within the GSA.

4.3.2.5 Current Standards Relevant to Sustainability Indicator

Regulation Requirements:

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

There are no known state, federal or local standards for establishment of minimum thresholds for groundwater storage.

4.3.2.6 Measurement of Minimum Thresholds

Regulation Requirements:

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

Groundwater level readings from wells in the monitoring network will be used to generate a groundwater level contour surface. From this groundwater level contour surface, the calculation of groundwater storage change will be made in accordance with the process described in **Section 3.2.3.**

4.3.3 Measurable Objectives

4.3.3.1 Description of Measurable Objectives

Regulation Requirements:

> §354.30 **(a)** Each Agency shall establish measurable objectives, including interim milestones in increments of five years, to achieve the sustainability goal for the basin with 20 years of Plan implementation and to continue to sustainably manage the groundwater basin over the planning and implementation horizon.
> **(b)** Measurable objectives shall be established for each sustainability indicator, based on quantitative values using the same metrics and monitoring sites as are used to define the minimum thresholds.

The groundwater storage measurable objective is based on the groundwater level measurable objective (described previously) as the basis for the calculation of groundwater in storage from the measurable objective to the minimum threshold. The groundwater storage minimum threshold is based on the groundwater level minimum thresholds (described previously) as the basis for the calculation of groundwater in storage above those water levels to the measurable objective and the interim milestones. The groundwater in storage between the ultimate measurable objectives and the minimum threshold provides the operational flexibility for pumping during dry years. With current groundwater levels above the ultimate measurable objectives, there is currently more water in storage than there will be once the Subbasin reaches sustainability at measurable objective levels. As described in **Section 4.2**, the measurable objective for water levels at each five-year milestone (interim milestone) have been identified. It is also critical to understand that there is still a significant amount of groundwater in storage below the minimum threshold as discussed in **Sections 2.5** and **4.2**. Utilizing the process for groundwater storage change estimation described in **Section 3.2.3**, the groundwater in storage between the measurable objective and at each interim milestone, and the minimum threshold was estimated and shown in **Table 4-7**.

Table 4-7 Estimate of Groundwater in Storage between Minimum Threshold and Measurable Objective Milestones

GSA	Volume at 2025 Milestone to Minimum Threshold (AF)	Volume at 2030 Milestone to Minimum Threshold (AF)	Volume at 2035 Milestone to Minimum Threshold (AF)	Volume at 2040 Milestone to Minimum Threshold (AF)
Central	900,000	780,000	700,000	680,000
James	150,000	130,000	110,000	110,000
Kings River East	810,000	710,000	640,000	620,000
McMullin	790,000	670,000	590,000	570,000
North Fork Kings	1,420,000	1,170,000	1,000,000	940,000
North Kings	1,300,000	1,180,000	1,090,000	1,070,000
South Kings	51,000	46,000	43,000	42,000
Total for Subbasin	**5,421,000**	**4,686,000**	**4,173,000**	**4,032,000**

Groundwater contour maps at the interim milestones, measurable objective and minimum threshold used to estimate the associated storage volume, as well as the supporting informational tables for the storage volume estimations are included in **Appendix 4-B**. Hydrographs included in **Appendix 4-A** graphically display the available groundwater level data, historic trendlines, measurable objective, interim milestones, operational flexibility, and minimum threshold for each indicator well.

4.3.3.2 Operational Flexibility

Regulation Requirements:

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

The amount of groundwater in storage between the Measurable Objective and Minimum Threshold provides the operational flexibility. The groundwater storage Measurable Objectives and Minimum Thresholds are based on the estimation of volume using the water level Measurable Objectives and Minimum Thresholds.

4.3.3.3 Representative Monitoring

Regulation Requirements:

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

The GSA is not proposing to use representative Measurable Objectives.

4.3.3.4 Path to Achieve Measurable Objectives

Regulation Requirements:

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

The MAGSA and the other GSAs in the basin will implement projects and programs to correct the declining groundwater levels and reach sustainability. The GSA's projects and programs are described in **Section 6** of this GSP and implementation discussed in **Section 7** of the GSP. The groundwater storage interim milestones are calculated based on the basin wide agreed incremental mitigation rate to reach groundwater level Measurable Objectives. The GSA has identified the schedule for implementation of each project and management action (when required) as well as that project's anticipated benefit or yield. The combined benefit of each project at each milestone shows that the GSA has identified projects to correct the total

overdraft by 2040. Other future projects and management actions which are currently unknown and not specifically identified in **Section 6** would be included in the anticipated reduction in demand and overdraft.

4.4 Seawater Intrusion

Regulation Requirements:

§354.26 **(d)** An Agency that is able to demonstrate that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin shall not be required to establish criteria for undesirable results related to those sustainability indicators.
§354.28 **(c) (3)** Seawater Intrusion. The minimum threshold for seawater intrusion shall be defined by a chloride concentration isocontour for each principal aquifer where seawater intrusion may lead to undesirable results. Minimum thresholds for seawater intrusion shall be supported by the following: **(A)** Maps and cross-sections of the chloride concentration isocontour that defines the minimum threshold and measurable objective for each principal aquifer. **(B)** A description of how the seawater intrusion minimum threshold considers the effects of current and projected sea levels.
§354.28 **(e)** An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in Section 354.26, shall not be required to establish minimum thresholds related to those sustainability indicators.

By definition, seawater intrusion occurs when saline water from the ocean infiltrates the groundwater system and begins to flow into areas of freshwater due to pressure differentials, in many cases caused by groundwater pumping. The Coastal Range lies between the Central Valley and the Pacific Ocean. The Kings Subbasin and MAGSA are over 100 miles from the Sacramento-San Joaquin Delta, which would be the only means for seawater to enter the Central Valley. Due to the great distance and the current groundwater elevations, MAGSA and the Kings Subbasin do not need to account for seawater intrusion.

4.5 Groundwater Quality

Groundwater quality concerns within MAGSA have been identified in this GSP's Groundwater Conditions Chapter (**Section 3.2**). Groundwater monitoring and reporting by community water systems and non-community public supply wells is a requirement of CCR Title 22. Community and other public supply wells within MAGSA monitoring network area already being routinely monitored for a wide range of contaminants, including the chemicals of concern, by the water purveyors under Title 22.

Groundwater pollution characterization and mitigation are typically enforced by local agencies and state level programs. The GSA will only have authority related to groundwater pumping policies, however MAGSA will review and analyze publicly available routine groundwater monitoring data reported by the community and non-community public supply wells and monitoring wells around the American Avenue Landfill in order to understand how and if groundwater pumping is exacerbating groundwater quality concerns and where to enforce pumping restrictions should it become necessary. The minimum thresholds will be set at the screening levels protective of human health as applicable for the respective chemicals of concern identified and discussed in this GSP's Groundwater Conditions Chapter (**Section 3.2**).

The following chemicals are groundwater quality concerns in MAGSA. Some of these are significant concerns while others are minor or geographically limited. Additional discussion on groundwater quality is presented in **Section 3.2.**

Arsenic
Arsenic occurs in natural deposits. Arsenic in groundwater in MAGSA is generally found at greater depths where reduced deposits are present. The MCL is 10 μg/L. Arsenic is seen at various locations throughout the greater area of the GSA.

Chloride
Chloride is a common constituent in groundwater particularly in the Central Valley of California. Chloride has an SMCL of 500 MG/L. Chloride is present in monitoring wells and municipal wells of various depths throughout MAGSA.

Manganese
Manganese can be found throughout MAGSA boundary with higher levels recorded north of Highway 180, and southeast of the American Avenue Landfill. The SMCL for Manganese is 50 μg/L.

Sodium
Sodium is a predominant constituent in MAGSA and maintains an Action Level of 50 mg/L. Higher levels are found surrounding the American Avenue Landfill as well as the central and southern portions of MAGSA.

Uranium
Uranium occurs naturally in groundwater in parts of the GSA. Uranium is derived from Sierra Nevada granitics and will preferentially adhere to clays. The MCL is 30 μg/L or 20 picocuries/liter.

Nitrates
Nitrate is commonly found in groundwater as a result of application of nitrogen fertilizers in irrigated agricultural and landscaped areas, seepage from feedlots/dairies, wastewater and food processing waste ponds, winery waste, sewage effluent, and leachate from septic system drain fields. The California drinking water MCL for nitrate (NO3) is 45 mg/L, and 10 mg/L for nitrate as nitrogen (NO3-N). Elevated concentrations are generally in the middle portion of the GSA near the American Avenue Landfill and the southeast of the GSA in the general area of Raisin City.

Dibromo-Chloropropane (DBCP)
DBCP was used as a fumigant to kill nematodes in soil before planting and was widely used in California until 1977. The MCL is 0.2 μg/L. DBCP was used in vineyards and deciduous orchards where sandy soils were present. Concentrations of DBCP above the MCL value have historically been detected in the southeast of the GSA in the general vicinity of Raisin City.

1,2,3-Trichloropropane (TCP)
TCP is used industrially (paint and varnish remover as a cleaning and degreasing agent) and chemically (solvent and intermediate for pesticides). There is no current federal MCL; however, California has adopted its own drinking water standard of 5 parts per trillion. TCP has been detected in shallow groundwater in the area around the American Avenue Landfill and in the general area of Raisin City in the southeastern area of the GSA.

Total Dissolved Solids (TDS)
TDS has a recommended SMCL of 1000 mg/L. Throughout MAGSA these values are present with little regularity or pattern.

4.5.1 Undesirable Results

An undesirable result would be the significant and unreasonable reduction in groundwater quality as it relates to groundwater pumping and recharge projects such that the groundwater is no longer generally suitable for

agricultural irrigation and domestic use. MAGSA will have authority related to groundwater management policies, and will review and analyze publicly available routine groundwater monitoring data reported by the community and non-community public supply wells, as it becomes available, in order to understand how and if groundwater pumping is exacerbating groundwater quality concerns and where to enforce pumping restrictions should it become necessary. **Section 5** of this GSP describes MAGSA monitoring well network.

4.5.1.1 Criteria to Define Undesirable Results

Regulation Requirements:

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

There are many existing agencies and programs that are generally responsible for groundwater quality. As described in the Plan Area chapter, these other agencies and programs include ILRP, CV-SALTS, Fresno County Rural Domestic Well Program (Volunteer basis), Dairy General Order, RWQCB, and DTSC.

While there are several existing groundwater monitoring programs, they do not monitor all contaminants of concern within MAGSA and may not provide depth-specific water quality data. Water quality of private domestic wells is largely unknown as testing of the wells is not required and the Fresno County Rural Domestic Well Program is voluntary and relies on well owners to have some knowledge of preexisting groundwater quality issues to opt in. Due to these limitations, the data from these programs will not be relied on to set sustainable management criteria at this time.

Groundwater monitoring and reporting by public water systems is a requirement of California Title 22 Code of Regulations. Monitoring and reporting schedule requirements can vary based on the service population size, geographic area and population type (i.e., transient vs. non-transient). Under California Domestic Water Quality and Monitoring Regulations, community water systems must distribute, to each customer, an annual water quality report on the water purveyed. This consumer confidence rule requires public water suppliers that serve the same customers throughout the year (community water systems) to provide consumer confidence reports to their customers. These reports are also known as annual water quality reports or drinking water quality reports. These reports are generally publicly available from the water suppliers or through an online data base such as the State Safe Drinking Water Information System (https://sdwis.waterboards.ca.gov/PDWW/). Generally speaking, California Domestic Water Quality and Monitoring Regulations do not require all chemicals and contaminants to be tested at public supply wells, rather the intent is to test for chemicals and contaminants that are known or likely to occur in the area. Therefore, not all chemicals of concern will be tested in every well and the monitoring frequency for individual chemicals can vary from once every 3 to 6 years to once every 3 to 12 months depending on well history and well location relative to known groundwater impacts. Groundwater monitoring results from the community and non-community wells within MAGSA monitoring network will be reviewed annually and the analytical results for the chemicals of concern specific to the individual well locations will be compared against the respective MCL values for the chemicals of concern. Chemical of concern within the MAGSA along with their respective MCL values are listed below in **Table 4-8.**

Undesirable results determinations will be based on the aggregated effect of: 1) the degradation of water quality to excess of MCLs (i.e. California potable water standards) where concentrations of chemicals of concern were historically below MCLs; and 2) for wells that have had recent historic concentrations of Chemicals of Concern above MCLs, the degradation of water quality to a level in excess of 20% greater than the recent historically high concentration of the Chemical of Concern in the well. The occurrence of an undesirable result will be defined as 15% of the monitoring indicator wells having reached either of these two criteria for two consecutive samples when shown to be altered by groundwater pumping or recharge activities.

Table 4-8 Chemicals of Concern and California MCLs

Chemical of Concern	California Primary MCL (mg/L unless otherwise shown)
Arsenic	0.01
Chloride	500**
Manganese	0.5*
Sodium	50
Uranium	20 (pCi/L)
Nitrate as NO3	45
Dibromo-Chloropropane (DBCP)	0.0002
1,2,3-Trichloropropane (TCP)	$5x10^{-6}$
Total Dissolved Solids (TDS)	1,000**

*=Notification Level, No MCL
**=Upper Secondary MCL

4.5.1.2 Causes of Groundwater Conditions that Could Lead to Undesirable Results

Regulation Requirements:

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

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

- The accumulated effects of fertilizer nutrient application and other farming practices leading to accumulation of chemicals of concern in groundwater, such as nitrates;
- One-time releases from sources of chemical contamination such as from fuel storage tanks; and
- The accumulated effects of regulated and unregulated waste discharge streams from wastewater treatment facilities, septic systems, industry, and food processors.

- The following are causes of groundwater quality degradation that could lead to undesirable results which fall under the GSA's management responsibility include:Declining groundwater levels can cause pumped groundwater to have higher concentrations of some naturally occurring chemicals which may be either health concerns or aesthetic concerns, such as arsenic or uranium;
- Groundwater pumping mobilizing groundwater contaminant plumes; and
- Recharge projects that are improperly located, causing downward movement of contaminants in the vadose zone or mobilize groundwater contaminant plumes.

Regulation Requirements:

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

The State MCL values for the chemicals of concern that have been identified in **Section 3.2** will be relied upon heavily as the criteria for defining undesirable results. An undesirable result determination will be based on exceedances in multiple monitoring locations within the GSA, rather than isolated exceedances.

Undesirable results determinations will be based on the aggregated effect of: 1) the degradation of water quality to excess of MCLs (i.e. California potable water standards) where concentrations of chemicals of

concern were historically below MCLs; and 2) for wells that have had recent historic concentrations of Chemicals of Concern above MCLs, the degradation of water quality to a level in excess of 20% greater than the recent historically high concentration of the Chemical of Concern in the well. The occurrence of an undesirable result will be defined as 15% of the monitoring indicator wells having reached either of these two criteria for two consecutive samples when shown to be altered by groundwater pumping or recharge activities.

Regulation Requirements:

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

Irrigation water quality is a critical factor in crop production and can be complicated as not all crops have the same sensitivity to water quality. Groundwater with high TDS or EC concentrations or general mineral concentrations can cause issues for plants and soil health, leading to crop yield impacts. High salinity content in irrigation water can detract from the amount of water and nutrient uptake in plant roots and leads to a crusty top layer in soil that makes seed sprouting difficult. Water quality within MAGSA is generally of such quality that groundwater degradation leading to impacts to crop is not considered a likely scenario.

Groundwater quality degradation has potential effects to urban area and rural residential drinking water quality. Increased salinity in drinking water can make treatment more difficult and expensive. Under California law, entities that provide drinking water are required to routinely sample groundwater from their wells and compare the results to potable water standards (MCL), as appropriate for the individual chemicals. These results are reported by the water purveyors and are publicly available. Residential structures not located within the service areas of urban agencies will typically have private domestic groundwater wells. Such wells have not been monitored routinely and groundwater quality from those wells is unknown unless the landowner has initiated testing and shared the data. Degraded water quality could potentially lead to rural residential use of groundwater not meeting potable water standards or the need for installation of new domestic wells to deeper depths to reach groundwater of better quality.

4.5.1.3 Evaluation of Multiple Minimum Thresholds

Regulation Requirements:

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

It is not practical for a single exceedance to lead to an undesirable result for the entire GSA, therefore an undesirable result determination will be based on multiple monitoring locations within the GSA over consecutive years.

4.5.2 Minimum Thresholds

Regulation Requirements:

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

Groundwater quality in MAGSA is generally suited for irrigation and domestic use, although groundwater issues for drinking water exist in some areas within the GSA. The minimum thresholds have been set consistent with State and local water quality standards to be protective of water uses and users and are intended to be protective of human health (Title 22 of the CCR).

Minimum Threshold values have been established by two different methods, as follows:

- Numeric values for MCLs (i.e. California potable water standards) as identified in **Table 4-8**, where concentrations of chemicals of concern were recently below MCLs; or
- For wells that have had recent concentrations of Chemicals of Concern above MCLs, the degradation of water quality to a level in excess of 20% greater than the recent historically high concentration of the Chemical of Concern in the well. The 20% increase was selected as a criterion to provide a reasonable balance between natural fluctuations and uncertainty in the data with the desire to minimize further degradation.

Based on available data, **Table 4-9** shows the historical maximum concentration of Chemicals of Concern and where MCL exceedances have occurred. Minimum Threshold numeric values in these instances will be set at a 20% increase to the indicated table values. If water quality sampling indicates a Minimum Threshold exceedance, then an evaluation will need to occur to determine if the exceedance is a result of groundwater management activities.

Table 4-9 Chemicals of Concern with Historic Exceedances of MCLs (2015 to 2021)

Well ID	Well Type	Arsenic (mg/L)	Chloride (mg/L)	Manganese (mg/L)	Sodium (mg/L)	Uranium (pCi/L)	Nitrate as N (mg/L)	DBCP (mg/L)	TCP (mg/L)	TDS (mg/L)
1000317-001	Public Supply	NA	NA	NA	NA	NA	8	NA	NA	NA
1000465-001	Public Supply	0.003	49	ND	37	7.2	11 (13.2)	0.0015 (0.0018)	$7.2X10^{-5}$ ($8.6X10^{-5}$)	310
1000551-001	Public Supply	0.0074	7.3	ND	53	NA	2.8	ND	ND	200
1000560-001	Public Supply	NA	NA	NA	NA	NA	2.6	NA	NA	NA
1000602-003	Public Supply	0.015 (0.018)	NA	NA	NA	4.8	0.58	ND	ND	NA
1000604-002	Public Supply	0.038 (0.046)	NA	ND	NA	NA	2.84	ND	ND	NA
1000641-001	Public Supply	0.0074	16	ND	70	NA	ND	ND	ND	220
1009120-001	Public Supply	0.011 (0.013)	61	ND	64	28 (33.6)	3.7	ND	$5.0X10^{-6}$ ($6x10^{-6}$)	350
L10006109169-DMW-21	Monitoring Well	0.0025	450	ND	140	NA	19 (22.8)	ND	ND	1600 (1920)
L10006109169-DMW-25	Monitoring Well	0.0025	320	ND	130	NA	11 (13.2)	ND	ND	1500 (1800)
L10006109169-DMW-17	Monitoring Well	0.0051	490	ND	330	NA	11 (13.2)	ND	ND	1800 (2160)
L10006109169-BMW-1	Monitoring Well	0.0047	450	ND	270	NA	22 (26.4)	ND	ND	1200 (1440)
California MCLs		**0.01**	**500****	**0.5***	*******	**20**	**10**	**0.0002**	**$5x10^{-6}$**	**1000****

Notes:

* = Notification Level, No MCL
** = No current drinking water standard
*** = California Upper Secondary MCL
NA = Not analyzed
ND = Not detected
Cells highlighted when max concentration is greater than the MCL. Minimum Threshold numeric values set at a 20% increase to the indicated max concentration value. Minimum Threshold actual values in parenthesis.

Regulation Requirements:

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

Declining water levels can potentially lead to increased concentrations of some chemicals that reside in larger proportions in deeper aquifer zones, such as arsenic or uranium. Conversely rising water levels can also lead to increased concentrations of some chemicals of concern, for example nitrates, that may reside in unsaturated soils at shallower depths. Groundwater levels will not be used as a proxy for water quality due to a lack of clear correlation between groundwater levels and changes in water quality.

4.5.2.1 Criteria to Define Minimum Thresholds

Regulation Requirements:

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

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

The criteria to define minimum thresholds will be based on the MCL values of the chemicals of concern discussed in the Groundwater Conditions chapter, **Section 3.2** of this GSP. The publicly available groundwater quality data from the selected representative wells will be obtained annually and compared against the Minimum Threshold values as discussed above**.** New emerging contaminants of concern and MCLs will be addressed in subsequent GSP updates.

4.5.2.2 Relationships Between Minimum Thresholds and Sustainability Indicators

Regulation Requirements:

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

Changes to groundwater quality can be related to significant changes in groundwater levels and groundwater storage sustainability indicators. Declining water levels, which relate directly with a reduction of groundwater storage, can potentially lead to increased concentrations of chemical of concern for those that reside in larger proportions in deeper aquifer zones, such as arsenic or uranium. Conversely, rising water levels, which relate directly with an increase in groundwater storage, can also lead to increased concentrations of some chemicals of concern, for example nitrates, that may reside in unsaturated soils at shallower depths. Groundwater quality cannot be used to predict responses of other sustainability indicators; however, groundwater quality can potentially be affected by changes in groundwater levels and reduction of groundwater storage indicators. Based on this relationship, groundwater quality minimum thresholds should be established separately from other indicators.

4.5.2.3 Minimum Thresholds in Relation to Adjacent Basins

Regulation Requirements:

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

The minimum threshold for groundwater quality is protective of water uses and users and will prevent causing undesirable results in adjacent basins and will not affect the ability of adjacent basins to achieve sustainability goals.

4.5.2.4 Impact of Minimum Thresholds on Beneficial Uses and Users

Regulation Requirements:

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

The minimum thresholds for groundwater quality will be protective of water uses and users from degradation of groundwater quality by known chemicals of concern to concentrations detrimental to human health. The minimum threshold for degraded water quality maintains existing and potential future beneficial uses of land and property interests.

4.5.2.5 Current Standards Relevant to Sustainability Indicator

Regulation Requirements:

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

The minimum thresholds for water quality are protective of human health and intended beneficial use and are based around MCLs found in Title 22 of the California Code of Regulations. The intent of SGMA is for the GSAs is to be responsible for groundwater aspects related to pumping only. Other existing agencies and programs are generally responsible for groundwater quality remediation. Minimum thresholds may differ from MCLs in locations where historic groundwater quality data indicates that MCLs have already been exceeded.

4.5.2.6 Measurement of Minimum Thresholds

Regulation Requirements:

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

Groundwater monitoring and reporting for public supply wells is a requirement of CCR Title 22. Public supply wells within MAGSA area are already being monitored for a wide range of contaminants, including the chemicals of concern, by the water purveyors under Title 22. In addition to the public supply wells, there are several groundwater monitoring wells installed around the perimeter of the American Avenue Landfill. These monitoring wells are monitored for several constituents of concern on a semi-annual basis and the groundwater data is reported publicly to the SWRCB online GeoTracker database. The publicly available groundwater quality data from selected representative wells will be obtained annually and compared against the Minimum Threshold values as discussed above**.**

Selected public supply wells and American Avenue Landfill monitoring wells will form the basis of the monitoring network for groundwater quality as shown on **Figure 4-3**. The chemicals of concern that the

individual wells are routinely monitored for are summarized in **Table 4-9**. The selected groundwater quality monitoring network will be evaluated and augmented in subsequent GSP 5-year revisions.

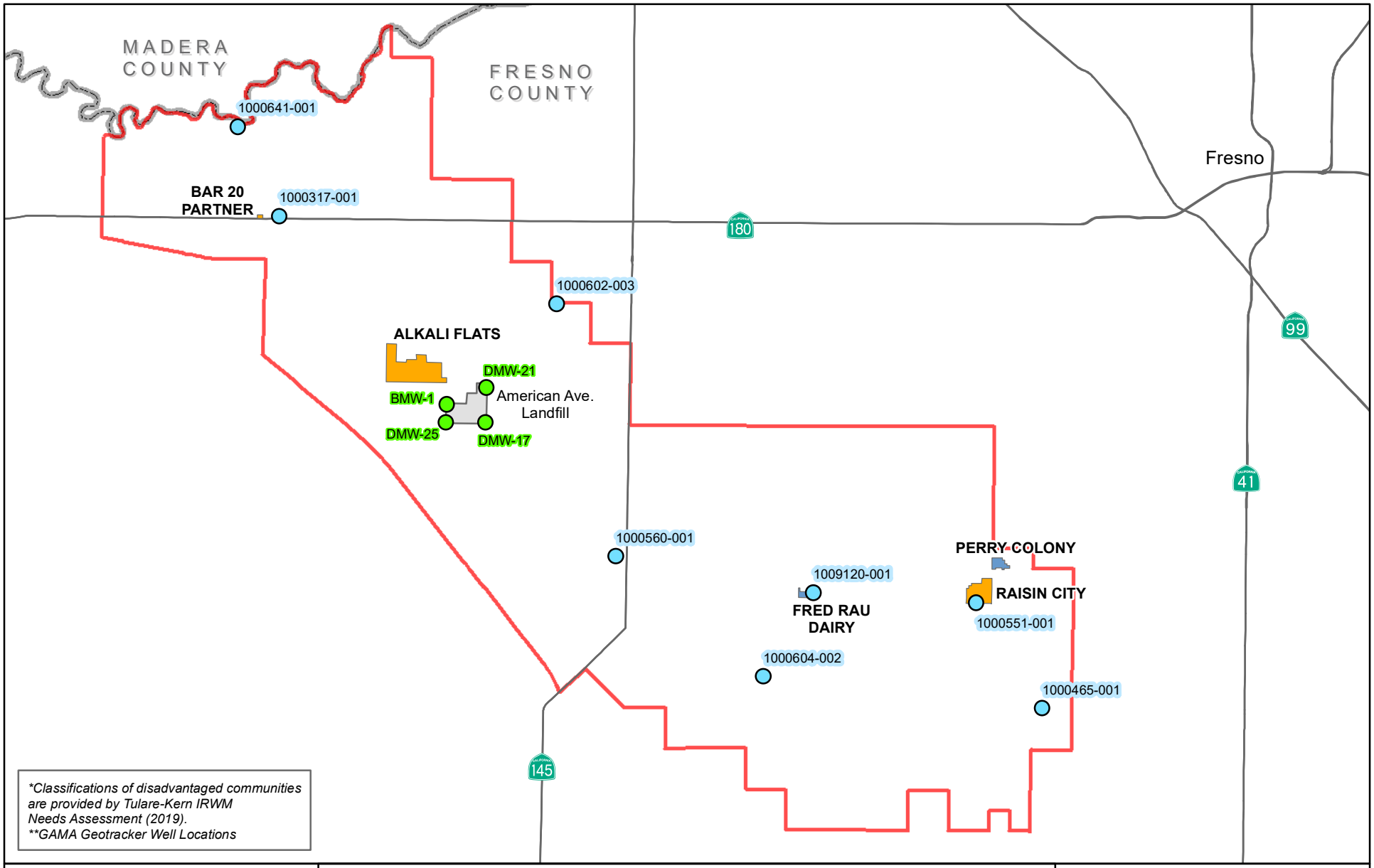


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Table 4-9 Selected Representative Wells and Monitored Chemicals of Concern

Public System NO. / GAMA ID	Well Owner	Chemicals of Concern Tested for								
		Arsenic	Chloride	Manganese	Sodium	Uranium	Nitrates	DCP	TCP	TDS
1000317-001	Holland Hulling Company	--	--	X	X	--	X	--	--	--
1000465-001	Batth Dehydrator	X	--	--	--	X	X	X	--	--
1000551-001	FCSA #43 / Raisin City	X	X	X	X	GA	X	X	--	X
1000560-001	Central CA Almond Growers Assn.	--	--	--	--	--	X	--	--	--
1005602-003	Baker Commodities	X	--	--	--	GA	X	X	X	--
1000604-002	Johann Dairy	X	--	--	--	--	X	X	X	--
1000641-001	Larry Shehadey Dairy	X	--	--	--	GA	X	X	X	--
1009120-001	Rau Dairy	X	X	X	X	GA	X	X	X	X
L10006109169-DMW-21	Fresno County	X	X	X	X	--	X	X	X	X
L10006109169-DMW-25	Fresno County	X	X	X	X	--	X	X	X	X
L10006109169-DMW-17	Fresno County	X	X	X	X	--	X	X	X	X
L10006109169-BMW-1	Fresno County	X	X	X	X	--	X	X	X	X

Notes:
X=chemical of concern is routinely rested for in well
--=chemical of concern is not routinely tested for in well
GA=Gross Alpha determination. If gross alpha is greater than 5pCi/L uranium analysis is performed.

4.5.3 Measurable Objectives

4.5.3.1 Description of Measurable Objectives

Regulation Requirements:

> **§354.30 (a)** Each Agency shall establish measurable objectives, including interim milestones in increments of five years, to achieve the sustainability goal for the basin with 20 years of Plan implementation and to continue to sustainably manage the groundwater basin over the planning and implementation horizon.
> **(b)** Measurable objectives shall be established for each sustainability indicator, based on quantitative values using the same metrics and monitoring sites as are used to define the minimum thresholds.

Groundwater within MAGSA is generally used beneficially for municipal/domestic consumption or agriculture. Groundwater quality standards are typically higher than those required for agriculture. The minimum threshold for degraded water quality has been set at values that are protective of human health and intended beneficial use and users of groundwater resources (i.e., CCR Title 22).

For wells within the monitoring network (either existing or future wells), where concentrations of the chemicals of concern are historically 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 historic concentrations above MCLs for contaminants of concern, the measurable objective is for the wells to maintain stable or improving groundwater quality trends in regard to the identified chemicals of concern.

4.5.3.2 Operational Flexibility

Regulation Requirements:

> **§354.30 (c)** Measurable objectives shall provide a reasonable margin of operational flexibility under adverse conditions which shall take into consideration components such as historical water budgets, seasonal and long-term trends, and periods of drought, and be commensurate with levels of uncertainty.

> **§354.30 (g)** An Agency may establish measurable objectives that exceed the reasonable margin of operational flexibility for the purpose of improving overall conditions in the basin, but failure to achieve those objectives shall not be grounds for finding of inadequacy of the Plan.

For wells within the monitoring network (either existing or future wells), where concentrations of the chemicals of concern are historically below MCLs, the operational flexibility is the difference between the MCL and recent historic concentration of the chemical of concern. No operation flexibility will be set at this time for situations where monitoring network wells (either existing or future wells) have historic concentrations above MCLs for contaminants of concern.

4.5.3.3 Representative Monitoring

Regulation Requirements:

> **§354.30 (d)** An Agency may establish a representative measurable objective for groundwater elevation to serve as the value for multiple sustainability indicators where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual measurable objectives as supported by adequate evidence.

Groundwater levels will not be used as a proxy for water quality due to a lack of clear correlation between groundwater levels and changes in water quality.

4.5.3.4 Path to Achieve Measurable Objectives

Regulation Requirements:

> **§354.30 (e)** Each Plan shall describe a reasonable path to achieve the sustainability goal for the basin within 20 years of Plan implementation, including a description of interim milestones for each relevant sustainability indicator, using the same metric as the measurable objective, in increments of five years. The description shall explain how the Plan is likely to maintain sustainable groundwater management over the planning and implementation horizon.

Groundwater pollution characterization and mitigation are typically enforced by local agencies and state level programs. The GSA will have authority related to groundwater pumping policies, however the GSA will review and analyze publicly available routine groundwater monitoring data reported by the community and non-community public supply wells and the monitoring wells around the American Avenue Landfill in order to understand how and if groundwater pumping is exacerbating groundwater quality concerns and where to enforce pumping restrictions or other mitigation measures should it become necessary. Management of groundwater pumping will occur over the lifetime of the planning and implementation horizon. No interim milestones have been set for the water quality indicator.

If a Minimum Threshold exceedance occurs, a site-specific investigation will be conducted to try to determine if GSA actions have contributed to the groundwater quality degradation. The investigation may include, but will not be limited to the following:

- Verification of groundwater gradient and flow direction in the area in question;
- Changes in the historic cropping record in the area compared against historic groundwater quality data;
- Groundwater quality compared against groundwater level changes in the area;
- Available groundwater pumping records for wells in the area will be reviewed and compared against groundwater quality trends;
- Available groundwater recharge records for recharge sites in the area will be reviewed and compared against groundwater quality data;
- A Phase I Environmental Site Assessment could potentially be performed in order to assess the possibility of degradation resulting form third party activities.

Should investigations indicate GSA actions have contributed to groundwater quality degradation, then management actions described in Chapter 6 will be implemented in the area where the water quality has changed.

4.5.3.5 Measurable Objectives for Additional Plan Elements

Regulation Requirements:

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

MAGSA will not be setting measurable objectives or interim milestones for additional plan elements described in Water Code Section 10727.4.

4.6 Land Subsidence

As described in **Section 3.2.6**, land subsidence within the Kings Subbasin primarily occurs in the western and southern portion of the basin that overlies the Corcoran Clay. The eastern extent of the Corcoran Clay is shown in **Figure 3-64**. Some pumping below the Corcoran Clay does occur within the Kings Subbasin, but a significant amount of the land subsidence within the Kings is believed to be caused by pumping below the Corcoran Clay that occurs outside of the Kings Subbasin.

DWR staff has indicated that the intent of SGMA was that land subsidence be avoided or minimized based to the extent within the GSAs control. Once groundwater levels have stabilized within the basin, land subsidence should be minimized. Measurable objectives for land subsidence were set based on this requirement.

According to USGS, land subsidence is a gradual settling or sudden sinking of the Earth's surface owing to subsurface movement of earth materials. The main form of subsidence in the MAGSA area is deep subsidence from declining groundwater levels from the confined aquifer. Current and historical information on land subsidence is discussed in **Section 3.2.6** and the land subsidence monitoring network is discussed in **Section 5.6**. **Section 4.6** discusses the Undesirable Result, Minimum Threshold, and Measurable Objective set for land subsidence.

4.6.1 Undesirable Results

The MAGSA has minimal land subsidence as described in detail in **Section 3.2.6**, and there have been no known significant impacts from land subsidence within the MAGSA.

SGMA defines an undesirable result for land subsidence as that which causes significant and unreasonable land subsidence that substantially interferes with surface land uses. The terms "significant and unreasonable" are not defined by regulations, rather the conditions leading to this classification are determined by the GSA, beneficial users, and the basin they are a part of. The primary concern related to interference with surface land uses in the Kings Basin is subsidence reducing the capacity of gravity flow water conveyance facilities such as canals or river channels. Subsidence within a portion of a river channel or canal could prevent conveyance of flood water in river channels increasing the risk of flooding adjacent land, or the subsidence within sections of an irrigation canal could restrict or prevent delivery of irrigation water to agricultural land.

The GSAs within the basin have defined the Undesirable Result of land subsidence as significant and unreasonable if loss of conveyance capacity of the Kings River or existing irrigation canals has occurred.

In MAGSA, land subsidence would be considered significant and unreasonable when infrastructure, such as roads, the distribution systems, levees, wells, and pumps begin to fail or take critical damage. There are two major highways located within the MAGSA, State Route 180 and State Route 145. Existing infrastructure includes JID canals within MAGSA and the James Bypass adjacent to MAGSA's westerly boundary. MAGSA currently does not have regional conveyance canals, but there are several canals proposed in the list of projects in **Section 6**. When those canals are built as part of the projects identified, it would be undesirable if subsidence caused the canal to lose significant conveyance capacity. Other infrastructure in MAGSA includes the levee along the SJR.

4.6.1.1 Criteria to Define Undesirable Results

Regulation Requirements:

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

The process used to develop the criteria for undesirable results began with the review of KRCD, USGS, DWR, NASA InSAR, and USBR land subsidence data, and through discussions with stakeholders and landowners regarding locally observed conditions. The conveyance capacity of the SJR channel is critical for both the conveyance of flood water and delivery of surface water for irrigation supplies. During flood periods, the conveyance capacity of the SJR is necessary to route water through portions of the basin without causing flooding of lands adjacent to the river. These conveyance facilities are gravity flow systems, relying on open channel hydraulic pressure to convey water through the existing channels. Subsidence that lowers the canal or channel at the headworks or within a section of channel prevents the channel from maintaining

the water levels needed to convey the needed capacity of the channel, thereby restricting deliveries unless mitigated. Defining the Undesirable Result was based on the criteria to maintain adequate channel capacity within the river system and irrigation canals to continue historic surface water deliveries.

From discussions with stakeholders and landowners, there have been no known undesirable results within MAGSA. Since there have been no known issues with historic land subsidence in MAGSA, the historical subsidence rate and cumulative subsidence would not lead to undesirable results over the 20-year implementation period.

4.6.1.2 Causes of Groundwater Conditions That Could Lead to Undesirable Results

Regulation Requirements:

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

As described in **Section 3.2.6**, there are five types of subsidence in California, but only deep subsidence from declining groundwater levels is found in MAGSA. Excessive pumping below the Corcoran Clay that occurs within the basin and outside the basin could cause the Undesirable Result of subsiding portions of a gravity flow channel or canal that reduces the conveyance capacity of that facility.

Excessive groundwater pumping can contribute to deep subsidence across a broad area, resulting in aquifer compaction, loss of storage capacity, and adverse effects to surface features, such as bridges, canals, flood control systems, and water supply pipelines that rely on gravity flow.

SGMA only applies to land subsidence from groundwater pumping. There are two general types of subsidence: elastic and inelastic. Elastic subsidence is recoverable if water levels later rise while inelastic subsidence is permanent. Elastic subsidence generally occurs in the coarse- grained portions of the aquifer where the materials compact. Although there are several causes of inelastic land subsidence, the compression of clay as a result of groundwater extraction from confined aquifers is the cause of the vast majority of subsidence documented in the San Joaquin Valley. This results in compaction of fine-grained confining beds (clays) above and within the confined aquifer system as water is removed from pores between the sediment grains. Once water is squeezed out of the compressible clay, the clay compacts resulting in the lowering of the overlying land surface. The compressed clays, in which the clay particles have been re-arranged more compactly, can no longer re-absorb water, thus the subsidence in these areas cannot be reversed. This process is known as aquifer system compaction.

In the Central Valley, aquifer system compaction primarily occurs within the Corcoran Clay layer. The Corcoran Clay layer within the Kings basin is shown in **Figure 4-4**. Since the Corcoran Clay is a confining layer, land subsidence would occur when too much water is pumped from the confined aquifer below the Corcoran Clay. In areas prone to subsidence, soil textures, clay mineralogy, and other geologic and geochemical properties were intensely studied by the USGS in a series of Professional Papers in the 1960s, 1970s and 1980s. Regionally, the areas prone to subsidence were underlain by deposits where the clayey deposits are dominated by the clay mineral montmorillonite (USGS 497-C, Meade 1967). Most of the permanent subsidence in the San Joaquin Valley has historically been correlated to overdraft in the confined aquifer below the Corcoran Clay. However, with increased reliance on groundwater to meet demands, land subsidence is currently occurring in some isolated areas outside of the Corcoran clay. However, in these areas, subsidence is typically lower than in areas underlain by the Corcoran Clay.

Kings Subbasin
Coordinated Effort

Kings Coordinated Effort GSAs

Land Subsidence
NASA (via CA Dept. Water Resources)
2015-2017

Figure 4-4

Legend

- Kings Subbasin GSAs
- Township/Range

E-Clay Eastern Extent

- Page and LeBlanc 1969, modified by KDSA

NASA InSAR Data (provided by CA DWR) *

Change from May 2015 to April 2017 (inches)

- 2 to 6
- 1 to 2
- 0 to 1
- -1 to 0
- -2 to -1
- -3 to -2
- -5 to -3
- -7 to -5
- -10 to -7
- -15 to -10

* The legend shows the change in ground surface elevation from May 2015 to April 2017. The positive values indicate rebound while the negative values indicate land subsidence.

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DWR DIRWM, Sources: Esri, USGS, NOAA

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Regulation Requirements:

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

The criteria to define when and where the effects of subsidence cause an Undesirable Result is based on the combination of exceedances of the minimum thresholds. The proposed subsidence monitoring network will measure the annual rate and cumulative subsidence to verify those variables have not exceeded the minimum threshold. The exceedance of the minimum threshold within a 36 square-mile area (roughly a Township) is significant based on how the basin has determined the minimum thresholds described later in this section. The exceedance of the annual rate or cumulative subsidence minimum threshold would potentially be significant to the stakeholders in the proximity of the subsidence area, and potentially downstream. A minimum threshold exceedance would warrant further evaluation by the GSA and potential action.

Regulation Requirements:

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

The potential effects of land subsidence include those on manmade structures and those on natural features. In the GSA, the main concerns related to land subsidence are the impacts to gravity driven water conveyance structures such as canals or river channels.

Within the MAGSA, the primary gravity flow systems are the SJR and various irrigation canals. The beneficial uses and users could potentially be affected by:

- Flooding caused by overtopping the river levees if subsidence lowers a section of channel, decreasing capacity and hindering the ability of SJR to convey flood flows or irrigation water.
- Reduced conveyance capacity in irrigation canals caused by subsidence in a section of irrigation canal preventing delivery of surface water needed for crop irrigation or groundwater recharge to downstream water users.
- Roadways or bridges needing to be reconstructed to accommodate the raising of canal/channel banks that have been impacted by subsidence. These improvements can require additional road right of way requirements to raise channel crossings as well as transportation impacts during construction.
- Gravity flow cast-in-place pipelines needing to be repaired if cracking occurs because of subsidence.

An additional impact of subsidence to beneficial uses is that compaction of the aquifer system may permanently decrease its capacity to store water. Most compaction that occurs as a result of historically low groundwater levels is irreversible.

4.6.1.3 Evaluation of Multiple Minimum Thresholds

Regulation Requirements:

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

Monitoring for land subsidence will be done by evaluating data released from NASA InSAR (see **Section 5.6**) and, as a cross-check, the GSA gathers subsidence data from sites historically monitored by KRCD. The SJR levees are monitored annually for subsidence. Therefore minimum thresholds have been set GSA-wide based on loss of conveyance capacity and will be evaluated by mapping the subsidence over the area. Monitoring

sites for these programs extend beyond the Kings Subbasin boundaries which is adequate for covering the GSAs using contouring and interpolation techniques. The determination that undesirable results are occurring shall depend upon measurements from multiple monitoring sites from within each GSA and InSAR mapping over the entire basin. The exceedance of the minimum threshold over a 36 square-mile area may be considered significant based on how the basin has determined the minimum thresholds.

4.6.2 Minimum Thresholds

Regulation Requirements:

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

Even though some subsidence has occurred, MAGSA is not currently experiencing any known significant subsidence impacts to river channel or canal facilities. While there are no known issues because of land subsidence, as described in **Section 3.2.6**, land subsidence has recently occurred in the GSA. There are projects identified in this GSP that would construct canals within the GSA. The minimum threshold has been set based on the amount of subsidence critical river channel and canal infrastructure can typically tolerate. The most vulnerable facilities in the GSA are irrigation canals due to their reliance on gravity flow as well as pipelines that may be subject to cracking. Irrigation canals in the GSA generally have about 3 feet of freeboard, which is the distance from the top of water surface to top of canal bank. Freeboard allows for operational flexibility so the water does not overtop the canal or channel. Hence, subsidence causing an elevation change of up to three feet difference between the head of a canal and the canal terminus can be tolerated before there is a loss of operational capacity. However, uniform subsidence along a canal reach would not impact the canal gradient or freeboard, so the spatial distribution of subsidence will be important in determining how specific facilities are impacted. The minimum threshold was set at 3 feet of subsidence. The SJR Levees have more than three feet of freeboard and can therefore tolerate this amount of subsidence before capacity is impacted.

Although an exact correlation between the groundwater level minimum thresholds and the anticipated amount of subsidence cannot be made, it is important to understand that subsidence will likely continue to occur during the planning period (2020-2040) until water levels are stabilized at the water level measurable objective in the Kings Subbasin as well as neighboring subbasins. It is anticipated that some subsidence would continue when hydrologic conditions cause the operational flexibility to be used and water levels drop below the Measurable Objective (potentially all the way to the Minimum Threshold level during a 5-year drought), but subsidence would stop after the water level reaches its lowest point and then is raised back up to the sustainable Measurable Objective level. Once water levels are stabilized at the measurable objective level then the minimum threshold for subsidence allows for water levels to drop to the minimum threshold level.

Regulation Requirements:

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

The water level SMCs are for the unconfined aquifer and confined aquifer groundwater levels would be needed to represent land subsidence. At this time, groundwater levels will not be used as a proxy for land subsidence due to a lack of quality data on the confined aquifer potentiometric surface. In the Central Valley, land subsidence usually occurs from the Corcoran Clay layer including the confined aquifer below. The Corcoran Clay layer extends into MAGSA and covers the majority of the GSA. Since the Corcoran Clay is a confining layer, land subsidence would occur when water is pumped from the confined aquifer below the Corcoran Clay. To monitor land subsidence based on water level, the well would have to be perforated below

the Corcoran clay, and not be composite (i.e. constructed across multiple aquifer zones). There are limited wells within MAGSA that are drilled below the Corcoran Clay with reliable well construction information that are not composite wells. There are few wells that only tap the confined aquifer, and of those that do the GSA does not have long-term water level data. The GSA will eventually add more wells to the representative monitoring well network to include more confined aquifer wells.

The groundwater level and pumping from the confined aquifer are considered a data and the project to fill those data gaps are included in this GSP, section **6.2.13**. The data gap project will include estimating groundwater pumping from the confined aquifer and identifying more confined aquifer wells to be able to develop a potentiometric surface. The data gap study is a high priority and will be commenced as soon as possible.

4.6.2.1 Criteria to Define Minimum Thresholds

Regulation Requirements:

§354.28 **(b)** The description of minimum thresholds shall include the following: **(1)** The information and criteria relied upon to establish and justify the minimum thresholds for each sustainability indicator. The justification for the minimum threshold shall be supported by information provided in the basin setting, and other data or models as appropriate, and qualified by uncertainty in the understanding of the basin setting.
§354.28 **(c)** Minimum thresholds for each sustainability indicator shall be defined as follows: **(5)** Land Subsidence. The minimum threshold for land subsidence shall be the rate and extent of subsidence that substantially interferes with surface land uses and may lead to undesirable results. Minimum thresholds for land subsidence shall be supported by the following: **(A)** Identification of land uses and property interests that have been affected or are likely to be affected by land subsidence in the basin, including and explanation of how the Agency has determined and considered those uses and interests, and the Agency's rationale for establishing minimum thresholds in light of those effects. **(B)** Maps and graphs showing the extent and rate of land subsidence in the basin that defines the minimum threshold and measurable objectives.

Most subsidence in the San Joaquin Valley has happened and is happening west of the MAGSA area over the axial trough of the Valley, in an area west and south of MAGSA. Refer to **Section 3.2.6** of the basin setting for more information on land subsidence conditions. Areas prone to subsidence, soil textures, clay mineralogy, and other geologic and geochemical properties were intensely studied by the USGS in a series of Professional Papers in the 1960s, 1970s and 1980s. Regionally, the areas prone to subsidence were underlain by deposits where the clayey deposits are dominated by the clay mineral montmorillonite (USGS 497-C, Meade 1967). The historic subsidence map, **Figure 4-5**, and the recent subsidence map, **Figure 4-6,** both show that generally subsidence increases westerly to southwesterly across MAGSA indicating that groundwater is likely increasingly confined to the west, and there is likely a higher percentage of montmorillonite in the finer-grained sediments near the axis of the valley. The maps and summary table showing historic subsidence within the GSA that were considered in establishing the minimum threshold for land subsidence are included in this section. **Table 4-10** shows the summary of historical land subsidence in MAGSA as estimated by different agencies over various time frames and **Table 4-11** shows the summary of the historical land subsidence rates. The tables include a minimum and maximum value for each map to show the variation of land subsidence in the MAGSA.

The criteria for cumulative subsidence were based on the amount of subsidence that could be tolerated for critical infrastructure. Irrigation canals are considered the most vulnerable infrastructure due to their reliance on gravity flow; they can tolerate up to 3 feet of subsidence based on the typical amount of freeboard found in most canals. Significant and unreasonable conditions would occur if the total freeboard was lost due to subsidence, causing canal overtopping and loss of capacity. It should be noted that 3 feet of subsidence in the GSA would not necessarily cause an undesirable result, since the subsidence would need to cause a difference of 3 feet along the canal reach (i.e., 3 feet of subsidence at the head of the canal and no subsidence at the canal terminus). The spatial distribution of subsidence could cause the impact to the freeboard to range anywhere from zero to three feet. Uniform subsidence along a canal reach would not necessarily cause a loss

of any capacity or freeboard. However, three feet of subsidence is the minimum amount that could cause significant issues. To address subsidence before reaching the Minimum Threshold, subsidence of one foot within a 36 square mile area in the GSA 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.

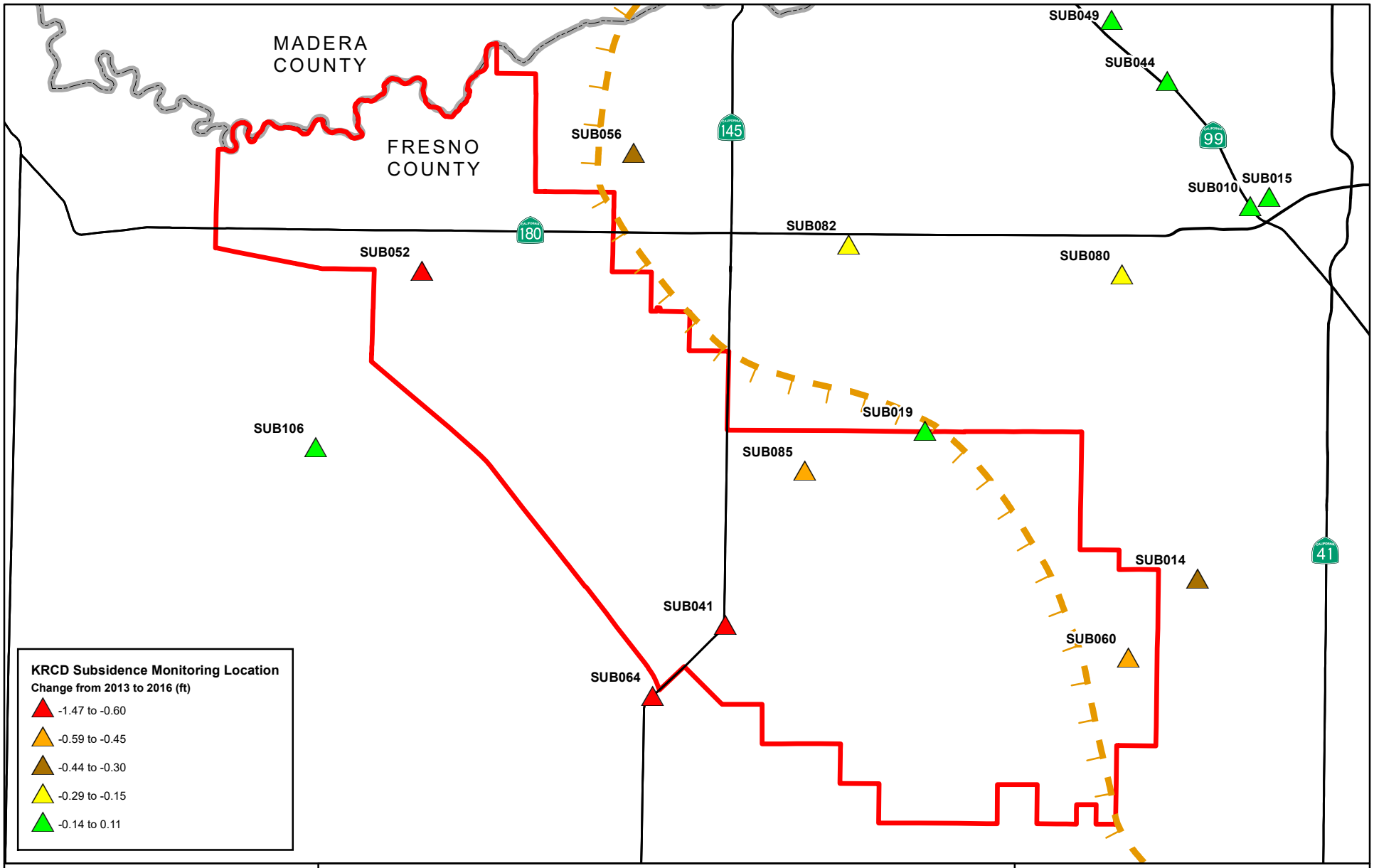
Minimum threshold exceedances may occur due to subsidence that originates outside of the GSA. The minimum threshold is set based on what the GSAs believe they can directly control. If subsidence appears to be encroaching into MAGSA from other regions as shown by InSAR data, then neighboring GSAs will be contacted to coordinate studies that would need to be performed to evaluate the sources of subsidence in the MAGSA and in the neighboring GSAs, and to coordinate mitigation efforts.

Table 4-10 Historical Total Land Subsidence in MAGSA

Total Subsidence in MAGSA						
Monitoring Agency	Date Range		West of Corcoran Clay		East of Corcoran Clay	
	Start	End	Min (in)	Max (in)	Min (in)	Max (in)
USGS	1926	1970	-12	-48	0	-12
DWR	1949	2005	0	-180	0	-60
USBR	2011	2016	-1.5	-3.24	-1	-1.5
KRCD	2013	2016	-5.4	-17.6	-5.4	-7.1
NASA	2015	2017	-1	-10	-1	-5

Table 4-11 Historical Land Subsidence Rates in MAGSA

Subsidence Rate in MAGSA						
Monitoring Agency	Date Range		West of Corcoran Clay		East of Corcoran Clay	
	Start	End	Min (in/yr)	Max (in/yr)	Min (in/yr)	Max (in/yr)
USGS	1926	1970	-0.27	-1.09	0.00	-0.27
DWR	1949	2005	0.00	-3.21	0.00	-1.07
USBR	2011	2016	-0.30	-0.65	-0.20	-0.30
KRCD	2013	2016	-1.80	-5.87	-1.80	-2.37
NASA	2015	2017	-0.50	-5.00	-0.50	-2.50



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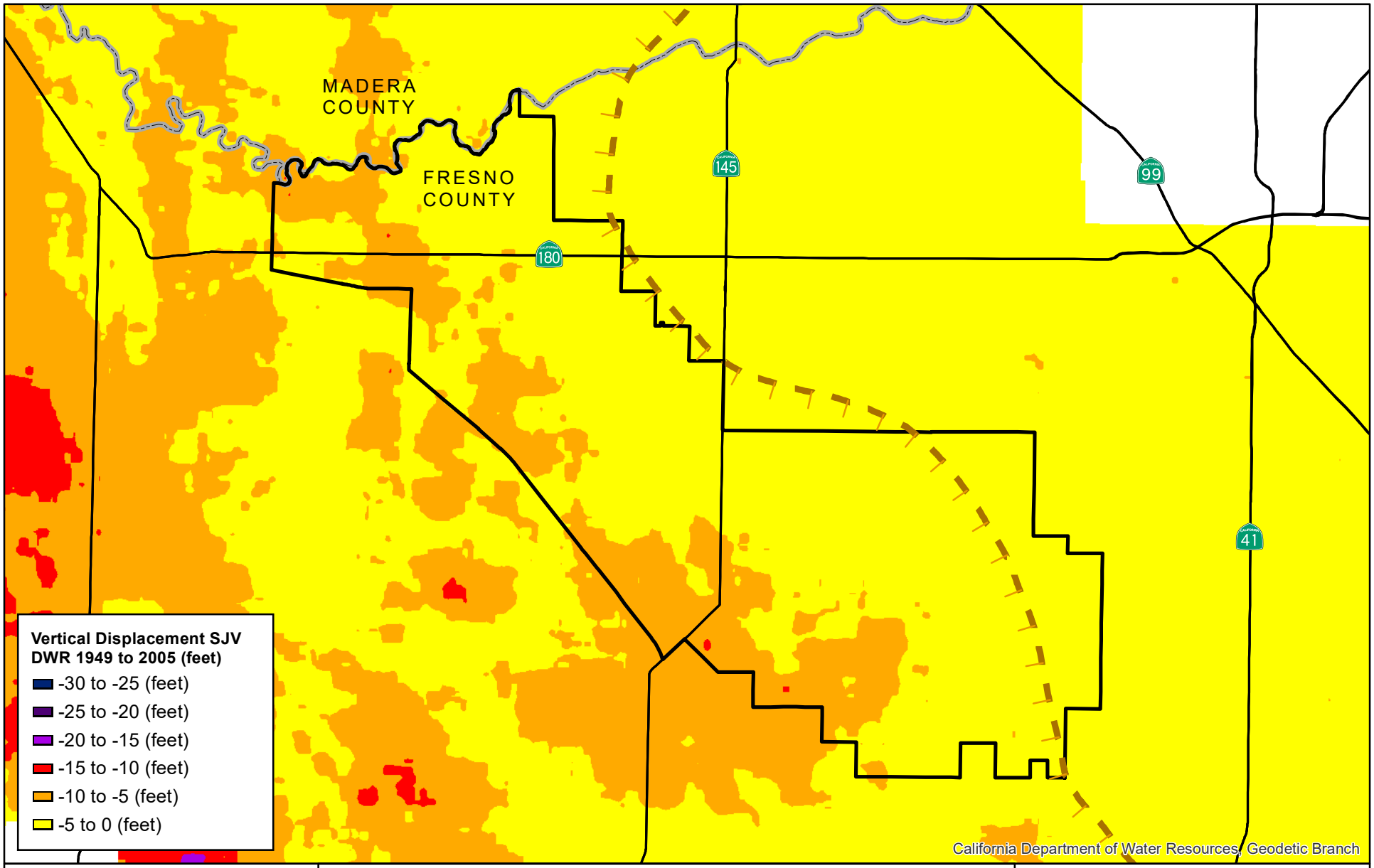

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McMullin Area GSA

County

North East Edge of Corcoran Clay

Page and LeBlanc 1969, KDSA (A Modification of Croft and Gordon 1968)

McMullin Area GSA

Land Subsidence
Department of Water Resources
1949-2005

Figure 4-6

7/3/2019 : G:\McMullin GSA-2659\265917002-Technical Services\GIS\Map\Report\Gen\Subsidence\subsidence_DWR.mxd

4.6.2.2 Relationships Between Minimum Thresholds and Sustainability Indicators

Regulation Requirements:

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

The following provides an explanation of the relationship between the subsidence minimum thresholds and the other sustainability indicators and how the GSA determined that the minimum thresholds will avoid undesirable results for each Indicator:

- Groundwater Levels. Land subsidence does not impact water levels, rather the water levels impact land subsidence. Land subsidence occurs due to a decline in water levels from confined groundwater pumping. It is assumed that the neighboring GSAs will reduce pumping to some extent from the confined aquifer to become sustainable. The reduction in confined groundwater pumping would lead to water levels stabilizing because of the water level sustainable management criteria, that would lead to land subsidence stabilizing. Although an exact correlation between the groundwater level minimum thresholds and the anticipated amount of subsidence cannot be made, it is important to understand that subsidence will likely continue to occur during the planning period (2020-2040) until water levels are stabilized at the water level measurable objective. Once water levels are stabilized at the measurable objective level then the minimum threshold for subsidence allows for water levels to drop to the minimum threshold level.
- Groundwater Storage. Land subsidence impacts storage change when there is inelastic land subsidence. Once inelastic land subsidence occurs, the loss in storage cannot be reversed.
- Sea Water Intrusion. This indicator is not applicable to this basin.
- Groundwater Quality. Research conducted by Stanford University and Community Water Center supports the premise that arsenic can reside within pore water of clay strata within aquifers and is released due to overpumping. Though historic groundwater pumping shows no link to current groundwater arsenic concentrations, there is a potential for land subsidence to be related to water quality. Further investigation and research are required to know the vertical locations/extent of subsidence, the presence of arsenic within clay pores, and potential impacts to surrounding aquifer water quality.
- Interconnected Surface Water. Land subsidence is not directly related.

4.6.2.3 Minimum Thresholds in Relation to Adjacent Basins

Regulation Requirements:

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

The minimum thresholds have been selected to avoid causing undesirable results in adjacent basins. The minimum thresholds do not exceed historical subsidence observed in the Kings Basin. It is anticipated that as water levels stabilize in MAGSA, so will land subsidence.

The majority of MAGSA has some subsidence but undesirable results have not been identified. **Figure 4-7** from NASA InSAR data shows that areas of greater subsidence originate outside of MAGSA; Tranquillity to the west and from North Fork Kings GSA to the south. MAGSA will continue to monitor the subsidence in the GSA as well as along the boarders to see if subsidence is spreading into the GSA where the subsidence is caused from confined aquifer pumping outside of the GSA. MAGSA cannot control land subsidence that originates outside of GSA boundaries and outside the Basin boundaries. When subsidence that originates

from confined aquifer pumping outside the GSA and extends into the GSA, MAGSA will coordinate with its neighboring GSAs to address the subsidence issue.

4.6.2.4 Impact of Minimum Thresholds on Beneficial Uses and Users

Regulation Requirements:

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

Within the MAGSA, the beneficial uses and users could potentially be affected by land subsidence that causes overtopping of the river levees or loss of conveyance capacity to delivery surface water through various irrigation canals for crop irrigation or groundwater recharge. Decreased channel capacity could also hinder the ability of the San Joaquin River to convey flood flows. Downstream water users and neighboring GSAs could also be impacted if they were anticipating capture and recharge of said flows.

At the minimum threshold, the impact on water uses and water users should be minimal. There are minimal existing surface water structures in MAGSA. The minimum threshold is set so that there would not be any undesirable results to the future infrastructure by future subsidence of the basin. There is also the James Bypass which is just outside of the MAGSA boundary that the GSA may use to divert water from for future projects. Since water may be diverted from the James Bypass, the GSA may monitor subsidence in the area so there is minimal loss in capacity due to land subsidence. If the land subsidence monitoring shows subsidence in the area, MAGSA may coordinate with James GSA to assess the land subsidence in the area and address accordingly. The James Bypass is also used for flood releases. Most beneficial users in MAGSA are farmers who have mentioned they are not aware of issues with land subsidence within the MAGSA. Since there have been no issues with subsidence historically, it is not anticipated that land subsidence will cause issues with the minimum threshold criteria, particularly as groundwater levels are sustained.

4.6.2.5 Current Standards Relevant to Sustainability Indicator

Regulation Requirements:

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

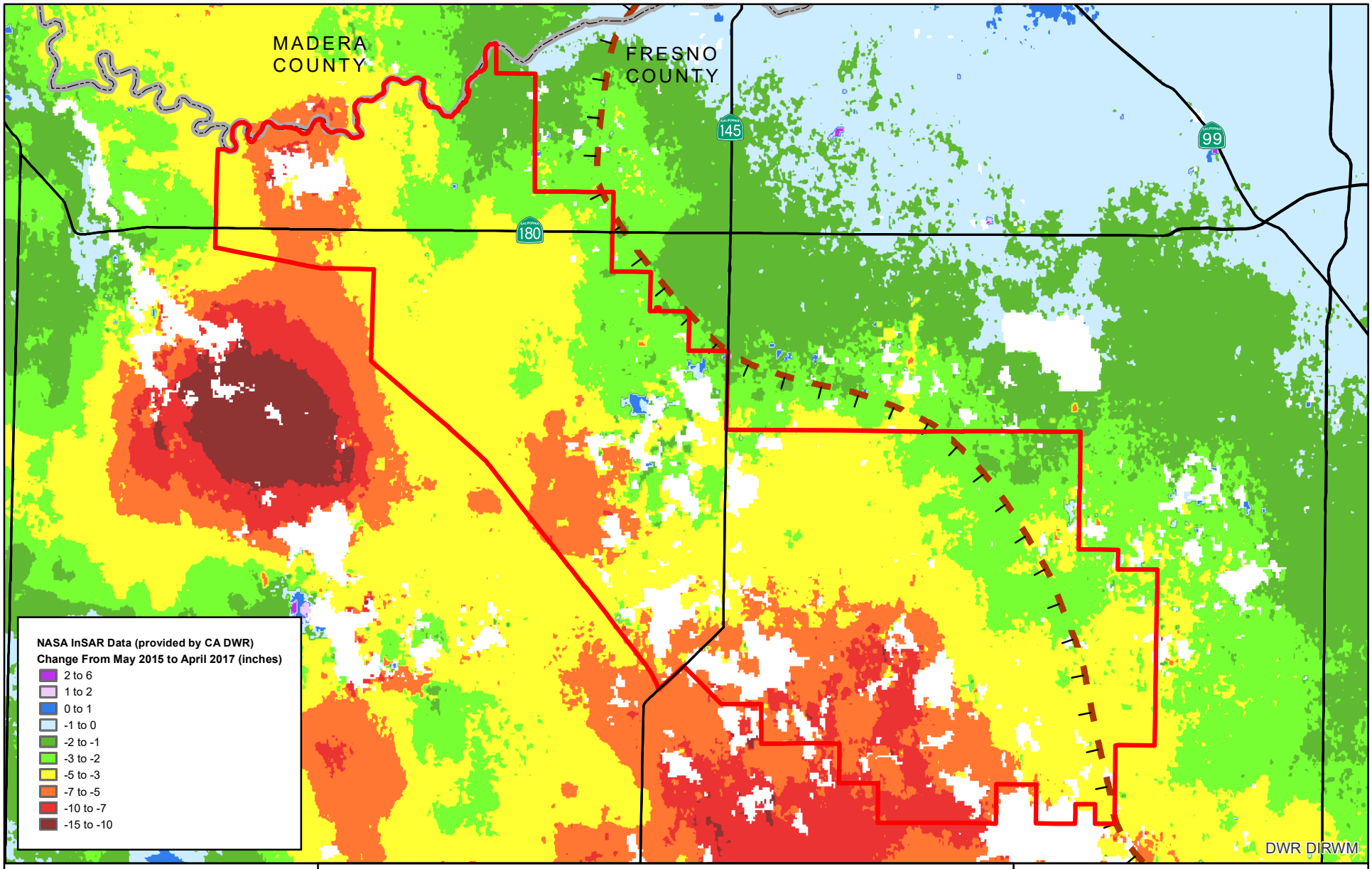
There are currently no standards for land subsidence. If state, federal, or local agencies implement a land subsidence standard, then it will be reviewed and may be incorporated into the GSP. If the minimum threshold differs from the regulatory standard, the nature and basis for the difference will be explained.

4.6.2.6 Measurement of Minimum Thresholds

Regulation Requirements:

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

Land subsidence is currently measured by NASA (remote sensing) and MAGSA is monitoring land subsidence site historically monitored by KRCD. The monitoring density is considered of adequate density and frequency to determine subsidence annually. Subsidence measurements will be made in accordance with the subsidence measurement protocols described in Chapter 5 – Monitoring Network of this GSP.



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Legend

- McMullin Area GSA
- County
- E Clay Eastern Extent (Page and LeBlanc1969, modified by KDSA)

The legend shows the change in ground surface elevation from May 2015 to April 2017. The positive values indicate rebound while the negative values indicate land subsidence.

McMullin Area GSA

Land Subsidence
NASA (via CA Dept. Water Resources)
2015-2017

Figure 4-6

5/9/2019 : \\ppeng.com\pzdata\clients\McMullin GSA-2659\265917002-Technical Services\GIS\Map\Report\Gen\Subsidence\subsidence_nasa.mxd

4.6.3 Measurable Objectives

4.6.3.1 Description of measurable objectives

Regulation Requirements:

§354.30 (a) Each Agency shall establish measurable objectives, including interim milestones in increments of five years, to achieve the sustainability goal for the basin with 20 years of Plan implementation and to continue to sustainably manage the groundwater basin over the planning and implementation horizon. **(b)** Measurable objectives shall be established for each sustainability indicator, based on quantitative values using the same metrics and monitoring sites as are used to define the minimum thresholds.

DWR staff has indicated that the intent of SGMA was that land subsidence be avoided or minimized based to the extent within the GSAs control. Once groundwater levels have stabilized within the basin, land subsidence should be minimized as long as water levels have also stabilized in neighboring basins. Measurable objectives for land subsidence were set based on this requirement. It is assumed that land subsidence would stabilize as the water levels stabilize as part of the water level measurable objectives and subsidence would stop after the water level reaches its lowest point and then is raised back up to the sustainable Measurable Objective level.

Table 4-12 Measurable Objective for Land Subsidence

Measurable Objective Parameter	Measurable Objective Quantity
Annual Land Subsidence Rate	1 inches/year over an area of 36 square miles

The Measurable Objective for land subsidence will be 1-inches/year over an area of at least 36 square miles to allow for the error of the InSAR data. The Measurable Objective for cumulative land subsidence will be 0 inches over 20 years. Though the measurable objective during the implementation may be exceeded due to the error in the InSAR data and water levels still stabilizing, the goal is to have no subsidence once the basin and neighboring basins reach sustainability in 2040. Even after water levels have stabilized there is the potential for residual subsidence. Residual subsidence, also called delayed subsidence, occurs when the land surface continues to decline for a period even after groundwater levels have been stabilized. This phenomenon likely occurs due to the delayed propagation of the piezometric decline in the fine-grained layers and viscous deformations typical of fine-grained materials. Also, in dry years when groundwater levels decline below the groundwater level measurable objective, it is anticipated that there will be some land subsidence that occurs with continued groundwater level declines. It is believed that once groundwater levels have declined to a certain level and rise back up, there will not be additional subsidence that occurs.

4.6.3.2 Operational Flexibility

Regulation Requirements:

§354.30 (c) Measurable objectives shall provide a reasonable margin of operational flexibility under adverse conditions which shall take into consideration components such as historical water budgets, seasonal and long-term trends, and periods of drought, and be commensurate with levels of uncertainty.
§354.30 (g) An Agency may establish measurable objectives that exceed the reasonable margin of operational flexibility for the purpose of improving overall conditions in the basin, but failure to achieve those objectives shall not be grounds for finding of inadequacy of the Plan.

The operational flexibility is the difference between the measurable objective and minimum threshold. For MAGSA, the operational flexibility is 36 inches of cumulative subsidence.

Representative Monitoring

Regulation Requirements:

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

The water level SMCs are for the unconfined aquifer and confined aquifer groundwater levels would be needed to represent land subsidence. At this time, groundwater levels will not be used as a proxy for land subsidence due to a lack of quality data on the confined aquifer potentiometric surface. In the Central Valley, land subsidence usually occurs from the Corcoran Clay layer, including the confined aquifer below. The Corcoran Clay layer extends into MAGSA and covers the majority of the GSA. Since the Corcoran Clay is a confining layer, land subsidence would occur when water is pumped from the confined aquifer below the Corcoran Clay. To monitor land subsidence based on water level, the well would have to be perforated below the Corcoran clay, and not be composite (i.e., constructed across multiple aquifer zones). There are limited wells within MAGSA that are drilled below the Corcoran Clay with well construction information that are not composite wells. There are few wells that only tap the confined aquifer, and of those that do the GSA does not have long-term water level data. The GSA will eventually add more wells to the representative monitoring well network to include more confined aquifer wells.

The groundwater level and pumping from the confined aquifer are considered a data gap and the project to fill those data gaps are included in this GSP, **Section 6.2.13**. The data gap project will include estimating groundwater pumping from te confined aquifer and identifying more confined aquifer wells to be able to develop a potentiometric surface. The data gap study is a high priority and will be commenced as soon as possible.

4.6.3.3 Path to Achieve Measurable Objectives

Regulation Requirements:

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

The interim milestones will be based on the cumulative amount of subsidence observed within a 36 square mile area over five-year incremental periods. The interim milestones are 1 foot of subsidence over a 5-year period. Subsidence of one foot within a 36-square-mile area in the GSA 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 GSA's 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 GSAs who may be causing the MAGSA undesirable results. If the land subsidence exceeds the Minimum Threshold and causes an undesirable result, then MAGSA will implement actions identified in Section 4.6.2.1.

4.6.3.4 Measurable objectives for additional plan elements

Regulation Requirements:

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

MAGSA will not be setting measurable objectives or interim milestones for additional plan elements described in Water Code Section 10727.4.

4.7 Interconnected Groundwater Surface Water Systems

Regulation Requirements:

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

Interconnected surface water has been defined in CCR Title 23, Division 2, Chapter 1.5, Subchapter 2 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.

An undesirable result would occur if groundwater pumping directly caused significant and unreasonable depletions of surface water. This would require the following: 1) surface water and groundwater are hydraulically connected; 2) groundwater pumping is causing a significant reduction in surface water flows; 3) the surface water depletion is not being mitigated by the GSA or other agencies/river management programs; and 4) third parties are being adversely impacted by the surface water depletion.

Figure 4-8 is a map of the Kings Subbasin, the main waterways, and other features related to interconnected surface water-groundwater. The San Joaquin River borders the northern part of MAGSA, and the lower reaches of the Kings River are along the western end of MAGSA.

Interconnection Status

There are no known riparian water users along the Kings River in MAGSA. There are also no mandated or minimum environmental flows in this portion of the Kings River. The Kings River fish flows end at least 50 miles upstream of the GSA. As a result, this portion of the river, called the Fresno Slough Bypass, is typically dry and only flows during wet years and during periods with high flows (i.e. flood releases). Based on the infrequency of flows, it is believed that the surface water and groundwater are not likely to be hydraulically connected.

The SJR is the main surface water body of significance within the MAGSA. Information to evaluate the presence of interconnected surface water systems in the MAGSA in a few locations along the SJR is available through the USBR's SJRRP, a USGS groundwater flow model documentation report (USGS SIR 2014-5148, 2014), and Friant Water Users Authority and Natural Resources Defense Council (FWUA and NRDC, 2002). The reports indicates that during the Fall of 1988 (a dry year) the depth to groundwater could have been as shallow as approximately 25 feet below ground adjacent to the river along the eastern and western borders of the MAGSA. Similarly, during the Fall of 2006 (a wet year) the depth to groundwater could have been as shallow as approximately 20 feet below ground in the same areas of the river. Based on the model reports and regional studies, it appears that there may be seasonal connections between surface water and groundwater in at least a limited number of locations along the SJR in the MAGSA. However, this data does not provide significant evidence as to a continuous connection throughout the year.

Shallow piezometers were placed along portions of the SJR edge as part of the SJRRP. This data was evaluated for evidence of interconnection of surface water and groundwater, but the information is inconclusive at this time and additional monitoring is required.

Water is released to the SJR as part of the SJRRP. Restoration flows must be maintained even if losses in the SJR are larger than assumed in the Settlement, (i.e., Reclamation will release additional water from Friant Dam such that the volume and timing of these flows are not otherwise impaired).

Data Gap Analysis

Overall, additional information is needed to better define the status of surface water-groundwater connection and the extent of surface water depletions, if any, in the GSA. As a result, the GSA has identified these as data gaps that must be researched before refined SMC can be developed to replace Interim SMCs. Chapter 6 includes the description of a project called "Interconnected Surface Water-Groundwater Data Gap Analysis." This is a high priority project that will include the following primary tasks:

1. Determine interconnection status of river reaches in the GSA based on various reports, studies, models and data
2. Coordinate with water rights holders and river management programs to determine how they impact and mitigate for surface water depletions, and if these efforts reduce or obviate the need for actions by the GSA
3. Evaluate impacts of groundwater pumping on surface water depletion using a model, analytical tool or other calculation method.

The study will provide the information needed to develop sustainable management criteria. Refer to **Chapter 6** for more details on the project.

Interim SMCs

In the determination letter dated January 28, 2022, DWR provided comments on the Kings Basin GSPs and noted that the GSPs did not fully define SMCs for the depletions of interconnected surface water. Corrective Action 3 for surface water-groundwater interconnection stated that the GSAs should '*identify depletion of interconnected surface water as a data gap*' and '*provide a plan within 180 days that describes how the GSAs will address the data gap*". As a result, the GSA has developed a detailed outline for a data gap study for interconnected surface water-groundwater (see Section 6). SGMA requires that SMCs be developed for depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water, but since SMCs cannot be effectively developed until this data gap study is completed, the letter also said that GSAs should provide '*updated sustainable management criteria by the first required periodic evaluation*.'

The determination letter also stated that, if sustainable management criteria cannot be developed with existing information, the GSAs *"must then either establish initial sustainable management criteria, establish representative minimum thresholds for groundwater elevations to serve as a proxy for the depletion of interconnected surface water*…". Accordingly, the GSA has developed interim SMCs for interconnected surface water-groundwater that will be used until more comprehensive, long-term and scientifically based criteria can be established following completion of the data gap study.

The proposed interim SMCs will use groundwater levels near the river system as a proxy for surface water depletion from rivers. While there is some uncertainty that this will fully protect against undesirable results, from a practical standpoint, and with the limited data currently available, this is considered the best available and only feasible alternative. This method will use the Measurable Objectives (MO) and Minimum Thresholds (MT) of representative wells, located within 2 miles of the Kings River and SJR, as proxies for surface water depletion. It has been determined that reductions in groundwater levels below the MO and MT represent abnormal overdraft conditions, and in those areas where surface water-groundwater

interconnection may exist, could cause significant and unreasonable surface water depletion, or cause rivers to become disconnected from the groundwater. This is an interim measure that will be updated once the data gap study is completed in 2025. The list of wells to be used as a proxy within the basin is shown in **Table 4-13**, and a map of the wells is included in **Figure 4-9.**

Table 4-13 Interconnected Surface Water Monitoring Network Wells

GSA	Well ID	Local ID
CKGSA	CID31	31
CKGSA	CID32	32
CKGSA	CID41	41
JIDGSA	366502N1201782W001	C65
JIDGSA	16S17E04P001M	D12
KREGSA	KRWD04	KRWD04
KREGSA	H020A	4A and H020A
KREGSA	B013B	B013B
KREGSA	I073A	I073A
MAGSA	366082N1201199W001	15S17E21J001M
MAGSA	367705N1202691W001	13S16E30L003M
MAGSA	367757N1201874W001	13S16E26A001M
MAGSA	367782N1202141W001	13S16E27C001M
MAGSA	A07	A07
MAGSA	A24	A24
MAGSA	A30	A30
NFKGSA	LID14	LID14
NFKGSA	LID21	LID21
NFKGSA	LID25	LID25
NFKGSA	LID26	LID26
NFKGSA	LID07	LID07
NFKGSA	364591N1200135W001	17S18E09R001M / N05
NFKGSA	364739N1196227W001	LID40
NFKGSA	364893N1200127W001	16S18E33Q001M / N01
NKGSA	12S20E23M001MX	FC143
NKGSA	368093N1199988W001	13S18E10P001M
NKGSA	13S23E33B001MX	FD33B1
NKGSA	12S19E33P001MX	FC160
NKGSA	12S19E36J001MX	FC091
SKGSA	CID10	10
SKGSA	CID34	34

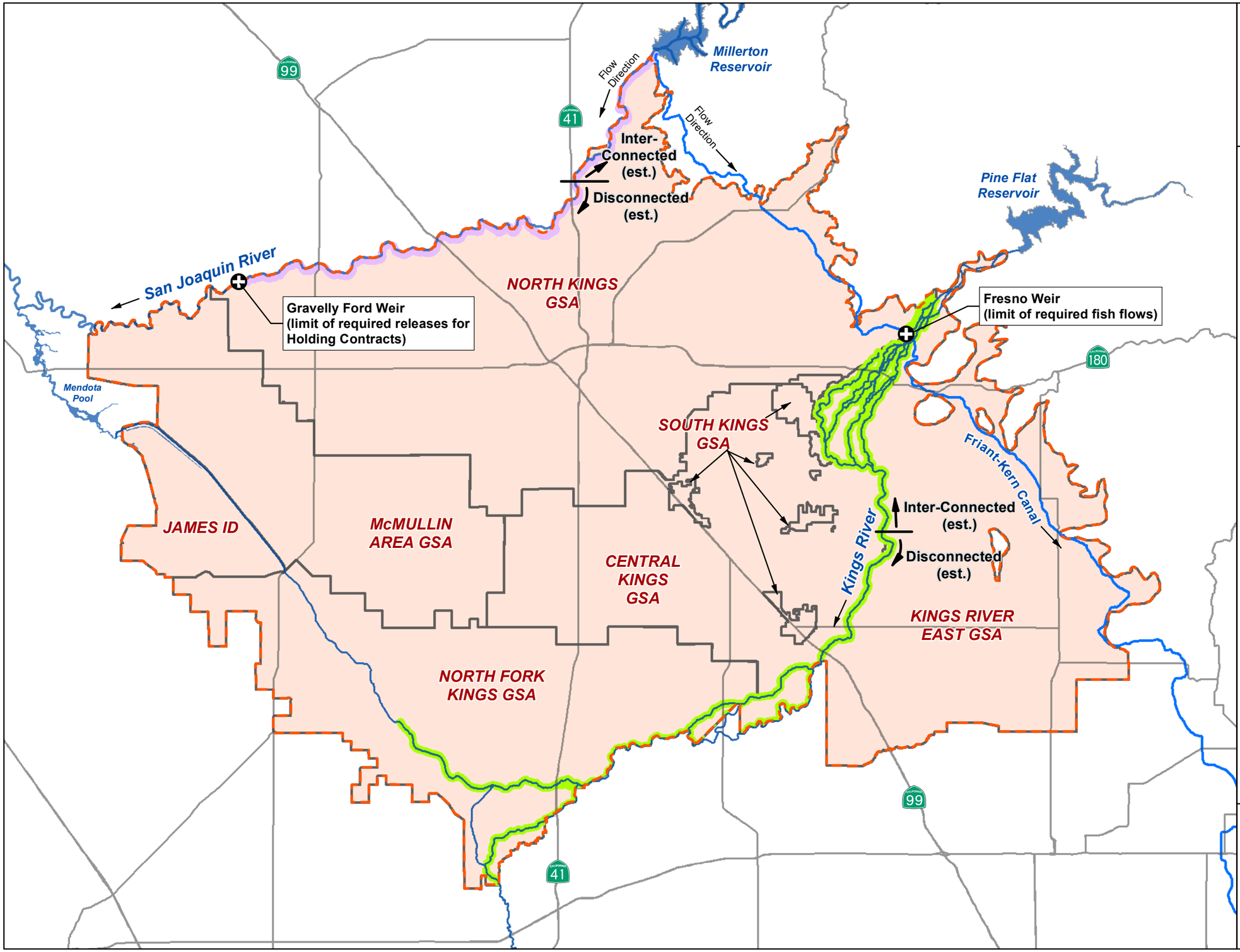
Since the GSA is not proposing near-term increases in pumping, and since river management programs on both rivers help to maintain minimum flow rates, it is not expected that MOs or MTs near the rivers will be exceeded, but they will be closely monitored. Since the areas of interconnection are not precisely known, the entire reach of both the Kings River and SJR will be evaluated annually.

Future SMCs will preferably be based on the actual depletion caused by nearby wells, which will provide a more accurate measure of actual impacts. However, lacking sufficient data on well locations, well pumping and aquifer parameters, this method is not currently feasible.

Kings Subbasin

Surface Water Features

Figure 4-8



Legend

- Weir
- Holding Contract Lands
- Riparian Water Right Users
- Kings Subbasin GSAs
- Kings Subbasin (2019)
- Highway

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Kings Subbasin Coordinated Effort

Interconnected Surface Water Monitoring Network

Figure 4-9

Legend

- Indicator Well To Serve As Proxy*
- Groundwater Sustainability Agency
- Township/Range
- Major Waterway
- 2-mile Buffer of Major Waterway

**Preliminary monitoring network*

12S20E23M001MX
12S19E36J001MX
12S19E33P001MX
368093N1199988W001
367705N1202691W001
367757N1201874W001
367782N1202141W001
13S23E33B001MX
B013B
CID10
H020A
KRWD04
A07
A24
366502N1201782W001
366082N1201199W001
A30
16S17E04P001M
CID31
I073A
CID32
CID34
CID41
364893N1200127W001
364591N1200135W001
364739N1196227W001
LID14
LID07
LID26
LID21
LID25

T11S
T12S
T13S
T14S
T15S
T16S
T17S
T18S

R16E R17E R18E R19E R20E R21E R22E R23E R24E R25E

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

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5 Monitoring Network

Regulation Requirements:

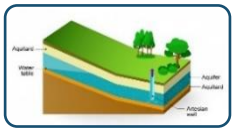
§354.32 This Subarticle describes the monitoring network that shall be developed for each basin, including monitoring objectives, monitoring protocols, and data reporting requirements. The monitoring network shall promote the collection of data of sufficient quality, frequency, and distribution to characterize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

A comprehensive monitoring network is a fundamental component of groundwater management and is needed to measure progress toward groundwater sustainability. Below, **Table 5-1** includes the monitoring programs needed to comply with SGMA monitoring and reporting requirements.

Table 5-1 Monitoring Requirements

Groundwater Levels

- Monitoring of static groundwater levels each spring and fall

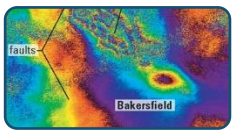


Groundwater Storage

- Measurement of the annual change in groundwater storage

Water Quality

- Monitoring for water quality degredation that could impact available groundwater supplies

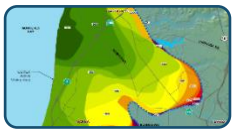


Land Subsidence

- Surface land subsidence caused by groundwater extraction

Depletion of Interconnected Surface Water

- Loss of permanent connections between surface water and groundwater



Seawater Intrusion

- Intrusion of seawater into local aquifers. This is not applicable to the McMullin Area GSA

Monitoring programs for these indicators are described later in this section including the history of the monitoring programs, proposed monitoring to comply with SGMA, and the adequacy and scientific rationale for each monitoring network. Monitoring of groundwater pumping, groundwater recharge, and surface water deliveries is discussed in **Section 3.3** – Water Budget Information.

5.1 Introduction

Regulation Requirements:

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

This chapter describes the monitoring network being developed by the MAGSA that will collect data to determine short-term, seasonal, and long-term trends in groundwater and related surface conditions. This information will yield data necessary to support: 1) the implementation of this Plan, 2) evaluation of the effectiveness of this Plan, and 3) decision making by the MAGSA management. This chapter describes current and future monitoring programs. The results and data from historical monitoring efforts can be found in **Section 3.2** – Current and Historical Groundwater Conditions.

5.1.1 Monitoring Network Objectives

Regulation Requirements:

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

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

The objectives of the various monitoring programs include the following:

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

5.1.2 Network Development Process

Groundwater levels have been monitored within MAGSA by KRCD and the DWR for many years. Hydrographs for monitored wells are available for the period of record. JID owns, operates, and monitors several wells in MAGSA along the McMullin grade. These programs will continue and may expand, as needed, to comply with SGMA monitoring requirements.

Additionally, new monitoring networks will be developed, and existing networks enhanced when necessary using the Data Quality Objective (DQO) process, which follows the U.S. EPA *Guidance on Systematic Planning Using the Data Quality Objective Process* (EPA, 2006). The DQO Process is also outlined in the DWR's Best Management Practices for monitoring networks (DWR, 2016a) and monitoring protocols (DWR, 2016b). The DQO process includes the following:

1. State the problem.
2. Identify the goal.
3. Identify the inputs.

4. Define the boundaries of the area/issue being studied.
5. Develop an analytical approach.
6. Specify the performance or acceptance criteria.
7. Develop a plan for obtaining data.

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

Regulation Requirements:

§354.34(c) Each monitoring network shall be designed to accomplish the following for each sustainability indicator: [§354.34(c)(1) through §354.34(c)(6) are individually listed below]

Sections 5.2 through 5.7 describe existing networks within MAGSA's boundary which track groundwater levels, groundwater storage, water quality, land subsidence, and depletion of interconnected surface water.

5.2 Groundwater Levels

5.2.1 Description of Monitoring Network

Regulation Requirements:

§354.34(c)(1) Chronic Lowering of Groundwater Levels. Demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and surface water features by the following methods:

A. A sufficient density of monitor wells to collect representative measurements through depth-discrete perforated intervals to characterize the groundwater table or potentiometric surface for each principal aquifer.

B. Static groundwater elevation measurements shall be collected at least two times per year, to represent seasonal low and seasonal high groundwater conditions.

Kings Basin monitoring networks for each GSA will utilize existing wells that are currently monitored for groundwater level including but not limited to CASGEM, KRCD, City, and District monitoring wells. The groundwater level monitoring network for each GSA is shown in **Figure 5-1.** Each GSA will discuss their individual monitoring network in their respective GSP. The groundwater elevation measurements will be collected every March and October to provide data on the seasonal high and seasonal low groundwater conditions, respectively.

Groundwater levels have been measured in the GSA on a bi-annual basis since the 1950s *(See Chapter 3: Groundwater Conditions-Groundwater Elevation Data)* by the DWR. For the past several years, DWR has also asked local agencies to collect and report groundwater level data under the CASGEM program. KRCD has also operated and maintained a groundwater monitoring network from 1989 until current day. These agencies will continue monitoring bi-annually for future data collection under SGMA. If a more frequent data collection schedule is required to either demonstrate progress toward sustainability, monitor impacts of beneficial use of groundwater, monitor groundwater levels more closely, or quantify annual changes in groundwater conditions, then the MAGSA will re-evaluate the monitoring network and make changes as appropriate. Fresno County monitors groundwater levels in Raisin City's lone community well under the County's Special Districts operations. Each agency within the MAGSA will continue to monitor groundwater levels, and the MAGSA may assist with data collection and monitoring as needed. The MAGSA will maintain a single database to assist with regional evaluations and annual reporting, preparation of groundwater contour maps, and assessment of groundwater flow. Data will also be shared with each of the six other GSAs within the Kings Subbasin for preparation of regional groundwater contour maps and annual reports.

The majority of MAGSA members are agricultural producers and/or landowners. In general, groundwater levels in these members' wells have not been measured on a regular basis. A small number of private wells have been monitored consistently and have detailed temporal groundwater elevation data; however, most landowners have not performed measurements at all or, at best, they have monitored wells on a sporadic "as needed" basis, and the timing of fall and spring measurements has not been consistent. In the future, each

agency will monitor groundwater levels every March and October to provide consistency in the measurements.

Kings Subbasin Coordinated Effort

Proposed Monitoring
Well Network Review
Figure 5-1

Legend

- Long Term Monitoring Well
- Groundwater Sustainable Agency
- Township/Range

T11S
T12S
T13S
T14S
T15S
T16S
T17S
T18S

R16E R17E R18E R19E R20E R21E R22E R23E R24E R25E

12S20E23D001MX 192.6
12S21E29K001M 284.8
12S22E19N001M 393.3
12S21E34H001M 329.2
12S22E26L001M 404.6
12S19E33P001MX 185.5
12S19E36J001MX 157.3
13S19E11L001MX 163.2
12S20E34K001MX 163.4
13S18E17A001MX 179.8
13S22E07R001MX 313.3
13S17E25C001MX 144.9
13S21E19E001MX 152.3
13S19E29A001MX 161.6
13S20E27C001MX 161.3
13S23E30B001MX 403.8
367705N1202691W001 28.6
367782N1202141W001 90.7
13S17E33M001MX 89.7
13S18E33M001MX 163.8
13S20E30B001MX 163.6
367556N1196666W001 240.1
367757N1201874W001 88.4
367477N1201460W001 64.6
13S22E32A001MX 292.1
13S23E33B001MX 412.7
A01 5.6
14S18E09H001MX 148.8
14S20E10M001MX 176.2
14S21E06Q001MX 176.5
B013B 378.7
14S24E17C001MX 437.1
367113N1200785W001 46.1
14S19E17C001MX 151.8
14S20E22J001MX 145.9
A07 51.5
A17 46.7
A20 5.1
CID06 275.2
CID10 312.6
14S18E32D001MX 47
14S19E33D001MX 145.4
14S21E22D001MX 228
KRWD04 318.2
A34 24.8
15S19E02M001MX 119.4
CID12 252.2
366502N1201782W001 10.2
A24 -9.3
A23 -44.8
15S18E02A001MX 66
A46 75.7
CID16 230.3
366767N1194568W001 304.5
I045A 318.3
15S19E14M001MX 92.2
15S20E13E001MX 176.5
15S24E14H001MX 377.8
I055A 259.8
15S16E28A003M 65.3
366082N1201199W001 -65.4
15S17E13R002M -57.7
15S20E07Q001MX 121
CID25 244.5
15S25E19A001MX 404
366188N1199104W001 60
A51 14.4
M065A 248.6
A30 -54.9
CID74 93.8
CID67 133.8
CID65 195.5
CID28 240.1
CID31 263.2
M105A 242.7
15S16E29N001M 62.8
16S17E04P001M -16.7
15S18E30L001M -83.2
A53 -58.1
I073A 232.4
T139A 279.3
16S25E10J001MX 353
A62 8.8
CID56 36.1
CID32 245.6
B06 -29.8
A58 -100.8
365463N1199268W001 -39.7
365283N1194482W001 179.8
O123A 274.2
CID48 60.7
365150N1197327W001 81.6
365143N1198529W001 -8.5
CID34 224.3
M130B 218
364960N1197554W001
CID62 176.9
T136A 243.1
364893N1200127W001 -100.2
364916N1198366W001 -32.2
CID51 44.2
CID41 259
X156A 260.7
364967N1197193W001 81.5
B22 -26.9
364813N1198968W001 -48.7
364668N1198257W001 -24.4
364816N1197785W001 18.8
364739N1196227W001 129.4
W172A 177
X176A 133.5
364591N1200135W001 -87.4
364682N1198732W001 -49.8
364603N1197510W001 14
364425N1193860W001 189.6
X213A 170.1
X234B 193
B31 -34.6
LID14 -2
364002N1197624W001 9.8
LID26 -36.9
LID25 -76.1

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Groundwater levels are measured in the various types of wells including:

- Community wells: Raisin City has one well available for groundwater level monitoring.
- JID Well Field: JID operates several irrigation wells along the McMullin grade where data is collected regularly.
- CASGEM wells: The DWR documents groundwater levels recorded by local agencies and reports them through the CASGEM program.
- Private Wells: Areas outside of those monitored by local or government agencies tend to lack appropriate monitoring coverage. As a result, MAGSA is seeking consent from numerous landowners and private well operators to monitor water levels in their wells. Access agreements are needed to monitor these wells. Assuming access agreements are obtained, at times, monitoring of these wells may not be possible (for example: when the well's pump is running or when access issues are encountered, such as a locked gate).
- Wells in Adjacent GSAs: Groundwater level data from adjoining areas, including other agencies to the north, east, west and southeast of the MAGSA, will also be collected to help provide better interpretation of GSA boundary flow conditions. (Note: long-term agreements still need to be prepared to collect/share data with other GSAs.) JID, City of Kerman, City of San Joaquin, and the Fresno-Clovis Regional Wastewater Treatment Facility all have wells which will aid in establishing boundary conditions.

Within the MAGSA, groundwater occurs in unconfined, semi-confined, and confined conditions. A network of existing wells is shown in **Figure 5-2.** As noted in *Chapter 3, Groundwater conditions: Groundwater elevation data*, there are 152 monitored wells within the GSA and 129 wells outside of the GSA ranging from 75 feet to 800 feet deep with an average depth of 450-550 feet. The wells for the MAGSA monitoring network were selected from the existing wells that are monitored. **Figure 5-3** shows the MAGSA monitoring network that appears to provide appropriate spatial representation for monitoring groundwater levels. Groundwater level data will continue to be collected from municipal, agricultural, and monitoring wells within the MAGSA and evaluated to gain a better understanding of the unconfined, semi-confined, and confined aquifer zones in the MAGSA. The MAGSA will develop a program to obtain additional construction information on wells in the monitoring network. This information will be used to help refine the understanding of confined and unconfined groundwater. In time, as more well construction information becomes available, the monitoring network may need to be augmented to monitor discrete aquifers.

5.2.2 Adequacy of Monitoring Network

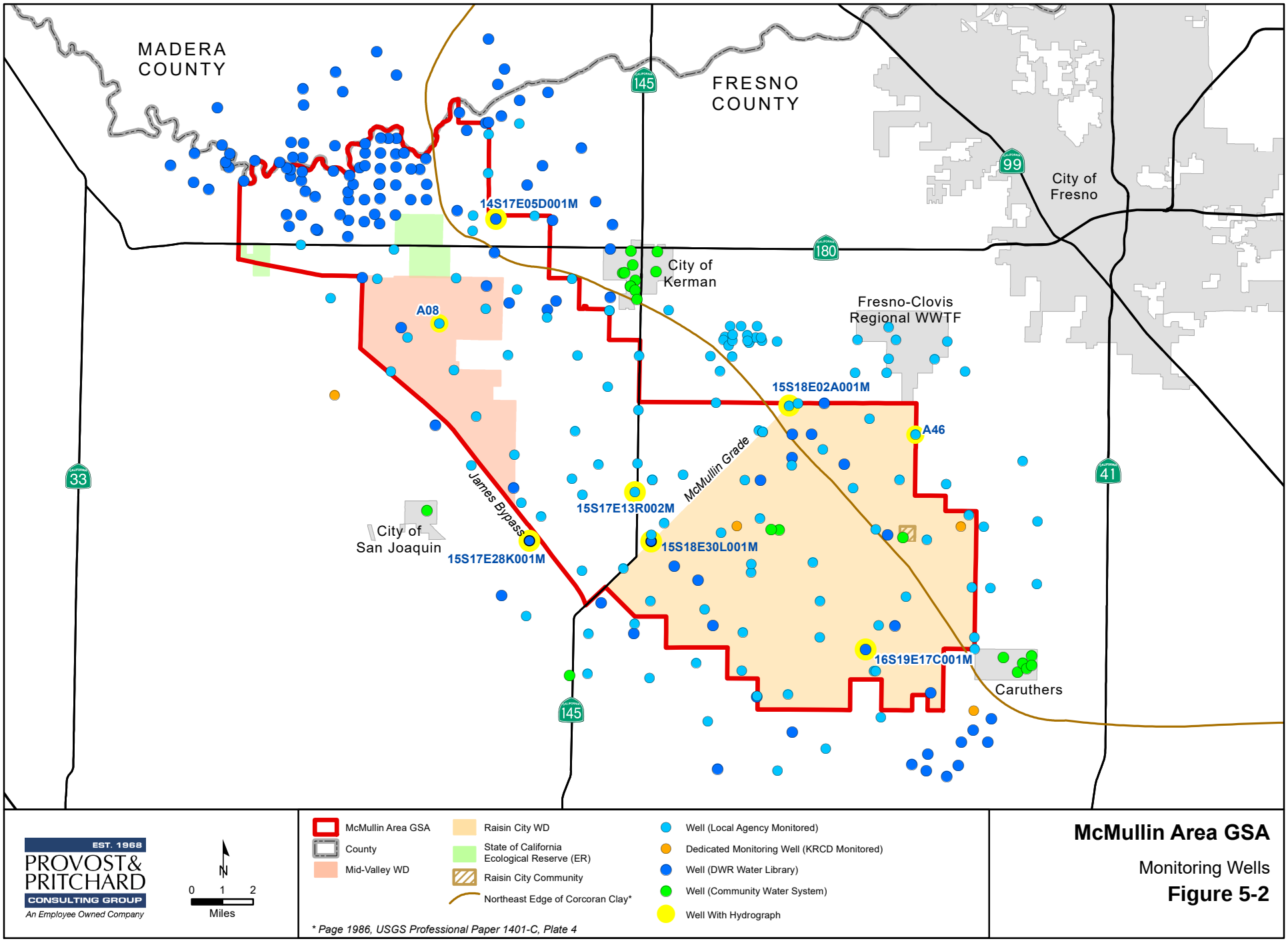
Regulation Requirements:

§354.34(d) The monitoring network shall be designed to ensure adequate coverage of sustainability indicators. If management areas are established, the quantity and density of monitoring sites in those areas shall be sufficient to evaluate conditions of the basin setting and sustainable management criteria specific to that area.
§354.34(e) A Plan may utilize site information and monitoring data from existing sources as part of the monitoring network.

The Kings Basin is not establishing management areas, rather the basin is split into 7 GSAs that will each have their own GSP. Each GSA will have a minimum monitoring density of 2 wells within each 36-square-mile township within the GSA. The monitoring networks will include wells that are currently being monitored. Townships within the MAGSA with fewer than three sections will not be monitored but will instead be represented by adjacent townships.

An existing groundwater-level monitoring network has been used for many years by Kings River Conservation District for preparing regional groundwater contours. The proposed MAGSA monitoring network will include wells that have been historically monitored and have a minimum monitoring network well density of 2 wells within each 36-square-mile township intersecting the GSA. The proposed monitoring

network will include 23 wells. Data on the depth and perforated intervals of the monitor wells is required according to SGMA guidelines. At this time this information is not known for many wells. Moreover, some of the wells in the monitoring network do not have consistent measurements for consecutive years throughout their operational life. Nothing can be done about past temporal gaps; however, moving forward groundwater levels will be measured in the monitoring network wells each spring and fall. Perforation data gaps will be addressed in the future as described in Section 5.2.8.



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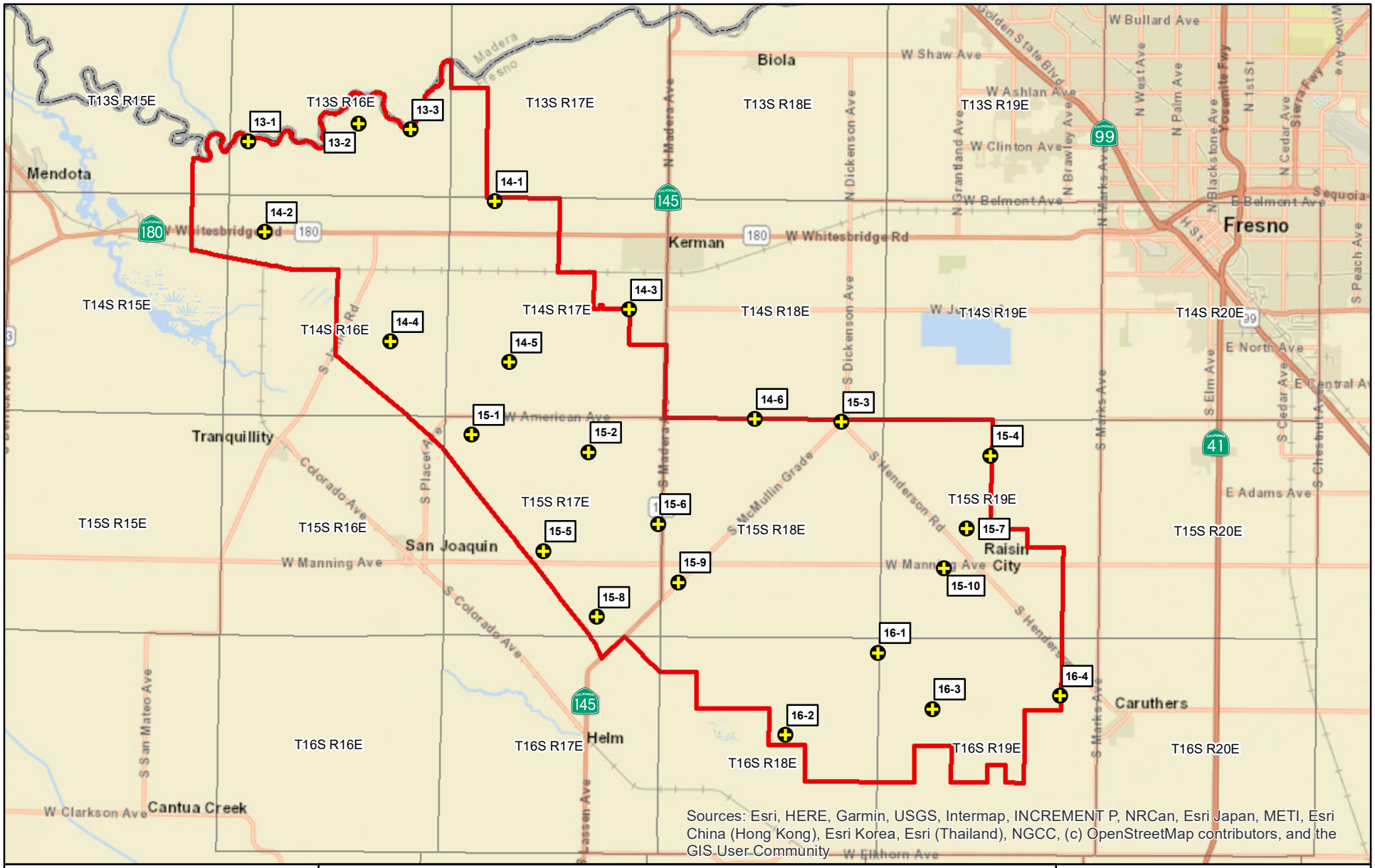

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5.2.3 Density of Monitoring Sites and Frequency of Measurements

Regulation Requirements:

§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.

Groundwater levels in the GSA area have been monitored since the 1920s. Some wells have been continuously monitored for much of that time. This data has enhanced understanding of long-term trends and the ability of the aquifer to respond to droughts and wet periods.

The groundwater levels will be measured in the spring (March) and fall (October) of each year. This differs slightly from historical measurements, but the GSA participants within the subbasin have agreed to this schedule to provide consistency in the data. Spring measurements are designed to capture the recovery of the groundwater basin after an extended period of minimal agricultural and landscape irrigation demand, assuming a normal rainfall. The fall measurement would capture a period after peak irrigation and summertime urban demands have ceased, thereby showing the cumulative impacts on the groundwater basin before any natural recovery has taken place.

Hopkins and Anderson (Hopkins, 2016) provide recommendations for groundwater-level monitor well densities. The densities range from 1 well per 100 square miles to 1 well per 25 square miles based on the quantity of groundwater pumped. A minimum density of 1 well/25 square miles is recommended for areas using over 100,000 AF of groundwater per year. Groundwater use in the MAGSA currently exceeds 100,000 AF/year and will likely exceed this value even after groundwater usage declines to comply with SGMA. As a result, a minimum well density of 1 well/25 square miles will be used. Well density is tracked per 36-square-mile Township, which results in about 1.5 wells per Township. A more practical value of 2 wells/Township is adopted resulting in a minimum density of 1 well/18 square miles. This is a bare minimum density, and the GSA will strive to maintain a denser network when economically feasible and practical.

The minimum density of 2 wells/Township shall include "High Quality Monitoring Points," which are defined as wells with reliable access each spring and fall, known information on the well depth and perforated interval, and adequate depth to accommodate seasonal fluctuations. Wells that do not meet these guidelines will be monitored unofficially in the network, as they can still provide useful information. Well construction information on these wells may be obtained in the future, and it is desired to keep wells that have a long period of record. During development of groundwater contours, those wells with and without well construction information will be labeled to assist with the analysis.

5.2.4 Monitoring Network Information

The following sections describe the monitoring network, including scientific rationale for the selection; consistency with data and reporting standards; corresponding sustainability indicator, minimum threshold, measurable objective, and interim milestone; and the locations of the monitoring sites.

5.2.4.1 Scientific Rationale for Site Selection

Regulation Requirements:

§354.34(g) Each Plan shall describe the following information about the monitoring network:
(1) Scientific rationale for the monitoring site selection process.

The scientific rationale for the groundwater level monitoring network includes the following:

1. The network meets the GSA's minimum density goal of, on average, 1 well/18 square miles.
2. Many wells have over 10 years of groundwater data and are useful for long-term evaluations.

The following scientific rationale will be used to add new wells:

- Add wells, whenever necessary to maintain minimum monitor well density (1 well/18 square miles) and/or to augment current monitoring sites.
- Avoid wells located near water bodies, such as canals, reservoirs, etc., whenever possible.
- Avoid wells perforated across multiple aquifers, especially wells underlain by the Corcoran clay member.
- Select wells which have access in both spring and fall seasons, preferably wells which do not have gates or occluded access.
- Select dedicated monitor wells over production wells where feasible.
- Select wells with available construction information (i.e., depth, perforated interval).
- Avoid domestic wells since they are rarely idle.
- If data for a specific monitoring site is lacking, other wells in the vicinity which have the desired data, if available, will be added to increase the monitoring network's scope and breadth.

5.2.4.2 Consistency with Data and Reporting Standards

Regulation Requirements:

§354.34(g)(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 is consistent with the standards identified in Section 352.4 of the California Code of Regulations related to Groundwater Sustainability Plans. The main topics of Section 352.4 are outlined below, and the full section is included as **Appendix 5-B**.

- Data reporting units (e.g., Water volumes shall be reported in acre-feet, etc.)
- Monitoring site information (e.g., Site identification number, description of site location, etc.)
- Well attribute reporting (e.g., CASGEM well identification number, casing perforations, etc.)
- Map standards (e.g., Data layers, shapefiles, and geodatabases shall be submitted in accordance with the procedures described in Article 4, etc.)
- Hydrograph requirements (e.g., Hydrographs shall use the same datum and scaling to the greatest extent practical, etc.)

5.2.4.3 Quantitative Values

Regulation Requirements:

§354.34(g)(3) For each sustainability indicator, the quantitative values for the minimum threshold, measurable objective, and interim milestones that will be measured at each monitoring site or representative monitoring sites established pursuant to Section 354.36.

The quantitative values for minimum threshold, measurable objective, and interim milestones will be set for each well in the monitoring network. Refer to section 4.2.2.1 Criteria to Define Minimum Thresholds in the Sustainable Management Criteria chapter for the table with the criteria set for each well.

5.2.5 Monitoring Locations

Regulation Requirements:

§354.34(h) The 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.

5.2.5.1 Map

Figure 5-1 shows the monitoring site locations for the Kings Basin. Seasonal monitoring will be compared to interim milestones, measurable objectives, and minimum thresholds established for these indicator wells. The monitoring site information in tabular format is included in each GSP within the Kings Basin in section 5.2.5.2.

Figure 5-3 shows the MAGSA monitoring site locations for groundwater levels.

Monitoring is also performed in areas outside of the GSA to help document more accurate boundary conditions. Groundwater is monitored in wells outside the MAGSA boundary by agencies that have agreed to share data with MAGSA.

5.2.5.2 Table

Appendix 5-A includes a table of monitoring well attributes.

5.2.6 Monitoring Protocols

Regulation Requirements:

§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.
§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.

Groundwater level monitoring in the Kings Subbasin will generally follow the protocols identified in the *Monitoring Protocols, Standards, and Sites BMP* (DWR, 2016b). Refer to **Appendix 5-C** for a copy of the Best Management Practices (BMP). The GSA may develop standard monitoring forms in the future if deemed necessary.

The following comments and exceptions to the BMP should be noted:

1. SGMA regulations require that groundwater levels be measured to the nearest 0.1 feet. The BMP suggests measurements to the nearest 0.01 feet; 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 the best one can achieve.
2. If used in a well suspected of contamination or if there are obvious signs of contamination (such as oil), well sounding equipment will be decontaminated after use.
3. Wells are surveyed within a horizontal accuracy of 0.5 feet, and the elevation of the Reference Point (RP) of each well surveyed will be accurate within 0.1 feet.

4. Unique well identifiers will be labeled on all public wells and on private wells if permission is granted.
5. The BMP states that measurements each spring and fall should be taken "preferably within a 1 to 2-week period." This is likely not feasible due to the large number of wells in the GSA, and a 4-week period will be granted for bi-annual monitoring.
6. If a vacuum or pressure release is observed, then water level measurements will be remeasured every 5 minutes until they have stabilized.
7. In the field, water level measurements will be compared to previous records; if there is a significant difference, then the measurement will be verified.

5.2.7 Representative Monitoring

Regulation Requirements:

§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:

5.2.7.1 Description of Representative Sites

Regulation Requirements:

§354.36(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.

DWR has referred to representative monitoring as utilizing a subset of wells in a management area. Groundwater conditions can vary substantially across the GSA, and the use of a small number of representative wells in the MAGSA is not practical to cover such a large area with varying conditions. The area has a history of using an adequate well network to monitor groundwater and will continue to use available water level data to assess groundwater conditions.

5.2.7.2 Use of Groundwater Elevations as Proxy for other Sustainability Indicators

Regulation Requirements:

§354.36(b) Groundwater elevations may be used as a proxy for monitoring other sustainability indicators if the Agency demonstrates the following:

1) Significant correlation exists between groundwater elevations and the sustainability indicators for which groundwater elevation measurements serve as a proxy.
2) Measurable objectives established for groundwater elevation shall include a reasonable margin of operational flexibility taking into consideration the basin setting to avoid undesirable results for the sustainability indicators for which groundwater elevation measurements serve as a proxy.

MAGSA plans to use groundwater elevations as a proxy for monitoring interconnected surface water until the data gap study identified in Section 6 can be completed. As noted, groundwater elevations will be used as a critical component of groundwater storage estimation, but the elevation monitoring will not replace the storage change estimation.

Regulation Requirements:

§354.36(c) The designation of a representative monitoring site shall be supported by adequate evidence demonstrating that the site reflects general conditions in the area.

MAGSA does not plan to use representative monitoring sites. MAGSA will monitor the 23 wells in the monitoring network.

5.2.8 Assessment and Improvement of Monitoring Network

5.2.8.1 Review and Evaluation of Monitoring Network

Regulation Requirements:

§354.38(a) Each Agency shall review the monitoring network and include an evaluation in the Plan and each five-year assessment, including a determination of uncertainty and whether there are data gaps that could affect the ability of the Plan to achieve the sustainability goal for the basin.

This section includes a description of the different types of data gaps, a summary of existing data gaps in each monitoring network and plans to fill the data gaps.

5.2.8.2 Identification of Data Gaps

Regulation Requirements:

§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.

There are three general types of data gaps to consider for monitoring networks:

1. **Temporal**: Insufficient frequency of monitoring. For instance, data may be available from a well only in the fall since it is rarely idle in the spring. In addition, a privately owned well may have sporadic access due to locked security fencing, roaming dogs, change in ownership, etc.
2. **Spatial**: Insufficient number or density of monitoring sites in a specific area.
3. **Insufficient quality of data**: Data may be available but be of poor or questionable accuracy. Poor data may at times be worse than no data since it could lead to incorrect assumptions or biases. The data may not appear consistent with other data in the area or with past readings at the monitoring site. The monitoring site may not meet all the desired criteria to provide reliable data, such as having information on perforation depth, etc. Past experiences have shown that well location information on Well Construction Reports is sometimes poor, making it difficult or impossible to match wells with their well logs.

The following are discussions on these data gaps in the groundwater level monitoring network:

Temporal Data Gaps: Some of the current wells used for data collection have not been measured consistently year after year, and data gaps exist ranging from one year to over a decade. However, these data can still be very useful for a historical narrative of the GSA's groundwater levels, but on review these data categorically do not adhere to the SGMA requirements. Going forward, the MAGSA will need to design a data collection program which assures bi-annual data collection, as mentioned in section 5.2.2 *Adequacy of Monitoring Network*.

Spatial Data Gaps: There are currently no spatial gaps in the network. The monitoring network map shows that the monitoring well density meets the minimum goal of 2 wells/Township in most of the GSA.

Insufficient Quality of Data: Currently, most of the wells monitored in unincorporated areas are privately owned. Specific well construction information, including depth and perforated interval, is not known for many of the wells. While these wells do not provide ideal data points, they will continue to be used until well attribute data can be collected. Collecting well attribute information is especially important throughout the MAGSA which is underlain, to a large extent, by the Corcoran Clay layer and other smaller aquitards. When funding permits, MAGSA will install dedicated monitor wells or acquire well data by other means e.g. well videos, so the precise depth and perforated interval will be known for the wells in the monitoring network.

Finally, since the MAGSA is underlain by multiple confining layers, such as the Corcoran Clay member, the A-Clay, and the E-Clay, it will need to locate or install depth discrete monitoring sites which will help monitor the various changes between the distinct confining layers. Currently, the GSA does not have well construction data or perforated intervals for some of the wells in the monitoring network, most notably in the northern

and western edges of the GSA where there are two and sometimes three confining layers. These layers will need to be monitored at locations to be determined at a later date. MAGSA will need to collect well construction information to help ensure all the aquifers are being monitored.

5.2.8.3 Plans to Fill Data Gaps

Regulation Requirements:

§354.38(c) If the monitoring network contains data gaps, the Plan shall include a description of the following:
1) The location and reason for data gaps in the monitoring network.
2) Local issues and circumstances that limit or prevent monitoring.

The groundwater-level network has insufficient temporal data and data quality, primarily in well construction information for the network and the spatial extent of those reports. The goal is to have at least 2 wells in each township with accurate well construction information and adequate temporal and spatial representation. Furthermore, in areas underlain by a confining layer or layers, a depth discrete monitoring site will need to be established for each confining layer. For example, in the northern portion of the MAGSA the Corcoran Clay and A-Clay are present. In that area, monitoring sites will need to monitor above the A-Clay, between the A-Clay and the Corcoran Clay, and then also below the Corcoran Clay.

Regulation Requirements:

§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.

These data gaps can be filled using the four alternatives below:

- **Collect well completion reports.** Well Completion Reports will provide the needed information. These could be collected from the landowner or the DWR; however, several challenges exist. First, landowners may not have the report or may not be willing to provide them. The GSA participants have found it very difficult to match up Well Completion Reports from DWR with actual wells, since so many have been drilled in the area and location maps in the reports are often poor or erroneous. Fresno County also tracks some well construction data in a GIS database as part of their permitting process. This information could be useful for some recently constructed wells.
- **Perform a video inspection of each well to obtain construction information.** A video inspection can be performed on desired wells to determine the total depth and perforated interval. The cost of each inspection is about $1,500 (2017), but up to $15,000 may also be needed to lift a pump to provide access. Additional costs would also be incurred for administration and outreach to landowners. Permission would be needed from the well owner; however, they may agree since they would obtain a free well assessment.
- **Replace monitoring point with a dedicated monitor well:** Dedicated monitor wells could be installed and used in place of private wells. The construction information would be known and there would be no access issues. Dedicated monitor wells are expensive to construct, and their installation will depend on available funding.
- **Replace monitoring point with another private well.** Private wells without construction information could be replaced with another private well that has well construction information. This may be simpler and less costly than a video inspection. However, replacing monitor well locations is not always desirable, since it is preferred to continue measurements in wells that have a long period of record (i.e., long hydrograph).

The GSA will either collect information on half of the wells lacking well construction information by 2030 and the remaining half by 2040 or will replace the wells with better monitoring sites.

5.2.8.4 Adjustment to Density of Monitoring Sites and Frequency of Measurements

Regulation Requirements:

§354.38(e) Each Agency shall adjust the monitoring frequency and density of monitoring sites to provide an adequate level of detail about site-specific surface water and groundwater conditions and to assess the effectiveness of management actions under circumstances that include the following:

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

The frequency and density of the proposed monitoring programs are discussed in previous sections. The criteria are considered adequate to provide the monitoring data to satisfy SGMA requirements. Beginning in 2020, when groundwater conditions are compared to sustainability goals, the monitoring network may be modified or enhanced if deemed necessary.

5.3 Groundwater Storage

5.3.1 Description of Monitoring Network

Regulation Requirements:

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

Groundwater storage change will be estimated by multiplying local specific yield values by the change in measured groundwater levels.

As part of the Kings Subbasin Coordination Efforts, KDSA (Kenneth D. Schmidt & Associates) and Provost & Pritchard (P&P) conducted a review of available published sources of specific yield data. Additionally, e-logs, geo-logs, and DWR well completion reports were reviewed to complement the available literature. Specific yield values were then estimated for each designated area, usually by 36-square-mile Townships, for depths of 10-50 feet, 50-100 feet, 100-200 feet, and greater than 200 feet below the ground surface. In some areas, specific yield data is limited to one value from 10-300 feet (see **Figure 3-20** in the Hydrogeologic Conceptual Model).

The process for calculating changes in groundwater storage includes the following steps:

1. Calculate average depth to groundwater for each specific yield area based on spring groundwater levels.
2. Multiply the height of water within each depth zone by the specific yield for that depth zone, and then 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 Plan.

Please refer to the subsection on Aquifer Characteristics in Chapter 3: Hydrologic Conceptual Model for more information on specific yield values.

5.3.2 Adequacy of Monitoring Network

Regulation Requirements:

§354.34(d) The monitoring network shall be designed to ensure adequate coverage of sustainability indicators. If management areas are established, the quantity and density of monitoring sites in those areas shall be sufficient to evaluate conditions of the basin setting and sustainable management criteria specific to that area.

§354.34(e) A Plan may utilize site information and monitoring data from existing sources as part of the monitoring network.

Groundwater storage capacity will be calculated using local groundwater levels and specific yield values. This methodology has proven to be adequate in estimating annual change in groundwater storage in other regions of the Kings Basin. Specific yield values for various depths have been determined through an extensive literature search. Groundwater storage calculations are largely dependent on the groundwater level monitoring network, which is being expanded for SGMA. Collection of well attribute information described above will also benefit groundwater storage monitoring.

5.3.3 Density of Monitoring Sites and Frequency of Measurements

Regulation Requirements:

§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.

Groundwater storage change will be estimated annually, based on spring groundwater levels. Groundwater storage changes will generally be reported for each 36-square-mile Township, which is based largely on the geographic availability of specific yield data (see **Figure 3-20** in Section 3.1.8.1-Hydrogeologic Conceptual Model, Aquifer Characteristics and Properties). The areas used are considered reasonable since overdraft is typically estimated on a regional scale; estimating overdraft on a very small or local scale may provide misleading results. Only wells with reasonable and reliable data will be used to develop groundwater contours and estimate storage change.

5.3.4 Monitoring Network Information

The following sections describe the monitoring network, including scientific rationale for the selection; consistency with data and reporting standards; corresponding sustainability indicator, minimum threshold, measurable objective, and interim milestone; and the locations of the monitoring sites.

5.3.4.1 Scientific Rationale for Site Selection

Regulation Requirements:

§354.34(g) Each Plan shall describe the following information about the monitoring network:
(1) Scientific rationale for the monitoring site selection process.

Change in groundwater storage is based on a calculation involving the specific yield and change in groundwater levels. The groundwater level monitoring sites are discussed above. Specific yield values were acquired from a review of several publications (see Section 5.2.4). The specific yield values generally cover 36-square-mile Townships. While this method is subject to some error, it is considered the most reliable method to estimate storage change since it is based largely on measured data. Storage change can also be estimated

with a water balance exercise, but that is subject to significant uncertainty and cumulative errors from numerous parameters.

5.3.4.2 Consistency with Data and Reporting Standards

Regulation Requirements:

§354.34(g)(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 is consistent with the standards identified in Section 352.4 of the CCR related to Groundwater Sustainability Plans. The main topics of Section 352.4 are outlined below, and the full section is included as **Appendix 5-B.**

- Data reporting units (e.g., Water volumes shall be reported in acre-feet, etc.)
- Monitoring site information (e.g., Site identification number, description of site location, etc.)
- Well attribute reporting (e.g., CASGEM well identification number, casing perforations, etc.)
- Map standards (e.g., Data layers, shapefiles, and geodatabases shall be submitted in accordance with the procedures described in Article 4, etc.)
- Hydrograph requirements (e.g., Hydrographs shall use the same datum and scaling to the greatest extent practical, etc.)

5.3.4.3 Quantitative Values

Regulation Requirements:

§354.34(g)(3) For each sustainability indicator, the quantitative values for the minimum threshold, measurable objective, and interim milestones that will be measured at each monitoring site or representative monitoring sites established pursuant to Section 354.36.

The quantitative values for minimum threshold, measurable objective, and interim milestones will be set for each GSA. Refer to section 4.3.2. Minimum Thresholds in the Sustainable Management Criteria chapter for the table with the criteria set for each GSA.

5.3.5 Monitoring Locations

Regulation Requirements:

§354.34(h) The 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.

5.3.5.1 Map

Figure 5-1 shows the monitoring site locations for the Kings Basin. The monitoring site information in tabular format is included in each GSP within the Kings Basin in section 5.2.5.2. Groundwater Storage monitoring utilizes the groundwater level monitoring network.

Figure 5-3 shows the MAGSA monitoring site locations for groundwater levels and groundwater storage (same sites as the groundwater level monitoring).

Monitoring is also performed in areas outside of the GSA to help document more accurate boundary conditions. Groundwater is monitored in wells outside the MAGSA boundary by agencies that have agreed to share data with MAGSA.

5.3.5.2 Table

Appendix 5-A includes a table of monitoring well attributes.

5.3.6 Monitoring Protocols

Regulation Requirements:

§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.

§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.

Groundwater level monitoring, which is the same as the storage change monitoring, will generally follow the protocols identified in the *Monitoring Protocols, Standards, and Sites BMP* (DWR, 2016b). Refer to **Appendix 5-C** for a copy of the BMP. The GSA may develop standard monitoring forms in the future if deemed necessary.

The following comments and exceptions to the BMP should be noted:

1. SGMA regulations require that groundwater levels be measured to the nearest 0.1 feet. The BMP suggests measurements to the nearest 0.01 feet; 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 the best one can achieve.
2. If used in a well suspected of contamination or if there are obvious signs of contamination (such as oil), well sounding equipment will be decontaminated after use.
3. Wells will be surveyed to a horizontal accuracy of 0.5 feet, and the elevation of the RP of each well surveyed will be accurate within 0.1 feet.
4. Unique well identifiers will be labeled on all public wells and on private wells if permission is granted.
5. The BMP states that measurements each spring and fall should be taken "preferably within a 1 to 2-week period." This is likely not feasible due to the large number of wells in the GSA, and a 4-week period will be granted for bi-annual monitoring.
6. If a vacuum or pressure release is observed, then water level measurements will be remeasured every 5 minutes until they have stabilized.
7. In the field, water level measurements will be compared to previous records; if there is a significant difference, then the measurement will be verified.

5.3.7 Representative Monitoring

Regulation Requirements:

§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:

5.3.7.1 Description of Representative Sites

Regulation Requirements:

§354.36(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.

DWR has referred to representative monitoring as utilizing a subset of wells in a management area. Groundwater conditions can vary substantially across the GSA, and the use of a small number of representative wells in the MAGSA is not practical to cover such a large area with varying conditions. The area has a history of using a robust well network to monitor groundwater and will continue to use available water level data to assess groundwater conditions.

5.3.7.2 Use of Groundwater Elevations as Proxy for other Sustainability Indicators

Regulation Requirements:

§354.36(b) Groundwater elevations may be used as a proxy for monitoring other sustainability indicators if the Agency demonstrates the following:

1) Significant correlation exists between groundwater elevations and the sustainability indicators for which groundwater elevation measurements serve as a proxy.
2) Measurable objectives established for groundwater elevation shall include a reasonable margin of operational flexibility taking into consideration the basin setting to avoid undesirable results for the sustainability indicators for which groundwater elevation measurements serve as a proxy.

As noted, groundwater elevations will be used as a critical component of groundwater storage estimation, but the elevation monitoring will not replace the storage change estimation.

Regulation Requirements:

§354.36(c) The designation of a representative monitoring site shall be supported by adequate evidence demonstrating that the site reflects general conditions in the area.

MAGSA does not plan to use representative monitoring sites. MAGSA will monitor the 24 wells in the water level monitoring network. MAGSA may use additional wells to the groundwater level monitoring sites as needed to use in the storage change estimation.

5.3.8 Assessment and Improvement of Monitoring Network

5.3.8.1 Review and Evaluation of Monitoring Network

Regulation Requirements:

§354.38(a) Each Agency shall review the monitoring network and include an evaluation in the Plan and each five-year assessment, including a determination of uncertainty and whether there are data gaps that could affect the ability of the Plan to achieve the sustainability goal for the basin.

This section includes a description of the different types of data gaps, a summary of existing data gaps in each monitoring network and plans to fill the data gaps.

5.3.8.2 Identification of Data Gaps

Regulation Requirements:

§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.

There are three general types of data gaps to consider for monitoring networks:

1. **Temporal**: Insufficient frequency of monitoring. For instance, data may be available from a well only in the fall since it is rarely idle in the spring. In addition, a privately owned well may have sporadic access due to locked security fencing, roaming dogs, change in ownership, etc.
2. **Spatial**: Insufficient number or density of monitoring sites in a specific area.

3. **Insufficient quality of data**: Data may be available but be of poor or questionable accuracy. Poor data may at times be worse than no data since it could lead to incorrect assumptions or biases. The data may not appear consistent with other data in the area or with past readings at the monitoring site. The monitoring site may not meet all the desired criteria to provide reliable data, such as having information on perforation depth, etc. Past experiences have shown that well location information on Well Construction Reports is sometimes poor, making it difficult or impossible to match wells with their well logs.

Groundwater storage change is dependent on groundwater level readings. Data gaps related to the groundwater level monitoring network are described in **Section 5.2**.

5.3.8.3 Plans to Fill Data Gaps

Regulation Requirements:

§354.38(c) If the monitoring network contains data gaps, the Plan shall include a description of the following: 1) The location and reason for data gaps in the monitoring network. 2) Local issues and circumstances that limit or prevent monitoring.
§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.

There is no current plan to fill data gaps in the groundwater storage monitoring network, except for the groundwater level data gaps previously described.

5.3.8.4 Adjustment to Density of Monitoring Sites and Frequency of Measurements

Regulation Requirements:

§354.38(e) Each Agency shall adjust the monitoring frequency and density of monitoring sites to provide an adequate level of detail about site-specific surface water and groundwater conditions and to assess the effectiveness of management actions under circumstances that include the following: 1) Minimum threshold exceedances. 2) Highly variable spatial or temporal conditions 3) Adverse impacts to beneficial uses and users of groundwater. 4) The potential to adversely affect the ability of an adjacent basin to implement its Plan or impede achievement of sustainability goals in an adjacent basin.

The frequency and density of the proposed monitoring programs are discussed in previous sections. The criteria are considered adequate to provide the monitoring data to satisfy SGMA requirements. Beginning in 2020, when groundwater conditions are compared to sustainability goals, the monitoring network may be modified or enhanced if deemed necessary.

5.4 Seawater Intrusion

Regulation Requirements:

§354.34(c)(3) Seawater Intrusion. Monitor seawater intrusion using chloride concentrations, or other measurements convertible to chloride concentrations, so that the current and projected rate and extent of seawater intrusion for each applicable principal aquifer may be calculated.
§354.34(j) An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in Section 354.26, shall not be required to establish a monitoring network related to those sustainability indicators.

The MAGSA western boundary lies approximately 80 miles from the ocean and, therefore, seawater intrusion is not feasible. In addition, there are no saline water lakes in or near the GSA. As a result, seawater intrusion is not discussed hereafter in this chapter. Saline intrusion from up-coning of deep saline groundwater is a potential problem and will be monitored as part of general water quality monitoring (see following section).

5.5 Water Quality

5.5.1 Description of Monitoring Network

Regulation Requirements:

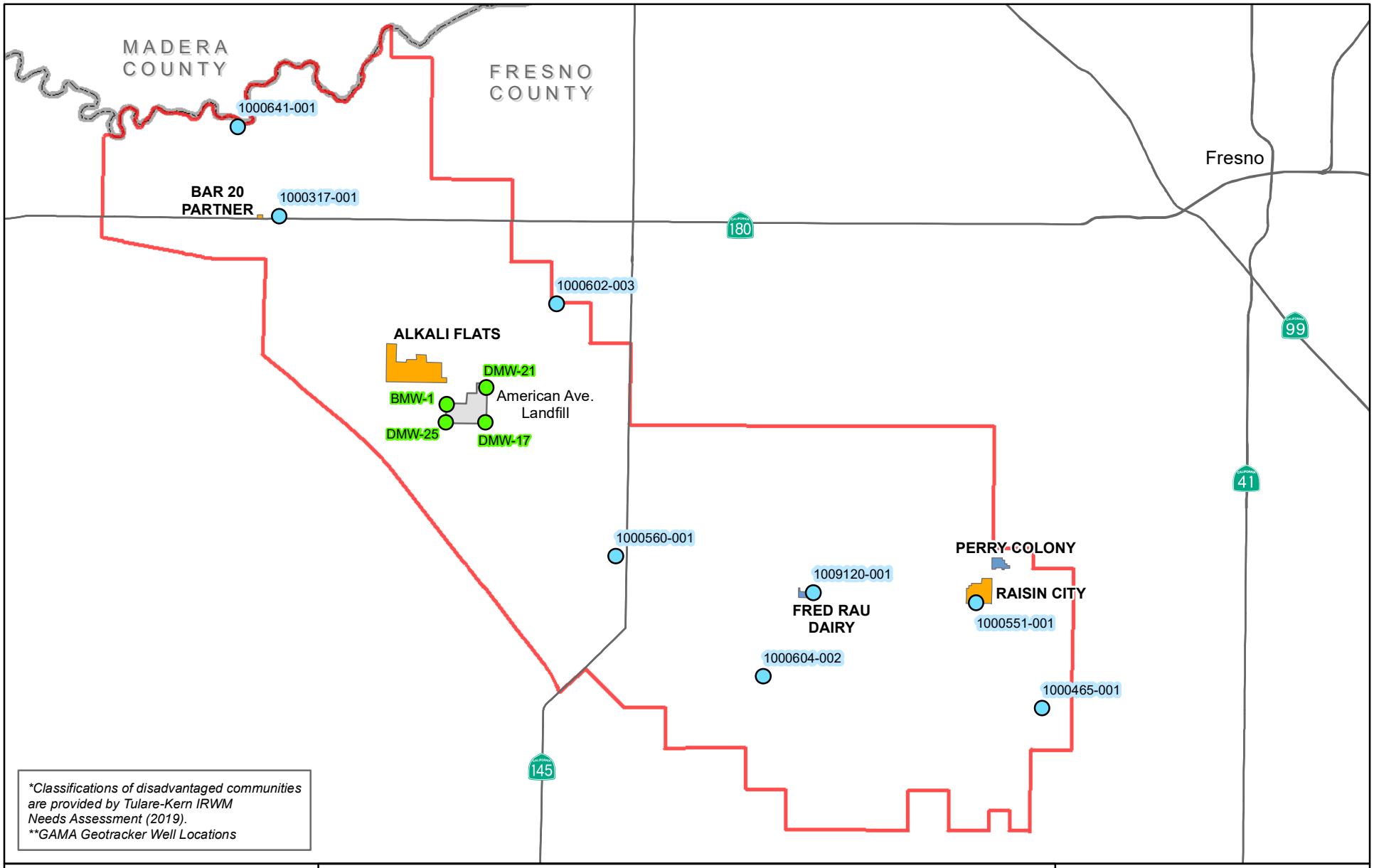
§354.34(c)(4) Degraded Water Quality. Collect sufficient spatial and temporal data from each applicable principal aquifer to determine groundwater quality trends for water quality indicators, as determined by the Agency, to address known water quality issues.

Groundwater quality in the MAGSA is generally well suited for irrigation and domestic use, although groundwater issues for drinking water may exist in localized areas within the GSA. While some of these chemical concerns are caused by humans, others are natural occurring. Groundwater pollution characterization and mitigation are typically enforced by local agencies and state level programs.

The GSA will review and analyze publicly available routine groundwater monitoring data reported by the community and non-community public supply wells and data from the GAMA monitoring wells around the American Avenue Landfill in order to understand how and if groundwater pumping is exacerbating groundwater quality concerns and where to enforce pumping restrictions or other mitigation measures should it become necessary.

Groundwater quality concerns within the MAGSA have been identified in this GSP's Groundwater Conditions Chapter (**Section 3.2**). Groundwater monitoring and reporting by community water systems and non-community public supply wells is a requirement of CCR Title 22. Community and other public supply wells within the MAGSA monitoring network area already being routinely monitored for a wide range of contaminants, including the chemicals of concern, by the water purveyors under Title 22. The publicly available groundwater quality data reported by GAMA from selected wells (public supply wells and monitoring wells associated with the American Avenue Landfill) will be obtained annually and evaluated against sustainable management criteria.

Selected public supply wells and American Avenue Landfill monitoring wells, will form the basis of the monitoring wells for groundwater quality are shown on **Figure 5-4**. The groundwater quality monitoring network will be evaluated and revised if needed in subsequent GSP 5-year revisions.



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5.5.2 Adequacy of Monitoring Network

Regulation Requirements:

§354.34(d) The monitoring network shall be designed to ensure adequate coverage of sustainability indicators. If management areas are established, the quantity and density of monitoring sites in those areas shall be sufficient to evaluate conditions of the basin setting and sustainable management criteria specific to that area.

§354.34(e) A Plan may utilize site information and monitoring data from existing sources as part of the monitoring network.

Groundwater quality monitoring is performed in Raisin City's only community well and adheres to strict state requirements. The ILRP also covers all irrigated areas within the GSA and monitors surface quality for numerous constituents related to agriculture and irrigation. Groundwater monitoring under the ILRP is anticipated to begin in Fall 2018. Boundary water quality will be monitored through cooperation with adjacent GSAs. The cooperation will yield relevant data on migratory contaminant plumes and potentially give the MAGSA forewarning of impending groundwater movement. While data from the ILRP will not necessarily be the primary source of water quality data for the GSA, the Board may choose to further investigate this data if deemed necessary moving forward.

In order to adequately select the parameters of the monitoring network moving forward, GAMA data was utilized in order to establish that while throughout various areas of the GSA possible contaminant MCL/SMCL exceedances had been seen in the past, there were no indications of continuous or rising patterns. It was adequately determined that the last three years of GAMA data would be examined in order to establish a basis for identifying the existing constituents within MAGSA.

The selected wells will provide annual data from the public water supply system data and GAMA data for the four selected monitoring wells surrounding the American Avenue Landfill. It will be the intention to monitor existing constituents and prevent future MCL/SMCL exceedances.

5.5.3 Density of Monitoring Sites and Frequency of Measurements

Regulation Requirements:

§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.

Water quality monitoring is performed in unincorporated Raisin City since it is the only urban zone within the GSA and, therefore, has the highest population density and/or urban water use. Groundwater quality is tested by Fresno County's Special District Operations according to State requirements. The frequency and density of monitoring for possible contaminant plumes would be based on project specific monitoring plans developed for each plume.

The selected monitoring wells were chosen based on their available data and spatial locations throughout MAGSA. Additionally, since the American Ave Landfill has been established as a possible area of contamination, the four monitoring wells surrounding the landfill were chosen. The publicly available groundwater quality data from selected wells will be obtained annually and compared against MCL/SMCL values if recent historical data has indicated chemicals of concern were initially below MCLs or evaluated for groundwater quality trends with respect to the chemicals of concern utilizing appropriate statistical methods, such as the Mann-Kendall trend test. The Mann-Kendall trend test is a nonparametric test used to identify a

trend in a series, even if there is a seasonal component to the series.

Lastly, as indicated in *Chapter 3 Basin Settings section 3.2.5* The Raisin City Oil Field is a site of possible groundwater contamination and will continue to be monitored utilizing the established MAGSA groundwater quality monitoring network. Moving forward the Board may choose to further monitor the Raisin City Oilfield and any concerns of possible plume development by utilizing information and data from KDSA and JID.

5.5.4 Monitoring Network Information

5.5.4.1 Scientific Rationale for Site Selection

Regulation Requirements:

§354.34(g) Each Plan shall describe the following information about the monitoring network:
(1) Scientific rationale for the monitoring site selection process.

The scientific rationale for the existing water quality monitoring sites is based primarily on State monitoring requirements and specific monitoring programs established by regulatory agencies. These sites were particularly selected due to their accurate representation of groundwater quality throughout the MAGSA. The selected network will present ongoing data from public water supply wells and GAMA data to assist in providing ongoing assessment as to known constituent levels in the MAGSA and preventing new concerns. The GSA Board may further study, develop, or expand the monitoring well network for the MAGSA, if deemed necessary in the future.

5.5.4.2 Consistency with Data and Reporting Standards

Regulation Requirements:

§354.34(g)(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 is consistent with the standards identified in Section 352.4 of the CCR related to Groundwater Sustainability Plans. The main topics of Section 352.4 are outlined below, and the full section is included as **Appendix 5-B.** Data reporting units (e.g., Water volumes shall be reported in acre-feet, etc.)

- Monitoring site information (e.g., Site identification number, description of site location, etc.)
- Well attribute reporting (e.g., CASGEM well identification number, casing perforations, etc.)
- Map standards (e.g., Data layers, shapefiles, and geodatabases shall be submitted in accordance with the procedures described in Article 4, etc.)
- Hydrograph requirements (e.g., Hydrographs shall use the same datum and scaling to the greatest extent practical, etc.)

5.5.4.3 Quantitative Values

Regulation Requirements:

§354.34(g)(3) For each sustainability indicator, the quantitative values for the minimum threshold, measurable objective, and interim milestones that will be measured at each monitoring site or representative monitoring sites established pursuant to Section 354.36.

As previously described in the *Chapter 4 Sustainable Management Criteria 4.5,* wells within the existing monitoring network will be annually evaluated in accordance with values set in order to protect human health and intended for both the beneficial use and users of groundwater resources (i.e., CCR Title 22). In the case that there are known constituent levels in exceedance of MCL or SMCL values over recent historical recordings, the objective will be for the wells to maintain stable or improving groundwater quality trends. In the case that a constituent is known to be present within the GSA and appears to have no recent historical

pattern or exceedances above the MCL or SMCL, the objective will be to maintain water quality standards below the MCL or SMCL threshold. For further discussion regarding the quantitative values for the minimum threshold set within the MAGSA, please reference *Chapter 3 Basin Settings Section 3.2.5* and *Chapter 4 Substantiable Management Criteria.*

5.5.5 Monitoring Locations

Regulation Requirements:

§354.34(h) The 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.

5.5.5.1 Map

Figure 5-4 shows the monitoring site locations for groundwater quality in MAGSA. These sites include public water supply wells and landfills surrounding the American Avenue Landfill. GAMA data will be utilized to monitor existing levels of known constituents; should the GSA Board deem it necessary to expand the existing monitoring network, additional policy may be adopted and implemented.

Monitoring is also performed in areas outside of the GSA to help document more accurate boundary conditions. Groundwater is monitored in wells outside the MAGSA boundary by agencies that have agreed to share data with MAGSA.

5.5.5.2 Table

Table 5-2 Monitoring Wells

Public System No./GAMA ID	Well Owner	Chemicals of Concern Tested For								
		Arsenic	Chloride	Manganese	Sodium	Uranium	Nitrates	DBCP	TCP	TDS
1000317-001	Holland Hulling Compan	--	--	X	X	--	X	--	--	--
1000465-001	Batth Dehydrator	X	--	--	--	X	X	X	X	--
1000551-001	FCSA #43/Raisin City	X	X	X	X	GA	X	X	X	X
1000560-001	Central CA Almond Growers Assn.	--	--	--	--	--	X	--	--	--
1000602-003	Baker Commodities	X	--	--	--	GA	X	X	X	--
1000604-002	Johann Dairy	X	--	--	--	--	X	X	X	--
1000641-001	Larry Shehadey Dairy	X	--	--	--	GA	X	X	X	--
1009120-001	Rau Dairy	X	X	X	X	GA	X	X	X	X
L10006109169-DMW-21	Fresno County	X	X	X	X	--	X	X	X	X
L10006109169-DMW-25	Fresno County	X	X	X	X	--	X	X	X	X
L10006109169-DMW-17	Fresno County	X	X	X	X	--	X	X	X	X
L10006109169-BMW-1	Fresno County	X	X	X	X	--	X	X	X	X

Notes:
X = chemical of concern is routinely tested for in well
-- = chemical of concern is not routinely tested for in well
GA = Gross alpha determination. If gross alpha is greater than 5 pCi/L, uranium analysis is performed.

5.5.6 Monitoring Protocols

Regulation Requirements:

§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.
§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.

Groundwater quality monitoring will generally follow the protocols identified in the *Monitoring Protocols, Standards, and Sites BMP* (DWR, 2016b). Refer to **Appendix 5-C** for a copy of the BMP. The GSA may develop standard monitoring forms in the future if deemed necessary.

The following comments and exceptions to the BMP should be noted:

1. SGMA regulations require that groundwater levels be measured to the nearest 0.1 feet. The BMP suggests measurements to the nearest 0.01 feet; 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 the best one can achieve.
2. If used in a well suspected of contamination or if there are obvious signs of contamination (such as oil), well sounding equipment will be decontaminated after use.
3. The elevation of the RP of each well surveyed will be accurate within 0.5 feet.
4. Unique well identifiers will be labeled on all public wells and on private wells if permission is granted.
5. The BMP states that measurements each spring and fall should be taken "preferably within a 1 to 2-week period." This is likely not feasible due to the large number of wells in the GSA, and a 4-week period will be granted for bi-annual monitoring.
6. If a vacuum or pressure release is observed, then water level measurements will be remeasured every 5 minutes until they have stabilized.
7. For water quality monitoring, 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.

5.5.7 Representative Monitoring

Regulation Requirements:

§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:

5.5.7.1 Description of Representative Sites

Regulation Requirements:

§354.36(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.

DWR has referred to representative monitoring as utilizing a subset of wells in a management area. Groundwater conditions can vary substantially across the GSA, and the use of a small number of representative wells in the MAGSA is not practical to cover such a large area with varying conditions. The area has a history of using an adequate well network to monitor groundwater and will continue to use available water quality data to assess groundwater conditions.

5.5.7.2 Use of Groundwater Elevations as Proxy for other Sustainability Indicators

Regulation Requirements:

§354.36(b) Groundwater elevations may be used as a proxy for monitoring other sustainability indicators if the Agency demonstrates the following:

1) Significant correlation exists between groundwater elevations and the sustainability indicators for which groundwater elevation measurements serve as a proxy.
2) Measurable objectives established for groundwater elevation shall include a reasonable margin of operational flexibility taking into consideration the basin setting to avoid undesirable results for the sustainability indicators for which groundwater elevation measurements serve as a proxy.

MAGSA does not plan to use groundwater elevations as a proxy for monitoring water quality.

Regulation Requirements:

§354.36(c) The designation of a representative monitoring site shall be supported by adequate evidence demonstrating that the site reflects general conditions in the area.

MAGSA does not plan to use representative monitoring sites. MAGSA will monitor the 12 wells in the water quality monitoring network.

5.5.8 Assessment and Improvement of Monitoring Network

5.5.8.1 Review and Evaluation of Monitoring Network

Regulation Requirements:

§354.38(a) Each Agency shall review the monitoring network and include an evaluation in the Plan and each five-year assessment, including a determination of uncertainty and whether there are data gaps that could affect the ability of the Plan to achieve the sustainability goal for the basin.

The following sections include descriptions of the different types of data gaps, a summary of existing data gaps in each monitoring network and plans to fill the data gaps, if deemed necessary.

5.5.8.2 Identification of Data Gaps

Regulation Requirements:

§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.

There are three general types of data gaps to consider for monitoring networks:

1. **Temporal**: Insufficient frequency of monitoring. For instance, data may be available from a well only in the fall since it is rarely idle in the spring. In addition, a privately owned well may have sporadic access due to locked security fencing, roaming dogs, change in ownership, etc.
2. **Spatial**: Insufficient number or density of monitoring sites in a specific area.
3. **Insufficient quality of data**: Data may be available but be of poor or questionable accuracy. Poor data may at times be worse than no data since it could lead to incorrect assumptions or biases. The data may not appear consistent with other data in the area or with past readings at the monitoring site. The monitoring site may not meet all the desired criteria to provide reliable data, such as having information on perforation depth, etc. Past experiences have shown that well location information on Well Construction Reports is sometimes poor, making it difficult or impossible to match wells with their well logs.

At this time, the existing data is of sufficient value moving forward to produce annual data to adequately assess constituent levels and assure that SMC criteria is met on an annual basis. Nothing can necessarily be done to address past, historical data gaps; however, moving forward, the GSA Board can develop and may adopt changes to the GSP to identify and/or close possible data gaps that may become apparent throughout the implementation of the GSP. Additionally, the Board may readdress the possible issue of data gaps during the five-year review of the GSP.

5.5.8.3 Plans to Fill Data Gaps

Regulation Requirements:

§354.38(c) If the monitoring network contains data gaps, the Plan shall include a description of the following:
1) The location and reason for data gaps in the monitoring network.
2) Local issues and circumstances that limit or prevent monitoring.

§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.

As previously discussed, MAGSA has identified the known constituents throughout the GSA. Moving forward, MAGSA will continue to evaluate the previously described monitoring network for water quality. Should it be deemed necessary, the GSA Board may adopt policy to expand or alter the existing monitoring network should concern arise regarding any singular constituent. There are no current plans to fill data gaps in the groundwater quality monitoring network.

5.5.8.4 Adjustment to Density of Monitoring Sites and Frequency of Measurements

Regulation Requirements:

§354.38(e) Each Agency shall adjust the monitoring frequency and density of monitoring sites to provide an adequate level of detail about site-specific surface water and groundwater conditions and to assess the effectiveness of management actions under circumstances that include the following:
1) Minimum threshold exceedances.
2) Highly variable spatial or temporal conditions
3) Adverse impacts to beneficial uses and users of groundwater.
4) The potential to adversely affect the ability of an adjacent basin to implement its Plan or impede achievement of sustainability goals in an adjacent basin.

The frequency and density of the proposed monitoring programs are discussed in previous sections. The criteria are considered adequate to provide the monitoring data to satisfy SGMA requirements. Beginning in 2020, when groundwater conditions are compared to sustainability goals, the monitoring network may be modified or enhanced if deemed necessary.

5.6 Land Subsidence

5.6.1 Description of Monitoring Network

Regulation Requirements:

§354.34(c)(5) Land Subsidence. Identify the rate and extent of land subsidence, which may be measured by extensometers, surveying, remote sensing technology, or other appropriate method.

Most land subsidence in the San Joaquin Valley originates from the axial trough of the valley westward. The plan area still has some subsidence which is east of the axial trough. Areas with the most significant subsidence are underlain by the Corcoran Clay member of the Tulare Formation. **Figure 5-5** and **Figure 5-6** show the land subsidence in the Kings Subbasin where most of the subsidence can be found west of the Corcoran Clay layer.

As shown below in **Figure 5-7**, the Corcoran Clay lays beneath nearly the entire MAGSA area.

While some local agencies in the San Joaquin Valley monitor for land subsidence, the majority rely on monitoring performed by regional water agencies or the State and Federal government. Measurement and monitoring for land subsidence is performed by a variety of agencies including USGS, KRCD, USBR, USACE, University NAVSTAR (UNAVCO), and various private contractors. Interagency efforts between the USGS, USBR, the U.S. Coast and Geodetic Survey (now the National Geodetic Survey), and DWR resulted in an intensive series of investigations that identified and characterized subsidence in the San Joaquin Valley. NASA also measures subsidence in the Central Valley and has maps on their websites that show the subsidence for a defined period (https://earthobservatory.nasa.gov/IOTD/view.php?id=89761&eocn=image&eoci=related_image).

The MAGSA monitoring network will utilize sites that have historically been monitored for subsidence, **Figure 5-8**, and use the NASA InSAR data, **Figure 5-9,** to verify the areas of subsidence. More information on these programs is provided below.

Kings Subbasin
Coordinated Effort

Kings Coordinated Effort GSAs

Land Subsidence
Kings River Conservation District
2013-2016

Figure 5-5

Legend

Kings Subbasin GSAs

Township/Range

E-Clay Eastern Extent

Page and LeBlanc 1969, modified by KDSA

KRCD Subsidence Monitoring Location

Change from 2013 to 2016 (ft)

- 0.01 to 0.12
- -0.24 to 0.00
- -0.49 to -0.25
- -0.99 to -0.50
- -1.49 to -1.00
- -1.99 to -1.50
- -2.49 to -2.00
- -3.91 to -2.50

Millerton Reservoir
Pine Flat Reservoir
San Joaquin River
Kings River

SUB020 SUB046 SUB045 SUB031 SUB048 SUB067 SUB075 SUB049 SUB044 SUB025 SUB100 SUB056 SUB051 SUB077 SUB015 SUB010 SUB079 SUB034 SUB082 SUB043 SUB103 SUB054 SUB052 SUB080 SUB033 SUB085 SUB058 SUB006 SUB014 SUB009 SUB041 SUB060 SUB088 SUB064 SUB072 SUB017 SUB035 SUB057 SUB097 SUB094 SUB005 SUB042 SUB013 SUB040 SUB039 SUB084 SUB021 SUB070 SUB092 SUB086 SUB029 SUB089 SUB105 SUB032 SUB016 SUB026 SUB022 SUB068 SUB036 SUB071 SUB028

Clovis
Fresno
Kerman
Fowler
Raisin City
San Joaquin
Selma
Reedley
Orange Cove
Kingsburg
Laton
Traver

NORTH KINGS GSA
SOUTH KINGS GSA
McMULLIN AREA GSA
JAMES ID
CENTRAL KINGS GSA
KINGS RIVER EAST GSA
NORTH FORK KINGS GSA

T11S T12S T13S T14S T15S T16S T17S T18S

R16E R17E R18E R19E R20E R21E R22E R23E R24E R25E

Sources: Esri, USGS, NOAA

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Kings Subbasin
Coordinated Effort

Kings Coordinated Effort GSAs

Land Subsidence
NASA (via CA Dept. Water Resources)
2015-2017

Figure 5-6

Legend

Kings Subbasin GSAs

Township/Range

E-Clay Eastern Extent

Page and LeBlanc 1969, modified by KDSA

NASA InSAR Data (provided by CA DWR) *

Change from May 2015 to April 2017 (inches)

- 2 to 6
- 1 to 2
- 0 to 1
- -1 to 0
- -2 to -1
- -3 to -2
- -5 to -3
- -7 to -5
- -10 to -7
- -15 to -10

* The legend shows the change in ground surface elevation from May 2015 to April 2017. The positive values indicate rebound while the negative values indicate land subsidence.

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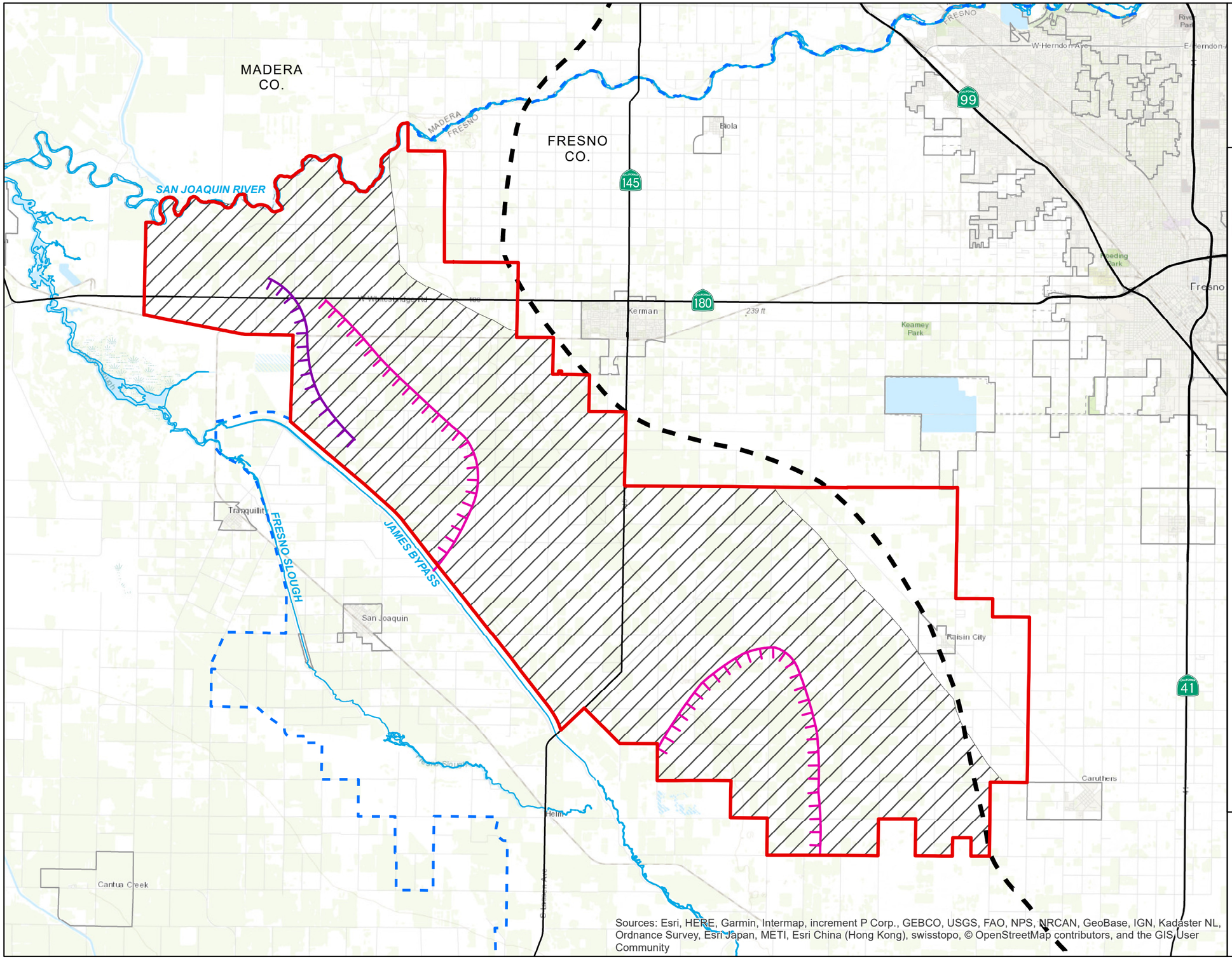

McMullin Area GSA

Extent of Lacustrine Clays
Figure 5-7

- McMullin Area GSA
- Kings Subbasin (DWR, Modified 2018)
- A-Clay Extent (USGS 1958)
- C-clay Extent (USGS 1958)
- Corcoran Clay Extent (E-Clay, Page 1986)

North East Edge of Corcoran Clay

- Page and LeBlanc 1969, KDSA Modification

Note: A and C Clays found on hachured side of extent lines.

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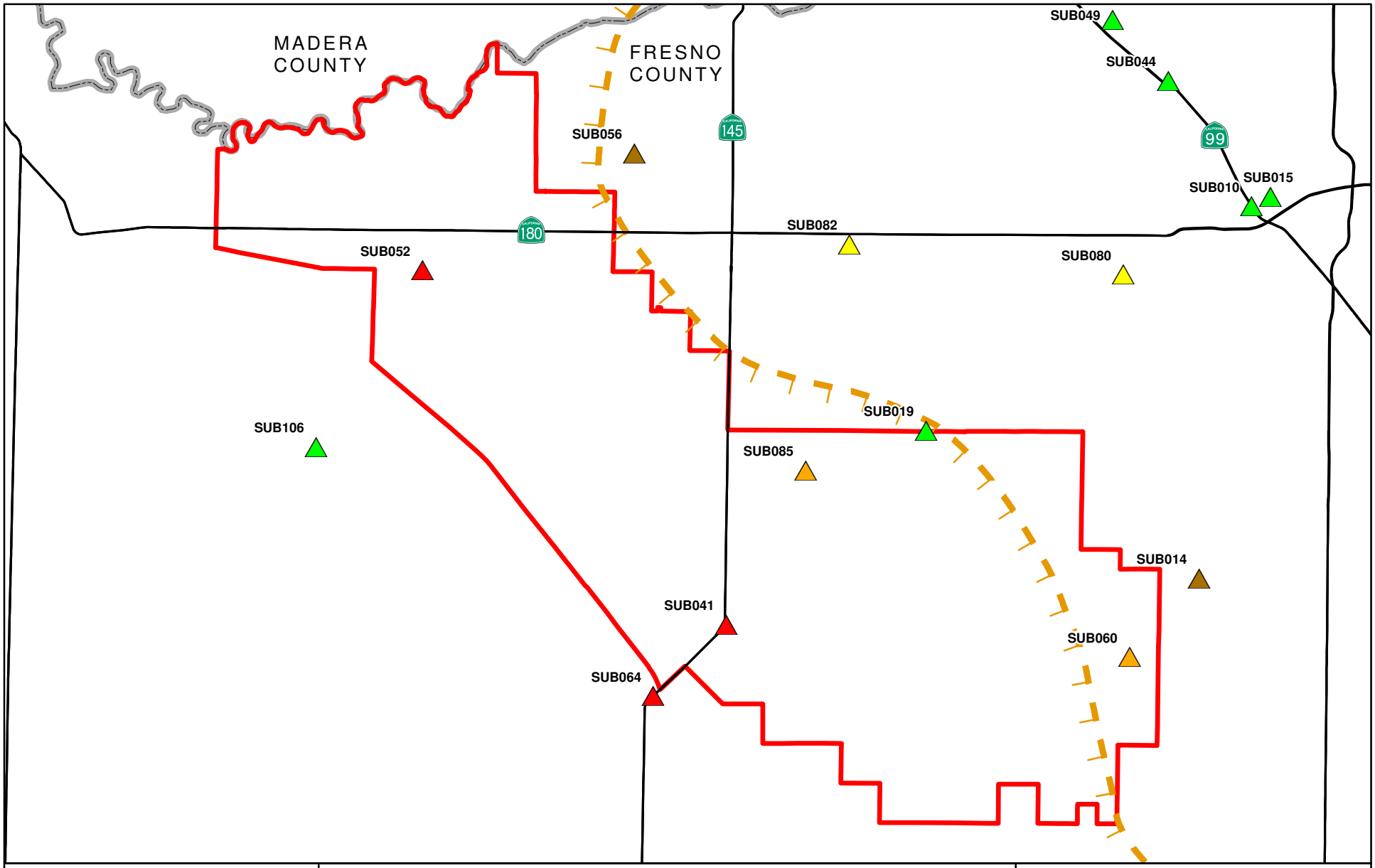

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Legend

McMullin Area GSA

County

North East Edge of Corcoran Clay

Page and LeBlanc 1969, KDSA (A Modification of Croft and Gordon 1968)

McMullin Area GSA

Land Subsidence
Kings River Conservation District
2013-2016

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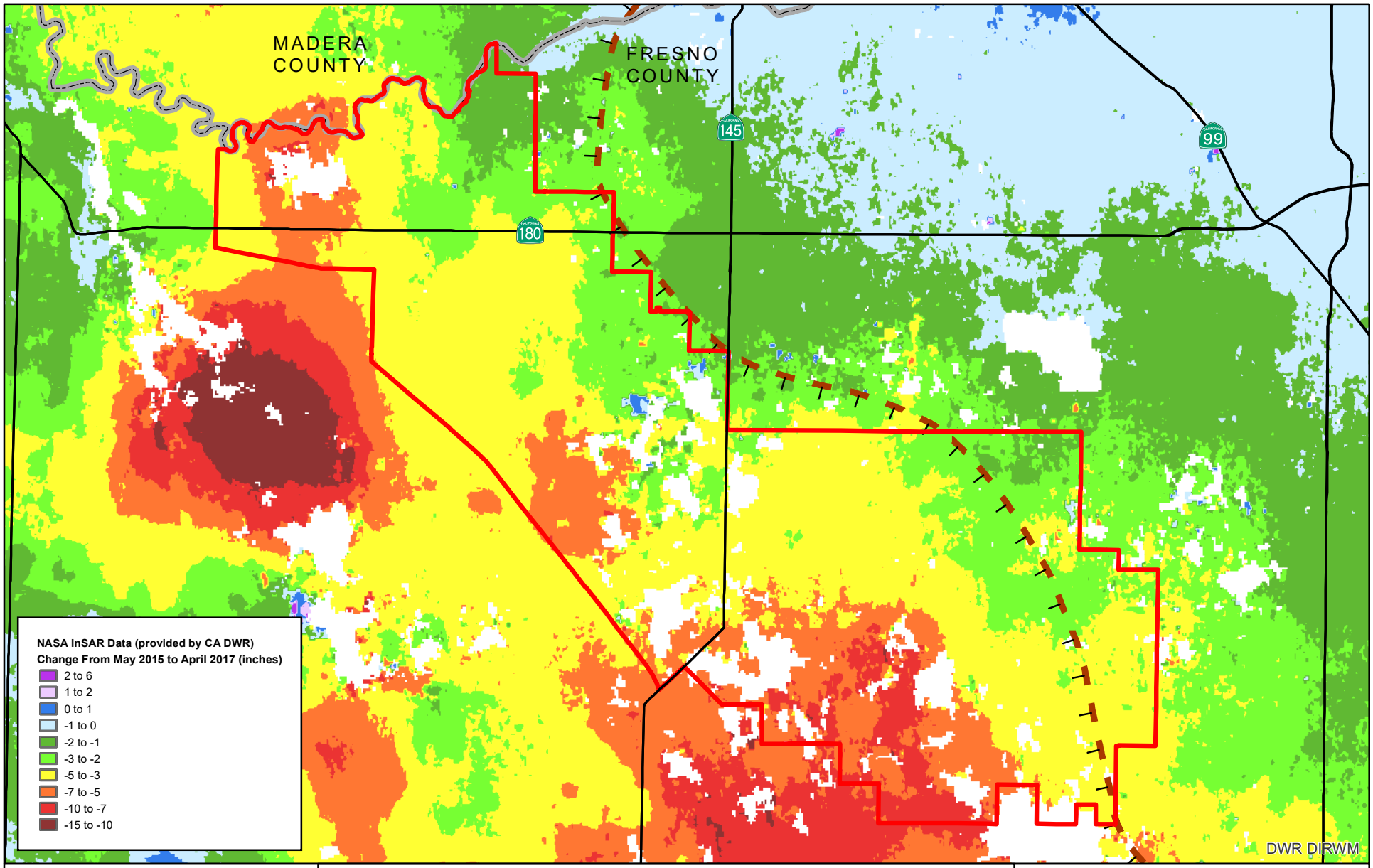

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Legend

- McMullin Area GSA
- County
- E Clay Eastern Extent (Page and LeBlanc1969, modified by KDSA)

The legend shows the change in ground surface elevation from May 2015 to April 2017. The positive values indicate rebound while the negative values indicate land subsidence.

McMullin Area GSA

Land Subsidence
NASA (via CA Dept. Water Resources)
2015-2017

Figure 5-9

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Subsidence Monitoring Methods and Technology

Several methods are available for measuring subsidence and are discussed below.

Continuous Global Positioning System. Subsidence can be measured using CGPS data. Various USGS studies obtain CGPS data from the University NAVSTAR Consortium UNAVCO, Plate Boundary Observatory (PBO) network of continuously operating GPS stations. The PBO is the geodetic component of UNAVCO, a consortium of research institutions whose focus is measuring vertical and horizontal plate boundary deformation across the western United States using high-precision measurement techniques. CGPS data is measured to one hundredth of a millimeter with a relatively low standard deviation.

Extensometers. Extensometers measure changes in the length of an object. As the surrounding soils move, the distances between reference points change, which allow for continuous measurement of subsidence. Extensometers are costly to install and require frequent maintenance and calibration. In the 1950s and 1960s, the USGS, DWR, and other agencies installed several borehole extensometers in the San Joaquin Valley. There are presently no known extensometers within the MAGSA area. Extensometers have a relative accuracy of approximately 1/100th of a foot.

InSAR. During the last decade, the USGS and other groups have been using data from radar emitting satellites in a technique called InSAR (interferometric synthetic-aperture radar). 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 Light Detection and Ranging (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 of a foot as measured in root-mean-square deviation and very similar to that of surveying.

Surveying. In the past, subsidence measurement relied upon optical (spirit level) surveying devices and, later, laser and GPS survey equipment. This type of measurement is still done today, usually along established highways and water conveyance facilities, such as levees and canals. The relative accuracy of GPS surveying is approximately +/- 1 inch.

Subsidence Monitoring Programs

Measurement and monitoring for subsidence is performed by a variety of agencies including USGS, DWR, USBR, MAGSA, USACE, UNAVCO, and various private contractors.

Continuous Global Positioning System Stations. Two CGPS Stations are near MAGSA area. The CGPS stations provide daily horizontal and vertical data at these locations with records starting as early as 2004. The CGPS stations also show subsidence or uplift at locations near the MAGSA area. The PBO and the Scripps Orbit and Permanent Array Center (SOPAC) upload and process the data from the network of CGPS stations and produce graphs depicting the horizontal and vertical change in a point's location through time. The nearest CGPS stations are in Mendota and Madera with none within the MAGSA boundary. Information on CGPS stations can be found at the following website:
https://www.unavco.org/instrumentation/networks/status/pbo/gps

McMullin Area Groundwater Sustainability Agency. MAGSA has a 7-mile grid that monitors existing benchmarks for land subsidence. **Figure 3-63** shows the locations of the benchmarks in the monitoring system.

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 satellite and aircrafts have been used to

produce the subsidence maps. More information can be found on their website: https://www.nasa.gov/jpl/nasa-california-drought-causing-valley-land-to-sink

San Joaquin River Restoration Program. Currently, USBR in conjunction with DWR, USGS, and USACE obtains subsidence data twice yearly and has published maps since 2012 of the results in July and December as part of the SJRRP. The subsidence areas shown in these maps cover the majority of the MAGSA area. The USBR, as part of the SJRRP, has been monitoring subsidence along the river and bypass levees as part of the restoration effort. More information can be found on their website: http://www.restoresjr.net/monitoring-data/subsidence-monitoring/

USGS Monitoring Network. A subsidence monitoring network consisting of 31 extensometers was installed in the 1950s to quantify the subsidence occurring in the San Joaquin Valley. By the 1980s, the land subsidence monitoring efforts decreased. Since then, a new monitoring network has been developed. The new network includes refurbished extensometers from the old network, CGPS stations, and InSAR. More information can be found on their website: https://ca.water.usgs.gov/land_subsidence/california-subsidence-measuring.html

5.6.2 Adequacy of Monitoring Network

Regulation Requirements:

§354.34(d) The monitoring network shall be designed to ensure adequate coverage of sustainability indicators. If management areas are established, the quantity and density of monitoring sites in those areas shall be sufficient to evaluate conditions of the basin setting and sustainable management criteria specific to that area.
§354.34(e) A Plan may utilize site information and monitoring data from existing sources as part of the monitoring network.

Land subsidence will be primarily monitored by MAGSA using historically monitored subsidence benchmarks. The monitoring network includes benchmark surveying at least every 7 miles with records dating back to 2010. This spatial and temporal network is adequate and designed with the flexibility to increase measurement frequency or decrease benchmark spacing if more data is warranted. NASA InSAR remote sensing data will be used to verify any observed subsidence and fill in gaps between the surveyed benchmarks. The MAGSA will also track land subsidence points just outside of its boundaries to see if subsidence is encroaching into the area.

5.6.3 Density of Monitoring Sites and Frequency of Measurements

Regulation Requirements:

§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.

The subsidence monitoring network has adequate density to determine land subsidence in the Kings Subbasin (see **Figure 5-5** and **Figure 5-6**). Within the Kings Basin, the KRCD land subsidence monitoring program has a 7-mile grid to monitor subsidence. Beginning in 2021 MAGSA has assumed responsibility for land subsidence monitoring in the GSA. InSAR data will also be used to monitor land subsidence in the Kings Basin. InSAR provides complete coverage of the basin and may be used to fill in the gaps in the MAGSA monitoring network.

5.6.4 Monitoring Network Information

The following sections describe the monitoring network, including scientific rationale for the selection; consistency with data and reporting standards; corresponding sustainability indicator, minimum threshold, measurable objective, and interim milestone; and the locations of the monitoring sites.

5.6.4.1 Scientific Rationale for Site Selection

Regulation Requirements:

§354.34(g) Each Plan shall describe the following information about the monitoring network:
(1) Scientific rationale for the monitoring site selection process.

The KRCD land-subsidence monitoring-program was established using National Geodetic Survey (NGS) control points. KRCD chose these points due to the details, history, and stability rankings of the monuments. The control points are the foundation for monitoring subsidence. From the control points, KRCD decided to use an approximately 7-mile grid to monitor subsidence in the Kings Subbasin. This is considered the best method to monitor subsidence since it involves direct measurements. These direct measurements, used in conjunction with remotely sensed data, will provide the strongest foundation for accuracy in determining if subsidence has occurred. Beginning in 2021 MAGSA has assumed responsibility for groundwater level monitoring in the GSA using the benchmarks historically used to monitor land subsidence.

If additional monitoring locations are added, the following scientific rationale will be used:

- Add monitoring sites to areas of known higher subsidence in the area.
- Add monitoring sites that can be easily surveyed and tied back to a nearby monument.
- Add monitoring sites where the ground surface is unlikely to be modified by future construction and will remain undisturbed.
- Add monitoring sites in areas where the geology and soil types present the greatest potential for subsidence.

5.6.4.2 Consistency with Data and Reporting Standards

Regulation Requirements:

§354.34(g)(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 is consistent with the standards identified in Section 352.4 of the California Code of Regulations related to Groundwater Sustainability Plans. The main topics of Section 352.4 are outlined below, and the full section is included as **Appendix 5-B**.

- Data reporting units (e.g., Water volumes shall be reported in acre-feet, etc.)
- Monitoring site information (e.g., Site identification number, description of site location, etc.)
- Well attribute reporting (e.g., CASGEM well identification number, casing perforations, etc.)
- Map standards (e.g., Data layers, shapefiles, and geodatabases shall be submitted in accordance with the procedures described in Article 4, etc.)
- Hydrograph requirements (e.g., Hydrographs shall use the same datum and scaling to the greatest extent practical, etc.)
- Groundwater and surface water models (e.g., the model shall include publicly available supporting documentation, etc.)

5.6.4.3 Quantitative Values

Regulation Requirements:

§354.34(g)(3) For each sustainability indicator, the quantitative values for the minimum threshold, measurable objective, and interim milestones that will be measured at each monitoring site or representative monitoring sites established pursuant to Section 354.36.

The quantitative values for minimum threshold, measurable objective, and interim milestones will be set for the GSA. Refer to section 4.6.3.4 Path to Achieve Measurable Objectives in the Sustainable Management Criteria chapter for the table with the criteria set for the GSA.

5.6.5 Monitoring Locations

Regulation Requirements:

§354.34(h) The 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.

5.6.5.1 Map

Figure 5-5 and **Figure 5-6** show the land subsidence in the Kings Basin where most of the subsidence can be found west of the Corcoran Clay layer.

As shown below in **Figure 5-7**, the Corcoran Clay lays beneath nearly the entire MAGSA area.

Monitoring is also performed in areas outside of the GSA to help document more accurate boundary conditions. Land subsidence is also monitored up to five miles outside of the border to track possible encroachment of subsidence into the GSA.

5.6.5.2 Table

Appendix 5-A includes a table of monitoring site attributes.

5.6.6 Monitoring Protocols

Regulation Requirements:

§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.

§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.

Groundwater level, groundwater quality, and land subsidence monitoring will generally follow the protocols identified in the *Monitoring Protocols, Standards, and Sites BMP* (DWR, 2016b). Refer to **Appendix 5-C** for a copy of the BMP. The GSA may develop standard monitoring forms in the future if deemed necessary. The following comments and exceptions to the BMP should be noted:

1. Identification of land subsidence conditions
2. Monitoring of regions of suspected subsidence where potential exists
3. Following of GPS surveying standards set out in the California Department of Transportation's Caltrans Surveys Manual

4. Greater use of available InSAR data as programs are developed

5.6.7 Representative Monitoring

Regulation Requirements:

§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:

MAGSA does not plan to use representative monitoring sites. MAGSA will monitor the 5 sites in the land subsidence monitoring network and the NASA InSAR data.

5.6.7.1 Description of Representative Sites

Regulation Requirements:

§354.36(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.

DWR has referred to representative monitoring as utilizing a subset of wells in a management area. MAGSA does not plan to use representative monitoring sites. The area has a history of using land subsidence monitoring sites to monitor land subsidence.

5.6.7.2 Use of Groundwater Elevations as Proxy for other Sustainability Indicators

Regulation Requirements:

§354.36(b) Groundwater elevations may be used as a proxy for monitoring other sustainability indicators if the Agency demonstrates the following:

1) Significant correlation exists between groundwater elevations and the sustainability indicators for which groundwater elevation measurements serve as a proxy.
2) Measurable objectives established for groundwater elevation shall include a reasonable margin of operational flexibility taking into consideration the basin setting to avoid undesirable results for the sustainability indicators for which groundwater elevation measurements serve as a proxy.

MAGSA does not plan to use groundwater elevations as a proxy for monitoring land subsidence.

Regulation Requirements:

§354.36(c) The designation of a representative monitoring site shall be supported by adequate evidence demonstrating that the site reflects general conditions in the area.

MAGSA does not plan to use representative monitoring sites. MAGSA will monitor the 5 land subsidence monitoring locations in the monitoring network and monitor the NASA InSAR land subsidence data.

5.6.8 Assessment and Improvement of Monitoring Network

5.6.8.1 Review and Evaluation of Monitoring Network

Regulation Requirements:

§354.38(a) Each Agency shall review the monitoring network and include an evaluation in the Plan and each five-year assessment, including a determination of uncertainty and whether there are data gaps that could affect the ability of the Plan to achieve the sustainability goal for the basin.

This section includes a description of the different types of data gaps, a summary of existing data gaps in each monitoring network and plans to fill the data gaps.

5.6.8.2 Identification of Data Gaps

Regulation Requirements:

§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.

There are three general types of data gaps to consider for monitoring networks:

1. **Temporal**: Insufficient frequency of monitoring. For instance, data may be available from a well only in the fall since it is rarely idle in the spring. In addition, a privately owned well may have sporadic access due to locked security fencing, roaming dogs, change in ownership, etc.
2. **Spatial**: Insufficient number or density of monitoring sites in a specific area.
3. **Insufficient quality of data**: Data may be available but be of poor or questionable accuracy. Poor data may at times be worse than no data since it could lead to incorrect assumptions or biases. The data may not appear consistent with other data in the area or with past readings at the monitoring site. The monitoring site may not meet all the desired criteria to provide reliable data, such as having information on perforation depth, etc. Past experiences have shown that well location information on Well Construction Reports is sometimes poor, making it difficult or impossible to match wells with their well logs.

No data gaps were identified in the subsidence monitoring network. The network includes benchmarks that are monitored annually along with remote sensing data (InSAR) that fills in gaps between the benchmarks.

5.6.8.3 Plans to Fill Data Gaps

Regulation Requirements:

§354.38(c) If the monitoring network contains data gaps, the Plan shall include a description of the following:
1) The location and reason for data gaps in the monitoring network.
2) Local issues and circumstances that limit or prevent monitoring.

§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.

There is no current plan to fill data gaps in the land subsidence monitoring network.

5.6.8.4 Adjustment to Density of Monitoring Sites and Frequency of Measurements

Regulation Requirements:

§354.38(e) Each Agency shall adjust the monitoring frequency and density of monitoring sites to provide an adequate level of detail about site-specific surface water and groundwater conditions and to assess the effectiveness of management actions under circumstances that include the following:
1) Minimum threshold exceedances.
2) Highly variable spatial or temporal conditions
3) Adverse impacts to beneficial uses and users of groundwater.
4) The potential to adversely affect the ability of an adjacent basin to implement its Plan or impede achievement of sustainability goals in an adjacent basin.

The frequency and density of the proposed monitoring programs are discussed in previous sections. The criteria are considered adequate to provide the monitoring data to satisfy SGMA requirements. Beginning in 2020, when groundwater conditions are compared to sustainability goals, the monitoring network may be modified or enhanced if deemed necessary.

5.7 Depletion of Interconnected Surface Water

5.7.1 Description of Monitoring Network

Regulation Requirements:

§354.34(c)(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.

Regulation Requirements:

§354.34(j) An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in Section 354.26, shall not be required to establish a monitoring network related to those sustainability indicators.

Interconnected surface water is recognized as a data gap. A project to fill the Interconnected Surface Water data gap is included in Chapter 6. In the interim, the Kings Subbasin will use groundwater levels near the river system as a proxy for surface water depletion from rivers. This method will use the Measurable Objectives (MO) and Minimum Thresholds (MT) of representative wells, located within 2 miles of the Kings River and San Joaquin River, as proxies for surface water depletion. A list of this wells and map showing their location is included in Section 4.7. This is an interim measure that will be updated once the data gap study is completed in 2025.

The SJR is the only surface water body of significance within the MAGSA. The SWRCB depicts interconnected surface water as 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 (**Cal. Code Regs. Tit. 23 § 351 (o)**). It is believed that there is no evidence as to the presence of continuous interconnected surface water groundwater systems within the MAGSA along the San Joaquin River; therefore, this criterion is not applicable to the MAGSA. This may be concluded since at various times of the calendar year primarily in October as seen in **Figure 5-10**, the incessant flow of the SJR has run dry below Gravelly Ford, therefore, identifying that the systems are not continuously interconnected **(354.34.c.6.b)**.

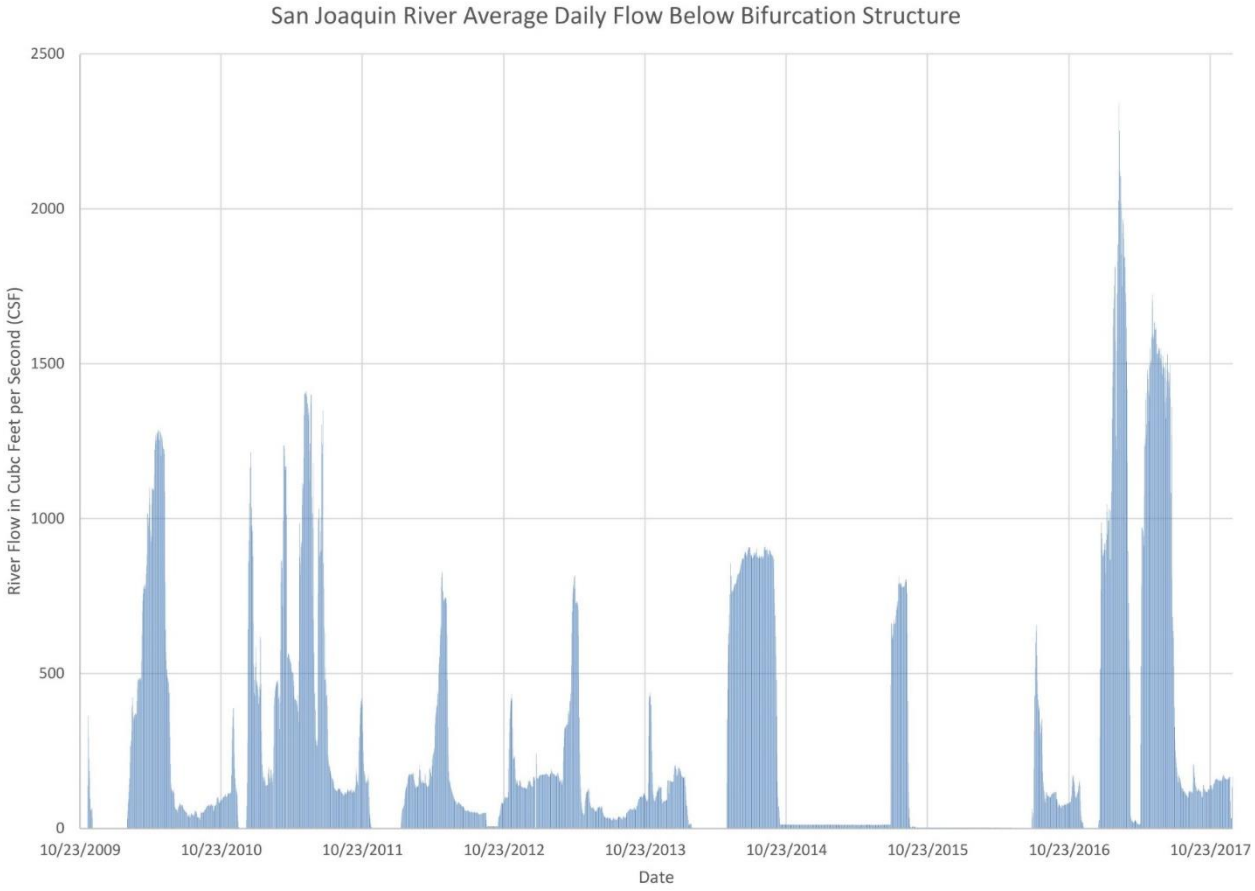


Figure 5-10 San Joaquin River Average Daily Flow Below Bifurcation Structure

5.7.2 Adequacy of Monitoring Network

Regulation Requirements:

§354.34(d) The monitoring network shall be designed to ensure adequate coverage of sustainability indicators. If management areas are established, the quantity and density of monitoring sites in those areas shall be sufficient to evaluate conditions of the basin setting and sustainable management criteria specific to that area.
§354.34(e) A Plan may utilize site information and monitoring data from existing sources as part of the monitoring network.

As discussed earlier in this Section under Groundwater Levels, the GSA has established a groundwater level monitoring network with an adequate density throughout the GSA, including near the rivers. Additionally, the GSA will continue to review data from San Joaquin River Restoration Program near-river groundwater monitoring wells as it becomes available. There is a current monitoring network established by the SJRRP that consistently collects groundwater elevation data along the SJR on an annual basis. This data is collected in a joint effort between the SJRRP and the USBR. The USBR monitoring wells are located along the SJR and can be seen in **Figure 5-11.** Regional groundwater data provided by the USBR and the SJRRP as well as the USGS Flow Model (USGS SIR 2014-5148, 2014) indicate that at various times of the calendar year, the incessant flow of the SJR has run dry below Gravelly Ford. Additionally, in 2006 a considerably wet year, the USGS SIR Report indicated that the estimated depth to water table along the portion of the SJR adjacent to MAGSA was approximately 20 feet. This, therefore, identifies that the groundwater and surface water systems are not continuously interconnected. MAGSA will continue to monitor the annual data collected

from the USBR and will discuss any changes to the monitoring network if necessary due to new reports or findings from the future USGS flow models.

5.7.3 Density of Monitoring Sites and Frequency of Measurements

Regulation Requirements:

§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.

Until the data gap study has been completed, wells in the groundwater level monitoring network will be used as a proxy as described in Section 4.7. The groundwater level frequency is described in Section 4.2. The USBR monitoring wells and the groundwater elevation data that is collected on an annual basis as discussed in *Chapter 3 Basin Settings 3.2.7* of the MAGSA GSP will continue to be reviewed and evaluated by the GSA. The existing monitoring wells run along the SJR adjacent to the MAGSA boundary. The monitoring of these sites is in conjunction with the SJRRP and will continue for the foreseeable future.

5.7.4 Monitoring Network Information

5.7.4.1 Scientific Rationale for Site Selection

Regulation Requirements:

§354.34(g) Each Plan shall describe the following information about the monitoring network:
(1) Scientific rationale for the monitoring site selection process.

Until the data gap study has been completed, wells in the groundwater level monitoring network will be used as a proxy as described in Section 4.7. In addition, MAGSA will review data from the existing USBR monitoring wells along the SJR. These USBR monitoring wells and the groundwater elevation data that is collected on an annual basis will continue to be reviewed and evaluated by the GSA. The existing monitoring wells run along the SJR adjacent to the MAGSA boundary. The monitoring of these sites is in conjunction with the SJRRP and will continue for the foreseeable future.

5.7.4.2 Consistency with Data and Reporting Standards

Regulation Requirements:

§354.34(g)(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 is consistent with the standards identified in Section 352.4 of the California Code of Regulations related to Groundwater Sustainability Plans. The main topics of Section 352.4 are outlined below.

- Data reporting units (e.g., water volumes shall be reported in acre-feet, etc.)
- Monitoring site information (e.g., site identification number, description of site location, etc.)
- Well attribute reporting (e.g., CASGEM well identification number, casing perforations, etc.)
- Map standards (e.g., data layers, shapefiles, geodatabases shall be submitted in accordance with the procedures described in Article 4, etc.)
- Hydrograph requirements (e.g., hydrographs shall use the same datum and scaling to the greatest extent practical, etc.)
- Groundwater and surface water models (e.g., the model shall include publicly available supporting documentation, etc.)

5.7.4.3 Quantitative Values

Regulation Requirements:

§354.34(g)(3) For each sustainability indicator, the quantitative values for the minimum threshold, measurable objective, and interim milestones that will be measured at each monitoring site or representative monitoring sites established pursuant to Section 354.36.

The wells that will be used as a proxy are listed in Section 4.7, and the MOs, MTs and Interim Milestones for these wells are identified in Section 4.2.

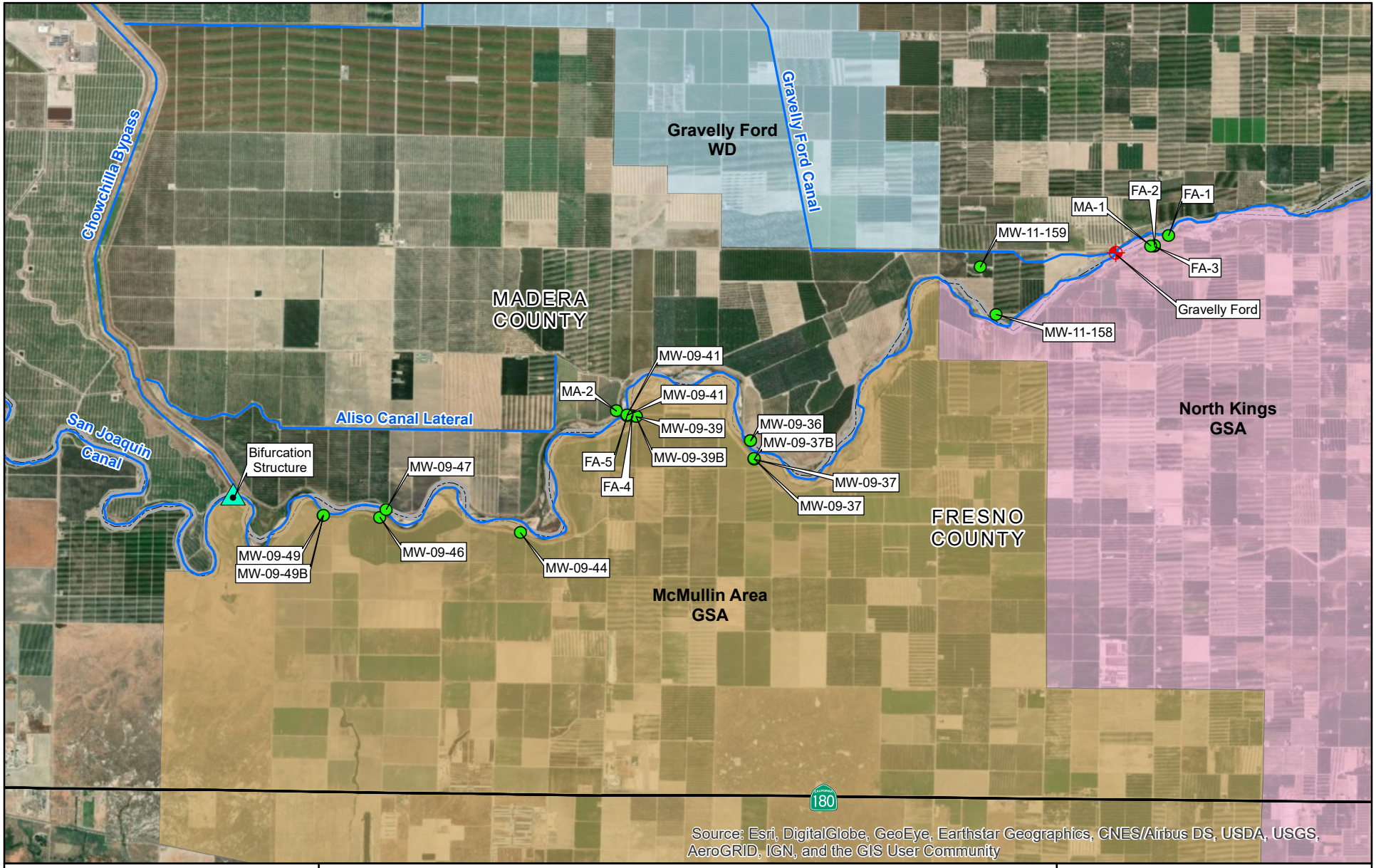
5.7.5 Monitoring Locations

Regulation Requirements:

§354.34(h) The 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.

5.7.5.1 Map

The list of wells to be used as a proxy within the basin is shown in Table 4-13, and a map of the wells is included in Figure 4-9**. Figure 5-11** indicates the USBR monitoring wells located directly adjacent to the portion of the SJR that runs along the border of the MAGSA **(354.34.h)**. As previously mentioned, the SJR is not believed to be continuously connected along the MAGSA boundary. However, the GSA will continue to monitor the area on a precautionary basis utilizing the USBR monitoring wells on an annual basis in conjunction with the SJRRP.



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- Gravelly Ford Water District
- North Kings GSA
- McMullin Area GSA
- USBR Monitoring Wells
- Bifurcation Structure

McMullin Area GSA

Well Locations Along the San Joaquin River

Figure 5-11

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5.7.6 Monitoring Protocols

Regulation Requirements:

§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.

§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.

Groundwater level, groundwater quality, and land subsidence monitoring will generally follow the protocols identified in the *Monitoring Protocols, Standards, and Sites BMP* (DWR, 2016b). Refer to **Appendix 5-C** for a copy of the BMP.

5.7.7 Representative Monitoring

Regulation Requirements:

§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:

5.7.7.1 Description of Representative Sites

Regulation Requirements:

§354.36(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.

DWR has referred to representative monitoring as utilizing one well to represent an entire GSA or Management Area. Use of one representative well in the GSA is not practical to cover such a large area with varying conditions. Not all wells within the GSA are monitored, so a subset of wells is used as representative of conditions in the GSA. Groundwater conditions can vary substantially across the GSA. The GSA area has a history of using multiple wells to monitor groundwater and will continue to use available water level and water quality data from multiple wells to assess groundwater conditions.

5.7.7.2 Use of Groundwater Elevations as Proxy for other Sustainability Indicators

Regulation Requirements:

§354.36(b) Groundwater elevations may be used as a proxy for monitoring other sustainability indicators if the Agency demonstrates the following:

1) Significant correlation exists between groundwater elevations and the sustainability indicators for which groundwater elevation measurements serve as a proxy.
2) Measurable objectives established for groundwater elevation shall include a reasonable margin of operational flexibility taking into consideration the basin setting to avoid undesirable results for the sustainability indicators for which groundwater elevation measurements serve as a proxy.

As noted, interconnected surface water is recognized as a data gap. A project to fill the Interconnected Surface Water data gap is included in Chapter 6. In the interim, the Kings Subbasin will use groundwater levels near the river system as a proxy for surface water depletion from rivers. This method will use the Measurable Objectives (MO) and Minimum Thresholds (MT) of representative wells, located within 2 miles of the Kings River and San Joaquin River, as proxies for surface water depletion. A list of this wells and map showing their location is included in Section 4.7. This is an interim measure that will be updated once the data gap study is completed in 2025.

Regulation Requirements:

§354.36(c) The designation of a representative monitoring site shall be supported by adequate evidence demonstrating that the site reflects general conditions in the area.

5.7.8 Interconnected surface water has been identified as a data gap and a detailed study to fill that data gap is included in Chapter 6. In the interim, the Kings Subbasin will use groundwater levels near the river system as a proxy for surface water depletion from rivers. Assessment and Improvement of Monitoring Network

5.7.8.1 Review and Evaluation of Monitoring Network

Regulation Requirements:

§354.38(a) Each Agency shall review the monitoring network and include an evaluation in the Plan and each five-year assessment, including a determination of uncertainty and whether there are data gaps that could affect the ability of the Plan to achieve the sustainability goal for the basin.

The following section includes a description of the different types of data gaps that can be seen in existing and future monitoring networks, a summary of existing data gaps in each monitoring network and plans to fill the data gaps. Nothing can be done to sufficiently address historical data gaps; however, moving forward the GSA Board may elaborate and address possible data collection methods as deemed necessary. .

5.7.8.2 Identification of Data Gaps

Regulation Requirements:

§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.

As described in Section 4.7, Interconnected Surface Water has been identified as a data gap. There are three general types of data gaps to consider for monitoring networks:

1. **Temporal**: The USBR has been collecting data from the monitoring wells adjacent to the MAGSA boundary along the SJR in conjunction with the SJRRP since 2007. Data gaps prior to 2007 may exist; however, since MAGSA is not setting criteria for interconnected surface water-groundwater systems, it would not be deemed necessary to further acquire historical data regarding groundwater elevation data recorded before the establishment of the SJRRP.
2. **Spatial**: At this time spatial data gaps may be present along the MAGSA stretch of the SJR, when referencing the monitoring wells utilized by the USBR for annual monitoring in accordance with the SJRRP. However, since MAGSA is not setting criteria for interconnected surface water groundwater, further expansions of these networks or addressing these data gaps is not deemed applicable at this time.
3. **Insufficient quality of data**: At this time the annual groundwater elevation data recorded and referenced by the USBR in accordance with the SJRRP is deemed sufficient. MAGSA is not setting criteria for surface water groundwater interaction.

5.7.8.3 Until the data gap study identified in Section 6 can be completed, the Kings Subbasin will use groundwater levels as a proxy for interconnected surface water.Plans to Fill Data Gaps

Regulation Requirements:

§354.38(c) If the monitoring network contains data gaps, the Plan shall include a description of the following:
1) The location and reason for data gaps in the monitoring network.
2) Local issues and circumstances that limit or prevent monitoring.

Regulation Requirements:

§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.

A detailed plan to fill the data gap for Interconnected Surface Water is included in Chapter 6.

5.7.8.4 Adjustment to Density of Monitoring Sites and Frequency of Measurements

Regulation Requirements:

§354.38(e) Each Agency shall adjust the monitoring frequency and density of monitoring sites to provide an adequate level of detail about site-specific surface water and groundwater conditions and to assess the effectiveness of management actions under circumstances that include the following:

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

The frequency and density of the proposed monitoring programs for MAGSA are discussed in previous sections. The criteria are considered adequate to provide the monitoring data to satisfy SGMA requirements. If necessary, adjustments to the monitoring network in order to address regulations **(354.38.e.5), (354.38.e.5), (354.38.e.6), (354.38.e.7),** and **(354.38.e.8)** may be developed if deemed appropriate by the Board of Directors.

5.8 Reporting Monitoring Data to the Department

Regulation Requirements:

§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.

Monitoring programs are coordinated within the Kings Subbasin. Well location, construction, and level data are shared amongst the different GSAs. In addition, the monitoring programs described in this chapter were reviewed by the other GSAs, and they are generally consistent throughout the basin. Similarly, data reported to DWR will be collected and reported in a consistent format. A detailed description of the Data Management System and the information that will be reported is included in Sections 7.4 and Section 7.5.

6 Projects and Management Actions to Achieve Sustainability

Legal Requirements

§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. The list shall include projects and management actions that may be utilized to meet interim milestones, the exceedance of minimum thresholds, or where undesirable results have occurred or are imminent. The Plan shall include the following:
(A) A description of the circumstances under which projects or management actions shall be implemented, the criteria that would trigger implementation and termination of projects or management actions, and the process by which the Agency shall determine that conditions requiring the implementation of particular projects or management actions have occurred.
(B) The process by which the Agency shall provide notice to the public and other agencies that the implementation of projects or management actions is being considered or has been implemented, including a description of the actions to be taken.
(2) If overdraft conditions are identified through the analysis required by Section 354.18, the Plan shall describe projects or management actions, including a quantification of demand reduction or other methods, for the mitigation of overdraft.
(3) A summary of the permitting and regulatory process required for each project and management action.
(4) The status of each project and management action, including a time-table for expected initiation and completion, and the accrual of expected benefits.
(5) An explanation of the benefits that are expected to be realized from the project or management action, and how those benefits will be evaluated.
(6) An explanation of how the project or management action will be accomplished. If the projects or management actions rely on water from outside the jurisdiction of the Agency, an explanation of the source and reliability of that water shall be included.
(7) A description of the legal authority required for each project and management action, and the basis for that authority within the Agency.
(8) A description of the estimated cost for each project and management action and a description of how the Agency plans to meet those costs.
(9) A description of the management of groundwater extractions and recharge to ensure that chronic lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels or storage during other periods.
(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 basin setting when developing projects or management actions.

6.1 Introduction

Each of the following projects are in various stages of development, ranging from conceptual projects to projects that have been constructed. Thus, each of the following projects have a different level of investigation that has been completed; from projects with limited information, to a feasibility level, to field surveys for a channel capacity study, to recently constructed. The agency will maintain a list of proposed projects and their characteristics, along with their development status, and will use this list to prioritize and secure funding as opportunities become available. The Board may consider environmental benefits in the assessment and prioritization of such projects. Projects discussed in this plan will remain a part of the potential projects that the GSA may choose to implement; however, other projects may come up with higher yield or lower cost and will be considered. The projects that are currently being considered are shown on **Figure 6-1** and **Figure 6-2.** They have been prioritized based on a cost-benefit matrix and are listed in order as follows:

1. Fresno City Wastewater Treatment Plant Recharge Basin, FID Houghton Canal System
2. Fresno City Wastewater Treatment Plant Recharge Basin, FID Lower Dry Creek System
3. Southwest Groundwater Banking
4. Lassen Avenue Reverse Flow & Recharge
5. James Bypass Surface Water Supply & Recharge
6. McMullin On-Farm Flood Capture, Phase 2 and 3
7. Houghton Wasteway Expansion
8. South Sandridge Canal Water Supply & Recharge

9. Stinson North Canal Phase 1
10. Grantland Area Recharge
11. CID Wristen Ditch Intertie
12. Upgradient Recharge Programs
13. Land Subsidence Data Gap Analysis
14. Surface Water- Groundwater Interconnection Data Gap Analysis
15. Domestic Well Mitigation Program

The process being used for project implementation has generally been as follows:

1. Identify potential projects
2. Prepare conceptual level feasibility study and cost estimate
3. Prioritize potential projects
4. Obtain agreement with project partner(s)
5. Secure funding
6. Prepare environmental documents and obtain permit and regulatory approvals
7. Design and prepare construction documents
8. Implement project construction
9. Operate and maintain project for sustainability

It is expected that the GSA will further develop and craft projects and management actions in response to stakeholder input on parallel timelines and will adapt the estimated schedules according to the best available information and best available science at any given time in accordance with *§354,44(c).* The GSA understands that there are various levels of uncertainty with project and program implementation per *§344.44.(d).* It is not unusual for project and program implementation to take longer than originally estimated. The various implementation timelines may fluctuate over time dependent upon the success or failure of the initial GSP projects and management action efforts to increase water supplies, reduce groundwater demands, and improve data collection.

The legal authority and basis for the projects and management actions described in this GSP Chapter 6 are outlined in the SGMA and related provisions in accordance with *§354.44.(b).7.*

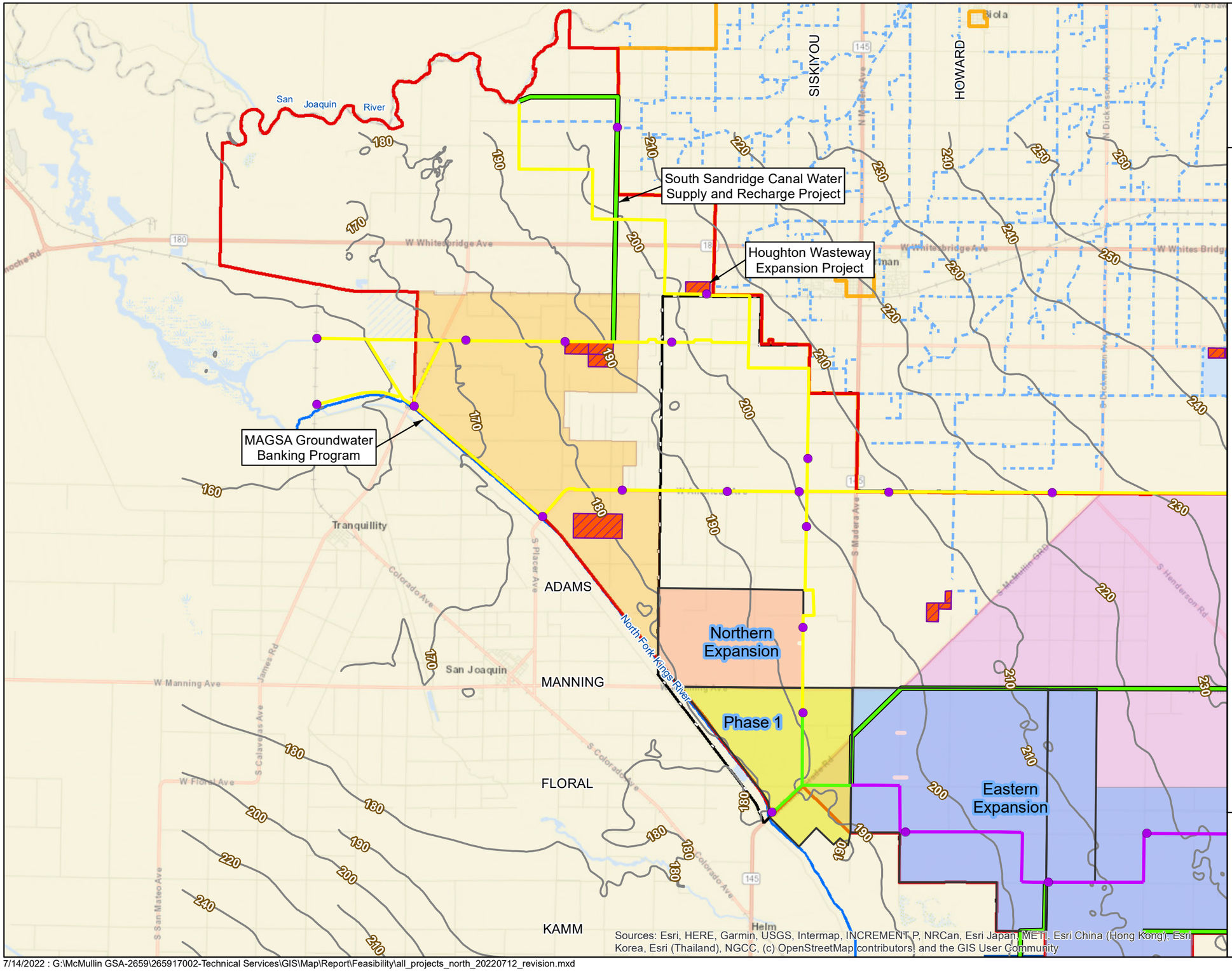
6.1.1 Public Notification

The Agency will provide notice to the public and other agencies as the implementation of each project or management action is being considered through public meetings, newsletters, and the GSA website www.mcmullinarea.org.

McMullin Area GSA

Northwesterly Area Projects

Figure 6-1



- Pump Stations
- Proposed Facility
- FID Facility
- USGS Ground Elevation Contour (ft, NAVD88)
- Proposed Dedicated Recharge Area
- McMullin Area GSA
- Mid-Valley WD
- Raisin City WD
- Raisin City WD SOI
- FID

McMullin Area GSA Conveyance

- McMullin Area On-Farm Phase 1
- McMullin Expansion
- Groundwater Banking

McMullin On-Farm Recharge Phases

- Phase 1
- Eastern Expansion
- Northern Expansion

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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

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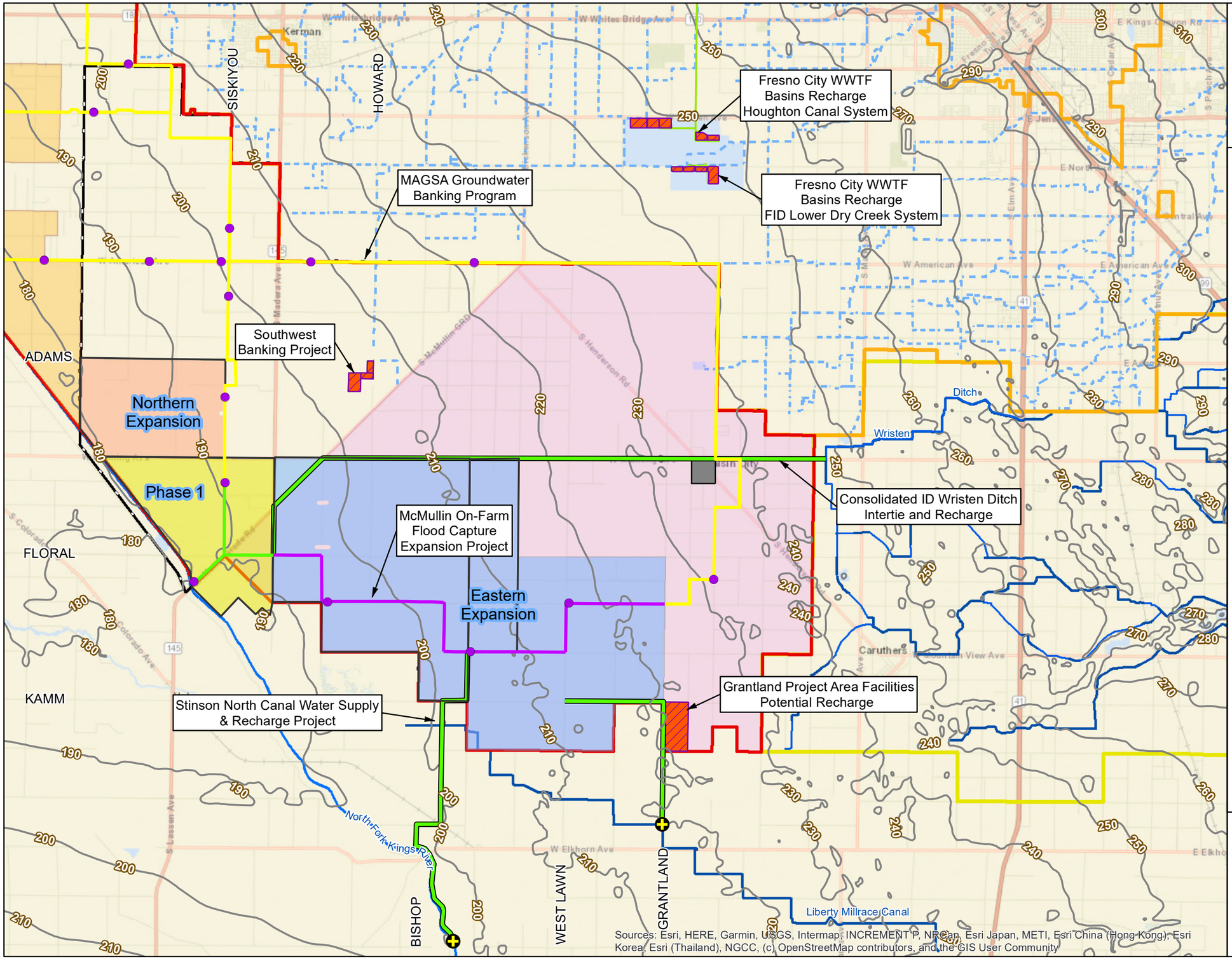
McMullin Area GSA

Southeasterly Area Projects

Figure 6-2



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

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6.2 Projects

6.2.1 Fresno City Wastewater Treatment Plant Recharge Basins, FID Houghton Canal System

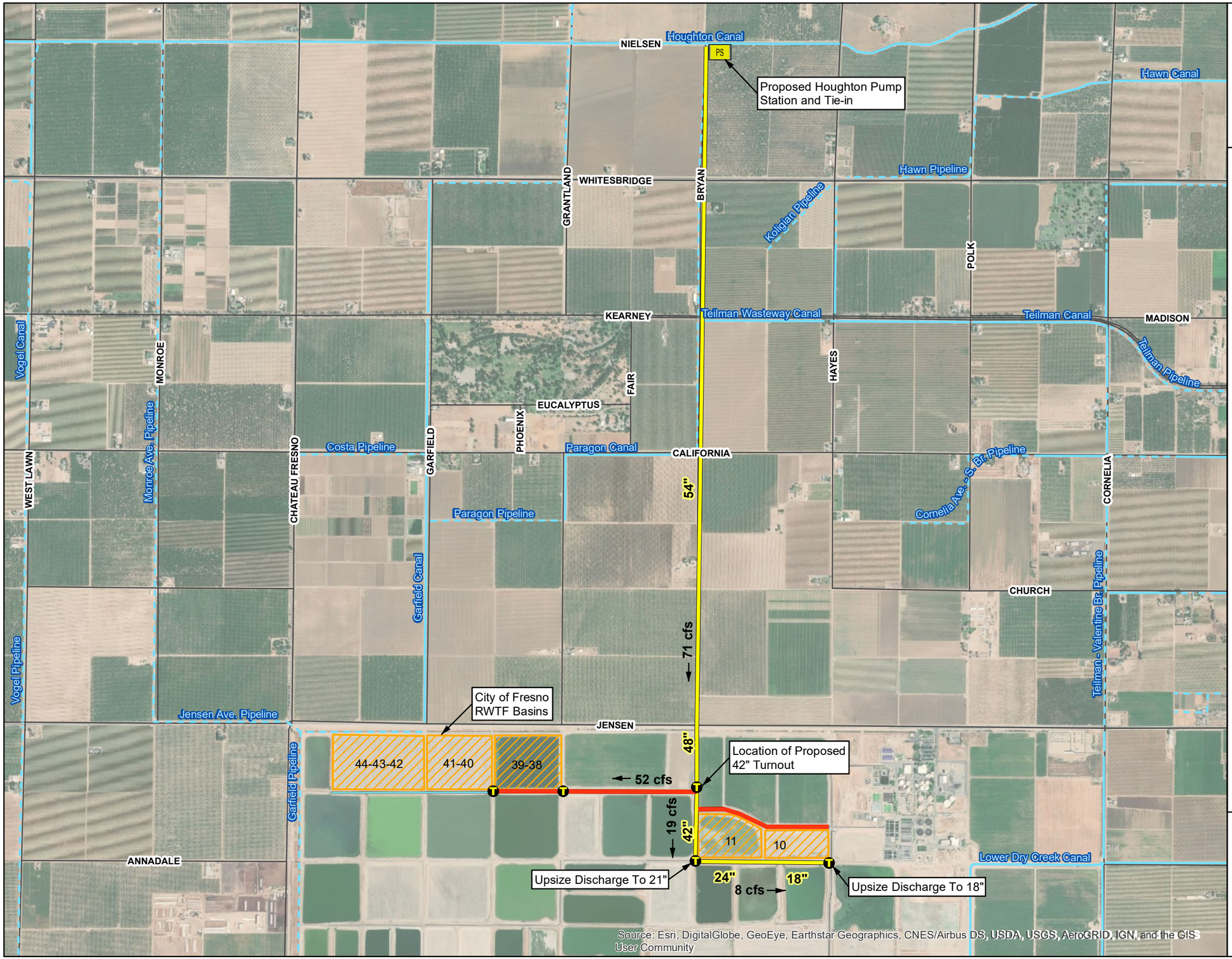
6.2.1.1 Project Description

FID and the City of Fresno (City) are interested in working collectively to recharge surface water, when available, at the City's Regional Wastewater Treatment Facility (RWTF). The project is located within the North Kings GSA, just outside of MAGSA, allowing for a potential groundwater credit to benefit MAGSA by an intra-basin groundwater transfer agreement between GSAs. A method to transfer groundwater between GSAs is yet to be developed through the efforts of the Kings Basin coordinated GSAs. The project involves a diversion from Houghton Canal to the proposed recharge basins at the RWTF as shown in **Figure 6-3**. A lift station will be required to divert a maximum flowrate of 71 cfs from Houghton Canal during wet and typical years when excess water is available.

McMullin Area GSA

Fresno City Wastewater Treatment
Plant Recharge Basins
FID Houghton Canal Facilities

Figure 6-3



- Turnout
- PS — Proposed Pump Stations
- Existing Distribution Canal
- Existing Houghton Pipeline
- Canal
- Pipeline
- Road
- Basins

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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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The project location for the lift station is in between Grantland Avenue and Hayes Avenue, approximately half a mile south of Belmont Avenue. The project will utilize existing pipelines of various sizes that run from the Houghton Canal to the RWTF basins shown in **Figure 6-3**. The surface area for each basin floor was calculated and is presented in **Table 2-2**.

Table 6-1 Recharge Basins for Houghton Canal

Basin	Acres
10	15.0
11	22.0
38-39	31.0
40-41	30.0
42-43-44	43.0
Total	141.0

Surface water from the FID Houghton Canal would supply the basins for recharge. During wet and typical years, when excess water is available, a maximum flow rate of 71 cfs can be diverted from Houghton Canal. The maximum flow rate is dictated by the 141 acres available for recharge (i.e., the ponds are not currently being used for treatment water) and the assumed maximum infiltration rate of 1 foot per day. It is expected that as the soil profile saturates the infiltration rate will decrease by 1/3 ft/day after 2 months, and an additional 1/3 ft/day after 4 months, until it reaches the estimated saturated infiltration rate of 1/3 ft/day as shown in **Table 6-2**.

Flow records were used to represent flows that may be expected during wet and typical hydrologic years for Houghton Canal. Based on the information of available flows from FID, recharge was figured for the seven months of a typical irrigation season (March through September), as this is the time when the canals are likely charged and when excess water may be available. With the connection to FID, any type of water available to FID could potentially be recharged in the project including Friant Division CVP or Kings River Water. Through exchanges, SJRRP flows or Westside CVP water could also be used. The preferred water supplies for the project for economic reasons are Kings River floodwater, Section 215 water, and/or local stormwater.

Table 6-2 Flow Rates Based on Assumed Infiltration Rates when Maximum Flows Available

Month	Infiltration Rate (ft/day)	Max Flow (cfs) Basin 10	Max Flow (cfs) Basin 11	Max Flow (cfs) Basin 38-39	Max Flow (cfs) Basin 40-41	Max Flow (cfs) Basin 42-44	Max Total Flow (cfs)	Volume Applied per day (AF)
March	1	7.6	11.1	15.6	15.1	21.7	71.1	141.0
April	1	7.6	11.1	15.6	15.1	21.7	71.1	141.0
May	2/3	5.0	7.4	10.4	10.1	14.5	47.4	94.0
June	2/3	5.0	7.4	10.4	10.1	14.5	47.4	94.0
July	1/3	2.5	3.7	5.2	5.0	7.2	23.6	47.0
August	1/3	2.5	3.7	5.2	5.0	7.2	23.6	47.0
September	1/3	2.5	3.7	5.2	5.0	7.2	23.6	47.0
							Total	**611.0**

The existing facilities include the basins available for recharge at the RWTF, existing pipelines from the RWTF to Houghton Canal and FID's Houghton Canal. An existing 54-inch pipeline from Houghton Canal runs along the Bryan Avenue alignment for approximately 2.5 miles then enters the RWTF where it begins to reduce to the various pipe sizes shown in **Figure 6-3**. The existing canal network at the RWTF will be utilized to divert surface water for basins 38-44. The existing pipelines that will be utilized currently divert reclaimed water from the RWTF to the Houghton Canal. The assumption is made that recharge at the RWTF would not occur when the reclaimed pumps are operating.

The facilities required for the Houghton Project include a new turnout and lift station to divert up to a maximum flow rate of 71 cfs. Two lift pumps will be required, each sized for 36 cfs. A variable-frequency drive (VFD) will be proposed at the lift station to regulate the flow from Houghton Canal. Both pumps will discharge into a manifold and connect to the existing 54-inch diameter concrete pipeline shown in **Figure 6-4**.

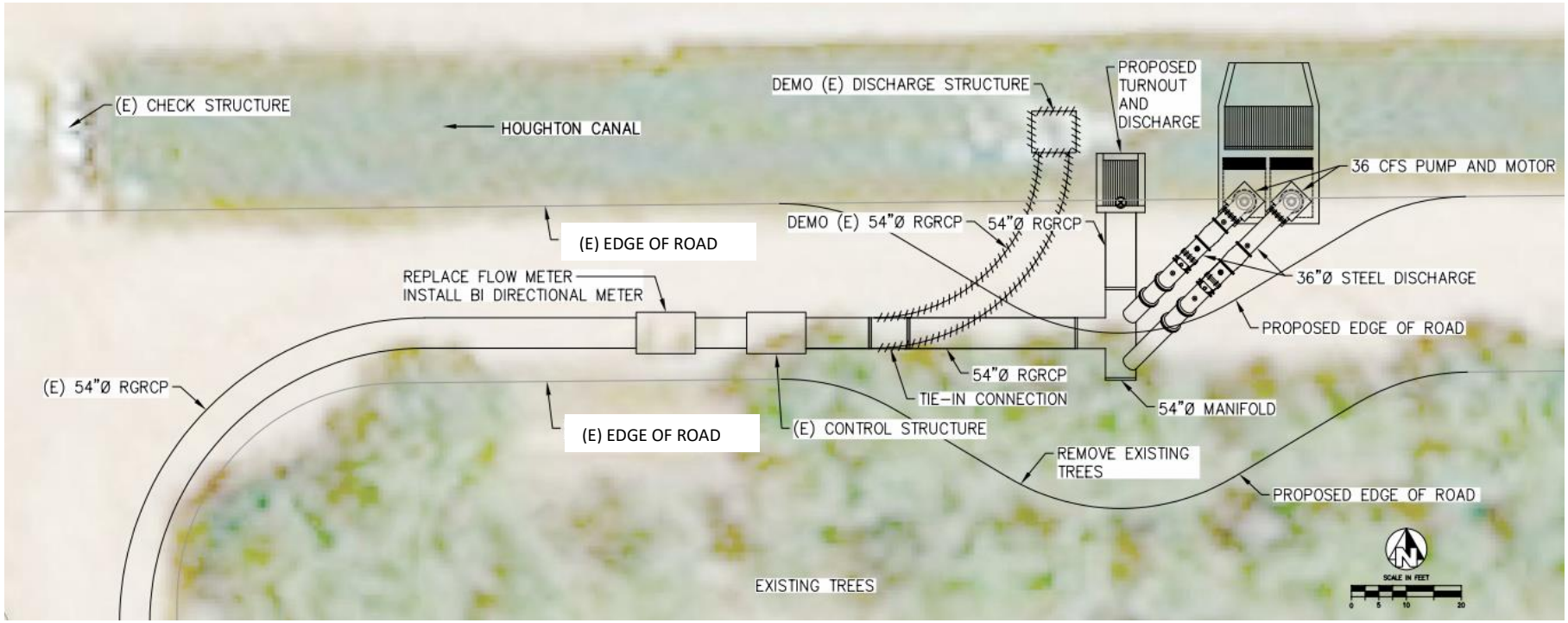


Figure 6-4 Houghton Canal Lift Station (Conceptual)

When the flow rate demand decreases below 25 cfs, bypassing the lift station and gravity feeding to the basins becomes an option. A separate turnout near the proposed lift station will be tied into the discharge manifold below ground shown in **Figure 6-4**. A canal gate for the turnout structure bypass will stay closed when the system is utilizing the lift pumps and open when gravity feeding to the basins. The proposed turnout will also serve as the discharge from the RWTF and the existing discharge structure will be demolished and removed. The existing flow meter structure will be utilized, and a new bi-directional meter will be installed as shown in **Figure 6-4**. The flow meter will have the ability to measure flows from the canal turnout, the proposed lift station and the reclaimed pumps when operating at the RWTF.

The existing infrastructure at the RWTF is currently limited to 44 cfs, which is the max flow rate that can be discharged from the existing turnouts. To meet the 71 cfs requirement for the system, modifications to the existing infrastructure will be required. The system flow path can be analyzed into two sections with basins 38-44 requiring 52 cfs and basins 10 and 11 needing 19 cfs. To reduce maintenance and operation costs, the existing turnouts will not be utilized for basins 38-44 as they are inadequate to satisfy the 52 cfs condition during peak infiltration. Instead, a proposed 42-inch turnout will tie into the existing 48-inch pipeline near Well 11A to divert 52 cfs into High Ditch Canal where it can be distributed into basins 38-44 as shown in **Figure 6-5.**

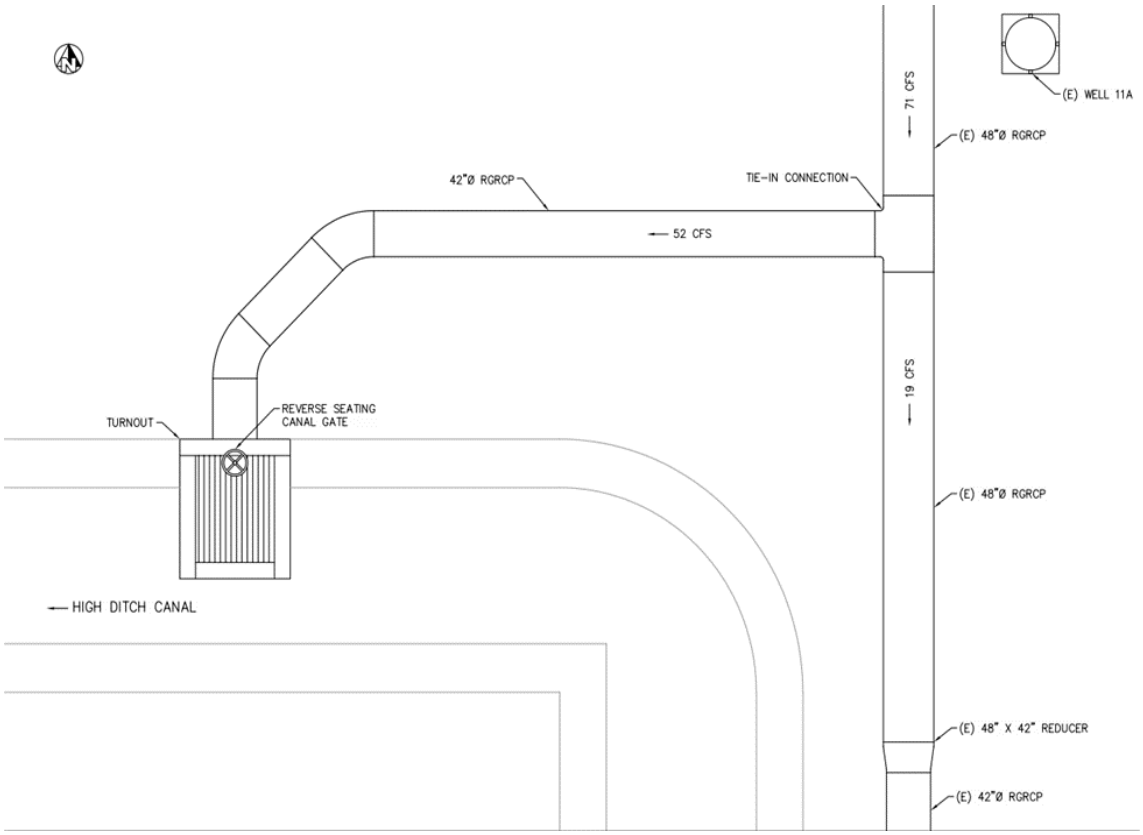


Figure 6-5 RWTF Turnout for Basins 38-44

The remainder 19 cfs will be distributed to basins 10 and 11 through piping associated with extraction Wells 7 and 19 that has bypass piping to discharge into the basins. Wells 7 and 19 can currently discharge into basins 10 and 11 but are undersized to meet the 19 cfs demand. To meet the 19 cfs demand, modifications to the discharge piping of existing Wells 7 and 19 will be required. Upsizing the existing discharges for Well 7 to 21-inch and Well 19 to 18-inch will satisfy the 19 cfs demand shown in **Figure 6-5.**

6.2.1.2 Measurable Objectives

This project will address declining water levels and the declining volume of groundwater stored in the aquifer. The main objective of the project is to deliver an average of roughly 6,700 acre-feet of water per year to the infiltration basins at the RWTF from the Houghton Canal during typical and wet years. Surface water that is delivered to the project site will be measured regularly. The water level of existing groundwater wells in the area will be measured and monitored and samples for typical agricultural irrigation suitability water quality testing will be collected periodically. This data will be used to establish current groundwater levels, quality for baseline comparison in order to determine if there are changes occurring from project operation, and quantification of overdraft mitigation.

6.2.1.3 Project Benefits and Water Reliability

For the months of March through September, the estimated capacity at the RWTF for Houghton Canal is 18,330 AF, based on the various water supplies that FID has indicated may be available. The capacity available for recharge was dictated by the area of the basins and the assumed infiltration rates. The maximum and typical volumes available for Houghton Canal were calculated by comparing the maximum flow to the canal's capacity during wet and typical years. During wet hydrologic years, the recharge capacity of the basins is the limiting factor. The estimated maximum recharge volume can be expected to be 18,330 AF. During typical years, less water may be available, and the total recharge is limited by the water that is potentially available. The estimated minimum recharge volume can be expected to be about 14,700 AF in a typical year. **Table 6-3** summarizes the capacity allowable at the RWTF compared to the maximum and typical volumes available from Houghton Canal for March through September.

Table 6-3 Summary of Maximum and Typical Recharge Volume

Month	Estimated Total Basin Recharge Capacity (AF)	Maximum Monthly Volume Available (AF)	Typical Monthly Volume Available (AF)	Maximum Recharge Volume (AF)	Typical Recharge Volume (AF)
March	4,230	14,203	4,939	4,230	4,230
April	4,230	7,859	2,142	4,230	2,142
May	2,820	7,455	2,559	2,820	2,559
June	2,820	5,682	2,380	2,820	2,380
July	1,410	4,706	595	1,410	595
August	1,410	9,182	4,165	1,410	1,410
September	1,410	12,558	6,010	1,410	1,410
			Total	**18,330**	**14,726**

Wet and typical years have historically occurred 49 times over the past 123 years (1895-2017) which is approximately 40 percent of the time. Of the 49 years, 30 of those years were classified as wet, and 19 were classified as typical. This shows that since 1895, water for this project would have been available about every 2 years out of every 5 years. Over a 30-year period, it can be anticipated that 12 of those years will be wet or typical, averaging 16,900 AF that can be recharged (18,330 AF x 30 years + 14,726 AF x 19 years = 829,694 AF / 49 years = 16,932 AF). During years of dry precipitation, excess water will not be available for recharge during the irrigation season. Therefore, on an average annual basis it is estimated that 6,770 AF per year could be recharged (12 years out of 30 will be wet or typical; 16,932 AF x 12 years = 203,190 AF / 30 years = 6,773 AF per year). As discussed earlier, the water supply available was during the irrigation season (March through September). Therefore, the average annual capacity for recharge will likely be when floodwater is available in the early part of the calendar year. This duration is longer than historical flood water from the Kings River or CVP since FID also has local stormwater supplies that are captured and can be put to beneficial use.

6.2.1.4 Management of Groundwater Extractions and Recharge

The project would be owned and managed by the City and an agreement with FID and MAGSA will be needed. Performance of the project would be a necessary part of MAGSA's reporting requirements as well as

evaluations of measurable objectives. This project will recharge groundwater in the wet season to help offset pumping during the summer and during droughts. In the event of a drought or in the occasion that the recharge rate is not enough to mitigate overdraft to the measurable objective, management actions will be taken, which are described in further detail in **Section 6.3** and following. The severity of the situation will dictate the actions taken. Priority will be given to actions that can be implemented in a relatively short amount of time and have a high benefit to cost ratio.

6.2.1.5 Project Cost Estimate/Acre-Foot of Yield

Table 6-4 shows probable construction costs based on similar projects for the conceptual level of design. The total cost of the project is estimated at about $3.5 million. Assuming a 5% interest rate loan, annualized over a 30-year period, the annual repayment cost is expected to be $230,000 (**Table 6-5**). The material required to complete this project is expected to last 30 years or more. The portion of the water cost due to capital expenditures, on an average annual basis, is expected to be about $41 per acre-foot for a yield of 6,745 acre-feet. Costs will be further developed once the project proceeds to a more detailed level of design. Based on this project being at a conceptual level, a 30% contingency was presumed. The costs do not include the cost to purchase the water. MAGSA will fund the project. Grant funding will be pursued and used to offset project costs if available.

Table 6-4 Summary of Probable Construction Cost for Houghton Canal

Item	Description	Amount
Field Cost	Canal Structure, Pump Station, Pipeline to RWTF	$1,781,000
General Conditions	Mobilization/Demobilization, Bonds and Insurance, Construction Permits, Protect and Replace Existing Facilities and Change Order Contingency	$ 250,000
Right of Way Acquisitions	None required for this project	$ -
Non-Contract Costs	Design Data, Data Collection, Design, Permitting & Construction Management	$ 690,000
Contingency	30% based on conceptual design	$ 816,000
	Total Capital Cost	$3,537,000

Notes:
1. 2018 costs.

Table 6-5 Summary of Cost per AF for Houghton Canal

Fresno City WWTP Recharge Basins FID Houghton Canal System			
Total Capital Cost	Capital Repayment	Annual Yield AF	Cost Per AF
$3,537,000	$230,000	6,745	$41

Notes:

1. Maintenance costs are assumed to be $12,000 per year.
2. Operation costs are estimated at $5.50/AF to operate the lift pumps.
3. Assumes 5% interest rate loan annualized over a 30-year period.
4. Assumes pumps will last 30 years.
5. Operation cost are not associated with Houghton Canal at 23.7 cfs (Months July-September) due to the assumption that 25 cfs can be gravity-fed to the basins.
6. Survey data will be required to confirm that 25 cfs can be gravity-fed to the basins.

It should be noted that no capital costs were included for the existing facilities proposed to be used, as they are unknown. It is possible that the City could require a fee to use their facilities.

6.2.1.6 Circumstances of Implementation

This project would be implemented by the City after MAGSA and the City reach an agreement as an integral piece of MAGSA's overall effort to reach sustainability, and accordingly no additional circumstances or triggers are considered necessary to its implementation other than availability of funding. It has been listed as a high priority project based on reliability of water source, cost effectiveness, assurance of water rights, and other relevant factors, as discussed in **Section 6.2.16**.

6.2.1.7 Project Status and Schedule

No project schedule has been determined, but a feasibility study was completed for the City for this project in March of 2018 (Provost & Pritchard, 2018). Because of this study, more detail is provided on this project compared to some projects discussed herein. Once a source of project funding is secured, a comprehensive schedule including environmental review, design, permitting and construction will be developed. Environmental review, permitting, and project agreements could be completed in 9 to 12 months, and design and construction could be completed on a similar timeline. It is anticipated that MAGSA will start working to secure funding within the first five years of GSP implementation.

6.2.1.8 Permitting and Regulatory Process

For MAGSA to use the site, an agreement or memorandum of understanding would be needed with FID and the City. It is anticipated that approvals from the following processes and organizations will be required:

- *California Environmental Quality Act (CEQA)* – compliance with CEQA for project approval
- *Pacific Gas & Electric Company (PG&E), Application for Service* – for new electrical connection to serve proposed booster pump
- *Fresno City, Building Permit* – for construction of project portions on City RWTF property
- *Fresno County, Building Permit* – for new electrical service for the proposed booster pump
- *Water Supply Organization Approvals: City of Fresno and Fresno Irrigation District* – for water supply purchase, construction and operations in FID right-of-way; North Kings GSA/MAGSA intra-basin groundwater credit agreement

An agreement from FID for constructing the turnout structure on the Houghton Canal will be required and it is anticipated that the project is to be completed outside of the irrigation season. An agreement with the City would be needed to work on and recharge surface water on the RWTF property.

In addition, the site is within the North Kings GSA, just outside of MAGSA. Therefore, a yet to be determined process for potential intra-basin groundwater credits would be needed. It is possible that the process developed would not end up with a 1:1 ratio of recharge to credit.

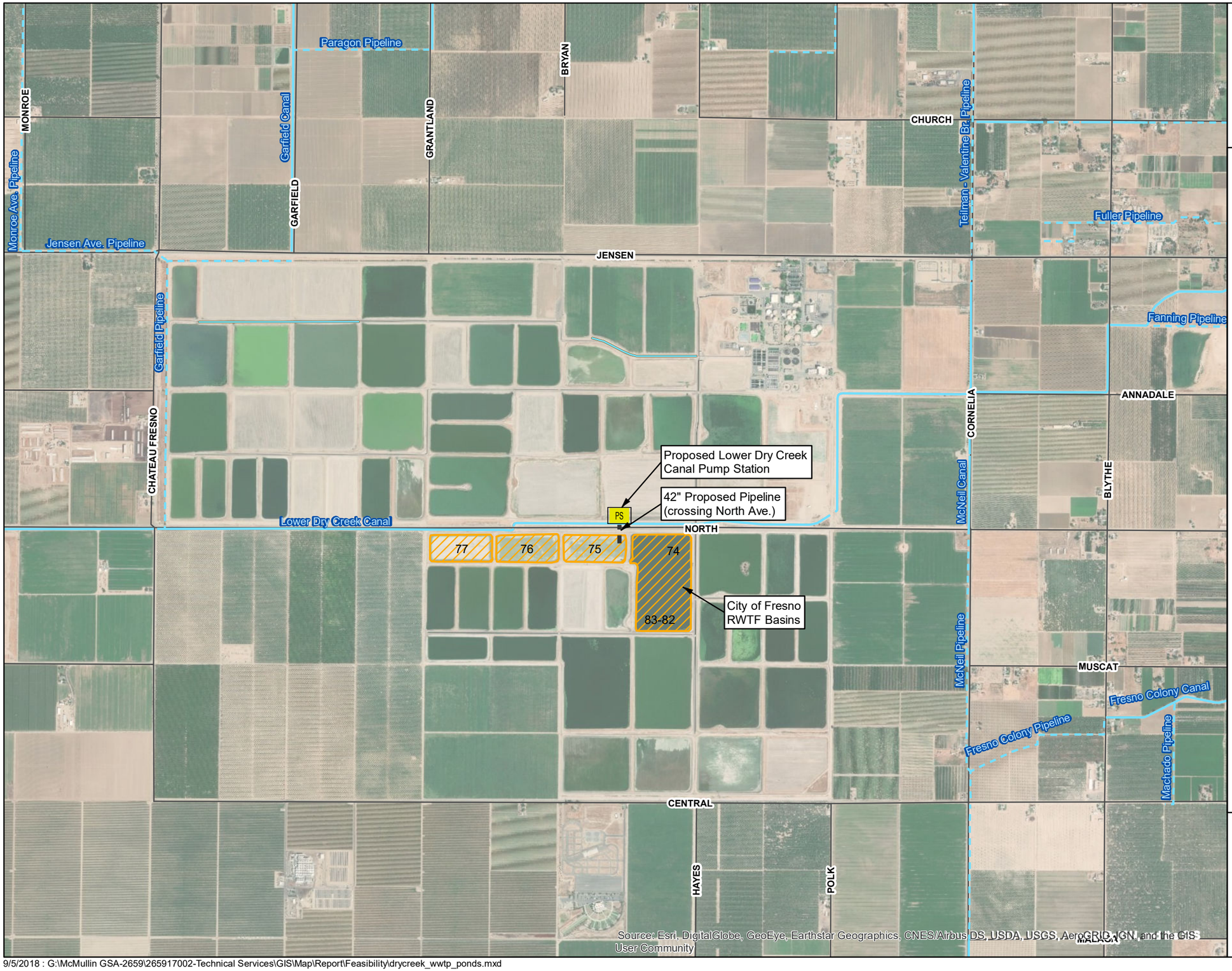
6.2.1.9 Legal Authority

The City would own the project site and, pending an agreement with MAGSA and receipt of the necessary permits and approvals, has the legal authority to construct the required facilities within the RWTF.

6.2.2 Fresno City Wastewater Treatment Plant Recharge Basin, FID Lower Dry Creek System

6.2.2.1 Project Description

FID and the City are interested in working collectively to recharge surface water, when available, at the City's RWTF. The project is located within the North Kings GSA, just outside of MAGSA, allowing for a potential groundwater credit to benefit MAGSA by an intra-basin groundwater transfer agreement between GSAs. The methodology to transfer groundwater between GSAs is yet to be developed through the Kings Basin coordinated GSA efforts. The project involves a diversion from Lower Dry Creek Canal to the proposed recharge basins, at the RWTF, shown in **Figure 6-6**. A lift station will be required to divert a maximum flowrate of 45 cfs from Lower Dry Creek Canal during wet and typical years when excess water is available.



McMullin Area GSA

Fresno City Wastewater Treatment
Plant Recharge Basins
FID Lower Dry Creek Canal Facilities

Figure 6-6

- PS — Proposed Pump Stations
- Canal
- Pipeline
- Dry Creek Pipeline-Proposed
- Basins
- Road

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The project location is in between Chateau Fresno Avenue and Cornelia Avenue, along North Avenue at the RWTF. The project will utilize the RWTF basins south of North Avenue shown in **Figure 6-6**. The surface area for each basin floor was calculated and is presented in **Table 6-6**

Table 6-6 Recharge Basins for Lower Dry Creek Canal

Basin	Acres
77	14.3
76	14.7
75	14.4
74,83,82	46.3
Total	**89.7**

Surface water from Lower Dry Creek Canal would supply the basins for recharge. During wet and typical years, when water is available, a maximum flow rate of 45 cfs can be diverted from Lower Dry Creek Canal. The maximum flow rate was dictated by the 89.7 acres available for recharge (i.e., the ponds are not currently being used for treatment water) and the assumed max infiltration rate of 1 foot per day. It is expected that as the soil profile saturates the infiltration rate will decrease by 1/3 ft/day after 2 months until it reaches the estimated saturated infiltration rate of 1/3 ft/day shown in **Table 6-7**.

FID records were used to represent flows that may be expected during wet and typical hydrologic years for the Lower Dry Creek Canal. Recharge was calculated for the seven months of a typical irrigation season (March through September), as this is the time when the canals are likely charged and when excess water may be available. With the connection to FID, any type of water available to FID could potentially be recharged in the project including Friant Divisions, CVP, Kings River Water, or other water available through exchange. The water supply for the project will most likely be high flows from the Kings River or Section 215 water.

Table 6-7 Flow Rates Based on Assumed Infiltration Rates when Maximum Flows Available

Month	Infiltration Rate (ft/day)	Max Flow (cfs) Basin 77	Max Flow (cfs) Basin 76	Max Flow (cfs) Basin 75	Max Flow (cfs) Basin 74,83,82	Max Total Flow (cfs)	Volume Applied per day (AF)
March	1	7.2	7.4	7.3	23.3	45.2	89.7
April	1	7.2	7.4	7.3	23.3	45.2	89.7
May	2/3	4.8	4.9	4.8	15.6	30.1	59.8
June	2/3	4.8	4.9	4.8	15.6	30.1	59.8
July	1/3	2.4	2.5	2.4	7.8	15.1	29.9
August	1/3	2.4	2.5	2.4	7.8	15.1	29.9
September	1/3	2.4	2.5	2.4	7.8	15.1	29.9
						Total	388.7

Existing facilities include the basins available for recharge at the RWTF and FID's Lower Dry Creek Canal. The facilities required for the Lower Dry Creek Project include a new turnout and lift station to divert up to a maximum flow rate of 45 cfs, as shown in **Figure 6-7**. Two lift pumps will be utilized for the lift station. The first lift pump will be sized for 30 cfs while the second lift pump will be sized at 15 cfs. A VFD will be necessary at the lift station to regulate the flow from Lower Dry Creek Canal. A flow meter structure, downstream of the lift station, will be installed to measure the amount of water diverted for recharge. Approximately 300 feet of new 42-inch reinforced concrete pipe will be installed, crossing North Ave., to reach the recharge basins.

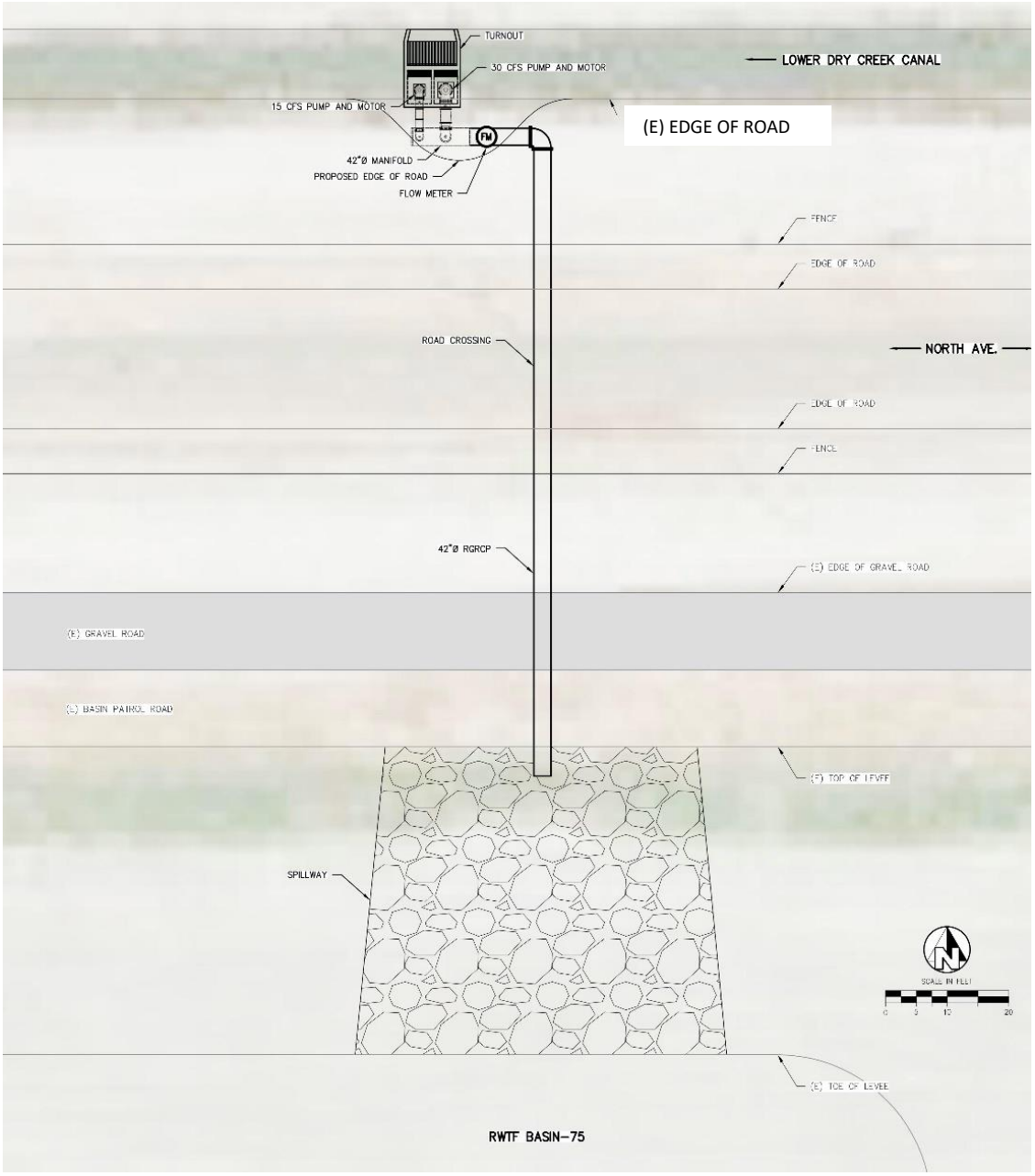


Figure 6-7 Lower Dry Creek Canal Lift Station (Conceptual)

6.2.2.2 Measurable Objectives

This project will address declining water levels and the declining volume of groundwater stored in the aquifer. The main objective of the project is to deliver an average of roughly 4,400 acre-feet of water per year to the infiltration basins at the RWTF from the Lower Dry Creek Canal during typical and wet years. Surface water that is delivered to the project site will be measured regularly. The water level of existing groundwater wells in the area will be measured and monitored and samples for typical agricultural irrigation suitability water quality testing will be collected periodically. This data will be used to establish current groundwater levels, quality for baseline comparison in order to determine if there are changes occurring from project operation, and quantification of overdraft mitigation.

6.2.2.3 Project Benefits and Water Reliability

For the months March through September, the estimated capacity at the RWTF for Lower Dry Creek Canal is about 11,660 AF, based on the various water supplies that may be available. The capacity available for recharge was dictated by the area of the basins and the assumed infiltration rates. The maximum and typical volumes available for Lower Dry Creek Canal were calculated by comparing the maximum flow to the canal's capacity during wet and typical years. During wet hydrologic years, the recharge capacity of the basins is the limiting factor. The estimated maximum recharge volume can be expected to be approximately 11,660 AF. During typical years, less water may be available, and the total recharge is limited by the water that is potentially available. The estimated minimum recharge volume can be expected to be about 9,970 AF in a typical year. **Table 6-8** summarizes the capacity allowable at the RWTF compared to the maximum and typical volumes available from Lower Dry Creek Canal for March through September.

Table 6-8 Summary of Maximum and Typical Recharge Volume

Month	Estimated Total Basin Recharge Capacity (AF)	Maximum Monthly Volume Available (AF)	Typical Monthly Volume Available (AF)	Maximum Recharge Volume (AF)	Typical Recharge Volume (AF)
March	2,691	8,836	3,630	2,691	2,691
April	2,691	5,904	2,261	2,691	2,261
May	1,794	5,654	3,094	1,794	1,794
June	1,794	4,090	2,618	1,794	1,794
July	897	3,410	536	897	536
August	897	4,932	0	897	0
September	897	7,476	5,058	897	897
			Total	**11,661**	**9,973**

Wet and typical years have historically occurred 49 times over the past 123 years (1895-2017) which is approximately 40 percent of the time. Of the 49 years, 30 of those years were classified as wet, and 19 were classified as typical. This shows that since 1895, water would have been available about every 2 years out of every 5 years. Over a 30-year period, it can be anticipated 12 of those years will be wet or typical, averaging 11,000 AF that can be recharged. During years of normal or dry precipitation, excess water will not be available for recharge during the irrigation season. Therefore, on an average annual basis it is estimated that 4,400 AF per year could be recharged.

By capturing excess surface flow for infiltration, groundwater reservoirs can be replenished. A benefit of recharge is that it establishes a more reliable water source that is available year-round. Additionally, if water levels are maintained, the need for drilling deeper wells to reach water tables is mitigated, and if levels rise, the cost of energy for pumping decreases as well. Benefits can be monitored by analyzing groundwater levels and pumping costs over time.

6.2.2.4 Management of Groundwater Extractions and Recharge

The project would be owned and managed by the City and an agreement with FID and MAGSA will be needed. Performance of the project would be a necessary part of MAGSA's reporting requirements as well as evaluations of measurable objectives. This project will recharge groundwater in the wet season to help offset pumping during the summer and during droughts. In the event of a drought or in the occasion that the recharge rate is not enough to mitigate overdraft to the measurable objective, management actions will be taken, which are described in further detail in **Section 6.3** and following. The severity of the situation will dictate the actions taken. Priority will be given to actions that can be implemented in a relatively short amount of time and have a high benefit to cost ratio.

6.2.2.5 Project Cost Estimate/Acre-Foot of Yield

Table 6-9 shows probable project costs based on similar projects. The total cost of the project is estimated at about $2.2 million. Assuming a 5% interest rate loan, annualized over a 30-year period, the annual repayment cost is expected to be $145,000 (**Table 6-10**). The material required to complete this project is expected to last 30 years. The portion of the water cost due to capital expenditures, on an average annual basis, is expected to be about $41/AF for a yield of about 4,385 acre-feet. Costs will be further developed once the project concept has been approved and proceeds to a more detailed level of design. Based on this project being at a conceptual level, a 30% contingency was presumed. The costs do not include the cost to purchase the water. MAGSA will fund the project. Grant funding will be pursued and used to offset project costs if available.

Table 6-9 Summary of Probable Construction Costs for Lower Dry Creek

Item	Description	Amount
Field Costs	Pump Station, Pipeline to Regional Wastewater Treatment Facility	$1,117,000
General Conditions	Mobilization/Demobilization, Bonds and Insurance, Construction Permits, Protect and Replace Existing Facilities, and Change Order Contingency	$ 158,000
Right of Way Acquisitions	None Required for this project	$ -
Non-Contract Costs	Design Data, Data Collection, Design, Permitting & Construction Management	$ 435,000
Contingency	30% based on conceptual design	$ 513,000
	Total Capital Cost	$2,223,000

Notes:
1. 2018 costs.

Table 6-10 Summary of Cost per AF for Lower Dry Creek

Fresno City WWTP Recharge Basins FID Lower Dry Creek Canal System			
Total Capital Cost	Capital Repayment	Annual Yield AF	Cost Per AF
$2,223,000	$145,000	4,385	$41

Notes:
1. Assumes 5% interest rate loan annualized over a 30-year period.
2. Assumes pumps will last 30 years.
3. Operations costs are estimated at $5.50/AF to operate the lift pumps.
4. Maintenance costs are estimated to be $12,000 per year.
5. Water purchase costs will be an additional cost.

It should be noted that no capital costs were included for the existing facilities proposed to be used, as they are unknown. It is possible that the City could require a fee to use their facilities.

6.2.2.6 Circumstances of Implementation

After MAGSA and the City reach an agreement, this project would be implemented by the City as an integral piece of MAGSA's overall effort to reach sustainability, and accordingly no additional circumstances or triggers are considered necessary to its implementation other than availability of funding. It has been listed as a high priority project based on reliability of water source, cost effectiveness, assurance of water rights, and other relevant factors, as discussed in **Section 6.2.16**.

6.2.2.7 Project Status and Schedule

A feasibility study was completed for the City for this project in March of 2018 (Provost & Pritchard, 2018). Because of this study, more detail is provided on this project compared to some projects discussed herein. Once a source of project funding is secured, a comprehensive schedule including environmental review, design, permitting and construction will be developed. It is anticipated that this project will start working on securing funding within the first five years of GSP implementation. However, environmental review, permitting and project agreements could be completed in 9 to 12 months, and design and construction could be completed on a similar timeline.

6.2.2.8 Permitting and Regulatory Process

For MAGSA to use the site, an agreement or memorandum of understanding would be needed with FID and the City. It is anticipated that approvals from the following processes and organizations will be required:

- *California Environmental Quality Act (CEQA)* – compliance with CEQA for project approval
- *Pacific Gas & Electric Company (PG&E), Application for Service* – for new electrical connection to serve proposed booster pump
- *Fresno City Building Permit* – for construction of project portions on City RWTF property
- *Fresno County, Building Permit* – for new electrical service for the proposed booster pump
- *Water Supply Organization Approvals: City of Fresno and Fresno Irrigation District* – for water supply purchase, construction, and operations in FID right-of-way; North Kings GSA/MAGSA intra-basin groundwater credit agreement

An agreement with FID for constructing the turnout structure on the Lower Dry Creek Canal will be required and it is anticipated that the project is to be completed outside of the irrigation season. An agreement with the City would be needed to work on the RWTF property, along with an agreement with FID and the City to convey and purchase water.

In addition, the site is within the North Kings GSA, just outside of MAGSA. Therefore, a yet to be determined process for potential intra-basin groundwater credits would be needed. It is possible that the process developed would not end up with a 1:1 ratio of recharge to credit.

6.2.2.9 Legal Authority

The City would own the project site and, pending an agreement with MAGSA and receipt of the necessary permits and approvals, has the legal authority to construct the required facilities within the RWTF.

6.2.3 Southwest Groundwater Banking

6.2.3.1 Project Description

FID and project partner JID constructed a new 100-acre groundwater banking facility and increased the conveyance capacity along a portion of Lower Dry Creek (LDC) Canal and the Lower Dry Creek Extension (LDCE) Canal as shown in **Figure 6-8**. The project serves as a groundwater banking facility for runoff from local stormwater from the City of Fresno and for recharge of other supplies when available. The facility also allows FID to send water to JID with a connection from the Lower Dry Creek Canal Extension to the JID canal along McMullin Grade Canal. FID has historically recharged small amounts of water in the area north of Cell 1, but usually allows flows out of their system to be picked up by JID in their facilities. The most recent portion of the project was completed in April 2018 and allows for the capture of as much as 150 cfs in flows off of the FID facilities when available. However, there is still room for expansion.

This project is expected to help address groundwater overdraft in the area west of McMullin Grade and about six miles south of the City of Kerman by recharging with water supplies and stormwater available to FID.

The project will recharge an estimated average of 2,625 AF/year. Recharged water can be recovered using nearby existing wells. This project will provide a reliable water source during dry years while minimizing overdraft near the project area. The locally available surface water that will be diverted into the basin will be of better quality than that of the groundwater and is expected to improve groundwater quality in the project area. Present canal capacities are limited to 150 cfs upstream of the project site, however, the basin and planned increased capacity of Lower Dry Creek Canal will ultimately allow for up to 200 cfs of water to be diverted.

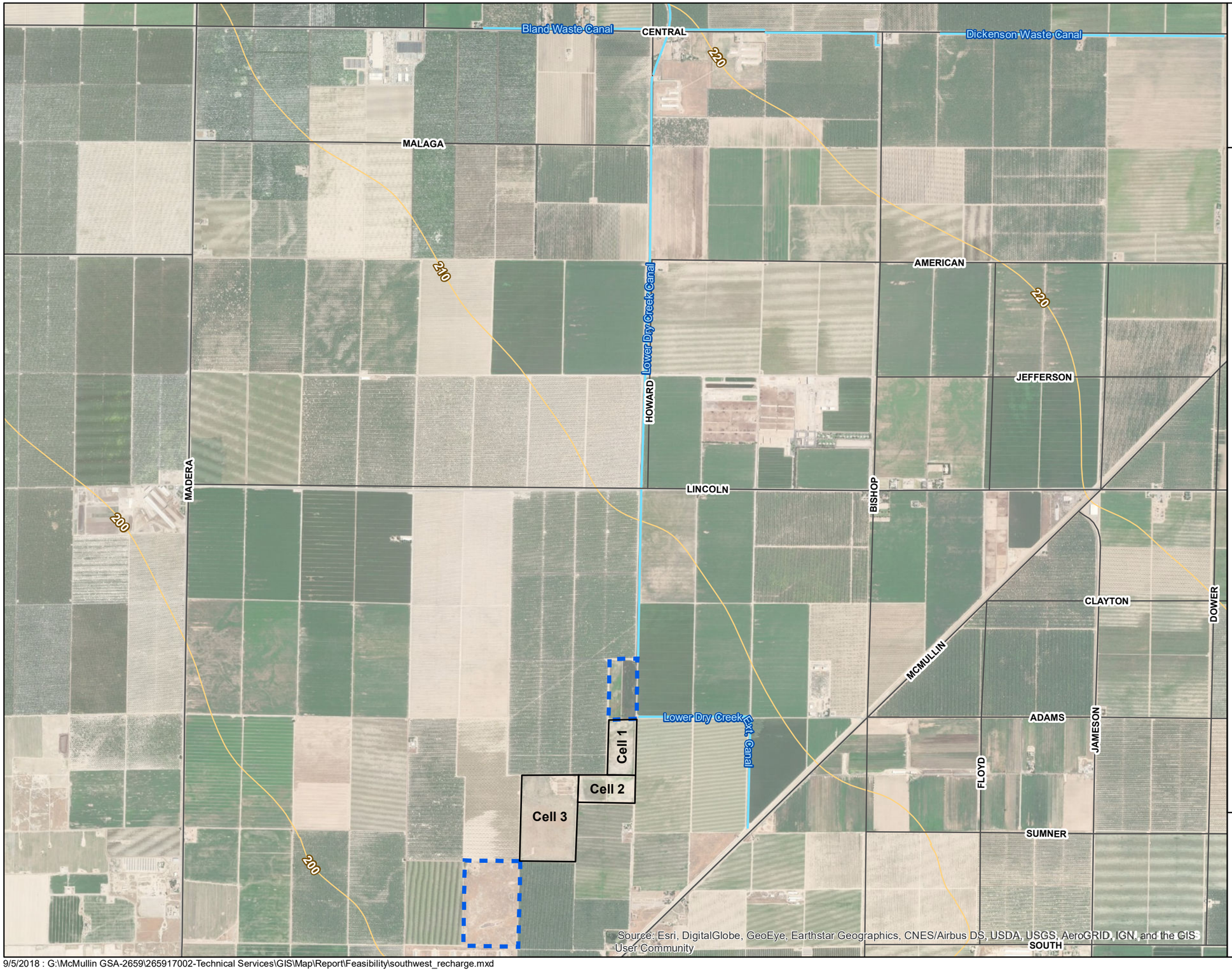
The project is located between McMullin Grade and Lincoln Avenue and between Highway 145 and Jameson Avenue. The site has access from McMullin Grade along LDCE Canal connecting the Project and James Irrigation District's McMullin Grade canal or along LDC Canal from Lincoln Avenue. Cell 1 and Cell 2 total 40 acres and are owned by FID and Cell 3 is 60 acres owned by JID as shown on **Figure 6-8**.

MAGSA could potentially coordinate with FID and JID on expansion of the facilities or use the existing facilities to obtain surface water for recharge for the benefit of MAGSA. This project could alternatively be purchased by MAGSA from FID and JID. MAGSA could then expand the project by designing and constructing new facilities to move the surface water into the GSA.

The baseline information necessary to develop the conceptual design was collected using the SAGBI Map developed by UC Davis. These values need to be confirmed by field investigation for further project development. **Figure 6-9** shows a map with SAGBI values to show the recharge potential of the possible expansion of the project, with green determined to have greatest potential for recharge for the surface soils (typically 6 to 8 feet in depth). The proposed expansion area to the north of the existing project has a SAGBI – Modified rating of moderately good while the expansion area to the southwest of the project has a rating ranging from moderately good to poor.

McMullin Area GSA

Southwest Groundwater
Banking Project
Figure 6-8



FID Canal
Road
USGS Ground Elevation Contour (ft, NAVD88)
Existing Recharge Areas
Potential Recharge Areas/Open Ground

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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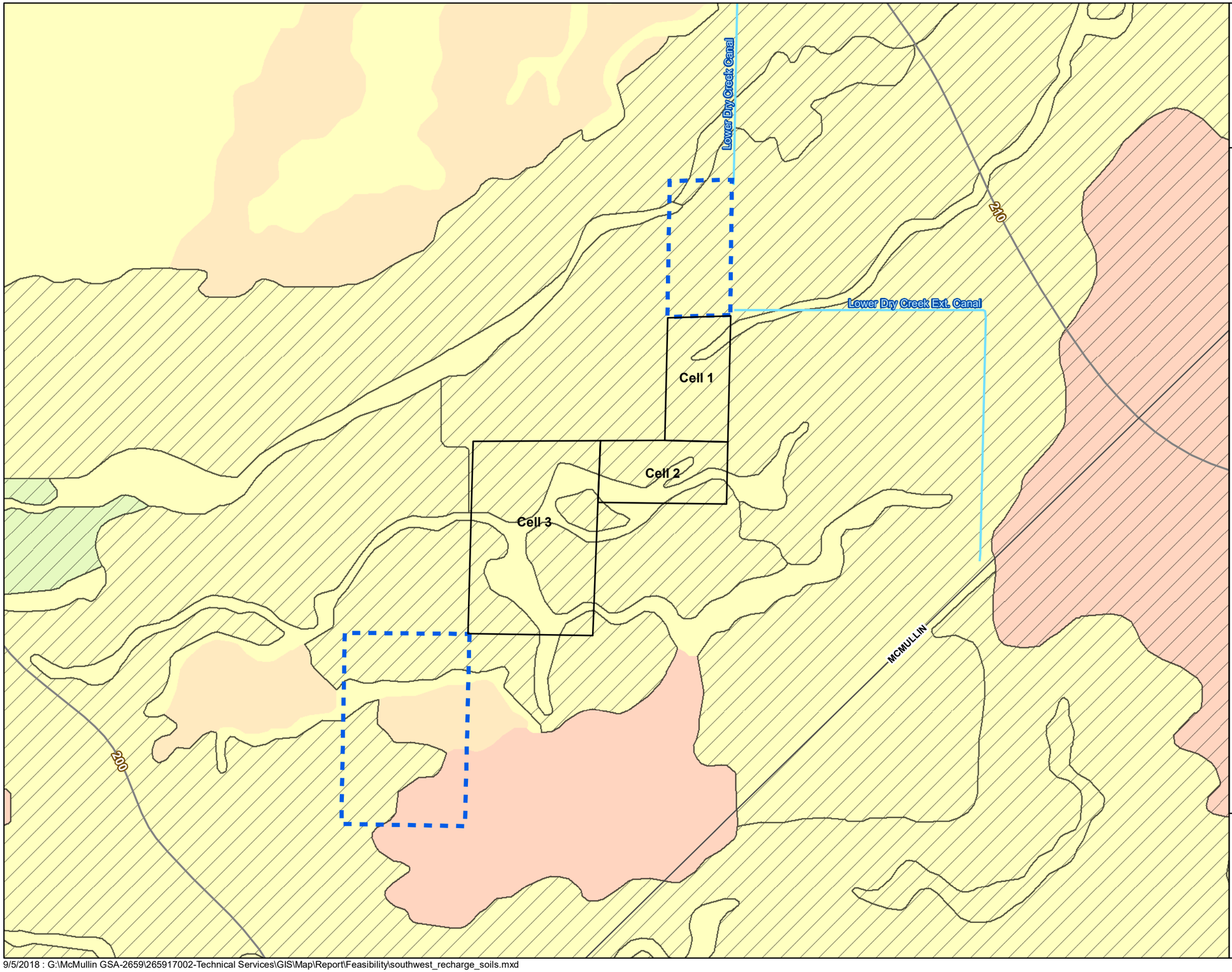
McMullin Area GSA

SAGBI Rating Soils

Southwest Groundwater Banking Project

Figure 6-9



- FID Canal
- Road
- USGS Ground Elevation Contour (ft, NAVD88)
- Existing Recharge Areas
- Potential Recharge Areas/Open Ground
- Restrictive Layer (Duripan or Abrupt Textural Change)

Soil Agricultural Groundwater Banking Index

SAGBI Rating - Modified

- 0 -15 Very Poor
- 15 - 29 Poor
- 29 - 49 Moderately Poor
- 49 - 69 Moderately Good
- 69 - 85 Good
- 85 - 100 Excellent

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The source of water for the project is FID's LDC Canal. The canals upstream of the site have a current capacity of approximately 150 cfs, though the turnout capacity to the project is sized for 200 cfs for the recharge facilities. Surface water enters the basins at the end of LDC and the head of the LDCE. FID has flood easement rights in the project area, including the surrounding 1,600 acres, but most are in permanent crops and flooding of these areas has not been occurring. The flood easement areas were initially obtained as an area for FID to send stormwater that enters City of Fresno from the foothills. FID also has an agreement with JID for JID to accept a certain amount of stormwater from FID in the area. The main water supply for the project will be runoff from the Kings River or local stormwater.

The average annual recharge for the basin floor area of 75 acres (of the 100-acre recharge facilities) was originally estimated to be 5,250 AF/year on average, provided the infiltration rate was 0.5 feet/day for the 140-day duration as was assumed in the feasibility study prepared in 2013 (Provost & Pritchard, 2013). However, in operations conducted in April 2018, the infiltration was determined to be less than estimated at about 0.40 feet/day over 28 days, and therefore the yield on a long-term basis is likely to be even less. Based on this operational data, the average annual recharge for this project will be estimated at a lower rate of 0.25 feet per day, or 2,625 AF/year.

By increasing the capacity of the Lower Dry Creek south of the proposed basins to the McMullin Grade Canal to 100 cfs, some of this floodwater could be conveyed to existing JID recharge facilities or be used as in-lieu recharge. JID currently uses Kings River floodwater supplies as its recharge water source. This project allows floodwater from other sources to be recharged at JID facilities when Kings River floodwater is not available, typically during the months of March through September. The additional average simulated recharge potential that this project could pass through to others was estimated to be approximately 1,300 AF/year. This could be used by JID or MAGSA depending on the agreement with FID.

6.2.3.2 Measurable Objectives

This project will address declining groundwater levels and the declining volume of groundwater stored in the aquifer. According to the estimates described above, the potential recharge for all the basins averages approximately 2,625 AF/year.

6.2.3.3 Project Benefits and Water Reliability

The project area is dominated by a large pumping depression due to agriculture solely dependent upon groundwater for irrigation, which can help to reduce continued overdraft in the area. It is likely that the long-term infiltration rate will be lower than the April 2018 recharge, which had an infiltration rate of about 0.4 feet per day over 28 days. Therefore, the project yield was estimated based on a conservative amended rate of 0.25 feet per day for the annual period of water availability of 140-days identified in the feasibility study (Provost & Pritchard, 2013), or 2,625 AF/year. This recharged water will help to raise groundwater levels, lower pumping costs, and provide a dry year water supply. The project has the capacity to divert up to 150 cfs of floodwater and provide 270 AF of storage capacity. This will reduce water levels and peak flows on the Kings River during flood periods, and thereby reduce flood damage as well. The removal of about 100 acres of permanent crops for the constructed dedicated recharge facilities will also reduce pumping by about 300 AF annually (assuming 3 AF/acre was the typical pumping).

6.2.3.4 Management of Groundwater Extractions and Recharge

The project is owned and managed by FID and JID. New agreements would need to be developed for MAGSA to participate in the project with FID and JID. If these agreements could be developed, performance of the project would be a necessary part of MAGSA's reporting requirements as well as evaluations of measurable objectives, and FID, JID, and MAGSA would coordinate the operation of the project in a way that optimizes its capabilities as well as monitors its performance regarding groundwater levels. This project will recharge groundwater in the wet season to help offset pumping during the summer and during droughts. In the event of a drought or in the occasion that the recharge rate is not enough to

mitigate overdraft to the measurable objective, management actions affecting groundwater extractions will be taken, which are described in further detail in **Section 6.3** and following. The severity of the situation will dictate the actions taken. Priority will be given to actions that can be implemented in a relatively short amount of time and have a high benefit to cost ratio.

6.2.3.5 Project Cost Estimate/Acre-Foot of Yield

Table 6-11 shows actual construction costs for the 100-acre project. The total cost of the project was about $6.2 million. Assuming a 5% interest rate loan, annualized over a 30-year period, the annual repayment cost is expected to be $405,000 (**Table 6-12**). The materials used to complete this project are expected to last 30 years or more. The portion of the water cost due to capital expenditures, on an average annual basis, is expected to be about $154 per acre-foot for a yield of 2,625 acre-feet. The costs do not include the cost to purchase the water. If purchase of the project is negotiable, MAGSA would raise funds to purchase the project. Grant funding will be pursued and used to offset costs if available.

Table 6-11 Summary of Construction Costs for Southwest Banking Project

Item	Description	Amount
Field Costs	Basin Work & Structures, Channel Work & Structures and Monitoring Wells	$ 3,288,062
General Conditions	Mobilization/Demobilization, Bonds and Insurance, Construction Permits, Protect and Replace Existing Facilities, and Change Order Contingency	$ 310,000
Right of Way Acquisitions	Basin Land Acquisition-100 Acres	$ 1,400,000
Non-Contract Costs	Design Data, Data Collection, Design, Permitting, & Construction Management	$ 1,223,341
	Total Capital Cost	$ 6,221,403

Table 6-12 Summary of Cost per AF for Southwest Banking Project

Southwest Groundwater Banking Project			
Total Capital Cost	Capital Repayment	Annual Yield AF	Cost Per AF
$6,221,403	$405,000	2,625	$154

Notes:

1. *Assumes 5% interest rate loan annualized over a 30-year period.*
2. *No operations or maintenance costs are included.*
3. *Water purchase costs will be an additional cost.*

6.2.3.6 Circumstances of Implementation

This project would be implemented by MAGSA as an integral piece of the overall effort to reach sustainability. A crucial prerequisite of the project is the willingness of FID and JID to coordinate with MAGSA in either expansion and water purchase agreements, or purchase of the project. If FID and JID are willing to coordinate, there is no other circumstance required for implementation other than securing a source of funding. It has been listed as a high priority project based on reliability of water source, cost effectiveness, assurance of water rights, and other relevant factors, as discussed in **Section 6.2.16**.

6.2.3.7 Project Status and Schedule

Cells 1, 2, and 3 have already been built and are currently in use by FID and JID. MAGSA will need to contact one or both organizations to begin discussions on coordination and expansion of the project. If FID is willing to sell the project and water supply to MAGSA, no new construction is necessary. However, it is possible that they would prefer to coordinate in an expansion, in which case an environmental review, permitting, and project agreements could be completed in 9 to 12 months, and design and construction could

be completed on a similar timeline. It is anticipated that MAGSA will start working to secure funding within the first five years of GSP implementation.

6.2.3.8 Permitting and Regulatory Process

Since the project is already constructed, no permits or regulatory requirements will be required to operate the project, except the potential agreement negotiated for purchase of the facilities from FID/JID and any agreement for operations and purchase of water from FID.

If expansion were to occur, the necessary anticipated construction permits and regulatory requirements required include, but are not limited to, the following:

- *California Environmental Quality Act (CEQA)* – compliance with CEQA for project approval.
- *State Water Resources Control Board, Stormwater Pollution Prevention Plan (SWPPP)* - for construction that disturbs more than five acres.
- *Fresno County, Encroachment Permit* – for the crossing of County Road right-of-way.
- *San Joaquin Valley Air Pollution Control District (SJVAPCD)* – for preparation of a Dust Control Plan for construction with disturbs a surface area of five acres or more.
- *Mosquito Abatement* – for operation of an open body of water that could host vectors.
- *Water Supply Organization Approvals* – from FID and JID for use of their existing facilities and connection to the existing FID system. Also, agreements with any organization for purchase of water and wheeling of said water through FID.

In addition, the existing facilities are connected to canals owned and operated by FID and approvals and agreements would be needed to connect to the existing facilities, as well as establishing operational requirements to take water from FID and coordination for possible spills with JID.

6.2.3.9 Legal Authority

JID and FID already own the recharge facilities and FID owns the facilities with the ability to deliver surface water to the recharge facilities. MAGSA has the authority to work with FID and JID to purchase or develop an agreement to use the facilities and obtain a surface water supply.

6.2.4 Lassen Avenue Reverse Flow and Recharge

6.2.4.1 Project Description

This project would improve groundwater levels and mitigate critical overdrafting by redirecting flood flows or other flows that could be wheeled through JID off the Mendota Pool for on-farm or in-lieu groundwater recharge. JID shares the southwestern border with MAGSA and owns a siphon which crosses the James Bypass as well as the two groundwater-fed canals connected to it located within the boundaries of MAGSA. One of the canals, the JID Kerman Line, follows the Lassen Avenue alignment due north for about 3.9 miles to collect water from their well fields; however, the canal does not run during the non-irrigation season. The non-irrigation season often aligns with the time of year flood flows occur or when there is lower irrigation demand, therefore there is potential to use the canal to bring surface water into MAGSA by reverse flows from within JID for groundwater recharge or direct use.

To minimize the number of lift stations and costs, the recharge zone will be located as close as possible to the James Bypass. Due to the nature of moving water against the slope of the existing canal, four check structures and lift stations will be needed to obtain a flow of 25 cfs for about 2.4 miles north of the James Bypass to approximately the Parlier alignment, as seen in **Figure 6-10**. The locations of the lift stations were determined by canal capacity, slope of the canal, and the number of road crossings or head loss. Through an iterative

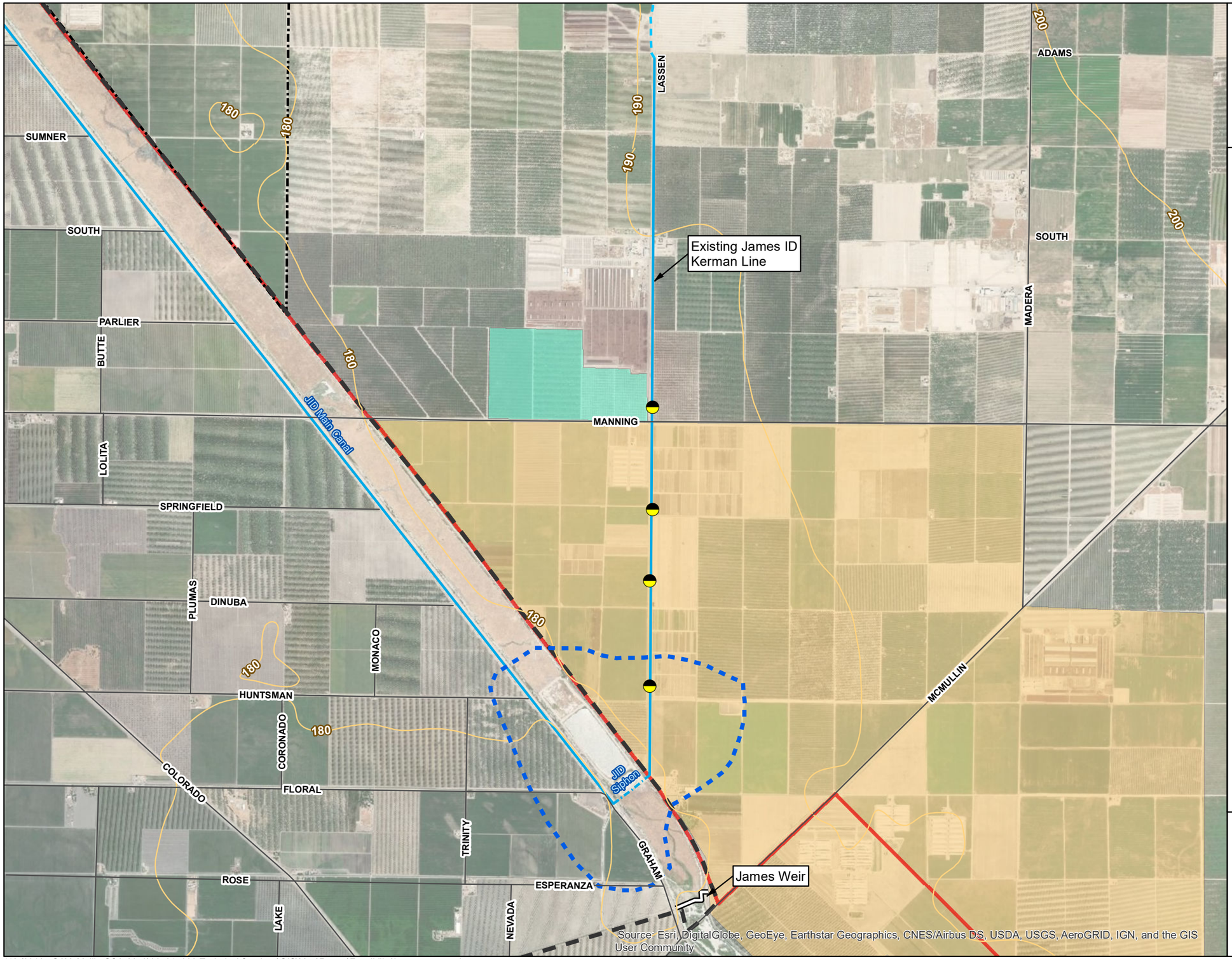
process, 25 cfs was selected as a flow rate near the upper end of available reverse flow capacity that will limit the pump size due to channel capacity and topography/slope.

JID initially proposed the project to bring surface water to the area of their wellfield, for a connection for MAGSA to the Mendota Pool and sources of water available there, and to work with MAGSA in solving groundwater overdraft in the Kings Basin. During normal JID operations, backwater from their Main Canal will travel about as far north as the South Avenue alignment, but not with sufficient depths for 25 cfs in flow nor for the submergence required for proper pumping plant operations.

McMullin Area GSA

Lassen Avenue Reverse Flow & Recharge

Figure 6-10



- Check Structure and Lift Station
- Canal
- Pipeline
- Potential Favorable Recharge Area For Dedicated Facilities
- On Farm Recharge
- Road
- USGS Ground Elevation (ft, NAVD88)
- McMullin On-Farm Recharge Phase 1
- Mid-Valley WD
- James ID
- McMullin Area GSA

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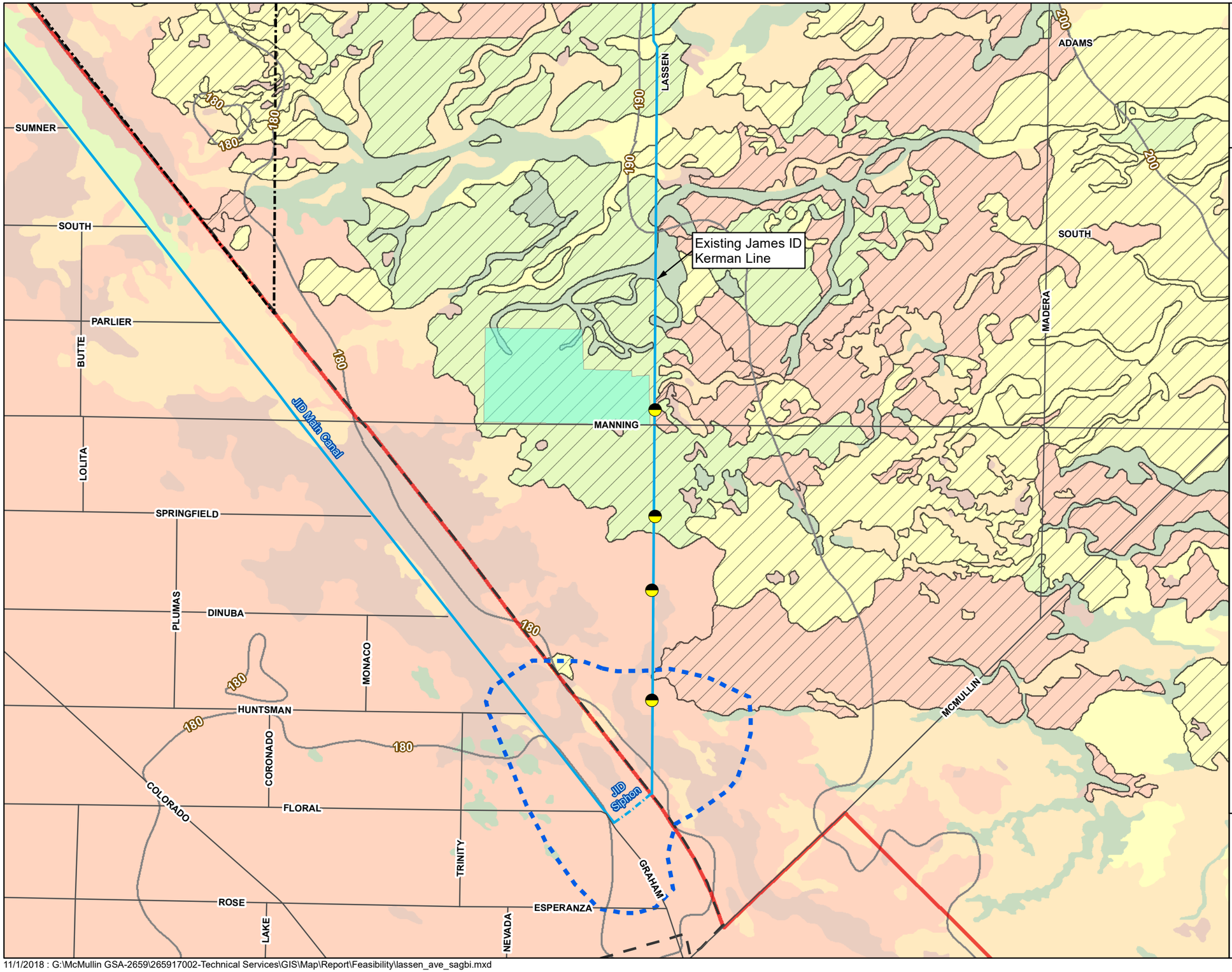
Based on consultant and landowner knowledge of the area, an area was identified that is initially thought to be favorable for recharge. This project has overlap with the McMullin On-Farm Flood Capture Project phase 1 area. However, this project has the potential to allow additional water supplies to be brought into the area in addition to the Kings River flows available to the McMullin On-Farm Flood Capture Project. The SAGBI map is an indicator for the potential of infiltration of the surrounding areas (**Figure 6-11**). It was developed by UC Davis as a tool to find areas that show the greatest potential for recharge based on surface soils (typically 6 to 8 feet in depth). Green indicates the greatest potential for recharge based on surface soils and the dark peach color indicates poor conditions. The area identified for on-farm recharge is primarily in a SAGBI good recharge area, though it may contain restrictive layers.

McMullin Area GSA

SAGBI Rating Soils

Lassen Avenue Reverse Flow & Recharge

Figure 6-11



- Lift Station
- Existing Canal
- Potential Favorable Recharge Area For Dedicated Facilities
- On Farm Recharge
- Road
- USGS Ground Elevation Contour (ft, NAVD88)
- Mid-Valley WD
- James ID
- McMullin Area GSA
- Restrictive Layer (Duripan or Abrupt Textural Change)

Soil Agricultural Groundwater Banking Index

SAGBI Rating - Modified

- 0 -15 Very Poor
- 15 - 29 Poor
- 29 - 49 Moderately Poor
- 49 - 69 Moderately Good
- 69 - 85 Good
- 85 - 100 Excellent

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According to a report on the McMullin On-Farm Flood Capture project conceptual design, an appropriate assumption for on-farm infiltration in the area would be about 0.2 ft/day. On-farm flood capture should be compatible with crop practices, meaning the crop should have the ability to tolerate extended inundation, have compatible time of dormancy, and tolerate saturated root zones. The proposed flow of 25 cfs would therefore require about 250 acres of farmland for recharge area at any one time if the entire flow is being used for on-farm recharge. The area identified in **Figure 6-11** is located generally in the most favorable area according to the SAGBI mapping, but any area with landowner interest along the JID Kerman Line canal could potentially be used for on-farm recharge.

6.2.4.2 Measurable Objectives

The objective of this project is to address declining groundwater levels and to increase groundwater storage by 3,000 AF on an average annual basis.

6.2.4.3 Project Benefits and Water Reliability

Groundwater around the project area is critically overdrafted due to the dependency of agriculture on groundwater in MAGSA and export of groundwater into JID. This project will aid in the mitigation of critical overdrafting by introducing surface water into the area for groundwater recharge on-farm as well as reducing groundwater demand. The existing facilities are owned by JID and thus have access to water supplies available to JID, which includes water from Mendota pool, CVP supplies from north of the Delta or the SJR, including Section 215 and Kings River flood flows that might be available for purchase by MAGSA. As described in **Section 3.4** as part of the project benefits and water reliability for the project, CVP Section 215 is the most likely water supply as it has historically been available 2 to 3 out of every five years for an average annual duration of about 60 days. Kings River floodwater has historically been available on an average annual basis for about 40 days, but the site is not currently within the Place of Use for the Kings River water rights.

For a flow of about 25 cfs, approximately 50 AF of water per day will be available for 60 days for recharge, amounting to 3,000 AF on an average annual basis. In years when water is available for longer than the average annual period, more recharge will be needed to maintain the 3,000 AF average.

6.2.4.4 Management of Groundwater Extractions and Recharge

The project would be managed by MAGSA in cooperation with JID in conformance with the SGMA. Performance of the project would be a necessary part of MAGSA's reporting requirements as well as evaluations of measurable objectives. Current water levels will be noted and monitored regularly over the years to evaluate success of the project. This project will recharge groundwater in the wet season to help offset pumping during the summer and during droughts. In the event of a drought or in the occasion that the recharge rate is not enough to mitigate overdraft to the measurable objective, management actions affecting groundwater extractions will be taken, which are described in further detail in **Section 6.3** and following. The severity of the situation will dictate the actions taken. Priority will be given to actions that can be implemented in a relatively short amount of time and have a high benefit to cost ratio.

6.2.4.5 Project Cost Estimate/Acre-Foot of Yield

Table 6-13 shows an engineer's opinion of probable project costs for the 2.4-mile reverse flow check and pump back recharge project. The total cost of the project was estimated to be about $3.3 million. Assuming a 5% interest rate loan, annualized over a 30-year period, the annual repayment cost is expected to be $212,000 (**Table 6-14**). The materials used to complete this project are expected to last 30 years or more. The portion of the water cost due to capital expenditures, on an average annual basis, is expected to be about $71 per acre-foot for a yield of 3,000 acre-feet. The costs do not include the cost to purchase the water. MAGSA will fund the project. Grant funding will be pursued and used to offset project costs if available.

Table 6-13 Summary of Probable Construction Costs for the Lassen Avenue Reverse Flow and Recharge Project

Item	Description	Amount
Field Costs	25 cfs Pump Stations and Check Structures	$1,645,000
General Conditions	Mobilization/Demobilization, Bonds and Insurance, Construction Permits, Protect and Replace Existing Facilities, and Change Order Contingency	$229,000
Right of Way Acquisitions	None required for this project	$ -
Non-Contract Costs	Design Data, Data Collection, Design, Permitting, & Construction Management	$636,000
Contingency	30% based on conceptual design	$ 753,000
	Total Capital Cost	$3,263,000

Table 6-14 Summary of Cost per AF for the Lassen Avenue Reverse Flow and Recharge Project

Lassen Avenue Reverse Flow and Recharge Project			
Total Capital Cost	Capital Repayment	Annual Yield AF	Cost Per AF
$3,263,000	$212,000	3,000	$71

Notes:

1. *Assumes 5% interest rate loan annualized over a 30-year period.*
2. *No operations or maintenance costs are included.*
3. *Water purchase costs will be an additional cost.*

6.2.4.6 Circumstances of Implementation

This project would be implemented by MAGSA to comply with the Sustainability Groundwater Management Act. For implementation to begin, an agreement would need to be made with JID regarding the use and alteration of their facilities for wheeling of surface water into MAGSA for recharge. The other necessary component for implementation is a source of funding. It has been listed as a medium priority project based on reliability of water source, cost effectiveness, assurance of water rights, and other relevant factors, as discussed in **Section 6.2.16**.

6.2.4.7 Project Status and Schedule

This project is in the conceptual phase and once a source of project funding is secured, a comprehensive schedule including environmental review, design, permitting and construction will be developed. The required environmental review, permitting, and project agreements could be completed in 3 to 6 months, and design and construction could be completed on a similar timeline. Due to the project being located within existing canal right-of-way and actively farmed properties, the time needed to formalize the project should be less than other projects with significant regulatory approvals. It is anticipated that MAGSA will start working to secure funding within the first five years of GSP implementation. Discussions on obtaining a potential water supply have already started.

6.2.4.8 Permitting and Regulatory Process

If expansion were to occur, the necessary anticipated construction permits and regulatory requirements required include, but are not limited to, the following:

- *California Environmental Quality Act (CEQA)* – compliance with CEQA for project approval.
- *Pacific Gas & Electric Company (PG&E), Application for Service* - for electrical service to new pump stations.
- *Fresno County, Building Permit* – for any electrical work to service facilities.
- *Water Supply Organization Approvals* – from James Irrigation District for construction and operations in JID right-of-way with connection to the JID system. Also, agreements with any organization for purchase of water and wheeling of said water through JID.

6.2.4.9 Legal Authority

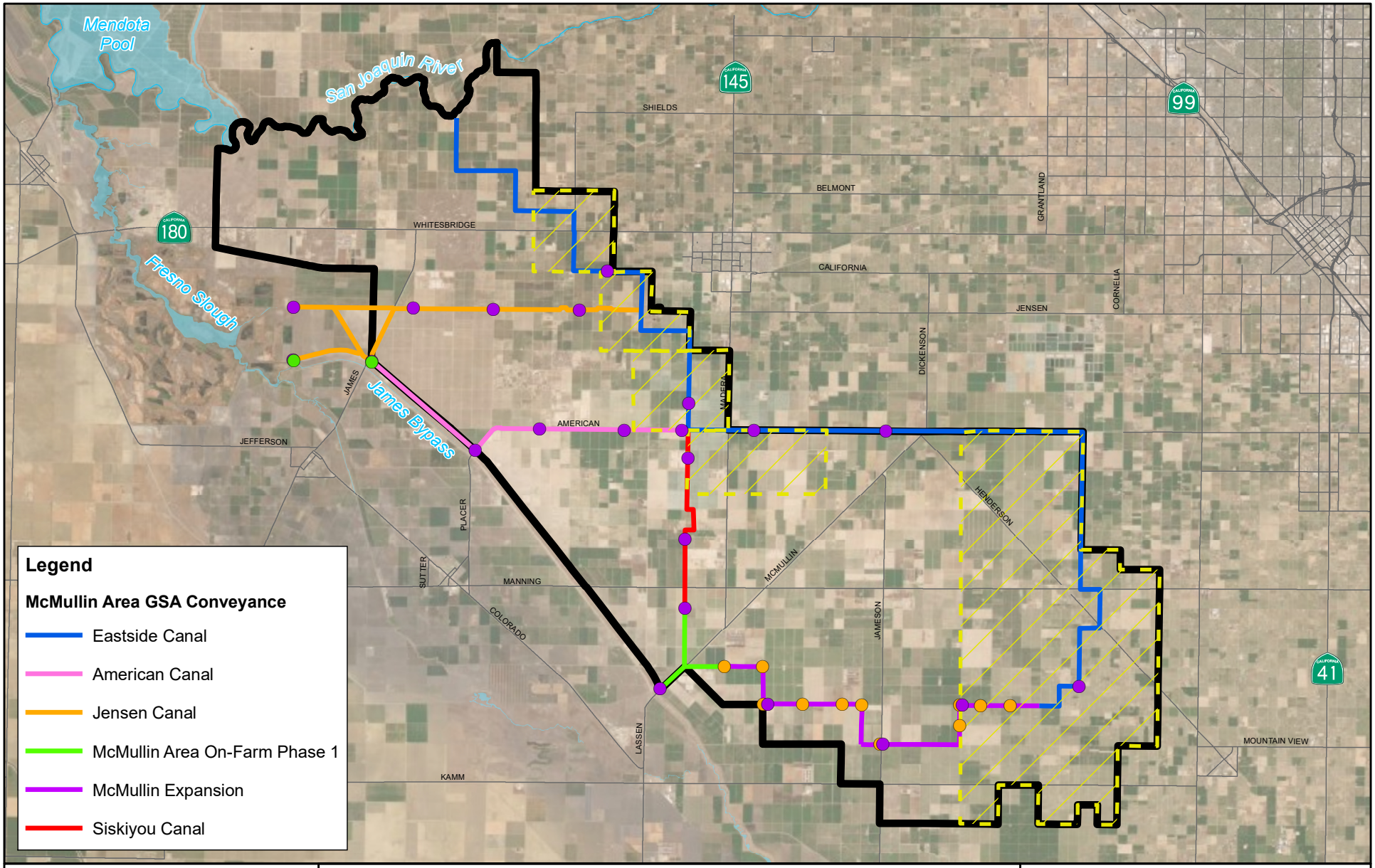
MAGSA would have to form an agreement with JID for the use and alteration of their facilities and decide on a management schedule. JID already owns and operates the facilities involved, and turnouts could be constructed by MAGSA upon agreement with JID.

6.2.5 MAGSA Groundwater Banking Program

6.2.5.1 Project Description

Conceptually, water from an interested party would be delivered from the O'Neil Forebay through the DMC and to the Mendota Pool. Once in the Fresno Slough arm of the Mendota Pool, water would then be diverted to MAGSA and conveyed to a dedicated groundwater banking facility, delivered to growers for them to utilize "in-lieu" of pumped groundwater, delivered to growers for them to recharge through an on-farm recharge program, or through a combination of these approaches. Water recovered in dry years would be collected in MAGSA and returned to the Mendota Pool, where it would be exchanged through the DMC for a water supply in the San Luis Reservoir on the California Aqueduct.

The MAGSA Groundwater Bank infrastructure will consist of canal conveyance, pump stations, recharge basins, recovery wells, and monitoring wells. The project design analyzed is based on a 770 cfs flow into facility during maximum recharge operations, and 480 cfs of flow to the Mendota Pool during maximum recovery operations. **Figure 6-12** shows the overview layout of the MAGSA Groundwater Bank facilities. During recharge operations, water will be initially pumped from the Fresno Slough into the Jensen Canal at the west end of the Jensen Canal and outside the wildlife refuge. The canal will follow Jensen Avenue to the eastern boundary of MAGSA and to the East-Side Canal. The East-Side Canal will generally follow the eastern MAGSA boundary north and south of Jensen Avenue to deliver water to the four recharge site locations. After the water has been recharged and an interested party is ready to recover water, recovery wells spread out among the basins will return water to the canal system. The canals will then return the water to the starting point at the Fresno Slough. MAGSA will attain long-term easements with landowners for these elements. Since MAGSA is a government agency, public ownership will allow use of these facilities by other public organizations in coordination and cooperation with MAGSA. The bank will include approximately 72 miles of canals, 22 pump stations, 4,000 acres of recharge basins, 90 recovery wells, and 55 monitoring wells.



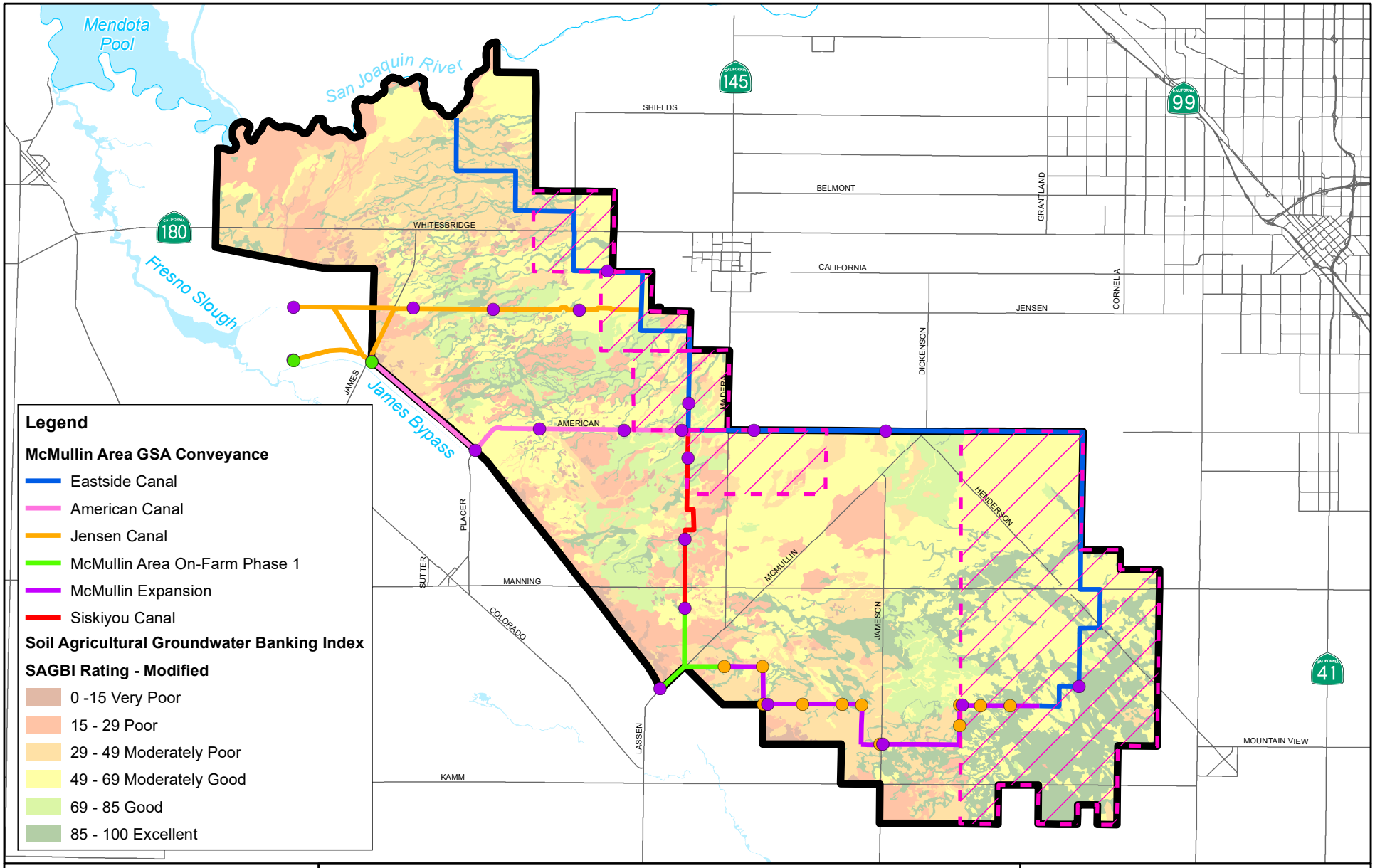
McMullin Area GSA

MAGSA Groundwater Banking Program

Figure 6-12

7/1/2022 : G:\McMullin GSA-2659\265921004-MAGSA GW Bank\400 GIS\Map\MAGSA_GroundwaterBank_Facil.mxd

The five potential recharge sites and the on-farm recharge identified were chosen due to their location in an area thought to be favorable for recharge from consultant and landowner knowledge of the area. The following SAGBI map is also an indicator for the potential of infiltration in the area of the proposed canal as well as the previously identified potential favorable area for recharge (possible recharge zone) (**Figure 6-13**). The SAGBI Map was developed by UC Davis as a tool to find areas that show the greatest potential for recharge based on surface soils (typically 6 to 8 feet in depth). Green indicates greatest potential for recharge based on surface soils and the dark peach color indicates poor conditions. Within the possible recharge zone, the area is identified as moderately good for shallow recharge, though a possible restrictive layer that may hinder recharge is also identified. These values need to be confirmed by field investigation prior to further project development.



McMullin Area GSA

MAGSA Groundwater Banking Program

Figure 6-13

7/1/2022 : G:\McMullin GSA-2659\265921004-MAGSA GW Bank\400 GIS\Map\MAGSA_GroundwaterBank_Sagbi.mxd

Recharge sites for the MAGSA Groundwater Bank will be comprised of multiple basins broken down into cells that are on average 40-acres. There are 5 recharge sites that will each consist of multiple basins. The total area for recharge were estimated assuming the basins could recharge 0.5 acre-feet per day. It is assumed only 80% of the acreage would be utilized for active recharge with the remaining 20% of the area would be comprised of levees and drive roads. The basins will have minimum side slopes of 3:1 and have a minimum top width of 14 feet to accommodate a drive road for construction, operations and maintenance equipment.

6.2.5.2 Measurable Objectives

The objective of this project is to address declining groundwater levels and to recharge 208,000 AF on an average annual basis with 10% leave behind for the GSA.

6.2.5.3 Project Benefits and Water Reliability

Groundwater around the project area is critically overdrafted due to the dependency of agriculture on groundwater in MAGSA. This project will aid in the mitigation of critical overdrafting by bringing surface water into the area for groundwater, in-lieu and on-farm recharge. The proposed MAGSA Groundwater Bank would be developed to receive surface water from, and deliver water to, the Fresno Slough and the hydraulically connected Mendota Pool in Fresno County. The MAGSA Groundwater Bank would develop access to water supplies from the Kings River, the San Joaquin River, the CVPDMC, and the SWP (through use of available capacity in the DMC). While the Kings and San Joaquin Rivers are potential surface water sources, the main source of water would be from potential partner agencies on the CVP and SWP systems.

The estimated volume of recharge from this project on an average annual basis will be 208,000 AF. This number does not include the potential for in-lieu recharge during irrigation months through any potential surface water purchases that might occur. On top of direct recharge, the removal of approximately 4,650 acres of farmland for the construction of facilities (dedicated recharge areas and canals) will result in a reduction in groundwater pumping of about 13,900 AF per year (assuming 3 AF/acre).

6.2.5.4 Management of Groundwater Extractions and Recharge

The proposed groundwater banking facilities would be owned and managed by MAGSA to help meet sustainability goals. Performance of the project would be a necessary part of MAGSA's reporting requirements as well as evaluations of measurable objectives. Current water levels will be noted and monitored regularly over the years to evaluate success of the project. This project will recharge groundwater in the wet season to help offset pumping during the summer and during droughts.

6.2.5.5 Project Cost Estimate/Acre-Foot of Yield

Table 6-15 shows a conceptual level engineer's opinion of project construction costs for the canals, pump stations, recharge basins, recovery wells, and monitoring wells. The total cost of the project is estimated to be about $777 million. Assuming a 5% interest rate loan, annualized over a 30-year period, the annual repayment cost is expected to be $50.5 million (**Table 6-16**). The materials used to complete this project are expected to last 30 years or more. The portion of the water cost due to capital expenditures, on an average annual basis, is expected to be about $2,454 per acre-foot for a yield of 208,000 acre-feet. The costs do not include the cost to purchase the water. MAGSA will fund the project. Grant funding will be pursued and used to offset project costs if available.

Table 6-15 Summary of Probable Construction Costs for MAGSA Groundwater Banking Program

Item	Description	Amount
Field Costs	Canal, Pump Stations, Basin Work, Recovery Wells, and Monitoring Wells	$376,195,000
General Conditions	Mobilization/Demobilization, Bonds and Insurance, Construction Permits, Protect and Replace Existing Facilities, and Change Order Contingency	$48,890,000

Right of Way Acquisitions	120-foot wide Easement for 72 miles, 35-foot wide for 72 miles of Construction Easement, 4,000acres of Dedicated Recharge property and Procurement Costs	$87,710,000
Non-Contract Costs	Design Data, Data Collection, Design, Permitting & Construction Management	$85,017,000
Contingency	30% based on conceptual design	$179,344,000
	Total Cost	$777,156,000

Table 6-16 Summary of Cost per AF for MAGSA Groundwater Banking Program

James Bypass Surface Water Supply & Recharge Project			
Total Capital Cost	Capital Repayment	Annual Yield AF	Cost Per AF
$777,156,000	$50,555,000	208,000	$2,454.13

Notes:

1. *Assumes 5% interest rate loan annualized over a 30-year period.*
2. *No operations or maintenance costs are included.*
3. *Water purchase costs will be an additional cost.*

6.2.5.6 Circumstances of Implementation

This project plays an important role in MAGSA meeting its sustainability goals. The only circumstance required for implementation of this project would be securing funding. It has been listed as a medium priority project based on reliability of water source, cost effectiveness, water rights, and other relevant factors, as discussed in **Section 6.2.16**.

6.2.5.7 Project Status and Schedule

This project is in the conceptual phase and once a source of project funding is secured, a comprehensive schedule including environmental review, design, permitting, and construction will be developed. However, environmental review, permitting, and project agreements could be completed in 1 to 3 years, and design and construction could be completed on a similar timeline. It is anticipated that MAGSA will start working to secure funding within the first five years of GSP implementation.

6.2.5.8 Permitting and Regulatory Process

If expansion were to occur, the anticipated necessary construction permits and regulatory requirements required include, but are not limited to, the following:

- *Army Corps of Engineers (Army Corps), 404 Permit* – for work within a Water of the US.
- *Federal Endangered Species Act* – for potential impacts to federally endangered species which potentially occur in the Fresno Slough Bypass.
- *California Environmental Quality Act (CEQA)* – compliance with CEQA for project approval.
- *Central Valley Flood Protection Board (CVFPB), Encroachment Permit* – for work within a State Designated Floodway.
- *Department of Fish and Wildlife, Stream Bed Alteration Agreement* – for work within the Fresno Slough Bypass, a Water of the State.
- *Regional Water Quality Control Board (RWQCB), Section 401 Water Quality Certification* – for compliance with the Clean Water Act in conjunction with the Army Corps 404 permit.
- *State Endangered Species Act* – for potential impacts to state endangered species which potentially occur in the Fresno Slough Bypass.
- *State Water Resources Control Board, Stormwater Pollution Prevention Plan (SWPPP)* - for construction that disturbs more than five acres.
- *Pacific Gas & Electric Company (PG&E), Application for Service* - for electrical service to new and/or larger pump stations.
- *Fresno County, Building Permit* – for any electrical work to service facilities.

- *Fresno County, Encroachment Permit* – for the crossing of County Road right-of-way.
- *San Joaquin Valley Air Pollution Control District (SJVAPCD)* – for preparation of a Dust Control Plan for construction with disturbs a surface area of five acres or more.
- *Mosquito Abatement* – for operation of an open body of water that could host vectors.
- *Railroad* – for an encroachment permit for crossing railroad property.
- *Water Supply Organization Approvals* – Agreements with interested parties for water to be recharged in the groundwater bank.

6.2.5.9 Legal Authority

MAGSA would need to purchase and/or acquire easements over the land necessary for the dedicated groundwater recharge basins and form agreements with landowners for flood easements in order to perform on-farm recharge. In addition, MAGSA would be required to obtain agreements with the interested parties with the surface supply or supplies that would be recharged in the groundwater bank.

6.2.6 McMullin On-Farm Flood Capture Expansion

6.2.6.1 Project Description

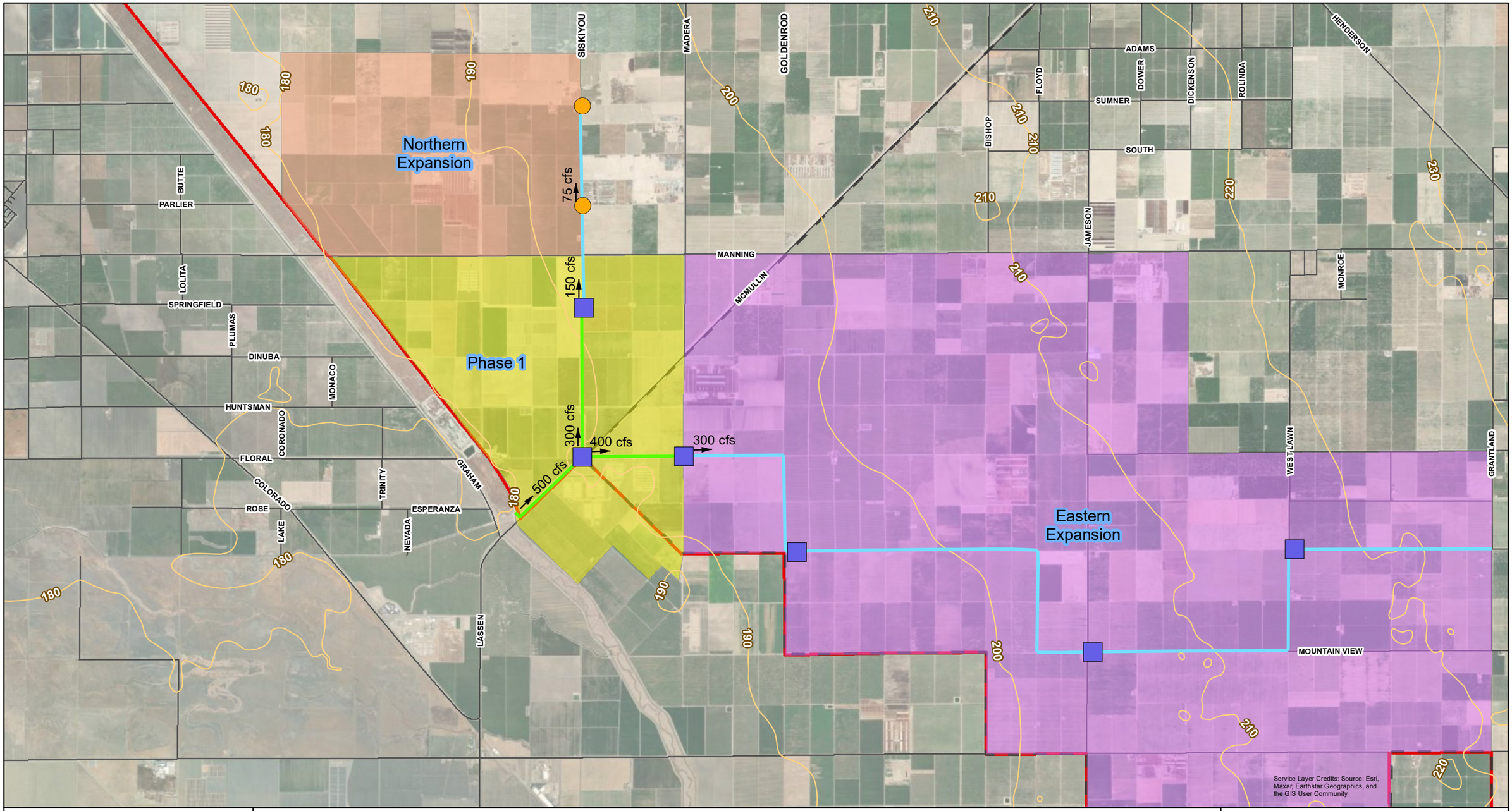
During high flow releases on the North Fork of the Kings River, up to 500 cfs is proposed to be diverted at the approved turnout and canal immediately downstream of McMullin Grade for in-lieu or on-farm recharge. Phase 1 of the project has already been approved and is in construction. Phase 1 of the project includes a 500 cfs turnout in the James Bypass with the 500 cfs McMullin Grade Canal to Floral Avenue. At Floral and McMullin Grade, a 150 cfs up to total 500 cfs capacity pumping plant will be installed, with one canal running east along the Floral Avenue alignment to the Madera Avenue alignment at 400 cfs design capacity and one canal running north at 300 cfs design capacity to about one-half mile south of Manning Avenue (Springfield alignment). The expansion would increase the pumping capacity at Floral at McMullin Grade to the full capacity and extend the canal along Floral Avenue and Nebraska Avenue East as far as Grantland Avenue and the canal running north to the Sumner Avenue alignment to increase the possible recharge capacity. The total expansion area is about 15,660 acres, with about 76% of the area, or 11,900 acres, within RCWD.

As of November 2018, the initial portion of Phase 1 facilities were in construction and the turnout is to be completed by the end of the 2018 calendar year. Phase 1 of this project will already have been installed when construction for Phase 2 and 3 would begin. Phase 1 specifies a 500 cfs turnout from the Kings River at the James Weir and a 150 cfs pump station to provide lift from a canal that is then diverted into two canals. The location of the Phase 1 facilities is shown in **Figure 6-14**.

Actual net acreage will depend on grower participation. The recharge rate for the project area for on-farm recharge has been estimated by others at about 0.20 ft/day (Bachand, 2012). The capacity of the entire system is governed by the Phase 1 turnout which is 500 cfs, or a volume of 992 acre-feet per day, and pumping capacities at Floral Avenue. Phase 1 commits 158 cfs of the available capacity to an area of 5,575 acres, for 313 AF/day. For the average annual flood duration of about 40 days, the remaining 342 cfs of turnout capacity available for recharge (direct or in-lieu) for the expansion area and could generate about 678 AF/day or 27,120 AF over the average annual flood duration of a 40-day period. With 76% of the Phase 2 and 3 area within RCWD, the prorated share of flow based on acreage is 260 cfs, 515 AF/day and 20,600 AF for the 40-day period. The expansion area in RCWD is significant because of grant funds that RCWD and MAGSA has obtained which are briefly described in Section **6.2.6.5**.

The proposed project location is west of the Raisin City community. The expansion northern canal extension begins about Springfield Avenue (1/2 mile south of Manning Avenue) along the Siskiyou Road alignment and runs North to Sumner Avenue. The eastern canal extension begins at the intersection of Floral and Madera Avenues and runs south and east, terminating at Nebraska Avenue and Grantland Avenue. The map in

Figure 6-14 shows the general area of the proposed project extensions and the locations of the expansion of the McMullin On-Farm Flood Capture project.



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McMullin Area GSA
Raisin City WD

McMullin On-Farm Recharge Phases
Phase 1
Eastern Expansion
Northern Expansion

McMullin Area GSA Conveyance
McMullin Area On-Farm Phase 1
McMullin Expansion

USGS Ground Elevation Contour (ft, NAVD88)
Road
Turnout
Pump Station

McMullin Area GSA

McMullin Expansion On-Farm Flood Capture Project Facilities

Figure 6-14

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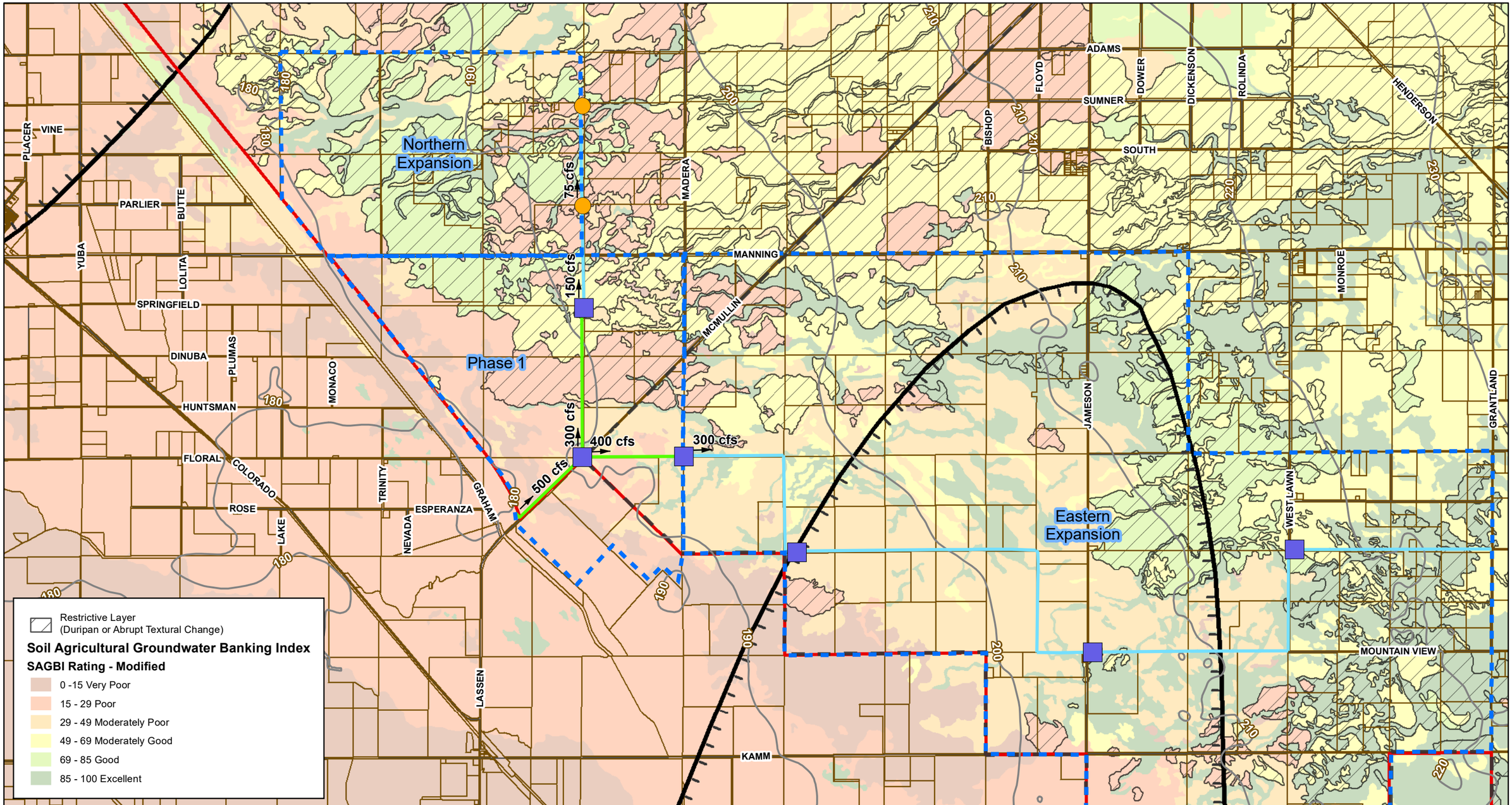
In wet years, floodwater is released into the North Fork of the Kings River and could be diverted to the project from the turnout downstream of McMullin Grade. Only Kings River water supply would be available to the project as currently envisioned. Historically floodwaters have occurred for about 40 days on an average annual basis. By prorating the 11,900 acres within RCWD from the expansion area, about 260 cfs is available for recharge (direct or in-lieu) that could generate 20,600 AF of recharge on an average annual basis within RCWD. The total expansion areas would generate about 27,120 AF/year for the 40-day period on an average annual basis for flow of 342 cfs and 678 AF/day.

Alignments and flows for the new facilities were determined by previous studies (Bachand & Associates, 2015). The placement of pumping stations was determined by considering general topographical changes, the canal slope being similar to the Phase 1 design, and by hydraulic losses across road crossings over the canal. The fields proposed to be serviced by the expansion canals are uphill from the terminus of the Phase 1 canals. To keep water flowing in the canal, the slope was set at one foot per mile. To limit the depth of the canal over all alignments, pump stations are required. It was assumed a road crossing for the canal is required every ½ mile and that a ½ foot drop in water surface elevation would occur across each crossing. The facilities required for the expansion include turnouts, pump stations, road crossings, and new canals, as shown in **Figure 6-14**.

The eastern canal expansion will be about eleven miles long in total and begin along Floral Avenue at the Madera Avenue alignment with a pump station capable of about 12.5 feet of lift and flow of 300 cfs located two miles downstream of Phase 1. The canal will have three pump stations, twelve road crossings, and thirty-eight turnouts to on-farm connections constructed by others. The canal will head east for 1 mile before continuing south along Goldenrod Avenue for 1 mile. The canal will head east along Nebraska Avenue where a pump station, capable of about 12.5 feet of lift, is located just east of Golden Rod. The canal then continues east for about 2.5 miles then heads south for 1 mile. The canal heads east along Mountain view for 2.5 miles with a pump station located just east of Jameson Avenue. The canal will follow Westlawn Avenue north for 1 mile then head east for 2 miles to the canal end. The third pump station is located just east of Westlawn Avenue on Nebraska Avenue.

The northern canal expansion will be about two miles long in total and begins ½ mile south of Manning Avenue and follows the Siskiyou Road alignment for about two miles. The canal will have one pump stations, four road crossings, and two turnouts to side laterals going to the west and on-farm turnouts constructed by others. A single pump station, capable of 11 feet of lift and a flow of 150 cfs, will be added at the beginning of the extension. The first section of the canal will have 150 cfs capacity and will cross Manning Avenue, continuing ½ mile north to a 75 cfs turnout. The final mile will carry 75 cfs and end at a turnout.

The goal of this project is to divert flood waters to agricultural fields for recharge of groundwater directly on farmed fields. Therefore, it is important to examine the mixture of soils that are present within the area of the project to identify the fields with the highest infiltration capacity. The SAGBI was developed to classify soils on their suitability to recharge groundwater based upon hydraulic conductivity. This spatial index provides a guide of soils in agricultural areas that would possibly be favorable to recharge and identifies other areas that have a restrictive layer that would not be useful for recharge purposes. **Figure 6-15** shows a map with SAGBI values to identify fields that are beneficial to on-farm recharge, with green determined to have greatest potential for recharge for the surface soils (typically 5 to 6 feet in depth). The area east of Westlawn along Nebraska located on either side of the area of the expansion canal appears to be the most favorable area for recharge.



McMullin Area GSA

SAGBI Rating Soils

McMullin Expansion On-Farm
Flood Capture Project

Figure 6-15

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6.2.6.2 Measurable Objectives

The objective of this project is to address declining groundwater levels and to increase groundwater storage by 27,000 AF on an average annual basis. To achieve this objective, another 3,000 acres of farmland will need to be secured through grower participation.

6.2.6.3 Project Benefits and Water Reliability

The benefits of this project are flood damage reduction and groundwater recharge. During high flows of the North Fork of the Kings River, redistribution of surface water mitigates the possibility of flooding to cities and lands downstream. The project diverts up to 500 cfs from flood flows on the King River to crops plotted on high infiltration capacity soils. These flood flows can then be used for on-farm recharge of groundwater to alleviate chronic overdraft conditions. The amount of recharge will depend on how many acres are made available by landowners for on-farm recharge and whether or not dedicated recharge facilities are constructed. For the portion of flow allocated to the area (11,900 acres) within RCWD, or 293 cfs, and given landowner participation, it is estimated that 2,906 acres of on-farm acreage could be recharging on a continuous basis for the annual average period of 40 days if the recharge rate is presumed to be 0.2 feet per day, which gives an average annual yield of 23,246 AF. The removal of about 167 acres of permanent crops for canal easements and turn around areas adjacent to the facilities will also reduce pumping by about 500 AF annually (if 3 AF/acre was the typical pumping).

6.2.6.4 Management of Groundwater Extractions and Recharge

The project would be owned and operated by RCWD (RCWD obtained partial funding for the project) or MAGSA (MAGSA obtained partial funding for the project) as a necessary part of meeting the requirements of the SGMA. Management of groundwater extractions and recharge is possible by keeping track of water levels over time and monitoring stream flow in the canals that deliver water to the recharge sites. Data can be reported to MAGSA to make sure levels do not continue to decline. This project will recharge groundwater in the wet season to help offset pumping during the summer and during droughts. In the event of a drought or in the occasion that the recharge rate is not enough to mitigate overdraft to the measurable objective, management actions affecting groundwater extractions will be taken, which are described in further detail in **Section 6.3** and following. The severity of the situation will dictate the actions taken. Priority will be given to actions that can be implemented in a relatively short amount of time and have a high benefit to cost ratio.

6.2.6.5 Project Cost Estimate/Acre-Foot of Yield

Table 6-17 and **Table 6-18** show probable project costs for Phase 2 and 3 respectively based on similar projects for the conceptual level of design. The total cost of Phase 2 is estimated at about $56.1 million, and Phase 3 is estimated as $5.8 million. Assuming a 5% interest rate loan, annualized over a 30-year period, the annual repayment cost is expected to be $4,027,000 (**Table 6-19**) for the combined phases cost of $61.9 million. The material required to complete this project is expected to last 30 years or more. The portion of the water cost due to capital expenditures, on an average annual basis, is expected to be about $148 per acre-foot for a yield of 27,120 acre-feet for the total combined Phase 2 and 3 areas. Costs will be further developed once the project proceeds to a more detailed level of design. Based on this project being at in design, a 10% contingency was presumed. The costs do not include the cost to purchase the water. RCWD has acquired $6.99 million in federal grant funds and will be pursuing the project. MAGSA has acquired $10 million in state grant funds towards this project. Additional grant funding will be pursued and used to offset project costs if available.

Table 6-17 Summary of Probable Construction Costs for Phase 2

Item	Description	Amount
Field Costs	Canal, Pump Stations, and Canal Crossings	$38,814,000
General Conditions	Mobilization/Demobilization, Bonds and Insurance, Construction Permits, Protect and Replace Existing Facilities, and Change Order Contingency	$5,433,000
Right of Way Acquisitions	120-foot wide Easement, 5 miles and Procurement Costs	$2,750,000
Non-Contract Costs	Design Data, Data Collection, Design, Permitting, and Construction Management	$4,424,000
Contingency	30% based on conceptual design	$5,142,000
	Total Capital Cost	$56,563,000

Table 6-18 Summary of Probable Construction Costs for Phase 3

Item	Description	Amount
Field Costs	Canal, Pump Station, and Canal Crossings	$ 2,546,000
General Conditions	Mobilization/Demobilization, Bonds and Insurance, Construction Permits, Protect and Replace Existing Facilities, and Change Order Contingency	$ 357,000
Right of Way Acquisitions	120-foot wide Easement, 2 miles and Procurement Costs	$ 585,000
Non-Contract Costs	Design Data, Data Collection, Design, Permitting, & Construction Management	$ 986,000
Contingency	30% based on conceptual design	$ 1,342,000
	Total Capital Cost	$ 5,816,000

Table 6-19 Summary of Cost per AF for Entire McMullin Phase 2 and 3

McMullin On-Farm Flood Capture Project Entire Phase 2 & 3 Area			
Total Capital Cost	Capital Repayment	Annual Yield AF	Cost Per AF
$61,911,000	$4,027,000	27,120	$148.49

Notes:

1. Assumes 5% interest rate loan annualized over a 30-year period.
2. Assumes pumps will last 30 years.
3. No operations or maintenance costs are included.
4. Water purchase costs will be an additional cost.
5. No costs are included for possible conveyance fees for use of Phase 1 facilities or capital payment of portion of Phase 1 (if required), construction of berms around fields, or farmer turnouts.

If only the Phase 2 and 3 areas within RCWD were used, only the capital cost of Phase 2 improvements for the distribution system would apply, or $56,095,000. The portion of the water cost due to capital expenditures, on an average annual basis, would then be expected to be about $177 per acre-foot for a yield of 20,600 AF for the Phase 2 and 3 areas within RCWD as shown in **Table 6-20**.

Table 6-20 Summary of Cost per AF for McMullin Phase 2 and 3 in RCWD

McMullin On-Farm Flood Capture Project Phase 2 & 3 in RCWD			
Total Capital Cost	Capital Repayment	Annual Yield AF	Cost Per AF
$56,095,000	$3,649,000	20,600	$177.14

Notes:

1. Assumes 5% interest rate loan annualized over a 30-year period.
2. Assumes pumps will last 30 years.
3. No operations or maintenance costs are included.
4. Water purchase costs will be an additional cost.
5. No costs are included for possible conveyance fees for use of Phase 1 facilities or capital payment of portion of Phase 1 (if required), construction of berms around fields, or farmer turnouts.

The RCWD applied for funding for partial payment of Phase 2 costs through the Regional Conservation Partnership Program (RCPP) administered through the USDA Natural Resources Conservation Service. The RCPP encourages partners to join in efforts with producers to increase the restoration and sustainable use of soil, water, wildlife, and related natural resources on regional or watershed scales. For the 2018 federal fiscal year, the RCWD was notified of an award of up to $6.99 million for a $17.22 million project that was described in the grant application. However, only the PL566 (Public Law 566) portion of the grant of about $5.47 million can be used for the major distribution system components of Phase 2 and the remainder is for on-farm improvements which were not investigated as part of this study. Additionally, the Project has been awarded $10M through the California State Water Board Prop 1 Stormwater Grant Program (SWGP), which requires an equivalent match. If the grant amounts reduced the capital cost of the portion of the project in RCWD estimated in the IMP by $15.47 million, the actual conceptual cost remaining would be about $46.441 million ($61.9-$15.47 = $46.441 million), and the annualized cost for capital portion of the water yield indicated would be about $111 per acre-foot.

6.2.6.6 Circumstances of Implementation

This project is being implemented by RCWD and MAGSA. Limitations for implementation include securing viable farmland for on-farm recharge of groundwater and acquiring the necessary funding. If these two conditions are met, no other circumstances would be necessary for implementation. It has been listed as a medium priority project based on reliability of water source, cost effectiveness, assurance of water rights, and other relevant factors, as discussed in **Section 6.2.16**.

6.2.6.7 Project Status and Schedule

The conceptual design for Phase 1, as well as the Phase 2 and 3 expansions of the project, were documented in the McMullin On-Farm Flood Capture Project, Phase 1 Conceptual Design (Bachand & Associates, 2015). On March 28, 2016, the Kings River Conservation District adopted a Mitigated Negative Declaration and associated Mitigation, Monitoring and Reporting Program for 6,000 acres of the Phase 1 project area to comply with CEQA. The Phase 2 and 3 area was not included in the CEQA evaluation. Phase 1 is near completion, and Phases 2 and 3 are currently being evaluated to determine which portion should be built under the grant acquired by RCWD, as it requires completion by 2023. The next steps to build the remainder not completed under grant funding would be to acquire the necessary permitting, comply with environmental documentation for the initiation of the project portions authorized by the RCPP grant funding, and then design the project, all of which is expected to take about 24 months. Construction is estimated to take another 12 months. Additional funding, such as assessments from an election, is anticipated to be pursued by MAGSA within the first five years of GSP implementation.

6.2.6.8 Permitting and Regulatory Process

It is anticipated that approvals from the following agencies will be required:

- *California Environmental Quality Act (CEQA)* – compliance with CEQA for project approval.
- *State Water Resources Control Board, Stormwater Pollution Prevention Plan (SWPPP)* - for construction that disturbs more than five acres.
- *Pacific Gas & Electric Company (PG&E), Application for Service* - for electrical service to new and/or larger pump stations.
- *Fresno County, Building Permit* – for any electrical work to service facilities.
- *Fresno County, Encroachment Permit* – for the crossing of County Road right-of-way.
- *San Joaquin Valley Air Pollution Control District (SJVAPCD)* – for preparation of a Dust Control Plan for construction with disturbs a surface area of five acres or more.
- *Mosquito Abatement* – for operation of an open body of water that could host vectors.
- *Kings River Conservation District* – for connection to the Phase 1 facilities and for operations, maintenance and cost sharing agreements.
- *Water Supply Organization Approvals* – from Kings River Water Association for an agreement for supply of water from the Kings River.

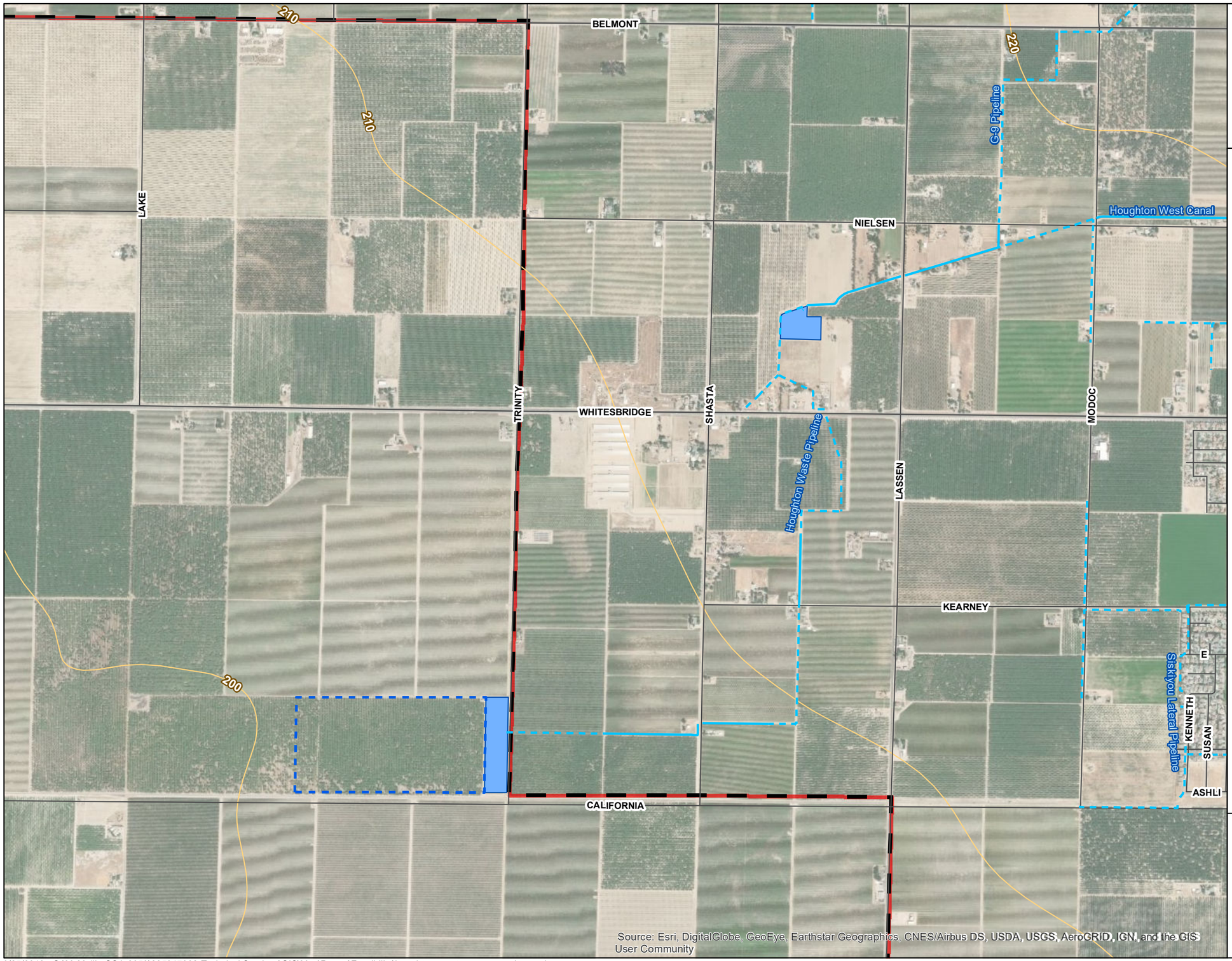
6.2.6.9 Legal Authority

MAGSA would need to purchase and/or acquire easements over the land necessary for the dedicated canal conveyance and form agreements with landowners for flood easements in order to perform on-farm recharge. Approvals and agreements would be needed to connect to the existing Phase 1 facilities. MAGSA and/or RCWD (partnership) has the legal authority to construct, operate, and maintain the expansion facilities and enter into agreements with Terranova for connection to the Phase 1 facilities.

6.2.7 Houghton Wasteway Expansion

6.2.7.1 Project Description

FID owns and operates a 10-acre basin just outside of FID and inside the edge of the MAGSA boundary, west of and along the Trinity Avenue alignment north of California Avenue. Leading to this basin is the FID Houghton Wasteway pipeline and canal system that extends out of the Houghton West Canal. With an estimated capacity of up to about 20 cfs, the pipeline could potentially supply approximately 40 AF of water per day and 2,190 AF/year on an average annual basis. This project proposes to expand the size of the existing recharge basin to match the capacity of the current distribution system. For 90-acres of property, about 73 acres of area is available for recharge after construction of the levees around the existing area as well as the 80-acre new area. The proposed recharge area along with the current system are shown below on **Figure 6-16**. The project will serve as a banking facility to recharge surface water supplies from FID when available, storing it for future use within MAGSA.



McMullin Area GSA

Houghton Wasteway Expansion Project

Figure 6-16

- FID Canal
- FID Pipeline
- Road
- Potential Recharge Area
- FID Pond
- USGS Ground Elevation (ft, NAVD88)
- Fresno ID
- McMullin Area GSA

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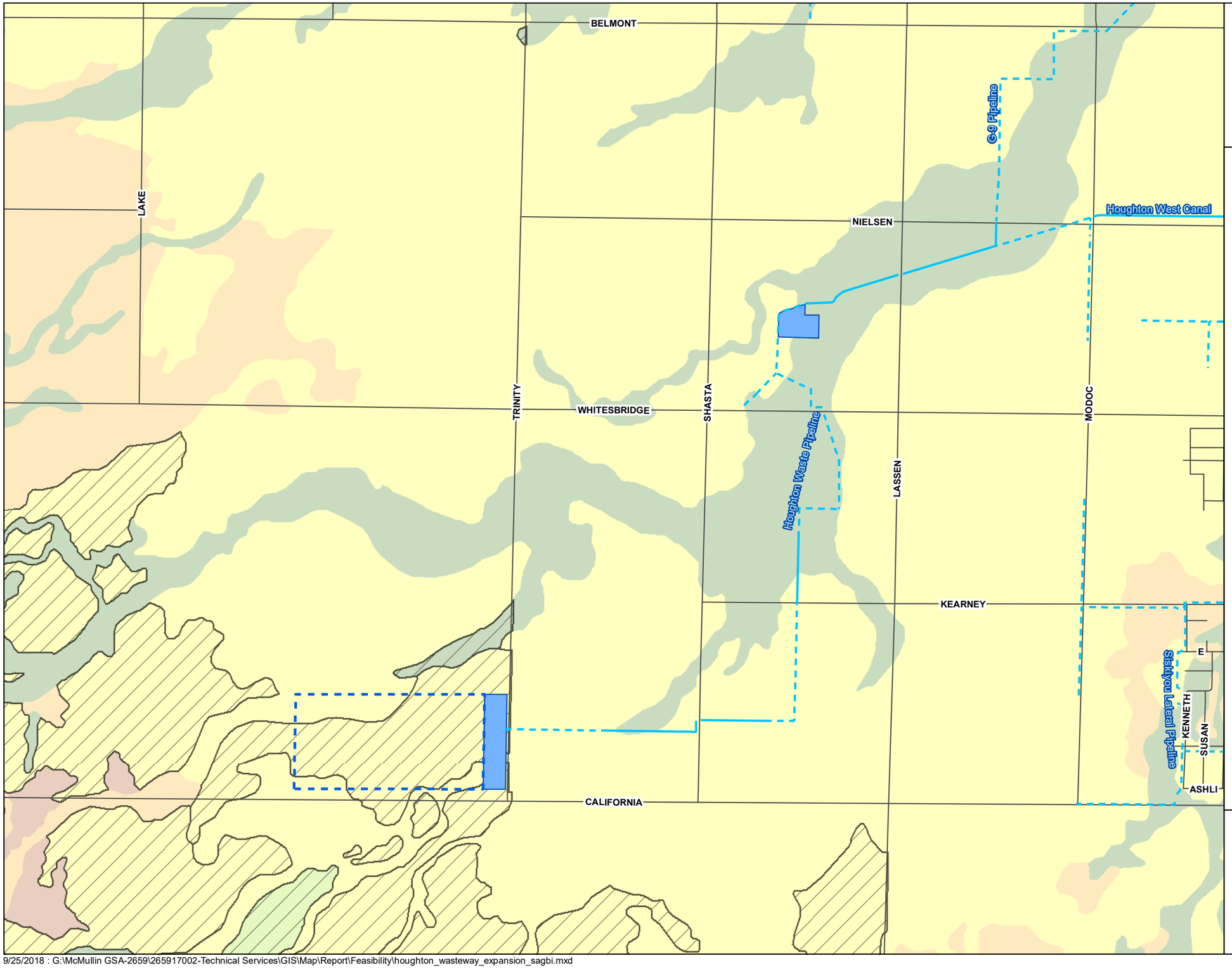
Existing facilities include the 10-acre basin (the Houghton Waste No. 195 facility) owned by FID along with the pipeline extending from the end of the Houghton West Canal. The facility serving the basin contains pipelined sections of canal which vary in size, with the smallest pipeline sections being reported as 30 inches in diameter. It is estimated that the 30-inch pipe could carry approximately 20 cfs by gravity flow (based on a maximum velocity through the pipe of three feet per second). The FID basin shows only about 2.5 of the 10 acres of surface area being used regularly. The rest of the basin is overgrown with shrubs and trees in the northwest corner. There is currently a levee and a check structure between the two sections of the 10-acre basin that would need to be taken out. The proposed field adjacent to the existing basin is approximately 80 acres of almond trees that would need to be removed as well as a well in the northeast corner.

The project could bring in approximately 40 AF of water per day for available flow of 20 cfs requiring an area of about 80 acres if assuming an infiltration rate of 0.5 ft/day. For 60 days of flow on an average annual basis, the project yield is estimated to be approximately 2,190 AF per year for the recharge footprint of 73 acres after the construction of levees around the project (73 acres x 0.5 ft/day = 36.5 AF/day x 60 days = 2,190 AF/year).

The following map is an indicator for the potential of infiltration in the possible recharge zones (**Figure 6-17**). The SAGBI Map was developed by UC Davis as a tool to find areas that show the greatest potential for recharge. Green indicates greatest potential for recharge based on surface soils and the dark peach color indicates poor conditions. The property adjacent to and west of the existing FID basin is 80 acres of orchards and is an area designated as potentially moderately good for recharge, though portions may contain restrictive layers. The parcel would need to be purchased from the current landowner to construct a recharge basin as well as facilities leading from the current basin into the new one. FID currently has an easement on the property proposed for the basin expansion that allows them to flood the area, though it does not appear to have been exercised by FID in recent times.



McMullin Area GSA

SAGBI Rating Soils

Houghton Wasteway Expansion Project

Figure 6-17

- FID Canal
- FID Pipeline
- Road
- Potential Recharge Area
- FID Pond
- Restrictive Layer (Duripan or Abrupt Textural Change)

Soil Agricultural Groundwater Banking Index

SAGBI Rating - Modified

- 0 -15 Very Poor
- 15 - 29 Poor
- 29 - 49 Moderately Poor
- 49 - 69 Moderately Good
- 69 - 85 Good
- 85 - 100 Excellent

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6.2.7.2 Measurable Objectives

This project will address declining water levels and the declining volume of groundwater stored in the aquifer. The objective of this project is to use the full potential of the Houghton West distribution system to deliver water from FID to a recharge basin for groundwater banking. The goal is to recharge up to 2,190 AF on an average annual basis by bringing in up to 20 cfs when flows are available. Surface water that is delivered to the project site will be measured regularly. Groundwater levels in the nearby area will be monitored before and after implementation of the project to measure the localized impact from the project.

6.2.7.3 Project Benefits and Water Reliability

Groundwater around the project area is critically overdrafted due to the dependency of agriculture on groundwater in the area. This project would be a step in the direction of mitigating overdraft by introducing surface water to the area by recharge into the ground. Up to 2,190 AF on an average annual basis will be recharged along with a reduction in demand by about 240 AF annually caused by the removal of permanent crops over 80 acres. By offsetting the declining water table levels, increased energy costs associated with the drop in groundwater levels will begin to level off.

For the project previously described in Section **6.2.1**, the Fresno City Wastewater Treatment Plant Recharge Basins, FID Houghton Canal System, flows were expected during wet and typical hydrologic years for seven months (210 days) of a typical irrigation season. Initial assumptions are that water will be available for at least 60 days on an average annual basis based on CVP Section 215 water sources, though it is likely to be more. Contracted CVP supplies could be available as MAGSA is located within the CVP Place of Use, and therefore additional CVP Class I or Class II supplies that might be available for purchase could be brought to the GSA.

6.2.7.4 Management of Groundwater Extractions and Recharge

The recharge basin could be owned and managed by MAGSA or by FID by agreement, but the water would be supplied through FID. Groundwater levels will be monitored, and management of extractions will be necessary if levels continue to decline. This project will recharge groundwater in the wet season to help offset pumping during the summer and during droughts. In the event of a drought or in the occasion that the recharge rate is not enough to mitigate overdraft to the measurable objective, management actions affecting groundwater extractions will be taken, which are described in further detail in **Section 6.3** and following. The severity of the situation will dictate the actions taken. Priority will be given to actions that can be implemented in a relatively short amount of time and have a high benefit to cost ratio.

6.2.7.5 Project Cost Estimate/Acre-Foot of Yield

Table 6-21 shows an engineer's opinion of probable project costs for adding 80 acres to the existing 10-acre project site. The total cost of the project was estimated to be about $5 million. Assuming a 5% interest rate loan, annualized over a 30-year period, the annual repayment cost is expected to be $320,000 (**Table 6-22**). The materials used to complete this project are expected to last 30 years or more. The portion of the water cost due to capital expenditures, on an average annual basis, is expected to be about $146 per acre-foot for a yield of 2,190 acre-feet. The costs do not include the cost to purchase the water. MAGSA will fund the project. Grant funding will be pursued and used to offset project costs if available.

Table 6-21 Summary of Probable Construction Costs for Houghton Wasteway Expansion Project

Item	Description	Amount
Field Costs	Basin Work & Structures, Channel Work & Structures, and Monitoring Wells	$ 1,693,600
General Conditions	Mobilization/Demobilization, Bonds and Insurance, Construction Permits, Protect and Replace Existing Facilities, and Change Order Contingency	$ 236,000
Right of Way Acquisitions	Basin Land Acquisition - 80 Acres	$ 1,200,000
Non-Contract Costs	Design Data, Data Collection, Design, Permitting, & Construction Management	$ 656,064
	Total Capital Cost	$ 4,921,664

Notes:
1. 2018 costs.

Table 6-22 Summary of Cost per AF for Houghton Wasteway Expansion Project

Houghton Wasteway Expansion Project			
Total Capital Cost	Capital Repayment	Annual Yield AF	Cost Per AF
$4,921,664	$320,000	2,190	$146

Notes:
1. *Assumes 5% interest rate loan annualized over a 30-year period.*
2. *No operations or maintenance costs are included.*
3. *Water purchase costs will be an additional cost.*

6.2.7.6 Circumstances of Implementation

This project would be implemented by MAGSA to comply with the SGMA. The only circumstance required for implementation of this project would be securing a source of funding. It has been listed as a medium priority project based on reliability of water source, cost effectiveness, water rights, and other relevant factors, as discussed in **Section 6.2.16**.

6.2.7.7 Project Status and Schedule

This project is in the conceptual phase and once a source of project funding is secured, a comprehensive schedule including environmental review, design, permitting, and construction will be developed. Environmental review, permitting, and project agreements could be completed in 9 to 12 months, where design and construction could be completed on a similar timeline. It is anticipated that MAGSA will start working to secure funding within the first five years of GSP implementation.

6.2.7.8 Permitting and Regulatory Process

If expansion were to occur, the anticipated necessary construction permits and regulatory requirements required include, but are not limited to, the following:

- *California Environmental Quality Act (CEQA)* – compliance with CEQA for project approval.
- *State Water Resources Control Board, Stormwater Pollution Prevention Plan (SWPPP)* - for construction that disturbs more than five acres.
- *Fresno County, Encroachment Permit* – for the crossing of County Road right-of-way.
- *San Joaquin Valley Air Pollution Control District (SJVAPCD)* – for preparation of a Dust Control Plan for construction with disturbs a surface area of five acres or more.
- *Mosquito Abatement* – for operation of an open body of water that could host vectors.

- *Water Supply Organization Approvals* – from Fresno Irrigation District for construction and operations in FID right-of-way with connection to the FID system. Also, agreements with any organization for purchase of water and wheeling of said water through FID.

In addition, the existing facilities are connected to canals owned and operated by FID and approvals and agreements would be needed to connect to the existing facilities, as well as operational requirements to take water from FID.

6.2.7.9 Legal Authority

FID owns the existing project site and, pending receipt of the necessary permits and approvals, has the legal authority to construct the required facilities on their property as well as additional property that MAGSA or FID would obtain for the project expansion. MAGSA would coordinate their efforts with FID to pursue recharging CVP Section 215 water as well as other local supplies whenever water becomes available for purchase.

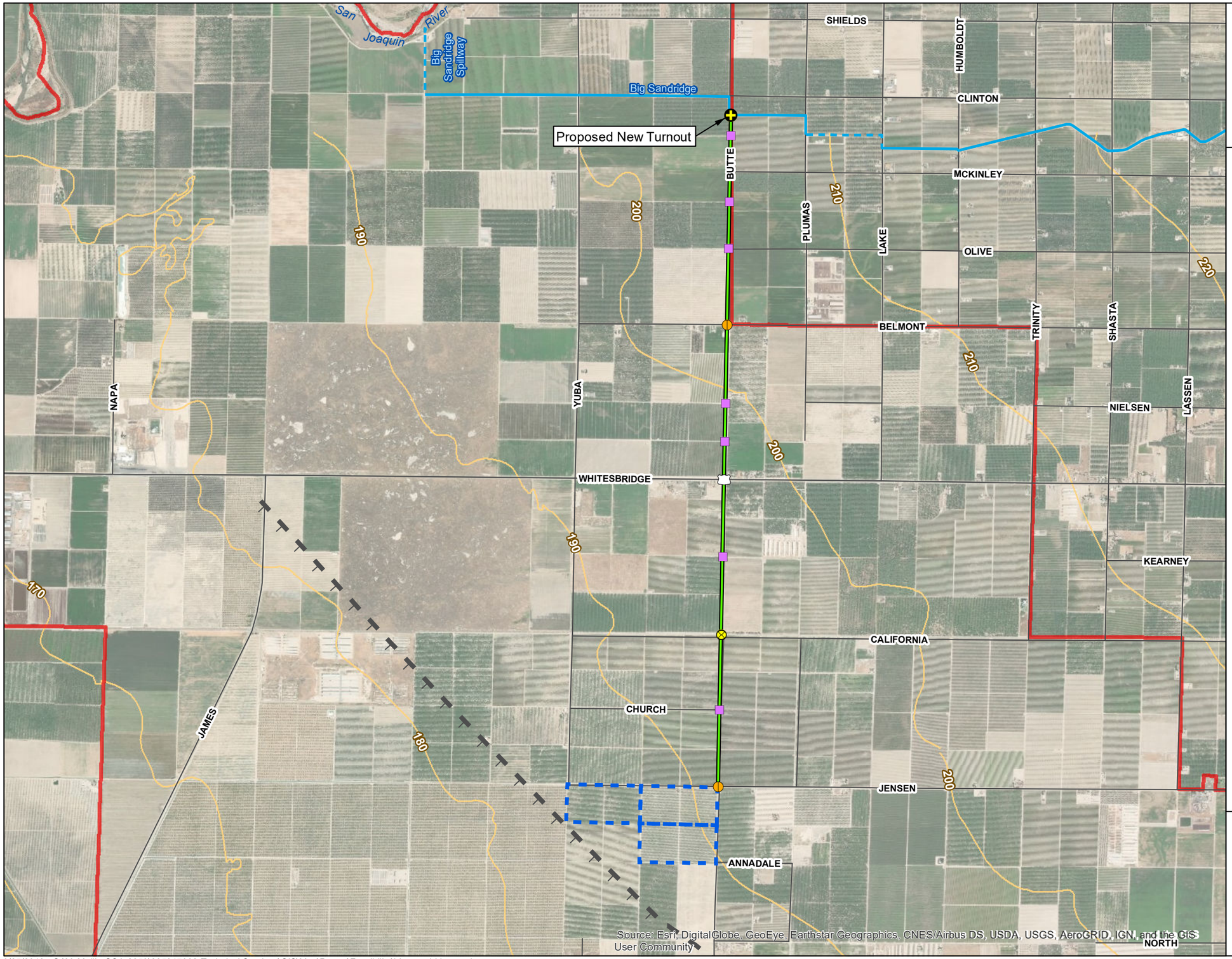
6.2.8 South Sandridge Canal Water Supply & Recharge

6.2.8.1 Project Description

This project requires MAGSA to work with FID to send surface water flows down the Big Sandridge Canal to a new turnout that would be located near the end of the canal. This project would require construction of a turnout from the Big Sandridge Canal near where it intersects with North Butte Avenue. Just before the new turnout location there is a section of the canal that is piped with a 48-inch diameter pipe with an estimated capacity of 40 cfs by gravity flow, which would limit the potential flow to much less than the 150 cfs capacity understood at the head of the system. After the turnout, a proposed canal would continue due south for approximately 4.4 miles until reaching an area of potential recharge within MVWD and MAGSA boundaries (**Figure 6-18**). The potential recharge area was selected to be as far south as possible within MAGSA on the Butte Avenue alignment before reaching the area with known shallow subsurface clay layers (the A-clay). The goal of this project is to improve groundwater levels and mitigate critical overdrafting by redirecting up to 40 cfs of available flows from FID through the proposed South Sandridge Canal into the ground via recharge basins or direct on-farm recharge.

The only currently existing component of this project is the FID Big Sandridge Canal. The turnout structure, canal, and recharge basin would all need to be constructed and the necessary land would need to be purchased or agreements would be needed for on-farm recharge. The proposed canal would have to cross over one railroad, three paved roads and a handful of farm roads to make it into the MVWD area within MAGSA.

It should be noted that landowners in the vicinity of the conceptual turnout (see **Figure 6-18**), around the Yuba and Colusa alignments with the FID Big Sandridge Canal have indicated an interest in project modifications or additions that could include connections to existing on-farm irrigation systems for in-lieu recharge or direct surface water irrigation. These options will be further investigated as the MAGSA projects begin to be implemented.



McMullin Area GSA

South Sandridge Canal Water Supply and Recharge Project

Figure 6-18

- Proposed New Turnout
- Proposed Canal
- Potential Recharge Area
- FID Canal
- FID Pipeline
- Road
- A Clay - Eastern Extent
- USGS Ground Elevation (ft, NAVD88), DEM)
- McMullin Area GSA

Crossings

- County Road
- Farm Road
- Railroad
- State Highway

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A SAGBI map was created to classify soils based on their suitability to recharge groundwater based on hydraulic conductivity. It serves as a tool to identify well-drained surface soils, where green has the highest potential for recharge and the pink areas have the lowest potential for recharge. **Figure 6-19** shows a map with SAGBI values to help identify where the most potential for recharge is located according to the SAGBI methodology. The suitability of an area for recharge would need to be confirmed by further investigation and actual soil borings in the field as part of future project development. **Figure 6-18** and **Figure 6-19** also show the generalized location of the extent of the shallow confining clay layer, or the "A-clay." The project intent is to bring water in for recharge as far south into MAGSA as possible without getting into the area with the shallow confining layer.

At a flow rate of 40 cfs, approximately 80 AF per day can be recharged. Based on previous feasibility studies near the area, a maximum infiltration rate of 0.5 ft/day is assumed for a dedicated recharge basin, meaning at least 160 acres of basin surface area would be needed to maximize the available flow. Based on the area preliminarily selected, an area of 235 acres is proposed for the basin, with about 176 acres of basin floor area and 59 acres for embankments and structures (25% of the area). If on-farm recharge were to be pursued, an infiltration rate of 0.2 ft/day would be more likely according to a previous study (Bachand & Associates, 2012). Approximately 400 acres of farmland would be needed for on-farm recharge. If a groundwater recharge basin site is unattainable, turnouts connected to irrigation systems may need to be installed on suitable adjacent properties for on-farm recharge.

Rough calculations using Manning's equation show that given a conveyance capacity of 40 cfs by gravity flow, an approximate channel bottom slope of 4.75 ft/mile based on USGS 7.5-minute Quadrangle data, a bottom width of 8 ft, and side slopes of 1.5:1, the normal depth of water would be about 1.8 ft. Adding a foot of freeboard would give a top width of roughly 16 ft. For a channel of this size with two drivable banks of at least 12 feet in width with side slopes, a 50-foot of right-of-way would be necessary for planning purposes.

McMullin Area GSA

SAGBI Rating Soils

South Sandridge Canal Water Supply and Recharge Project

Figure 6-19

Big Sandridge Spillway

Big Sandridge

Proposed New Turnout

SHIELDS

HUMBOLDT

CLINTON

BUTTE

MCKINLEY

PLUMAS

LAKE

OLIVE

BELMONT

TRINITY

SHASTA

NAPA

YUBA

NIELSEN

LASSEN

WHITESBRIDGE

KEARNEY

CALIFORNIA

JAMES

CHURCH

JENSEN

ANNADALE

NORTH

- Proposed New Turnout
- Proposed Canal
- Potential Recharge Area
- FID Pipeline
- FID Canal
- Road
- A Clay - Eastern Extent
- McMullin Area GSA
- Restrictive Layer (Duripan or Abrupt Textural Change)

Soil Agricultural Groundwater Banking Index

SAGBI Rating - Modified

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- 15 - 29 Poor
- 29 - 49 Moderately Poor
- 49 - 69 Moderately Good
- 69 - 85 Good
- 85 - 100 Excellent

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6.2.8.2 Measurable Objectives

This project will address declining water levels and the declining volume of groundwater stored in the aquifer. The main objective of this project is to use the full potential of the FID Big Sandridge Canal system to deliver water to a designated basin or to farms for recharge. The goal would be to recharge 4,800 AF on an average annual basis by bringing in 40 cfs when flood flows are available. Groundwater levels in the nearby area will be monitored before and after implementation of the project to measure the impact of the project.

6.2.8.3 Project Benefits and Water Reliability

Groundwater is the primary water supply for landowners within the GSA, and the project will increase the reliability of the groundwater supply, helping lead to sustainable water resource management. Based on historical flow data for Section 215 CVP flows, there are about 60 days of flood flows on an average annual basis, giving a total annual average of 4,800 AF. Reduction in demand by about 840 AF annually would occur due to the removal of crops over the 46 acres of right-of-way land (138 AF) and 235 acres for a basin (assuming 3 AF/acre was the typical pumping for irrigation). By offsetting the declining water table levels, increased energy cost associated with the drop in levels will begin to level off.

Since the project is connected to FID, with the proper approvals, theoretically any waters available to FID could be delivered to the project site – Kings River, CVP, or local supplies. As described in **Section 3.4** as part of the project benefits and water reliability for the project, CVP Section 215 is the most likely water supply, as it has historically been available 2 to 3 out of every five years for an average annual duration of about 60 days. Contracted CVP supplies could be available for purchase as MAGSA is located within the CVP Place of Use, and therefore additional CVP Class I or Class II supplies might be permitted and brought to the GSA. Kings River floodwater has historically been available on an average annual basis for about 40 days, but the site is not currently within the Place of Use for the Kings River water rights.

6.2.8.4 Management of Groundwater Extractions and Recharge

The recharge basin and canal would be owned and managed by MAGSA, but the water would be supplied by agreement with FID and/or purchase from others. An agreement with FID would need to be made for flows to be directed to the turnout location. Groundwater levels will be monitored, and management of extractions will be necessary if levels continue to decline. This project will recharge groundwater in the wet season to help offset pumping during the summer and during droughts. In the event of a drought or in the occasion that the recharge rate is not enough to mitigate overdraft to the measurable objective, management actions affecting groundwater extractions will be taken, which are described in further detail in **Section 6.3** and following. The severity of the situation will dictate the actions taken. Priority will be given to actions that can be implemented in a relatively short amount of time and have a high benefit to cost ratio.

6.2.8.5 Project Cost Estimate/Acre-Foot of Yield

Table 6-23 shows an engineer's opinion of probable construction costs for the 235-acre basin and 4.4-mile canal. The total cost of the project was estimated to be about $8.7 million. Assuming a 5% interest rate loan, annualized over a 30-year period, the annual repayment cost is expected to be $568,000 (**Table 6-24**). The materials used to complete this project are expected to last 30 years or more. The portion of the water cost due to capital expenditures, on an average annual basis, is expected to be about $119 per acre-foot for a yield of 4,800 acre-feet. The costs do not include the cost to purchase the water. MAGSA will fund the project. Grant funding will be pursued and used to offset project costs if available.

Table 6-23 Summary of Probable Construction Costs for South Sandridge Canal Water Supply & Recharge Project

Item	Description	Amount
Field Costs	Canal Turnout Structure, Canal Alignment, Big Sandridge Canal Improvements	$3,974,000
General Conditions	Mobilization/Demobilization, Bonds and Insurance, Construction Permits, Protect and Replace Existing Facilities, and Change Order Contingency	$556,000
Right of Way Acquisitions	50-foot-wide Easement, 4.4 miles, and Procurement Costs	$650,000
Non-Contract Costs	Design Data, Data Collection, Design, Permitting, & Construction Management	$1,540,000
Contingency	30% based on conceptual design	$2,016,000
	Total Cost	$ 8,736,000

Table 6-24 Summary of Cost per AF for South Sandridge Project

South Sandridge Canal Water Supply & Recharge Project			
Total Capital Cost	Capital Repayment	Annual Yield AF	Cost Per AF
$ 8,736,000	$ 568,000	4,800	$ 119

Notes:
Assumes 5% interest rate loan annualized over a 30-year period.
No operations or maintenance costs are included.
Water purchase costs will be an additional cost.

6.2.8.6 Circumstances of Implementation

This project would be implemented by MAGSA as an integral piece of MAGSA's overall effort to comply with the SGMA. No additional circumstances or triggers are considered necessary to its implementation other than availability of funding. It has been listed as a medium priority project based on reliability of water source, cost effectiveness, assurance of water rights, and other relevant factors, as discussed in **Section 6.2.16**.

6.2.8.7 Project Status and Schedule

This project is currently in the conceptual phase. Once a source of project funding is secured, a comprehensive schedule including environmental review, design, permitting, and construction will be developed. It is anticipated that that MAGSA will start working to secure funding for higher priority projects within the first five years of GSP implementation. Environmental review, permitting, and project agreements could be completed in 9 to 12 months, and design and construction could be completed on a similar timeline.

6.2.8.8 Permitting and Regulatory Process

If construction were to occur, the necessary anticipated construction permits and regulatory requirements required include, but are not limited to, the following:

- *California Environmental Quality Act (CEQA)* – compliance with CEQA for project approval.
- *State Water Resources Control Board, Stormwater Pollution Prevention Plan (SWPPP)* -for construction that disturbs more than five acres.
- *Caltrans* – for an encroachment permit to cross a state highway.
- *Fresno County, Encroachment Permit* – for the crossing of County Road right-of-way.
- *San Joaquin Valley Air Pollution Control District (SJVAPCD)* – for preparation of a Dust Control Plan for construction with disturbs a surface area of five acres or more.
- *Mosquito Abatement*– for operation of an open body of water that could host vectors.

- *Water Supply Organization Approvals: Fresno Irrigation District* - for construction and operations in FID right-of-way with connection to the FID system. Also, agreements with any organization for purchase of water and wheeling of said water through FID.
- *Railroad* – encroachment agreement for crossing railroad property.

6.2.8.9 Legal Authority

FID owns the existing Big Sandridge Canal and has the legal authority to construct the required facilities for the turnout. MAGSA has the legal authority to purchase and secure right-of-way for construction of the proposed canal and dedicated recharge facilities. The canal would be owned by MAGSA and surface water rights secured from FID. MAGSA would coordinate their efforts with FID to pursue recharging with CVP Friant Division Section 215 flood waters as well as other local supplies whenever water becomes available for purchase. Land would need to be purchased from local farmers to build a recharge facility unless an agreement is made for on-farm recharge.

6.2.9 Stinson North Canal Water Supply and Recharge

6.2.9.1 Project Description

This project would convey up to 500 cfs of flood water from the North Fork of the Kings River into the GSA. The conveyance method would be an earthen canal starting from just upstream of the Stinson Weir and then following an alignment roughly between the 195-foot and 200-foot contour lines, as seen in **Figure 6-20.** By following elevation contour lines, flow by gravity may be possible, though some pump stations may be needed pending future investigation. Upon reaching MAGSA, the water would either be put into one or multiple groundwater recharge basins and/or used for on-farm recharge. If the canal were to terminate at a groundwater recharge basin, on-farm recharge along the alignment would still be possible with landowner turnouts. The Stinson North Canal will terminate at the McMullin On-Farm Recharge Project Phase 2 canal and has the potential to connect into the Phase 2 improvements of said recharge project.

The Stinson Weir is an existing check structure along the North Fork of the Kings River. The weir sits in the designated floodway of the Kings River and is about nine miles upstream of the James Weir and McMullin Grade. The existing floodplain has turnouts along the right bank within the project area and continues past the 195-foot contour around Clarkson Ave and Howard Ave. There is a canal adjacent to the floodplain that runs parallel from just south of Harlan Ave until it connects into the Murphy Slough just south of Davis Avenue that will have to be relocated.

Along any of the possible alignments there are seasonal crops, permanent crops, irrigation systems, power poles, storage sheds, storage yards, canals, turnouts, farmer basins, railroad crossings, road crossings, crossing of Murphy Slough, and fencing.

McMullin Area GSA

Stinson North Canal Facilities
Figure 6-20

McMullin Phase 1 Facilities
McMullin Phase 2 and 3 Facilities
Connection to McMullin Facilities
Proposed Facility
Stinson Weir
Phase 1
Phase 2
Phase 3
Liberty
Railroad
North Fork Kings River
Reed Ditch
Millrace Canal
Murphy Slough
TRINITY
ESPERANZA
GRAHAM
NEVADA
MCMULLIN
COLORADO
HOWARD
BISHOP
JAMESON
KAMM
CONEJO
SWANSON
ELKHORN
FLORAL
ROSE
WEST LAWN
GRANTLAND
MOUNTAIN VIEW
DICKENSON
DAVIS
CHATEAU FRESNO
DOWER
GARFIELD
ROLINDA
LASSEN
VINELAND
GOLDENROD
MADERA
CERINI
180
190
200
210
220

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Farm Road Crossing
Paved County Road Crossing
Murphy Slough Crossing
Railroad Crossing
Stinson Weir
Proposed 500 cfs Canal
McMullin Phase 2 and 3 Distribution Canals
McMullin Phase 1 Distribution Canals
Road
USGS Ground Elevation Contour (ft, NAVD88)
McMullin Area GSA
Raisin City WD

McMullin On-Farm Recharge Phases

Phase 1
Phase 2
Phase 3

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The proposed project consists of a new 500 cfs turnout on the Kings River and an earthen canal about 10.5 miles in length from above the Stinson Weir into MAGSA. The canal is very roughly estimated to be a 12-foot-deep trapezoidal earth canal with a 12-foot bottom width and 2:1 (horizontal to vertical ratio) side slopes with water depth of 10 feet to convey the desired 500 cfs to the GSA. About 100 feet of right-of-way would be needed along the alignment. Permanent clearance of existing crops would be needed to construct the canal. More than just the construction area would need to be cleared of crops. Turnaround areas at the end of fields for tractors and other farm equipment (about 35 feet) would also need to be considered in the clearance of the existing crops. The new canal would include turnouts, road crossings, a railroad crossing, and crossings of other canals, as well as possible relocation of irrigation pipelines.

The number of turnouts and crossings will depend on which alignment the GSA choses as well as how many of the existing road crossings are negotiated as part of the real estate actions. Multiple alignments could be considered depending on willingness of the landowners, but one alignment was chosen for the conceptual level at this time. Turnouts would be constructed by the individual landowners.

There are multiple existing facilities that will need crossings, some of which will require pipelines to be installed either by bore and jack methods or by open trench methods. Specific crossings will be required at the Murphy Slough, Southern Pacific Railroad, Fresno County Roads of Elkhorn, Kamm and Conejo Avenues, and multiple farm road crossings. The crossings were conceptually designed as six 72-inch diameter pipes with 0.3-foot headloss across each structure for the 500 cfs flow.

Based on historical hydrology, floodwater from the North Fork of the Kings River would supply the project with water about 40 days per year. Based on the estimated canal capacity of 500 cfs, a total water supply of about 990 AF/day is potentially available to be conveyed into a groundwater recharge basin, used as on-farm recharge, or for irrigation in-lieu of groundwater pumping.

The baseline information necessary to develop the conceptual design was collected using the SAGBI Map developed by UC Davis. These values need to be confirmed by field investigation for further project development. **Figure 6-21** shows a map with SAGBI values to identify fields that are beneficial to on-farm recharge, with green determined to have the greatest potential for recharge for the surface soils (typically 5 to 6 feet in depth). Almost the entirety of the proposed alignment has a SAGBI – Modified rating of very poor to moderately poor. At the northern end of the alignments, a few spots of moderately good and excellent ratings can be found but are scarce. Further investigation will be needed to better understand what infiltration rate may be possible for on-farm recharge, as well as if there are any areas deemed favorable for dedicated recharge.

McMullin Area GSA

SAGBI Rating Soils

Stinson North Canal

Figure 6-21

McMullin Phase 1 Facilities

McMullin Phase 2 and 3 Facilities

Connection to McMullin Facilities

Phase 1

Phase 2

Phase 3

Proposed Facility

Stinson Weir

TRINITY

ESPERANZA

NEVADA

GRAHAM

MCMULLIN

COLORADO

LASSEN

MADERA

VINELAND

GOLDENROD

HOWARD

BISHOP

DOWER

ROLINDA

CHATEAU FRESNO

GARFIELD

DAVIS

DICKENSON

JAMESON

WEST LAWN

FLORAL

ROSE

GRANTLAND

MOUNTAIN VIEW

KAMM

CONEJO

SWANSON

ELKHORN

CERINI

North Fork Kings River

190

200

210

220

- Stinson Weir
- Proposed Stinson North Facility
- McMullin Phase 2 and 3 Distribution Canals
- McMullin Phase 1 Distribution Canals
- Road
- USGS Ground Elevation Contour (ft, NAVD88)
- A Clay Extent
- McMullin Area GSA
- Raisin City WD
- McMullin On Farm Recharge Phases
- Restrictive Layer (Duripan or Abrupt Textural Change)

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6.2.9.2 Measurable Objectives

This project will address declining water levels and the declining volume of groundwater stored in the aquifer. The main goal of this project is to secure up to 2,000 acres of farmland for on-farm recharge of up to 990 AF/day during the rainy season. If the maximum possible flow is delivered over the 40 days of high flows in Kings River, then the average annual recharge potential is approximately 39,000 AF. The water level of existing groundwater wells in the area will be measured and monitored and samples will be periodically collected for typical agricultural irrigation suitability water quality testing. This data will be used to establish the current groundwater levels and quality for baseline comparison in order to determine if there are changes occurring from project operation and for quantification of overdraft mitigation.

6.2.9.3 Project Benefits and Water Reliability

As stated previously, a water supply of about 990 AF/day is potentially available to be conveyed into a groundwater recharge basin or used as on-farm recharge, which equates to 39,670 AF on an average annual basis for the 40 days of Kings River flows. For both recharge options, an infiltration rate of 0.5 feet per day is estimated. To recharge 990 AF daily, approximately 2,000 acres would be needed for on-farm recharge. The amount of water that this project can recharge would depend on the acreage of land chosen for a groundwater recharge basin and/or on-farm recharge. The removal of about 540 acres of permanent crops for dedicated recharge facilities, canal easements, and turnaround areas adjacent to the facilities will also reduce pumping by about 1,620 AF annually (if 3 AF/acre was the typical pumping).

6.2.9.4 Management of Groundwater Extractions and Recharge

The project could either be owned and operated by MAGSA or jointly with other agencies as a necessary part of meeting the requirements of the SGMA. Management of groundwater extractions and recharge is possible by tracking water levels over time and monitoring stream flow in the canals that deliver water to the recharge sites. Data can be reported to MAGSA to make sure levels do not continue to decline. This project will recharge groundwater in the wet season to help offset pumping during the summer and during droughts. In the event of a drought or in the occasion that the recharge rate is not enough to mitigate overdraft to the measurable objective, management actions affecting groundwater extractions will be taken, which are described in further detail in **Section 6.3** and following. The severity of the situation will dictate the actions taken. Priority will be given to actions that can be implemented in a relatively short amount of time and have a high benefit to cost ratio.

6.2.9.5 Project Cost Estimate/Acre-Foot of Yield

Table 6-25 shows probable construction costs based on similar projects for the conceptual level of design for the Stinson North Canal project. The total cost of the project is estimated at about $61 million. Assuming a 5% interest rate loan, annualized over a 30-year period, the annual repayment cost is expected to be $4 million (**Table 6-26**). The material required to complete this project is expected to last 30 years or more. The portion of the water cost due to capital expenditures on an average annual basis is expected to be about $100 per acre-foot for a yield of 39,669 acre-feet. Costs will be further developed once the project proceeds to a more detailed level of design. Based on this project being at a conceptual level of design, a 30% contingency was presumed. The costs do not include the cost to purchase the water. MAGSA will fund the project. Grant funding will be pursued and used to offset project costs if available.

Table 6-25 Summary of Probable Construction Costs for Stinson North Canal

Item	Description	Amount
Field Costs	New Conveyance Canal (500 cfs capacity for 10.5 miles)	$25,962,000
General Conditions	Mobilization/Demobilization, Bonds and Insurance, Construction Permits, Protect and Replace Existing Facilities, and Change Order Contingency	$ 3,635,000
Right of Way Acquisitions	Basin Land Acquisition-320 Acres, Canal Right-of-Way 130 Acres	$ 7,350,000
Non-Contract Costs	Design Data, Data Collection, Design, Permitting, & Construction Management	$10,064,000
Contingency	30% based on conceptual design	$14,103,000
	Total Capital Cost	$61,114,000

Table 6-26 Summary of Cost per AF for Stinson North Canal

Stinson North Canal Water Supply & Recharge Project			
Total Capital Cost	Capital Repayment	Annual Yield AF	Cost Per AF
$61,114,000	$3,976,000	39,670	$100

Notes:

1. Assumes 5% interest rate loan annualized over a 30-year period.
2. No operations or maintenance costs are included.
3. Water purchase costs will be an additional cost as well as landowner turnouts.

6.2.9.6 Circumstances of Implementation

This project plays an important role in MAGSA meeting its sustainability goals. It is dependent upon the willingness of farmers and landowners who would be willing to either sell their land for the purpose of creating a recharge basin or use their farm for on-farm recharge. Before implementation of the project, land and funding must be secured. Once there is funding and approval from landowners, there are no other circumstances necessary to implementation of this project. It has been listed as a low priority project based on reliability of water source, cost effectiveness, water rights, and other relevant factors, as discussed in **Section 6.2.16**.

6.2.9.7 Project Status and Schedule

The conceptual phase of this project is complete and waiting to secure funding before permitting, design and implementation begin. Environmental documentation and permitting could take as long as five years, and construction 24 months. It is anticipated that MAGSA will start working on securing funding within the first 5 years of GSP implementation.

6.2.9.8 Permitting and Regulatory Process

It is anticipated that approvals from the following agencies will be required:

- *Army Corps of Engineers (Army Corps), 404 Permit* – for work within a Water of the US.
- *Federal Endangered Species Act* – for potential impacts to federally endangered species which potentially occur in the North Fork of the Kings River.
- *California Environmental Quality Act (CEQA)* – compliance with CEQA for project approval.
- *Central Valley Flood Protection Board (CVFPB), Encroachment Permit* – For work within a State Designated Floodway.
- *Department of Fish and Wildlife, Stream Bed Alteration Agreement* – for work within the North Fork of the Kings River, a Water of the State.

- *Regional Water Quality Control Board (RWQCB), Section 401 Water Quality Certification* – for compliance with the Clean Water Act in conjunction with the Army Corps 404 permit.
- *State Endangered Species Act* – for potential impacts to state endangered species which potentially occur in the North Fork of the Kings River.
- *State Water Resources Control Board, Stormwater Pollution Prevention Plan (SWPPP)* - for construction that disturbs more than five acres.
- *Pacific Gas & Electric Company (PG&E), Application for Service* - for electrical service to new and/or larger pump stations.
- *Fresno County, Building Permit* – for any electrical work to service facilities.
- *Fresno County, Encroachment Permit* – for the crossing of County Road right-of-way.
- *San Joaquin Valley Air Pollution Control District (SJVAPCD)* – for preparation of a Dust Control Plan for construction with disturbs a surface area of five acres or more.
- *Mosquito Abatement* – for operation of an open body of water that could host vectors.
- *Water Supply Organization Approvals* – with Kings River Water Association for an agreement for supply of water from the Kings River.
- *Railroad* – for an encroachment permit for crossing railroad property.

In addition, the alignments are outside of MAGSA and in an area that is not within any water district. MAGSA will have to work with the North Fork Kings GSA whom may want to participate in the project and obtain part of the project yield when there are Kings River flows available.

6.2.9.9 Legal Authority

Since the project is not located entirely within MAGSA boundaries, MAGSA may have to work with the North Fork Kings GSA to get project approval.

6.2.10 Grantland Area Recharge

6.2.10.1 Project Description

Due to the proximity of the Liberty Millrace Canal (LMC) to RCWD, a connection with the LMC was investigated to divert Kings River floodwater when available. The LMC is operated by Laguna Irrigation District on behalf of the Liberty Millrace Canal Co. The connection would be accomplished through the development of a new conveyance canal from the LMC into the RCWD area of MAGSA at the Grantland Avenue alignment. This will allow MAGSA to develop a groundwater recharge project, or projects, to capture excess surface water during wet years and replenish the aquifer through either direct recharge, on-farm recharge, or an in-lieu recharge method.

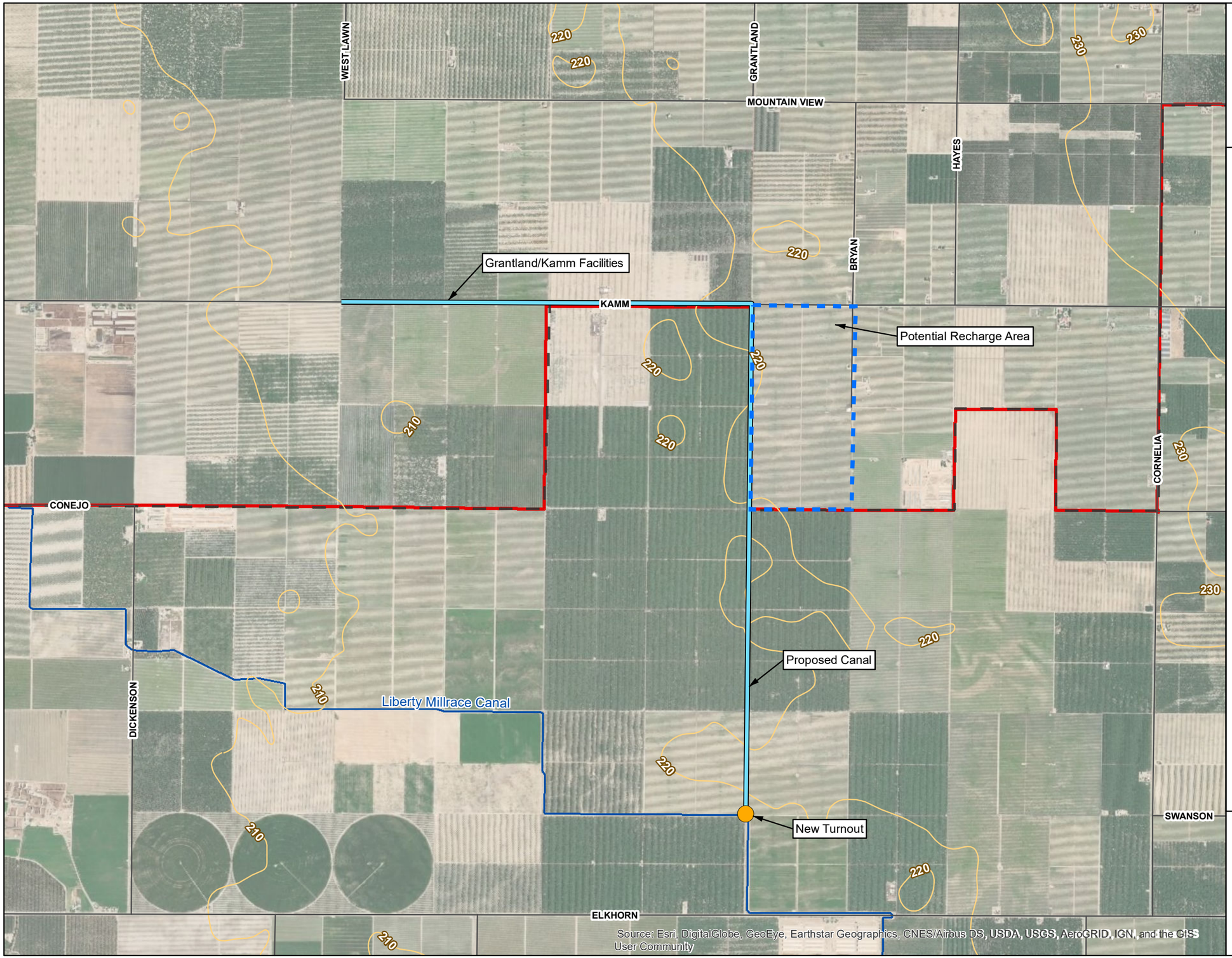
The project includes building a new 100 cfs canal to convey flood water from the LMC when available and a pump station to move water from the canal to a new 320-acre groundwater recharge facility. The proposed groundwater recharge basin and/or adjacent properties are in an area preliminarily deemed favorable for recharge in the southeasterly portion of MAGSA. Previously identified possible groundwater recharge basin locations are between Bryan and Grantland Avenues, and between Kamm and Conejo Avenues (**Figure 6-22**). Other possible groundwater recharge basin locations or on-farm recharge sites could be sited east of the Grantland and Kamm area between that site and Cornelia Avenue.

The proposed canal alignment is located along Grantland Avenue about 2.5 miles from the LMC at Swanson Avenue to Kamm Avenue, and then follows west along Kamm Avenue 2 miles, terminating at Westlawn Avenue (**Figure 6-22**), which is approximately the extent of the most favorable recharge area. It is unlikely that any facility along Kamm Avenue would be located any further than another ½ mile, as the surface soils recharge capability is diminished, and A-clay is likely to be encountered. However, other possible alignments could be followed off the LMC along Hayes or Cornelia Avenues.

McMullin Area GSA

Grantland Area Recharge
Project Facilities

Figure 6-22



- Turnout
- Proposed Canal
- Liberty Millrace Canal
- Road
- USGS Ground Elevation Contour (ft, NAVD88)
- Potential Recharge Location
- McMullin Area GSA
- Raisin City WD

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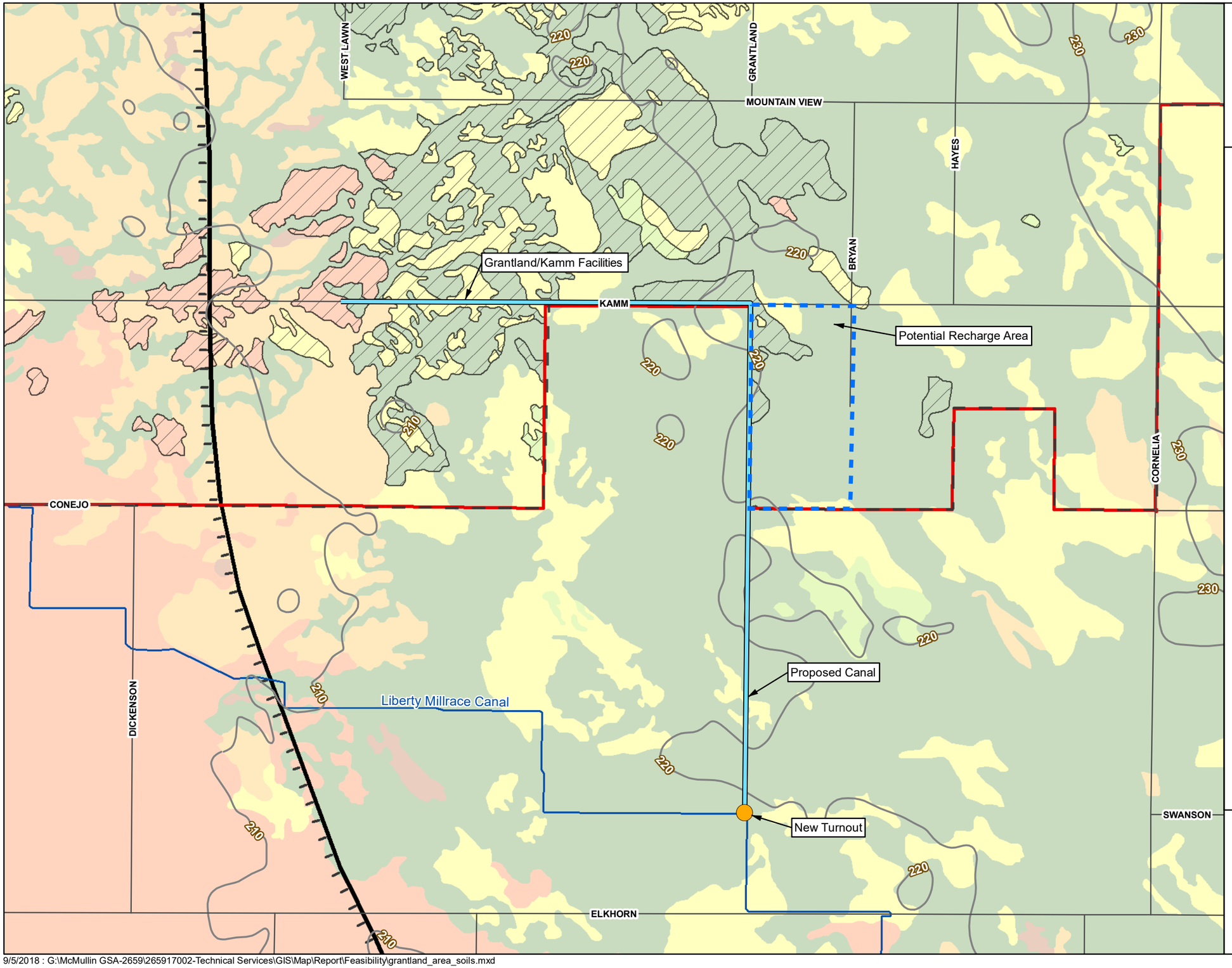
According to LID staff, the LMC has a capacity of approximately 220 cfs at the head of the canal where it crosses Elkhorn Avenue. The capacity reduces to 126 cfs by the time it reaches the proposed Grantland turnout. Demand downstream of the turnout is estimated to be about 93 cfs, leaving only 33 cfs possible for diversion. Hydraulic modeling indicates that, with proposed improvements, the capacity of the canal can be increased by approximately 100 cfs when supply is available. The project area could potentially receive approximately 7,920 AF of Kings River surface water on an average annual basis. This volume is based on 100 cfs (198 AF/day) diversion for 40 days over the average annual flood release period. For the January to June period, floodwaters on average occurred over 83 days, almost double the average annual amount for 17 of the 22 flood events. Therefore, it is possible that about double the recharge area could be needed in a given year compared to the average annual amount.

The baseline information necessary to develop the conceptual design was collected using the SAGBI mapping developed by researchers from UC Davis. The suitability of an area for recharge needs to be confirmed by further investigation and soil borings in the field as part of future project development. The previously selected parcels (APN 041-200-39S and APN 041-200-02S) were classified as having a high potential suitability for groundwater recharge. The sites also fall within an area known to overlie the Corcoran clay (E-Clay) which is approximately 550 feet below ground surface (bgs).

Figure 6-23 shows a map with SAGBI values to identify fields that are beneficial to on-farm recharge, with green determined to have the greatest potential for surface soils recharge (typically 5 to 6 feet in depth). The area between Westlawn and Grantland Avenues has a mix of SAGBI – Modified rating of excellent and moderately good, though a restrictive layer covers most of the area. East of Grantland Avenue to the border of the GSA at Brawley Avenue, the SAGBI – Modified rating is mostly excellent (except for the area between Grantland and Hayes Avenues, and Floral and Saginaw Avenues, which has a rating of mostly moderately good) and the restrictive layer is minimal.



McMullin Area GSA

SAGBI Rating Soils

Grantland Area Recharge Project

Figure 6-23

- Turnout
- Proposed Canal
- Liberty Millrace Canal
- Road
- USGS Ground Elevation Contour (ft, NAVD88)
- Potential Recharge Location
- McMullin Area GSA
- Raisin City WD
- A Clay Extent
- Restrictive Layer (Duripan or Abrupt Textural Change)

Soil Agricultural Groundwater Banking Index

SAGBI Rating - Modified

- 0 -15 Very Poor
- 15 - 29 Poor
- 29 - 49 Moderately Poor
- 49 - 69 Moderately Good
- 69 - 85 Good
- 85 - 100 Excellent

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A new check and turnout structure would need to be designed and constructed in the LMC that would divert water into a new earthen canal to convey the water by gravity into the GSA. Due to the Grantland alignment roughly following the 220-foot elevation contour, conveyance by gravity into the GSA should be possible, though pump stations may be needed to get the water out of the canal.

The earthen canal is estimated to be a 5-foot deep, trapezoidal canal with a bottom width of 20 feet and 2:1 side slopes (horizontal to vertical ratio) to convey the desired 100 cfs to the GSA. This conveyance option would need about 70 feet of right-of-way. Clearance of existing permanent crops would be needed to construct the canal. More than just the construction area might need to be cleared of crops, depending on the width of the existing dirt roads along the alignment. Turnaround areas at the end of fields for tractors and other farm equipment (about 35 feet) and a temporary construction easement will also need to be considered in the clearance of the existing crops.

A lift pump will be needed at the basin site to overcome the elevation difference between the new canal water surface and the basin if a groundwater recharge basin location is chosen. The potential basin is estimated to have 1.5 to 2 feet of freeboard, an inside slope of 5:1 (horizontal to vertical ratio), an outboard slope of 3:1 horizontal to vertical ratio, and a levee top width of 15 feet. Basin depth, levee height, and levee fill depth would be dependent on existing site conditions.

If a groundwater recharge basin site is unattainable, flood irrigation systems may need to be installed on suitable adjacent properties for on-farm recharge and irrigation in-lieu of groundwater pumping. Approximately 1,000 acres would be needed to recharge 100 cfs, assuming an infiltration rate of 0.2 feet/day (Bachand & Associates, 2012).

Along with the new facilities, the hydraulic modeling included some channel capacity improvements to increase the capacity of the existing LMC to allow the desired 100 cfs flow rate to be delivered to MAGSA. These improvements included removal of areas of high sediment deposits, grading on the channel invert where there is an existing drop, and raising the embankments one to two feet in some areas as shown in **Figure 6-24**.

MARKS AVE CROSSING — CHECK STRUCTURES AND CROSSINGS

CHECK STRUCTURE — CHECK STRUCTURES AND CROSSINGS THAT WILL OVERTOP WITH THE 290 CFS FLOW PROFILE

350 = 350+00 = 35,000' — STATIONING IN 100s OF FEET

± 1' FILL TO RAISE BANK ON ONE SIDE

± 1' FILL TO RAISE BANKS ON BOTH SIDES

± 2' FILL TO RAISE BANKS ON BOTH SIDES

SCALE IN FEET
0 500 1000 2000

LIBERTY MILLRACE CANAL

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PRELIMINARY
NOT FOR CONSTRUCTION
1/11/18

Figure 6-24

No.	REVISION	BY	DATE

FOR REVIEW ONLY

LIBERTY MILLRACE CANAL CAPACITY ANALYSIS
RAISIN CITY WATER DISTRICT
FRESNO COUNTY
####

LIBERT MILLRACE CANAL EXHIBIT

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LICENSE NO: ####

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DATE: 1/11/2018

JOB NO: 111617002

PROJECT NO: ####

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6.2.10.2 Measurable Objectives

This project will address declining water levels and the declining volume of groundwater stored in the aquifer. The main goal of this project is to recharge approximately 8,000 AF of water from Kings River surface flows per year within the boundaries of MAGSA. Surface water that is delivered to the project site will be measured regularly. The water level of existing groundwater wells in the area will be measured and monitored and samples will be periodically collected for typical agricultural irrigation suitability water quality testing. This data will be used to establish the current groundwater levels and quality for baseline comparison in order to determine if there are changes occurring from project operation and for quantification of overdraft mitigation.

6.2.10.3 Project Benefits and Water Reliability

Groundwater is the primary water supply for landowners within the GSA, and the project will increase the reliability of the groundwater supply, helping lead to sustainable water resource management. By diverting flood water in wet years, the project will lessen the burden on the downstream flood control facilities and provide an additional factor of safety to protect the communities and land that depends on the facilities for protection. Approximately 7,920 AF of surface water can be recharged on an average annual basis based on the typical duration of 40 days for Kings River flood flows. The removal of about 369 acres of permanent crops for dedicated recharge facilities, canal easements, and turnaround areas adjacent to the facilities will also reduce pumping by about 1,100 AF annually (if 3 AF/acre was the typical pumping).

6.2.10.4 Management of Groundwater Extractions and Recharge

The project would be owned and operated by MAGSA as a necessary part of meeting the requirements of the SGMA. Management of groundwater extractions and recharge is possible by tracking water levels over time and monitoring stream flow in the canals that deliver water to the recharge sites. Data can be reported to MAGSA to make sure levels do not continue to decline. This project will recharge groundwater in the wet season to help offset pumping during the summer and during droughts. In the event of a drought or in the occasion that the recharge rate is not enough to mitigate overdraft to the measurable objective, management actions affecting groundwater extractions will be taken, which are described in further detail in **Section 6.3** and following. The severity of the situation will dictate the actions taken. Priority will be given to actions that can be implemented in a relatively short amount of time and have a high benefit to cost ratio.

6.2.10.5 Project Cost Estimate/Acre-Foot of Yield

Table 6-27 shows probable construction costs based on similar projects for the conceptual level of design. The total cost of the project is estimated at about $22 million. Assuming a 5% interest rate loan, annualized over a 30-year period, the annual repayment cost is expected to be $1.4 million (**Table 6-28**). The material required to complete this project is expected to last 30 years or more. The portion of the water cost due to capital expenditures, on an average annual basis, is expected to be about $181 per acre-foot for a yield of 7,920 acre-feet. Costs will be further developed once the project proceeds to a more detailed level of design. Based on this project being at a conceptual level of design, a 30% contingency was presumed. The costs do not include the cost to purchase the water. RCWD will fund the project. Grant funding will be pursued and used to offset project costs if available.

Table 6-27 Summary of Probable Construction Costs for Grantland

Item	Description	Amount
Field Costs	Liberty Millrace Canal Earthwork Modifications, New Conveyance Canal, 320 Acre Groundwater Recharge Basin	$7,533,000
General Conditions	Mobilization/Demobilization, Bonds and Insurance, Construction Permits, Protect and Replace Existing Facilities, and Change Order Contingency	$1,057,000
Right of Way Acquisitions	Easements and Procurement Costs	$5,445,000
Non-Contract Costs	Design Data, Data Collection, Design, Permitting, & Construction Management	$2,921,000
Contingency	30% based on conceptual design	$5,087,000
	Total Capital Cost	$22,043,000

Table 6-28 Summary of Cost per AF for Grantland Area Recharge Project

Grantland Area Recharge Project			
Total Capital Cost	Capital Repayment	Annual Yield AF	Cost Per AF
$22,043,000	$1,434,000	7,920	$181

Notes:

1. Assumes 5% interest rate loan annualized over a 30-year period.
2. Assumes pumps will last 30 years
3. No operations or maintenance costs are included
4. Water purchase costs will be an additional cost

6.2.10.6 Circumstances of Implementation

Cooperation of nearby farmers for on-farm recharge or willingness of landowners to sell property for a recharge basin needs to occur for implementation of this project to begin. Once recharge land and a source of funding have been secured, implementation of this project may begin. It has been listed as a low priority project based on reliability of water source, cost effectiveness, assurance of water rights, and other relevant factors, as discussed in **Section 6.2.16**.

6.2.10.7 Project Status and Schedule

The initial preliminary investigation regarding project viability was conducted for the RCWD Board of Directors in 2017. An analysis of the Kings River floodwater availability and a conceptual design and cost estimate for the project has already been completed. A hydraulic analysis on the LMC has also been completed and recommendations for channel improvements would provide the increased capacity necessary for the success of this project. Once funding is secured, environmental documents and permitting could be completed within 6 to 9 months, while the engineering design and construction phases would take another 9 to 12 months. It is anticipated that MAGSA will start working to secure funding within the first five years of GSP implementation.

6.2.10.8 Permitting and Regulatory Process

It is anticipated that approvals from the following agencies will be required:

- *California Environmental Quality Act (CEQA)* – compliance with CEQA for project approval.
- *State Water Resources Control Board, Stormwater Pollution Prevention Plan (SWPPP)* - for construction that disturbs more than five acres.
- *Pacific Gas & Electric Company (PG&E), Application for Service* - for electrical service to new and/or larger pump stations.
- *Fresno County, Building Permit* – for any electrical work to service facilities.
- *Fresno County, Encroachment Permit* – for the crossing of County Road right-of-way.

- *San Joaquin Valley Air Pollution Control District (SJVAPCD)* – for preparation of a Dust Control Plan for construction with disturbs a surface area of 5 acres or more.
- *Mosquito Abatement* – for operation of an open body of water that could host vectors.
- *Water Supply Organization Approvals* – from Liberty Millrace Canal Co. for construction and operations in the LMC right-of-way. Also, agreements with any organization for purchase of water and wheeling of said water through LMC or LID managed facilities.

6.2.10.9 Legal Authority

The project would be owned and operated by RCWD. The LMC is an existing canal owned by a local canal company (a KRWA member unit) and operated by LID that runs outside of the MAGSA southern border. An agreement with the LMC owner for constructing the turnout structure will likely be required and it is anticipated that the connection will need to be constructed outside of the normal irrigation season.

6.2.11 Consolidated ID Wristen Ditch Intertie

6.2.11.1 Project Description

MAGSA and RCWD are interested in working with CID to divert water from the Wristen Ditch for recharge. The project includes about 5.25 miles of canal from the CID's Wristen Ditch at Manning Avenue to convey 40 cfs of Kings River floodwater when available along Manning Avenue into the GSA to then be diverted to nearby properties for on-farm recharge.

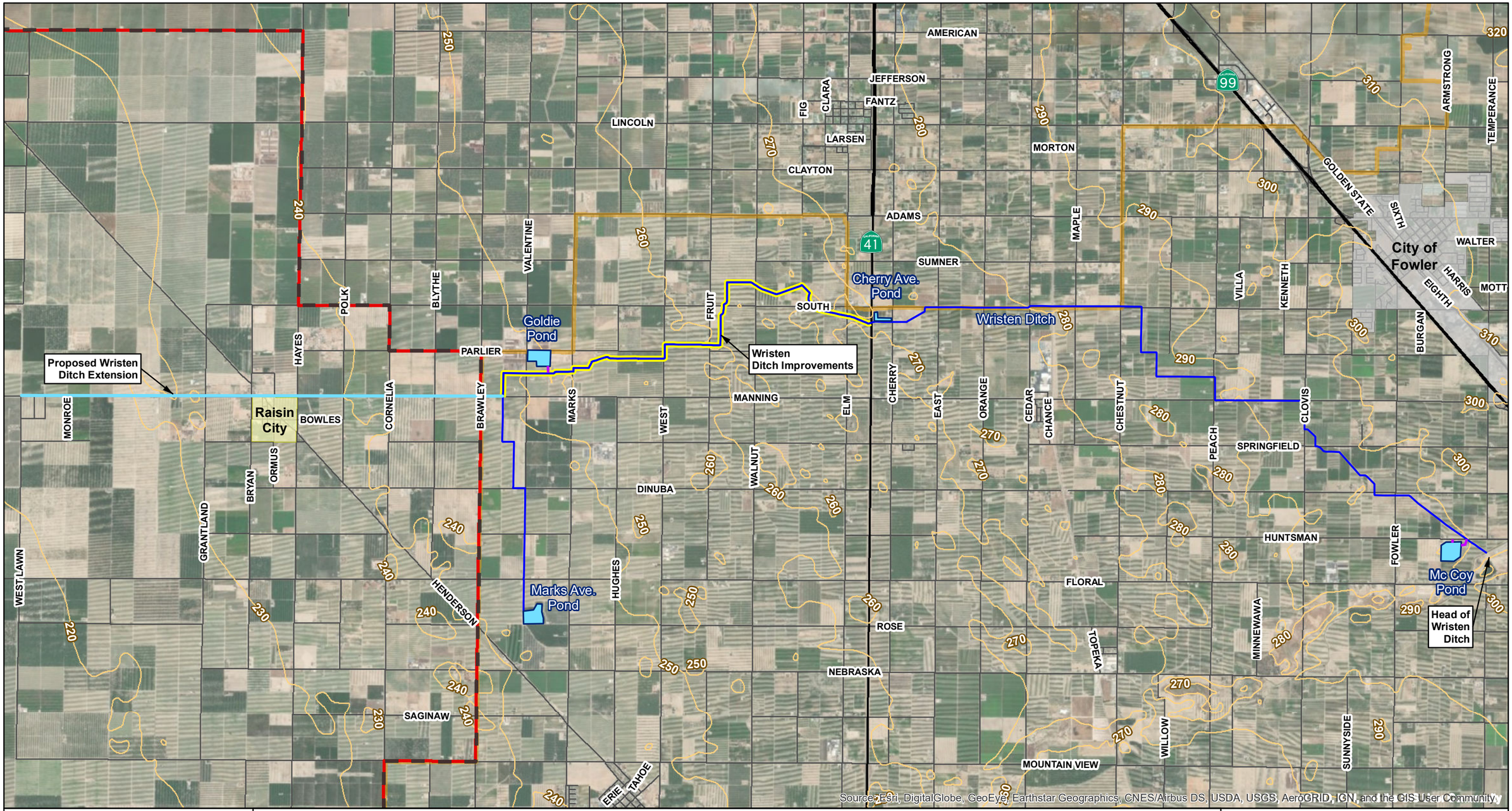
Actual net acreage for this project will depend on grower participation. The on-farm recharge rate for the project area has been estimated by others (Bachand & Associates, 2012) at about 0.20 ft/day. The capacity of the entire system is determined by the new Wristen Ditch turnout which will be 40 cfs or a volume of 80 acre-feet per day. Based on historical hydrology, Kings River floodwater is available 40 days per year on an average annual basis. The total water supplied for this project is estimated by assuming 40 cfs can be diverted for all 40 days when flood water is available which totals about 3,175 AF annually.

The CID demand during the irrigation offseason was estimated by totaling the area of CID recharge ponds on the Wristen Ditch. **Table 6-29** shows the flow for existing recharge in the Wristen Ditch and adjacent basins assuming an infiltration rate of 0.5 ft/day. The total flow required for the proposed project and existing recharge by CID is therefore estimated at about 71 cfs, with 31 cfs being reserved for CID. Demand will likely be greater when adjoining landowners are irrigating.

Table 6-29 Estimated Recharge Demand for the Wristen Ditch

Recharge Areas	Acreage (AC)	Infiltration Rate (ft/day)	Acre Feet (AF)	Flow (cfs)
McCoy Pond	27	0.5	13.5	6.8
Cherry Pond	5	0.5	2.5	1.3
Goldie Pond	24	0.5	12	6.1
Marks Pond	32	0.5	16	8.1
Wristen Ditch	34.5	0.5	17.25	8.7
		Proposed Canal Demand		40
			Total Flow	**71**

The proposed project will be in the southeast portion of MAGSA. There will be a turnout on the Wristen ditch in CID at Manning Avenue after the piped section when the Wristen Ditch reverts back to a canal. The new canal for this project will start at that turnout and head west along Manning Avenue, terminating at Westlawn Avenue as shown in **Figure 6-25.**



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- McMullin Area GSA
- Raisin City Community
- Raisin City WD
- Consolidated ID
- City Limits
- Existing Pond
- Wristen Ditch
- Proposed Facility Improvements
- Proposed New Canal

McMullin Area GSA

Wristin Ditch Extension Intertie

Figure 6-27

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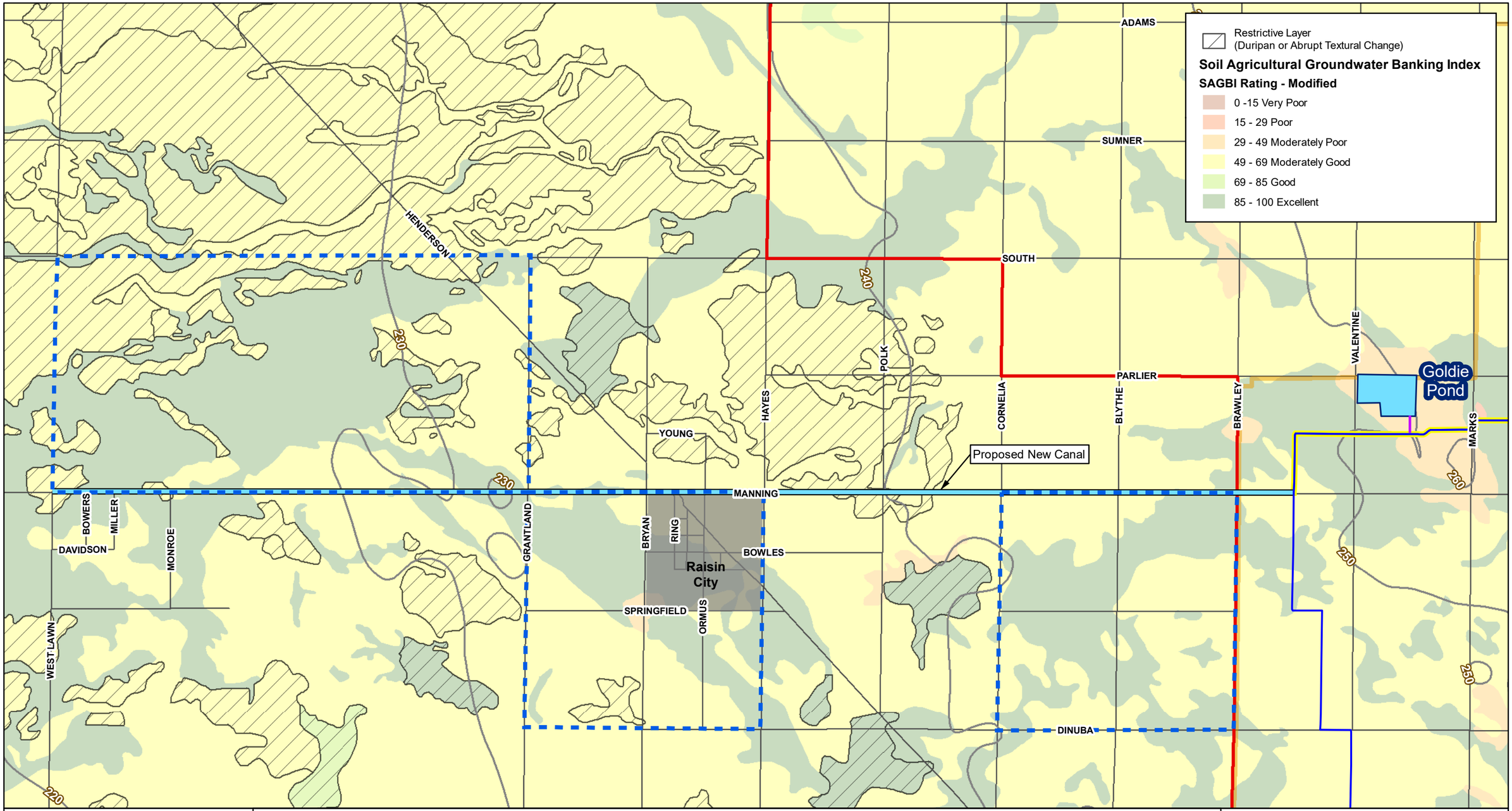
Figure 6-26 shows the SAGBI information for this area in relation to the new canal alignment. There are three areas of favorable recharge with the first area between Manning Avenue and Dinuba and between Brawley Avenue and Cornelia Avenue. The second area of apparent favorable recharge is between Manning Avenue and Dinuba Avenue and between Hayes Avenue and Grantland Avenue. The third area of apparent favorable recharge is between South Avenue and Manning Avenue and between Grantland Avenue and Westlawn Avenue.

The area between Brawley Avenue and Cornelia Avenue has a mix of SAGBI – Modified soil ratings of excellent and moderately good with no restrictive layer, as seen in **Figure 6-26**. From Hayes Avenue to Grantland Avenue, the SAGBI – Modified rating is a mix of excellent and moderately good (apart from the area near the intersection of Bryan and Springfield which has a rating of moderately poor) and the southwest corner by Grantland Ave and Dinuba Ave which has a restrictive layer and is the edge of the Corcoran clay. The area between Grantland Ave and Westlawn has a mix of SAGBI – Modified ratings of excellent and moderately good with some restrictive layers in the moderately good areas. The west side of this site also falls within an area known to overlie the Corcoran clay (E-Clay), which is approximately 550 ft below ground surface (bgs).



McMullin Area GSA

SAGBI Rating Soils

Wristin Ditch Intertie
Figure 6-26

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The existing facility for this project is the Wristen Ditch in CID. According to a report by WRIME (2012), the Wristen Ditch has a headgate capacity of about 100 cfs and a tail-end capacity of about 45 cfs. The study also identifies constraints along the Wristen Ditch that limit the flow through the canal. To increase capacity in the ditch, the canal would need to be enlarged starting downstream of Highway 41, an additional siphon pipe under Highway 41 would need to be added, and a piped section running between Valentine and Manning Avenues for about ½ mile would need to be enlarged.

The Wristen Ditch will need to be improved downstream of Highway 41 to have enough capacity for 71 cfs. The existing flow capacity of the ditch is around 30-50 cfs based on the cross-section measurements from the site visit and assuming a slope of 1 foot/mile. To increase the capacity, the canal would need to be excavated to a level of about 1 foot deeper.

Piped sections of the Wristen Ditch are limiting the flowrate through the Wristen facility. Caltrans record drawings show the Highway 41 underpass as a 60-inch concrete pipe which would allow flow of approximately 50 cfs with head loss of about ¼ foot and a velocity of 2.5 feet/second. An additional pipeline with diameter of about 42 inches will be needed to allow the total capacity to be about 71 cfs (based on ¼ foot of head loss across the siphon).

A second piped section that will need to be improved to increase the flow rate is a ½ mile of 48-inch pipe just upstream of the diversion point for this project (the section between Valentine and Manning Avenues). The pipe measured 42 inches at the inlet on Valentine, and the outlet about 48-inches at the outlet on the south side of Manning Avenue. The 48-inch pipe would currently allow approximately 21 cfs with a head loss of ¾ foot and a velocity of 2 feet/second. The pipes need to be at least 72-inch diameter to handle 71 cfs with 0.6 feet head loss and a velocity of about 3 feet/second, or the addition would be needed of a 60-inch diameter concrete pipe to increase the capacity by 40 cfs with ¾ foot head loss. The canal and piped sections need to be enlarged to handle an additional 40 cfs for the proposed project as well as the existing flow demand for recharge during the wet months.

A new canal would be installed as part of this project in order to divert water by gravity from the Wristen Ditch into MAGSA along Manning Avenue to recharge by on-farm recharge. The canal would be constructed on the south side of Manning Avenue and be about 5.25 miles long and is proposed to terminate at about Westlawn Avenue. A new turnout structure would be designed and constructed in the Wristen Ditch that would divert water into a new earthen canal that would optimize the use of gravity to convey the water into MAGSA.

The earthen canal conveyance is estimated to be 4-foot-deep trapezoidal earth canal with an 8-foot bottom width and 2:1 (horizontal to vertical ratio) side slopes to convey the desired 40 cfs into MAGSA as far as Westlawn Avenue. This canal would need about 50 feet of right-of-way. Permanent clearance of existing crops would be needed to construct the canal. Clearance of the crops may require more than just the construction area depending on the width of the existing dirt roads along the alignment. Turnaround areas at the end of fields for tractors and other farm equipment (about 35 feet) will also need to be considered in the clearance of the existing crops.

Another alternative that may be more favorable to CID could be to construct facilities in CID for recharge and pay CID for the groundwater credit. CID may be more favorable to this approach as the facility improvements are in CID and could also be used for CID as well. The location is also in the Kings River water rights Place of Use, and CID would benefit from the higher groundwater levels that would result from the recharge. MAGSA would benefit from lower facility costs for transporting the water over long distances. However, the methodology to transfer groundwater between GSAs is yet to be developed through the Kings Basin coordinated GSA efforts.

6.2.11.2 Measurable Objectives

This project will address declining water levels and the declining volume of groundwater stored in the aquifer. The main goal of this project is to increase groundwater recharge within the boundaries of RCWD and MAGSA to mitigate overdrafting through a diversion of surface water or a groundwater transfer. Groundwater levels and quality can be monitored by taking samples from existing wells around the area and comparing them to current conditions.

6.2.11.3 Project Benefits and Water Reliability

The capacity available for recharge was estimated by the flow being diverted for this project and the number of days the flood water would be available. The capacity of the project is about 40 cfs or volume of 80 acre-feet per day. For the average annual flood duration of about 40 days, the 40 cfs of turnout capacity available for recharge (direct or in-lieu) for the project could generate about 80 AF/day or 3,175 AF. The on-farm recharge rate for the project area has been estimated by others at about 0.20 ft/day (Bachand & Associates, 2012). To recharge 3,200 AF assuming 0.20 ft/day for the recharge rate, approximately 400 acres would be needed for on-farm recharge (400 acres x 0.20 ft/day = 80 acres). However, the 40 days is an average annual number, and in a majority of years about 83 days of flood flows have been available for the January to June period, almost double the average annual amount for 17 of the 22 flood events. Therefore, about double the recharge period is possible in most years. The removal of about 73 acres of permanent crops for canal easements and turnaround areas adjacent to the facilities will also reduce pumping by about 220 AF annually (if 3 AF/acre was the typical pumping).

6.2.11.4 Management of Groundwater Extractions and Recharge

The project would be owned and operated by RCWD or MAGSA as a necessary part of meeting the requirements of the SGMA. Management of groundwater extractions and recharge is possible by keeping track of water levels over time and monitoring stream flow in the canals that deliver water to the recharge sites. Data can be reported to MAGSA to make sure levels do not continue to decline. This project will recharge groundwater in the wet season to help offset pumping during the summer and during droughts. In the event of a drought or in the occasion that the recharge rate is not enough to mitigate overdraft to the measurable objective, management actions affecting groundwater extractions will be taken, which are described in further detail in **Section 6.3** and following. The severity of the situation will dictate the actions taken. Priority will be given to actions that can be implemented in a relatively short amount of time and have a high benefit to cost ratio.

6.2.11.5 Project Cost Estimate/Acre-Foot of Yield

Table 6-30 shows probable construction costs based on similar projects for the conceptual level of design. The total cost of the project is estimated at about $13.4 million. Assuming a 5% interest rate loan, annualized over a 30-year period, the annual repayment cost is expected to be $873,000 (**Table 6-31**). The material required to complete this project is expected to last 30 years or more. The portion of the water cost due to capital expenditures, on an average annual basis, is expected to be about $275 per acre-foot. Costs will be further developed once the project proceeds to a more detailed level of design. Based on this project being at a conceptual level of design, a 30% contingency was presumed. The costs do not include the cost to purchase the water. RCWD or MAGSA will fund the project. Grant funding will be pursued and used to offset project costs if available.

Table 6-30 Summary of Probable Construction Cost for Wristen Ditch Intertie

Item	Description	Amount
Field Costs	New Canal Alignment, Wristen Ditch Improvements, Highway 41 crossing	$ 6,062,000
General Conditions	Mobilization/Demobilization, Bonds and Insurance, Construction Permits, Protect and Replace Existing Facilities, and Change Order Contingency	$ 847,000
Right of Way Acquisitions	75-foot wide Easement, 5.25 miles and Procurement Costs	$ 1,065,000
Non-Contract Costs	Design Data, Data Collection, Design, Permitting, & Construction Management	$ 2,349,000
Contingency	30% based on conceptual design	$ 3,097,000
	Total Capital Cost	$ 13,420,000

Table 6-31 Summary of Cost per AF for Wristen Ditch Intertie

CID Wristen Ditch Intertie			
Total Capital Cost	Capital Repayment	Annual Yield AF	Cost Per AF
$13,420,000	$873,000	3,175	$275

Notes:

1. Assumes 5% interest rate loan annualized over a 30-year period.
2. No operations or maintenance costs are included.
3. Water purchase costs will be an additional cost.

6.2.11.6 Circumstances of Implementation

This project would be helpful in trying to mitigate groundwater overdrafting, however, the cost per AF is high in comparison to other proposed projects. It is not a high priority project due to the difficulty of implementation as well as the high associated cost. This project would only be implemented if water levels are still drastically declining after implementation of the previous projects and various management actions. The last circumstance that would need to be met is a secured source of funding. It has been listed as a low priority project based on reliability of water source, cost effectiveness, assurance of water rights, and other relevant factors, as discussed in **Section 6.2.16**.

6.2.11.7 Project Status and Schedule

The project is currently in its conceptual phase. Should the GSA decide to move forward with implementation, environmental documentation, agreements, and project design would take 9 to 12 months and construction would take approximately 6 to 9 months. It is anticipated that MAGSA will start working to secure funding for projects within the first five years of GSP implementation.

6.2.11.8 Permitting and Regulatory Process

It is anticipated that approvals from the following agencies will be required:

- *California Environmental Quality Act (CEQA)* – compliance with CEQA for project approval.
- *State Water Resources Control Board, Stormwater Pollution Prevention Plan (SWPPP)* - for construction that disturbs more than five acres.
- *Caltrans* – for an encroachment permit to cross a state highway.
- *Pacific Gas & Electric Company (PG&E), Application for Service* - for electrical service to new and/or larger pump stations.
- *Fresno County, Building Permit* – for any electrical work to service facilities.
- *Fresno County, Encroachment Permit* – for the crossing of County Road right-of-way.

- *San Joaquin Valley Air Pollution Control District (SJVAPCD)* – for preparation of a Dust Control Plan for construction with disturbs a surface area of five acres or more.
- *Mosquito Abatement* – for operation of an open body of water that could host vectors.
- *Water Supply Organization Approvals* – from Consolidated Irrigation District for connection to the CID system and right-of-way, as well as agreements for purchase of water and wheeling of said water through CID. Kings River Water Association for an agreement for supply of water from the Kings River.

In addition, the Wristen Ditch is within the Central Kings GSA, just outside of MAGSA. Therefore, a yet-to-be-determined process for potential intra-basin coordination would be needed.

6.2.11.9 Legal Authority

As the source of water for the potential project is outside the boundaries of MAGSA, coordination with CID and the Central Kings GSA would be necessary.

6.2.12 Upgradient Recharge Programs

6.2.12.1 Project Description

MAGSA and RCWD are interested in working with neighboring districts to recharge surface water upgradient from MAGSA in a nearby district for the mutual benefit of all participating entities. The project yield will likely be split in some manner between the parties that develop the project. No specific location has been identified for a joint project. However, the most likely areas being considered are in Consolidated Irrigation District and/or Fresno Irrigation District on existing farmed land. Both CID and FID are upgradient and groundwater flow comes from these areas toward MAGSA due to the pumping cone of depression within MAGSA. This type of program would help to mitigate those circumstances in the affected districts. For the purposes of providing an estimate of potential yield and costs, the water source is presumed to be Kings River high flow supplies and the site to be 480 acres (gross area) that would be located adjacent to existing distribution facilities. Since no specific location within a district has been identified, the project discussion and costs are more general in nature compared to the other projects identified.

Sites that would be considered are presumed to have infiltration rates of 1 foot per day and require about 20 percent of the gross areas for levees, leaving a net recharge area of 80 percent or about 384 acres. Average annual recharge is therefore estimated to be approximately 15,360 AF/year (480 acres x 0.8 x 1 ft/day x 40 days = 15,360 AF/year). As previously discussed, based on historical hydrology, Kings River Flood water is available 40 days per year on an average annual basis, though local supplies or Kings River allocated supplies might also be possible as the project would be located within the Kings River service area.

Since specific sites have not been selected, the project is not considered within the project ranking in **Section 6.2.16.**

6.2.12.2 Measurable Objectives

This project will address declining water levels and the declining volume of groundwater stored in the aquifer. The goal of this project is to increase groundwater recharge outside the boundaries of MAGSA to mitigate for groundwater flow to MAGSA from surrounding areas due to overdrafting in MAGSA. Groundwater levels and quality can be monitored by taking samples from existing wells around the area and comparing them to current conditions.

6.2.12.3 Project Benefits and Water Reliability

The capacity available for recharge was estimated by the flow being diverted for this project and the number of days the Kings River flood water would be available based on historical trends. For the average annual

flood duration of about 40 days, the project could generate about 384 AF/day if the recharge rate is 1 foot/day for the net area of 384 acres or 15,360 AF. However, the 40 days is an average annual number, and in a majority of years about 83 days of flood flows have been available for the January to June period, almost double the average annual amount for 17 of the 22 flood events. Therefore, about double the recharge period is possible in most years.

The presumed removal of about 480 acres of permanent crops for dedicated recharge facility site will also reduce pumping. For example, if the project was in CID, their Groundwater Management Plan (2009) estimates the average annual groundwater budget from 1964 to 2004 as about 231,000 AF/year for agricultural pumping. In comparison, average surface water diversions are 278,000 AF/year, indicating that groundwater has historically provided approximately 45% of CID's water supply. Therefore, if a permanent crop has a rough water demand of 3 AF/acre, the removal of 480 acres of permanent crops would reduce groundwater pumping on average about 650 AF annually from groundwater in the neighboring district (3 AF/acre x 480 acres x 0.45 = 648).

6.2.12.4 Management of Groundwater Extractions and Recharge

The project would be owned and operated by MAGSA, RCWD, or the irrigation district that the facility is located in as a necessary part of meeting the requirements of the SGMA. Management of groundwater extractions and recharge is possible by tracking water levels over time and monitoring stream flow in the canals that deliver water to the recharge sites. Data can be reported to MAGSA to make sure levels do not continue to decline. This project will recharge groundwater in the wet season to help offset pumping during the summer and during droughts, as well as to mitigate a portion of the groundwater flow that is moving toward MAGSA from surrounding areas. In the event of a drought or in the occasion that the recharge rate is not enough to mitigate overdraft to the measurable objective, management actions will be taken, which are described in further detail in **Section 6.3** and following. The severity of the situation will dictate the actions taken. Priority will be given to actions that can be implemented in a relatively short amount of time and have a high benefit-to-cost ratio.

6.2.12.5 Project Cost Estimate/Acre-Foot of Yield

Land costs are estimated to be between $25,000 and $35,000 per acre and based on recent projects construction costs for the improvement in the order of magnitude of $30,000 to $35,000 per acre, or an approximate total range of about $55,000 to $70,000 per acre for land and improvements. Using 34 percent of estimated costs for non-contract items, as used on the other project estimates (design, data collection, permitting, construction management), the total project cost is estimated to be between $30.5 and $42.5 million for a 480-acre site as detailed in **Table 6-32**. Assuming a 5% interest rate loan, annualized over a 30-year period (project components should also last for this time), the annual repayment cost is expected to range from about $2 to $2.8 million with water costs of about $130 to $180 per acre-foot for the average annual yield of 15,360 AF as also included in **Table 6-32**. The costs do not include the cost to purchase the water. MAGSA will fund the project. Grant funding will be pursued and used to offset project costs if available.

Table 6-32 Summary of Cost per AF for Upgradient Out-of-Area Recharge Project

Upgradient Out-of-Area Recharge Project				
Land & Improvements Cost ($/acre)	Total Capital Cost	Capital Repayment	Annual Yield (AF)	Cost Per AF
$55,000	$30,480,000	$1,983,000	15,360	$130
$70,000	$42,464,000	$2,762,000	15,360	$180

Notes:
1. Assumes 5% interest rate loan annualized over a 30-year period.
2. No operations or maintenance costs are included.

3. Water purchase costs will be an additional cost.

6.2.12.6 Circumstances of Implementation

This project would be helpful in trying to mitigate groundwater overdraft and enable Kings River water to be used to arrest declining water levels in neighboring districts. Costs for overall yield are comparable to other projects being considered. However, the cost per AF is high in comparison to other proposed projects and expected to be higher than projected depending on how the yield is split up between the various participating agencies. The circumstances required for project implementation are a willingness of neighboring districts to participate in a joint project, an available water supply, and a secure source of funding (likely to be land-based assessments).

6.2.12.7 Project Status and Schedule

The project is currently in its conceptual phase. Should the GSA decide to move forward with implementation, environmental documentation, agreements, and project design would take 9 to 12 months and construction would take approximately 6 to 9 months. It is anticipated that MAGSA and/or RCWD will start working to secure funding within the first five years of GSP implementation.

6.2.12.8 Permitting and Regulatory Process

It is anticipated that approvals from the following agencies will be required:

- *California Environmental Quality Act (CEQA)* – compliance with CEQA for project approval.
- *State Water Resources Control Board, Stormwater Pollution Prevention Plan (SWPPP)* - for construction that disturbs more than five acres.
- *Fresno County, Encroachment Permit* – for the potential crossing of County Road right-of-way.
- *San Joaquin Valley Air Pollution Control District (SJVAPCD)* – for preparation of a Dust Control Plan for construction with disturbs a surface area of five acres or more.
- *Mosquito Abatement* – for operation of an open body of water that could host vectors.
- *Water Supply Organization Approvals* – from any participating irrigation districts for right-of-way, connection of new facilities to the irrigation district system, agreements for purchase of water, and operation and maintenance of facilities.

The nearby district where the project would be constructed would benefit from the higher groundwater levels resulting from the recharge. MAGSA would benefit from lower facility costs for transporting the water over long distances. The methodology to transfer groundwater between GSAs is yet to be developed through the Kings Basin coordinated GSA efforts.

6.2.12.9 Legal Authority

As the source of water for the potential project is outside the boundaries of MAGSA, coordination with the district and other GSAs would be necessary.

6.2.13 Land Subsidence Data Gap Analysis

The following describes a project to perform additional research and data gathering to fill data gaps related to analysis of land subsidence. Note that specific details still need to be developed as part of the project, and a general description is provided below. This project will only be applicable to GSAs with significant areas experiencing or subject to inelastic subsidence. The information will help to identify land subsidence impacts, monitor sustainable management criteria, and develop appropriate mitigation measures.

6.2.13.1 Project Description

The GSA currently lacks some information on the confined aquifer that would help improve prediction and management of land subsidence. Specifically, the quantity of water pumped from the confined aquifer, potentiometric surface maps, and confined aquifer flow patterns are not well known. This information can be used to evaluate the causes of land subsidence, estimate future subsidence, and identify appropriate mitigation measures.

The work will be comprised of five tasks:

Task 1: Define Study Area
Task 2: Estimate Groundwater Pumping from the Confined Aquifer
Task 3: Identify Wells Perforated in the Confined Aquifer for Monitoring
Task 4: Installation of Monitoring Wells
Task 5: Evaluate Potential Influence of Neighboring Areas

These five tasks are described below in more detail, including specific tasks that may be required to fill existing data gaps.

Task 1 – Define Study Area
This task includes identifying the limits of the study area based on historical subsidence, current subsidence, and mapped boundaries of significant clay layers. Only areas with potentially significant inelastic subsidence will be investigated. It is expected that the study area will include lands within James GSA, MAGSA and North Fork Kings GSA as well as some neighboring subbasins.

Task 2 - Estimate Groundwater Pumping from Confined Aquifer
The volume of water pumped from the confined aquifer is currently unknown since most wells are not metered, most active wells have not been inventoried, and the screened interval is not known for many wells. In many cases, even though a Well Completion Report was prepared for the well, the owner cannot locate the Report, or the well has not been matched up with the appropriate Report. In addition, many wells that tap the confined aquifer are also screened across the unconfined aquifer (i.e., composite wells).

In this preliminary phase, groundwater pumping from the confined aquifer will be estimated through evaluation of well data in the DWR Well Completion Report Map Application Database (https://data.cnra.ca.gov/showcase/well-completion-report-map-app). This database has tabular information on wells including depth, perforated interval, etc. and is the best available data at this time, although it is known that the database is incomplete. This information will be used to estimate the percentage of wells tapping the confined aquifer, unconfined aquifer and those tapping both aquifers. Using information on total groundwater pumping, groundwater levels, perforated intervals, and relative yields in the different aquifers, the amount of pumping from the confined aquifer will be estimated. This exercise will also show the spatial distribution of confined aquifer wells, and provide temporal data on construction of confined aquifer wells. Since the status of individuals well are not currently known, only wells constructed after a certain year would be assumed active.

The process defined above will provide a preliminary assessment of confined aquifer pumping, yet it would also be the best estimate currently available. Over time, the active wells will be inventoried, and some may be investigated by video or matched to a Well Completion Report. As a result, it is expected that the pumping estimate will be refined throughout the SGMA planning period.

Task 3 - Identify Wells Perforated in the Confined Aquifer for Monitoring
This task includes identifying specific wells that only tap the confined aquifer for use in developing potentiometric surface maps. This will be accomplished in several ways:

- Existing monitoring networks include a few wells that are known to tap the confined aquifer. These wells have already been labeled and will be used in future analysis.
- Existing production wells in the monitoring network will be matched with Well Completion Reports, when possible. This method typically has limited success since many Well Completion Reports lack detailed well location data, or the well location data is poor quality.
- As funding is available, wells in the monitoring network will be inspected by video to verify the perforated interval.
- Identify new wells to add to the monitoring network, specifically, for this effort, any that are known to tap only the confined aquifer. This would require permission from the landowner to allow long-term monitoring. In addition, any well would need to be suitable for monitoring (i.e., accessible, desirable location, etc.).

This information will be used to develop potentiometric maps to determine confined aquifer flow patterns, and whether the potentiometric surface is falling and contributing to land subsidence.

Task 4 - Installation of Monitoring wells.
If necessary to fill in data gaps, and if funding is available, dedicated deep monitoring wells will be installed to monitor the potentiometric surface in the confined aquifer. These may include nested wells with casings at different depths to compare confined, semi-confined and unconfined water levels. Due to the large area to cover, and the potential costs, this will be an on-going effort throughout the entire planning period (i.e., through 2040).

An effort will also be made to work with DWR and/or USGS to evaluate and obtain funding for installation of one or more extensiometers in the Kings Subbasin and neighboring basins to measure subsidence.

Task 5 - Evaluate Potential Influence of Neighboring Areas
This task includes evaluating the influence of neighboring areas on land subsidence in the Kings Subbasin. Current data shows more severe subsidence in some surrounding areas. Subsidence in these areas could be encroaching into the Kings Subbasin, and deep groundwater pumping could be causing confined aquifer flows out of the Kings Subbasin. This evaluation will require collecting data on groundwater conditions outside of the Kings Subbasin, likely through coordination and data sharing agreements with other GSAs.

6.2.13.2 Measurable Objectives
The project will provide information to help manage land subsidence in the GSA.

6.2.13.3 Project Benefits and Water Reliability
The project will help to provide information and data to better manage land subsidence and the local groundwater. Specific information will include estimates of annual groundwater pumping from confined aquifers and potentiometric surface data.

6.2.13.4 Management of Groundwater Extractions and Recharge
The project will not impact groundwater extractions or recharge. The project is meant to gain a better understanding of confined aquifer extraction to help better manage the groundwater supply.

6.2.13.5 Project Cost Estimate/Acre-Foot of Yield
The estimated combined costs for Tasks 1-3 and Task 5 are between $10,000 and $50,000 for each GSA. Installation of monitoring wells could range from $0 to $1 million, depending on what data gaps need to be filled. Funding for initial investigations will be covered by existing GSA funds and reserves. Installation of a network of deep monitoring wells would likely require some outside funding and be performed over an

extended period. The GSA will look for State and Federal grant opportunities for constructing monitoring wells.

6.2.13.6 Circumstances of Implementation

This is a high priority project that is necessary to understand, manage and limit the impacts from surface land subsidence. The GSAs are committed to implementing this project.

6.2.13.7 Project Status and Schedule

A preliminary schedule for completing the project is provided below:

Task Description	Period
1 - Define Study Area	Jan 2023 – Apr 2023
2 - Estimate Groundwater Pumping from Confined Aquifer	May 2023 – Dec 2023
3 - Identify Wells Perforated in the Confined Aquifer for Monitoring	Jan 2024 – Dec 2025
4 - Installation of Monitoring Wells	2024 through 2040
5 - Evaluate Potential Influence of Neighboring Areas	Jan 2024- Dec 2025

Note: Tasks 2, 3 and 5 will include the initial phases shown above, but will be continually refined through 2040.

6.2.13.8 Permitting and Regulatory Process

Well permits will be required if any monitoring wells are installed. Since the wells will not extract water, obtaining the well permits should not be a problem. Right-of-way agreements or easements may be needed depending on where the wells are located. No other permits or approvals are expected to be necessary.

6.2.13.9 Legal Authority

The GSA has the authority to implement a project such as this because the SGMA statute grants the GSA the powers and authorities to "perform any act necessary or proper" to implement SGMA regulations and allows the GSA to adopt rules, regulations, ordinances, and resolutions necessary for SGMA implementation (CWC 10725.2).

6.2.14 Surface Water-Groundwater Interconnection Data Gap Analysis

The following describes a project to perform additional research and data gathering to fill data gaps related to interconnected surface water and groundwater. Note that specific details still need to be developed as part of the project, and a general description is provided below.

6.2.14.1 Project Description

The GSA currently lacks sufficient information on where local rivers are interconnected with groundwater, to what extent groundwater pumping is depleting surface water, if at all, and how river management programs ameliorate impacts of surface water depletions.

The study described below will help provide a better picture of the extent groundwater pumping is impacting surface water and whether the GSA considers those impacts to be significant and unreasonable. This information can then be used to develop sustainable management criteria.

The work will be performed in three general phases:

Phase 1: Determine Interconnection Status
Phase 2: Coordinate with Water Rights Holders and River Management Programs
Phase 3: Evaluate Impacts of Groundwater Pumping on Surface Water

These three phases are described below in more detail, including specific tasks that may be required to fill existing data gaps.

Phase 1: Determine Interconnection Status

The purpose of this phase is to determine which reaches of the rivers, if any, are interconnected with groundwater. Some existing information was documented in the 2020 GSPs, but more research will be performed to better define reaches that may be interconnected. Reaches that are determined to be interconnected will be addressed in Phases II and III described later. Reaches that are not interconnected will not be evaluated further, and sustainable management criteria for surface water-groundwater interconnection will not be established in these areas.

Existing studies, reports and models will be reviewed to determine if interconnection has already been firmly established within the GSA area. Sources that will be reviewed include:

- USGS Reports
- San Joaquin River Restoration Project Reports
- Department of Water Resources Reports
- Central Valley Hydrologic Model
- ICONS Dataset Tool
- Groundwater Sustainability Plans for neighboring GSAs
- Other studies and models not listed above

The next step will include evaluating water level data from existing riverside wells, existing piezometers, and regional groundwater contour maps to assess interconnection. This will also include collecting data on river flows and river stage, when available. A comparison of river bottom to groundwater levels will be made, and in accordance with guidance documents an assumption of depth of unlikely interconnection may be made to determine areas of impact. River thalweg elevations will also be surveyed in specific locations, if needed.

If the presence of interconnection cannot be determined with existing information, then riverside piezometers may need to be installed to collect water level data for comparison to river flow and river stage. Due to the seasonal and annual variability of flows, the piezometers may need to be monitored for several years before conclusions on the interconnection status can be made.

Phase 2 - Coordinate with Water Rights Holders and River Management Programs

Several factors unique to the Kings River and SJR impact river releases, river seepage and depletion of surface waters. These include Holding Contracts along the SJR, SJRRP Flows, riparian water users along the Kings River, the Kings River Fisheries Management Program, and highly variable surface water supplies. The agencies involved with these programs will be contacted to discuss the SGMA requirements, existing data available, future data needs and sustainable management criteria. Working with these agencies and the water rights holders, the GSA will develop a framework for evaluating and managing river reaches that are interconnected with groundwater.

These existing river management programs currently account for river losses, which help to mitigate for surface water depletion. Consequently, the conclusions from these discussions may determine that groundwater pumping is not causing significant and unreasonable depletion of surface water, or they may conclude that additional efforts are needed to quantify surface water depletion (see Phase III below) to eventually develop sustainable management criteria.

Phase 3 – Evaluate Impacts of Groundwater Pumping on Surface Water

This phase would include estimating the impact of groundwater pumping on surface water depletions for use in ultimately establishing sustainable management criteria for the 2025 GSP update. This work would only be performed in areas known to be interconnected under Phase I, and determined to be potentially impacted based on discussions with other agencies described in Phase II.

The first step will be to select a model, analytical tool or calculation method for estimating groundwater pumping impacts on the rivers. The tool will be selected based on several factors, especially what is most practical and useful with the existing data available.

A zone of influence (distance from the river's border) will be established along interconnected areas to identify corridors along rivers where pumping could have a significant impact on river flows. These will define the study areas. Groundwater pumping from these areas will be estimated. Surface water depletion will be estimated using the selected tool. Surface water depletion will vary by season and different hydrologic year types. Investigations will also look at whether the study area is already fully developed (i.e., built-out), and the likelihood of any future increases in groundwater pumping in the corridor.

Development of sustainable management criteria is not included or described in this project, since it will depend on the results from the aforementioned tasks. However, sustainable management criteria will be developed based on the legal requirements established under SGMA.

6.2.14.2 Measurable Objectives

The project will provide information to help manage interconnected surface water and groundwater in the GSA.

6.2.14.3 Project Benefits and Water Reliability

The proposed study will collect data and perform analyses needed to establish which sections of the rivers are interconnected with groundwater, and whether surface water depletions from groundwater pumping are having adverse impacts. This information is needed to develop sustainable management criteria and meet the legal requirements of SGMA.

6.2.14.4 Management of Groundwater Extractions and Recharge

The project will not impact groundwater extractions or recharge. The project is meant to gain a better understanding of the impact of extractions on surface water through data collection.

6.2.14.5 Project Cost Estimate/Acre-Foot of Yield

The total combined cost of the project for all seven GSAs in the Kings Basin is estimated to vary from $100,000 to $2 million. The actual cost for each individual GSA will vary based on their local conditions. Total costs will vary based on the length of river found to be interconnected, whether piezometers need to be installed, whether existing river management programs obviate the need for developing sustainable management criteria, and the type of analysis tool developed.

Installing piezometers could cost several hundred thousand dollars. Development of a numerical model for the San Joaquin and Kings Rivers could be as much as $500,000 to $1 million and would be of limited use until sufficient data is collected to calibrate the model. Other analytical methods would likely cost significantly less.

Initial studies and investigations will be funded with existing GSA funds. Piezometers and a numerical model would likely require supplemental funding, such as State or Federal grants.

6.2.14.6 Circumstances of Implementation

This is a high priority project that is necessary to understand, manage and limit the impacts from depletion of surface waters from groundwater pumping. The GSAs are committed to implementing this project. The hydrogeologic analyses will be performed using standard methods and best practices.

6.2.14.7 Project Status and Schedule

Following is a preliminary schedule for each of the three project phases:

Phase	Description	Period
1	Determine Interconnection Status	Jan 2023– December 2023*
2	Coordinate with Water Rights Holders and River Management Programs	January 2024 – December 2024
3	Evaluate Impacts of Groundwater Pumping on Surface Water	January 2024 – December 2025

* If piezometers need to be installed to evaluate interconnection, then several years of monitoring may be required to firmly establish the interconnection status. Preferably, data would be collected and analyzed for several hydrologic year types, including dry, normal and wet years. This could result in certain river sections falling behind the schedule shown in the table above.

6.2.14.8 Permitting and Regulatory Process

Permits will be required for new monitoring wells, if they are needed. Since the wells would not extract water, obtaining the well permits should not be a problem. Right-of-way agreements or easements may be needed depending on where the wells are located. No other permits or approvals are expected to be necessary for the program.

6.2.14.9 Legal Authority

The GSAs have the authority to implement a project such as this because the SGMA statute grants the GSA the powers and authorities to "perform any act necessary or proper" to implement SGMA regulations and allows the GSA to adopt rules, regulations, ordinances, and resolutions necessary for SGMA implementation (CWC 10725.2).

6.2.15 Domestic Well Mitigation Program

The following describes a project to develop policies and procedures for mitigating domestic wells that go dry or are in imminent threat of going dry. Specific details still need to be developed as part of the project, and a general description is provided below. This description was developed with guidance from the *Framework for a Drinking Water Well Impact Mitigation Program* (Self Help Enterprises et al.). The Domestic Well Mitigation Program will initially be developed through a basin-wide effort, and each GSA will then refine the policy to meet their specific conditions, develop funding and implement their individual program.

6.2.15.1 Project Description

The Kings Basin and the GSA have been in overdraft for many years resulting in a significant lowering of the regional and local groundwater elevations, and a significant reduction in the amount of useable groundwater in storage. The GSA plans to correct the overdraft by 2040 as required by SGMA, however there will be a continued decline through 2040 until water levels have stabilized. Stabilizing groundwater levels immediately or raising groundwater levels is not feasible without significant land fallowing given the current water supply conditions, and would have devastating immediate economic impacts. Although water levels will be stabilized by 2040 at the Measurable Objective level, they will likely reach lower levels during dry years. The maximum anticipated lower water level is called the Minimum Threshold. As a result, some domestic

wells are expected to go dry during the SGMA implementation period (2020-2040). This is generally limited to shallow domestic wells, since most irrigation wells and agency-owned wells are typically deeper and have often been designed to account for declining water levels. However, some small water supply systems and certain agricultural wells may be impacted and may be considered for mitigation. As described within the GSP, most of the basin has several hundred feet of aquifer with suitable water quality below current water levels.

A Domestic Well Mitigation Program (Program) is proposed to be developed and implemented for wells that have gone dry or are in imminent threat of going dry. The policies and procedures for the Program will be developed through a basin-wide effort, then each GSA can modify the Program to meet their specific needs and will perform public outreach, develop funding, and implement the program for their GSA.

The overall process for developing and implementing a Domestic Well Mitigation Program is outlined below:

1. Review other existing and planned well mitigation programs within other GSAs throughout the State
2. Evaluate the merits of partnering with or expanding any current local or State programs.
3. Develop policies and procedures with input from GSAs and stakeholders
4. Develop detailed inventory of domestic wells
5. Predict number of potentially impacted wells and identify high priority areas
6. Secure long-term funding for the program
7. Perform public outreach to landowners and stakeholders
8. Develop database and registration system for wells owners to sign up
9. Develop criteria for qualifying wells
10. Evaluate each application and determine merits for funding

Following are discussions on specific topics that will be investigated during program development:

Evaluation Process

An application form will be developed for landowners to request mitigation for domestic well impacts. A detailed step-by-step evaluation process will also be documented.

The following are some of the items that will be considered when evaluating applications for mitigation:

- What is causing loss of well capacity? Decline in water levels or other issues such as plugged screens, the well pump, etc.
- The appropriateness of the original well design and construction. Can the well be deepened, or would a new well be needed?
- The percentage (if any) of well owner's mitigation responsibility and other sources of potential funding.
- What is the best mitigation option? Installing a new well, well deepening, other option.

Mitigation

Once a potential well has been identified as adversely impacted by declining groundwater levels and requires mitigation, then several options may be considered including:

- Installing a new well
- Deepening the well if it has an open bottom
- Modifying pump equipment
- Modify current pumping practices (i.e., reduce or cycle pumping from a nearby well)

Deepening a well could be the most economical option but will only be technically feasible if the well is an open bottom well. When necessary, a new well may need to be constructed. The program may have different contribution levels for deepening a well versus construction of an entirely new well. The age and condition of the well impacted will be considered, and the GSA will develop standard depreciated value of wells by age based on published literature, guidelines and local understanding.

The need for short-term solutions, such as providing bottled water and water tanks while a well is being mitigated, will be considered as part of the program. Landowners will be encouraged to contact the GSA before their well goes completely dry to avoid these circumstances. In addition, protocols will be established to help process applications and approve well mitigation in an expedient manner.

Design Criteria

The GSA will develop minimum design criteria for new wells. New wells will need to meet State and GSA Well Standards to receive any reimbursement, and will be subject to routine monitoring by the GSA. Criteria will also be considered for materials used in construction of the well, and minimum depth beyond existing or anticipated future groundwater levels.

Outreach

Public outreach and education will be performed during development of the mitigation program and prior to implementation.

Comments on the draft mitigation program will be solicited during initial development of the policies and procedures. If a Proposition 218 election is needed to establish funding, then education on the program will be an integral part of garnering support for any new fees or assessments.

Prior to implementation, extensive outreach will be needed to notify landowners of the program requirements and how they can apply for assistance. Outreach may need to be performed in multiple languages as appropriate for the GSA. Outreach methods could include workshops, mailings, flyers, website postings, Board meeting announcements, etc.

6.2.15.2 Measurable Objectives

The program will directly address the impacts of the chronic lowering of groundwater levels and reduction in groundwater storage by providing funding for replacement wells or well modifications to eligible landowners.

6.2.15.3 Project Benefits and Water Reliability

The proposed Domestic Well Mitigation Program will directly mitigate impacts due to the following:

- Reduction of groundwater in storage; and
- Chronic lowering of groundwater levels.

The Domestic Well Mitigation Program will provide a direct benefit to beneficial users in the GSA who have had their well go dry because of declining water levels during GSP implementation. The metric for measuring program benefits will be the number of domestic wells that are impacted and mitigated under this program.

6.2.15.4 Management of Groundwater Extractions and Recharge

The program will not impact groundwater extractions or recharge. The program is meant to maintain domestic well capacity and use as water levels continue to decline until sustainability has been reached.

6.2.15.5 Project Cost Estimate/Acre-Foot of Yield

Following are preliminary estimated costs for implementing the program. These will be refined during project development and finalized prior to efforts to secure funding.

Development of Policies and Procedures. The estimated cost to develop the Domestic Well Mitigation Program policies and procedures is $70,000, which will be split among the different GSAs in the Kings Groundwater Subbasin. Each GSA will then modify the Program, if needed, to be compatible with their specific conditions.

Develop Funding. The Subbasin will collaborate with programs and funding sources that already exist. Each GSA will need to develop long-term funding as needed for their specific GSA needs for expected impacted wells within each GSA. This could include preparation of grant applications, a Proposition 218 election, user fees or other options. These costs will vary by GSA.

Public Outreach. Public outreach will be performed in each GSA. These costs will vary by GSA and will be estimated during development of the Program.

Project Administration. General administration costs for the program will vary by GSA and will be determined during the development of the Program.

Well Mitigation. Well mitigation costs will vary by GSA and location within each GSA in accordance with groundwater levels and the specific minimum thresholds that have been determined. An estimate of well mitigation costs will be developed by each GSA as part of their Program development and funding plan development. For reference, in 2022, a local well driller quoted $60 to $75/lineal foot for a new domestic well, which does not include costs for the pump or other appurtenances. The cost to abandon a well is approximately $5,000. Assuming an estimated cost per well for mitigation of $40,000 and estimated 1,000 wells in the basin that might need to be mitigated during the implementation period until water levels stabilize, the total cost of this program could be $40,000,000. A contingency funding plan may need to be developed if the number of impacted wells is found to be significantly higher than estimated.

The funding source for this Program is yet to be identified. The GSA will investigate several funding sources including grants, land-based assessment, and water use fees and collaborate with programs and funding sources that already exist. The State has many existing grant programs for community water systems and well construction funding. County, state and federal assistance will be needed to successfully implement this program. Grants may help to defray some costs, but a local funding source will also be needed, so the GSA landowners will likely need to be taxed to fund the program. The GSAs or individual water agencies may need to perform a Proposition 218 election to increase fees to fund the program. The GSAs will also work with local NGOs that may be able to provide assistance or seek grant monies to help fund the program.

6.2.15.6 Circumstances of Implementation

This is a high priority program that is necessary to mitigate the impacts of declining water levels and provide water supply to meet basic health and safety needs. The GSAs are committed to implementing this program. No funding is currently available for the program, so various sources, such as grants, funding through existing state programs, and land-based assessment or water user fees, will be investigated. If the landowners do not approve funding the program through a ballot measure (such as Proposition 218 election), this would signify low public support for the program, and the lack of funding could jeopardize implementation. Any election-based assessment process will need to incorporate public outreach to educate voters on the project benefits.

6.2.15.7 Project Status and Schedule

The policies and procedures for the Domestic Well Mitigation Program will be developed as a Basin-wide effort by the end of 2024. This will likely include coordination with other local mitigation programs, evaluation of a range of potential policies and procedures, economic studies, and preparation of a final report. Each GSA will then modify the Program as needed for their specific conditions and seek to develop a funding mechanism for the Program. Funding development for the Program is anticipated to take 12-24 months. Once the program is funded, a public outreach program will be implemented and the Domestic Well Mitigation Program will be initiated. The GSAs have been and will be reviewing well construction permits to recommend future well construction below minimum threshold levels. Currently in the Kings Basin, domestic well mitigation programs are already being implemented by other entities for low-income residents. During program development, the GSAs will refer landowners to these local programs as well as other resources and funding programs from the County, State or non-profit organizations. Some of these programs include: California Safe and Affordable Drinking Water Fund, Safe and Affordable Funding for Equity and Resilience program, Proposition 1 funding, and programs being administered by Self-Help Enterprises. These programs can assistance with well replacement, as well as interim support such as bottled water and storage tanks while waiting for a new well.

6.2.15.8 Permitting and Regulatory Process

The Domestic Well Mitigation Program may require a CEQA Initial Study but will more likely qualify for a CEQA exemption. The program could also qualify for a Programmatic Environmental Impact Report. If the wells owners are reimbursed for the well construction then the GSA would not be responsible for any permits. No other permits are expected to be necessary for the program.

6.2.15.9 Legal Authority

DWR has indicated that GSAs have the authority to implement a program such as this because the SGMA statute grants the GSA the powers and authorities to "perform any act necessary or proper" to implement SGMA regulations and allows the GSA to adopt rules, regulations, ordinances, and resolutions necessary for SGMA implementation (CWC 10725.2).

6.2.16 Project Ranking

This section discusses ranking of the water supply projects discussed above and includes an evaluation of their total cost and annual water yield. The two data gap analysis projects and the domestic well mitigation projects are not discussed below since they do not provide a new water yield and are not comparable. These three projects are also considered very high priority and will be commenced in 2022 or 2023.

As has been discussed previously, for each project, the conceptual costs were annualized over a 30-year period assuming a 5% interest rate to estimate an annual repayment cost. The portion of the water cost due to capital expenditures on an average annual basis was also calculated. The costings of all projects investigated are summarized together in one location in **Table 6-33.**

Table 6-33 Project Cost & Yield Summary

Rank	Projects	Capital Cost	Annual Capital Payment	Average Annual Yield (AF)	Annualized Cost Per AF
1	Fresno City Wastewater Treatment Plant Recharge Basins, FID Houghton Canal System	$3,537,000	$230,000	6,745	$41
2	Fresno City Wastewater Treatment Plant Recharge Basins, Lower Dry Creek System	$2,223,000	$145,000	4,385	$41
3	Southwest Groundwater Banking	$6,221,000	$405,000	2,625	$154
4	Lassen Avenue Reverse Flow & Recharge	$3,263,000	$212,000	3,000	$71
5	MAGSA Groundwater Banking Program	$777,156,000	$50,555,000	208,000	$2,454.13
6	McMullin On-Farm Flood Capture, Phase 2 and	$61,911,000	$4,027,000	27,120	$148.49
7	Houghton Wasteway Expansion	$4,922,000	$320,000	2,190	$146
8	South Sandridge Canal Water Supply &	$8,736,000	$568,000	4,800	$119
9	Stinson North Canal Phase 1	$61,114,000	$3,976,000	39,670	$100
10	Grantland Area Recharge	$22,043,000	$1,434,000	7,920	$181
11	CID Wristen Ditch Intertie	$13,420,000	$873,000	3,175	$275
12	Upgradient Recharge Program	$42,464,000	$2,762,000	15,360	$180

Notes:

4. Assumes 5% interest rate loan annualized over a 30-year period.
5. No operations or maintenance costs are included, except on City of Fresno projects.
6. Water purchase costs will be an additional cost.

The costs and yields are based on very broad assumptions and include a thirty percent contingency. Actual water costs will be greater than estimated as none of the projects include the actual water supply purchase cost, which is yet to be negotiated with the water supply source. Additionally, none of the projects include the cost to recover the supply as groundwater if the water is recharged.

On an average annual basis, Kings River floodwater supplies are available about 40 days per year (**Section 3.4.2**), and SJR flows for CVP Section 215 water are available about 60 days (**Section 3.4.3**). If a project receives water from FID, the project could obtain either Kings River water, CVP water, or local stormwater.

6.2.16.1 Projects Recommendations

As groundwater is the only current water supply, it is imperative that surface water supplies be brought into the area for current agricultural practices to continue and the area to become sustainable in accordance with the SGMA. It is therefore recommended that chosen projects be implemented as soon as possible. Higher priority should be given to projects with greater flexibility in water sources.

To assist in prioritizing the projects, a matrix was developed with a weighted ranking or scoring criteria as follows:

- High importance
  - Readily available or multiple water supplies possible
  - Water rights allow project access to surface water source
  - Average annual water supply yield

- Medium importance
  - Landowner willingness
  - Complexity/quantity of regulatory permits
  - Time for project implementation
  - In an area favorable for on-farm recharge (SAGBI ranking)

- Low importance
  - If the project is in MAGSA completely, partially, or not at all
  - Perceived willingness of water supply agency to cooperate on the project
  - Amount of permanent crop removal required by the project

Table 6-34 summarizes the ranking by project. Based on the criteria previously identified, the ranking table prioritizes the projects as identified below:

1. Fresno City Wastewater Treatment Plant Recharge Basin, FID Houghton Canal System
2. Fresno City Wastewater Treatment Plant Recharge Basin, FID Lower Dry Creek System
3. Southwest Groundwater Banking
4. Lassen Avenue Reverse Flow & Recharge
5. MAGSA Groundwater Banking Program
6. McMullin On-Farm Flood Capture Expansion
7. Houghton Wasteway Expansion
8. South Sandridge Canal Water Supply & Recharge
9. Stinson North Canal Phase 1
10. Grantland Area Recharge
11. CID Wristen Ditch Intertie

Table 6-34 Project Ranking and Scoring Criteria

Criteria	Max Score Possible	Houghton Canal	Lower Dry Creek	Southwest Groundwater Banking	Lassen Avenue Reverse Flow	MAGSA Groundwater Banking Program	McMullin Expansion	Houghton Wasteway Expansion	South Sandridge Recharge	Stinson North Canal Phase 1	Grantland	Wristen Ditch Intertie	Scoring Factors for Each
Water Supply	20	20	20	20	15	20	5	20	20	15	5	5	Are there more than one possible water supplies available (i.e. Kings, CVP, local). Point system: 20 = over 2 sources of supply available, 15 = two supply sources, 5 = one source of supply
Water Rights	20	20	20	10	10	10	10	10	10	5	5	5	Do the existing water rights currently allow transfer of water to the area (Place of Use)? Point system: 20 = yes, all water supply sources have place of use, 10 = Partial water supply has place of use, 5 = No, in process
Yield	20	10	5	5	5	20	20	5	5	20	10	5	The average annual yield of the project. Point system: 20 = over 20,000 AF, 15 = 10,000-20,000 AF, 10 = 5,000-10,000 AF, 5 = less than 5,000 AF
Annual Cost per Acre-Foot	10	10	10	5	7	7	7	5	5	7	5	2	Point System: 10 = < $50/AF, 7 = $51-$100, 5 = $101-200, 2 = > $200
Project Site/ROW Land Owners Willingness to Sell Property	10	10	10	10	0	5	5	5	5	0	5	0	Point System: 10 = known to be willing or there are existing recharge basins, 5 = thought to be willing, 0 = unknown willingness
Environmental/Regulatory Permits Complexity	10	10	10	10	10	1	5	5	5	1	5	5	Point System: 10 = Local only, relatively simple or few in quantity, 5 = Multiple permits, 1 = Endangered species likely or multiple complex level permits requirements
Project Time to Implementation	10	10	10	10	10	5	8	10	5	4	5	5	The time estimated to have the permits, agreements, and construction done to implement the project. Point System: 10 = < 2 years, 8 = 2-5 years, 5 = 5-10 years, 4 = 10-15 years, 2 = >15 years
Areas of Favorable Recharge	10	8	5	5	8	2	5	5	5	2	10	10	Primary SAGBI modified ranking found at the dedicated recharge site and near the canal alignments. Point system: 10 = Excellent, 8 = Good, 5 = Moderately Good, 2 = Moderately Poor, 1 = Poor, 0 = Very Poor
Project Outside of GSA	5	1	1	5	5	5	5	3	5	3	3	3	Project includes recharge basin or on-farm recharge locations and conveyance system to deliver water to project location. Point System: 5 = completely inside GSA, 3 = Partially outside GSA, 1 = Completely outside GSA
Willingness Expressed thus far by Cooperating Agencies	5	5	5	3	5	3	5	3	3	1	3	1	Point System: 5 = Known to be willing, 3 = Believed to be willing, 1 = Unknown
Land Use	5	5	5	5	5	1	1	1	1	1	1	1	Less permanent crops and pastureland provide a more preferable alternative site due to 1) the site will easily convert into a recharge site 2) less concern for on-farm recharge due to when crops are dormant, 3) permanent crops that have a long productive life remaining will be a lost investment for the landowner therefore these lands will be costlier to acquire. Point system: Percentage of permanent crops along proposed site location and conveyance system to site: 80-100% = 1, 60 - 79%= 3, less than 60%= 5
Total	**125**	**109**	**101**	**88**	**80**	**79**	**76**	**72**	**69**	**59**	**57**	**42**	

6.3 Management Actions

GSAs have a variety of tools which can be used to achieve sustainable groundwater management. The projects previously identified in this chapter primarily focus on the capture, use, recharge, and increase of surface water supplies within the GSA and surrounding areas. Alternatively, management actions could be taken which primarily focus on the reduction of groundwater demand. These could be accomplished through increasing data collection, education and outreach, regulatory policies, incentive-based programs, and enforcement actions.

The following sections will discuss a suite of management action options that MAGSA may consider during the GSP implementation. The menu of management actions discussed below may not be implemented in the strictly linear fashion as numbered in the GSP and specific actions may not be implemented if sustainability is achieved through projects and other actions. It is expected that the GSA will further develop and craft projects and management actions in response to stakeholder input on parallel timelines and will adapt the estimated schedules according to the best available information and best available science at any given time in accordance with *§354,44(c)*. The GSA understands that there are various levels of uncertainty with project and program implementation per *§344.44.(d)*. It is not unusual for project and program implementation to take longer than originally estimated. In addition, the accrual of expected benefits may take multiple years to be individually realized and vary substantially from year to year. The various implementation timelines may fluctuate over time dependent upon the success or failure of the initial GSP projects and management action efforts to increase water supplies, reduce groundwater demands, and improve data collection.

This chapter is not a comprehensive list of management actions and future additions and revisions may be enforced by MAGSA as needed to achieve sustainability. The legal authority and basis for the projects and management actions described in this GSP Chapter 6 are outlined in the SGMA and related provisions in accordance with *§354.44.(b).7*. The SGMA describes the powers and authorities, financial authority, and enforcement powers of GSAs in Chapters 5, 8, and 9 respectively. These GSA authorities include adopting regulations, regulating groundwater extractions, imposing fees, monitoring, enforcing programs, and more. Though the law grants the GSA these powers, the pursuit and implementation of the projects and management actions is the GSA's responsibility. The GSA must enforce their legal authority to the extent necessary to achieve sustainable groundwater management for all beneficial users within the GSA per *§354.44(b)2*. In the development of management actions, MAGSA intends to embody the lessons learned from other groundwater managed basins and strive to accomplish the following:

- Develop trust by being inclusive and transparent.
- Use a portfolio of approaches to achieve sustainability.
- Ensure efficient and accurate data collection.
- Devise a fair groundwater allocation.
- Craft a groundwater trading structure that reflects local hydrologic conditions.
- Address concerns of funding GSA management actions.
- Assure performance by rigid penalties and enforcement.

It is the mission of this GSP to promote responsible water resource management, while effectively enforcing the policies and standards set in place by MAGSA to conserve and protect the region's water resources for future generations to come.

Legal Requirements:

§354.44 Projects and Management Actions

(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. The list shall include projects and management actions that may be utilized to meet interim milestones, the exceedance of minimum thresholds, or where undesirable results have occurred or are imminent. The Plan shall include the following:

(A) A description of the circumstances under which projects or management actions shall be implemented, the criteria that would trigger implementation and termination of projects or management actions, and the process by which the Agency shall determine that conditions requiring the implementation of particular projects or management actions have occurred.

(B) The process by which the Agency shall provide notice to the public and other agencies that the implementation of projects or management actions is being considered or has been implemented, including a description of the actions to be taken.

(2) If overdraft conditions are identified through the analysis required by Section 354.18, the Plan shall describe projects or management actions, including a quantification of demand reduction or other methods, for the mitigation of overdraft.

(3) A summary of the permitting and regulatory process required for each project and management action.

(4) The status of each project and management action, including a time-table for expected initiation and completion, and the accrual of expected benefits.

(5) An explanation of the benefits that are expected to be realized from the project or management action, and how those benefits will be evaluated.

(6) An explanation of how the project or management action will be accomplished. If the projects or management actions rely on water from outside the jurisdiction of the Agency, an explanation of the source and reliability of that water shall be included.

(7) A description of the legal authority required for each project and management action, and the basis for that authority within the Agency.

(8) A description of the estimated cost for each project and management action and a description of how the Agency plans to meet those costs.

(9) A description of the management of groundwater extractions and recharge to ensure that chronic lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels or storage during other periods.

(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 basin setting when developing projects or management actions.

6.3.1 Education and Outreach Management Actions

6.3.1.1 Notification of Annual Groundwater Use

EO-1 Regular Communication

The GSA will promote education and outreach to all beneficial uses and users within the GSA as detailed in *Chapter 2 Plan Area 2.5 Notice and Communication*. Specific to projects and management actions, the GSA may adopt a program which provides groundwater users their approximate groundwater use in acre-feet on a per acre basis as an education tool every year. The program may be established before the GSA would consider enforcement action on an established groundwater allocation. The goal is to provide ongoing correspondence to groundwater users and promote awareness of the overdraft condition in the GSA, particularly for those groundwater users who do not currently have metered wells. This correspondence may provide individual user information as well as aggregate GSA groundwater data for comparison purposes. The ongoing correspondence may contain the following information:

- Individual grower's estimated groundwater use amount in acre-feet/acre.
- Average crop demand in acre-feet/acre based upon published evapotranspiration values specific to individual's location and corresponding California DWR evapotranspiration (ETo) Zone.
- GSA average groundwater use amount for individual grower's crop in acre-feet/acre.
- GSA average groundwater overdraft in acre-feet/acre.
- Current status of GSA adoption of groundwater allocation per acre or groundwater allocation, if applicable, per **Section 6.3.3**.
- Detailed reminder of the GSA powers and authorities granted in SGMA.
- Additional quarterly statements.

In order to determine the individual grower's groundwater use amount, the GSA may consider multiple quantification methods for a consistent determination of groundwater use per acre. The various quantification methods will be discussed further below in **Section 6.3.3**.

EO-2 Non-Routine Responses to Minimum Threshold Exceedances

In addition to regular correspondence, the GSA may also immediately notify individual growers of a MT exceedance as defined in **Section 4.3**. The notice of MT exceedance would alert the monitoring well owner and groundwater users within a defined radius of the MAGSA boundary. In order to provide communication and outreach, the notification may contain the following information:

- Description and location of the MT exceedance.
- Notice of increased frequency of water level and/or water quality monitoring.
- The potential effects to the individual growers (i.e. their well potentially going dry or drinking water quality concerns).
- The planned GSA response (i.e. trigger of specific projects and management actions).
- Current funding opportunities available through the GSA or other entities, which would combat the determinantal effects of the MT exceedance.
- A written reminder of how individuals can communicate with the GSA, find more information, and provide public input regarding the implementation of the GSP.
- A written reminder of the GSA powers and authorities granted in SGMA and potential for State intervention should Undesirable Results occur.

The regular correspondence and notice of MT exceedance may not generate a quantifiable groundwater demand reduction. However, they would serve as useful education and outreach tools which may change individual pumping practices and encourage growers to implement water conservation BMPs and/or other demand reduction solutions.

The goal is to provide education and correspondence with groundwater users and promote awareness of the GSA overdraft condition, particularly for those groundwater users who do not currently have metered wells. The measurable objective would be the number of annual correspondence letters and MT exceedance notices that are mailed each year. In preparation of the quarterly or annual letters and immediate notices, the GSA would develop template letters and a current mailing address database to expedite the notification process. In addition, other ancillary measurable objectives may include the increase of persons on the GSA's Interested Person's List, visits to the GSA website, and attendance at public GSA meetings and events. If the education and outreach program did result in a reduction of groundwater extraction, the marginal amount would be estimated at 1-100 acre-feet/year.

6.3.1.2 Measurable Objectives Check List

Groundwater Level	X
Storage Change	X
Groundwater Quality	X
Land Subsidence	X
Surface Water-Groundwater Interconnection	NA
Seawater Intrusion	NA

6.3.1.3 Circumstances for Implementation EO-1 - EO-2 (Sec. 354.44.b.1.A)

The education and outreach management action may be developed and implemented prior to adoption of the GSP. The policy would remain indefinitely and be reevaluated every five years. A trigger for the end of this management action may be that another management action or program provides comparable annual education letters and outreach notices.

6.3.1.4 Process for Public Notification EO-1 - EO-2 (Sec. 354.44.b.1.B)

The process for public notification will be addressed by the consistent communication and outreach between the GSA and the groundwater user. The GSA will develop a system to initiate communication with the grower on a regular basis and will additionally respond to overdraft or non-compliance with minimum thresholds with escalating correspondence as deemed necessary. The cost associated with GSA correspondence will be assessed on an annual basis.

6.3.1.5 Permitting and Regulatory Process EO-1 - EO-2 (Sec. 354.44.b.3)

No permit or regulatory process is required for the GSA to adopt the policy. The management action may be accomplished by GSA policy adoption.

6.3.1.6 Status and Schedule EO-1 - EO-2 (Sec. 354.44.b.4)

The education and outreach program with annual education letter and notice of MT exceedance has not been drafted. It is expected to commence shortly after the adoption of the GSP and be completed within 1 year. The initial focus will be the annual correspondence letter since the notices of MT exceedance may not occur for many years.

6.3.1.7 Benefit Realization and Evaluation EO-1 - EO-2 (Sec. 354.44.b.5)

The GSA will use education and outreach opportunities to encourage active engagement, open lines of communication with interested and affected stakeholders, communicate the future opportunities for input, and receive feedback on the GSP implementation process.

The expected benefits may include mitigated overdraft by educating the public about the current use and quality of groundwater supplies. Groundwater users may see that their individual use exceeds published crop demand values, GSA average use, and/or GSA groundwater allocation and re-evaluate their usage. Without levying penalties, the GSA intends for all correspondence and mailed notices to educate users about the GSA's monitoring practices, procedures, and enforcement capabilities. Other program benefits include the transparent and expeditious communication of GSA groundwater overdraft conditions, implementation of specific projects and managements actions, funding opportunities, and potential for State intervention if undesirable results occur.

6.3.1.8 How This Management Action Will Be Accomplished EO-1 - EO-2 (Sec. 354.44.b.6)

The annual correspondence and escalation letters will be accomplished by utilizing the in-house mailing database that the GSA will develop and maintain. All correspondence will be drafted by GSA staff and will be in accordance with the actions of the Board of Directors. Further detail regarding communication can be found in **Section 2.5**.

6.3.1.9 Legal Authority EO-1 - EO-2 (Sec. 354.44.b.7)

The legal authority and basis for the management actions described in this GSP Chapter 6 are outlined in the SGMA and related provisions. The SGMA describes the powers and authorities, financial authority, and enforcement powers of GSAs in Chapters 5, 8, and 9 respectively.

6.3.1.10 Costs EO-1 - EO-2 (Sec. 354.44.b.8)

The costs related to the education and outreach management action include one-time expenses and reoccurring annual expenses. The one-time expenses include the labor costs of the GSA, GSA's counsel, and GSA's consultant to prepare the formal program description and adopt the management action policy. The written policy would detail the specific content of the chosen correspondence method, the source of the data being reported, the frequency of the correspondence, mailing or delivery logistics, expected costs, and the intent of the policy. Through a GSA Board resolution, the program would be incorporated into the GSA's policy manual for transparency. The database of current GSA mailing addresses and template letters would be created. These initial costs are estimated at $20,000. The reoccurring costs for mailed correspondence would include the costs of printing, stuffing envelopes, labeling, and postage. The GSA would likely contract with local businesses that perform these mail services. In terms of the content of all correspondence, the costs associated with the GSA's selected groundwater extraction quantification method are not to be included in this section; these options and costs will be described in **Section 6.3.3**. The estimated cost of ongoing correspondence and letter mailings GSA-wide is approximately $10,000. The reoccurring costs associated with the mailing or delivery of MT exceedance notices are difficult to estimate at this time because there are multiple factors that would change the notice frequency. For example, MT exceedances may not start occurring for 15+ years, notices may only be mailed to affected portions of the GSA, and exceedances may occur multiple times within a given year.

The ongoing estimated program cost/acre-foot yield could be less than $10/acre-foot depending upon the amount of acre-foot demand reduction and number of mailings.

6.3.2 Well Head Requirements Management Actions

6.3.2.1 Well Metering and Sampling Requirements

The GSA recognizes that community involvement and outreach alone will not curtail groundwater overdraft. Additional well requirements will likely be required to more effectively manage and understand the dynamic groundwater conditions. Within the MAGSA, well construction permitting is managed by Fresno County Environmental Health Division (FCEHD) as detailed in **Section 2.3.4**. Obtaining a well permit is currently a ministerial process, not requiring discretionary action or CEQA. The intent of this management action is to have the MAGSA work cooperatively with the FCEHD to increase well requirements without disrupting the current ministerial permit process. Additionally, the GSA would promote constant communication with the FCEHD and would seek to maintain more monitoring responsibility. The GSA may adopt a policy to augment the current well requirements set by the State/FCEHD and establish new permit criteria, enforce GSA policies, and require GSA approval of all permit paperwork for non-de minimis users before FCEHD permit issuance. The policy would affect permits to construct, deepen, destroy, recondition, or repair a well. In order to increase data collection, reporting, and ongoing groundwater management efforts, the additional well requirements policy may contain the following information:

- Registration of pumping facilities with the GSA.
- Require the installation of well flow meters, sounding tubes, and water quality sample ports.
- Require the well owner to self-report groundwater pumping volumes, static water levels, and water quality data.
- Regulate new well construction.

The GSA may consider separating the additional well requirements management action into multiple policies or be silent on various bulleted components until the GSA deems them necessary. For example, the requirement of installing sounding tubes and water quality sample ports may be enacted before the requirement of a well flow meter. Further explanation and detail of the potential additional well requirements are continued below.

The desired outcome of additional well permitting requirements is the ability to monitor groundwater extractions, water levels, and water quality in a thorough, accurate, and efficient manner across the GSA. The measurable objectives differ amongst the bulleted considerations.

WH-1 Registration of Extraction Facilities

As stated in SGMA §10725.6, "a GSA may require the registration of a groundwater extraction facility within the management area of the GSA." The GSA may adopt this policy to hopefully improve and supplement the existing well records housed by the FCEHD and DWR. The GSA has greatly benefited from the current exchange of well information and use of the online DWR Well Completion Report Map Application tool found here:
https://dwr.maps.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37.
However, through local outreach and research of the proposed well monitoring network, the GSA suspects many existing wells do not have the State and FCEHD well completion reports (the well driller documentation on the geology and well construction details) or have not been entered into the DWR database and may be absent from the existing FCEHD records. Unfortunately, the historic well completion reports (especially the older ones) and available DWR 429 Forms (Well Data Form indicating the state well number and detailed well location information) often have insufficient information to confidently locate the exact position of an older well. In recent decades, the advances in technology, standardization of forms, and accessibility to GPS location have significantly improved the accuracy of well locations and recordkeeping. The intent of registration of groundwater extraction facilities would be to complement existing well recordkeeping and ensure that the GSA can fully understand and quantify the potential impacts of

groundwater decline. In addition to the registration of extraction facilities, the GSA may invest in a complete well canvass study to verify the number of wells and presence of a flow meter.

The goal would be to monitor the number of documented extraction facilities. The method of evaluation may be comparing the number of registered wells to the FCEHD and DWR well records.

WH-2 Installation of Well Flow Meters

The GSA may require the installation of a flow meter on all groundwater extraction facilities to provide more accurate quantities of groundwater extraction and serve as the nexus to other management actions. The policy would describe the acceptable types of flow measurement devices, installation standards and requirements, operation and maintenance requirements, and penalties for tampering, neglect, or misconduct. For example, the flow meter would be installed at each source facility inline before any other connections or discharge points in accordance with the meter manufacturer's specifications. The meter must accurately quantify the volume of extracted groundwater in acre-feet and be routinely maintained by the well owner. Failure to comply with the policy may result in civil penalty or criminal fine in accordance with SGMA §10732. Once the well construction, deepening, or destruction work was completed, the well drilling contractor would be required to provide a Notice of Completion, also known as a Well Completion Report (DWR Form 188), Driller's Report, or Well Log, to the FCEHD office within thirty (30) days of completion. The report would document that the work was completed in accordance with the Well Standards Ordinance and the GSA additional well requirements policy.

The metric would be the number of installed meters. The method of evaluation would be reviewing the number of well permits and confirming whether meters were installed.

WH-3 Installation of Sounding Tubes and Water Quality Sample Ports

The GSA may require the installation of a well sounding tube, air line, electric depth gauge, and/or other water level sensor for the purpose of measuring water levels throughout the GSA. In addition, the GSA may require the installation of a sample port on the well discharge piping for the purpose of collecting water quality samples throughout the GSA. The accurate and widespread collection of water level and water quality data will provide the GSA with the necessary information to monitor the success/failure of the GSP against the established Sustainable Management Criteria in **Section 4**. The policy would describe the acceptable types of water level measuring devices and sample ports, installation requirements, and penalties for tampering, neglect, or misconduct. The installation must provide or allow for the accurate measurement of static groundwater level in feet below the ground surface and water sample collection. If applicable, the water level measurement device must be routinely maintained by the well owner. Once the well construction, deepening, or destruction work was completed, the contractor would be required to provide a Notice of Completion, also known as a Well Driller's Report or Well Log, to the FCEHD office within thirty (30) days of completion. The report would document that the work was completed in accordance with the Well Standards Ordinance and GSA additional well requirements policy.

The metric would be to monitor the number of installed sounding tubes and water quality sample ports. The method of evaluation would be reviewing the number of well permits and confirming whether sounding tubes and sample ports were installed.

WH-4 Self-Reporting of Groundwater Extraction, Level, and Water Quality

The GSA may require the well owner to self-report to the GSA the groundwater extraction volumes, static water levels, and water quality data twice per year, generally in March and October. The policy would describe the frequency of reporting, various methods of reporting, due dates, and specific instructions for data collection. The GSA may provide users with a self-addressed mailer for return mailing. The mailer may include information on which water quality constituents are being requested and reporting instructions. For example, "the well owner must report the groundwater extraction volume in acre-feet and include the current

flow meter totalizer reading" would be a sample reporting instruction. Other example instructions may indicate that static water level measurements should be taken once water levels have stabilized after the last pumping cycle. If there is limited compliance with self-reporting, the GSA may elect to gather the appropriate data with their own staff. The policy would describe that the frequency of the reporting may be temporarily increased if minimum thresholds are exceeded.

The goal would be to monitor received reports for each mailing cycle. The method of evaluation would be reviewing the number of responses from groundwater users (excluding de minimis users), analyzing data validity/accuracy, and filling data gaps.

6.3.2.2 Measurable Objectives Check List

Groundwater Level	X
Storage Change	X
Groundwater Quality	X
Land Subsidence	X
Surface Water-Groundwater Interconnection	NA
Seawater Intrusion	NA

6.3.2.3 Circumstances for Implementation of WH-1 – WH-4 (Sec. 354.44.b.1.A)

The current situation of unsustainable management of groundwater resources leading to critical groundwater overdraft justifies the implementation of additional well requirements. This policy requires the support and coordination of the FCEHD for successful implementation. In addition, the users and beneficial uses within the GSA must be properly notified far in advance of the policy adoption, especially because of the increased well owner costs and self-reporting efforts. For existing wells, there may be extenuating circumstances where the installation of flow meters, sounding tubes, and/or water quality sample ports are not practical or financially advisable. These situations would need further analysis on a case-by-case basis. The policy would remain indefinitely or until another GSA or FCEHD program serves the same purpose.

6.3.2.4 Process for Public Notification of WH-1 – WH-4 (Sec. 354.44.b.1.B)

Educational correspondence regarding self-reporting of groundwater extractions would be accomplished through direct communication between the GSA and the grower. This will take place in the form of self-reporting and the monitoring of water level and water quality, which will then be compiled and distributed through each cycle of correspondence mailings. Should the Board of Directors choose to adopt a policy addressing WH-1-WH-5, the public will be notified through established GSA correspondence methods as explained in **Section 2.5**.

6.3.2.5 Permitting and Regulatory Process of WH-1 -WH-4 (Sec. 354.44.b.3)

The regulatory process would require FCEHD coordination and support to ensure new well permits issued within the GSA adhere to GSA policy. No other environmental or regulatory permits would be required.

6.3.2.6 Status and Schedule of WH-1 - WH-4 (Sec. 354.44.b.4)

The additional well requirements policy has not been drafted, but preliminary discussions with the County have commenced. The draft policy and GSA discussions may commence shortly after the adoption of the GSP and be completed within 2 years.

6.3.2.7 Benefit Realization and Evaluation of WH1 - WH-4 (Sec. 354.44.b.5)

An expected benefit would be a complete geo-database of groundwater extraction locations. Requiring new well permit applicants to provide accurate information on location, depth, perforated zone, and measured

water use and level would allow for more accurate data analysis of groundwater extraction, storage change, and water table fluctuations. The policy requiring metered wells would also provide private owners with personal usage history and would complement other management actions including education and outreach, groundwater allocation, groundwater marketing and trading, fees and incentives, and pumping restrictions. Requiring water quality sample ports and analytical testing would fill data gaps and provide users with useful information. The benefits of self-reporting include the avoidance of time needed for GSA staff or consultants to individually collect data. The evaluation of these actions would include assessing the accuracy and completion of the data collected on a regular basis or as seen fit by the GSA Board.

6.3.2.8 How Management Actions Will Be Accomplished for WH-1 – WH-4 (Sec. 354.44.b.6)

The Registration of Extraction Facilities (WH-1) will be accomplished by validating all documented extraction facilities. The GSA may authorize a complete well canvass study to verify the number of wells and presence of a flow meter. Additional review will be necessary in order to confirm the number of reported well permits and to verify the installation of meters, sounding tubes, and sample ports (WH-2-WH-3). WH-4 will be accomplished by analyzing the received reports from each mailing cycle and assessing the data for accuracy and gaps.

6.3.2.9 Legal Authority for WH-1 – WH-4 (Sec. 354.44.b.7)

The legal authority and basis for the management actions described in this GSP Chapter 6 are outlined in the SGMA and related provisions. The SGMA describes the powers and authorities, financial authority, and enforcement powers of GSAs in Chapters 5, 8, and 9 respectively.

6.3.2.10 Costs for WH-1 – WH-4 (Sec. 354.44.b.8)

The additional well requirements management action would not directly generate a quantification of demand reduction. However, the foundation for the mitigation of overdraft would be established by implementing ongoing monitoring of groundwater extractions, water levels, and water quality.

The costs related to the additional well requirements management action include one-time expenses and ongoing monthly expenses. The one-time expenses include the labor costs of the GSA, GSA's counsel, FCEHD, and GSA's consultant to prepare the formal program description and adopt the management action policy. Through a GSA Board resolution, the program would be incorporated into the GSA's policy manual for transparency. The database of extraction facilities would be created and include individual fields for owner, location, well construction information, GSA additional requirements (i.e. meter, sounding tube, sample port, etc.), and future measurement data. These initial costs are estimated at $30,000. The online reporting tool may be developed for well owners to self-report their monitoring data; initial cost is estimated at $15,000. If the GSA were to separate the additional well requirements management action into multiple policies, the one-time costs for program description and adoption would be duplicated, but coordination efforts with the FCEHD would be reduced.
The ongoing monthly costs include the database maintenance, reporting website support, self-addressed post cards, and data entry costs and are estimated at $75,000 annually.
The adoption of this policy would result in additional costs for the groundwater user, including:

- Purchase and installation of a well meter, sounding tube, and sample port
- Pump discharge modifications to ensure proper meter installation per the manufacturer's specifications (for existing wells only)
- Labor costs related to self-reporting
- Laboratory testing of water quality

6.3.3 Groundwater Allocation Management Actions

6.3.3.1 Groundwater Allocations

GSAs experiencing large amounts of annual groundwater overdraft may pursue individual groundwater allocations if the development of projects and new water supplies cannot solely offset the current groundwater demands and overdraft condition. Demand management will become increasingly more important because of the reduced reliability of imported and flood water supplies, especially when taking into consideration the historical drought periods, uncertain role of climate change, and increased competition for available water supplies.

GA-1 Development of Groundwater Allocation Per Acre

The GSA may adopt a policy which provides a finite groundwater allocation on a per acre basis. The policy would identify and forecast the demands associated with prior rights, domestic, and environmental uses. The sustainable yield and ultimate groundwater allocation would take into consideration the existing water rights holders, DACs, county service areas, GDEs, and California Native American tribes. The GSA through collaboration with its users and beneficial uses may consider whether an equal-, reduced-, or zero-allocation is given to lands with unexercised groundwater rights. There are a myriad of advantages and disadvantages associated with each method of establishing groundwater pumping allocations. A "Comprehensive Allocation Method," as detailed in the *Groundwater Pumping Allocations under California's Sustainable Groundwater Management Act* (Environmental Defense Fund et. al, 2018), is one possible approach that could be considered because it offers GSAs the important advantage of presenting an allocation methodology that tracks judicial precedent if an adjudication is ultimately initiated.

GA-2 Groundwater Allocation Gradual Decrease "Ramp-Down"

Once an individual groundwater allocation is determined, the GSA may adopt a policy which provides a gradual "ramp-down" allocation decrease over time to arrive at the actual groundwater allocation to allow growers time to adjust to the concept of an allocation and, for many growers, a likely significant reduction in groundwater use. The policy would detail the number of years and amount of reduction each year. For example, a 10% reduction over a 5-year period for an actual groundwater allocation of 1.50 acre-feet per acre is shown below:

Table 6-35 Example Groundwater Allocation "Ramp Down"

Year	Groundwater Allocation (AF/ac)	Reduction at Year End (%)	Reduction at Year End (AF/ac)
1	2.54	10	0.25
2	2.29	10	0.23
3	2.06	10	0.21
4	1.85	10	0.18
5	1.67	10	0.17
6 Actual	1.50	0	0

The annual changes in groundwater allocation would be provided in the annual correspondence mailer described in the education and outreach management action above as well as presented on the GSA website.

GA-3 Groundwater Allocation "Adaptive Management" Approach

The GSA may adopt a policy which implements an adaptive management approach, whereby the groundwater allocation may be reviewed, changed, and reestablished frequently or during extreme drought as necessary to achieve long term sustainability. It is prudent for the GSA to acknowledge existing data gaps and the current level of uncertainty in the available data by providing flexibility in initial groundwater allocations as more data is gathered and analyzed in the upcoming years. Adaptive management is an approach to resource management that "promotes flexible decision making that can be adjusted in the face of

uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes both advances scientific understanding and helps adjust policies or operations as part of an iterative learning process. Adaptive management also recognizes the importance of natural variability in contributing to ecological resilience and productivity. It is not a 'trial and error' process, but rather emphasizes learning while doing" (Environmental Defense Fund et al., 2017).

GA-4 Groundwater Use Quantification Methods

The GSA may adopt a policy to specify the approved method or methods to quantify the individual and aggregate groundwater extractions for the required SGMA annual reporting. If adoption of the additional well requirements policy, specifically the installation of flow meters, takes years to fully implement, the GSA may consider a variety or combination of quantification methods including, but not limited to, the following:

- Irrigated acreage – determined by aerial flyovers or remote sensing
- Irrigated area hybrid – determined by annual crop survey alongside aerial flyovers or remote sensing of irrigation areas including crop coefficients
- Calibrated energy records – determined by energy records and meter calibrations
- Flow meters – determined by meter readings
- Remote sensing of evapotranspiration – determined by remote sensing
- Other methods

There are various advantages, disadvantages, and costs to each of the stated quantification methods. The GSA may consider exploring some of these methods with neighboring GSAs and basin-wide for an aggregated approach and mutual cost savings.

6.3.3.2 Measurable Objectives Check List

Groundwater Level	X
Storage Change	X
Groundwater Quality	
Land Subsidence	
Surface Water Groundwater Interconnection	NA
Seawater Intrusion	NA

The goals of the groundwater allocation management action are to ensure a fair groundwater allocation, allow groundwater users time to adjust, provide future flexibility in allocation determinations, and accurately and efficiently quantify groundwater extractions. The measurable objective is the volume of groundwater extraction in acre-feet GSA wide and on a per acre basis.

The method of evaluation of groundwater extraction in acre-feet depends upon the GSA's selected quantification method or combination of methods. The GSA evaluation of various methods may consider a wide range of factors including cost, accuracy, reliability, timeliness, functionality, personnel required, and legal defense. Once the GSA has established a consistent quantification method, the evaluation of the "ramp-down" gradual allocation decrease could be analyzed in the annual comparison of groundwater extraction. Though the annual groundwater extraction amount would be affected by other factors, such as weather and available surface water supplies, the total extraction amount could be normalized to an average water year for comparative purposes.

6.3.3.3 Circumstances for Implementation of GA-1 – GA-4 (Sec. 354.44.b.1.A)

The GSA may consider an investigative study to determine the current and future needs of existing water rights holders, DACs, CSDs, Public Utility Districts, GDEs, Native American tribes, and unexercised rights to determine the sustainable yield and groundwater allocation. A groundwater extraction method may be selected shortly after the adoption of the GSP for the purposes of the required SMGA annual reporting. The selected groundwater extraction quantification method may change over time, but the groundwater allocation would remain indefinitely.

6.3.3.4 Process for Public Notification of GA-1 – GA-4 (Sec. 354.44.b.1.B)

All public notification will take place in the form of regular correspondence from the GSA, as well as any supplementary communication between the users/growers and the GSA as deemed necessary by the Board of Directors.

6.3.3.5 Permitting and Regulatory Process of GA-1 – GA-4 (Sec. 354.44.b.3)

The GSA adhere to state water rights law. No permit or regulatory process is required for the GSA to adopt a groundwater allocation policy. The GSA may consider the advantages & disadvantages of the mentioned quantification methods due to differing levels of accuracy and reliability. However, *SGMA §10725.4 (c)* allows GSAs to investigate property and extraction facilities, though encroachment permits or access agreements may be necessary for some locations.

6.3.3.6 Status and Schedule of GA-1 – GA-4 (Sec. 354.44.b.4)

The policy for a groundwater extraction quantification (GA-1) method has not been drafted. GA-1 – GA-4 are expected to commence shortly after the adoption of the GSP and be completed within one year. The groundwater allocation is in draft form and needs more data and analysis. It is expected to commence shortly after the adoption of the GSP and be completed within three years.

6.3.3.7 Benefit Realization and Evaluation of GA-1 – GA-4 (Sec 354.44.b.5)

These actions are expected to beneficially mitigate overdraft by improving the GSA's knowledge of aggregate and individual groundwater extractions. The development of a groundwater allocation per acre may be based on the GSA's current sustainable yield. The groundwater allocation management actions alone could generate a quantifiable demand reduction, and would benefit from the implementation of Education and Outreach (See EO1-EO2). These groundwater allocation management actions serve as a prerequisite to other management actions including groundwater marketing and trading, fees and incentives, and pumping restrictions (GMT 1-5, FI 1-4).

6.3.3.8 How This Management Action will be Accomplished for GA-1 – GA-4 (Sec. 354.44.b.6)

The GSA will consider the option to adopt a "Comprehensive Allocation Method" as detailed in the *Groundwater Pumping Allocations under California's Sustainable Groundwater Management Act* (Environmental Defense Fund et. al, 2018) as a possible approach in addressing GA-1. The annual correspondence mailer will address any annual changes in groundwater allocation based off annual data reported to the GSA (GA-2). The GSA will consider utilizing an adaptive management approach in which allocations are assessed and changed as deemed necessary by the Board of Directors in order to address GA-3. Lastly, the GSA will adopt a necessary policy to assist in establishing quantification methods in order to obtain data for the required SGMA reporting requirements.

6.3.3.9 Legal Authority for GA-1 – GA-4 (Sec. 354.44.b.7)

The legal authority and basis for the management actions described in this GSP Chapter 6 are outlined in the SGMA and related provisions. The SGMA describes the powers and authorities, financial authority, and enforcement powers of GSAs in Chapters 5, 8, and 9 respectively.

6.3.3.10 Costs for GA-1 – GA-4 (Sec. 354.44.b.8)

The costs related to the groundwater allocation management action include one-time expenses and reoccurring annual expenses. The one-time expenses include the labor costs of the GSA, GSA's counsel, and GSA's consultant to prepare the formal program description and adopt the management action policy. The written policy would describe the groundwater allocation method, available source data, assumptions, groundwater allocation per acre, the gradual decrease to actual allocation, the adaptive management approach, the groundwater extraction quantification methods, expected costs, and the overall intent of the policy. Through a GSA Board resolution, the program would be incorporated into the GSA's policy manual for transparency. Much of the source data collection and analysis were completed in preparation of this GSP. The initial costs to draft and adopt the policy are estimated at $25,000. The reoccurring costs associated with the GSA's selected groundwater extraction quantification vary considerably depending upon the selected method and frequency of data collection.

- Irrigated acreage – determined by aerial flyovers or remote sensing
    - Assumes 4 flights per year at $5,000 per flight
    - Estimated $20,000 annually
- Irrigated area hybrid – determined by annual crop survey alongside aerial flyovers or remote sensing of irrigation areas including crop coefficients
    - Assumes 4 flights per year at $5,000 per flight
    - $5,000 labor coordination to obtain cropping information from Agriculture Commissioner or another source
    - Estimated $25,000 annually
- Calibrated energy records – determined by energy records and meter calibrations
    - $500/meter/year
    - $350/10 meters/year
    - $250/100 meters/year
    - Assumes 6,000 to 8,000 meters GSA wide (non-de minimis users).
    - Estimated $15,000 - $20,000 annually
- Flow meters – determined by meter readings
    - Assumes meters are furnished and installed by well owner
    - Estimated $15,000 annual labor to collect and input meter readings into GSA database
- Remote sensing of evapotranspiration – determined by remote sensing
    - Assumes 4 flights per year at $5,000 per flight
    - Estimated $20,000 annually
- Other methods

It is anticipated that the groundwater allocation management action would directly generate a quantifiable demand reduction.

6.3.4 Groundwater Marketing and Trading Management Actions

6.3.4.1 Groundwater Marketing and Trading

Once a groundwater allocation policy including individual allocations and a chosen quantification method has been adopted, the GSA would pursue a groundwater market and trading program to provide users and beneficial uses more flexibility in utilizing their allocation. This management action would detail a groundwater allocation carryover structure, banking program, water marketing strategy study, trading structure, and related rules.

GMT-1 Groundwater Allocation Carryover Structure

The GSA may adopt a policy to define groundwater allocation carryover provisions year-to-year and/or allow multi-year pumping averages. The inter-annual flexibility may be useful to growers who could change cropping patterns or fallow acreage. Though there is a risk that extreme drought may induce exceptionally high pumping in a single year, groundwater users may be able to strategize and better manage their assets.

The goal of the groundwater allocation carryover structure is to provide groundwater users with more flexibility in utilizing their groundwater allocation year to year. The measurable objective is the amount of banked carry-over water in acre-feet.

GMT-2 Water Marketing Strategy Study

The GSA may consider a study of water marketing strategies. The study may focus on the development of a groundwater banking/trading program and coordination with other agencies that could potentially create a market to bring water into the GSA.

The goal of the water marketing study is to analyze the best available groundwater banking/trading structure for the GSA and to research, coordinate, and solicit external surface water transfers into the GSA. The measurable objective is the preparation of a research study and report.

GMT-3 Groundwater Banking Program

The GSA may adopt a policy to define a groundwater banking program. The banking program would consider using surface water supplies when available in lieu of groundwater pumping. Though not feasible for all users, growers capable of surface water recharge on-farm may be able to percolate floodwater or other transferred water for recharge credits. There are many complexities and considerations required to initiate and successfully manage a banking program. The GSA must acknowledge and discuss any other water bank/credit systems currently in existence. The GSA may approve past replenishment projects and determine a timeframe for any banking efforts that took place prior to banking program adoption. The GSA may consider adjusting banked credits if future changes in sustainable yield and/or groundwater allocation require adjustment. The GSA may define a "leave-behind" amount for groundwater migration and operational and evaporative losses, as well as to buffer against impacts to neighboring wells. The GSA may consider finite timelines or expiration dates on banked water or ongoing "leave-behind" amounts.

The goal of the groundwater banking program is to provide groundwater users an optional banking program to fairly and responsibly bank groundwater allocations. The measurable objective is the adoption of a banking program and the number of users.

GMT-4 Groundwater Trading Structure

In addition to a groundwater banking program, the GSA may adopt a policy to define a groundwater trading structure. The GSA may consider a variety of structures including, but not limited to, the following:

- Bilateral contracts or "coffee shop" markets
- Brokerages
- Bulletin boards
- Auctions and reverse auctions
- Electronic clearinghouses or "smart markets"
- Other trade structures

There are various advantages, disadvantages, and costs to each of the stated trading structures. The GSA may consider exploring some of these options with neighboring GSAs and basin-wide for an aggregated approach and mutual cost savings. Trading may be executed through short- and long-term leases, permanent transfers,

inter-annual water exchanges, or dry-year option contracts. The GSA may determine physical trade limitations such as distance, aquifer or soil conditions, and detrimental effects to surrounding wells.

The goal of the groundwater trading structure is to provide groundwater users an optional trading structure to fairly and responsibly market groundwater allocations. The measurable objective is the adoption of a trading structure and number of controlled and documented trades.

GMT-5 Regulate Groundwater Allocation Transfers Outside of GSA

The GSA may adopt a policy to regulate groundwater allocation transfers outside of the MAGSA boundary. The GSA may assure adherence by enforcing rigid penalties for illegal actions. The GSA may approve external transfers in limited quantities for emergency situations and levy fees for metering the transferred amount.

The goal of regulating groundwater allocation transfers outside the MAGSA boundaries is to ensure all groundwater supplies are consumed or retained within the MAGSA area. The objective is the accounting of transferred water volume with the goal of having virtually no groundwater transferred out of the GSA.

6.3.4.2 Measurable Objectives Check List

Groundwater Level	X
Storage Change	X
Groundwater Quality	X
Land Subsidence	X
Surface Water Groundwater Interconnection	NA
Seawater Intrusion	NA

6.3.4.3 Circumstances for Implementation for GMT-1 – GMT-5 (Sec. 354.44.b.1.A)

GMT-1

The policy to define groundwater allocation carryover provisions year-to-year and/or allow multi-year pumping averages may be implemented shortly after the adoption of the groundwater allocation per acre and remain indefinitely.

GMT-2

The study of water marketing strategies could be considered at any time but is recommended within five years of GSP adoption.

GMT-3

You cannot bank what you do not measure. Prerequisites of banking may include the installation of flow meters for participants and payment of any GSA assessments, penalties, or fees. The policy may be implemented within five years of GSP adoption and remain indefinitely.

GMT-4

You cannot trade what you do not measure. Prerequisites of trading may include the installation of flow meters for buyer and seller and payment of any GSA assessments, penalties, or fees. The policy may be implemented within five years of GSP adoption and remain indefinitely until GSA overdraft has ended or the market no longer exists.

GMT-5

Though groundwater allocation transfers do not currently exist, the GSA understands the changing water market conditions may entice beneficial users to seek financial gains by transferring groundwater allocations. The policy may be implemented shortly after the adoption of the GSP and remain until GSA overdraft has ended or indefinitely. The policy fees and penalties may be reviewed by the GSA annually.

6.3.4.4 Permitting and Regulatory Process (Sec. 354.44.b.3)

GMT-1

No permit or regulatory process is required for the GSA to adopt the groundwater allocation carryover policy. No external water source is used.

GMT-2

No permit or regulatory process is required for the GSA to conduct the water marketing study. Through the study, multiple jurisdictions and agencies may be contacted for the potential permits and regulatory requirements of new surface water supplies. The management action may be accomplished by GSA policy adoption. The study may examine the external water sources and reliability.

GMT-3

No permit or regulatory process is required for the GSA to adopt the groundwater banking policy. The GSA may coordinate with any other agencies with existing banking programs. Banking projects will require conformance with the CEQA. External water sources with varying reliability and quality may be used if local surface water supplies are not available.

GMT-4

No permit or regulatory process is required for the GSA to adopt the groundwater trading structure policy. Trades may require CEQA. GSA may prioritize and incentivize trades with smaller physical distances, within the same aquifer, and/or in desired locations such as cones of depression or forebays upgradient of confining clay layers.

GMT-5

No permit or regulatory process is required for the GSA to adopt the policy of regulating groundwater allocation transfers outside of the GSA. The GSA may develop a groundwater allocation transfer request form for emergency transfer permits. No external water source is used.

6.3.4.5 Status and Schedule (Sec. 354.44.b.4)

GMT-1

The policy has not been drafted. It is expected to commence shortly after the adoption of the GSP and be completed within three years.

GMT-2

The water marketing strategy grant has been approved by the USBR. It is expected to commence prior to the GSP adoption and be completed within two years.

GMT-3

The policy has not been drafted. It is expected to commence within five years of GSP adoption and be adopted within two years.

GMT-4

The policy has not been drafted. It is expected to commence within five years of GSP adoption and be adopted within two years. The GSA may consider starting with short-term annual leases only until the program grows.

GMT-5

The policy has not been drafted. It is expected to commence shortly after the adoption of the GSP and be completed within three years.

6.3.4.6 Benefit Realization and Evaluation (Sec. 354.44.b.5)

GMT-1

The groundwater allocation carryover structure is expected to provide groundwater users more flexibility year to year and encourage other on-farm changes such as crop conversion, crop rotation, deficit irrigation, and other best management practices. The method of evaluation may consider the number of participants, cost, accounting, and legal defense. This management action allows sustainable carryover allocations but may not generate a quantifiable demand reduction.

GMT-2

The expected benefits of a water marketing strategy study may include increased water supplies, improved water reliability, reduction in land subsidence, incentives to conserve groundwater, improved coordination with other agencies, and creation of a sustainable water supply. The method of evaluation may be the resulting increased water supplies.

GMT-3

The groundwater banking program is expected to allow groundwater users more flexibility in managing their groundwater allocations and assets. The method of evaluation may consider a wide range of factors including cost, difficulty, timeliness, functionality, and legal defense.

GMT-4

The expected benefits of a groundwater trading structure may include increased water supplies, improved water reliability, reduction in land subsidence, conserved groundwater, improved coordination with other agencies, and creation of a sustainable water supply. The method of evaluation may be the resulting increased water supplies.

GMT-5

Regulating groundwater allocation transfers outside the GSA is expected to mitigate local overdraft and deepening cones of depression by ensuring groundwater supplies are consumed or retained within the MAGSA boundary. The emergency groundwater allocation transfers may be accounted and recorded by the GSA. The method of evaluation may be reviewing the number of emergency transfer permits.

6.3.4.7 How Management Action Will be Accomplished for GMT-1 - GMT-5 (Sec. 354.44.b.6)

The GSA will evaluate and establish the policy to be implemented regarding defining groundwater allocation carryover provisions year-to-year and/or allowing multi-year pumping averages (GMT-1). The GSA will address GMT-2 by considering a study of water marketing strategies. Such a study may focus on the development of a groundwater banking/trading program and coordination with other agencies that could potentially market water into the GSA. The GSA will explore, analyze, and possibly develop future policy to address groundwater banking and trading structures to be implemented. Lastly, in order to address GMT-5 the GSA may adopt a policy to regulate groundwater allocation transfers outside of the MAGSA boundary.

6.3.4.8 Legal Authority for GMT-1 – GMT-5 (Sec.354.44.b.7)

The legal authority and basis for the management actions described in this GSP Chapter 6 are outlined in the SGMA and related provisions. The SGMA describes the powers and authorities, financial authority, and enforcement powers of GSAs in Chapters 5, 8, and 9 respectively.

6.3.4.9 Costs (Sec. 354.44.b.8)

GMT-1

The cost of the groundwater allocation carryover structure draft and policy adoption is estimated at $10,000. The ongoing costs would vary annually depending on chosen management method and annual tabulation of extracted water. The ongoing costs are estimated at $10,000 – $15,000 for administration and database management.

GMT-2

The water marketing strategy study is estimated to cost $386,000. A USBR grant has been approved to share in 50% of the study cost for the GSA.

GMT-3

The cost of the groundwater banking program draft and policy adoption is estimated at $25,000. Ongoing costs will vary annually depending on chosen program structure.

GMT-4

The cost of the groundwater trading structure draft and policy adoption is estimated at $25,000. Ongoing costs will vary annually depending on chosen structure. GSA may levy management fees or fees on water transportation which could offset ongoing costs.

GMT-5

The cost to draft and adopt a policy to regulate groundwater allocation transfers outside the GSA is estimated at $5,000. Future emergency permits would require fees to cover administrative and accounting costs.

6.3.5 Fees and Incentives Management Actions

6.3.5.1 Fees and Incentives

The GSA will explore multiple financing options to cover its operational costs as detailed in **Section 7.2**. Specific to projects and management actions, the GSA may adopt a management action to levy groundwater fees and/or provide individual incentives to groundwater users to reduce groundwater pumping. The GSA may consider a fee structure and incentives study to determine the best strategy for curbing groundwater overdraft without causing inequitable economic impact. The following potential fee structures and incentives would affect groundwater users differently, so a composite fee or incentives structure may also be considered.

FI-1 Pumping Fees for Groundwater Allocations Exceedances

Once a groundwater allocation policy including individual allocations and a chosen quantification method has been adopted, the GSA may adopt a policy to levy fees for pumping beyond the current groundwater allocation. The GSA realizes certain landowners will need or elect to utilize an amount of groundwater in excess of their annual allocation. In order to meet such demands while still minimizing overdraft conditions and sustaining the groundwater aquifer, the GSA must augment water supplies or manage demands. The water charge is proposed to fund the costs of augmenting water supplies and/or managing demands. For example, in their *Conceptual Draft Memorandum Rosedale-Rio Bravo Water Storage District* (District, 2018), Rosedale-Rio Bravo Water Storage District described the approach and calculation of their water charge. The pumping

fee for groundwater allocation exceedance is based upon the value of fallowed or retired land. In their example, an average unit amount of 2.6 acre-feet per acre was used. The average land cost of $25,000 per acre is divided by 2.6 acre-feet per acre divided by a planning horizon of 20 years. The resulting maximum initial water charge per unit is calculated as $480 per acre-foot.

The goal is to incentivize groundwater users to reduce pumping and/or pump only their groundwater allocation per year. The measurable objective is the volume of groundwater extraction in acre-feet.

FI-2 Pumping Fees for Groundwater Extractions

If an individual groundwater allocation per acre policy is not established or takes many years for the GSA to adopt, the GSA may adopt a policy to levy tiered fees per acre-feet of pumped groundwater. As a prerequisite, the GSA must first adopt the policy for a groundwater quantification method, such that the GSA can efficiently and accurately calculate the groundwater use per acre. If pumping fees were not paid, the GSA may consider liens or cease and desist orders.

The goal is to incentivize groundwater users to reduce pumping and/or pump only their groundwater allocation per year. The measurable objective is the volume of groundwater extraction in acre-feet.

FI-3 Incentives

Incentives are voluntary, monetary programs that could be put in place by the GSA board in order to aid in meeting the goals and objectives of the GSP while easing the economic factor involved in many on-farm changes.

The following conceptual examples provide basic information as to how possible incentive programs may be structured should the GSA choose to adopt a policy that would provide framework for incentive programs to be established and implemented. The Board may incentivize these, or other programs as deemed necessary.

Example No. 1

The GSA may vote to adopt a policy to incentivize groundwater users to construct canal or basin infrastructure to utilize available imported flood waters. The goal is to incentivize growers to construct infrastructure and utilize surface water supplies. The metric would be the amount of infrastructure available to receive surface water.

Example No. 2

The GSA may adopt a policy to incentivize groundwater users to change crop types to ones with lower water demand. The goal is to change the high-water demand crops to low-water demand crops so that irrigated acreage is not necessarily reduced. The metric would be the acreage of converted crops and anticipated reduction in groundwater extract.

Crop conversion is expected to reduce the overall groundwater demand. The method of evaluation may consider the incentive amount and the amount of converted acreage, which is estimated to be 0-10,000 acre-feet per year.

Example No. 3

The GSA may adopt a policy to incentivize groundwater users to rotate crops and temporarily fallow portions of their irrigated acreage in order to reduce water demand.

The goal is to reduce groundwater extractions. The metric would be the anticipated reduction in groundwater extraction.

Example No. 4

The GSA may adopt a policy to incentivize farmers to implement best management practices (BMPs) for on-farm water management such as soil moisture sensors, high efficiency irrigation methods, and metering to apply precise irrigation.

The goal is to improve on-farm irrigation efficiency and extract only the crop demand. The metric would be the anticipated reduction in groundwater extract.

Example No. 5

The GSA may adopt a policy to incentive farmers to retire or permanently fallow land.

The goal is to reduce groundwater extraction. The metric would be the amount of acreage of retired land.

On-farm water conservation is expected to reduce the overall groundwater pumping. The method of evaluation may consider the incentive amount and number of participants. An estimated 0 - 25,000 acre-feet per year could be conserved.

6.3.5.2 Measurable Objectives Check List

Groundwater Level	X
Storage Change	X
Groundwater Quality	
Land Subsidence	X
Surface Water Groundwater Interconnection	NA
Seawater Intrusion	NA

6.3.5.3 Circumstances for Implementation of FI-1 – FI-3 (Sec. 354.44.b.1.A)

The GSA may consider an investigative study to determine the most effective and equitable fee and incentive structure. Prerequisites of levying groundwater fees may include the installation of flow meters or other quantification methods for groundwater users (excluding de minimis users). The policy would remain indefinitely.

6.3.5.4 Process for Public Notification of FI-1 – FI-3 (Sec. 354.44.b.1.B)

The GSA would utilize continuous correspondence as discussed in EO-1-EO-2 to notify the public as to various opportunities to participate in incentives programs. Additionally, the GSA would utilize such correspondence to discuss and announce policy development and implementation regarding fees and incentives.

6.3.5.5 Permitting and Regulatory Process of FI-1 – FI-3 (Sec. 354.44.b.3)

No permit or regulatory process is required for the GSA to adopt the policy. The GSA has the power as outlined in the SGMA and related provisions to adopt ordinances. The management action may be accomplished by GSA policy adoption. The canal or basin infrastructure may rely on external water sources for imported or flood waters, such as those discussed in F-3 Example 1.

6.3.5.6 Status and Schedule of FI-1 – FI-3 (Sec. 354.44.b.4)

The policies have not been drafted. Some policies would be expected to commence 3-5 years after the adoption of the GSP and be completed within two years. The policy fees, associated non-payment penalties, and incentives amounts may be reviewed by the GSA annually.

6.3.5.7 Benefit Realization and Evaluation (Sec. 354.44.b.5)

FI-1

This fee structure is expected to mitigate local overdraft by incentivizing groundwater users to reduce pumping or pump groundwater supplies in a sustainable fashion. The ancillary benefits include additional funds for the GSA to invest in other projects and management actions. The method of evaluation may be review of the effective fee structures, amounts, and number of fees levied. The groundwater savings are estimated to be 0 - 30,000 acre-feet per year. It may vary significantly depending upon levied fees, water year, and available transfers/banked credits.

FI-2

This fee structure is expected to mitigate local overdraft by incentivizing groundwater users to reduce pumping or pump groundwater supplies in a sustainable fashion. The ancillary benefits include additional funds for the GSA to invest in other projects and management actions. The method of evaluation may be review of the effective fee structures, amounts, and number of fees levied. The groundwater savings are estimated to be 0 - 30,000 acre-feet per year. It may vary significantly depending upon levied fees, water year, and available transfers/banked credits.

FI-3

Adding incentives is expected to mitigate local overdraft by incentivizing groundwater users to reduce pumping of groundwater supplies.

6.3.5.8 How Management Action Will be Accomplished for FI-1 – FI-3 (Sec. 354.44.b.6)

Groundwater extraction fees and agricultural land conversion have great potential to significantly reduce the demand on groundwater supplies. The quantification of the possible water savings depends on the individual need for reduction and the number of participants. The GSA will consider an investigative study to determine the most effective and equitable fee and incentive structure to implement.

6.3.5.9 Legal Authority for FI-1 – FI-3 (Sec. 354.44.b.7)

The legal authority and basis for the management actions described in this GSP Chapter 6 are outlined in the SGMA and related provisions. The SGMA describes the powers and authorities, financial authority, and enforcement powers of GSAs in Chapters 5, 8, and 9 respectively.

6.3.5.10 Costs for FI-1 – FI-3 (Sec. 354.44.b.8)

The costs related to the fees and incentives management action include one-time expenses and ongoing annual expenses. The one-time expenses include the labor costs of the GSA, GSA's counsel, and GSA's consultant to prepare the formal program description and adopt the management action policy. Through a GSA Board resolution, the program would be incorporated into the GSA's policy manual for transparency. If the GSA were to separate the fees and incentives management action into multiple policies, the one-time costs for program description and adoption would be duplicated, but ongoing efforts would be reduced.

FI - 1-3 Fees and Incentives

Fees

The one-time expenses are estimated at $15,000 cost to draft and adopt the policy. The costs associated with creation of a user database and quantification of groundwater extraction are included in the *Additional Well Requirements* management action described in **Section 6.3.2**. The ongoing costs related to levying fees of any type include accounting, billing, and processing payments. These costs are estimated at $25,000 annually. Once adopted, the levied fees will recoup these costs and generate revenue for the GSA to fund other projects and management actions.

Incentives

The one-time expenses are estimated at $10,000 cost to draft and adopt the policy. Since the incentives program would be voluntary with an unknown number of participants, it is assumed the GSA would define a maximum budget account with each corresponding type of incentive and would define the parameters of the incentives program. In addition, there would be costs associated with field verification prior to enrollment in the incentives program. Ongoing costs may range from $10,000 - $1,000,000 annually.

6.3.6 Groundwater Pumping Restrictions Management Actions

6.3.6.1 Groundwater Pumping Restrictions

The GSA may consider a groundwater pumping restrictions management action encompassing policies related to the restriction of new groundwater exports, requiring new developments to prove sustainable water supply, pumping restrictions during droughts, and moratorium on new production wells that are not replacement wells.

GP-1 Regulate Groundwater Exports

The GSA may adopt a policy to charge a fee for existing groundwater exports and/or regulate new groundwater exports outside of the GSA boundary. The GSA may assure performance by enforcing rigid penalties for illegal actions. The GSA may approve external exports in limited quantities for emergency situations and levy fees for metering the exported amount.

The goal is to ensure that all groundwater supplies within the GSA are consumed or retained within the GSA boundary. The measurable objective is the metered volume of exported water with the goal of 0.0 acre-feet/year.

GP-2 Require New Developments to Prove Sustainable Water Supply

The GSA may adopt a policy to require new developments (non-de minimis users) to prove sustainable water supplies based upon the current GSA groundwater allocation. The GSA may review and comment on all new development environmental documents to ensure water balance and that corresponding mitigation measures are implemented. This policy requires the support and coordination of the City or County during their typical project permitting process.

The goal is to ensure all new developments (non-de minimis users) do not exceed the current GSA groundwater allocation and that groundwater supplies are consumed or retained within the GSA boundary. The measurable objective is proving new developments water balances with the goal of 0.0 acre-feet groundwater overdraft /year.

GP-3 Pumping Restrictions During Droughts

The GSA may adopt a policy to immediately reduce or temporarily suspend groundwater pumping during specific intervals such as extreme drought periods. Immediate restrictions may be the result of minimum threshold exceedances. The GSA may consider significant penalties for violators. The GSA may also consider liens or cease and desist orders for excessive abuse.

The goal is to immediately reduce groundwater pumping in specific circumstances. The measurable objective is the volume of groundwater extraction in acre-feet and number of violators.

6.3.6.2 Measurable Objectives Check List

Groundwater Level	X
Storage Change	X
Groundwater Quality	
Land subsidence	X
Surface Water Groundwater Interconnection	NA
Seawater Intrusion	NA

6.3.6.3 Circumstances for Implementation GP-1 – GP-3 (Sec. 354.44.b.1.A)

The groundwater pumping restrictions policy may have certain components that may be considered sooner than others.

GP-1

If deemed necessary, the Board of Directors may adopt policies and implement regulations and fees in order to address groundwater exports within the GSA, in order to ensure that all groundwater is consumed or retained within the GSA boundary.

GP-2

Should a new development within the GSA take place, an individual may be responsible for proving sustainability. The GSA may request to review all environmental documents to ensure that water balance and corresponding mitigation measures are implemented. If deemed necessary, the Board of Directors may develop or implement additional policies to address this concern within the GSA boundary.

GP-3

The Board of Directors may develop and adopt policies to immediately reduce or restrict groundwater pumping during times of drought. The GSA Board may develop and adopt various parameters of enforcement and implement such as deemed necessary.

6.3.6.4 Process for Public Notification GP-1 – GP-3 (Sec. 354.44.b.1.B)

The GSA will utilize the established methods of correspondence as described in EO-1-EO-2 to coordinate directly with users/growers to address necessary actions associated with groundwater pumping restrictions. If deemed necessary, the Board of Directors will adopt policies, issue warnings, and implement pumping restrictions if the circumstances require it.

6.3.6.5 Permitting and Regulatory Process GP-1 – GP-3 (Sec. 354.44.b.3)

No permit or regulatory process is required for the GSA to adopt the policy describing the prohibition of groundwater exports or pumping restrictions during droughts. The GSA may develop a groundwater export request form for emergency export permits. No external water source is used.

The regulatory process to adopt the policy describing requirements for new developments to provide sustainable water supplies may require cooperation from the County/City to ensure that the GSA reviewed and commented on the environmental documents prior to County/City approval. No external water source is used. The regulatory process would require FCEHD coordination and support to ensure new well permits issued within the GSA adhere to the GSA policy. No other environmental or regulatory permits would be required. No external water source is used.

6.3.6.6 Status and Schedule GP-1 – GP-3 (Sec. 354.44.b.4)

The policy has not been drafted. It is expected to commence after ten years of GSP adoption and be completed within five years.

6.3.6.7 Benefit Realization and Evaluation (Sec. 354.44.b.5)

GP-1

Charging fees for and/or regulating groundwater exports is expected to mitigate overdraft by ensuring groundwater supplies are consumed or retained within the GSA boundary. Emergency groundwater exports may be metered and recorded by the GSA. The method of evaluation may be reviewing the number of emergency export permits. An estimated 0 – 25,000 acre-feet per year may be retained within the GSA boundary as a result of this action.

GP-2

Ensuring new developments prove sustainability is expected to mitigate overdraft by assuring that new developments remain in accordance with current GSA groundwater allocations and that groundwater supplies are consumed or retained within the GSA boundary. The method of evaluation may be quantifying the number of new developments that are approved without GSA comment/approval. An estimated 0 - 100 acre-feet per year may be retained within the GSA boundary as a result of this action.

GP-3

Reducing groundwater pumping during specific intervals is expected to mitigate local overdraft and minimum threshold exceedances in a given area. The method of evaluation may be reviewing the financial impacts of reduced or suspended pumping. An estimated 0 - 10,000 acre-feet per year may be retained within the GSA boundary as a result of this action. It may vary significantly depending upon levied fees, water year, available transfers/banked credits, etc.

6.3.6.8 How This Management Action Will be Accomplished GP-1 – GP-3 (Sec. 354.44.b.6)

The GSA may adopt a policy to charge a fee for existing groundwater exports and/or prohibit new groundwater exports outside of the GSA boundary in order to accomplish GP-1. Additionally, the GSA will assess groundwater conditions as deemed necessary and may adopt policies in which GP-2 and GP-3 would be directly addressed and could become implemented.

6.3.6.9 Legal Authority GP-1 – GP-3 (Sec. 354.44.b.7)

The legal authority and basis for the management actions described in this GSP Chapter 6 are outlined in the SGMA and related provisions. The SGMA describes the powers and authorities, financial authority, and enforcement powers of GSAs in Chapters 5, 8, and 9 respectively.

6.3.6.10 Cost (Sec. 354.44.b.8)

GP-1

This action has an estimated $10,000 cost to draft and adopt policy. Future emergency permits would include fees to cover administrative and monitoring costs.

GP-2

This action has an estimated $10,000 cost to draft and adopt policy, plus an estimated $5,000 cost to coordinate development approval changes at the County/City.

GP-3

This action has an estimated $20,000 cost to draft and adopt policy. Once adopted, the levied fees may fund other projects and management actions.

7 Plan Implementation

The adoption of the GSP by its Board of Directors will be the official start of the Plan Implementation for the MAGSA. The GSA will continue its efforts to engage the public and secure the necessary funding to successfully monitor and manage groundwater resources within the McMullin Area in a sustainable manner. While the GSP is being reviewed by DWR, the GSA will coordinate with various stakeholders and beneficial users to improve the monitoring network and begin the implementation of both projects and management actions.

The following chapter outlines the estimated proposed budget and implementation timeline for the suggested projects and management actions of the MAGSA GSP. All the projects discussed have been evaluated as potential investments that would assist in achieving the long-term goals of the GSA. Of the projects, McMullin's On-Farm Flood Capture project has already begun construction. The potential schedules and budgets outlined below, are purely estimates and may be adapted or eliminated should the GSA board deem it necessary.

7.1 Estimate of GSP Implementation Costs

There are two main types of expenses that require funding in order to successfully implement the MAGSA GSP; Ongoing Administrative Expenses and Project Costs.

Ongoing Administrative Expenses
These include but are not limited to the cost of annually operating the GSA, including the executive officer's salary, fiscal agent and staff expenses, audit, annual data collection and reporting, outreach, legal and other administrative costs. This does not include agency specific project implementation costs but may include GSA wide efforts such as identification of construction information for wells in the monitoring network. Costs are estimated to be in the range of approximately $750,000 to $1,255,800 annually.

Project Costs
Projects which may include infrastructure or management programs will be required to achieve groundwater sustainability. Project costs may include planning, capital, financing and operations and maintenance of infrastructure. The project costs listed throughout this chapter are estimates and may be adapted or eliminated by the GSA Board should it be deemed necessary. Additionally, the implementation of the ranked projects is dependent on both obtained funding and the availability of flood water to be utilized in many of the projects. Further discussion regarding projects and their individual components, as well as their estimated timelines can be found in *Section 6.2 in Chapter 6 Projects and Management Actions.*

Grant Funding
The GSA, through the Kings Coordinated Group, has applied for and received Proposition 1 Technical Support Services grant funding to offset some of the capital improvement costs associated with the development of new monitoring wells to fill existing data gaps in the monitoring network. The GSA and its member agencies and partners will be exploring other federal and state grant funding opportunities to help finance the initial steps of plan implementation.

Additionally, as discussed in *Sections 6.3.4 of Chapter 6 Projects and Management Actions,* the GSA has been approved for an approximately $386,000 grant from the Bureau of Reclamation to be utilized for 50% of the study cost for a Water Marketing Strategy Study.

Table 7-1 Estimated Administrative Costs

Estimated Annual GSP Implementation Cost	Estimated Annual Expenses	2020	2025	2030	2035	2040
Part 1. Administration						
Public Outreach (KRCD)	$25,800	$25,800	$29,900	$34,700	$40,200	$46,600
Office Supplies / Postage / Outreach Materials	$10,000	$10,000	$11,500	$13,400	$15,500	$18,000
Staff	$240,000	$240,000	$278,200	$322,500	$374,000	$433,600
Reporting	$20,000	$20,000	$23,200	$26,900	$31,200	$36,200
Legal	$280,000	$280,000	$324,700	$376,300	$436,200	$505,700
Consulting	$50,000	$50,000	$57,900	$67,100	$77,800	$90,200
Correspondence	$5,000	$5,000	$6,000	$7,000	$8,000	$9,300
Other/Miscellaneous Overhead	$50,000	$50,000	$57,900	$67,100	$77,800	$90,200
Enforcement	$25,000	$25,000	$29,000	$33,700	$39,000	$45,200
Reporting						
Monitoring, Filling Gaps, Database	$500,000	$500,000	$579,700	$672,100	$779,200	$903,300
GSP 5 Year Update	$50,000		$58,000	$68,000	$78,000	$90,000
Part 1: Total Estimate	**$1,255,800**	**$1,205,800**	**$1,456,000**	**$1,688,800**	**$1,956,900**	**$2,268,300**

Table 7-1 is referring to the estimated administrative costs that may be needed on an annual basis for fulfilling typical responsibilities of the GSA. The above costs were compiled purely as an estimation and may be adapted or eliminated should the Board of Directors deem it necessary. It is impossible to accurately determine how many hours may be required on a weekly basis to complete the regular responsibilities of the GSA. The line items seen in **Table 7-1** may not accurately represent all the actions said funding would be applied toward. Additionally, it should be noted that for the future projections, a 3% inflation rate was applied to the overall cost for each line item.

Table 7-2 Estimated MAGSA Project Costs

Rank	Projects	Capital Cost	Annual Capital Payment	Average Annual Yield (AF)	Annualized Cost Per AF
1	Fresno City Wastewater Treatment Plant Recharge Basins, FID Houghton Canal System	$3,537,000	$230,000	6,745	$41
2	Fresno City Wastewater Treatment Plant Recharge Basins, Lower Dry Creek System	$2,223,000	$145,000	4,385	$41
3	Southwest Groundwater Banking	$6,221,403	$405,000	2,625	$154
4	Lassen Avenue Reverse Flow & Recharge	$3,263,000	$212,000	3,000	$71
5	MAGSA Groundwater Banking Program	$777,156,000	$50,555,000	208,000	$2,454.13
6	McMullin On-Farm Flood CaptureExpansion	$61,911,000	$4,027,000	27,120	$148.49
7	Houghton Wasteway Expansion	$4,921,664	$320,000	2,190	$146
8	South Sandridge Canal Water Supply & Recharge	$8,736,000	$568,000	4,800	$119
9	Stinson North Canal Phase 1	$61,114,000	$3,976,000	39,670	$100
10	Grantland Area Recharge	$22,043,000	$1,434,000	7,920	$181
11	CID Wristen Ditch Intertie	$13,420,000	$873,000	3,175	$275
12	Upgradient Recharge Program	$42,464,000	$2,762,000	15,360	$180

Table 7-2 refers to the estimated costs for the ranked projects as seen in **Section 6.2.16**. The existing ranking structure is not necessarily permanent and may be altered at appropriate times by the GSA Board of Directors. Additionally, it should be noted that fiscal resources are not the only necessary component for these projects to come to fruition. At the current time the estimated Kings River floodwater flows available for potential project utilization are approximately 42,500 acre-feet. It is the intention of the GSA Board that the list of projects listed in
Table 7-2 would contribute substantially to MAGSA sustainability goals.

Table 7-3 Estimated Costs for Implementing Management Actions

Estimated Costs for Management Action Implementation	Estimated Initial Costs	Estimated Cost Per AF	Estimated Annual Cost	2020	2025	2030	2035	2040
Part 3. Management Actions								
Education and Outreach MA	$20,000	$100-$10,000	$10,000	$10,000	$11,500	$13,400	$15,500	$18,000
Well Head Requirements MA	$50,000	$ -	$75,000	$75,000	$87,000	$100,900	$116,900	$135,400
Groundwater Allocation MA	$25,000	$ -	$25,000	$25,000	$29,000	$33,700	$39,000	$45,200
Groundwater Marketing/Trading MA	$25,000	$ -	$15,000	$15,000	$17,500	$20,300	$23,500	$27,200
Fees and Incentives MA	$25,000	$450-$480	$500,000	$25,000	$29,000	$33,700	$39,000	$45,200
Groundwater Pumping Restrictions MA	$20,000	$ -	$10,000	$10,000	$11,500	$13,400	$15,500	$18,000
Part 3: Total Estimate	**$165,000**	**$ -**	**$635,000**	**$160,000**	**$185,500**	**$215,400**	**$249,400**	**$289,000**

Table 7-3 indicates the estimated costs to the GSA associated with the proposed management actions as seen in *Section 6.3 of Projects and Management Actions,* these ranked management actions serve as pivotal framework for achieving sustainability within the MAGSA. **Table 7-3** explains the estimated costs associated with each proposed management action as it is implemented and indicates its conceivable annual costs. These estimates may be altered by the GSA Board of Directors as necessary and may also be reviewed, analyzed and adjusted during the 5-year GSP review. It should be noted that for Management Actions for Groundwater Marketing and Training as well as Well Head Requirements, there are several different subsections (GMT1-GMT5; WH1-WH5) that may have varying implementation and annual costs. **Table 7-3** is an estimation of these and other costs, while actual values may be in excess of or less than those depicted.

Table 7-4 Pre-GSP Proposition 218 Election Draft 5-Year Budget

McMullin Area GSA 5-year Budget
Excluding Parcels Less Than 2 Acres

	Category	FY[a] 2017-2018	FY[a] 2018-2019	FY[a,b] 2019-2020	FY[a,b] 2020-2021	FY[a,b] 2021-2022	FY[a,b] 2022-2023	TOTAL
1	**GSA Administration**							
1.1	Public Outreach (KRCD)	$ 20,000	$ 25,000	$ 25,800	$ 26,600	$ 27,400	$ 28,200	$ 133,000
1.2	Office Supplies / Postage / Outreach Materials		$ 5,000	$ 5,200	$ 5,400	$ 5,600	$ 5,800	$ 27,000
1.3	Insurance	$ 3,000	$ 5,000	$ 5,200	$ 5,400	$ 5,600	$ 5,800	$ 27,000
1.4	Fiscal Agent Services/Annual Audit	$ 10,000	$ 10,000	$ 10,300	$ 10,600	$ 10,900	$ 11,200	$ 53,000
1.5	Other/Miscellaneous Overhead	$ 5,000	$ 10,000	$ 10,300	$ 10,600	$ 10,900	$ 11,200	$ 53,000
	ITEM 1 SUBTOTAL	**$ 38,000**	**$ 55,000**	**$ 56,800**	**$ 58,600**	**$ 60,400**	**$ 62,200**	**$ 293,000**
2	**Professional Services**							
2.1	Agency Management	$ 208,000	$ 350,000	$ 360,600	$ 371,400	$ 382,500	$ 394,000	$ 1,858,500
2.2	Prop 218 Elections / Funding		$ 43,000	$ 44,400	$ 45,800	$ 47,200	$ 48,600	$ 229,000
2.3	Groundwater Sustainability Plan Preparation	$ 234,000	$ 569,900	$ 370,050				$ 939,950
2.4	Legal, Litigation Reserve	$ 20,000	$ 278,371	$ 249,590	$ 392,012	$ 346,982	$ 300,564	$ 1,567,518
2.5	Grant Writing		$ 100,000	$ 103,000	$ 106,100	$ 109,300	$ 112,600	$ 531,000
2.6	Project Development		$ 230,000	$ 283,900	$ 292,300	$ 301,100	$ 310,100	$ 1,417,400
2.7	Governmental Relations / Legislative Advocate		$ 50,000	$ 51,500	$ 53,000	$ 54,600	$ 56,200	$ 265,300
	ITEM 2 SUBTOTAL	**$ 462,000**	**$ 1,621,271**	**$ 1,463,040**	**$ 1,260,612**	**$ 1,241,682**	**$ 1,222,064**	**$ 6,808,668**
3	**Monitoring and Implementation**							
3.1	Monitoring and Implementation		$ 215,000	$ 371,500	$ 572,100	$ 589,300	$ 607,100	$ 2,355,000
	ITEM 3 SUBTOTAL	**$ -**	**$ 215,000**	**$ 371,500**	**$ 572,100**	**$ 589,300**	**$ 607,100**	**$ 2,355,000**

ITEM 4 - 15% RESERVE / CONTINGENCY	**$ -**		**$ 283,700**	**$ 283,700**	**$ 283,700**	**$ 283,700**	**$ 283,700**	**$ 710,170**
TOTAL ESTIMATED BUDGET (ITEMS 1 - 4)	**$ 500,000**		**$ 2,174,971**	**$ 2,175,040**	**$ 2,175,012**	**$ 2,175,082**	**$ 2,175,064**	**$ 10,875,168**
AVERAGE COST PER ACRE[d]			**$ 19.00**	**$ 19.00**	**$ 19.00**	**$ 19.00**	**$ 19.00**	

	5-YEAR AVERAGE COST PER ACRE	**$ 19.00**

Notes: a Fiscal Year (FY) is July 1 - June 30
b Assumes 3% per year increase for FY2019-20 through FY2022-23.
c Assumes $180,000 per year salary plus $60,000 for taxes, benefits
d MAGSA Assessable Acres = 114,749 +/-
Total Acreage (< 2acres) = 274 +/-
Prop. 218 Assessed Acreage = 114,475 +/-
MAGSA Total Acres = 120,635 +/-

Prior to the development of the GSP, the GSA sought local funding through a Proposition 218 election, based upon the foregoing draft 5-year budget. During the development of this GSP, individual costs were estimated for the various projects and management actions included in Chapter 6. The total cost of all projects and management actions far exceed the adopted 5-year budget, which served as a basis for the pre-GSP Proposition 218 Election (**Table 7-4**). Therefore, in order to achieve sustainability, a future Proposition 218 election or other funding mechanism will be required if the GSA intends to actively pursue supply augmentation projects instead of groundwater demand reducing management actions. It is important to note, that the information from **Figure 7-4** was significantly utilized in estimating the various budgets seen throughout this section.

7.2 Identify Funding Alternatives

The GSA successfully passed a local Proposition 218 Election securing funds to generate enough revenue to fund both annual Agency operation costs and expenses associated with the development and implementation of a GSP. Expenses consist of administrative support, GSP development, and GSP implementation, with GSP development occurring over the next several years and GSA administration and GSP implementation anticipated to be on-going expenses.

The administrative annual expenses include an assumed annual 3% inflation factor. The actual assessment rate will be set annually by the Board based upon the budget needs but will not exceed the maximum allowed rate. Assessments are expected to continue beyond Fiscal Year 2022-23, but at this time the future assessment rate is unknown because the final GSP implementation costs will not be fully determined until after the GSP is approved. The projects and management actions in the GSP may require supplemental funding and assessments greater than the maximum potential assessments. Therefore, there is a high probability of a future Proposition 218 election or development of another funding mechanism.

The GSA, through the Kings Coordinated Group, has applied for and received grant funding from the Proposition 1 Technical Support Services to offset some of the capital improvement costs associated with the development of new monitoring wells to fill existing data gaps in the monitoring network. Because Proposition 3 did not pass in the last election, the GSA will be exploring other federal and state grant funding opportunities and low interest loans to help finance the initial steps of plan implementation. If local, state, and federal funding is not readily available, the GSA may consider implementing various management actions to impose fees as discussed *in Section 6.3.5 of Chapter 6 Projects and Managements Actions* which, after formal adoption, would generate a continual revenue stream for future GSP implementation costs.

7.3 Schedule for Implementation

7.3.1 MAGSA Plan Implementation Schedule:

Figure 7-1 represents the tentative implementation plan for the MAGSA GSP, shown as a cumulative mitigation. MAGSA's share of the overall basin overdraft was estimated to be approximately 91,100Acre-feet prior to the development of the GSP. It is estimated that by 2025, the pre-existing overdraft value will have decreased by approximately 10% primarily due to the implementation of MAGSA projects. In the year 2030 it is estimated that the implementation of both GSP projects and management actions will have decreased the amount of overdraft by 30% with 75% coming from project implementation and 25% from management actions. The progress of this trend is cumulative and will continue to increase throughout the GSP's implementation until sustainability is met. **Figure 7-1**, is an estimated projection and results from both MAGSA projects and management actions and may vary from this expectation.

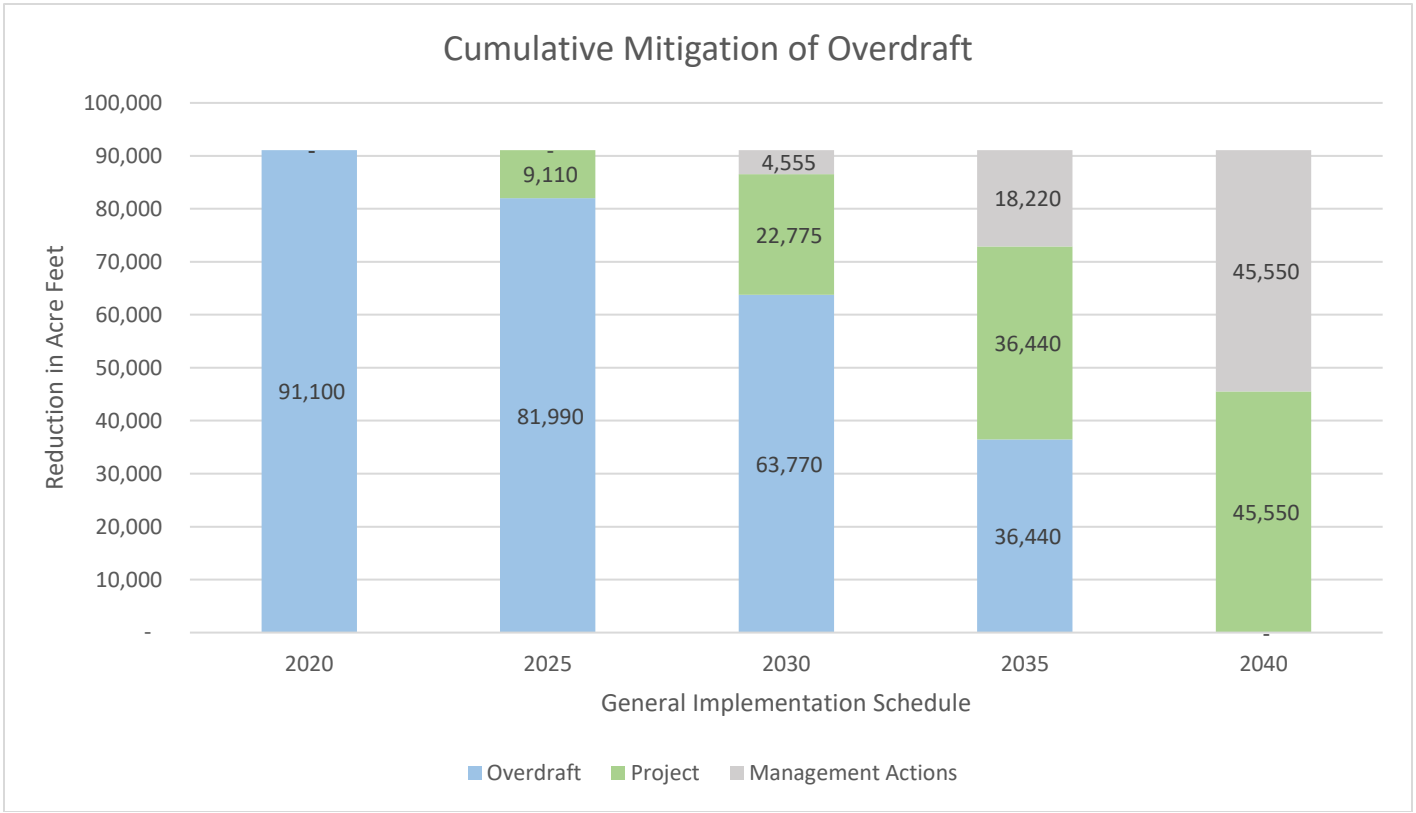

Figure 7-1 MAGSA Plan Implementation

7.3.2 Schedule for Project Implementation

*Estimated Project Implementation Schedule**	2020	2025	2030	2035	2040
1. Fresno City Wastewater Treatment Plant (FID Houghton)					
2. Fresno City Wastewater Treatment Plant (Lower Creek)					
3. Southwest Groundwater Banking					
4. Lassen Ave Reverse Flow & Recharge					
5. MAGSA Groundwater Banking Program					
6. McMullin On-Farm Flood Capture					
The following projects require flood water that exceeds the current available amount					
7. Houghton Wasteway Expansion					
8. South Sandridge Canal Water Supply & Recharge					
9. Stinson North Canal Phase 1					
10. Grantland Area Recharge					
11. Consolidated ID Wristen Ditch Intertie					
12. Upgradient Recharge Programs					
* *Estimations made by evaluating available flood water 42,500 AF*					

Figure 7-2 Estimated Project Implementation Schedule

Figure 7-2 indicates the estimated projected timeline for project implementation starting in 2020 and spanning to 2040. It is important to note that projects may initiate at different times and the above estimation of implementation may be altered by the GSA Board of Directors should it be deemed necessary. Additionally, as discussed previously, the amount of water necessary to fulfill all the various projects listed in **Table 7-2** and described in *Section 6.2 of Chapter 6 Projects and Management Actions* exceeds the current amount available. The GSA plans to continue broadening its scope in attempting to obtain additional resources to be utilized by these and other projects. The depicted schedule does not represent on site construction schedules. In most cases, there are several steps in moving forward with implementation including environmental documentation, agreements, project design and many others. Therefore, the estimated schedule in **Figure 7-2** should serve as a template for MAGSA implementation.

7.3.3 Schedule for Management Actions Implementation

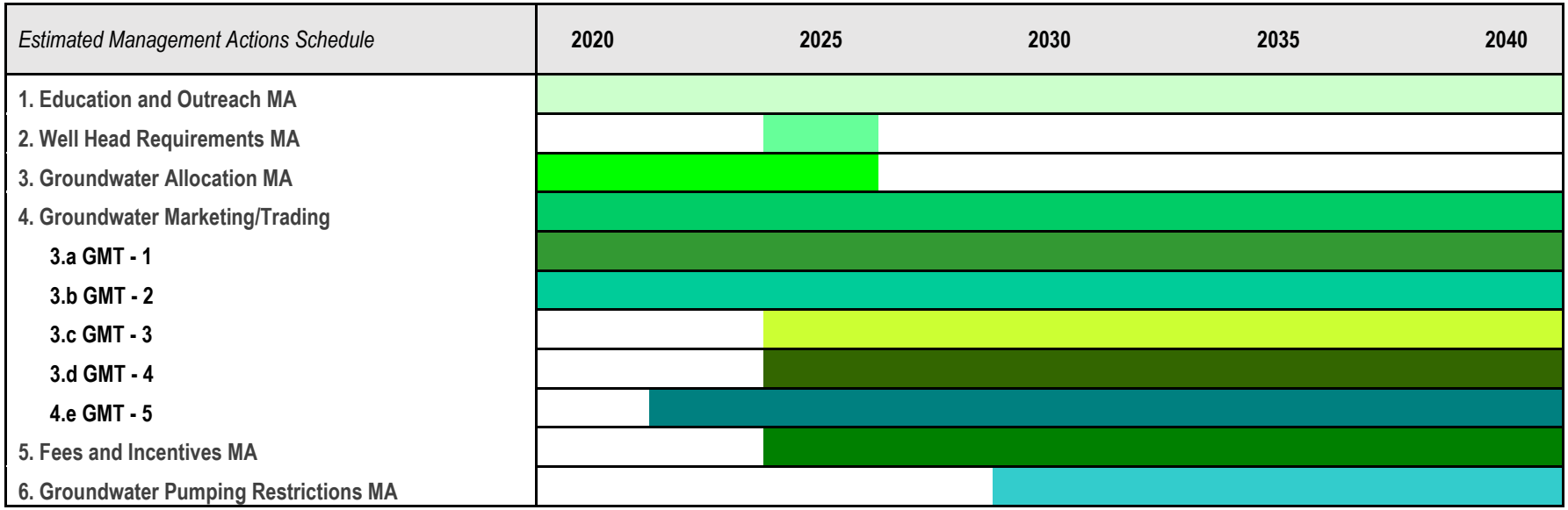

Figure 7-3 Estimated Management Actions Implementation Schedule

Figure 7-3 depicts the possible implementation schedule for the various MAGSA management actions. In the future it is assumed that not all the management actions would be fully developed or go into effect at the same time. In many cases there can be a significant lapse between policy development, drafting, and actual MA implementation. The actual implementation timeframe may be altered by the GSA Board of Directors if deemed necessary. Many of the proposed management actions have various components, all of which may be implemented at roughly different times. It is the intention of the GSA board that these management actions be integrated to work cohesively to achieve the MAGSA's long-term sustainability goals.

Both the suggested management actions and proposed MAGSA projects may be altered at any time by the GSA Board of Directors or during the 5-year GSP update.

7.4 Data Management System

The GSA, in coordination with the other GSAs in the Subbasin, has developed a Data Management System (DMS) to share data and store the necessary information for annual reporting. The GSAs have hired a consultant to build a user-friendly accessible database that standardizes the basin-wide data and allows GSA representatives to input their data and use basic tools for viewing, exporting or printing information for their GSA or the Subbasin. The DMS is a web-based software hosted on a cloud server. The DMS is the single repository for data aggregation and analysis for the Subbasin and generate the required annual reporting to DWR. GSA representatives have access to all data in the DMS. The DMS currently includes 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 map and tables of estimation
- Graph with Water Year type, Groundwater Use, Annual Cumulative Storage Change

The DMS also includes basic data layers for references including GSA boundaries, topographic information, land use, streets, aerial imagery, geologic information, specific yield information. Additional items may be added to the DMS in the future as required. A screen shot of the DMS is shown in **Figure 7-4.**

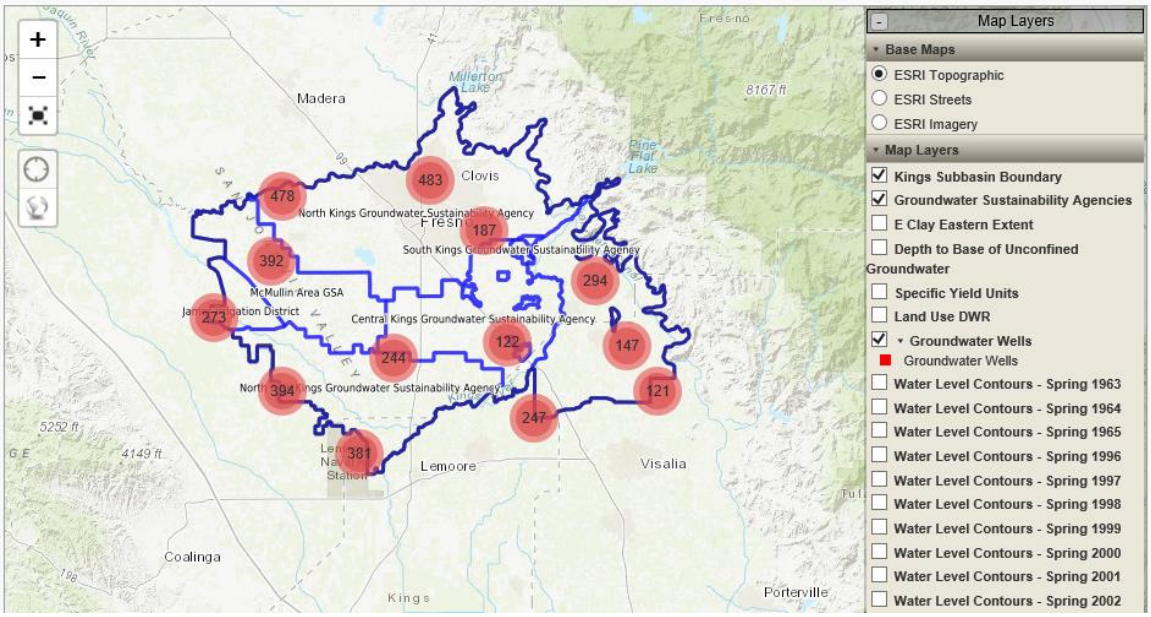

Figure 7-4 Kings Subbasin Data Management System Screenshot

Data is entered into the DMS by each GSA. Much of the data is then aggregated 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, then the results of those calculations uploaded to the DMS for annual reporting and trend monitoring. Since most of the pumping in the GSA (and the Subbasin) is not currently measured, the groundwater pumping estimates are also calculated outside of the DMS using the agreed basin-wide water budget approach then uploaded to the DMS for annual reporting and trend analysis. Surface water deliveries 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. **Table 7-5** provides a summary of how the DMS addresses each required element of the DMS and annual reporting requirements. The GSA may choose to have their own separate system for additional analysis.

Table 7-5 DMS Annual Reporting Requirements

Regulation	Requirement	Input to DMS
356.2(b)(1)(B)	Hydrographs incl water year type from Jan 2015	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 lines uploaded into DMS
356.2(b)(2)	GW extraction by water use sector incl method of determination and map	Determined outside DMS. Total use by sector input by each GSA then summarized for basin in DMS
356.2(b)(3)	Surface Water use by source	Total by GSA input to DMS and summarized for basin in DMS
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 map	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, GW use, annual & cumulative GW Storage change	DMS generated basin total graph using data in DMS

7.5 Annual Reporting

Regulation Requirements:

§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.

(c) 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 GSA will provide the Basin Coordinator the required information of groundwater levels, estimated extraction volume, surface water use, total water use, groundwater storage change, and progress of GSP

implementation for the Basin Annual Report in accordance with the timelines required to meet the April 1 deadline each year. The anticipated schedule for completion of the annual report each year will be:

- Dec 31 – Deadline for GSAs to provide GSA specific information
- Feb 28 – Completion of draft annual report
- Mar 15 – Review by GSA and Board approval
- Apr 1 – Submittal to DWR by Basin Coordinator

The Kings Subbasin annual report will have the following outline:

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 Basin-wide reporting to DWR, the GSA will generate an annual report that will include the elements reported with other GSAs to DWR, as well as GSA specific information which may include, but is not limited to:

- 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; and
- GSA funding status.

7.6 Periodic Evaluations

Regulation Requirements:

§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:

(1) 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.

(2) 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.

(3) 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 GSA will include updates of changes to the GSP or policy changes in its annual report and submit that report to DWR. 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 being met, additional data is acquired, or priorities change. Those results will be incorporated into the GSP when it is resubmitted to DWR every five years.

In addition, the GSA will provide an assessment to DWR in accordance with the regulatory requirements, which are currently set to be at least every five years. The assessment will include providing 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 SGMA law §356.4. Periodic Evaluation by Agency.

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Appendix 1 A
Kings Basin Coordination Agreement

KINGS SUBBASIN COORDINATION AGREEMENT

THIS KINGS SUBBASIN COORDINATION AGREEMENT ("Coordination Agreement" or "Agreement") is made effective as of the date of execution by the last of the GSA Parties by, between and among the groundwater sustainability agencies ("GSAs") within the Kings Subbasin; namely, the Central Kings GSA, James GSA, Kings River East GSA, McMullin Area GSA, North Fork Kings GSA, North Kings GSA and the South Kings GSA (referred to individually as a "GSA Party," and collectively as the "GSA Parties").

PREAMBLE

The GSA Parties each agree that by executing this Agreement, they are committing to the other GSA Parties to carry out the actions specified in this Coordination Agreement in good faith, and in a manner consistent with their individual responsibilities to comply with the California Sustainable Groundwater Management Act of 2014 ("SGMA");

RECITALS

This Coordination Agreement is made with reference to the following facts:

WHEREAS, each of the GSA Parties is a Groundwater Sustainability Agency ("GSA"), as the same is defined in the SGMA, and collectively, they provide GSA coverage of the entire Tulare Lake Hydrologic Region, San Joaquin Valley Groundwater Basin, Kings Subbasin; identified in California Department of Water Resources ("DWR") Bulletin 118 as Basin Number 5-22.08 ("Subbasin"); and

WHEREAS, the Kings Subbasin includes multiple GSAs that intend to manage the Subbasin through the development and implementation of multiple Groundwater Sustainability Plans ("GSPs"); and

WHEREAS, the SGMA requires GSAs in all basins that are managed by more than one GSP to enter into a Coordination Agreement (Cal. Water Code section 10727(b)(3)) to provide the appropriate coordinated methodologies to allow for the multiple GSPs to successfully manage the Subbasin in a manner compliant with the SGMA; and

WHEREAS, more specifically, consistent with the requirements of SGMA (Cal. Water Code section 10727.6), the Coordination Agreement must contain provisions ensuring that each of the GSPs utilizes the same data and methodologies within the basin for (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 California Code of Regulations (Title 23, section 357.4) further specifies that agencies intending to develop multiple GSPs shall enter into a Coordination Agreement to ensure that: (a) the GSPs are developed and implemented utilizing the same data and methodologies; (b) elements of the GSPs necessary to achieve the sustainability goal for the basin are based upon consistent interpretations of the basin setting; and (c) the Coordination Agreement shall be submitted to DWR along with the GSPs for review; and

WHEREAS, in recognition of the need to sustainably manage the groundwater within the Kings Subbasin, the GSA Parties desire to enter into this Coordination Agreement between and among their individual GSAs; and

WHEREAS, the GSA Parties acknowledge that nothing contained in this Coordination Agreement determines or alters surface water rights, including but not limited to existing Pre-1914 and licensed water rights of the Kings River Water Association member units, or groundwater rights under common law or any other provision of law that determines or grants surface water rights, in accordance with California Water Code 10720.5 (b).

NOW, THEREFORE, in consideration of the Recitals, which are deemed true and correct and incorporated herein, and of the mutual promises, covenants, terms and conditions set forth herein, the GSA Parties agree as follows:

SECTION 1 – DEFINITIONS

1.1 "Coordinated Plan Expenses" shall mean any authorized expenses incurred by the Coordination Workgroup or the Plan Manager for the purpose of implementing the Coordination Agreement.

1.2 "Coordination" shall mean the integration and synchronization of the efforts of the individual GSA Parties so as to provide coordinated action in the pursuit of a common basin goals under the enabling SGMA statutes.

1.3 "Coordination Agreement" shall mean this Agreement, which is entered into pursuant to and intended to be consistent with Water Code sections 10721 subdivision (d), 10727.6 and California Code of Regulations, Title 23, section 357.4.

1.4 "Coordination Workgroup" shall mean the Workgroup of GSA Representatives established pursuant to this Coordination Agreement.

1.5 "GSA" shall mean a groundwater sustainability agency as defined by Water Code section 10721, subdivision (j) established in accordance with Water Code sections 10723 *et seq.* and "GSAs" shall mean more than one such groundwater sustainability agency. Each GSA Party is a GSA.

1.6 "GSP" shall mean a groundwater sustainability plan as defined by Water Code section 10721, subdivision (k), and "GSPs" shall mean more than one such plan.

1.7 "GSA Alternate Representative," "Alternate Representative," or "Alternate" and their plural forms shall mean an alternate member of the Coordination Workgroup selected to represent the GSA in accordance with **Exhibit "A"** and Section 4.1.2-4.1.4 of this Coordination Agreement who shall serve in the absence of the respective GSA Representative and shall be entitled to cast the vote for the absent GSA Representative.

1.8 "GSA Party" or "GSA Parties" shall mean a Groundwater Sustainability Agency or in the plural, two or more Groundwater Sustainability Agencies within the Kings Subbasin that is (are) a signatory to this Coordination Agreement.

1.9 "GSA Representative" or "Representative" and their plural forms as appropriate shall mean a member of the Coordination Workgroup selected to represent the GSA in accordance with **Exhibit "A"** and Sections 4.1.2 – 4.1.4 of this Coordination Agreement.

1.10 "Interbasin Agreements" shall mean any voluntary agreement entered into by a GSA, GSAs or a Coordination Workgroup with a GSA, GSAs or a Coordination Workgroup in any adjacent basin in order to better establish understanding regarding fundamental elements of the GSPs of any of the contracting GSA, GSAs, or Coordination Workgroups as the same may relate to enhanced sustainable groundwater management between the basins; all as more specifically set forth at Title 23 Cal. Code Regs section 357.2(a) through (d).

1.11 "Plan Manager" shall mean an entity or individual, appointed at the pleasure of the Coordination Workgroup, or as provided in Section 4.2 of this Coordination Agreement, to perform the role of the Plan Manager to serve as the point of contact to DWR, consistent with Title 23 Cal. Code Regs. section 351, subdivision (z).

1.12 "Service Providers" shall mean engineers, hydrogeologists, hydrologists, economists, technicians, attorneys or other professional service providers hired by the GSA Parties to provide assistance in accordance with this agreement.

1.13 "SGMA" shall mean the California Sustainable Groundwater Management Act of 2014, as amended from time to time, commencing at Water Code section 10720, together with its implementing regulations applicable to Groundwater Sustainability Plans, set forth at California Code of Regulations, Title 23, Division 2, Chapter 1.5, Subchapter 2.

1.14 "Subbasin" shall mean the Kings Subbasin (Basin Number 5-022.08, DWR Bulletin 118, Interim Update 2016) within the Tulare Lake Hydrologic Region.

1.15 "Technical Memoranda" shall mean the memoranda prepared by and/or for the Coordination Workgroup and includes the data and methodologies for assumptions identified in Water Code section 10727.6 used to prepare the coordinated GSPs. Individually, the memoranda shall be referred to as a "Technical Memorandum."

SECTION 2 – GENERAL OBLIGATIONS AND LIMITATIONS OF AGREEMENT

2.1 Obligation to Coordinate

The GSA Parties to this Coordination Agreement agree to work cooperatively and collaboratively to meet the coordination requirements of the SGMA and this Coordination Agreement. Each GSA Party to this Coordination Agreement is a GSA and acknowledges that it is bound by the terms of this Coordination Agreement as an individual GSA Party. However, it is further understood and agreed that in order to bind or otherwise obligate a GSA Party on any matters affecting its individual rights, responsibilities and obligations under SGMA, or any

recommendations received by it arising from the terms and conditions contained in this Agreement (including any proposed future amendments hereto), that GSA Party's governing body must take final action at public meeting(s) and hearing(s) consistent with Water Code section 10728.4 regarding GSPs.

2.1.1 Obligation to Appoint Representatives and Alternatives

Each GSA Party understands its coordination participation, as more fully set forth in Section 4 of this Coordination Agreement, is based on representation through and by its individual designated GSA Representative. It is the responsibility and obligation of each GSA Party under this Coordination Agreement to appoint and authorize its respective GSA Representative and/or its Alternate Representative. Each GSA Party shall appoint and authorize one Representative and one Alternate to participate in coordination functions as described herein, and to facilitate timely and informed input and direction to the Coordination Workgroup and the Plan Manager.

By execution of this Coordination Agreement, each GSA Party confirms the authority of its GSA Representative and Alternate to provide input and direction to the Coordination Workgroup and the Plan Manager on behalf of that GSA Party, and each GSA Party understands that the Coordination Workgroup and the Plan Manager may undertake further consideration or conduct further analysis on the basis of that input and direction.

2.1.2 Non-Entity Status

The GSA Parties acknowledge and agree that this Coordination Agreement is entered into pursuant to the authorities referenced in Section 1.3 hereof, and that execution hereof does not act to create a legal entity separate and apart from the individual GSA Parties; that nothing contained in this Agreement is intended to create the power to sue or be sued, to enter into contract, or to enjoy the benefits or accept the obligations of a legal entity.

2.1.3 Implementation of Individual GSPs

Except as otherwise provided herein, this Coordination Agreement does not in any manner affect each GSA Party's responsibility to develop, approve and implement its respective individual GSP in accordance with the requirements of the SGMA.

2.2 No Adjudication Actions or Alternate Plans in the Subbasin

In accordance with the Title 23, California Code of Regulations section 357.4(f), the GSA Parties acknowledge that, as of the date of this Coordination Agreement, no area of the Subbasin is subject to (1) an adjudication action pursuant to Water Code section 10721(a), or (2) an alternative groundwater management plan submitted pursuant to Water Code section 10733.6.

2.3 No Restrictions on Interbasin Agreements

Nothing in this Coordination Agreement shall prevent any GSA Party or GSA Parties from entering into interbasin agreements with an Agency or individual parties within an adjacent Subbasin, or any other relevant Subbasin, so long as such interbasin agreements are not in direct

conflict with or otherwise prevent compliance with this Coordination Agreement or compliance with the SGMA.

SECTION 3 – FINANCIAL MATTERS

3.1 Coordination Expenses

Each GSA Party shall bear its own costs associated with activities performed under this Coordination Agreement. No GSA Party shall incur debts, liabilities or obligations on behalf of any other GSA Party unless provided for in a separate agreement.

3.2 Contracting for Services

The GSA Parties shall contract with all Service Providers, including the Plan Manager, directly in their capacity as individual GSAs. Nothing in this Coordination Agreement shall be construed to create a fiscal agent relationship between the individual GSA Parties or between the GSA Parties and the Plan Manager or any other individuals or entities unless further set forth in a separate written agreement.

3.3 Arrangements for Cost Sharing

When the GSA Parties agree to perform activities that involve a financial obligation under this Coordination Agreement, the GSA Parties may enter into a cost-sharing arrangement or separate cost sharing agreement(s) as a part of approving and undertaking the activity.

3.4 Incorporation of Cost Sharing Agreements

Any cost sharing agreement executed by all of the GSA Parties shall be incorporated into this Coordination Agreement for the purposes of Section 13.1.2. No other cost sharing agreements or arrangements shall be incorporated into the Coordination Agreement for the purposes of Section 13.1.2.

SECTION 4 – RESPONSIBILITIES FOR KEY FUNCTIONS

4.1 Coordination Workgroup

4.1.1 The GSA Parties have established a Coordination Workgroup to provide an informal forum for the GSA Parties to direct the Plan Manager and Service Providers on the development and coordination of data and methodologies to support the technical assumptions and information in each GSP, as provided in the SGMA, and to satisfy the coordination and annual reporting obligation in the years following initial GSP adoption.

4.1.2 The Coordination Workgroup will consist of one GSA Representative identified on **Exhibit "A,"** attached hereto and incorporated herein by this reference, as said **Exhibit "A"** may be modified from time to time. Each GSA Representative shall have one Alternate Representative authorized to participate in the absence of the GSA Representative.

4.1.3 Individuals serving as GSA Representatives and Alternate Representatives shall be selected and appointed by each respective GSA Party in the sole and absolute discretion of the respective GSA Party, and such appointments shall be effective upon providing written notice to the Plan Manager and to each of the other GSA Representatives listed on **Exhibit "A"**.

4.1.4 The Coordination Workgroup will recognize each GSA Representative and GSA Alternate Representative until such time as a GSA Party may provide written notice of removal and replacement of the Representative or Alternate to the Plan Manager and to every other GSA Representative designated on **Exhibit "A."** Each GSA Party shall promptly fill any vacancy created by the removal of such Representative or Alternate Representative so that each GSA Party shall have the number of validly designated Representatives and Alternate Representatives specified on **Exhibit "A".**

4.1.5. Informal meeting notes of the meetings of the Coordination Workgroup will be prepared and maintained as set forth in Section 4.5.3.

4.2. Plan Manager

The Coordination Workgroup shall appoint, by unanimous consent, a Plan Manager, who may be a consultant hired by the GSA Parties pursuant to the Coordination Agreement or a public agency serving as or participating in a GSA that is a GSA Party to this Coordination Agreement. In accordance with the Title 23, California Code of Regulations Section 357.4(b)(1) the Plan Manager shall serve as the point of contact for DWR as specified by the SGMA (section 1.11 above). The Plan Manager has no authority to make policy decisions or represent the Coordination Workgroup without the prior unanimous consent of the Coordination Workgroup. The Plan Manager has no authority to bind or otherwise create legal obligations on behalf of the Coordination Workgroup. The Plan Manager is obligated to disclose all substantive communications he/she transmits and receives in his/her capacity as Plan Manager to the Coordination Workgroup. The Plan Manager serves at the pleasure of the GSA Parties, shall serve until he/she resigns or is otherwise replaced by unanimous consent of the Coordination Workgroup and shall have a separate written agreement with each GSA Party. The Plan Manager is identified in **Exhibit "A"**.

4.3 Coordination Workgroup Role and Limitations

4.3.1 Workgroup Role

In an effort to further the effective coordination of the GSA Parties under this Coordination Agreement, the Coordination Workgroup is convened to research, consider, and otherwise forward unanimous recommendations to each individual GSA Party's Board of Directors, subject to the ultimate formal approval of each said GSA Party's GSA Board of Directors, for the following enumerated items:

(a) Technical Memoranda for the SGMA required GSP elements described in Water Code section 10727.6, subdivisions (a) through (g) and Sections 8 through 10 of this Coordination Agreement, including the technical data and methodologies, as further collectively approved by the individual GSA Parties, in the GSA Parties' respective GSPs.

(b) Following the submittal to and approval of the GSPs and this Coordination Agreement by DWR, recommendations for ongoing review and updating of the Technical Memoranda as needed; for assuring submittal of annual reports; for providing five-year assessments and for any needed revisions to the Coordination Agreement; and for providing review and assistance with coordinated projects and programs.

(c) Review and recommendation for approval of annual estimates of Coordinated Plan Expenses presented by the Plan Manager and any updates to such estimates; provided, that such estimates or updates with supporting documentation shall be circulated to all GSA Parties in advance of the meeting at which the Coordination Workgroup will consider the annual estimate and within an adequate timeframe for GSA Representatives to present to their respective GSA Party Board of Directors for consideration and approval.

(d) Provide input and direction to the Plan Manager in the performance of its duties in conformance with the SGMA.

4.3.2 Limitations

It is the intent of the GSA Parties that every effort be made to achieve a consensus on the items to be recommended by the Coordination Workgroup for individual GSA Board consideration. The Coordination Workgroup shall be limited in scope to this intended result. When the terms of this Coordination Agreement or applicable law require the approval of a GSA Party, that approval shall be evidenced as indicated in Section 5 of this Agreement.

4.4 Ad Hoc Sub-Workgroups

The Coordination Workgroup may informally organize ad hoc sub-workgroups. Such ad hoc sub-workgroups may include qualified individuals possessing the knowledge and expertise to assist the Coordination Workgroup, consistent with the Coordination Agreement, on specific topics identified by the Coordination Workgroup. Individuals participating in ad hoc sub-workgroups need not be GSA Representatives or Alternate Representatives.

4.4.1 Work of Ad Hoc Sub-Workgroups

Tasks assigned to ad hoc sub-workgroups, or staff made available by the GSA Parties, may include more specific technical assistance to the Coordination Workgroup concerning development of recommendations for technical data, supporting information or documentation, and/or recommendations on matters of interest to the Coordination Workgroup, from time to time.

4.5 Coordination Workgroup Meetings

4.5.1 Timing and Notice

Any two GSA Representatives or, more typically, the Plan Manager, may call meetings of the Coordination Workgroup as needed to carry out the activities described in this Coordination Agreement. The Coordination Workgroup may, but is not required to, set a date for regular meetings for the purposes described in this Coordination Agreement. It is agreed and understood

that, in the interest of cooperation and overall efficiency, every effort will be made to schedule meetings of the Coordination Workgroup at such times and places as will result in the ability of each GSA Party to have a GSA Representative present at the meeting.

4.5.2 Effective Participation

In order to provide timely and comprehensive consideration in its role as a Coordination Workgroup of items included within its scope, it is agreed that every effort will be made to have at least one of the GSA Representatives from every GSA Party listed on **Exhibit "A"** present for purposes of holding a Coordination Workgroup meeting. It is understood and agreed that the intent of the GSA Parties is to reach a consensus on all matters considered by the Coordination Workgroup for recommendation forward to each GSA Party's Board of Directors for final consideration. The GSA Representatives from every GSA Party listed on **Exhibit "A"** must be present at a meeting, or may provide a written communication in advance of the meeting, of the absent GSA Party's position on the item being considered to the Coordination Workgroup and/or the Plan Manager should the GSA be unable to have their Representative present, for any Coordination Workgroup attempt to reach consensus for a final recommendation on a matter described in section 4.3.1 to take place.

4.5.3 Informal Meeting Notes

The Plan Manager shall keep and prepare informal meeting notes of all Coordination Workgroup meetings. Notes of ad hoc sub-workgroup meetings shall be kept by the Plan Manager or Plan Manager's appointee. All Coordination Workgroup meeting notes and ad hoc sub-workgroup meeting notes shall be maintained by the Plan Manager as Coordination Workgroup records and shall be available to the GSA Parties.

SECTION 5 – APPROVAL BY INDIVIDUAL PARTIES

5.1 Whether by operation of law or by action of the Kings Subbasin under the terms of this Coordination Agreement any recommendation, action, position or agreement of this Subbasin requires separate written approval by each of the GSA Parties, and such approval shall be evidenced to the other GSA Parties, in writing, by providing a copy of the Resolution, Motion, or Minutes of the formal action taken by each of their respective Boards of Directors to the Plan Manager of the Coordination Workgroup.

SECTION 6 – EXCHANGE OF DATA AND INFORMATION

6.1 Exchange of Information

In accordance with Title 23, California Code of Regulations Section 357.4(b)(2) of the GSP Regulations, the GSA Parties acknowledge and recognize that for this Coordination Agreement to be effective in promoting basin-wide groundwater sustainability and compliance with the SGMA and the basin level coordinating and reporting regulations, the GSA Parties will have an affirmative obligation to exchange certain minimally necessary information among and between the other GSA Parties. The GSA Parties agree that they shall only use the information exchanged amongst them for the purposes set forth in this Agreement.

6.2 No Duty of Confidentiality

All Parties are public agencies and each Party acknowledges that any exchanged information is subject to the provisions of the California Public Records Act and a duly issue subpoena or court order. Each GSA Party shall be responsible for determining whether the information minimally necessary from its GSA to comply with the data and methodologies coordination and subsequent annual coordinated reporting of basin level data to DWR, as further set forth in this Coordination Agreement and in **Exhibit "B"** attached hereto, is subject to any non-disclosure or privacy restrictions. It shall be the responsibility of each individual GSA Party to take such steps and employ such measures as it deems necessary to configure the information in a form that satisfies its privacy concerns while otherwise complying with its statutory and regulatory obligations under this Coordination Agreement. This Coordination Agreement imposes no duty or obligation upon any GSA Party, nor its agents, contractors or other professional associates, for the protection of the information provided by other GSA Parties in satisfying the minimal coordination and reporting requirements under the SGMA and the regulations.

6.3 Voluntary Exchange of Information

Nothing in this Coordination Agreement shall be construed to prohibit any GSA Party from voluntarily exchanging information with any other GSA Party by any other mechanism separate from the Coordination Workgroup.

6.4 Public Records Act Requests

The GSA Parties agree that the Coordination Workgroup is not a public agency and shall take all appropriate actions to ensure the non- public agency status of the Coordination Workgroup when receiving any data requests under the Public Records Act or otherwise. As such, the Plan Manager is not authorized to accept or respond to any Public Records Act request, and may, but is not obligated to, refer the requesting party to one or more of the GSA Parties.

SECTION 7 – COORDINATED DATA MANAGEMENT SYSTEM

7.1 In accordance with the Title 23, California Code of Regulations Section 357.4(e), the GSA Parties are developing and will maintain a coordinated data management system that is capable of storing and reporting information relevant to and in compliance with the SGMA reporting requirements, the coordinated monitoring network of the Subbasin and the coordinated implementation of the GSA Parties' GSPs.

7.2 The GSA Parties likewise agree to develop and maintain the data required for the Basin data management system to provide the minimum required annual reporting information, as well as other pertinent information determined necessary by the Coordination Workgroup. Each GSA shall provide data in a format compatible with the Basin Data Management System. After providing the Coordination Workgroup with data from the individual GSPs, the Coordination Workgroup will cause the data to be stored and managed in a coordinated manner among the GSA Parties and reported to DWR periodically, as required. A description of the Data Management System is included in **Exhibit "B"**.

SECTION 8 – METHODOLOGIES AND ASSUMPTIONS

8.1 SGMA Coordination Requirements

Pursuant to the SGMA, this Coordination Agreement must demonstrate that the individual GSAs intending to develop and implement multiple GSPs pursuant to Water Code section 10727(b)(3) have coordinated with the other GSAs preparing a GSP within the Subbasin to ensure that the GSPs utilize the same data and methodologies for the following assumptions used in developing the GSPs: (1) groundwater elevation; (2) groundwater extraction data; (3) surface water supply; (4) total water use; (5) changes in groundwater storage; (6) water budgets; and (7) sustainable yield. (Water Code Section 10727.6.)

8.2 Coordination during GSP Development

During development of the individual GSPs, the GSA Parties have developed common methodologies and assumptions for the required plan elements listed in Water Code section 10727.6. This development was facilitated through research, analysis and discussion within the Coordination Workgroup. Once consensus was achieved at the Coordination Workgroup, the recommendations of the Coordination Workgroup were forwarded to the individual GSA Party's Board of Directors for further consideration and approval as part of their GSPs. The final approved set of data gathering, storage and analysis criteria, along with the approved methodologies associated with each required item specified in Water Code section 10727.6 specified above in section 7.1 of this Agreement, is attached to this Coordination Agreement as **Exhibit "B,"** and incorporated into each GSP and in this Agreement as if originally set out in full. Generally, the basis upon which the methodologies and assumptions were developed includes, but shall not be limited to, collection of existing relevant data/information, consideration of applicable best management practices, methodologies considered as standard accepted practices in the water and groundwater industries and/or best modeled or projected data available and may include consultation with the DWR, as appropriate.

8.3 Description of Data and Methodologies

The data and methodologies for assumptions described in Water Code section 10727.6 and Title 23, California Code of Regulations Section 357.4 for preparation of coordinated plans, in addition to **Exhibit "B"** as set forth above, is further supported by applicable relevant Technical Memoranda prepared by the Coordination Workgroup, and recommended to the individual GSA Parties for each of the elements discussed in Sections 8, 9, and 10 of this Coordination Agreement. The data and methodologies required for coordination are subject to the unanimous consent of the Coordination Workgroup and all GSA Parties' Boards of Directors, and have been incorporated to this Coordination Agreement and incorporated into each GSA Party's GSP, as appropriate. The Technical Memoranda created pursuant to this Agreement have been utilized by the GSA Parties during the development and implementation of their GSPs in order to assure coordination of the GSPs in compliance with the SGMA. The GSA Parties acknowledge that this Coordination Agreement is required to be submitted to DWR along with each GSA's completed GSP to ensure that each GSP has included the information developed in **Exhibit "B".**

SECTION 9 – MONITORING NETWORK

9.1 In accordance with the Title 23, California Code of Regulations Section 357.4(b)(3)(A), the GSA Parties hereby agree to coordinate the development and maintenance of a Subbasin monitoring network through the coordination of the respective GSA monitoring networks established pursuant to the GSA Parties' GSPs. The description of the Subbasin monitoring network includes monitoring objectives, protocols, and data reporting requirements specific to enumerated sustainability indicators. Each GSA Party's network facilitates the collection of data in order to adequately characterize groundwater and related surface water conditions in the Subbasin and reasonably evaluate changing conditions that occur from implementation of the individual GSPs. Each GSA Party's GSP describes the GSA monitoring network's objectives as they relate to the Subbasin as well as their individual GSA area as required by the regulations, including, but not limited to, an explanation of coordinated network development and implementation to monitor groundwater and related surface conditions, and the interconnection of surface water and groundwater.

9.2 Each GSA Party has provided and shall continue to provide to the Coordination Workgroup, at a minimum, all relevant required data and information for their respective representative monitoring sites established in accordance with Title 23, California Code of Regulations, Section 354.36, as amended from time to time. A description of the groundwater elevation data and monitoring network has been included in **Exhibit "B"** in accordance with the Title 23, California Code of Regulations Section 357.4(b)(3)(A).

SECTION 10– COORDINATED WATER BUDGET

10.1 In accordance with the Title 23, California Code of Regulations Section 357.4(b)(3)(B), the GSA Parties hereby agree to prepare a single coordinated water budget for the Subbasin for use in the individual GSA Party's GSP. The water budget includes those elements required by Title 23, California Code of Regulations, Section 354.18, including groundwater extraction data, surface water supply, total water use, and change in groundwater in storage.

10.2 In accordance with the Title 23, California Code of Regulations Section 357.4(b)(3)(C), the GSA Parties have utilized and will continue to utilize the coordinated water budget to determine the sustainable yield for the basin. The determination of sustainable yield is supported by a description of the undesirable results for the basin, and an explanation of how the minimum thresholds and measurable objectives defined by each GSP relate to those undesirable results, based on information described in the basin setting. A description of the Coordinated Water Budget is included in **Exhibit "B".**

SECTION 11 – ADOPTION AND USE OF THE COORDINATION AGREEMENT

11.1 Coordination of GSPs

In accordance with the Title 23, California Code of Regulations Section 357.4(c), this section has been included to provide clarification of how the GSPs implemented together satisfy the requirements of SGMA and are substantially compliant with Title 23, California Code of Regulations. Each GSA Party acknowledges that it is responsible to ensure that its own GSP

complies with the statutory requirements of the SGMA. The GSA Parties further acknowledge the existence of more than one GSA within the Kings Subbasin and the related requirements of the California Water Code and the California Code of Regulations to coordinate among the multiple GSAs within the Subbasin. It is the intent of the GSA Parties that, through development and execution of this Coordination Agreement and the implementation of their collective GSPs within the Subbasin, that they shall satisfy the requirements of sections 10727.2 and 10727.4 of the Water Code, and that when taken together as a whole, they shall provide a detailed description of how the Subbasin will timely achieve sustainability and be managed sustainably into the future. As described in this Agreement and the Exhibits, the GSA Parties have developed their respective GSPs using common data and methodologies. The GSA Parties have coordinated development of their GSPs prior to GSP submittal. Each GSP within the basin is using the same GSP outline structure, and includes common language describing the basin where appropriate.

11.2 GSP and Coordination Agreement Submission

In accordance with the Title 23, California Code of Regulations Section 357.4(d), the GSA Parties agree to submit this Coordination Agreement and their respective GSPs to DWR through the Coordination Workgroup and Plan Manager, in accordance with all applicable requirements.

SECTION 12 – MODIFICATION AND TERMINATION

12.1 Modification or Amendment of **Exhibit "A"**

The GSA Parties agree that **Exhibit "A,"** except for the withdrawal of GSA Parties to this Agreement, may be updated by written direction from the GSA Parties from time to time. Upon such modification, the updated **Exhibit "A"** shall be attached to this Agreement as a replacement to the previously existing **Exhibit "A."** Upon such attachment, the updated "**Exhibit "A"** shall become a part of this Coordination Agreement without further approval being required. The Plan Manager shall provide notice of such change to all GSA Representatives.

12.2 Modification or Amendment of **Exhibit "B"**

The GSA Parties agree that **Exhibit "B"** may be updated by written direction from the GSA Parties and consensus of the Coordination Workgroup, followed by approval of each individual GSA Party's Board of Directors from time to time without the necessity of amending the main body of the Agreement. Upon such modification, the updated **Exhibit "B"** shall be attached to this Agreement as a replacement to the previously existing **Exhibit "B."** Upon such attachment, the updated "**Exhibit "B"** shall become a part of this Coordination Agreement. The Plan Manager shall provide notice of such change to all GSA Representatives.

12.3 Amendment for Compliance with Law

Should any provision of this Coordination Agreement be determined to be not in compliance with legal requirements under circumstances where amendment of the Agreement to include a provision addressing the legal requirement will cure the non-compliance, the GSA Parties agree to promptly prepare and approve such amendment.

12.4 Modification or Amendment of Coordination Agreement

Except as provided in Sections 12.1 and 12.2, the GSA Parties hereby agree that this Coordination Agreement may be supplemented, amended, or modified only by a writing approved by each individual GSA Party's Board of Directors and signed by the GSA Parties.

SECTION 13 – WITHDRAWAL, TERM, AND TERMINATION

13.1 Withdrawal

13.1.1 Any GSA Party may withdraw from this Coordination Agreement upon providing the Plan Manager and all other remaining GSA Parties with at least one (1) year's written notice of such withdrawal. Such a withdrawal from this Coordination Agreement shall not cause or require termination of this Coordination Agreement.

13.1.2 Any GSA Party who withdraws shall remain obligated for Coordinated Plan Expenses as provided in any then-existing separate cost sharing agreement.

13.2 Term

This Coordination Agreement, as modified from time to time pursuant to Section 12, shall continue for a term that is coterminous with the requirements of the SGMA, as the same may be modified, from time to time.

13.3 Termination

This Coordination Agreement shall terminate if the requirements of SGMA no longer apply to the GSA Parties or if the requirements of SGMA no longer require a Coordination Agreement. This Coordination Agreement may also be terminated upon the unanimous written consent of the GSA Parties.

SECTION 14 – WATER RIGHTS

14.1 Acknowledgement of Water Code Section 10720.5

The GSA Parties acknowledge that pursuant to Water Code Section 10720.5(a), that SGMA does not modify rights or priorities to use or store groundwater consistent with Section 2 of Article X of the California Constitution, except as so provided in said subsection. The GSA Parties further acknowledge that pursuant to Water Code Section 10720.5(b), SGMA does not determine or alter surface water rights or groundwater rights under common law or any provision of law that determines or grants surface water rights. Water rights may be determined in an adjudication action as described in Water Code Section 10720.5(c). Any dispute involving water rights including without limitation as to priority of water rights shall be separately resolved based upon applicable law before a proper judicial, administrative or enforcement forum, and is

specifically excluded from the provisions of this Agreement, including without limitation, Section 15 below.

SECTION 15 – RESOLUTION OF CONFLICTS

15.1 Procedure for Resolving Conflicts or Disputes

In accordance with Title 23, California Code of Regulations Section 357.4(b)(2) of the GSP Emergency Regulations, the GSA Parties have identified procedures for resolving conflicts between Parties. In the event that any conflict or dispute arises between or among the GSA Parties relating to the enforcement or interpretation of any term, covenant or condition of this Agreement or the rights and obligations arising from this Agreement ("Dispute"), the aggrieved GSA Party or GSA Parties ("Aggrieved GSA Party") shall provide written notice, sufficiently detailing the basis upon which the Dispute is alleged to exist, to the other GSA Parties. Within fifteen (15) days after such written notice, the GSA Parties shall meet and confer and/or commence an attempt in good faith to resolve the Dispute through informal means. If the GSA Parties cannot agree upon a resolution of the Dispute within thirty (30) days following the provision of written notice specified above, the Dispute shall be submitted to mediation as provided in Section 15.2.

15.2 Mediation

Upon expiration of thirty (30) days as described in Section 15.1, the Aggrieved GSA Party shall initiate mediation by notifying all GSA Parties in writing of the Dispute, the informal attempts to resolve the Dispute pursuant to Section 15.1, and the initiation of mediation. The notice shall be submitted no later than thirty (30) days from the expiration date outlined in Section 15.1. A mediator shall be selected that is mutually agreeable to the GSA Parties. The GSA Parties shall: (i) mediate in good faith; (ii) exchange all documents which each believes to be relevant and material to the issue(s) in the Dispute; (iii) exchange written position papers stating their position on the Dispute and outlining the subject matter and substance of the anticipated testimony of persons having personal knowledge of the facts underlying the Dispute; and (iv) engage and cooperate in such further discovery as the disputing GSA Parties agree or mediator suggests may be necessary to facilitate effective mediation. Each GSA Party that is a party to the mediation shall bear its own costs, fees and expenses of the mediation. Venue of the mediation shall be a mutually agreeable city within Fresno County, California or as otherwise agreed to. Should the GSA Parties be unable to resolve the Dispute through the mediation process, any GSA Party may seek legal or other relief as they may deem appropriate.

SECTION 16 – GENERAL PROVISIONS

16.1 Authority of Signers

The individuals executing this Coordination Agreement represent and warrant that they have the authority to enter into this Coordination Agreement and to legally bind the GSA Party for whom they are signing to the terms and conditions of this Coordination Agreement.

16.2 Governing Law

The validity and interpretation of this Coordination Agreement will be governed by the laws of the State of California.

16.3 Severability

Except as provided for cure by amendment in Section 12.2, if any term, provision, covenant, or condition of this Coordination Agreement is determined to be unenforceable by a court of competent jurisdiction, it is the GSA Parties' intent that the remaining provisions of this Coordination Agreement will remain in full force and effect and will not be affected, impaired, or invalidated by such a determination.

16.4 Counterparts

This Coordination Agreement may be executed in any number of counterparts, each of which will be an original, but all of which will constitute one and the same agreement.

16.5 Good Faith

The Parties agree to exercise their best efforts and utmost good faith to effectuate all the terms and conditions of this Coordination Agreement and to execute such further instruments and documents as are reasonably necessary, appropriate, expedient, or proper to carry out the intent and purposes of this Coordination Agreement.

16.6 Construction and Interpretation.

This Agreement has been developed through negotiation and each of the GSA Parties has had a full and fair opportunity to review and make suggestions to revise the terms of this Agreement. As a result, the normal rule of construction that any ambiguities are to be resolved against the drafting GSA Parties shall not apply in the construction or interpretation of this Agreement.

16.7 Indemnity

No GSA Party, nor any director, officer or employee of a GSA Party, shall be responsible for any damage or liability occurring by reason of anything done or omitted to be done by another GSA Party under or in connection with this Coordination Agreement. The GSA Parties further agree, pursuant to Government Code section 895.4, that each Party shall fully indemnify and hold harmless each other GSA Party and its agents, directors, officers, employees and contractors from and against all claims, damages, losses, judgments, liabilities, expenses and other costs, including litigation costs and attorney fees, arising out of, resulting from, or in connection with any work delegated to or action taken or omitted to be taken by such GSA Party under this Coordination Agreement.

16.8 Entire Agreement

This Agreement constitutes the entire agreement among the GSA Parties and supersedes all prior agreements and understandings, written or oral.

IN WITNESS WHEREOF, the GSA Parties have executed this Agreement as of the date of the last signature hereto.

CENTRAL KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By Phillip G. Desatoff

Date: 11/15/19

JAMES GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

KINGS RIVER EAST GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

MCMULLIN AREA GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

NORTH FORK KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

NORTH KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

SOUTH KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

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CENTRAL KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

JAMES GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____
STEVEN P. STADLER, EXECUTIVE DIR.

Date: DECEMBER 12, 2019

KINGS RIVER EAST GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

MCMULLIN AREA GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

NORTH FORK KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

NORTH KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

SOUTH KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

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CENTRAL KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

JAMES GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

KINGS RIVER EAST GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: 11/21/2019

MCMULLIN AREA GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

NORTH FORK KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

NORTH KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

SOUTH KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

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IN WITNESS WHEREOF, the GSA Parties have executed this Agreement as of the date of the last signature hereto.

CENTRAL KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

JAMES GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

KINGS RIVER EAST GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

MCMULLIN AREA GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____
MATTHEW H. HURLEY, Gen. Mgr.

Date: 11/6/2019

NORTH FORK KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

NORTH KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

SOUTH KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

16.8 Entire Agreement

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IN WITNESS WHEREOF, the GSA Parties have executed this Agreement as of the date of the last signature hereto.

CENTRAL KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

JAMES GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

KINGS RIVER EAST GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

MCMULLIN AREA GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

NORTH FORK KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: 11-22-2019

NORTH KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

SOUTH KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

16.8 Entire Agreement

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IN WITNESS WHEREOF, the GSA Parties have executed this Agreement as of the date of the last signature hereto.

CENTRAL KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

JAMES GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

KINGS RIVER EAST GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

MCMULLIN AREA GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

NORTH FORK KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

NORTH KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By Gary R. Serrato

Date: Oct 24, 2019

SOUTH KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

16.8 Entire Agreement.

This Agreement constitutes the entire agreement among the GSA Parties and supersedes all prior agreements and understandings, written or oral.

IN WITNESS WHEREOF, the GSA Parties have executed this Agreement as of the date of the last signature hereto.

CENTRAL KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

JAMES GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

KINGS RIVER EAST GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

MCMULLIN AREA GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

NORTH FORK KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

NORTH KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: _____

SOUTH KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By _____

Date: 12/20/2019

EXHIBIT "A"

GSA DESIGNATED REPRESENTATIVES AND SUBBASIN PLAN MANAGER

DATED: 12/20/2019

CENTRAL KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

Representative: Phil Desatoff

Alternate: Earl Hudson

JAMES GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

Representative: Steve Stadler

Alternate: Robert Motte

KINGS RIVER EAST GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

Representative: Chad Wegley

Alternate: Jack Brandt

MCMULLIN AREA GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

Representative: Matt Hurley

Alternate: Don Cameron

NORTH FORK KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

Representative: Mark McKean

Alternate: Scott Sills

NORTH KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

Representative: Gary Serrato

Alternate: Kassy Chauhan

SOUTH KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

Representative: Karnig Kazarian

Alternate: Sherman Dix

The PLAN MANAGER is:

Name: Ronnie Samuelian

Agency/Entity: Provost & Pritchard

Exhibit "B"
To the Kings Subbasin Coordination Agreement

The GSAs may update and modify the processes described in this exhibit as new preferred methods are identified, additional data is gathered, or reporting requirements change. Updates to the methods or information will be subject to agreement by GSAs under the terms of this agreement and documented in Basin annual reports and GSP updates.

I. Sustainability Goal

The sustainability goal of the Kings Basin and each GSA 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 water demand with available water supply to stabilize declining groundwater levels without significantly and unreasonably impacting water quality, land subsidence, or interconnected surface water. The goal of the basin is to correct and end the long-term trend of a declining water table understanding that water levels will fluctuate based on the season, hydrologic cycle, and changing groundwater demands within the basin and its proximity.

II. Description of Monitoring Networks

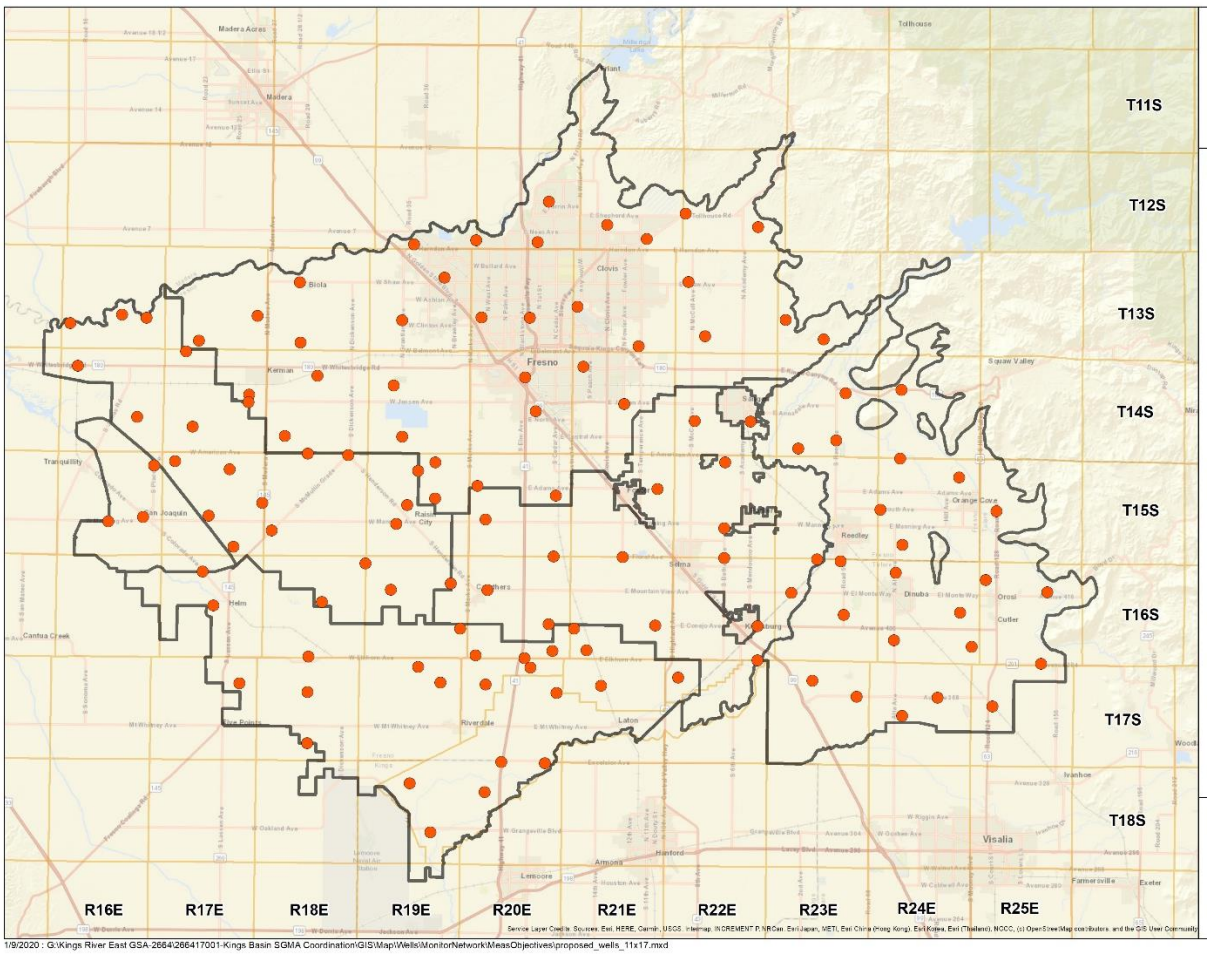
The GSAs within the Kings Basin have established three monitoring networks within each GSA for water level, water quality and subsidence.

The objectives of the various monitoring programs include the following:

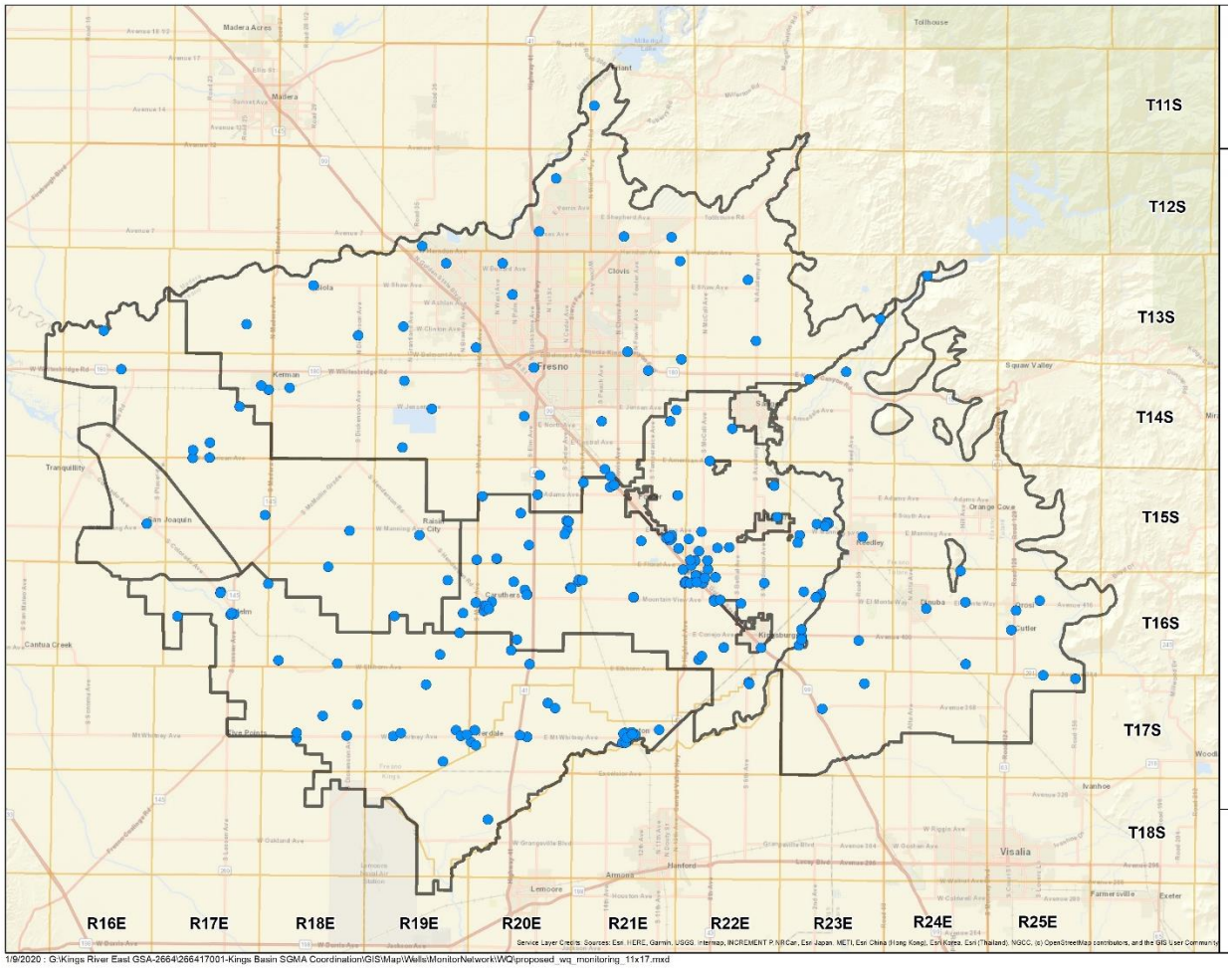
1. Establish a baseline for future monitoring.
2. Provide warning of potential future problems.
3. Use data gathered to generate information for water resources evaluation.
4. Help to quantify annual changes in water budget components.
5. Develop meaningful long-term trends in groundwater characteristics.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

The water level monitoring network will utilize existing wells that have been historically monitored for groundwater level. The GSAs are planning to locate additional monitor wells in areas with limited data, and these will be added to the network. Each GSA will discuss their individual monitoring network in their respective GSP. The groundwater elevation measurements will be collected every March and October to provide data on

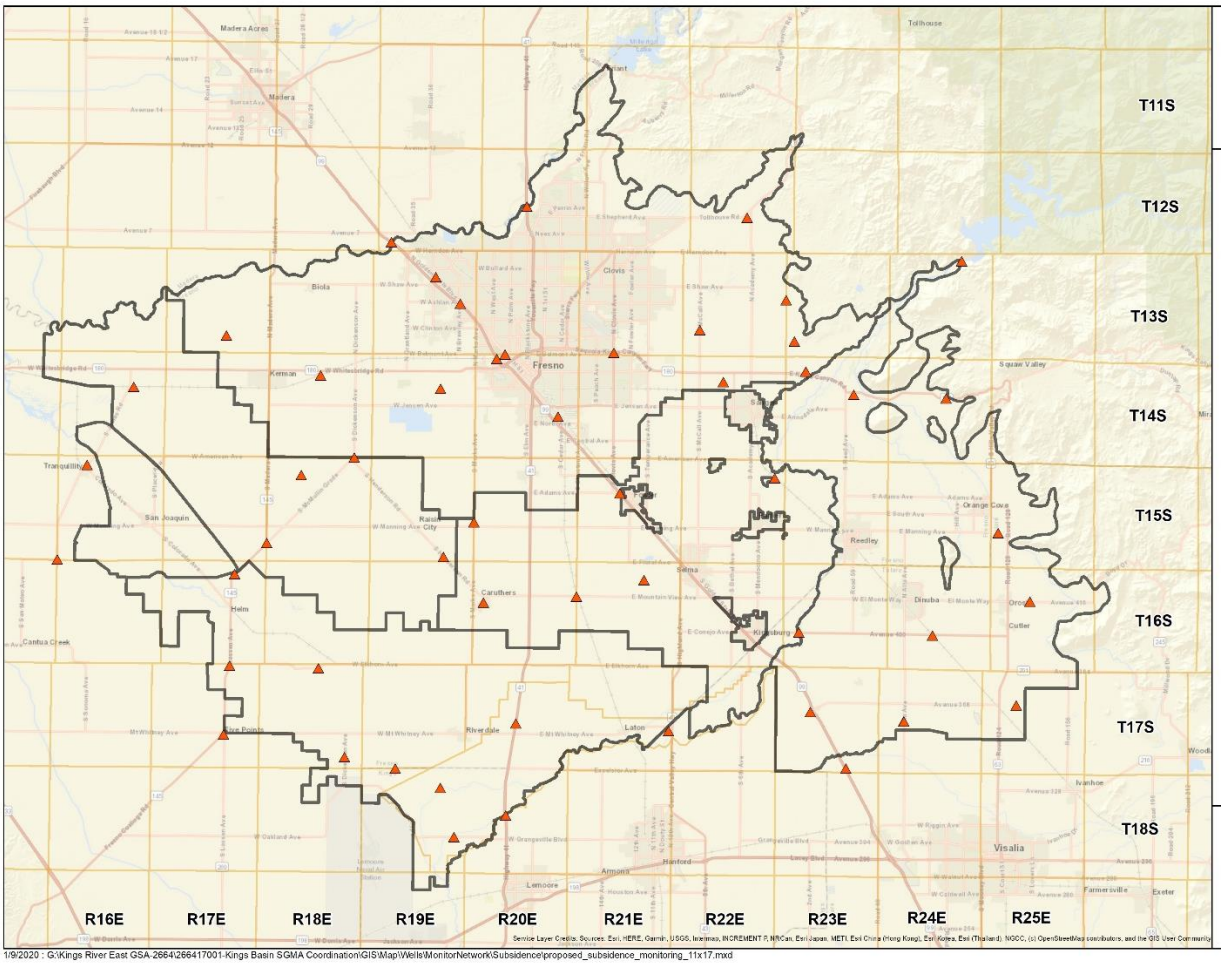
the seasonal high and seasonal low groundwater conditions. Each GSA will provide the water level data to the Plan Manager for the Basin for inclusion in the Data Management System and annual reports. These wells along with additional wells will be used for groundwater storage calculations. A copy of the preliminary water level monitoring network is shown in the figure below.



Groundwater quality reporting by community water systems and non-community public supply wells is a requirement of California Code of Regulations (CCR) Title 22, and the GSAs will rely on this data for groundwater quality monitoring. Community and other public supply wells are already being routinely monitored for a wide range of contaminants, including the chemicals of concern, by the water purveyors under Title 22. The publicly available groundwater quality data from selected representative wells will be obtained annually and evaluated against sustainable management criteria. Locations were selected to be representative of large and small communities dependent on groundwater and to spatially cover each GSA. The representative groundwater quality monitoring network will be evaluated and revised as needed. A copy of the preliminary groundwater quality monitoring network is shown in the figure below.



Land subsidence is limited primarily to the western portion of the Subbasin. Land subsidence will be primarily monitored using Kings River Conservation District's land subsidence surveying program. The monitoring network includes benchmark surveying at least every 7 miles with records dating back to 2010. This spatial and temporal network is adequate and designed with the flexibility to increase measurement frequency or decrease benchmark spacing if more data is warranted. NASA InSAR remote sensing data will be used to verify any observed subsidence and fill in gaps between the surveyed benchmarks. The GSAs will also track land subsidence points just outside of their boundaries to see if subsidence is encroaching into the area. A copy of the subsidence monitoring network is shown in the figure below.



1/9/2020 : G:\Kings River East GSA-2664\266417001-Kings Basin SGMA Coordination\GIS\Map\Wells\MonitorNetwork\Subsidence\proposed_subsidence_monitoring_11x17.mxd

III. Description of Coordinated Data Management System

The GSAs have developed a Data Management System (DMS) to share data and store the necessary information for annual reporting. The GSAs have hired a consultant to build a user-friendly accessible database that standardizes the basin-wide data and allows GSA representatives to input their data and use basic tools for viewing, exporting or printing information for their GSA or the Subbasin. The DMS is a web-based software hosted on a cloud server. The DMS is the single repository for data aggregation and analysis for the Subbasin, and will generate the required information for annual reporting to DWR. GSA representatives have access to all data in the DMS. The DMS currently includes 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 map and tables of estimation
- Graph with Water Year type, Groundwater Use, Annual Cumulative Storage Change

The DMS also includes basic data layers for refences including GSA boundaries, topographic information, landuse, streets, aerial imagery, geologic information and specific yield information. Additional items may be added to the DMS in the future as needed or required.

Data is entered into the DMS by each GSA. Much of the data is then aggregated 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 for quality assurance and will not change once approved. Groundwater storage calculations are performed outside of the DMS in accordance with the method described in the GSPs, then the results of those calculations are uploaded to the DMS for annual reporting and trend monitoring. Since most of the pumping in the GSA (and the Subbasin) is not currently measured, the groundwater pumping estimates are also calculated outside of the DMS using the agreed basin-wide water budget approach then uploaded to the DMS for annual reporting and trend analysis. Surface water deliveries 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 each required element of a DMS and annual reporting requirements is included in the GSP and listed in the table below. GSAs may choose to have their own separate system for additional analysis.

DMS Annual Reporting Requirements

Regulation	Requirement	Input to DMS
356.2(b)(1)(B)	Hydrographs incl water year type from Jan 2015	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 lines uploaded into DMS
356.2(b)(2)	GW extraction by water use sector incl method of determination and map	Determined outside DMS. Total use by sector input by each GSA then summarized for basin in DMS
356.2(b)(3)	Surface Water use by source	Total by GSA input to DMS and summarized for basin in DMS
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 map	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, GW use, annual & cumulative GW Storage change	DMS generated basin total graph using data in DMS

IV. Overdraft Mitigation Responsibility for Each GSA

The GSAs have agreed to an initial target overdraft volume for each GSA to include in their respective GSPs along with projects and management actions to mitigate for that volume. A table showing the total for each GSA is included in below. Although specific values are identified, there is significant margin of

error in calculating both storage change and boundary flows. The overdraft estimates are only for the unconfined aquifer and do not include any external boundary flow estimates, from either the unconfined or confined aquifer, as the GSAs will need to further evaluate how these external boundary flows are going to be addressed with the neighboring basin GSAs. The initial values do not consider James pumping in McMullin GSA. The GSAs agree to evaluate and adjust these values regularly in future years as additional information is collected and estimates of storage change are updated.

GSA	Proposed Initial Responsibility (AF)
Central/South	-7,100
James	16,700
Kings River East	-11,000
McMullin	-91,100
North Fork	-50,300
North Kings	20,800
Total	-122,000

V. Description of Kings Subbasin Coordinated Water Budget

As provided for in SGMA, coordinated water budgets were prepared by Kings Subbasin Groundwater Sustainability Agencies (GSA). The water budgets quantify the components of water supply and use along with change in groundwater in storage. The coordinated water budgets can be used as tools in numerous aspects of groundwater sustainability management including:

- Determining Sustainable Yield
- Identifying Overdraft
- Identifying beneficial groundwater uses
- Identifying data uncertainties and monitoring needs
- Quantifying the effects of proposed projects and management actions
- Supporting development of sustainable management criteria

In developing the initial Groundwater Sustainability Plans (GSP), the Kings Subbasin GSAs have regularly coordinated and have used consistent approaches to groundwater budget development. The methods used in the initial GSPs are described generally below and may vary somewhat depending on what kind of water budget (historical, current or projected) is being discussed. The Kings Subbasin GSAs intend on continuing to

coordinate in development of water budgets in the future and will revise this exhibit as necessary to meet future management needs and data availability.

The historical, current and projected water budgets for the Kings Subbasin have been developed directly from measured and estimated data. A numerical model has not been used for development of the water budgets due to documented deficiencies with currently available groundwater models, including an existing numerical model of the Kings Susbasin, limited data availability for model development purposes and limited time available for refinement, calibration and validation of a model. The use of an analytical water budget (spreadsheet) has the advantage of clearly showing the origin of data used for the water budget, as opposed to extracting disaggregated data from a numerical groundwater model which does not explicitly identify the data source or computation method. Overall, the GSAs in the Kings Basin mutually agreed that an analytical water budget would be a more practical and useful tool, at least initially, and therefore offer greater value in managing groundwater. Much of the data developed as part of the analytical water budget will be used as model input if the existing Kings Subbasin numerical model is updated in the future.

The Kings Subbasin Coordinated Water Budgets quantify the following information in accordance with SGMA §354.18 (b):

(1) Total Surface water entering or leaving the subbasin
(2) Inflows to the groundwater system by water source type, including subsurface groundwater inflow and infiltration of precipitation, applied water, and surface water systems, such as lakes, streams, rivers, canals, springs and conveyance systems.
(3) Outflows from the groundwater system by water use sector, including evapotranspiration, groundwater extraction, groundwater discharge to surface water sources, and subsurface groundwater outflow.
(4) The change in the annual volume of groundwater in storage between seasonal high conditions.
(5) Identification of overdraft over a period of years during which water year and water supply conditions approximate average conditions.
(6) The water year type associated with the annual supply, demand, and change in groundwater stored
(7) An estimate of sustainable yield for the basin.

The water budget information listed above is described first for the historical 15-year period of Water Years 1996/97-2010/11 (WY 1997-2011). This historical period was selected by the Kings Subbasin based on average surface water delivery amounts during the period compared to long term records, since average surface water deliveries would equate to average groundwater pumping. While a more recent historical period would

have been ideal, unfortunately extreme drought conditions between 2012 and 2016 would have made this impractical.

Total Surface Water

During the WY 1997-2011 historical period, records were available for most surface water supplies entering or leaving the Kings Subbasin. Records of the largest surface water amounts (Kings River diversions) from major divertors were summarized for each GSA for the historical period for irrigation and municipal purposes, and for recharge. The Kings River diversion records were headgate diversions, so canal losses were also included. Records of smaller Kings River and San Joaquin River diversions were estimated based on crop acreage amounts and evapotranspiration estimates. Precipitation to each Kings Subbasin GSA was estimated based on available precipitation records, with isohyetal contour maps used to determine average quantifies for specific GSAs. Lesser amounts of surface water derived from minor streams were estimated based on limited available direct measurements and correlations with other small watersheds based on watershed areas and average precipitation amounts.

Groundwater System Inflows

Groundwater system inflows are not directly measured for the most part and were estimated directly (where possible) or based on related parameters. The largest groundwater system inflow in the Kings Subbasin, deep percolation of irrigation water, was quantified based on estimated water use and irrigation efficiencies, with deep percolation computed as the difference between estimated total applied water and evapotranspiration of applied water. Water use for the historical period was estimated based on unit evapotranspiration of applied water and land use interpolated from available DWR crop survey information for the historical period. The unit evapotranspiration of applied water estimates for the historical period were based on DWR estimates of unit water use developed for Detailed Analysis Units as background information for the California Water Plan.

Deep percolation of municipal and industrial water was estimated based on applied water use with reductions for evapotranspiration of applied water and allowance for recharge of treated wastewater. Seepage to groundwater of irrigation conveyance and reservoirs was estimated based on limited investigations of channel seepage in Kings Subbasin irrigation districts, with loss estimates applied to total diversion amounts.

Lesser amounts of groundwater inflows (from precipitation, subsurface inflow, river seepage and minor streams) were all estimated. Groundwater percolation from precipitation was estimated based on total precipitation using procedures from the Department of Water Resources to estimate the portion of total precipitation that results in groundwater recharge. Subsurface inflows to GSAs were determined for the

unconfined aquifer based on gradients from groundwater contour maps each year and groundwater transmissivities for boundaries between GSAs and with other Subbasins. Total minor stream flows were reduced by runoff outside of the Subbasin to quantify recharge from that source.

Groundwater System Outflows

The largest quantity of groundwater system outflows in the Kings Subbasin is groundwater pumping. Groundwater pumping for irrigation is not directly measured for the most part and was estimated based on crop consumptive use, crop acreages and irrigation efficiencies, with adjustments for cropland surface water deliveries. The data used for the crop consumptive use estimates was primarily from DWR sources, as described in the Outflows from Groundwater System section of the GSPs. Records of groundwater pumping for municipal uses were obtained from municipal agencies when available and estimates for individual domestic pumpers were estimated based on population and approximate unit use. Unconfined aquifer subsurface outflows from GSAs were estimated using the same procedure previously described for use in estimating unconfined subsurface inflows. Confined aquifer subsurface outflows to adjacent subbasins was estimated in a similar manner as the unconfined aquifer outflows. Insufficient data was available to estimate confined aquifer flows between GSAs within the Kings Subbasin.

Change in Groundwater Storage

Differences in groundwater inflows and outflows result in changes to groundwater storage, either in the unconfined aquifer or the confined aquifer. The larger amount of groundwater storage change in the Kings Subbasin occurs in the unconfined zone. This unconfined groundwater storage change was estimated annually for Kings Subbasin GSAs based on changes in yearly groundwater contour maps and specific yields estimates. Confined groundwater storage change was less common in the Kings Subbasin, occurring only in confined zones on the western side of the subbasin. Confined groundwater storage change was not quantified because of lack of confined groundwater level data, but estimates were made for several GSAs based on surface land subsidence estimates which is equivalent to the volume of water occurring in subsurface clays when groundwater levels fall below historical minimums.

Overdraft

Overdraft is defined as groundwater storage change during a period when groundwater extractions exceed groundwater recharge. An initial estimate of overdraft was based on estimated storage change (unconfined and confined) for the historical WY 1997-2011 period, which had approximately average water supply conditions. In GSAs with changing

land use, the computed change in groundwater storage for current conditions can be adjusted upwards or downwards based on current water use estimates.

Water Year Types

Water year types were identified for the Kings Subbasin based on review of historical diversion records for the period 1955 through 2018. Kings River diversions to Kings Subbasin GSAs (which are the primary water supply source to the Kings Subbasin) were tabulated and segregated into three categories – Dry, Normal and Wet. Wet Year types were defined as years when Kings River diversions were greater than 125% of the long-term average and Dry Year Types were defined as years when Kings River diversions were less than 75% of the long-term average. Normal years occurred when Kings River diversions were between 75% and 125% of the long-term average. Water supply parameters for the historical period were grouped into the water year types and 50-year averages summarized in the water budget.

Sustainable Yield

Sustainable yield is a level of groundwater use that results in avoidance of undesirable results for sustainability indicators in the groundwater basin. A water budget resulting in no ongoing storage change under average conditions was used as the basis for determining sustainable yield, in addition to localized review for areas with potential undesirable results. In general, reductions in water use equivalent to estimated groundwater storage change in the current and projected water budgets were used as the basis for determining the sustainable yield. The quantity of groundwater pumping for current and projected conditions can be reduced by the amount of ongoing storage decrease, with adjustment for deep percolation of pumped overdraft quantities.

Current Water Budget

The current water budget was developed to represent groundwater conditions for current levels of water supply and water use on a long-term average basis. For the Kings Subbasin, Kings River water supplies during the historical average period were used as the basis for the current water budget. The water supply estimates for sources with regulatory changes, such as the CVP Friant Kern Canal, were adjusted based on available operations studies. Other water supply amounts were left the same as historical amounts for the current water budget.

The major changes for the current water budget were made to water use. Estimated irrigation and municipal and industrial water use estimates were updated to current levels based on the most recent land use and population estimates. For irrigation water use, unit water use amounts for the historical period obtained from DWR were used together with the 2014 land use to develop an updated current water use estimate. This current

irrigation water use estimate was then used to compute related factors, such as deep percolation of irrigation water and groundwater pumping. Municipal and industrial water use was similarly updated based on unit per capita water use rates and more recent population estimates. Other water use parameters were kept the same as for the historical period.

Groundwater storage change for the current water budget was estimated directly through the water budget itself. A computation of actual groundwater storage change for a recent historical period would not correspond to average conditions, and one-year storage change estimates are subject to a greater degree of uncertainty than long-term storage change estimates due to uncertainties in factors such as the time lag for recharge to impact the aquifer.

Projected Water Budget

Projected water budgets for the Kings Subbasin for early future (2040) and late future (2070) were estimated similarly to the current water budget, with additional adjustments to reflect climate change conditions and management practices.

Water supplies for the Kings Subbasin were reviewed for climate change effects on runoff patterns and ultimately most were left unchanged. The climate change projections for Kings River runoff show a very slight increase in total runoff with a relatively large shift in the timing of runoff. Runoff (presumably from rainfall) increased significantly in the winter and early spring and was reduced in late spring and summer. Due to the lack of analytical ability to quantify the effects of these changes, along with the ability of Kings Subbasin water managers to accommodate changes in runoff timing through storage in Pine Flat Reservoir and other management actions, the historical water supplies from the Kings River were assumed to remain consistent into the future.

Water supplies for the Friant Kern Canal were updated for early future and late future climate conditions based on DWR CALSIM projections with climate change, as adjusted by the Friant Water Authority.

No change was made to water supply from precipitation for early future and late future climate conditions. The climate change projections indicate a very slight increase in precipitation during the November through April rainfall season. Based on the slight precipitation increase and the generally negligible effect of precipitation on overall water supply, the historical estimates of precipitation were used for future projections. Other water supply components were similarly left unchanged from historical levels.

The climate change forecasts indicate that the major change for projected water conditions is likely to occur through increased evapotranspiration. Projected evapotranspiration rates from climate change models were estimated for Kings Subbasin

GSAs and showed increases for early future and late future levels. While increased evapotranspiration rates appear to result in direct increases for perennial crops, USBR analyses indicate that for annual crops they result primarily in a shift in crop timing without an overall water use increase. To account for these differences, the increased evapotranspiration rates were used to adjust perennial crop unit water use rates while unit water use rates for annual crops were left constant.

Groundwater storage change for the projected water budgets was determined directly through the water budget. In addition to the historical water use and water supply components, the projected water budgets also include estimates of supply projects and management actions that are planned for implementation by Kings Subbasin GSAs. These anticipated projects and management actions show sustainability for the early future (2040) water budgets as well as sustainability for the late future (2070) water budgets.

Appendix 1 B
GSP Checklist

Table 1. Preparation Checklist for GSP Submittal

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
Article 3. Technical and Reporting Standards				
352.2		Monitoring Protocols	• Monitoring protocols adopted by the GSA for data collection and management • Monitoring protocols that are designed to detect changes in groundwater levels, groundwater quality, inelastic surface subsidence for basins for which subsidence has been identified as a potential problem, and flow and quality of surface water that directly affect groundwater levels or quality or are caused by groundwater extraction in the basin	Sections 5.2.6, 5.3.6, 5.5.6, 5.6.6, 5.7.6
Article 5. Plan Contents, Subarticle 1. Administrative Information				
354.4		General Information	• Executive Summary • List of references and technical studies	Section ES Section 8 Appendices
354.6		Agency Information	• GSA mailing address • Organization and management structure • Contact information of Plan Manager • Legal authority of GSA • Estimate of implementation costs	Section 1.5 Section 1.5.1 Section 1.5.2
354.8(a)	10727.2(a)(4)	Map(s)	• Area covered by GSP • Adjudicated areas, other agencies within the basin, and areas covered by an Alternative • Jurisdictional boundaries of federal or State land • Existing land use designations • Density of wells per square mile	Section 2 (Figure 2-1, 2-2) Section 2 (Figure 2-3) Section 2 (Figure 2-6) Section 2 (Figure 2-4) Section 2 (Figure 2-5)

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
Article 5. Plan Contents, Subarticle 1. Administrative Information (Continued)				
354.8(b)		Description of the Plan Area	• Summary of jurisdictional areas and other features	Section 2.1
354.8(c) 354.8(d) 354.8(e)	10727.2(g)	Water Resource Monitoring and Management Programs	• Description of water resources monitoring and management programs • Description of how the monitoring networks of those plans will be incorporated into the GSP • Description of how those plans may limit operational flexibility in the basin • Description of conjunctive use programs	Section 2.2 Section 2.2 Section 2.2.11 Section 2.2.16
354.8(f)	10727.2(g)	Land Use Elements or Topic Categories of Applicable General Plans	• Summary of general plans and other land use plans • Description of how implementation of the GSP may change water demands or affect achievement of sustainability and how the GSP addresses those effects • Description of how implementation of the GSP may affect the water supply assumptions of relevant land use plans • Summary of the process for permitting new or replacement wells in the basin • Information regarding the implementation of land use plans outside the basin that could affect the ability of the Agency to achieve sustainable groundwater management	Section 2.3 (2.3.1) Section 2.3.2 Section 2.3.3 Section 2.3.4 Section 2.3.5

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
Article 5. Plan Contents, Subarticle 1. Administrative Information (Continued)				
354.8(g)	10727.4	Additional GSP Contents	**Description of Actions related to:** • Control of saline water intrusion • Wellhead protection • Migration of contaminated groundwater • Well abandonment and well destruction program • Replenishment of groundwater extractions • Conjunctive use and underground storage • Well construction policies • Addressing groundwater contamination cleanup, recharge, diversions to storage, conservation, water recycling, conveyance, and extraction projects • Efficient water management practices • Relationships with State and federal regulatory agencies • Review of land use plans and efforts to coordinate with land use planning agencies to assess activities that potentially create risks to groundwater quality or quantity • Impacts on groundwater dependent ecosystems	Section 2.4 Section 2.4.1 Section 2.4.2 Section 2.4.3 Section 2.4.4 Section 2.4.5 Section 2.4.5(2.2.12) Section 2.4.6 Section 2.4.7 Section 2.4.8 Section 2.4.9 Section 2.4.10 Section 2.4.11
354.10		Notice and Communication	• Description of beneficial uses and users • List of public meetings • GSP comments and responses • Decision-making process • Public engagement • Encouraging active involvement • Informing the public on GSP implementation progress	Section 2.5 (2.5.1) Section 2.5.1 Appendix 2-C Section 2.5.2 Section 2.5.3 Section 2.5.4 Section 2.5.4 (and Section 7.5)

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
Article 5. Plan Contents, Subarticle 2. Basin Setting				
354.14		Hydrogeologic Conceptual Model	• Description of the Hydrogeologic Conceptual Model • Two scaled cross-sections • Map(s) of physical characteristics: topographic information, surficial geology, soil characteristics, surface water bodies, source and point of delivery for imported water supplies	Section 3.1 Section 3.1.7 (Figures 3-9 through 3-14) Section 3.1.1-3.1.11 (Figures 3-6,3-5,3-8, 3-23)
354.14(c)(4)	10727.2(a)(5)	Map of Recharge Areas	• Map delineating existing recharge areas that substantially contribute to the replenishment of the basin, potential recharge areas, and discharge areas	Section 3.1.12 Figure 3-24
	10727.2(d)(4)	Recharge Areas	• Description of how recharge areas identified in the plan substantially contribute to the replenishment of the basin	Section 3.1.12
354.16	10727.2(a)(1) 10727.2(a)(2)	Current and Historical Groundwater Conditions	• Groundwater elevation data • Estimate of groundwater storage • Seawater intrusion conditions • Groundwater quality issues • Land subsidence conditions • Identification of interconnected surface water systems • Identification of groundwater-dependent ecosystems	Section 3.2 Section 3.2.1 Section 3.2.3 Section 3.2.4 Section 3.2.5 Section 3.2.6 Section 3.2.7 Section 3.2.8
354.18	10727.2(a)(3)	Water Budget Information	• Description of inflows, outflows, and change in storage • Quantification of overdraft • Estimate of sustainable yield • Quantification of current, historical, and projected water budgets	Section 3.3 Sections 3.3.5-7 Section 3.3.11 Section 3.3.13 Section 3.3.8-10
	10727.2(d)(5)	Surface Water Supply	• Description of surface water supply used or available for use for groundwater recharge or in-lieu use	Section 3.3.4

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
Article 5. Plan Contents, Subarticle 2. Basin Setting (Continued)				
354.20		Management Areas	• Reason for creation of each management area • Minimum thresholds and measurable objectives for each management area • Level of monitoring and analysis • Explanation of how management of management areas will not cause undesirable results outside the management area • Description of management areas	Section 3.3.14. Sections 4 and 5
Article 5. Plan Contents, Subarticle 3. Sustainable Management Criteria				
354.24		Sustainability Goal	• Description of the sustainability goal	Section 4.1
354.26		Undesirable Results	• Description of undesirable results • Cause of groundwater conditions that would lead to undesirable results • Criteria used to define undesirable results for each sustainability indicator • Potential effects of undesirable results on beneficial uses and users of groundwater	Section 4.2.1, 4.3.1, 4.4, 4.5.1 and 4.6.1
354.28	10727.2(d)(1) 10727.2(d)(2)	Minimum Thresholds	• Description of each minimum threshold and how they were established for each sustainability indicator • Relationship for each sustainability indicator • Description of how selection of the minimum threshold may affect beneficial uses and users of groundwater • Standards related to sustainability indicators • How each minimum threshold will be quantitatively measured	Sections 4.2.2, 4.3.2, 4.4, 4.5.2, and 4.6.2

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
Article 5. Plan Contents, Subarticle 3. Sustainable Management Criteria (Continued)				
354.30	10727.2(b)(1) 10727.2(b)(2) 10727.2(d)(1) 10727.2(d)(2)	Measurable Objectives	• Description of establishment of the measurable objectives for each sustainability indicator • Description of how a reasonable margin of safety was established for each measurable objective • Description of a reasonable path to achieve and maintain the sustainability goal, including a description of interim milestones	Sections 4.2.3, 4.3.3, 4.4, 4.5.3 and 4.6.3
Article 5. Plan Contents, Subarticle 4. Monitoring Networks				
354.34	10727.2(d)(1) 10727.2(d)(2) 10727.2(e) 10727.2(f)	Monitoring Networks	• Description of monitoring network • Description of monitoring network objectives • Description of how the monitoring network is designed to: demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and surface water features; estimate the change in annual groundwater in storage; monitor seawater intrusion; determine groundwater quality trends; identify the rate and extent of land subsidence; and calculate depletions of surface water caused by groundwater extractions • Description of how the monitoring network provides adequate coverage of Sustainability Indicators • Density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends • Scientific rationale (or reason) for site selection • Consistency with data and reporting standards • Corresponding sustainability indicator, minimum threshold, measurable objective, and interim milestone	Section 5 Section 5.1.1 Sections 5.2.1, 5.3.1, 5.4, 5.5.1, 5.6.1, 5.7.1 Sections 5.2.2, 5.3.2, 5.5.2, 5.6.2 and 5.7.2 Sections 5.2.3, 5.3.3, 5.5.3, 5.6.3, 5.7.3 Sections 5.2.4, 5.3.4, 5.5.4, 5.6.4 & 5.7.4

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
			(Monitoring Networks Continued) • 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 • Description of technical standards, data collection methods, and other procedures or protocols to ensure comparable data and methodologies	Sections 5.2.5, 5.3.5, 5.5.5, 5.6.5 and 5.7.5 Sections 5.2.6, 5.3.6, 5.5.6, 5.6.6 and 5.7.6
354.36		Representative Monitoring	• Description of representative sites • Demonstration of adequacy of using groundwater elevations as proxy for other sustainability indicators • Adequate evidence demonstrating site reflects general conditions in the area	Sections 5.2.7, 5.3.7, 5.5.7, 5.6.7, 5.7.7
354.38		Assessment and Improvement of Monitoring Network	• Review and evaluation of the monitoring network • Identification and description of data gaps • Description of steps to fill data gaps • Description of monitoring frequency and density of sites	Sections 5.2.8, 5.3.8, 5.5.8, 5.6.8, 5.7.8

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
Article 5. Plan Contents, Subarticle 5. Projects and Management Actions				
354.44		Projects and Management Actions	• Description of projects and management actions that will help achieve the basin's sustainability goal • Measurable objective that is expected to benefit from each project and management action • Circumstances for implementation • Public noticing • Permitting and regulatory process • Timetable for initiation and completion, and the accrual of expected benefits • Expected benefits and how they will be evaluated • How the project or management action will be accomplished. If the projects or management actions rely on water from outside the jurisdiction of the Agency, an explanation of the source and reliability of that water shall be included. • Legal authority required • Estimated costs and plans to meet those costs • Management of groundwater extractions and recharge	Section 6
354.44(b)(2)	10727.2(d)(3)		• Overdraft mitigation projects and management actions	Section 6

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

Appendix 2 A
MAGSA Joint Powers Agreement

McMULLIN AREA
GROUNDWATER SUSTAINABILITY AGENCY
JOINT POWERS AGREEMENT

THIS McMULLIN AREA GROUNDWATER SUSTAINABILITY AGENCY JOINT POWERS AGREEMENT (this "Agreement") is made and entered into this 31 st day of January, 2017 (the "Effective Date") by and between the Mid-Valley Water District, the Raisin City Water District and the County of Fresno each a "Member" and collectively, the "Members."

RECITALS

A. Whereas, on September 16, 2014, the Governor of the State of California signed into law Senate Bills 1168 and 1319, and Assembly Bill 1739 collectively, the Sustainable Groundwater Management Act, which is codified at Water Code Sections 10720 *et seq.;* and

B. Whereas, the Act allows certain local agencies to become a Groundwater Sustainability Agency ("GSA") and adopt a Groundwater Sustainability Plan ("GSP") as a means to manage and regulate groundwater in an underlying groundwater basin, which is defined as a basin or subbasin identified and defined in California Department of Water Resources Bulletin 118; and

C. Whereas, each Member is a local agency as defined in Water Code Section 10721(n) and is eligible to become a GSA and adopt a GSP; and

D. Whereas, the Act set forth that multiple local agencies overlying a single groundwater basin or subbasin may adopt separate GSPs if those plans are coordinated, or may join together to adopt a single plan; and

E. Whereas, each Member to this Agreement overlies a portion of the Kings Subbasin as it is currently defined by the California Department of Water Resources Bulletin 118 and each Member desires to participate in the implementation of the Act specifically within the area identified as the McMullin Area on Exhibit A attached hereto and incorporated herein by reference; and

F. Whereas, the Joint Exercise of Powers Act (Government Code Sections 6500 *et seq.*) provides that two or more public agencies may by agreement jointly exercise any powers common to those agencies and may by that agreement create an entity separate from the Members to the Agreement; and

G. Whereas, each Member signing this Agreement is a public entity organized and operating under the laws of the State of California, and/or a public agency as defined in California Government Code Section 6500; and

H. Whereas, the Members intend by this Agreement to create a joint powers authority ("JPA") for the purpose of acting as a separate and independent public agency and as a single GSA for this area, hereinafter identified as the McMullin Area Groundwater Sustainability Agency ("MAGSA"); and

I. Whereas, the Members agree among themselves to comply with Section 10720.5(b) of the Act, which states "[n]othing in this part, or in any groundwater management plan adopted pursuant to this part, determines or alters surface water rights or groundwater rights under common law or any provision of law that determines or grants surface water rights."

NOW, THEREFORE, in consideration of the mutual promises, covenants and conditions herein and these Recitals, which are hereby incorporated by this reference, it is agreed by and among the Members hereto as follows:

Article I: Definitions

As used in this Agreement the meaning of the terms hereinafter set forth shall be as follows:

A. "Act" shall mean the Sustainable Groundwater Management Act of 2014 and all regulations adopted under the legislation (SB 1168, SB 1319, and AB 1739) which collectively comprise the Act, as that legislation and those regulations may be amended from time to time.

B. "Authority" or "MAGSA" shall mean the McMullin Area Groundwater Sustainability Agency Joint Powers Authority, which is the public and separate legal entity created by this Agreement.

C. "Board of Directors" or "Board" shall mean the governing body of the Authority as established by Section 3.01 of this Agreement.

D. "Fiscal Year" shall mean that period of twelve (12) months established as the Fiscal Year of the Authority pursuant to Section 4.01 of this Agreement.

E. "Groundwater Sustainability Agency" or "GSA" shall mean an agency enabled by the Act to regulate all or a portion of a subbasin pursuant to the Act.

F. "Groundwater Sustainability Plan" or "GSP" shall mean the plan developed, adopted and implemented by the Authority proposed or adopted pursuant to the Act.

G. "Member" shall mean any of the signatories to this Agreement and "Members" shall mean all of the signatories to this Agreement.

H. "McMullin Area" shall mean the area depicted on Exhibit A.

I. "Project Agreement" means an agreement between the Authority and one or more Members to provide for carrying out Special Activities, as defined below, that are within the authorized purposes of the Authority.

J. "Special Activities" shall mean activities consistent with the purpose of this Agreement, but which are undertaken by fewer than all Parties.

Article II: Creation of Authority

Section 2.01 – Creation.

A. Pursuant to Government Code Section 6503.5, the Members of this Agreement hereby create a public entity separate and independent from the Members.

B. Pursuant to Government Code section 6509, the County of Fresno is the designated agency with respect to the Authority's exercise of power.

C. Within thirty (30) days after the Effective Date of this Agreement and after any amendment, the Authority shall cause a notice of such Agreement or amendment to be prepared and filed with the office of the California Secretary of State containing the information required by Government Code Section 6503.5.

D. Within seventy (70) days after the Effective Date of this Agreement, the Authority shall file with the Secretary of State on a form prescribed by the Secretary of State and also with the county clerk of each county in which the Authority maintains an office, a statement of the following facts:

1. The full legal name of the Authority.

2. The official mailing address of the governing body of the Authority.

3. The name and residence or business address of each member of the governing body of the public agency.

4. The name, title, and residence or business address of the chairman, president, or other presiding officer, and clerk or secretary of the governing body of the Authority.

E. Within ten (10) days after any change in the facts listed in section 2.01(D), the Authority shall file an amended statement as required in Government Code Section 53051.

The Members, pursuant to their joint exercise of powers, hereby create a public entity to be known as the "McMullin Area Groundwater Sustainability Agency."

Section 2.02 – Purpose.

The Authority is formed with the purpose and intent of jointly forming a separate entity to fulfill the role of a GSA so that the Members may collectively or in conjunction with other entities develop, adopt, and implement a GSP for the sustainable management of groundwater for that portion of the Kings Subbasin underlying the McMullin Area.

Notwithstanding their intent to collectively develop, adopt, and implement a GSP, the Parties shall maintain complete control and autonomy over the surface water and groundwater supply assets to which they are currently legally and individually entitled, and make no commitments by entering into this Agreement to share or otherwise contribute their water supply assets as part of the preparation of or participation in a GSP.

The Members may exercise independent power within their own jurisdiction, including but not limited to, conducting Special Activities establishing or approving fees, and exercising and administering all powers held by each Member with regards to groundwater management and regulation as they existed prior to the approval of this Agreement or consistent with the Act, except as otherwise provided in this Agreement or as required by the Act. Members may be responsible within each of their own jurisdictions or service areas for the implementation of any GSP developed by the Authority, unless otherwise provided for in this Agreement, by decision of the Board of Directors, or as required by the Act. Each Member will be responsible for adhering to the terms of this Agreement, for constructively participating in the efforts to achieve compliance with the Act, and for timely payment of contributions that are approved by the Board of Directors in compliance with this Agreement.

Section 2.03 –Powers.

The Authority shall have the power to take any action to carry out the purposes of this Agreement. Subject to the applicable voting requirements described in this Agreement, the Authority is authorized, in its own name, to do all acts necessary for the exercise of said powers, including but not limited to, any and all of the following:

A. Undertaking, on behalf of the Members, all actions required by the California Department of Water Resources ("DWR") and State Water Resources Control Board ("SWRCB") for GSA purposes under the Act.

B. Conducting research and investigations and compiling appropriate reports for preparing a GSP and for developing Coordination Agreements, as defined in Water Code section 10721(d), with other GSAs.

C. Developing, adopting, and implementing a GSP.

D. Adopting initial and annual operating budgets, and establishing Member, contributions.

E. Making and assuming contracts, and employing agents, employees, consultants, and other such persons or firms as the Board may deem necessary to exercise the Authority's powers.

F. Incurring debts, liabilities, or obligations, subject to the limitations provided in this Agreement.

G. Issuing bonds and all other forms of indebtedness, on behalf of the GSA and any separate entity as permitted by the Board of Directors, to the extent and on the terms provided by law for the Authority.

H. Cooperating, acting in conjunction with, and contracting with the United States, the State of California or any agency thereof, Counties, and other local agencies, commensurate with the Authority's powers as a GSA.

I. Applying for, accepting and receiving licenses, permits, new or future water rights (to the extent such application does not infringe on the rights of Members), approvals, agreements, grants, loans, gifts, contributions, donations, or other aid from any agency of the United States, the State of California, or other public or private person or entity necessary for fulfilling the purposes of the GSA.

J. Acquiring, by eminent domain or otherwise, holding, and disposing of real or personal property.

K. Acquiring, leasing, owning, constructing, managing, maintaining, operating, and disposing of buildings, works, or improvements.

L. Suing and being sued in its own name

M. Providing for the prosecution of, defense of, or other participation in actions or proceedings at law or in public meetings in which the Members, pursuant to this agreement may have an interest, and employing counsel or other expert assistance for that purpose.

N. Participating in groundwater sustainability projects related to the Act.

O. Assisting the Members, pursuant to this agreement in groundwater sustainability projects related to the Act.

P. Creating committees and sub-committees.

Q. Employing all GSA enforcement powers identified in the Act.

R. Imposing fees as authorized by the Act.

S. Adopting rules, bylaws, regulations, policies and procedures for governing the operation of the GSA, and adopting and implementing a GSP consistent with the powers and purposes of the Authority and as authorized by the Act.

T. Entering into Project Agreements with Members.

Section 2.04 – Adoption of GSP.

The Members agree that the GSP shall be coordinated and managed by the Authority and all modifications of or amendments to of the GSP shall be adopted only by the Authority's Board of Directors and in accordance with this Agreement.

Article III: Internal Organization

Section 3.01 – Governing Body.

The governing body of the Authority shall be a five (5) - member Board of Directors, with each seat selected by the respective board of each Member as identified in Table 1 below.

Table 1 – MAGSA Board of Directors

Seat	Assignment
1	Raisin City Water District
2	Raisin City Water District
3	Mid-Valley Water District
4	County of Fresno
5	'White Area' landowner appointed by the County of Fresno

A. Alternates - Each Director representing a Member on the Board of Directors of the Authority may identify up to two alternates to serve on the Member's, behalf. Unlike Directors, Alternates need not be elected officials.

B. Vacancies – Filling a vacancy of a Director's seat is the responsibility of the Member who is represented by that Director's seat on the Board of Directors.

C. Seat 5 – Seat 5 shall be an individual, or authorized representative of an entity, that owns land that is: (1) within the boundaries of the Authority; and (2) outside the service area of Mid-Valley Water District or Raisin City Water District.

D. If the Board of Directors determines that reasonable cause exists to remove a Director from the Board, it can request that the Member that appointed the Director remove the individual and appoint a new Director.

Section 3.02 – Board Terms.

All Board terms shall be two (2) years. For initiation of the Board, three (3) seats—two held by Raisin City Water District and one held by Mid-Valley Water District—shall be three (3)-year terms.

Section 3.03 – Administration and Officers.

The officers of the Authority are the Chair, Vice-Chair, Secretary and Treasurer.

A. The Board of Directors shall, at its first meeting and thereafter at its first meeting following July 1 of each succeeding year, elect a Chair and Vice-Chair from among the Directors. The Vice-Chair shall assume responsibilities of the Chair in the absence of the Chair.

B. The Secretary shall (1) keep or cause to be kept, at the principal executive office or such other place as the Board may direct, a book of summary minutes of all meetings and actions of the Board of Directors and committees of the Authority, with the time and place of holding, whether regular or special, and, if special, how authorized, the notice given, the names of those present at such meetings and the proceedings of such meetings; and (2) give, or cause to be given, notice of all meetings of the Board and committees of the Authority required by the Bylaws be given. The Secretary has such powers and may perform such other duties as may be prescribed by the Board.

C. The Board of Directors shall designate a qualified person to act as the Treasurer of the Authority. The person holding the position of Treasurer of the Authority shall have charge of the depositing and custody of all funds held by the Authority. The Treasurer shall perform such other duties as may be imposed by provisions of applicable law, including those duties described in Government Code section 6505.5, and that may be prescribed by the Board or the Bylaws. In the event that the person designated by the Board is not a Director, the person serving as Treasurer may be reasonably compensated for performing such work. In the event that the person designated by the Authority to perform such services is an employee of a Member, the governing body of that Member shall determine the reasonable charges to be made against the Authority for the services of the Treasurer.

The Treasurer shall be responsible for all money of the Authority from whatever source. All funds of the Authority shall be strictly and separately accounted for and regular reports shall be rendered of all receipts and disbursements at least quarterly during the Fiscal Year. The books and records of the Authority shall be

open to inspection by the Members and by bondholders as and to the extent provided by resolution or indenture. The Treasurer shall contract with a certified public accountant to make an annual audit of the accounts and records of the Authority which shall be conducted in compliance with Section 6505 of the California Government Code.

D. Management: In addition to, or in lieu of, hiring employees, the Authority may engage one or more third parties to manage any or all of the business of the Authority on terms and conditions acceptable to the Board of Directors. A third party so engaged may, but need not, be a Member. Any third party so engaged shall have such responsibilities as are set forth in the contract for such third party's services.

E. Fiscal Agent: Without limiting the breadth of Section 3.03(D), the Board of Directors may select a Member or a third party to act as the fiscal agent for the Authority pursuant to an agreement with the fiscal agent approved by the Board of Directors.

Section 3.04 – Voting Thresholds.

All board actions require a majority vote of the Board of Directors, except the following nine (9) board actions:

Table 2 – Voting Thresholds for Specific Board Actions

	Board Action	Voting Threshold
1.	Adoption of or amendment to a GSP	Unanimous vote of all Directors
2.	To incur debts, liabilities or obligations on behalf of the Authority	Unanimous vote of all Directors
3.	Adoption of or revisions to policies of the Authority	Unanimous vote of all Directors
4.	GSA Enforcement	Three affirmative votes by Directors
5.	Authorization to participate in litigation, or other legal proceedings	Unanimous vote of all Directors
6.	Amendment of the Agreement	Unanimous vote of all Directors, subject to ratification by all Members
7.	Any assessment or fee levied or imposed by the GSA	Unanimous vote of all Directors

8.	Budget allocation among Members for GSA operations after initial GSP	Unanimous vote by all Directors
9.	Removal of a Member from the GSA	Three affirmative votes by Directors

Section 3.05 - Compensation, Expenses, and Reimbursement.

Directors and their alternates shall not be compensated by the Authority for participation on the Board. The Authority shall develop a policy for reimbursement associated with direct expenses.

Section 3.06 - Conflicts of Interest.

The Authority shall adopt a conflict of interest code and policy.

Section 3.07 – Application of Laws to Authority Functions.

The Authority shall comply with all applicable laws in the conduct of its affairs, including, but not limited to, the Joint Exercise of Powers Act (Gov. Code §6500, et seq.); Ralph M. Brown Act (Gov. Code § 54950, et seq.); and conflict of interest laws/regulations (such as Gov. Code §1090, et seq., the requirements of the California Political Reform Act, Gov. Code § 87100, et seq., and the regulations of the Fair Political Practices Commission concerning disclosure and disqualification, 2 California Code of Regulations §18700, et seq., as amended.

Section 3.08 – Meetings.

The Board of Directors shall fix the hour, date, and place for its regular meetings, provided the Board shall meet at least once per month.

Section 3.09 – Committees.

The Board of Directors may establish standing committees and ad hoc committees as it deems necessary. The Board of Directors shall establish membership of those committees. The Board of Directors may also dissolve any committee it deems to be no longer necessary.

Article IV: Financial Provisions

Section 4.01 – Fiscal Year.

The Fiscal Year of the Authority shall be from July 1 through June 30 of each year.

Section 4.02 – Property Custodian.

The Board of Directors shall from time to time designate the officers and persons, in addition to those specified in Section 3.03 above, who shall have charge of, handle, or have access to any property of the Authority. The Authority shall acquire such fidelity bonds or comparable insurance covering such officers and persons in amounts designated by the Board of Directors; provided that if no bond amount is set by the Board of Directors, no bond shall be required. Such bond amount shall be subject to ratification by the Members in compliance with California Government Code Section 6505.1.

Section 4.03 – Budget.

The cost-share formula for the MAGSA is defined in the attached Exhibit B. These funds serve to develop the Authority's initial GSP. Subsequent budgets shall be set by the Board of Directors each Fiscal Year, and the Board of Directors shall adopt an annual budget for the Authority for the ensuing Fiscal Year.

The Contribution and Participation Percentage may be adjusted by the Board of Directors in the event of admission, withdrawal, reinstatement or termination of a Member consistent with Section 5.03, or in the event of modification of a Member's service area.

Section 4.04 – Member Contributions To The Authority.

All contributions adopted by the Board of Directors as provided in Section 4.03 shall be paid to the Authority on a schedule set by the Board of Directors; provided, that no Member shall be obligated to make any such payment unless and until such Member's governing body has approved and appropriated the funds necessary to make such payment. In the event a payment by a Member is otherwise required – but is not made because such Member's governing body has not approved such payment or appropriated the funds necessary to make such payment – such Member shall be subject to termination from the Authority pursuant to Section 5.03(D), but upon any such termination shall not be liable for the amount of such payment.

Article V: Relationship of Authority and Its Members

Section 5.01 – Separate Entity.

In accordance with California Government Code Sections 6506 and 6507, the Authority shall be a public entity separate from the Members. To the greatest extent permitted by law, unless otherwise specifically agreed herein by all Members as to a specific debt, liability and/or obligation, the debts, liabilities and obligations of the Authority shall not be debts, liabilities or obligations of the Members under California Government Code Section 6508.1. The Authority shall own and hold title to all funds, property and works acquired by it during the term of this Agreement.

No Member has the power to obligate any other Member hereof and no Member debt, liability or obligation due any third party may be asserted or collected against this

JPA, the GSA or any individual Member as a result of membership in this GSA by and among the Members. The Authority shall indemnify, defend, and save harmless the Members, their officers, agents, directors, and employees, from and against any and all claims and losses whatsoever, occurring or resulting to persons, firms, or entities furnishing or supplying work, services, labor, materials or supplies to the Authority in connection with the performance of this Agreement, and, except as expressly provided for by law, from any and all claims and losses accruing or resulting to any persons, firm or entity, for damage, injury, death arising out of our connected with the Authority's performance of its obligations under this Agreement. The Authority may also acquire such policies of directors and officers liability insurance and in such amounts as the Board of Directors shall deem prudent. The Board of Directors members, officers, and employees of the Authority shall use ordinary care and reasonable diligence in the exercise of their powers, and in the performance of their duties pursuant to this Agreement. The Board of Directors shall not be liable to the Members to this Agreement for any mistake of judgment or any other action made, taken, or omitted by any agent, employee, or independent contractor selected with reasonable care, nor for loss incurred through the investment of Authority funds or failure to invest same. To the extent authorized under California law, no Director, officer or employee of the Authority shall be responsible for any action made, taken, or omitted, by any other Director, officer or employee.

Section 5.02 – Insurance.

The Board of Directors shall, from time to time and at least annually, review the general liability, automobile, directors and officers, and other insurance coverage maintained by the Authority for adequacy and determines the nature, extent and limits of insurance to be maintained by the Authority. The Authority shall purchase and maintain such insurance as the Board of Directors determines to be appropriate after such review.

Section 5.03 – Admission, Withdrawal, Reinstatement and Termination of Members.

A. Notwithstanding anything herein to the contrary, any Member may withdraw from this Agreement by giving sixty (60) days written notice of its election to do so, which notice shall be given to the Board of Directors provided, that such withdrawal does not in any way impair any contracts, resolutions, indentures or other obligations of the Authority then in effect. In the event of a disagreement between the Authority and the withdrawing Member as to whether such withdrawal shall cause the impairment of any contracts, resolutions, indentures or other obligations of the Authority, such determination shall be made, notwithstanding anything in the Agreement to the contrary, by a unanimous vote of the remaining Board of Directors. Any Member that withdraws and later seeks reinstatement to the Authority shall provide funds to the Authority, proportionate to their responsibility, as if they had never left.

A withdrawing Member shall in all events remain liable for its proportionate share of (i) its full amount of the adopted fiscal year budget; (ii) any call for funds or assessment

levied by the Authority prior to the date it provides its notice of withdrawal; (iii) any contribution required by Section 4.03 to reflect the Participation Percentages in existence at the time the subject act or omission occurred; and (iv) the amount of any annual budget approved prior to the date it provides its notice of withdrawal.

Should a Member choose to withdraw from the Authority in accordance with the terms of this Agreement, that Member expressly retains the right to serve as the GSA for the portion of the groundwater basin underlying its jurisdictional boundaries to the extent permitted by the Act.

B. Any Member may be terminated by a vote of the Board of Directors as set forth in Section 3.04 above, and upon termination shall no longer be a Member of the Authority. A Member so terminated shall not be liable for the amounts described in clauses (i), (ii) and (iii) of the immediately preceding paragraph except to the extent they are delinquent on the date of termination.

C. In the event a Member withdraws from the Authority or is terminated in accordance with the terms and conditions hereof, such Member shall not receive a refund of any amounts advanced to the Authority by such Member prior to the date of its withdrawal or termination and shall be obligated to continue to pay its share of any legal fees and costs for any action in which the Member is named or participating as part of the Authority.

D. Notwithstanding the foregoing provisions of Section 5.03, should the Authority be sued for any action or inaction by the Authority, then the Members constituting the Authority at the time of said action/inaction complained of shall not have the right to withdraw from the Authority during the pendency of that suit. Similarly, if the action or inaction upon which a suit is/was filed occurred when a Member was in the Authority but subsequently withdrew prior to the filing of a suit against the Authority, then such departed Member shall participate in the defense of that action as if it was still a Member to the Authority.

Section 5.04 – Term and Disposition Of Property Upon Dissolution.

A. The Authority shall be formed and come into existence on the Effective Date and shall continue in existence unless terminated by the governing body of each of the Members then a party to this Agreement or at any point in time at which there ceases to be at least two parties to this Agreement, at which point in time this Agreement shall be automatically terminated; provided however, that the Authority and this Agreement shall continue to exist for the purpose of disposing of liabilities distributing funds, property and/or other assets (such funds, property and/or other assets, collectively, the "Authority Assets"), and all other functions necessary to conclude the business of the Authority.

B. Notwithstanding any other provision herein, this Agreement shall remain in effect and be binding upon the Members hereto and upon all subsequent Members joined herein for such a period as the Authority desires to engage in any activities under this

Agreement. The foregoing provision shall not apply, however, to any Member that withdraws or is terminated from its participation in the Authority in accordance with this Agreement.

C. Upon termination of this Agreement, after the payment and fulfillment of all obligations of the Authority, any Authority Assets remaining shall be distributed to the Parties in proportion to the total contribution made by the Parties toward the funding of the Authority over the lifetime of the Authority's existence. The Authority shall cease to exist when the Authority Assets have been distributed according to the provisions contained in this Section, this Agreement generally, and the Joint Exercise of Powers Act (Gov. Code §6500 *et seq.*).

Article VI: Liabilities

A. The Authority, and those persons, agencies and instrumentalities used by it to perform the functions authorized herein, whether by contract, employment or otherwise, shall be exclusively liable for any/all injuries, costs, claims, liabilities, damages of whatever kind arising from or related to activities of the Authority.

B. The Authority shall hold harmless and indemnify the Members, and each of them, including their officers and employees, from any claim or liability arising from acts or omissions of the Authority in pursuit of this Agreement, and in so doing, shall provide the Members, and each of them, with legal defense of any and all claims or liabilities and shall pay reasonable attorney's fees and costs incurred in providing such defense.

C. Funds of the Authority may be used to defend, indemnify, and hold harmless the Authority, the Members, and any officers, agents, and employees for their actions taken within the scope of their duties while acting on behalf of the Authority.

Article VII: Miscellaneous Provisions

Section 7.01 – Amendment.

This Agreement may be amended from time to time.

Section 7.02 – Severability And Validity Of Agreement.

Should the participation of any Member to this Agreement, or any part, term or provision of this Agreement be decided by the courts or the legislature to be illegal, in excess of that Member's authority, in conflict with any law of the State of California, or otherwise rendered unenforceable or ineffectual, the validity of the remaining portions, terms or provisions of this Agreement shall not be affected thereby and each Member hereby agrees it would have entered into this Agreement upon the same terms as provided herein as if that Member had not been party to in this Agreement.

Section 7.03 – Assignment.

Except as otherwise provided in this Agreement, the rights and duties of the Members to this Agreement may not be assigned or delegated without the approval of the Board of Directors. Any attempt to assign or delegate such rights or duties in contravention of this section shall be null and void. Any assignment or delegation permitted under the terms of this Agreement shall be consistent with the terms of any contracts, resolutions or indentures of the Authority then in effect. This Agreement shall inure to the benefit of and be binding upon the successors and Board of Directors-authorized assigns of the Members hereto.

Section 7.04 – Execution In Parts Or Counterparts.

This Agreement may be executed in parts or counterparts, each part or counterpart being an exact duplicate of all other parts or counterparts, and all parts or counterparts shall be considered as constituting one complete original and may be attached together when executed by the Members hereto. Facsimile and electronic signatures shall be binding.

Section 7.05 – Notices.

Notices authorized or required to be given pursuant to this Agreement shall be in writing and shall be deemed to have been given when mailed, postage prepaid, or delivered during working hours to the addresses set forth for each of the Members beneath their signatures on this Agreement, or to such other changed addresses communicated to the Authority and the Members in writing.

Section 7.06 – Governing Law and Venue.

This Agreement shall be governed by, construed, and enforced in accordance with the laws of the State of California, excluding any conflict of laws rule which would apply the law of another jurisdiction. Venue for purposes of the filing of any action regarding the enforcement or interpretation of this Agreement and any rights and duties hereunder shall be Fresno County, California. The parties to this Agreement hereby expressly waive any right to remove any action to a county other than Fresno County as permitted pursuant to California Code of Civil Procedure Section 394.

Section 7.07 – Dispute Resolution.

The Members agree that any dispute regarding the enforcement or interpretation of any term, covenant or condition of this Agreement ("Dispute") shall first, for a period of not less than thirty (30) days, be submitted to mediation before a mutually acceptable mediator prior to initiation of litigation or any other binding arbitration or adjudicative dispute resolution process. The Members shall: (i) mediate in good faith; (ii) exchange all documents which each believes to be relevant and material to the issue(s) in the Dispute; (iii) exchange written position papers stating their position on the Dispute and outlining the

subject matter and substance of the anticipated testimony of persons having personal knowledge of the facts underlying the Dispute; and (iv) engage and cooperate in such further discovery as the Members agree or mediator suggests may be necessary to facilitate effective mediation. Each Member shall bear its own costs, fees and expenses of the mediation. Venue of the mediation shall be a mutually agreeable city within Fresno County, California.

Section 7.08 – Attorney's Fees.

If any Member commences any proceeding or legal action to enforce or interpret any term, covenant or condition of this Agreement, the prevailing Member in such proceeding or action shall be entitled to recover from the other Member(s) its reasonable attorney's fees and legal expenses.

IN WITNESS WHEREOF, the Members hereto, pursuant to resolutions duly and regularly adopted by their respective governing boards, have caused their names to be affixed by their proper and respective officers as of the day and year first above-written.

COUNTY OF FRESNO

Brian Pacheco, Chairman
Board of Supervisors

ATTEST:
Bernice E. Seidel, Clerk
Board of Supervisors

By _____

REVIEWED AND RECOMMENDED FOR APPROVAL

By: _____
Steven E. White, Director
Department of Public Works and Planning

APPROVED AS TO ACCOUNTING FORM
Oscar J. Garcia, CPA
Auditor-Controller/ Treasurer-Tax Collector

By _____
Deputy

APPROVED AS TO LEGAL FORM
Daniel C. Cederborg
County Counsel

By: _____
Deputy

FOR ACCOUNTING USE ONLY

Fund:	0001
Subclass	10000
Org. No	4360-1250
Account	7295

Raisin City Water District

By:_____

Mid-Valley Water District

By:_____

EXHIBIT A

McMullin Area of the Kings Subbasin

Exhibit A

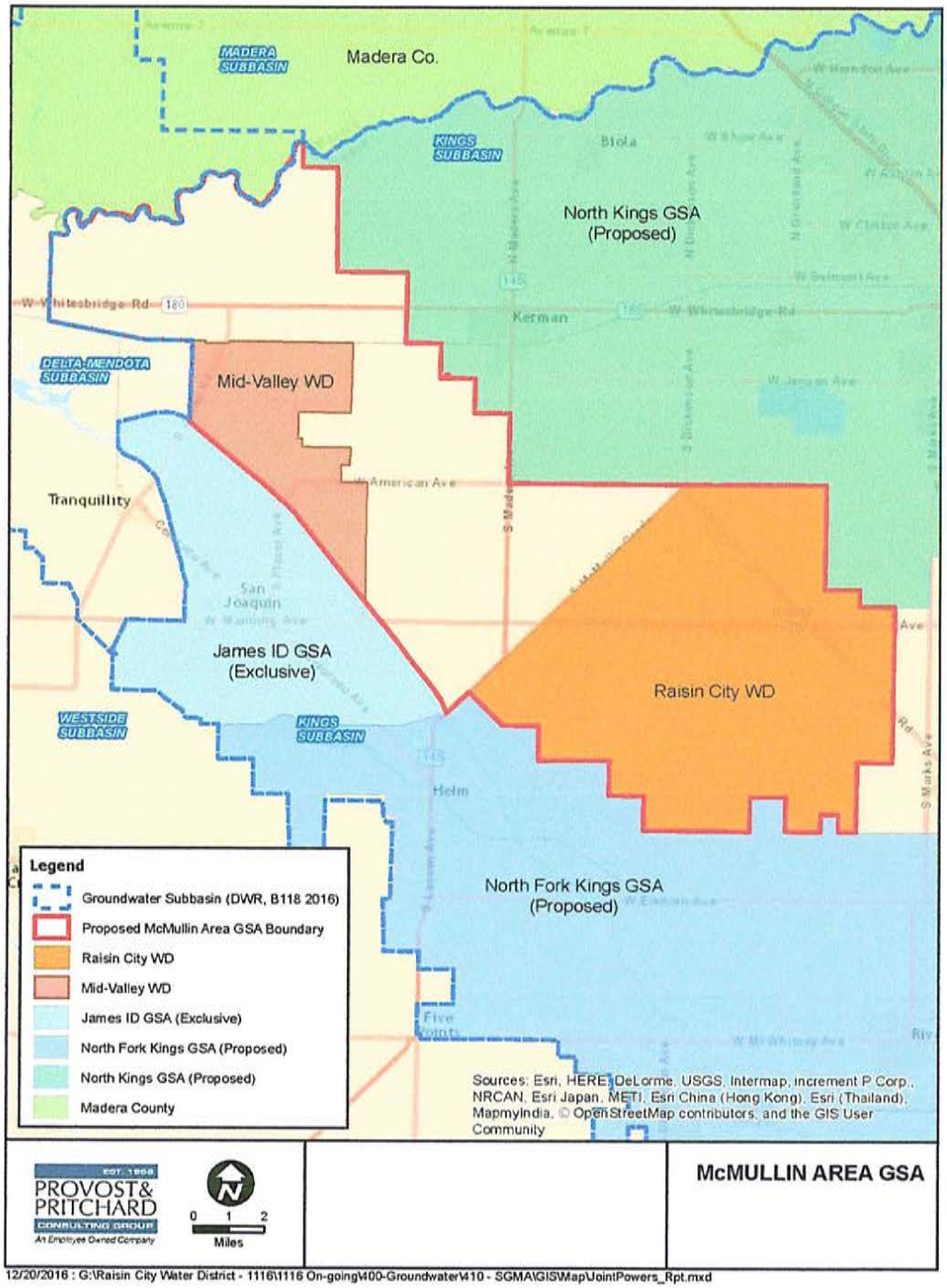


EXHIBIT B

AGENCY	SERVICE AREA	% of Total	INTIAL BUDGET $100,000
RAISIN CITY WATER DISTRICT	51,719 (Acres)	42.87%	$42,870
MID-VALLEY WATER DISTRICT	13,678 (Acres)	11.34%	$11,340
COUNTY OF FRESNO	55,238 (Acres)	45.79%	$45,790
Total	120,635	100%	$100,000

Appendix 2 B
Outreach Strategy

McMullin Area
Groundwater Sustainability Agency

MAGSA SGMA Stakeholder Outreach Strategy April – June 2017

The McMullin Area GSA (MAGSA) is scheduled to become exclusive on July ??, 2017. In anticipation of the robust stakeholder outreach that must be conducted during GSP development, a 3-month interim outreach strategy has been developed to educate and inform stakeholders about SGMA and MAGSA and to encourage stakeholders to participate in the development of the MAGSA GSP. The following is a framework for outreach to be conducted for the period of April – June 2017.

Goals

- Inform and educate regarding SGMA including purpose, timeline and requirements
- Inform and raise awareness about MAGSA including purpose, make-up of Board
- Provide understanding about the content of a GSP
- Build support for assessments to fund GSP development and implementation activities
- Encourage involvement in GSP development process

Strategies for Engagement

1. Field Briefings. These will be more localized events held either in local hangouts, farms, packing sheds, or public facilities in locations in each of the three JPA member agency service areas. To encourage participation, key leaders within the grower community could "host" the meeting and encourage growers within their circle of influence to attend.

Things to Consider - Limitations to this type of event are locations outside may not have facilities, electricity, or furniture and weather may be a factor. Would we want to target the audience to a radius around a certain location or invite all growers within a service area, e.g. Mid-Valley WD, to all meetings being held within their area. We may want to consider RSVP. I like the idea of holding an event at a packing shed/ag business if available because it allows us to outreach to the business as well.

2. Webinar. This provides growers another option if they are not able to participate in one of the Field Briefings. This will allow them to hear the presentations and participate in Q&A but would not include any handouts.

<u>Suggested Handouts</u>

1. SGMA Overview/GSP Overview
2. SGMA FAQ
3. Kings Subbasin Map
4. Sample Interested Person Sign-up Letter (SGMA regulation)
5. Sign-up sheet MAGSA E-Blasts
6. Sign-up sheet for SGMA Updates E-Newsletter

Key Messages

- SGMA was written to allow local agencies to manage groundwater; however there are requirements in the law that allow the State to intervene if they are not met.

- The Kings Subbasin must as a whole become sustainable by 2020.
    - The Kings Subbasin has been divided into six separate agencies that in the end must come together to make the subbasin sustainable
    - The McMullin Area GSA is one of the six

- McMullin Area GSA is a joint powers authority that includes the boundaries of 3 agencies (list)
    - Your representation on the Board depends on your location in the McMullin Area.
    - The McMullin Area GSA is responsible for developing and implementing a GSP that fits into the other 5 GSPs to achieve subbasin sustainability

- A GSP has specific requirements under SGMA
    - While these requirements are similar for all GSAs, the McMullin Area's issues and solutions will be very specific.
    - MAGSA has unique groundwater management challenges
    - The goal of the MAGSA Board is develop a GSP that will allow as much flexibility in supply and demand side solutions for sustainability

- Development of a GSP will require the services of hydrologists, technical consultants, lawyers, and other costs.
    - It is estimated that just to develop a GSP can cost up to $1,000,000.
    - SGMA is an unfunded mandate from the State that can have severe consequences to landowners if the requirements are not met.
    - The McMullin Area GSA is utilizing member agency staff and public agency support to minimize expenses and provide efficiencies in the process
    - The McMullin Area GSA will assess landowners to cover the costs of implementing SGMA.
    - Alternative is to have State intervention. Draft State fees are high.

- Many decisions affecting your groundwater use will be made as the GSP is developed and implemented.
    - The McMullin Area GSA needs landowner involvement each step of the way
    - We will be asking for stakeholder input at specific junctures
    - An Advisory Committee will be formed to include representatives from various stakeholder interests

Spokesperson Designation

Member Agency Board Member
Fresno County Staff Member
KRCD Staff Member

Audiences

For the April – June 2017, it is planned to provide outreach to only Priority #1 Audiences. Priority #2 & #3 Audiences will be included in the next phase of outreach starting in July 2017.

Priority #1 Audience – landowners (separated out according member agency affiliation)

- 261 landowners are in Fresno County White Areas (no district, no DAC, no community)
- 405 landowners are in Raisin City WD, not in a DAC and not in a community
- 32 landowners are in Mid-Valley WD, not in a DAC and not in a community

Priority #2 Audience – communities & industries

Priority #3 Audience – business, industry associations, environmental justice organizations, schools

DRAFT McMullin Area GSA Stakeholder Inventory	
Priority #1 Audiences	**Priority #3 Audiences**
Ag Pumpers	*Schools*
	Raisin City Elementary
Priority #2 Audiences	*DAC Organizations*
Communities	Community Water Center
Raisin City	Leadership Counsel for Justice & Accountability
Alkai Flats	Center on Race poverty and the Environment
Perry Colony	California Rural Legal Assistance
Agriculture Organizations	Self-Help Enterprises
Fresno Co. Farm Bureau	*Environmental Organizations*
Almond Board	Sierra Club - Tihipite Chapter
Raisin Bargaining Association	*Business*
American Pistachio Growers	Rotary, Kiwanis, Lions Clubs
California Tomato Commission	*Planning Agencies*
	Planning Commission
Packing Houses, Food Processors	Fresno County LAFCO
Rural Domestic Well Owners	*Academia*
	UC Cooperative Extension
	Fresno State

Budget

Potential costs for the April-June 2017 outreach strategy could include postage, printing of postcard notices, materials, room rental, refreshments, and staff time.

Tasks and Timelines

Task	Timeline	Responsible Party
Identify Key Grower Leaders, locations, and field briefing dates	Complete by April 14	Member Agency Board Members
Draft invite (postcard)	Complete by April 7	KRCD Staff
Finalize postcard	Complete by April 14	KRCD/Fresno County Staff
Develop mailing lists	Complete by April 14	KRCD staff
Print and mail postcards	Complete by April 21	Fresno County staff
Develop presentation	Complete by April 28	KRCD staff
Develop handouts	Complete by April 28	KRCD staff
Conduct field briefings	May and June	Member Agencies and KRCD

McMullin Area
Groundwater Sustainability Agency

MAGSA Stakeholder Outreach Strategy September – December 2017

Goals

- Inform and educate regarding SGMA including purpose, timeline and requirements
- Inform and raise awareness about MAGSA including purpose, make-up of Board
- Provide understanding about the content of a GSP
- Build support for assessments to fund GSP development and implementation activities
- Encourage involvement in GSP development process

Strategies for Engagement

Field Briefings

These will be more localized events held either in local hangouts, farms, packing sheds, or public facilities in locations in each of the three JPA member agencies service areas. Key leaders within the grower community could "host" the meeting and encourage growers within their circle of influence to attend.

Key Stakeholder Meetings

These will be one-on-one meetings with key stakeholders in each of the 3 member agencies service areas. Key Stakeholders include large landowners within MAGSA service area .

Community Meeting

This will be similar to the landowner meetings but format and messaging will be tailored to DACs. Will partner with EJ organizations to implement.

Industry/Associations Outreach

Provide stories for newsletters. Participate in regional update meetings.

Newsletter

This will allow us to touch all MAGSA constituents. The outreach budget includes two newsletters. The first can be used for general education prior to the 218/26 outreach. The second can be used as an outreach piece for the 218/26 election.

Landowner Meetings/Webinar

Similar to previous landowner meetings located in Raisin City and Kerman and one webinar. The meetings will focus on 218/26 election education.

Implementation Pre-218/26 Election Timeframe

Strategy	Timeline	Audience	Method	Support
Newsletter #1	Sep/Oct	landowners, residents	direct mail	MAGSA staff
Industry/Assoc. Outreach	Sep/Oct/Nov	Assoc. CEOs	e-mail, meetings	MAGSA staff

Implementation 218/26 Election Timeframe

Strategy	Timeline	Audience	Method	
Newsletter #2	TBD	landowners, residents	direct mail	MAGSA staff
Landowner Meetings/Webinar	TBD	landowners	direct mail, IP list	MAGSA staff
Community Meeting	TBD	residents	door-to-door, inserts	MAGSA staff, EJ org.
Key Stakeholder Meetings	TBD	Large landowners	personal contact	Directors, MAGSA staff
Field Briefings	TBD	targeted landowners	IP list, personal contact	Directors, MAGSA staff
Industry/Assoc. Outreach	TBD	Assoc. CEOs	e-mail, meetings	MAGSA staff

Key Messages

- SGMA was written to allow local agencies to manage groundwater; however there are requirements in the law that allow the State to intervene if they are not met.
- The Kings Subbasin must as a whole become sustainable by 2040.
    - The Kings Subbasin has been divided into seven separate Groundwater Sustainability Agencies that must come together to make the subbasin sustainable
      The McMullin Area GSA is one of the seven
- McMullin Area GSA is a joint powers authority that includes the boundaries of 3 agencies (list)
    - Your representation on the Board depends on your location in the McMullin Area.
      The McMullin Area GSA is responsible for developing and implementing a GSP that fits into the other 6 GSPs to achieve subbasin sustainability
- A GSP has specific requirements under SGMA
    - While these requirements are similar for all GSAs, the McMullin Area's issues and solutions will be very specific.
    - MAGSA has unique groundwater management challenges
      The goal of the MAGSA Board is develop a GSP that will allow as much flexibility in supply and demand side solutions for sustainability
- Development of a GSP will require the services of hydrologists, technical consultants, lawyers, and other costs.
    - It is estimated that just to develop a GSP can cost up to $1,000,000.
    - SGMA is an unfunded mandate from the State that can have severe consequences to landowners if the requirements are not met.
    - The McMullin Area GSA is utilizing member agency staff and public agency support to minimize expenses and provide efficiencies in the process
    - The McMullin Area GSA will assess landowners to cover the costs of implementing SGMA. Alternative is to have State intervention. State fees are high.
- Many decisions affecting your groundwater use will be made as the GSP is developed and implemented.
    - The McMullin Area GSA needs landowner involvement each step of the way
    - We will be asking for stakeholder input at specific junctures
    - Ad Hoc Committees were formed that allow for engagement in the various administrative and technical functions of the McMullin Area GSA.

Additional messaging will be developed using Provost & Pritchard's engineering report.

Materials

- SGMA Overview/GSP Overview (*completed*)
- SGMA FAQ (complete)
- Kings Subbasin/MAGSA Boundary Maps (*completed*)
- Interested Person Sign-up (*completed*)
- MAGSA 218 Election Handout (*to be developed*)

McMullin Area GSA Stakeholder Inventory

Landowners
- Ag pumpers
- Domestic pumpers

Ag Organizations
- Fresno Co. Farm Bureau
- Almond Board
- Raisin Bargaining Association
- American Pistachio Growers

Ag Businesses
- Palomote Packing House
- American Huntsman
- Panoche Creek Packing
- Holland Hulling
- Superior Organic
- Schaad Family Almonds
- Sran Family Almonds
- Central CA Almond Growers
- National Raisin
- Boghosian Raisins
- Sun Maid
- Lyons

Schools
- Raisin City Elementary

Communities
- Raisin City
- Alkai Flats
- Perry Colony

DAC Organizations
- Community Water Center
- Leadership Counsel
- Center on Race Poverty and the Environment
- California Rural Legal Assistance
- Self-Help Enterprises

Business Organizations
- Kerman Lions Club

Other Agencies
- Fresno County LAFCO
- CA Department of Fish & Wildlife

Academia
- UC Cooperative Extension
- Fresno State

2017-18 MAGSA Outreach Budget

4 postcard mailings @ $700 each	$2,800.00
2 newsletter mailings @ $2,000 each	$4,000.00
materials development	$3,600.00
website upkeep	$900.00
outreach meetings (eight)	$6,500.00
bulk mail permit $225 setup, $225 annual	$450.00
GSP workshops (4)	$4,000.00
	$22,250.00

Notes from 8/30/17 Ad Hoc Outreach Committee Meeting

- Inventory organizations/packing houses/associations annual meetings, luncheons and grower communication. Offer to present, setup a table, or provide articles for grower communications.
- Provide communication pieces to auto/farm supply stores for posting on their bulletin boards.
- Contact organizer for Kerman Ag Show. Ask about exhibit space and presenting opportunities.
- Insert communication pieces into bills.
- Setup MAGSA staff member interview with KMJ580 reporter Don York.
- Update website business cards when available with contact phone # and add FAQ/timeline facts on the backside.
- Consider future use of social media including text alerts and twitter account
- Poll landowners to get the pulse of voting for a MAGSA fee

McMullin Area
Groundwater Sustainability Agency

MAGSA SGMA Stakeholder Outreach Strategy FY 2018-19

Situation Analysis

Under the requirements of SGMA, GSAs must consider interests of all beneficial uses and users of groundwater. As a result, the GSP development needs to consider effects to other stakeholder groups in or around the groundwater basin with overlapping interests. Furthermore, the GSP Regulations require that GSAs document in a communication section of the GSP the opportunities for public engagement and active involvement of diverse social, cultural, and economic elements of the population within the basin.

Central Problem

What are we working to solve?

The McMullin GSA Groundwater Sustainability Plan needs broad support for its adoption from a diverse public that has actively engaged in the development of the Plan.

Goals

How can MAGSA solve our central problem?

1. Build public understanding of SGMA, in particular a Groundwater Sustainability Plan
2. Implement SGMA in a transparent manner
3. Provide accurate, easy-to-understand, timely information on GSP development

Key Messages

What messages must we convey to our audiences to achieve our goals?

Goal 1: Build public understanding of SGMA, in particular a Groundwater Sustainability Plan

1. The new groundwater law, SGMA, allows for local management of groundwater; however, the State can intervene if the requirements in the law are not met.
2. A GSP has specific requirements under SGMA to achieve a sustainable subbasin.
3. The McMullin Area GSA Board is responsible for developing and implementing programs and projects that will support achieving sustainability for the entire subbasin.
4. The McMullin Area GSA Board will develop a GSP with flexibility in supply and demand side solutions.

Goal 2: Implement SGMA in a transparent manner

1. The McMullin Area GSA Board encourages participation and input from stakeholders.
2. The McMullin Area GSA Board seeks to incorporate public input received in decisions.
3. The McMullin Area GSA staff is committed to being available and responding to all stakeholder inquiries and comments.

Goal 3: Provide accurate, easy-to-understand, timely information on GSP development

1. The McMullin Area GSA maintains a list of Interested Persons and sends out regular notices and updates about GSA Board activities including GSP development.
2. The McMullin Area GSA has a robust website that maintains up-to-date information and materials.

Tactics

Goal 1	**Build public understanding of SGMA, in particular a GSP**			
	Tactic	**Target Audience**	**Timing**	**Tools/Channels**
	Create a GSP web portal	Stakeholders	3rd quarter 2019	McMullin Website
	Distribute e-updates as key information on GSP development is available	Interested Persons	ongoing	Constant contact
	Conduct GSP workshops	Stakeholders	2nd quarter 2019 3rd quarter 2019	First class mail, website, constant contact
	Speakers Bureau	Service clubs, school boards, farm bureau boards	3rd quarter 2018	e-mail, constant contact
Goal 2	**Implement SGMA in a transparent manner**			
	Tactic	**Target Audience**	**Timing**	**Tools/Channels**
	Invitational letter and informational insert	Schools, ag org., CDFW	3rd quarter 2018	First class mail
	Conduct survey to receive input on sustainability thresholds and knowledge level	Stakeholders	3rd quarter 2018	In-person, constant contact, website
	Pitch news stories to media	Influencers		Kerman News
Goal 3	**Provide accurate, easy-to-understand, timely information on GSP Development**			
	Tactic	**Target Audience**	**Timing**	**Tool/Channels**
	Produce 1-page informational sheets on key GSP aspects	Stakeholders	ongoing	GSA workshops, websites
	Utilize whenever possible infographics to communicate complex information	Stakeholders, influencers	ongoing	Website, constant contact
	Produce videos of workshops and complex issues related to groundwater hydrology	Stakeholders, general public	ongoing	YouTube, website

Evaluation

KRCD has implemented a planning and tracking calendar for the purpose of establishing and tracking MAGSA stakeholder outreach. This includes the implementation creative briefs during campaign inception, campaign monitoring using quantitative and qualitative metrics, and postmortem analysis meetings. Such evaluation methods will allow staff to adequately monitor execution strengths and weaknesses, and quickly pivot its focus or introduce new tactics if needed.

Activity Timeline

Activity	Timeline	Target Audience
Kerman Lion's Club Ag Expo	2018: October 24	landowners
Targeted letters/surveys	2018: 3rd quarter	Schools/Businesses/Associations
Speakers Bureau	2018: 3rd quarter	Schools/Businesses/Associations
Stakeholder GSP Workshop(s)	2019: April/May	Landowners/residents/DACs
Stakeholder GSP Webinar	2019: April/May	Landowners/residents/DACs
Public Hearing, Adoption of GSP	2019: Nov. 4 Board Meeting	

2018-19 MAGSA Outreach Budget	
website development & maintenance (1 hr/month)	$900.00
website hosting ($8/month)	$96.00
GSP workshops (6 @ $1,000)	$6,000.00
Fact Sheets (4 @$600)	$2,400.00
Video	$2,000.00
E-updates (12/year @ $75)	$900.00
Board meetings (12/year @ $225)	$2,700.00
GSP workshop mailers 3 @ $1,300	$3,900.00
special project	$1,100.00
	$19,996.00

2019-20 MAGSA Outreach Budget	
website development & maintenance (1 hr/month)	$900.00
website hosting ($8/month)	$96.00
GSP workshops (6 @ $1,000)	$6,000.00
Fact Sheets (4 @$600)	$2,400.00
E-updates (12/year @ $75)	$900.00
Board meetings (12/year @ $225)	$2,700.00
Newsletters (2/year @ $2,000 each)	$4,000.00
special project	$1,000.00
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Ag Pumpers

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Raisin City
Alkai Flats
Perry Colony

Agriculture Organizations

Fresno Co. Farm Bureau
Almond Board
Raisin Bargaining Association
American Pistachio Growers
California Tomato Commission

Packing Houses
Central CA Almond Growers Assoc.

Food Processors

Rural Domestic Well Owners

Schools
Raisin City Elementary

DAC Organizations
Community Water Center
Leadership Counsel for Justice & Accountability
Center on Race poverty and the Environment
California Rural Legal Assistance
Self-Help Enterprises

Environmental Organizations
Sierra Club - Tihipite Chapter

Business
Rotary, Kiwanis, Lions Clubs

Planning Agencies
Planning Commission

Fresno County LAFCO

Academia
UC Cooperative Extension
Fresno State

McMullin Area
Groundwater Sustainability Agency

MAGSA SGMA Stakeholder Outreach Strategy

February-December 2019

Situation Analysis

Under the requirements of SGMA, GSAs must consider interests of all beneficial uses and users of groundwater. As a result, the GSP development needs to consider effects to other stakeholder groups in or around the groundwater basin with overlapping interests. Furthermore, the GSP Regulations require that GSAs document in a communication section of the GSP the opportunities for public engagement and active involvement of diverse social, cultural, and economic elements of the population within the basin.

Central Problem

What are we working to solve?

The MAGSA Groundwater Sustainability Plan needs broad support for its adoption from a diverse public that has actively engaged in the development of the Plan. Plan information has great depth and breadth to communicate to the public.

Goals

How can MAGSA solve our central problem?

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2. Implement SGMA in a transparent manner
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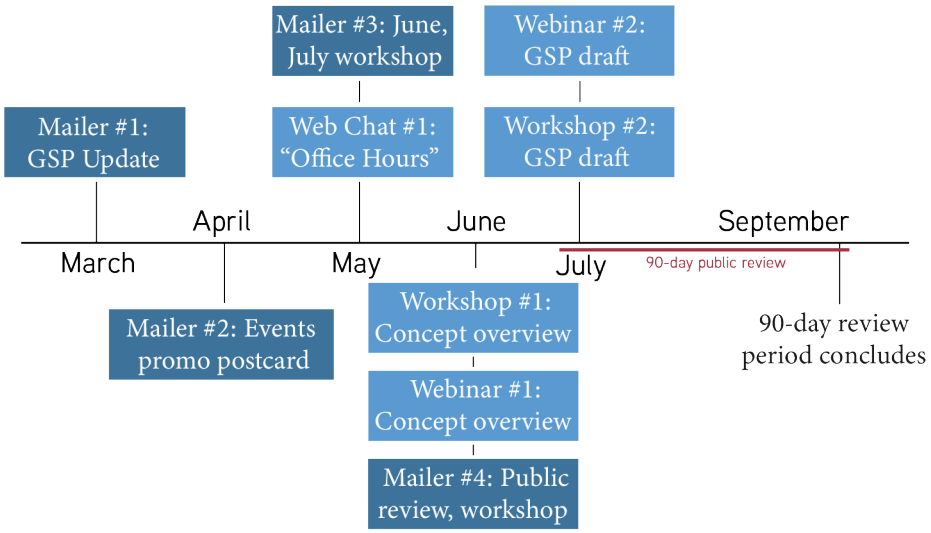
1. The MAGSA maintains a list of Interested Persons and sends out regular notices and updates about GSA Board activities including GSP development.
2. The MAGSA has a robust website that maintains up-to-date information and materials.

Tactics

Goal 1	**Build public understanding of SGMA, in particular a GSP**			
	Tactic	**Target Audience**	**Timing**	**Tools/Channels**
	Create a GSP web portal	stakeholders	completed	McMullin Website
	Distribute e-updates as key information on GSP development is available	Interested Persons	ongoing	Constant contact
	Conduct GSP workshops/webinar	Stakeholders	2nd-4th quarters 2019	First class mail, website, constant contact
	Virtual "office hour"	stakeholders	2nd quarter 2019	Postcard, website, constant contact
Goal 2	**Implement SGMA in a transparent manner**			
	Tactic	**Target Audience**	**Timing**	**Tools/Channels**
	General background survey	Schools, ag org., CDFW,	4th quarter 2019	First class mail
	Conduct survey to receive input on sustainability thresholds and knowledge level	stakeholders	1st quarter 2019	In-person, constant contact, website
	GM Introduction letter/contact info collection	Stakeholders	1st quarter 2019	mail
	Comment cards	stakeholders	2nd-4th quarter 2019	Online, workshops
Goal 3	**Provide accurate, easy-to-understand, timely information on GSP Development**			
	Tactic	**Target Audience**	**Timing**	**Tool/Channels**
	Produce 1-page informational sheets on key GSP aspects	stakeholders	4th quarter 2019	GSA workshops, websites
	Utilize whenever possible infographics to communicate complex information	Stakeholders, influencers	4th quarter 2019	Website, constant contact
	Produce videos of workshops and complex issues related to groundwater hydrology	Stakeholders, general public	4th quarter 2019	YouTube, website

Timeline



Evaluation

KRCD has implemented a planning and tracking calendar for the purpose of establishing and tracking MAGSA stakeholder outreach. This includes the implementation creative briefs during campaign inception, campaign monitoring using quantitative and qualitative metrics, and postmortem analysis meetings. Such evaluation methods will allow staff to adequately monitor execution strengths and weaknesses, and quickly pivot its focus or introduce new tactics if needed.

February - June 2019 (6 months) costs	
website development & maintenance	$450.00
website hosting ($8/month)	$48.00
GSP workshops (2@ $2,000)	$4,000.00
Fact Sheets (2 @$600)	$1,200.00
E-updates	$2,700.00
Board meetings	$2,250.00
GM letter/update	$2,000.00
Virtual Office Hour (includes postcard mailer)	$1,500.00
special project	$1,000.00
Total	**$15,148.00**
Budget 2018-19	$32,660.00
Jul-Dec expenditures	$13,406.00
Budget remaining as of 12/31/18	**$19,254.00**

MAGSA Stakeholder Inventory

Ag Pumpers

Communities
Raisin City
Alkali Flats
Perry Colony

Agriculture Organizations

Fresno Co. Farm Bureau
Almond Board
Raisin Bargaining Association
American Pistachio Growers
California Tomato Commission

Packing Houses
Central CA Almond Growers Assoc.

Food Processors

Rural Domestic Well Owners

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Leadership Counsel for Justice & Accountability
Center on Race poverty and the Environment
California Rural Legal Assistance
Self-Help Enterprises

Environmental Organizations
Sierra Club - Tihipite Chapter

Business
Rotary, Kiwanis, Lions Clubs

Planning Agencies
Planning Commission

Fresno County LAFCO

Academia
UC Cooperative Extension
Fresno State

STAKEHOLDER SURVEY RESULTS

As of 7/3/2019

32 responses

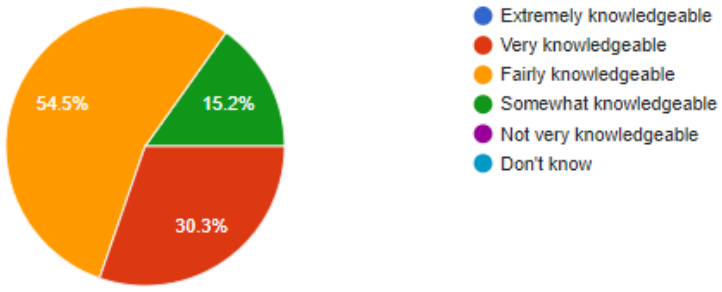
For questions 1-3, the total score was added for each answer choice. The lower the total score, the higher the importance. The higher the total score, the less the importance. The answers shown here are ranked from what the survey says is most important to what is least important.

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.
    a. Agricultural – 54
    b. Municipal – 71
    c. Wildlife/Fisheries – 127
    d. Recreational – 133
    e. Manufacturing – 137
    f. Mining/Petroleum – 169

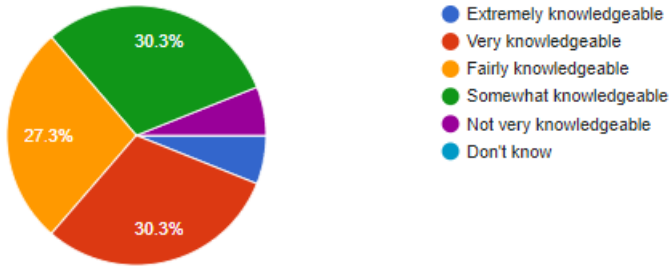
2. How important are the following uses of water to the region? Please rank the categories with 1 being the most important use of water and 6 being the least important
    a. Agricultural – 50
    b. Municipal – 87
    c. Wildlife/Fisheries – 130
    d. Manufacturing – 144
    e. Recreational – 147
    f. Mining/Petroleum – 165

3. Please rank the categories with 1 being the most important reason for managing groundwater and 5 being the least important.
    a. My ability to earn a living is directly linked – 69
    b. Ensure drinking water supply for domestic uses – 78
    c. Ensure water supply for future generations – 79
    d. Future economic growth for region – 96
    e. Provide reliable water for industry/business – 105

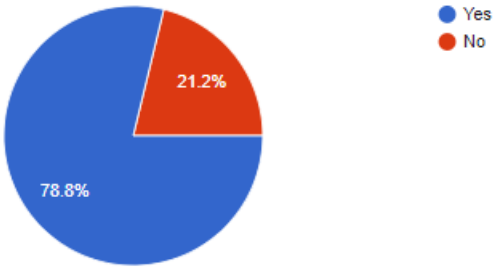
4. How knowledgeable do you consider yourself of local water issues? (select one)



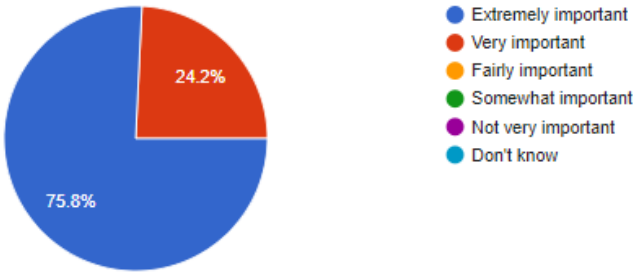
5. How knowledgeable do you consider yourself of the new groundwater regulation, the Sustainable Groundwater Management Act?



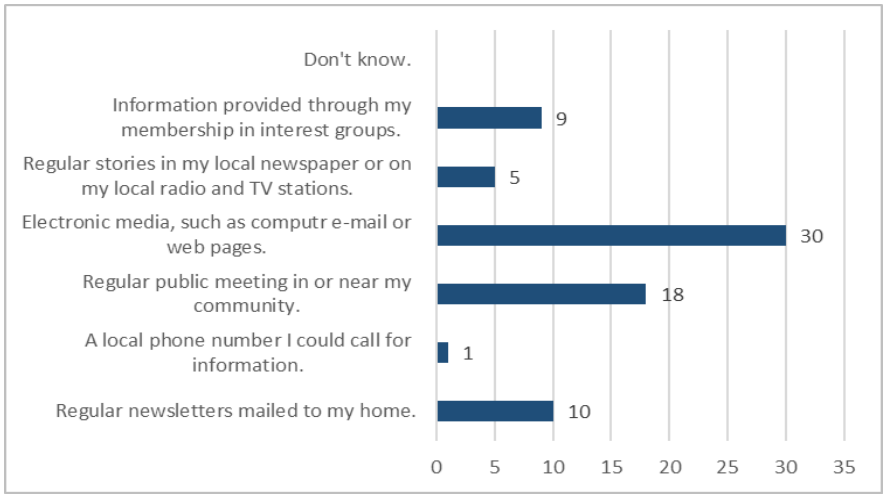
6. Are you currently engaged in activity or discussions regarding groundwater management in your area?



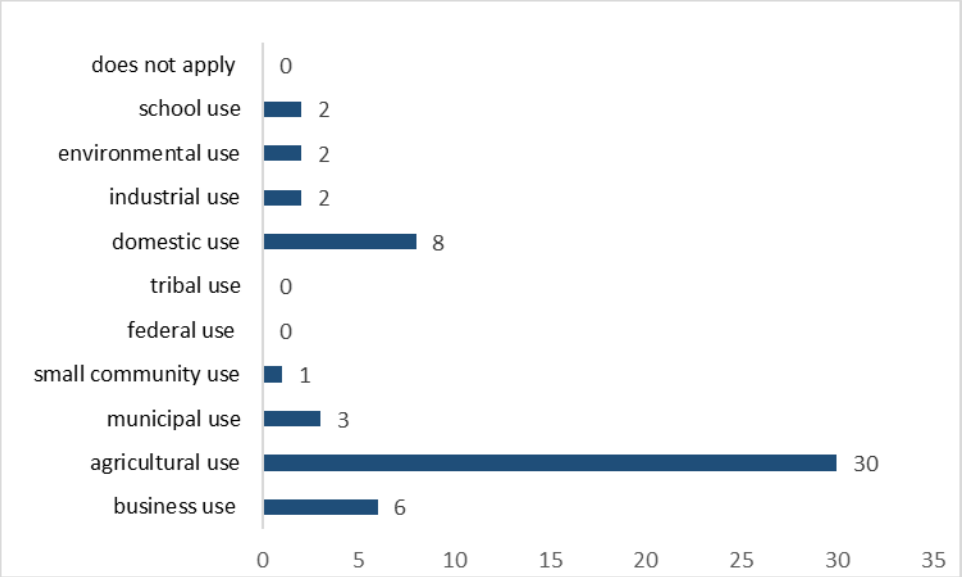
7. How important to you is information on anticipated impacts of new state regulations?



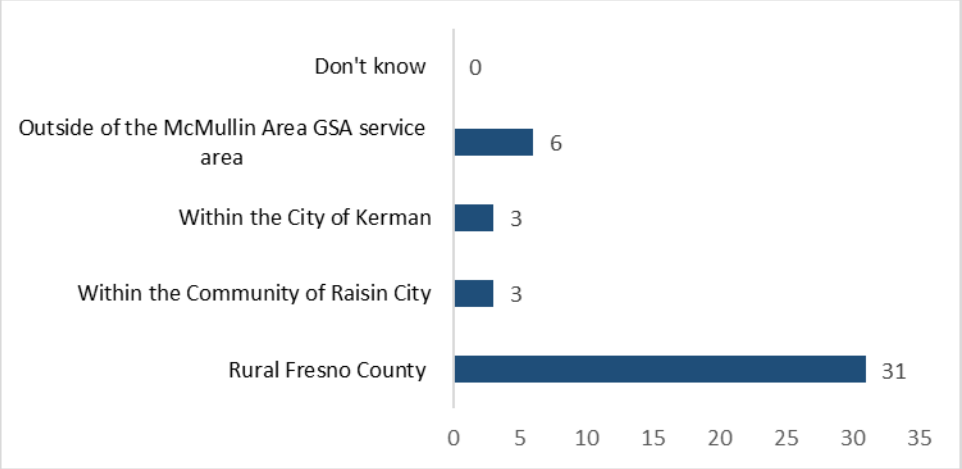
8. Which format or formats would you prefer for receiving information about groundwater management planning process? (Select all that apply)



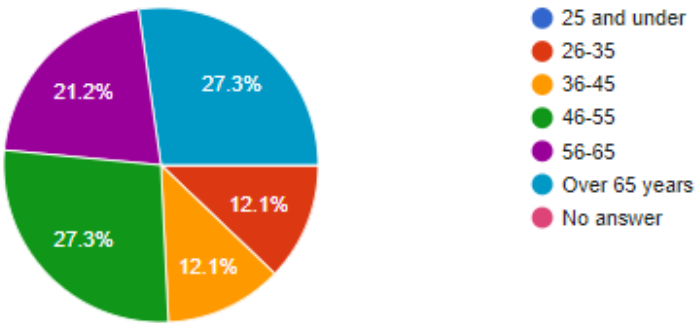
9. Which applies to you? I am a stakeholder representing pumping for...(Select all that apply)



10. Which best describes the community in which you or your industry/business resides? (Select all that apply)



11. Please indicate your age range?



Appendix 2 C
GSP Public Comments Table

Comment Response Summary

GSA **McMullin Area**

Date: November 5, 2019 **Job No.:**

No.	Section.	By	Review Comments	Date Received	Response	Response Date
1.	ES-9	Aquashares	Remove the word "continuously" from the bullet point "The basin is continuously operated within its sustainable yield."	7/23/19	Removed the word continuously.	10/9/19
2.	2.2.13	James ID	Section 2.2.13 includes an assessment of land outside of MAGSA with data that is not current and not properly cited.	9/17/19	Removed map and discussion of JID wellfield under section 2.2.13.	10/9/19
3.	3-96, 3-97, 5-35	California Oak	Comment was addressed to NFKGSA.	10/7/19	MAGSA will monitor groundwater levels along the San Joaquin River.	10/9/19
4.	3-134	Toste Family Farms LP	The water budget is flawed in that it imposes the burden of natural groundwater flows to the GSP basin area on the landowners rather than characterizing those natural inflows as a source of supply.	10/15/19	MAGSA will continue to monitor as necessary.	10/31/2019
5.	3-134	Toste Family Farms LP	The use of a 1925 study which took place prior to the construction of Friant Dam and many other substantial water development projects should be discounted or discarded.	10/15/19	Comment noted.	10/31/2019

6.		Toste Family Farms LP	The GSP should adopt as a management action the prohibition of all exports of groundwater from the basin.	10/15/19	MAGSA already has a potential management action designated.	10/31/2019
7.		Toste Family Farms LP	The GSP should identify lands which are not arable or usable. Those land should not be allocated groundwater until the basin is in balance.	10/15/19	Outside of GSA jurisdiction.	10/31/2019
8.		Toste Family Farms LP	Flood waters made available in the basin should first be allocated to the existing conveyance and storage systems so that such flood waters can be diverted to recharge projects within the basin as opposed to being exported from the basin by outside agencies or landowners.	10/15/19	Comment noted.	10/31/2019
9.		Toste Family Farms LP	No exportation from the basin should be permitted pending the entire basin reaching sustainability.	10/15/19	Outside of GSA jurisdiction.	10/31/2019
10.		Toste Family Farms LP	The GSA should develop substantially more detailed and reliable information regarding the basin prior to recommending or requiring any management actions.	10/15/19	MAGSA will continue to monitor and collect data to guide management actions.	10/31/2019
11.	6.2	California Poultry	CPF encourages MAGSA to perform the necessary studies for management actions.	10/15/19	Comment noted.	10/31/2019

12.	3-126	Fresno County	It is noted that subsurface waters entering the GSA are outflows, where they should be noted as inflows.	10/15/19	Changed outflows to inflows.	10/31/2019
13.	2.5.1	TNC	Please identify whether or not the following beneficial uses and users of groundwater in the Subbasin are present: Protected Lands, including refuges, conservation areas, and recreational areas; and Public Trust Uses, including wildlife, aquatic habitat, fisheries, and recreation.	10/11/2019	MAGSA is in communication with DFW, which is an active member of the stakeholder committee. CDFW has expressed no concerns or objections with the plan.	10/31/2019
14.	2.2.9	TNC	When speaking directly to KRWA, FWA & SLDMWA, please explain the relationship of existing stream flow monitoring to the protection of ISWs and GDEs, and if there are instream flow criteria for the ISWs.	10/11/2019	Item is not applicable to MAGSA's plan.	10/31/2019
15.	2.2.15	TNC	Please discuss the potential impact of the SJRRP on the wetlands and potential GDEs present along or adjacent to the river.	10/11/2019	The plan indicates that it is MAGSA's intention to monitor the SJR stretch along the MAGSA boundary and continue to assess the data gathered.	10/31/2019
16.	2.3	TNC	Please include a discussion of how implementation of the GSP may affect and be coordinated with General Plan policies (specifically Fresno County	10/11/2019	Not applicable.	10/31/2019

			General Plan) and procedures regarding the protection of wetlands, aquatic resources and other GDEs and ISWs. Please identify all relevant HCPs and NCCPs within the Subbasin, and address how GSP implementation will coordinate with the goals of these HCPs or NCCPs. Please include a discussion regarding the management of critical habitat for these aquatic species (handbook provided by TNC) and its relationship to the GSP.			
17.	2.3.4	TNC	Please include a discussion of how future well permitting will be coordinated with the GSP to assure achievement of the Plan's sustainability goals. Compliance of well permitting programs (specifically pertaining to streams near public trusts) with this requirement should be stated in the GSP.	10/11/2019	The County of Fresno, to this date, still maintains their well permitting program.	10/31/2019
18.	3.1.7	TNC	The cross-sections have been taken from a 1969 source and, as reproduced in the GSP, are very difficult to read and understand.	10/11/2019	These are the best available cross sections, and the reference sources are cited in the GSP. MAGSA has determined initially that no connection exists but will continue to collect additional	10/31/2019

			Please reproduce the regional cross-sections so that they can be understood by the reader and update them to illustrate data obtained from more recent well installations. Include an example of near-surface cross sections that depicts the conceptual understanding of shallow groundwater and river interactions at different locations, as well as any potential GDEs and ISWs.		data as available and make adjustments as indicated.	
19.	3.1.8	TNC	The extent of the clay layers is shown in Figure 3-15 (p. 3-24). It is important to determine if confined conditions exist between the C-Clay and the E-Clay, and to confirm that only wells with screened intervals in the unconfined aquifer are being used to compare with surface water to identify and confirm potential GDEs.	10/11/2019	The wells in MAGSA's monitoring network are only in the unconfined zone.	10/31/2019
20.	3.1.8.1	TNC	Please correct figure labels for Figures 3-17, 3-18, and 3-19 (labeled as 3-13, 3-14 and 3-15). "The definable bottom of the basin should be at least as deep as the deepest groundwater extractions." Thus,	10/11/2019	Labels have been updated, and it's believed that data referenced in the figures are appropriate.	10/31/2019

			groundwater extraction well depth data should also be included in the determination of the basin bottom.			
21.	3.1.12	TNC	Please discuss in the GSP that portions of these Reserves (1,800-acre Kerman Ecological Reserve and the 930-acre Alkali Sink) are considered potential GDEs and refer to Figure 3-77. Also, if the Wetland Inventory was in fact the US Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI), then correct the text and reevaluate the data. The NWI does not always include or segregate separate existing wetlands that are on the periphery of other features. Please describe the wetland types in more detail. If they are truly vernal pools confined by a clay layer then they are not GDEs, but they must meet the criteria of a vernal pool as described by the California Rapid Assessment Methodology or the United States Army Corps of Engineers to qualify.	10/11/2019	The DFW are represented on MAGSA's stakeholder committee and are satisfied with the plan.	10/31/2019

22.	3.2.7	TNC	Please provide depth to groundwater contour maps. See Attachment D for best practices for completing this step. Specifically, ensure that the first step is contouring groundwater elevations, and then subtracting this layer from land surface elevations from a DEM to estimate depth to groundwater contours across the landscape. Please provide a cross-section and/or corresponding hydrographs (MW-09-36 and MW-09-37) to show the relationship between the river channel and the depth to groundwater at wells near the river. Please evaluate with depth to groundwater contour maps as described above and see Attachment D for best practices for completing this step. Please remove or restate this sentence. Expand the discussion of ISWs to include the above referenced recommendations on identifying and mapping ISWs and provide discussion of the depletions on specific rivers. Please reconcile any data	10/11/2019	The basin will be reporting the necessary groundwater elevation contour maps to DWR as required by SGMA on an annual basis.	10/31/2019

			gaps (shallow monitoring wells, stream gauges, and nested/clustered wells) along surface water features in the Monitoring Network section of the GSP to improve ISW mapping.			
23.	5.7	TNC	Please provide a discussion of the expected effect of the SJRRP on flows, GDEs and ISWs along the San Joaquin River.	10/11/2019	See comment 15 response.	10/31/2019
24.	3.2.8	TNC	**1.** Please map the original NC dataset, and clearly document which polygons were added (and what local sources were used to identify them), removed (and the removal reason), and kept (from the original NC dataset). **2.** For text on page 3-116, 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, include those polygons in the GSP until data gaps are reconciled in the monitoring network.	10/11/2019	Existing data did not support this position, MAGSA will continue to monitor.	10/31/2019

			Please provide depth to groundwater contour maps as described above as related to Checklist Items 8, 9 and 10 for Section 3.2.7 **3.** Please remove the 30-foot criteria for excluding GDEs and present a more comprehensive analysis for identifying GDEs in the Subbasin, as outlined in Appendix III (Worksheet 1) of the GDE Guidance. **4.** Please indicate what vegetation is present in the possible GDEs. **5.** 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. Ensure that groundwater condition data prior to the SGMA benchmark date of January 1, 2015 is included in the analysis. Please refer to our comment above related to Checklist Items 8-10 for Section 3.2.7, and 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, include those polygons in the GSP until data gaps are reconciled in the monitoring network. **6.** Please clarify how the 100-foot buffer was used to include or exclude GDEs in the McMullin Area, and how this is supported by groundwater level and plant physiological data. If there is a potential GDE near the river, we suggest the entire GDE is included, rather than using an arbitrary 100-foot cutoff.			
25.	3.2.1	TNC	**1.** Once potential GDEs are identified, please provide information on the historical or current groundwater conditions in the GDEs or the ecological conditions present. **2.** Please provide an ecological	10/11/2019	MAGSA has not identified GDEs within its boundary.	10/31/2019

			inventory (see Appendix III, Worksheet 2 of the GDE Guidance) for all potential GDEs that includes the vegetation types or habitat types and rank the GDEs as having a high, moderate or low value; and what characterizes the rank. **3.** 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.			
26.	3.3.8	TNC	**1.** Please quantify the estimated amount of induced groundwater flow in the historical budget, clearly indicate if this amount is included in the current budget, and indicate why there are differences in inclusion from historical, current and future budgets. **2.** Please clarify whether a term is included for native or riparian vegetation evapotranspiration and for wetlands in the McMullin Area	10/11/2019	MAGSA is assuming that 'induced groundwater flow' refers to 'induced river seepage'. Existing data indicates that SW and GW are not hydraulically connected in MAGSA, so there would be no river seepage. Future induced river seepage cannot be estimated with any reasonable accuracy, so on-going monitoring will need to contribute to future understanding of this topic.	10/31/2019

			historical, current, and future water budgets.		The only riparian and wetland areas are located along the southern side of the San Joaquin River. These cover relatively minor areas, and the evapotranspiration were estimated as part of the total evaporation from the San Joaquin River, which was estimated internally as part of the River seepage estimates. Native vegetation evapotranspiration would be from local rainfall and is captured in the Water Budget variable 'Rainfall Evaporation and Runoff'.	
27.	4.1	TNC	**1.** Since GDEs are likely present in the Subbasin (see comments under Checklist Items 16-20) (Claimed in comments from TNC), they should be recognized as beneficial users of groundwater and should be included in the Sustainability Goal. In addition, a statement about any intention to address pre-SGMA impacts should be included. **2.** TNC notes evidence of connectivity between surface water and	10/11/2019	The sustainability goal is meant to include all beneficial users.	10/31/2019

			groundwater and potential GDEs have been identified near the San Joaquin River. We disagree with the statement that there are not ISWs within the GSA. Even though the ISWs are not continuously connected (see comments under Checklist Items 8-10), they should be included in the Sustainability Goal. **3.** TNC recommends including ISWs and their potential GDEs in the sustainability goal and criteria. Since GDEs may be affected by water quality, they should be included in the Sustainability Goal.			
28.	4.2	TNC	Figure 4-1 Path A Path to Sustainability. Please elaborate on how this continued groundwater decline will affect the ability of adjacent GSP areas within the Subbasin to recover, and how potential unintended consequences within the McMullin Area and adjacent areas will be evaluated.	10/11/2019	Figure 4-1 is a representation of the basin-wide approach, MAGSA will continue to monitor effects of the basin plan.	10/31/2019
29.	4.2.3	TNC	Please include GDEs to MO's (see comments under Checklist Items 8-10) in this section and whether the measurable objectives and interim milestones will help	10/11/2019	Not applicable.	10/31/2019

			achieve the sustainability goal as it pertains to the environment.			
30.	4.5.3	TNC	Please include a discussion about GDEs and water quality and whether the measurable objectives and interim milestones will help achieve the sustainability goal as it pertains to the environment.	10/11/2019	Not applicable.	10/31/2019
31.	4.7	TNC	**1.**Please include ISWs (see comments under checklist items 16-20) in this section and whether the measurable objectives and interim milestones will help achieve the sustainability goal as it pertains to the environment. **2.** Set MO's and please include instream flow requirements in this section and whether the measurable objectives and interim milestones will help achieve the sustainability goal as it pertains to the environment.	10/11/2019	Not applicable.	10/31/2019
32.	4.2.2	TNC	Please include GDEs in this section and whether the measurable objectives and interim milestones will help achieve the sustainability goal as it pertains to the environment.	10/11/2019	Not applicable.	10/31/2019

33.	4.5.2	TNC	Please include a discussion about GDEs and water quality and whether the measurable objectives and interim milestones will help achieve the sustainability goal as it pertains to the environment.	10/11/2019	Not applicable.	10/31/2019
34.	4.7	TNC	**1.**Please include GDEs and ISWs in this section and whether the measurable objectives and interim milestones will help achieve the sustainability goal as it pertains to the environment.**2**. Please include instream flow and critical habitat requirements in this section and whether the measurable objectives and interim milestones will help achieve the sustainability goal as it pertains to the environment.	10/11/2019	Not applicable.	10/31/2019
35.	4.2.1	TNC	Please add “potential adverse impacts to GDEs” to the list of potential undesirable results presented in Section 4.	10/11/2019	Not applicable.	10/31/2019
36.	4.5	TNC	The section should be modified to state that overpumping and dewatering of aquitards has been identified as a potential source of elevated arsenic concentrations above	10/11/2019	Continuing to monitor for groundwater degradation as in the plan.	10/31/2019

			drinking water standards in San Joaquin Valley aquifers. In addition, any potential undesirable results from degradation of water quality that may impact GDEs and freshwater species in the area should be discussed in this section.			
37.	4.7	TNC	Even though the ISWs are not continuously Connected, they should be included in the Undesirable Results. The analysis for potential depletion of ISWs in Section 4.7 should include all beneficial users of surface water that could be affected by groundwater withdrawals, including environmental. The SJRRP identifies instream flow needs for salmon in Reach 2a which forms the northern border in the Plan area(http://www.restoresjr.net/about/overview-map/). Please include instream flow requirements and critical habitat designations in this section and whether the measurable objectives and interim milestones will help	10/11/2019	Not applicable.	10/31/2019

			achieve the sustainability goal as it pertains to the environment.			
38.	5.2	TNC	It is not clear exactly which aquifer is being monitored using the proposed system of 152 wells. To accurately characterize GDEs, please clarify how the unconfined aquifer will be monitored and how many wells will be used.	10/11/2019	Not applicable.	10/31/2019
39.	5.7	TNC	The identification and mapping of ISWs in Section 3.2.7 of the GSP was not adequate, data gaps must be recognized, and a monitoring plan put in place to reconcile these data gaps prior to dismissal of these sensitive habitats. Please reconcile these data gaps with specific recommendations (shallow monitoring wells, stream gauges, and nested/clustered wells) along surface water features to improve ISW mapping and inform an adequate analysis. **2.** Per the GSP Regulations (23 CCR §354.34 (a) and (b)), monitoring must address trends in groundwater and related surface conditions (emphasis added). To clarify if GDEs are present, consider	10/11/2019	Comment noted.	10/31/2019

			adding monitoring of potential GDEs at any locations where ISWs have been present regardless of their seasonal or discontinuous nature.			
40.	6.1	TNC	Please include environmental benefits and multiple benefits as criteria for assessing project priorities.	10/11/2019	Sentence added to reflect this comment.	10/31/2019
41.	6.2	TNC	**1**. Because maintenance or recovery of groundwater levels, or construction of recharge facilities, may have potential environmental benefits in many cases, it would be advantageous to demonstrate multiple benefits from a funding and prioritization perspective. **2.** For the projects already identified, please consider stating how ISWs and GDEs will benefit or be protected, or what other environmental benefits will accrue.**3.** If ISWs will not be adequately protected by those listed, please include and describe additional management actions and projects targeted for protecting ISWs.**4**. For	10/11/2019	Comment noted.	10/31/2019

			projects that construct recharge ponds, please consider identifying if there is habitat value incorporated into the design and how the recharge ponds will be managed to benefit environmental users.			
42.	6.3	TNC	Please consider modifying the Management Actions to include education and outreach for protection of GDEs and ISWs. Please update Section 6.3.1.2 (p. 6-97) to include GDEs and ISWs.	10/11/2019	Comment noted.	10/31/2019
43.	Executive Summary, 3.3.9	FID	There is error in MAGSA's calculation of sustainable yield; please revisit boundary flow amounts in equation.	10/16/19	Have removed MAGSA sustainable yield reference from executive summary.	10/31/2019
44.	Chapter 3	FID	There is error in MAGSA's calculation of annual overdraft deficit; please revisit boundary flow amounts in equation and further application of annual overdraft deficit to overall sustainability plan.	10/16/19	Overdraft deficit is taken from TM 4 agreed upon by the Kings Basin Coordination Committee.	10/31/2019
45.	Chapter 4	FID	Need to recalculate measurable objectives and minimum thresholds based on a revisitation of sustainable yield calculations.	10/16/19	MOs and MTs were developed consistent with basin-wide methodology.	10/31/2019
46.	Chapter 4	FID	MAGSA's GSP should include actions to	10/16/19	MAGSA has included management actions to	10/31/2019

			immediately mitigate the overdraft deficit starting in the year 2020.		address obligations as appropriate.	
47.		FID	MAGSA has a responsibility for collaboration with NKGSA. The GSP should include actions that assist NKGSA with their goals.	10/16/19	MAGSA plans to collaborate with FID to develop solutions that support the goals of both agencies.	10/31/2019
48.		FID	MAGSA does not have rights to waters which cross the boundary between FID and MAGSA as a byproduct of pumping operations in MAGSA.	10/16/19	Comment noted.	10/31/2019
49.	3.3.3, 3.4.4	FID	There is error in MAGSA's calculations of Kings River excess floodwater and planned usage of said water.	10/16/19	Floodwater availability will continue to be evaluated as conditions develop in the region.	10/31/2019
50.	6.2	FID	MAGSA's planned project collaborations with FID and NKGSA are overly assumptive.	10/16/19	MAGSA looks forward to working with FID to develop collaborative solutions.	10/31/2019
51.	Executive Summary, 3.3.9	NKGSA	There is error in MAGSA's calculation of sustainable yield; please revisit boundary flow amounts in equation.	10/16/19	Refer to response for item 43.	10/31/2019
52.	Chapter 3	NKGSA	There is error in MAGSA's calculation of annual overdraft deficit; please revisit boundary flow amounts in equation and further application of annual overdraft deficit to overall sustainability plan.	10/16/19	Refer to response for item 44.	10/31/2019

53.	Chapter 4	NKGSA	Need to recalculate measurable objectives and minimum thresholds based on a revisitation of sustainable yield calculations.	10/16/19	Refer to response for item 45.	10/31/2019
54.	Chapter 4	NKGSA	MAGSA's GSP should include actions to immediately mitigate the overdraft deficit starting in the year 2020.	10/16/19	Refer to response for item 46.	10/31/2019
55.		NKGSA	MAGSA has a responsibility for collaboration with NKGSA; the GSP should include actions that assist NKGSA with their goals.	10/16/19	MAGSA plans to collaborate with NKGSA to develop solutions that support the goals of both agencies.	10/31/2019
56.		NKGSA	MAGSA does not have rights to waters which cross the boundary between FID and MAGSA as a byproduct of pumping operations in MAGSA.	10/16/19	Comment noted.	10/31/2019
57.	3.3.3, 3.4.4	NKGSA	There is error in MAGSA's calculations of Kings River excess floodwater and planned usage of said water	10/16/19	Refer to response for item 49.	10/31/2019
58.	6.2	NKGSA	MAGSA's planned project collaborations with FID and NKGSA are overly assumptive.	10/16/19	MAGSA looks forward to working with FID to develop collaborative solutions.	10/31/2019
59.	ES-5	KRWA	Clarify in the GSP that MAGSA itself is outside the KRWA service area and does not directly receive water.	10/16/19	Altered language to reflect comment.	10/31/2019
60.	ES-6	KRWA	Diversions of Kings River to Terranova Ranch should be	10/16/19	Altered language to reflect comment.	10/31/2019

			labeled as potential diversions as they do not directly match KRWA records & and floodwater agreements are temporary and made available only when in excess of KRWA diversions.			
61.	2.2.12	KRWA	The GSP overestimates the amount of available Kings River floodwater; historical average amount of floodwater will no longer be available due to development of new projects in Kings and Tulare Lake subbasins.	10/16/19	Altered language to reflect comment.	10/31/2019
62.	3.4.5	KRWA	Care should be exercised in planning to use Kings River floodwater as a long-term water source.	10/16/19	Comment noted.	10/31/2019

Appendix 3 A
Kings Subbasin GSA Coordination Efforts Technical Memoranda 1-6

Technical Memorandum 1
Base of the Unconfined Aquifer

The six Groundwater Sustainability Agencies (GSAs) in the Kings Groundwater Sub-basin (Kings Basin) are in the process of developing data and analyses to evaluate historical changes in groundwater storage. The attached memorandum from Kenneth D. Schmidt and Associates (KDSA) provides a description of the base of the unconfined aquifer within the Kings Sub-basin and describes the extent of the existing significant clay layers within the Sub-basin.

KDSA Est. 1972
EST. 1968 PROVOST& PRITCHARD CONSULTING GROUP An Employee Owned Company

TECHNICAL MEMORENDUM ON DETERMINATION OF BASE OF UNCONFINED GROUNDWATER IN THE KINGS SUB-BASIN

INTRODUCTION

In order to estimate changes in groundwater in storage, it is important to distinguish between shallow unconfined conditions and deeper confined conditions. For unconfined aquifers, water-level changes can be multiplied by specific yields to estimate the changes in groundwater storage. Storage changes in confined aquifers are usually insignificant, as they stay full of water, despite water-level declines, as long as the water level stays above the top of the aquifer. Another purpose of separating the shallow unconfined and deep confined groundwater is for groundwater flow determinations. In general, the direction of groundwater flow may not be the same for the shallow and deep groundwater at specific locations. This is particularly true near the southwest edge of the Kings Basin. Thus water-level slopes and transmissivities need to be known for both the unconfined and confined groundwater, in order to estimate groundwater flows.

HISTORICAL CONTEXT

As of the 1950's and 1960's, when many of the earlier U.S. Geological Survey groundwater reports were done for the westside

of Fresno County and for the Fresno and Hanford Visalia areas, the concept was that there were two aquifers beneath the westerly areas, where the Corcoran Clay was present. Groundwater above this clay was generally considered to be unconfined, whereas the underlying groundwater was considered to be confined. In contrast, one unconfined aquifer was assumed at that time for the eastside lands, east of the Corcoran Clay. As of the mid-1960's, there were few deep water wells that had been drilled in the east part of the Fresno and Hanford-Visalia areas. The cable-tool method was widely used in this area through the mid-1960's. Most water wells were no deeper than about 300 to 400 feet, and electric logs were not available, as they could not be run in cased wells. Many of the eastside water supply wells prior to the mid-1960's tapped the upper coarse-grained deposits, termed the "Quaternary older alluvium" by the U.S. Geological Survey. For the most part, this groundwater was unconfined, and information on the deeper deposits was lacking in many areas along the eastside.

With the advent of reverse rotary drilled wells in the mid-1960's, deeper wells were drilled and eventually many electric logs became available. Along with geologic logs for many City and school wells drilled after the late 1970's, a much better understanding of the deposits below a depth of 300 to 400 feet

was obtained along the eastside. These Tertiary-Quaternary continental deposits are generally much finer grained than the overlying deposits, and clay layers are often present. After the 1960's, test holes and wells were commonly drilled to depths ranging from about 700 to 900 feet, or deeper. While no laterally continuous single confining bed like the Corcoran Clay (a geological marker bed) was indicated, a number of important, less continuous, local confining beds were identified.

In the Fresno urban area alone, there are more than 150 sites where nested monitor wells were installed during the past several decades. Electric logs and geologic logs are available, as well as water levels and groundwater quality for the shallow (about 200 feet deep), intermediate (about 400 feet deep), and deep (about 700 feet deep) groundwater. Major confining beds were identified. These were normally below 200 feet in depth and above 400 feet in depth. Monitoring of these wells allowed water-level differences and vertical hydraulic gradients to be determined. Differences in groundwater quality are consistent with the separation of shallow (above the confining bed) and deep (below the confining bed) groundwater. Information on vertical differences in water levels and groundwater quality, and the depths of confining beds has also been developed at hundreds of sites for wells in other cities, small water systems,

schools, and industries in the Kings Sub-Basin. These were obtained from test well and pilot hole programs associated with the development of new water supply wells. Subsurface geologic cross sections showing the deeper subsurface geologic conditions have been prepared in many parts of the Kings Sub-Basin. Together, these sources of information provide a good indication of the base of the unconfined groundwater in most of the Kings Sub-Basin east of the Corcoran Clay.

ENHANCED CONCEPT OF AQUIFER CONFINEMENT

The enhanced concept of aquifer confinement in the San Joaquin Valley is that the shallow groundwater throughout most of the valley is unconfined. In contrast, groundwater at depth in most of the valley is confined in most of the valley. Generally, confining beds east of the Corcoran Clay in the Kings Sub-Basin are below a depth of several hundred feet, and appear to often be near the base of the Quaternary older alluvium or in the upper part of the underlying continental deposits. As one drills deeper into the underlying continental deposits, local clay layers are more common than in the overlying deposits, and even though they are not continuous over distances of tens or hundreds of miles, like the Corcoran Clay, they are important locally. Some of these localized clays are much thicker than

the Corcoran Clay, and they tend to be found at specific depths in specific parts of the sub-basin.

As part of the City of Fresno Nitrate Study in 2006, KDSA defined confining beds at an average depth of about 250 feet in south and southeast Fresno. In general, high nitrate and DBCP concentrations were found in groundwater above the beds in those areas, whereas concentrations were much lower in the groundwater below these beds. Throughout much of the Kings Sub-Basin, unconfined groundwater beneath irrigated areas has usually been affected by irrigation practices. Based on its chemical composition and some age dating, this groundwater is generally indicated to be younger than about 70 years old. This groundwater has higher concentrations of total dissolved solids (TDS) and nitrate than does the underlying deeper groundwater. In much of the Kings Sub-Basin, groundwater beneath the confining beds is indicated to either not have been affected by irrigation practices, or to have been minimally affected by such practices.

Vertical hydraulic gradients are determined by dividing the difference in water levels (above and below the confining bed(s)) by the thickness of the confining bed(s). Vertical hydraulic gradients have been determined at many sites, and commonly range from about 10 to 20 feet per 100 feet, much greater than for lateral hydraulic gradients (commonly about 5 to 10 feet per mile).

UNCONFINED GROUNDWATER IN THE KINGS SUB-BASIN

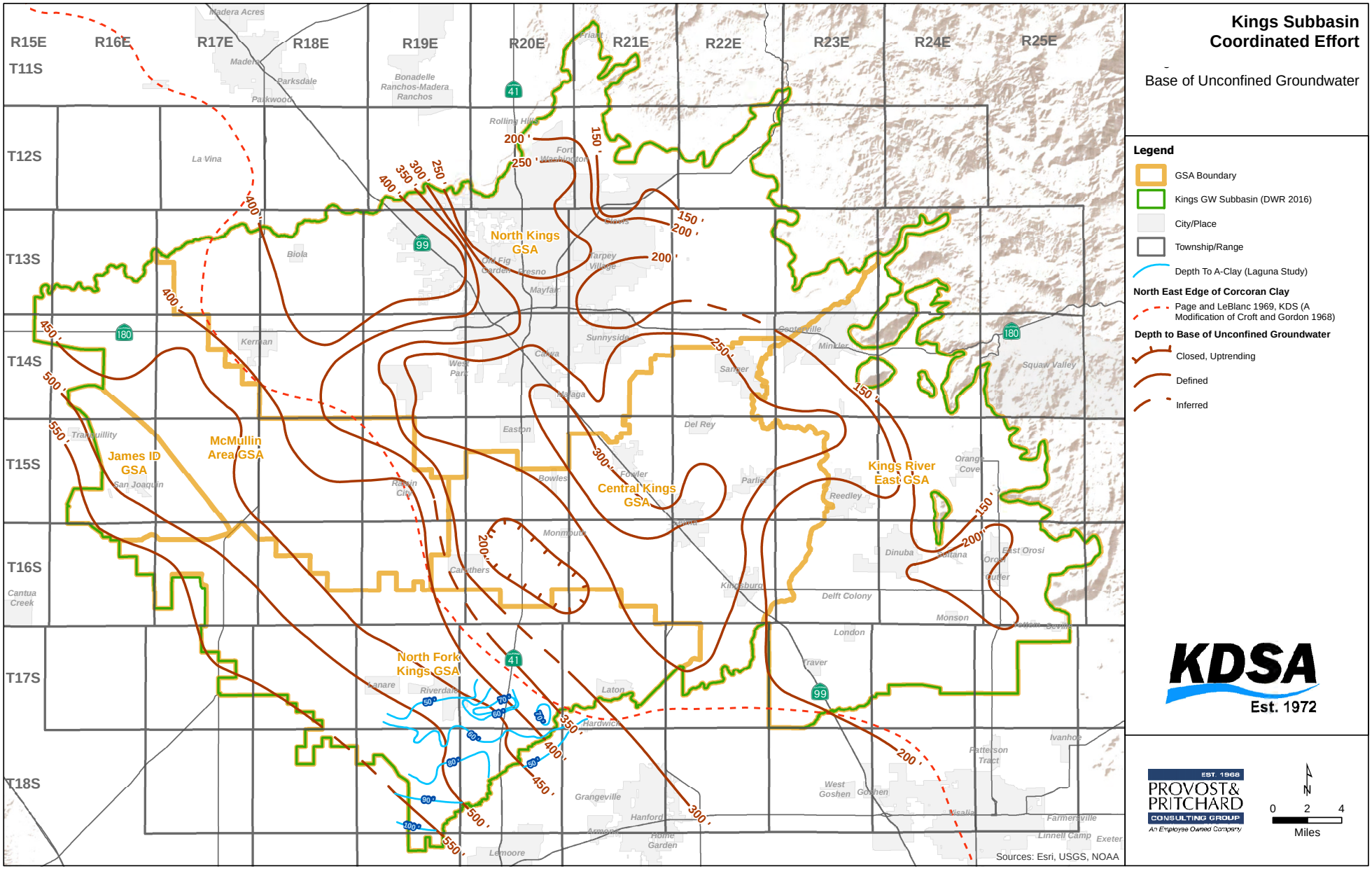
Figure 1 shows contours of depth to the base of the unconfined groundwater in most of the Kings Sub-Basin. The extent of the Corcoran Clay is shown on this figure. To the southwest, where the Corcoran Clay is present, the base of the unconfined groundwater is considered to be the top of this clay. The depth to the top of this clay was determined by reviewing a number of subsurface geologic cross sections, where the clay was identified, and several maps where the top of the Corcoran Clay was contoured. This information was supplemented by evaluating electric logs, where the clay was clearly identifiable. The depth to the top of the Corcoran Clay ranges from about 200 feet deep south of Traver to more than 550 feet to the southwest, near the southwest boundary of the Kings Sub-Basin.

The base of the unconfined groundwater generally becomes shallower to the northeast, and in some places it is less than 150 feet deep. In some parts of the sub-basin, such as in the Orange Cove I.D., no confined groundwater is indicated to be present. This is supported by the vertical distribution of nitrate, which doesn't indicate any influence of a confining bed. In the Fresno urban area, the base of the unconfined aquifer deepens rather quickly to the southwest, from less than 250 feet

to more than 400 feet. Between most of the area between northwest Fresno and Kerman, the base of the unconfined groundwater is more than 400 feet deep. This area includes the locations of the Fresno Irrigation District water banking projects. In contrast, the base of the unconfined groundwater is less than 200 feet deep in the area east of the Fresno Air Terminal, in an interfan area, where fine-grained deposits are predominant.

CALCULATING STORAGE CHANGES

Once the base of the unconfined groundwater has been established, then water-level measurements are selected for wells that only tap these deposits (not deeper ones). Also, specific yield estimates are made only for the unconfined groundwater (between the water level and the base of the unconfined groundwater). Storage changes for the groundwater are then calculated by multiplying the change in water levels during a base period by the specific yields.



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Technical Memorandum 2
Specific Yield Values

The six Groundwater Sustainability Agencies (GSAs) in the Kings Groundwater Sub-basin (Kings Basin) are in the process of developing data and analyses to evaluate historical changes in groundwater storage. This memorandum provides a recommendation of the specific yield values to be used for each portion of the Kings basin for the groundwater storage calculation, and documents the research and reasoning for the recommendation. The recommendations are based on published sources and additional analysis by Kenneth D. Schmidt and Associates (KDSA).

Background

Specific yield is defined as the ratio of the volume of water a rock or soil will yield by gravity drainage to the volume of rock or soil (Meinzer, 1932). Specific yield data derived from subsurface material textures are generally considered to be the most accurate values that can be obtained. To calculate storage change, specific yield for unconfined groundwater is multiplied by the change in groundwater level for an area. For instance, if over a 1,000 acre area there is a 10-foot per year decline in the groundwater level, and an estimated specific yield of 8%, then the volume of overdraft would be equivalent to 1,000 acres x 10 feet x 8% = 800 acre-feet per year. The Sustainable Groundwater Management Act (SGMA) requires, among other things, annual reporting of change in storage per GSA.

Historically, the Fresno Irrigation District (FID) has used specific yield values from U.S. Geological Survey Water Supply Paper 1469 (Davis et al., 1959), referred to herein as USGS 1469 to calculate changes in groundwater storage. The main emphasis of this evaluation focused on comparing specific yields from other published sources to USGS 1469 specific yields and to research additional sources of data in areas not covered by USGS 1469.

The six GSAs desire to use specific yield information from published sources where possible.

Storage change estimations will be limited to the unconfined aquifer which is described in Technical Memorandum 1 (TM 1).

Survey of Published Sources of Specific Yield

Table 1, below, is a list of published sources of specific yield information used in this evaluation, and a general description of what areas and depths these sources cover in the Kings Basin. **Attachment 1** is a Specific Yield Data Sources Coverage map showing the area covered by each source in **Table 1**.

Table 1 - Summary of Specific Yield Data Sources and General Coverage

Publication Information	Title	Data Coverage*	Depth of Coverage
USGS WSP 1469, (Davis and others,1959)	Ground-Water Conditions and Storage Capacity in	San Joaquin Valley, except Fresno Slough Area and locations against the foothills	10-50 feet 50-100 feet 100-200 feet

	the San Joaquin Valley, California		
Page and Leblanc, 1969	Geology, Hydrology, and Water Quality in the Fresno Area, California	San Joaquin Valley, except portions of Fresno Slough Area and locations against the foothills	O - 300 feet
USGS PP 1401-D, (Williamson, Prudic and Swain, 1989)	Ground-Water Flow in the Central Valley, California	San Joaquin Valley, except locations against the foothills	Variable from 150 feet near the foothills to greater than 600 feet to the west
Kings River Conservation District, 1992	Alta Irrigation District, Groundwater Study	Alta Irrigation District and portions of Orange Cove Irrigation District	Unknown
USBR, 1947	Geologic Study of the Orange Cove Irrigation District	Orange Cove Irrigation District	20 to 234 feet
* See **Attachment 1**			

USGS WSP 1469

In USGS Water-Supply Paper (WSP) 1469 specific yield was estimated down to depths of 200 feet for most of the valley floor. The general method employed by USGS 1469 was to group the 300 drillers' terms commonly used to describe alluvial subsurface materials into five principal classes. These groupings were then assigned specific yield values that ranged from 25 percent for Group G – gravels, sand and gravel and similar materials down to a low of 3 percent for Group C materials - clay and related material. The data for the total footage for each Group of material were summarized for a given well and an average specific yield calculated for the depth intervals of 10 to 50 feet, 50 to 100 feet, and 100 to 200 feet by Township and Range. The Township and Range grid was modified by groundwater storage units so that the data more accurately represented the varying geologic conditions in the valley. Therefore, a given Township and Range may have two or more specific yield values, depending on how many different geologic units (which in USGS 1469 are referred to as storage units) are intersected by the overlying Township and Range. The authors recognized that in 1959 water levels in certain parts of the valley already exceeded depths of 200 feet, but the methodology they used could readily be made to determine specific yield in strata deeper than 200 feet. USGS 1469 data covers most of the Kings Basin, except in some areas near the foothills, and areas of lake beds deposits and overflows lands (the area termed the Fresno Slough Area in the Kings Basin). The extent of the Kings Basin covered by USGS 1469 is shown in **Attachment 1**.

Page and Leblanc (1969)

Page and Leblanc (1969) working for the USGS derived specific yield estimates based on geologic facies. Facies is a geologic term that means the appearance and characteristics of a sedimentary deposit that is used to distinguish a subsurface material from contiguous subsurface materials. The facies data are based on descriptions of alluvial texture. Six facies categories were defined from Facies A with an estimated specific yield of 5.3 percent to Facies F with an estimated specific yield of 18.7 percent. These data were plotted on a map and an average specific yield was generated by Township and Range based on the relative percentage of each facies. The data were compared to USGS 1469, and in general are within 2 to 3 percent, which is considered good agreement. There is a general trend between the two data

sets where in the northeast portion of the basin, the Page and Leblanc (1969) estimated specific yields tend to be slightly higher than those in USGS 1469, and in the western portion of the basin the Page and Leblanc (1969) estimated specific yields tend to be slightly lower.

USGS PP 1401-D

USGS Professional Paper (PP)1401-D, was one of the original groundwater modeling efforts by the USGS in the Central Valley. Specific yield was estimated using methods and groupings of deposits by descriptions into five categories with similar properties as described in USGS 1469. The authors indicated that more than 7,400 driller's logs in the San Joaquin Valley were coded for analysis. Specific yield was assigned to subsurface materials according to a model grid oriented northwest along the axis of the valley. This report did not report specific yield by depth range but rather for the entire saturated thickness of the aquifer. Specific yield data from this report appears to be reasonable along the east side of the Kings Basin near the foothills where bedrock is shallow, and in most of North Fork GSA area. These data are not reasonable in areas where wells are much deeper than the upper confined groundwater.

KRCD 1992

The Kings River Conservation District (KRCD) prepared a groundwater study for the Alta Irrigation District (KRCD 1992). This study addressed a list of objectives through a District-wide water balance and groundwater/surface water model. As part of model development, KRCD used unpublished data from the California Department of Water Resources (DWR) that we could not verify. The KRCD report indicates that the DWR data was developed for each quarter-Township and Range from well drillers logs. This data was mapped as specific yield contours, and, to compare these data to USGS 1469, the average specific yield was used between two specific yield contours. For example, the area between the 11 percent and 12 percent specific yield contours would be 11.5 percent. The KRCD specific yields were averaged by Township and Range and compared to USGS 1469 specific yield data. The two sets of data matched within 2 or 3 percent where they overlap except for two small areas on the north part of the KRCD study area where the differences were 4.3 and 3.5 percent. A limitation of this information is that the depths of deposits corresponding to specific yield was not provided.

USBR 1947

The U.S. Bureau Reclamation prepared a Geologic Study and a Water Supply Study both for the Orange Cove Irrigation District (OCID) in 1947 (USBR 1947a & USBR 1947b). They divided the OCID into seven investigational subareas and estimated specific yield for each sub area. Specific yield values for standard textural descriptions were based on previous work done in the Mokelumne area (115 miles northwest of OCID) and from twenty percolation tests in OCID. These values were used along with the stratigraphy in 52 local well logs, and 115 large diameter auger holes drilled along the Friant Kern Canal, to estimate local specific yield. Specific yields ranged from a low of 6.5 percent to 8.3 percent. In most areas where USBR 1947 and USGS 1469 overlap, specific yields from both sources are within less than one percent. The maximum difference in specific yields between the studies is 2.1 percent in the south part of the investigational area. For those areas outside of USGS 1469 coverage, mainly near the foothills, the specific yields from USBR 1947 was used.

USDA Technical Bulletin 1604

USDA Technical Bulletin 1604 provides estimates of specific yield in the Fresno-Clovis northeast area at depths from 0 to 20 feet, 0 to 50 feet, 50 to 100 and 100 to 150 feet. This

report develops estimated specific yield from soil texture as described on well drillers logs and in similar groupings as USGS 1469. However, for this study the descriptive terms were regrouped into four categories that reflected the reduced number of descriptive terms on the area's well logs. This report and analysis was done to aid in recharge investigations and is a resource for that purpose, but does not provide detailed specific yield coverage in some areas, and to the depths desired. The intent of this publication was to help focus future recharge studies, so areas where specific yield is higher are clearly delineated. However, there are significant portions of the USDA study area where specific yield data is sporadic or not estimated, and thus is not readily comparable to the more extensive data from the other sources.

McMullin Area Evaluation

KDSA prepared a memorandum documenting their estimates of specific yield in the McMullin Area GSA, James ID GSA and the northwestern most portion of North Fork Kings GSA area (**Attachment 3**). Additional evaluation was needed in this area where USGS PP 1401-D specific yields were estimated over the entire saturated thickness of the aquifer, i.e., down to depths of several thousand feet or more. As noted by Page and Leblanc (1969) the deeper Continental Deposits of Tertiary and Quaternary are finer grained than the overlying deposits of Quaternary age. These deep, finer deposits have lower specific yield and therefore the overall specific yield based on the entire saturated thickness of the aquifer are lower than specific yields in the unconfined aquifer above the Corcoran Clay. As previously noted the change in groundwater storage is based on water level changes in the unconfined aquifer, and in this area the base of the unconfined aquifer is the top of the Corcoran Clay. The KDSA analysis was based on electric logs, geologic logs and DWR Well Completion Reports with good descriptions of texture. The data were used to develop several subsurface geologic cross sections in the area. On the subsurface cross sections, three types of deposits; sand or coarser materials, clay or silt, and intermediate type materials such as sandy clay were shown. These deposit types were assigned specific yield values of 20 percent, 3 percent, and 8 percent, respectively. Specific yield was estimated from the Spring 2005 water table to the top of the Corcoran Clay. Based on this evaluation, average specific yields in the area above the Corcoran Clay range from 10 percent southwest of the City of San Joaquin to 15 percent south of the City of San Joaquin near McMullin Grade and the Fresno Slough (**Attachment 2**). Proposed specific yields for deposits above the Corcoran Clay in this area based on the KDSA evaluation are shown on **Attachment 2**.

Friant Area Evaluation

The northernmost portion of the North Kings GSA is not covered by any of the referenced specific yield data sources. Previous work by KDSA in 2012 (described in **Attachment 11**) included development of a subsurface geologic which extends from near Friant to south of Little Dry Creek. Specific yield was estimated for three segments along the subsurface cross section as follows; from near Friant to the southern part of Beck Ranch, south end of Beck Ranch to north end of Ball Ranch, and from Ball Ranch to near Little Dry Creek. Specific yield was estimated to be 25 percent, 20 percent and 14 percent, respectively, for a proposed average of 20 percent for this portion of the North Kings GSA (**Attachment 10**).

Depth to Water and Specific Yield

For the overall Kings Basin, USGS 1469 appears to have the best data for the area covered in the publication. As mentioned above, USGS 1469 provides specific yield estimates in the depth range from 10-50 feet, 50 to 100 feet and 100-200 feet, and therefore does not apply in areas

where depth to water is greater than 200 feet. In the areas covered by USGS 1469 and water levels shallower than 200 feet, the depth to water will be used to determine which depth interval specific yield is appropriate to use for calculating storage change, if the water levels are shallower than the base of the unconfined aquifer. For example, if an average depth to water of 185 feet is obtained for a Township and Range, then the depth interval specific yield used would be 100 to 200 feet from USGS 1469. However, recent depth to water maps indicate that in some areas, the depth to water has already exceeded 200 feet. In those areas, providing there is coverage by USGS 1969, the average specific yield from that study would be used for depths to water between 200 and 300 feet. The subsurface geologic cross section derived specific yield is proposed to be used in the west part of the Kings Basin where the base of the unconfined groundwater is deeper.

Kings Basin – Eastside Specific Yield Coverage

The three main sources consulted for this study, USGS 1469, USGS 1969, and USGS 1401-D all have gaps in coverage on the valley floor near the foothills on the east side of the Kings Basin. A few gaps are covered by the USGS PP 1401-D model grid which indicate that specific yield in those areas is about 6 to 7 percent for most of the area, which is in the interfan area, and is likely about 20 percent along the San Joaquin River below Friant, based on subsurface geologic cross sections available in this area. Because of the shallow depth to bedrock, USGS PP 1401-D can be used along the east edge of the area. In those areas not covered by one of the USGS studies, use of KRCD 1992 or USBR 1947 is appropriate where information from these reports is available. However, this still leaves gaps in coverage against the foothills, and, as the sources indicate that specific yield is lower in these areas, it is proposed that a specific yield of 6 percent is used along the foothills in interfan areas lacking data coverage. A specific yield of 6 percent, except near Friant, appears reasonable and agrees well with adjacent USGS 1401-D model grid cells, USGS 1969 and USGS 1469 estimates of specific yield. In addition, these areas are relatively small and probably have few wells, so the impact to storage change estimates will likely be minimal.

Conclusions

The following is a list of specific yield data prioritized by publication source:

1. USGS 1469 – use in areas covered by that study
2. Page and Leblanc (1969) – use in areas lacking USGS 1469 coverage and for areas where base of unconfined water is between 200 and 300 feet where covered by this study.
3. Use subsurface geologic cross sections evaluation in west part of area, near Friant, and in parts Fresno urban area.
4. USGS 1401-D – use in North Fork Kings GSA Area where base of unconfined aquifer is greater than 300 feet, and along foothills in areas not covered by other studies or additional evaluation.
5. In areas along the foothills in interfan areas lacking specific yield coverage, use a specific yield of 6 percent.
6. Use only values below the water level, i.e., only for saturated strata.

Attachment 4 shows the recommended sources of specific yield data for all areas in the Kings Basin. **Attachment 5 to 10** are maps of each GSA showing the recommended specific yields for use in calculating storage change.

Attachments

1 – Kings Basin, Specific Yield Data Sources Coverage
2 – McMullin GSA Area of Evaluation, Location of Subsurface Geologic Cross Sections and Specific Yield Values
3 – KDSA, Memorandum on Specific Yield Estimates from Subsurface Geologic Cross Sections, June 19, 2017
4 – Kings Basin, Recommended Sources of Specific Yield
5 – Central Kings GSA, Data Sources and Recommended Specific Yield
6 – James ID GSA, Data Sources and Recommended Specific Yield
7 – Kings River east GSA, Data Sources and Recommended Specific Yield
8 – McMullin Area GSA, Data Sources and Recommended Specific Yield
9 – North Fork Kings GSA, Data Sources and Recommended Specific Yield
10 – North Kings GSA, Data Sources and Recommended Specific Yield
11 – KDSA, Memorandum on Friant area Specific Yield Estimates

References

Cehrs, D., Soenke, S., and Bianchi, W.C., (1980), *A Geologic Approach to Artificial Recharge Site Selection in the Fresno-Clovis Area, California*, U.S. Department of Agriculture, Technical Bulletin 1604

Davis, G.H., Green, J.H., Olmstead, F.H., and Brown, D.W., (1959), *Ground-Water Conditions and Storage Capacity in the San Joaquin Valley, California*, U.S. Geological Survey Water-Supply Paper 1469. Prepared in cooperation with the California Department of Water Resources.

Meinzer, O.E., (1932), *Outline of Methods for Estimating Ground-water Supplies*, U.S. Geological Survey Water Supply Paper 638-C

Page, R.W., and Leblanc, R.A., (1969). *Geology, Hydrology and Water Quality in the Fresno Area, California*, U.S. Geological Survey, Water Resources Division, Open File Report. Prepared in cooperation with the California Department of Water Resources

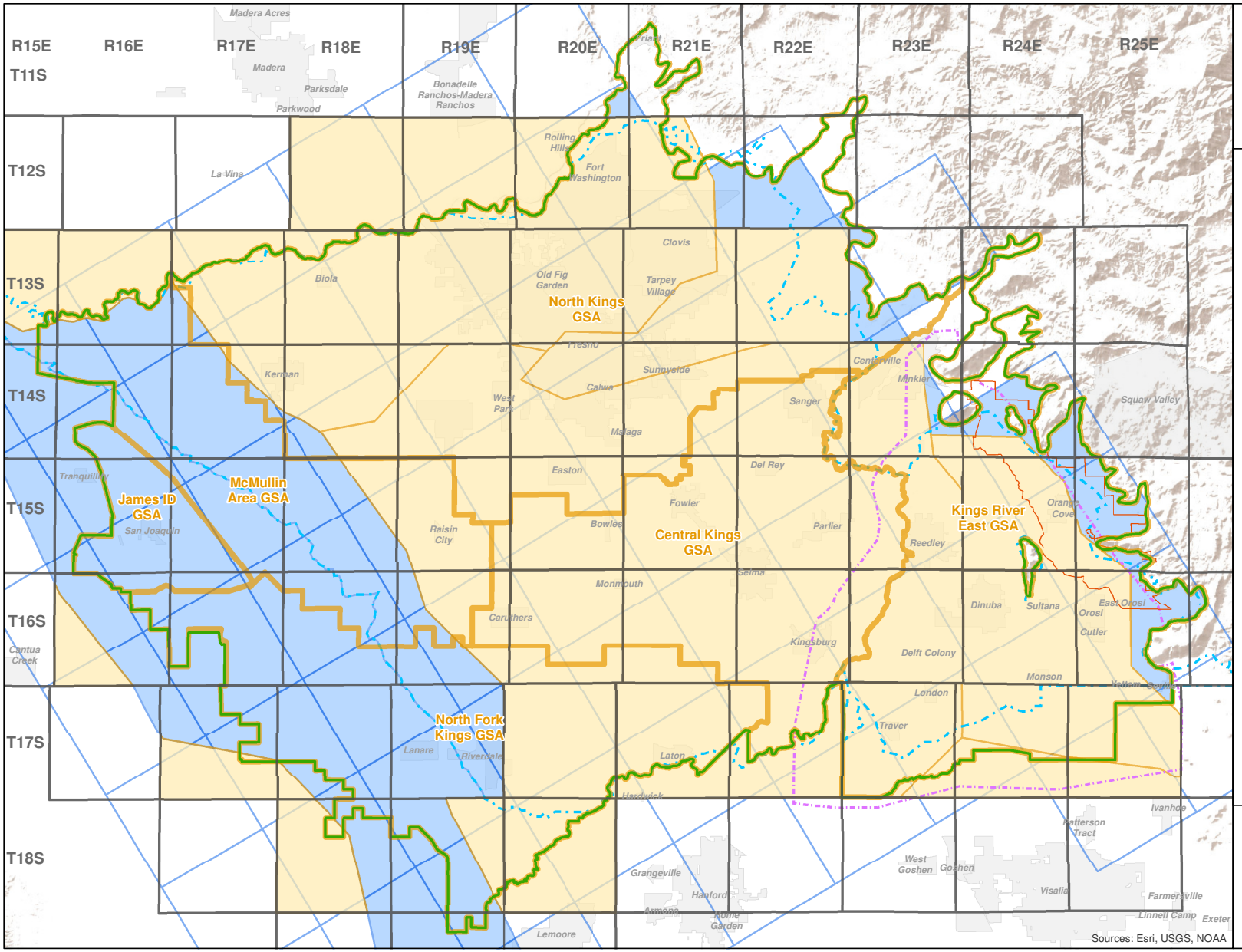
U.S. Bureau of Reclamation, Tulare Basin District (1947a), *Geologic Study of the Orange Cove Irrigation District*.

U.S. Bureau of Reclamation, Tulare Basin District (1947b), *Water Supply Study, Orange Cove Irrigation District.*

Williamson, A.K., Prudic, D.E., and Swain, L.A., (1989). *Ground-Water Flow in the Central Valley, California, Regional Aquifer System Analysis-Central Valley, California*, U.S. Geological Survey Professional Paper 1401-D.

Attachments 1

Kings Basin, Specific Yield Data Sources Coverage



Kings Subbasin Coordinated Effort

Specific Yield Data Sources Coverage

ATTACHMENT 1

Legend

- GSA Boundary
- Kings GW Subbasin (DWR 2016)
- City/Place
- Township/Range

Coverage By Report

- USGS PP 1401-D (1989)
- USGS PP 1401-D (1989, Overlapping Other Studies or Outside of Kings Subbasin)
- USGS WSP 1469 (1959)
- Page and LeBlanc 1969 (1969, Facies Extent)
- Alta ID GW Study (KRCD 1992)
- Orange Cove ID GW Study (USBR 1947)

KDSA Est. 1972

EST. 1963 PROVOST & PRITCHARD CONSULTING GROUP An Employee Owned Company

N

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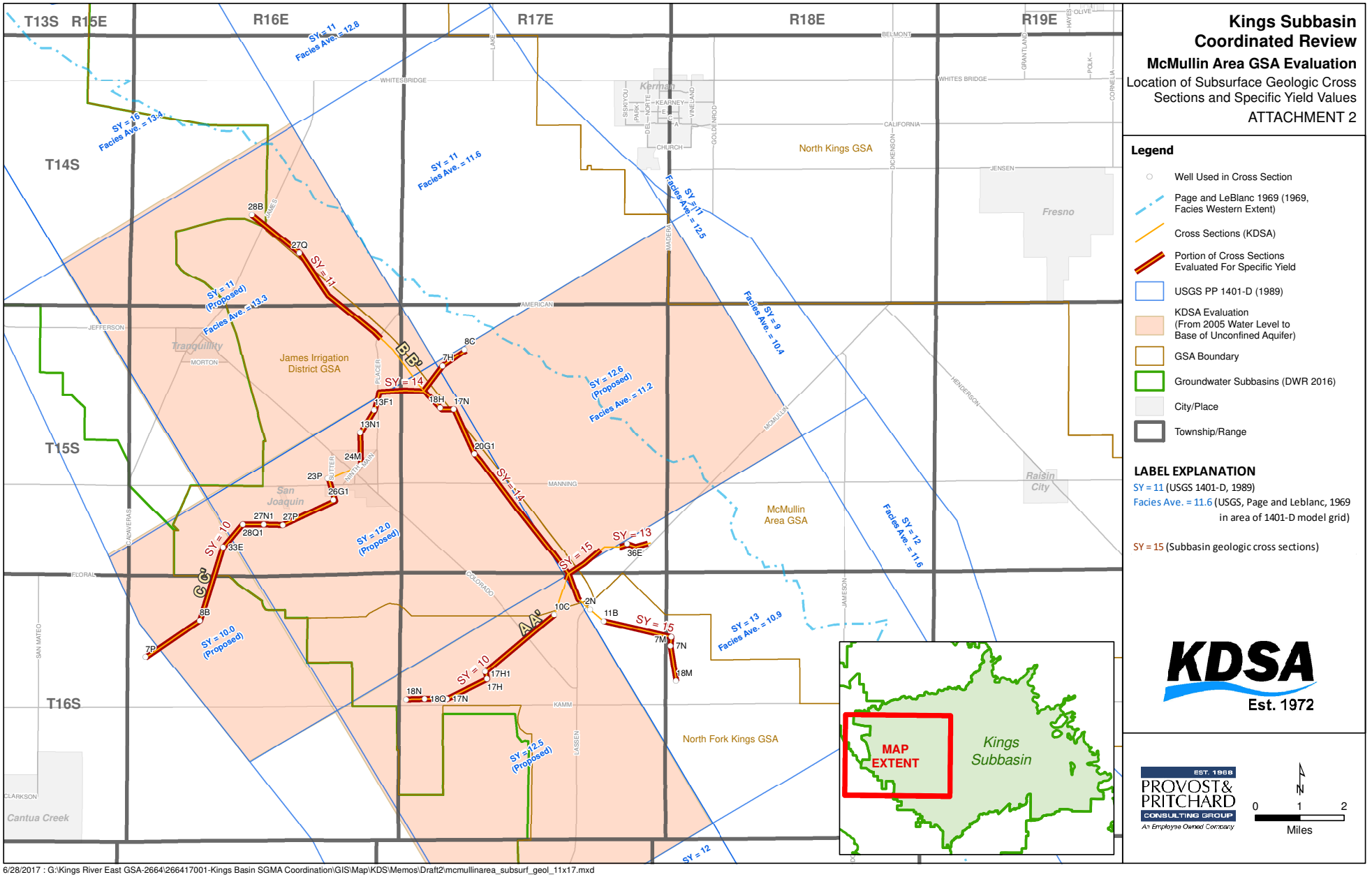
Attachments 2

McMullin GSA Area of Evaluation,
Location of Subsurface Geologic Cross Sections and Specific Yield Values



Kings Subbasin Coordinated Review

McMullin Area GSA Evaluation

Location of Subsurface Geologic Cross Sections and Specific Yield Values

ATTACHMENT 2

Legend

- Well Used in Cross Section
- Page and LeBlanc 1969 (1969, Facies Western Extent)
- Cross Sections (KDSA)
- Portion of Cross Sections Evaluated For Specific Yield
- USGS PP 1401-D (1989)
- KDSA Evaluation (From 2005 Water Level to Base of Unconfined Aquifer)
- GSA Boundary
- Groundwater Subbasins (DWR 2016)
- City/Place
- Township/Range

LABEL EXPLANATION

SY = 11 (USGS 1401-D, 1989)

Facies Ave. = 11.6 (USGS, Page and Leblanc, 1969 in area of 1401-D model grid)

SY = 15 (Subbasin geologic cross sections)

KDSA Est. 1972

PROVOST & PRITCHARD CONSULTING GROUP EST. 1988 An Employee Owned Company

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Attachments 3

KDSA, Memorandum on Specific Yield Estimates from Subsurface Geologic Cross Sections, June 19, 2017

MEMO

To: Ron Samuelian, Provost & Pritchard
From: Ken Schmidt
Topic: Specific Yield Estimates from Subsurface Geologic Cross Sections
Date: June 19, 2017

As part of an evaluation for the James Irrigation District (JID), KDSA developed four subsurface geologic cross sections that extend through the District and its associated well fields (Figure 1). The westerly parts of these cross sections are located where the base of the unconfined aquifer is relatively deep, beyond the depths of where specific yields have been estimated in U.S. Geological Survey reports. These cross sections show three types of deposits: 1) sand or coarser material, 2) clay or silt, and 3) intermediate type materials, such as sandy clay. Specific yield values were assigned to these three types as follows: 20 percent, 3 percent, and 8 percent, respectively. The cross sections also show static water levels for the upper aquifer as of Spring 2005. The specific yield estimates were made to cover deposits between the water level and the top of the Corcoran Clay

Cross Section A-A′ extends along McMullin Grade to the southwest, to the west edge of the Kings Sub-Basin. The part of this section that was evaluated extended from the southwest edge of the section (Well T16S/R16E-18N) to the northeast to James I.D. Well D-34, located near McMullin Grade and Huntsman Avenue. Eleven wells with the best logs were evaluated. For the westernmost segment, the calculated specific yields for five wells ranged from 7 to 11 percent and averaged 10 percent. The 1401-D specific yield values in the nearest T&R were 8 and 15 percent, or an average of 11.5 percent. For the next segment to the northeast, extending from C-76 at the Fresno Slough to D-32 (three wells), the specific yields ranged from 13 to 17 percent and averaged 15 percent. The closest 1401-D T&R values were 15 percent and 16 percent. For the northeasternmost segment, extending from Well D-35 to D-34, the specific yields ranged for 12 to 13 percent and averaged 13 percent. The closest 1401-D T&R value was 13 percent. Overall, specific yields derived from Cross Section A-A′ are in good agreement with the 1401-D estimates.

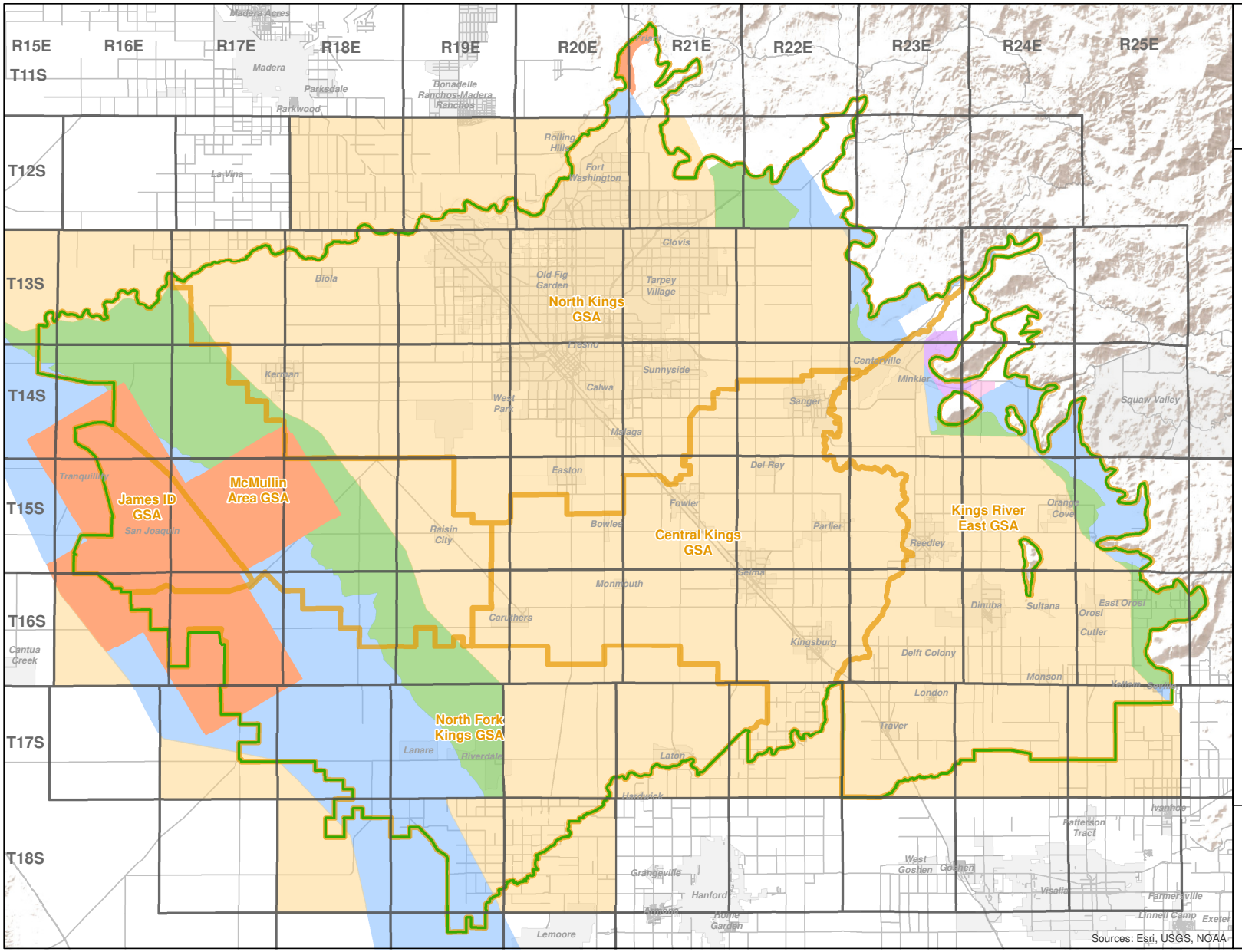
Cross Section B-B′ extends along the Fresno Slough. Fifteen wells with good logs were selected for evaluation. The northwestmost segment evaluated comprised five wells (28B to C-65). Specific yields ranged from 9 to 15 percent and averaged 11 percent. The closest 1401-D T&R values ranged from 10 to 11 percent. The next segment evaluated along the cross section extended from D-59 to D-30 (seven wells). Specific yields ranged from 12 to 17 percent and averaged 14 percent. The closest 1401-D T&R values ranged from 9 to 10 percent, and are considered too low for the area. The last part of the segment included three wells (11B to 18M). Specific yields ranged from 12 to 20 percent and averaged 15 percent. The closest 1401-D T&R values were 13 and 15 percent, in good agreement. Overall, specific yields along Cross Section B-B′ were in good agreement with the 1401-D values, except in T15S/R17E, where the 1401-D value appears to be too low.

Cross Section C-C′ extends from the west edge of the Kings Sub-Basin (7P) to the northeast to well 8C. This section passes through San Joaquin, and nine wells with good logs were selected for evaluation. For the segment southwest of San Joaquin (4 wells), specific yields ranged from 5 to 14 percent and averaged 10 percent. The nearest 1401-D T&R values were 9 and 10 percent. For the other five wells (24M to 8C) along the section, specific yields ranged from 6 to 20 percent and averaged 14 percent. The nearest 1401-D T&R values were 9 to 10 percent, and are indicated to be too low. Again, the 1401-D value for T15S/R17E appears to be too low.

Please call me if you have any questions

Attachments 4

Kings Basin, Recommended Sources of Specific Yield



Kings Subbasin Coordinated Effort

Recommended Sources of Specific Yield

ATTACHMENT 4

Legend

- GSA Boundary
- Kings GW Subbasin (DWR 2016)
- City/Place
- Township/Range

Proposed SY Data Source Heirarchy

- USGS WSP 1469 (1959)
- Page and LeBlanc 1969 (1969)
- USGS PP 1401-D (1989)
- OCID GW Study (USBR 1947)
- Alta ID GW Study (KRCD 1992)
- KDSA Evaluation (From 2005 Water Level to Base of Unconfined Aquifer)

KDSA Est. 1972

EST. 1963 PROVOST & PRITCHARD CONSULTING GROUP An Employee Owned Company

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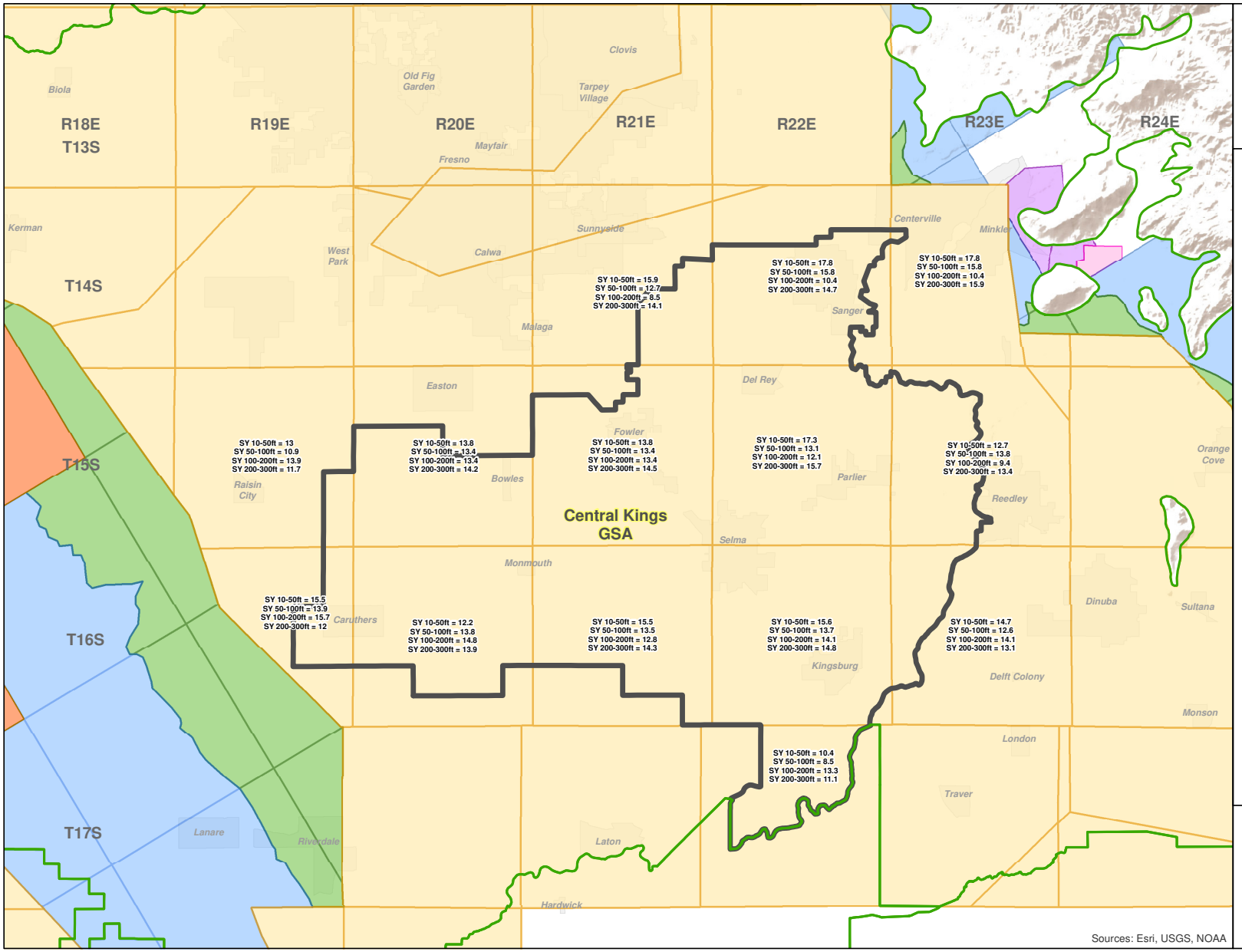
Attachments 5

Central Kings GSA, Data Sources and Recommended Specific Yield



Kings Subbasin Coordinated Effort
Data Sources Coverage and Recomended Specific Yield
Central Kings GSA

ATTACHMENT 5

Legend

- GSA Boundary
- Groundwater Subbasins (DWR 2016)
- City/Place

Proposed SY Data Source Heirarchy

- USGS WSP 1469 (1959)
- Page and LeBlanc 1969 (1969)
- USGS PP 1401-D (1989)
- OCID GW Study (USBR 1947)
- Alta ID GW Study (KRCD 1992)
- KDSA Evaluation (From 2005 Water Level to Base of Unconfined Aquifer)

Note: SY from 200-300ft from USGS OFR 1969

KDSA Est. 1972

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

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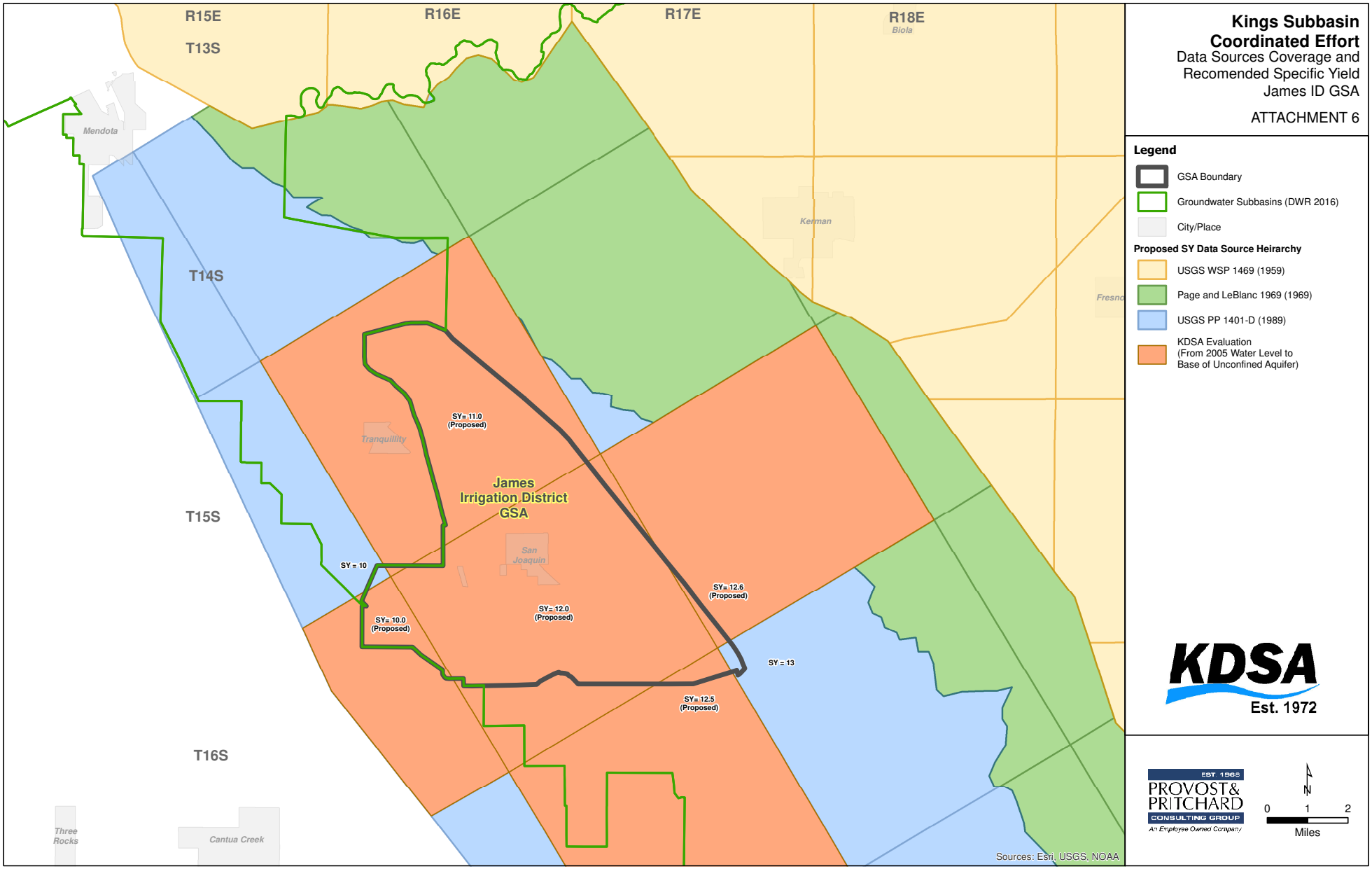
Attachments 6

James ID GSA, Data Sources and Recommended Specific Yield



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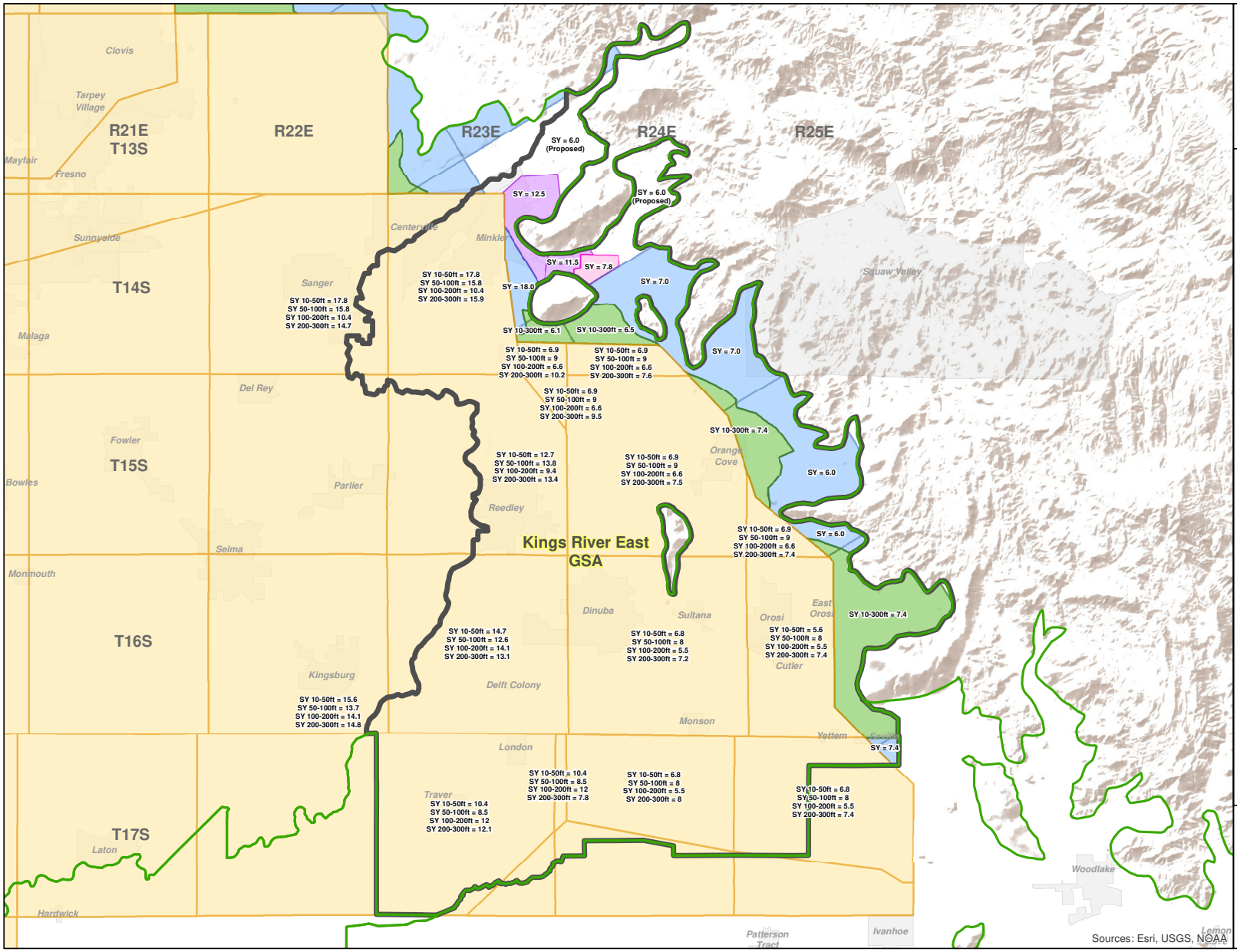
Attachments 7

Kings River east GSA, Data Sources and Recommended Specific Yield



Kings Subbasin Coordinated Effort

Data Sources Coverage and Recomended Specific Yield
Kings River East GSA

ATTACHMENT 7

Legend

- GSA Boundary
- Groundwater Subbasins (DWR 2016)
- City/Place

Proposed SY Data Source Heirarchy

- USGS WSP 1469 (1959)
- Page and LeBlanc 1969 (1969)
- USGS PP 1401-D (1989)
- OCID GW Study (USBR 1947)
- Alta ID GW Study (KRCD 1992)

Note: SY from 200-300ft from USGS OFR 1969

KDSA Est. 1972

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

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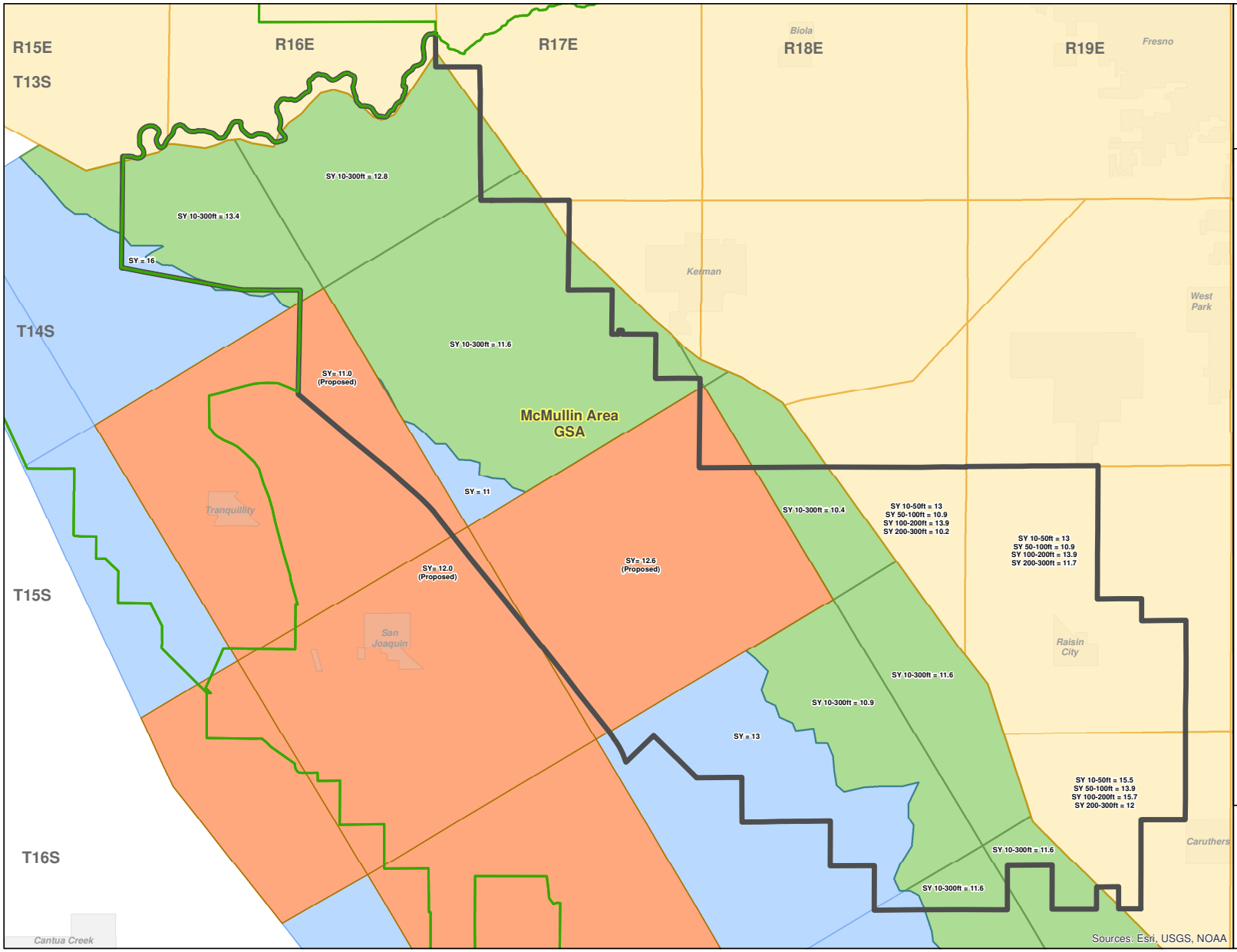
Attachments 8

McMullin Group GSA, Data Sources and Recommended Specific Yield



Kings Subbasin Coordinated Effort
Data Sources Coverage and Recomended Specific Yield
McMullin Area GSA

ATTACHMENT 8

Legend

- GSA Boundary
- Groundwater Subbasins (DWR 2016)
- City/Place

Proposed SY Data Source Heirarchy

- USGS WSP 1469 (1959)
- Page and LeBlanc 1969 (1969)
- USGS PP 1401-D (1989)
- KDSA Evaluation (From 2005 Water Level to Base of Unconfined Aquifer)

Note: SY from 200-300ft from USGS OFR 1969

KDSA Est. 1972

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

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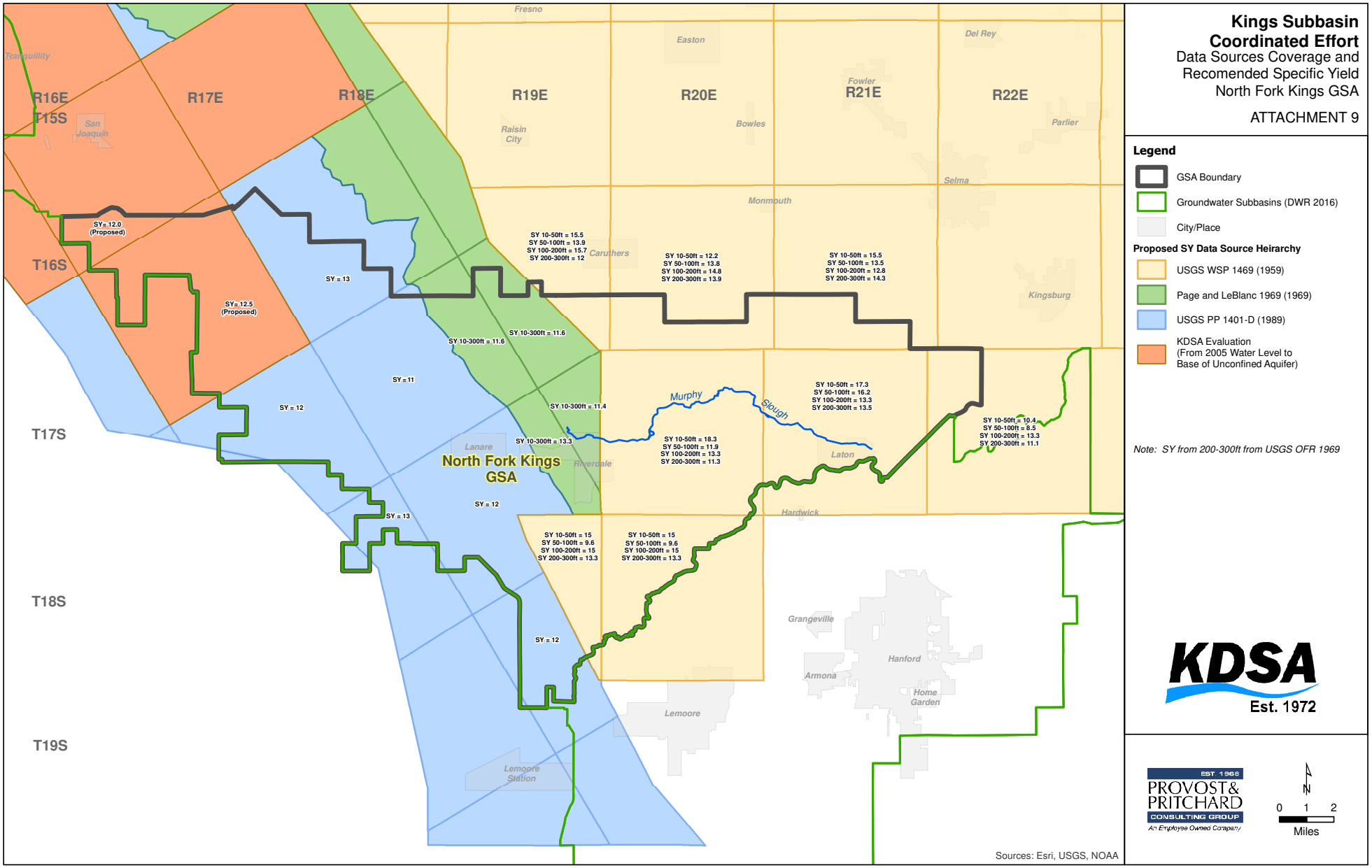
Attachments 9

North Fork Kings GSA, Data Sources and Recommended Specific Yield



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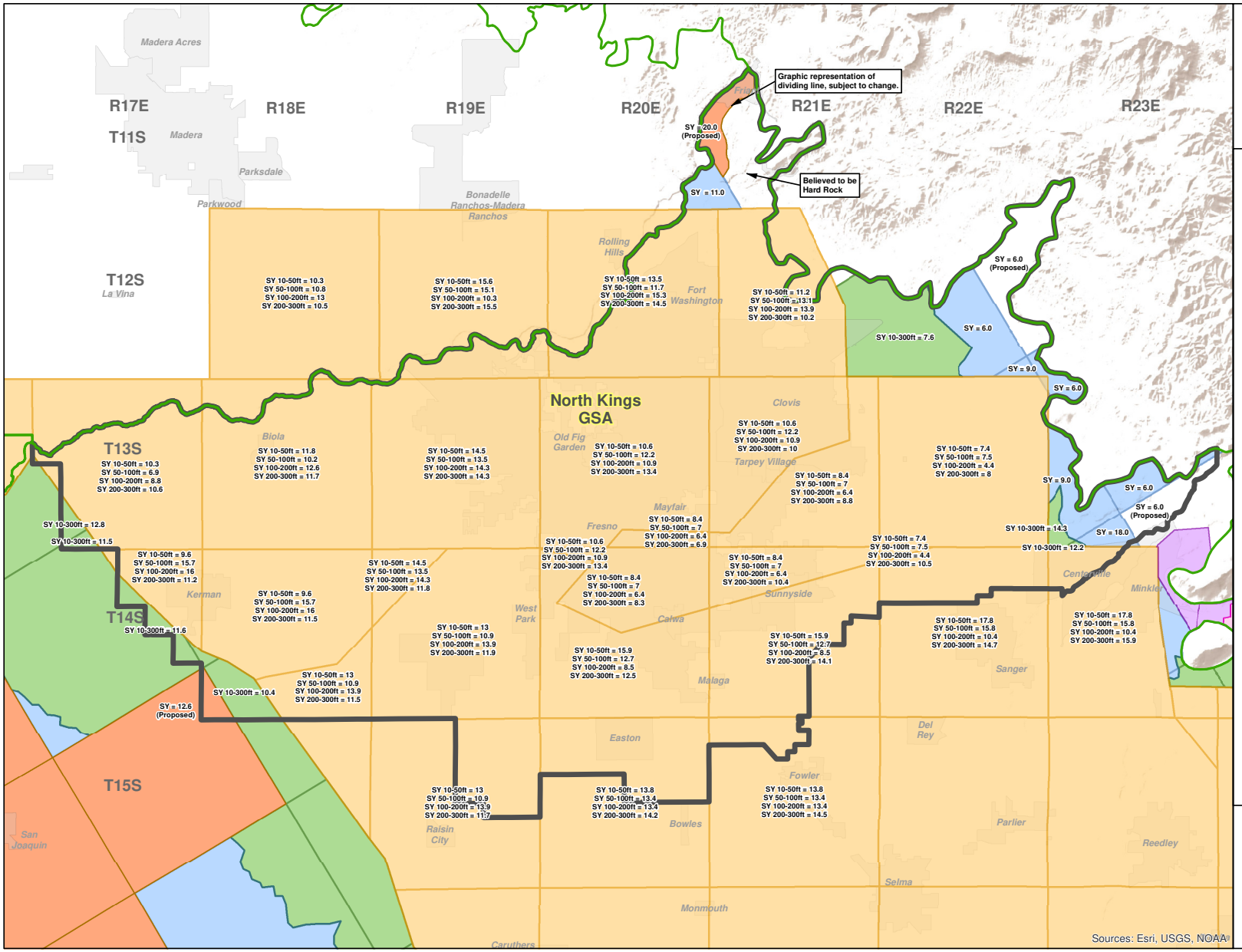
Attachments 10

North Kings GSA, Data Sources and Recommended Specific Yield



Kings Subbasin Coordinated Effort
Data Sources Coverage and Recomended Specific Yield
North Kings GSA

ATTACHMENT 10

Legend

- GSA Boundary
- Groundwater Subbasins (DWR 2016)
- City/Place

Proposed SY Data Source Heirarchy

- USGS WSP 1469 (1959)
- Page and LeBlanc 1969 (1969)
- USGS PP 1401-D (1989)
- OCID GW Study (USBR 1947)
- Alta ID GW Study (KRCD 1992)
- KDSA Evaluation (From 2005 Water Level to Base of Unconfined Aquifer)

Note: SY from 200-300ft from USGS OFR 1969

KDSA Est. 1972

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

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Attachments 11

KDSA, Memorandum on Friant area Specific Yield Estimates

REACH ALONG SAN JOAQUIN RIVER BELOW FRIANT

For the alluvium along the San Joaquin River between Friant and the confluence of Little Dry Creek, a subsurface geologic cross section from a KDSA report of November 2012 on the Beck Ranch was used. This cross section essentially shows three reaches. The upper reach, extending from near Friant to the south end of the Beck Ranch, is predominantly underlain by cobbles and gravel, having an estimated specific yield of 25 percent. The middle reach, extending from the south end of Beck Ranch to the north end of Ball Ranch, is underlain primarily by sand and gravel, with an estimated specific yield of 20 percent. The southernmost reach, along Ball Ranch near and south of Little Dry Creek, is underlain by alternating layers of cobbles and gravel, sand, and clay. The average specific yield of these deposits is 14 percent. Combining the three reaches, the average specific yield in the reach below Friant is 20 percent.

Technical Memorandum 3
Hydrologic Period

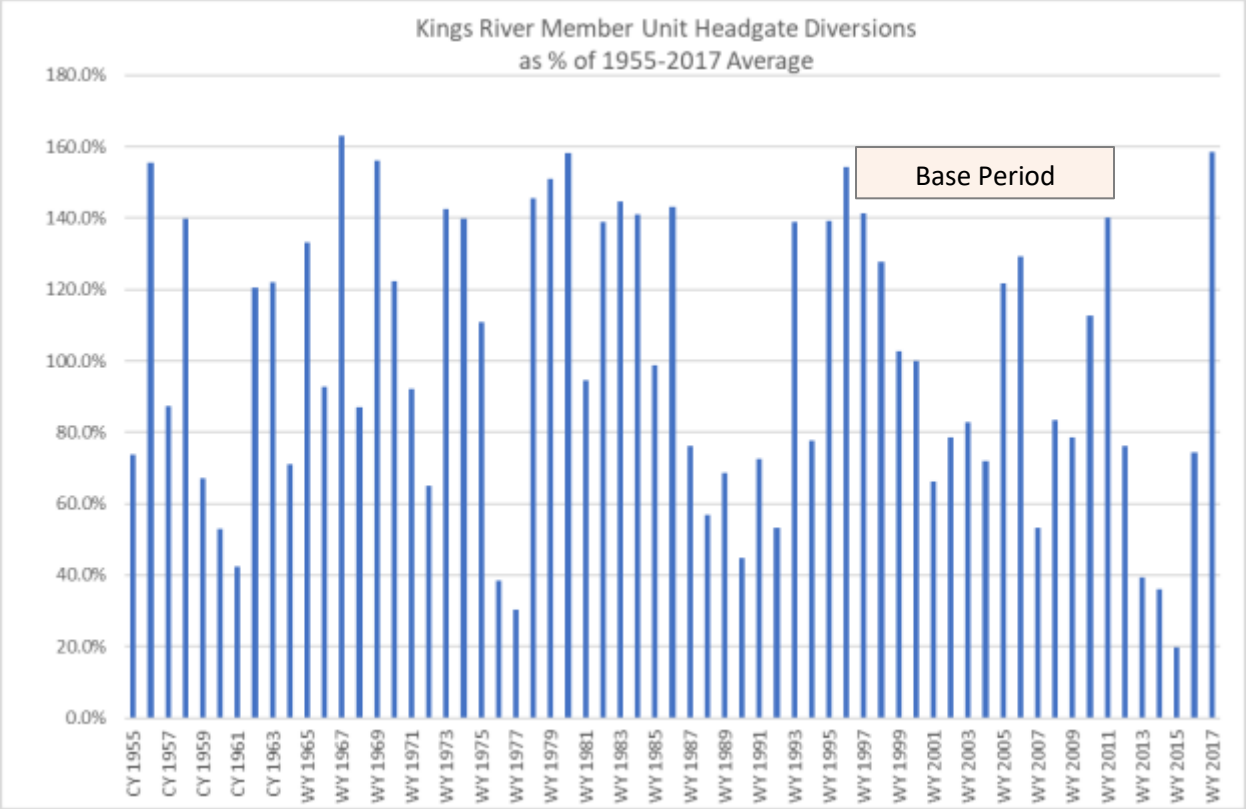
This memo identifies the recommended hydrologic period to utilize as part of the Kings Groundwater Sub-basin (Kings Basin) effort to evaluate historical changes in groundwater storage. Determination of a recent hydrologic period that approximates long-term average conditions is needed to consider the change in groundwater storage over time.

Section 354.18 (b) (5) of DWR's Groundwater Regulations states: "*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*."

Surface water supplies in the Kings Basin come from three primary sources: Kings River, San Joaquin River and local streams. The Kings River is the primary source of surface supply, and typically accounts for nearly 90% of the delivered surface water. Therefore, the analysis to determine the hydrologic period was performed based on Kings River supplies. To determine an average period within the Kings for analysis, the total deliveries of Kings River water into the Kings Subbasin were considered rather than the total runoff of the Kings River (Pre-Project Piedra), which would include water delivered to the Tulare Subbasin as well as periodic flood releases that leave the KRWA service area. Actual deliveries into the Kings Subbasin can further vary significantly on a percent of average basis each year as compared to the total watershed runoff of the Kings because of the entitlement schedule and ability to store water for coordinated water runs. This is especially true in dry years during which portions of the Kings basin receives considerably more surface water than other areas within the KRWA service area.

Surface water diversions from the Kings River are measured at the head gates for each canal by the Kings River Water Association (KRWA) and then aggregated to head gate diversions for each KRWA member unit. Historic annual water year head gate diversions for each member unit in each GSA were obtained from the KRWA Watermaster Reports through 2009 and from the KRWA database through 2017. The water year on the Kings River occurs from October to September. Attachment 1 shows that the average annual head gate diversions for the member units in each GSA from 1955 through 2017 was approximately 1,088,696 AF. Included in Attachment 1 is the water year total for diversions into the Kings Basin as a percentage of the 1955-2017 average, as well as for comparison the water year Pre-Project Piedra (PPP) total runoff percentage and the April-July runoff of the Kings River for each year. To determine an appropriate average base period, 10, 15, and 20 year rolling averages of water year totals were calculated as a percentage of the 1955-2017 average, with the 15-year period for water years 1997 through 2011 representing a normal period for surface water deliveries, and hence an expected normal period for groundwater pumping. The average Kings River diversions during this base period for each GSA is also shown in Attachment 1.

The graph below shows each water year as a percentage of the 1955-2017 average.



Recommendation

Although this effort is not directly associated with the Water Budget requirements of the SGMA regulations, Section 354.18 (c) (2) (A), requires that the water budget start with the most recently available information and extend back a minimum of 10 years. A 10-year period was considered as a minimum number of years to establish average water conditions.

The desired outcome was to find a minimum 10-year period that approximates close to 100% of the long-term average. It is recommended to consider as recent a period as practical to represent surface water use in meeting more recent demands based on current cropping patterns in the basin, as well as changes in facilities and water use that are different from 30 to 40 years ago. In reviewing the rolling averages, the period from water year 1997-2011 is recommended as the base period. This 15 year period is approximately 99.4% of the 1955-2017 average. This range of years includes a few above average years, as well as some dry years.

Groundwater level readings used for the storage change analysis will cover this base period. Fall readings are not available for all areas in the basin, so the recommended water level readings for the storage calculation will be Spring 1997 and Spring 2012. This is also consistent with SGMA guidelines that require groundwater storage calculations to be based on seasonal high-water levels in the Spring.

Other Surface Water Supplies

Data was collected for other surface water sources delivered into the subbasin, including CVP deliveries from the Friant Kern Canal and Delta-Mendota Canal, along with Kings River floodwater diversions that were added to the Kings River diversions. A listing of annual diversions from each source for each GSA is included as Attachment 2.

Total Surface Water Supplies

A summary of Kings River diversions and other surface water supplies for each GSA during the base period is shown in the table below.

Kings Subbasin GSA Surface Water Deliveries

	Kings River SW Deliveries into each GSA			
GSA	Historical Member Unit Diversions from KRWA Records 1955-2016/2017 Average	Base Period WY 1996/1997-2010/2011	Other Surface Water Supplies	Total Surface Water Supplies during Base Period
Central Kings	277,669	275,366	0	275,366
James	5,691	2,064	32,458	34,522
Kings River East	206,343	210,862	36,063	246,925
McMullin Area	0	0	1,874	1,874
North Fork Kings	152,559	163,671	162	163,833
North Kings	446,807	429,737	64,608	494,345
Total	1,089,069	1,081,700	135,165	1,216,865
% of Long-term Avg		99%		

Notes:

1) Base period selected based on member unit head gate diversions from canal headgate diversions. Data from KRWA Watermaster Reports or KRWA database.
2) Central Kings includes Consolidated ID and Lone Tree Kings River head gate diversions.
3) James ID includes James Kings River head gate diversions plus other CVP water to James ID.
4) Kings River East includes Kings River head gate diversions to Alta ID and Kings River WD ; other includes CVP Friant-Kern Canal water to Hills Valley ID, City of Orange Cove, Orange Cove ID and Tri-Valley WD.
5) McMullin Area other includes KR floodwater to Mid-Valley WD and Terranova, plus CVP to Mid-Valley WD
6) North Fork Kings includes Kings River head gate diversions to Burrel Ditch Company, Clark's Fork RD, Crescent Canal Company, Laguna ID, Liberty Canal Company, Murphy Slough Association, Stinson Canal & Irrigation, and Upper San Jose Water Company. Other includes CVP Section 215 water.
7) North Kings includes Kings River head gate diversions to Fresno ID, other includes CVP FKC water to City of Fresno, Fresno ID, Garfield WD, and International WD.

Attachment 1
Historical Kings River Member Unit Headgate, AF Diversions

Kings Basin GSAs surface water data for Coordinated Kings effort **ATTACHMENT 1**

Historical Kings River Member Unit Headgate Diversions in Acre-Feet

						CENTRAL KINGS GSA		JAMES ID GSA	KINGS RIVER EAST GSA		NORTH FORK KINGS GSA								NORTH KINGS GSA		
		WY PPP	% WY	Apr-Jul	% A-J	Consolidated ID	Lone Tree Channel	James ID	Alta ID	Kings River WD	Burrel Ditch Company	Clark's Fork Recl District	Crescent Canal Co	Laguna ID	Liberty Canal Co	Murphy Slough Assoc	Stinson Canal & Irrigation	Upper San Jose Water Co	Fresno ID	Total	% 1955-2017
CY 1955		1,119,176	65.9%	861,924	70.0%	143,904		-	109,983	56,080	4,903	748	7,156	30,397	1,777	25,153	6,408	1,704	414,866	803,079	73.7%
CY 1956		2,600,733	153.1%	1,599,859	129.9%	433,041	-	22,441	276,019	55,320	19,319	1,558	24,222	111,743	18,121	93,189	35,016	3,065	598,825	1,691,879	155.4%
CY 1957		1,251,497	73.7%	1,011,180	82.1%	185,048	24,427	-	180,157	53,856	6,050	1,577	12,396	46,219	5,146	36,173	-	3,164	398,079	952,292	87.4%
CY 1958		2,545,394	149.8%	2,016,761	163.8%	397,891	23,821	29,397	247,027	54,490	10,423	1,180	27,148	84,051	15,513	99,828	16,487	2,458	514,123	1,523,837	139.9%
CY 1959		806,803	47.5%	528,285	42.9%	104,217	28,390	4,068	101,498	57,583	-	617	8,651	29,701	2,650	27,108	5,452	2,082	360,388	732,405	67.3%
CY 1960		722,629	42.5%	542,217	44.0%	86,133	28,193	-	71,097	54,217	-	484	-	14,533	-	1,016	-	76	321,819	577,568	53.0%
CY 1961		568,993	33.5%	403,682	32.8%	58,759	18,122	-	46,225	56,448	-	-	-	11,304	-	11,041	-	-	258,249	460,148	42.3%
CY 1962		1,900,229	111.8%	1,499,752	121.8%	305,618	27,282	-	234,915	60,425	9,586	1,457	18,793	69,282	13,796	65,069	7,210	4,108	494,469	1,312,010	120.5%
CY 1963		1,939,139	114.1%	1,435,163	116.6%	357,135	24,456	-	213,984	52,619	9,959	1,177	15,997	75,684	12,292	56,973	12,002	3,356	492,825	1,328,459	122.0%
CY 1964		911,642	53.7%	645,306	52.4%	114,760	29,332	-	125,441	53,241	3,724	652	7,017	39,167	-	30,632	1,488	1,047	368,184	774,685	71.1%
WY 1964	- 1965	2,013,721	118.5%	1,336,183	108.5%	347,131	28,789	**10,515**	**239,474**	**58,779**	9,067	**895**	21,745	82,232	11,459	62,859	12,435	**4,590**	**561,469**	1,451,438	133.3%
WY 1965	- 1966	1,215,778	71.6%	833,554	67.7%	239,546	29,185	-	**112,724**	**61,980**	2,922	**617**	9,596	46,681	5,337	46,376	4,669	**1,107**	**450,217**	1,010,957	92.8%
WY 1966	- 1967	3,374,398	198.6%	2,367,938	192.3%	525,136	33,580	**6,754**	**281,538**	**53,862**	2,992	**1,706**	24,493	111,549	20,598	94,440	19,000	**3,019**	**595,359**	1,774,026	162.9%
WY 1967	- 1968	843,204	49.6%	565,657	45.9%	198,681	30,295	**637**	**94,645**	**59,731**	4,300	**817**	10,873	36,466	-	37,245	6,834	**1,260**	**466,696**	948,479	87.1%
WY 1968	- 1969	4,386,300	258.2%	3,140,519	255.1%	536,275	27,269	**28,979**	**258,016**	**46,091**	3,009	**1,059**	24,039	104,176	21,119	100,810	18,067	**766**	**530,991**	1,700,665	156.2%
WY 1969	- 1970	1,330,595	78.3%	886,438	72.0%	334,162	40,462	**1,720**	**169,439**	**54,284**	1,339	**1,139**	18,809	57,422	7,702	57,983	7,348	**2,448**	**578,030**	1,332,285	122.3%
WY 1970	- 1971	1,174,952	69.2%	822,353	66.8%	161,959	24,772	-	**138,093**	**55,018**	3,604	**956**	8,912	38,890	5,163	35,325	3,426	**1,799**	**525,411**	1,003,329	92.1%
WY 1971	- 1972	859,583	50.6%	548,352	44.5%	99,349	26,904	-	**86,774**	**60,628**	1,204	**871**	1,211	19,815	-	18,896	-	**438**	**392,176**	708,266	65.0%
WY 1972	- 1973	2,135,442	125.7%	1,673,187	135.9%	490,632	23,528	**99**	**208,240**	**50,817**	7,950	**1,182**	17,531	88,313	17,078	70,398	4,993	**2,398**	**568,445**	1,551,605	142.5%
WY 1973	- 1974	2,095,945	123.4%	1,540,003	125.1%	422,996	39,667	**17,024**	**205,604**	**51,492**	8,545	**1,577**	26,111	92,482	14,220	81,243	8,307	**2,069**	**551,006**	1,522,343	139.8%
WY 1974	- 1975	1,583,365	93.2%	1,276,059	103.6%	210,603	34,655	-	**184,035**	**55,435**	6,000	**1,882**	16,695	64,790	4,278	55,883	8,426	**3,340**	**559,379**	1,205,401	110.7%
WY 1975	- 1976	540,664	31.8%	305,499	24.8%	-	13,894	-	**43,381**	**50,288**	-	**865**	3,965	18,890	-	25,315	5,576	**1,353**	**255,148**	418,674	38.4%
WY 1976	- 1977	395,994	23.3%	280,318	22.8%	153	15,597	-	**38,722**	**47,798**	-	**474**	-	-	-	6,815	-	**666**	**220,962**	331,187	30.4%
WY 1977	- 1978	3,453,853	203.3%	2,412,444	195.9%	520,937	35,483	**12,607**	**217,628**	**45,422**	889	**1,978**	21,493	94,298	16,265	84,582	18,340	**4,522**	**511,505**	1,585,949	145.6%
WY 1978	- 1979	1,729,846	101.8%	1,267,726	103.0%	469,458	40,473	**7,543**	**210,624**	**53,096**	14,493	**1,747**	25,321	86,127	14,678	79,010	28,374	**2,682**	**609,539**	1,643,166	150.9%
WY 1979	- 1980	3,046,952	179.3%	1,989,470	161.6%	499,664	48,305	**26,627**	**253,273**	**50,375**	8,634	**1,989**	30,329	106,448	22,609	104,457	31,173	**5,586**	**531,727**	1,721,195	158.0%
WY 1980	- 1981	1,040,415	61.2%	799,848	65.0%	181,711	26,674	-	**145,400**	**53,271**	6,773	**1,097**	23,969	23,969	5,717	47,292	15,974	**2,563**	**496,327**	1,030,737	94.6%
WY 1981	- 1982	3,111,011	183.1%	2,230,771	181.2%	413,642	15,571	**19,442**	**231,137**	**49,468**	13,339	**1,995**	32,853	86,911	17,121	100,577	20,753	**3,515**	**507,629**	1,513,954	139.0%
WY 1982	- 1983	4,476,391	263.5%	2,728,596	221.6%	514,494	19,042	**32,829**	**222,733**	**39,442**	3,610	**1,543**	33,662	70,947	17,614	109,059	28,368	**4,873**	**475,370**	1,573,586	144.5%
WY 1983	- 1984	1,971,145	116.0%	1,139,961	92.6%	379,581	22,029	**11,159**	**217,919**	**46,803**	18,105	**1,890**	35,404	72,343	13,179	75,821	26,001	**2,517**	**611,124**	1,533,875	140.8%
WY 1984	- 1985	1,252,501	73.7%	908,459	73.8%	187,617	29,268	-	**170,827**	**45,184**	2,838	**1,141**	10,875	51,723	5,584	38,839	10,720	**2,608**	**516,841**	1,074,064	98.6%
WY 1985	- 1986	3,262,497	192.0%	2,086,612	169.5%	390,452	26,131	**31,181**	**227,708**	**44,660**	11,937	**2,095**	38,882	97,124	18,603	118,027	25,203	**4,205**	**523,704**	1,559,911	143.2%
WY 1986	- 1987	779,051	45.9%	569,580	46.3%	158,999	19,751	-	**121,323**	**43,395**	3,481	**2,037**	9,945	34,207	2,181	29,590	12,570	**2,493**	**390,539**	830,511	76.3%
WY 1987	- 1988	827,211	48.7%	539,687	43.8%	72,086	19,967	-	**59,348**	**42,280**	149	**1,172**	-	-	743	13,274	-	**768**	**410,916**	620,703	57.0%
WY 1988	- 1989	905,624	53.3%	639,909	52.0%	114,136	23,618	-	**89,636**	**48,491**	298	-	-	28,788	1,190	15,870	-	-	**424,943**	746,970	68.6%
WY 1989	- 1990	662,989	39.0%	493,197	40.1%	61,775	18,964	-	**58,283**	**43,885**	-	-	-	-	-	7,728	-	-	297,670	488,305	44.8%
WY 1990	- 1991	1,075,608	63.3%	859,308	69.8%	147,523	19,470	-	**107,230**	**39,315**	3,400	**434**	6,367	30,878	3,567	23,228	4,054	**730**	405,293	791,489	72.7%
WY 1991	- 1992	705,247	41.5%	500,401	40.6%	74,649	17,373	-	**66,816**	**43,230**	-	-	-	-	337	9,072	-	-	368,478	579,956	53.3%
WY 1992	- 1993	2,553,114	150.3%	1,884,141	153.0%	338,183	30,540	-	**246,845**	**47,784**	11,405	**2,733**	35,642	111,502	21,013	87,214	25,462	**3,935**	549,368	1,511,627	138.8%
WY 1993	- 1994	861,045	50.7%	632,612	51.4%	167,122	21,220	-	**123,895**	**44,159**	4,439	**1,204**	5,629	29,754	2,896	21,499	3,808	**647**	418,821	845,093	77.6%
WY 1994	- 1995	3,460,047	203.6%	2,398,607	194.8%	436,102	24,626	-	**235,529**	**38,652**	4,835	**3,168**	39,293	101,064	18,814	115,610	26,156	**4,566**	467,790	1,516,205	139.2%
WY 1995	- 1996	2,095,921	123.4%	1,509,461	122.6%	437,416	32,512	-	**221,624**	**51,087**	17,542	**4,524**	43,357	88,446	12,778	102,051	26,577	**4,360**	636,275	1,678,550	154.1%
WY 1996	- 1997	2,652,070	156.1%	1,344,730	109.2%	382,346	33,149	-	**214,341**	**51,664**	16,497	**2,955**	32,831	91,680	18,487	103,457	27,575	**5,835**	558,018	1,538,836	141.3%
WY 1997	- 1998	3,104,062	182.7%	2,300,989	186.9%	392,186	23,197	30,847	172,176	40,504	4,860	2,337	31,777	75,124	15,701	118,028	26,097	2,914	455,173	1,390,921	127.7%
WY 1998	- 1999	1,261,024	74.2%	890,467	72.3%	262,680	28,511	111	155,463	46,821	10,324	2,331	20,833	59,994	8,887	52,034	18,574	2,609	449,068	1,118,240	102.7%
WY 1999	- 2000	1,534,654	90.3%	1,157,277	94.0%	261,592	25,978	-	166,411	50,622	8,180	1,726	15,194	61,822	6,681	54,010	12,218	3,572	419,477	1,087,483	99.9%
WY 2000	- 2001	1,010,201	59.5%	781,979	63.5%	118,242	18,708	-	124,465	48,403	6,050	1,452	13,095	30,672	3,745	32,567	7,720	1,628	313,330	720,077	66.1%
WY 2001	- 2002	1,141,149	67.2%	839,385	68.2%	179,455	21,609	-	133,219	49,903	1,363	1,032	7,087	33,868	3,172	24,220	2,894	1,543	396,707	856,072	78.6%

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Kings Basin GSAs surface water data for Coordinated Kings effort **ATTACHMENT 1**

Historical Kings River Member Unit Headgate Diversions in Acre-Feet

						CENTRAL KINGS GSA		JAMES ID GSA	KINGS RIVER EAST GSA		NORTH FORK KINGS GSA								NORTH KINGS GSA		
		WY PPP	% WY	Apr-Jul	% A-J	Consolidated ID	Lone Tree Channel	James ID	Alta ID	Kings River WD	Burrel Ditch Company	Clark's Fork Recl District	Crescent Canal Co	Laguna ID	Liberty Canal Co	Murphy Slough Assoc	Stinson Canal & Irrigation	Upper San Jose Water Co	Fresno ID	Total	% 1955-2017
WY 2002	- 2003	1,426,170	83.9%	1,038,245	84.3%	178,511	21,407	-	137,603	47,403	6,119	1,351	6,910	42,222	4,114	39,240	4,810	1,535	409,908	901,133	82.7%
WY 2003	- 2004	1,050,714	61.8%	698,583	56.7%	135,600	25,320	-	128,426	59,580	396	4	3,881	18,102	2,632	18,235	1,601	807	389,044	783,628	72.0%
WY 2004	- 2005	2,531,327	149.0%	1,917,065	155.7%	328,331	22,135	-	212,052	46,836	9,868	1,978	26,768	76,070	12,972	81,162	18,181	4,751	483,028	1,324,132	121.6%
WY 2005	- 2006	2,948,677	173.5%	2,352,852	191.1%	397,176	10,779	-	211,646	44,436	4,634	2,921	29,816	81,189	10,733	103,461	27,500	3,873	477,848	1,406,012	129.1%
WY 2006	- 2007	679,047	40.0%	436,295	35.4%	49,801	15,733	-	76,225	53,289	1,785	801	3,429	15,285	595	14,860	3,916	436	344,190	580,345	53.3%
WY 2007	- 2008	1,216,651	71.6%	915,185	74.3%	216,719	16,776	-	131,685	52,261	2,578	660	5,018	27,310	2,390	25,869	5,506	908	421,157	908,837	83.5%
WY 2008	- 2009	1,348,201	79.3%	1,006,920	81.8%	147,690	22,298	-	150,834	48,229	4,126	329	6,496	31,351	1,494	35,385	2,487	698	405,715	857,132	78.7%
WY 2009	- 2010	2,062,001	121.4%	1,576,537	128.0%	311,141	24,970	-	220,277	43,008	11,017	1,359	13,740	65,517	6,920	67,543	7,963	4,646	449,830	1,227,931	112.8%
WY 2010	- 2011	3,319,830	195.4%	2,295,580	186.4%	431,959	26,492	-	**208,331**	**36,816**	11,732	**2,388**	38,178	96,959	15,383	119,436	59,671	3,810	473,562	1,524,717	140.0%
WY 2011	- 2012	825,683	48.6%	543,009	44.1%	165,460	18,632	-	**127,137**	**42,530**	482	**820**	2,981	27,856	1,716	27,749	536	1,760	411,320	828,979	76.1%
WY 2012	- 2013	691,301	40.7%	430,191	34.9%	13,722	8,692	-	**35,730**	**44,856**	-	-	-	**6,807**	-	**5,365**	-	-	314,036	429,208	39.4%
WY 2013	- 2014	536,924	31.6%	405,903	33.0%	50,234	5,795	-	**25,791**	**44,924**	-	-	-	**2,029**	-	**7,603**	-	-	255,211	391,587	36.0%
WY 2014	- 2015	360,979	21.2%	208,480	16.9%	**11,858**	-	-	-	**42,770**	-	**597**	**115**	**4,413**	-	**1,503**	-	-	**153,802**	215,058	19.7%
WY 2015	- 2016	1,253,961	73.8%	880,495	71.5%	**137,298**	**20,104**	-	**130,613**	**40,630**	**1,962**	-	-	**12,153**	**3,941**	**14,335**	**343**	**329**	**449,317**	811,025	74.5%
WY 2016	- 2017	4,096,148	241.1%	2,700,109	219.3%	**519,137**	**5,891**	**64,577**	**241,182**	**35,218**	**9,918**	**1,863**	**43,589**	**106,913**	**22,060**	**142,975**	**38,885**	**5,294**	**488,110**	1,725,612	158.4%
Min		360,979	21%	208,480	17%	-	-	-	-	35,218	-	-	-	-	-	1,016	-	-	153,802	215,058	
Max		4,476,391	263%	3,140,519	255%	536,275	48,305	64,577	281,538	61,980	19,319	4,524	43,589	111,743	22,609	142,975	59,671	5,835	636,275	1,774,026	
Avg		1,724,403	101%	1,213,195	99%	254,124	23,545	5,691	157,118	49,225	5,602	1,288	15,875	53,264	8,139	54,152	11,955	2,283	446,807	1,089,069	
GSA Average						277,669		5,691	206,343		152,559								446,807		
Average 1996/97-2010/11						*252,895*	*22,471*	*2,064*	*162,877*	*47,985*	*6,635*	*1,575*	*17,004*	*53,811*	*7,594*	*59,300*	*15,114*	*2,638*	*429,737*	*1,081,700*	*99%*
GSA Average						*275,366*		*2,064*	*210,862*		*163,671*								*429,737*		

Data from KRWA Watermaster Reports

Bold numbers from KRWA database

Attachment 2

Kings Basin GSA surface water data, AF

Kings Basin GSAs surface water data for Coordinated Kings effort **ATTACHMENT 2**

All data in Acre-Feet

		WY 1996 - 1997	WY 1997 - 1998	WY 1998 - 1999	WY 1999 - 2000	WY 2000 - 2001	WY 2001 - 2002	WY 2002 - 2003	WY 2003 - 2004	WY 2004 - 2005	WY 2005 - 2006	WY 2006 - 2007	WY 2007 - 2008	WY 2008 - 2009	WY 2009 - 2010	WY 2010 - 2011	Average 1997 - 2011
CENTRAL KINGS GSA																	275,366
Kings River Diversions	Consolidated ID Head Gate Diversions	382,346	392,187	262,680	261,592	118,242	179,455	178,511	135,600	328,331	397,176	49,801	216,719	147,690	311,141	431,959	252,895
	Lone Tree Channel Head Gate Diversions	33,149	23,197	28,511	25,978	18,708	21,609	21,407	25,320	22,135	10,779	15,733	16,776	22,298	24,970	26,492	22,471
Subtotal		415,495	415,384	291,191	287,570	136,950	201,064	199,918	160,920	350,466	407,955	65,534	233,495	169,988	336,111	458,451	275,366
Other surface water supplies	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
JAMES ID GSA																	34,522
Kings River Diversions	James ID Head Gate Diversions	-	*30,847*	111	-	-	-	-	-	-	-	-	-	-	-	-	2,064
Other surface water supplies	CVP - JID	44,142	13,219	43,304	33,242	29,051	33,280	38,336	38,216	38,669	44,175	38,502	20,147	14,198	24,672	33,710	32,458
KINGS RIVER EAST GSA																	246,925
Kings River Diversions	Alta ID Head Gate Diversions	214,341	172,176	155,463	166,411	124,465	133,219	137,603	128,426	212,052	211,646	76,225	131,685	150,834	220,277	208,331	162,877
Kings River Diversions	Kings River WD Head Gate Diversions	51,664	40,504	46,821	50,622	48,403	49,903	47,403	59,580	46,836	44,436	53,289	52,261	48,229	43,008	36,816	47,985
Subtotal		266,005	212,680	202,284	217,033	172,868	183,122	185,006	188,006	258,888	256,082	129,514	183,946	199,063	263,285	245,147	210,862
Other surface water supplies	FKC - Hills Valley Irrigation District	4,084	2,546	3,507	3,887	3,642	4,895	4,225	5,121	3,901	4,649	5,538	4,888	5,778	5,551	4,770	4,465
	FKC - City of Orange Cove	1,464	923	1,218	1,398	1,442	1,580	1,582	1,899	1,971	2,078	2,099	2,334	2,063	1,921	1,793	1,718
	FKC - Orange Cove Irrigation Distric	35,215	22,167	28,742	28,204	29,772	30,056	29,393	34,401	26,014	29,774	29,313	25,864	26,697	31,251	25,981	28,856
	FKC - Tri-Valley Water District	878	594	874	1,098	1,040	1,493	1,416	1,640	1,040	930	826	860	991	1,015	653	1,023
Subtotal		41,641	26,230	34,341	34,587	35,896	38,024	36,616	43,061	32,926	37,431	37,776	33,946	35,529	39,738	33,197	36,063
McMullin GSA																	1,874
Other surface water supplies	Kings River Floodwater - MVWD	-	7,298	459	-	-	-	-	-	-	3,648	-	-	-	-	-	760
	CVP - MVWD	2,986	1,830	1,343	275	17	2	368	-	849	3,980	-	-	-	-	2,899	970
	Kings River Floodwater - Terranove Ranch	-	-	-	-	-	-	-	-	-	2,162	-	-	-	-	-	144
Subtotal		2,986	9,128	1,802	275	17	2	368	-	849	9,790	-	-	-	-	2,899	1,874
NORTH FORK KINGS GSA																	163,833
Kings River Diversions	Burrel Ditch Company Head Gate Div	16,497	4,860	10,324	8,180	6,050	1,363	6,119	396	9,868	4,634	1,785	2,578	4,126	11,017	11,732	6,635
Kings River Diversions	Clark's Fork Recl District Head Gate Div	2,955	2,337	2,331	1,726	1,452	1,032	1,351	4	1,978	2,921	801	660	329	1,359	2,388	1,575
Kings River Diversions	Crescent Canal Company Head Gate Div	32,831	31,777	20,833	15,194	13,095	7,087	6,910	3,881	26,768	29,816	3,429	5,018	6,496	13,740	38,178	17,004
Kings River Diversions	Laguna Irrigation District Head Gate Div	91,680	75,124	59,994	61,822	30,672	33,868	42,222	18,102	76,070	81,189	15,285	27,310	31,351	65,517	96,959	53,811
Kings River Diversions	Liberty Canal Company Head Gate Div	18,487	15,701	8,887	6,681	3,745	3,172	4,114	2,632	12,972	10,733	595	2,390	1,494	6,920	15,383	7,594
Kings River Diversions	Murphy Slough Association Head Gate Div	103,457	118,028	52,034	54,010	32,567	24,220	39,240	18,235	81,162	103,461	14,860	25,869	35,385	67,543	119,436	59,300
Kings River Diversions	Stinson Canal & Irrigation Head Gate Div	27,575	26,097	18,574	12,218	7,720	2,894	4,810	1,601	18,181	27,500	3,916	5,506	2,487	7,963	59,671	15,114
Kings River Diversions	Upper San Jose Water Company HG Div	5,835	2,914	2,609	3,572	1,628	1,543	1,535	807	4,751	3,873	436	908	698	4,646	3,810	2,638
Subtotal		299,317	276,838	175,586	163,403	96,929	75,179	106,301	45,658	231,750	264,127	41,107	70,239	82,366	178,705	347,557	163,671
Other surface water supplies	FKC Section 215 water		-	-	-	-	-	1,906	-	200	-	-	-	-	-		162
NORTH KINGS GSA																	494,345
Kings River Diversions	Fresno ID Head Gate Diversions	558,018	455,173	449,068	419,477	313,330	396,707	409,908	389,044	483,028	477,848	344,190	421,157	405,715	449,830	473,562	429,737
Other surface water supplies	FKC - City of Fresno	60,000	25,333	74,686	38,618	58,000	60,595	59,689	56,226	60,130	54,704	42,692	59,303	7,743	20,530	50,649	48,593
	FKC - Fresno Irrigation District	20,587	1,978	26,129	57,555	1,805	6,418	3,887	11,606	7,711	3,090	4,462	558	23,288	8,778	3,731	12,106
	FKC - Garfield Water District	3,806	2,017	3,216	2,949	2,680	2,797	2,564	2,841	1,988	2,490	2,023	2,238	2,127	1,808	1,552	2,473
	FKC - International Water District	1,533	1,325	1,310	1,498	1,413	1,548	1,423	1,584	1,751	1,589	1,091	1,034	1,713	1,106	1,622	1,436
Subtotal		**85,926**	**30,653**	**105,341**	**100,620**	**63,898**	**71,358**	**67,563**	**72,257**	**71,580**	**61,873**	**50,268**	**63,133**	**34,871**	**32,222**	**57,554**	**64,608**

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Technical Memorandum 4
Estimate of Groundwater Storage Change

This Technical Memorandum (TM) summarizes the process used to estimate the groundwater storage change within the unconfined aquifer of the Kings Subbasin. This TM utilizes the information presented in TMs 1, 2 and 3. Storage change in the confined aquifer or above the A-Clay is not calculated in this TM. It is also critical to note that this estimation does not include an estimate of boundary flow as that is covered in a separate TM.

Water Level Data and Contour Maps

TM3 recommended evaluating the range of years from Spring 1997 to Spring 2012 as the hydrologic base period of average conditions. Well water level readings were requested from the GSA representatives, and data from DWR's well data library was collected. Well construction information was not evaluated at this time. The following table lists the well water level data sources:

Alta Irrigation District	Fresno Irrigation District
Kings River Water District	Consolidated Irrigation District
Orange Cove Irrigation District	Kings River Conservation District
Laguna Irrigation District	California Department of Water Resources
James Irrigation District	Kaweah Delta Water Conservation District

Water surface elevation contour maps were generated for Spring 1997 and Spring 2012 based on the available water level data. A total of more than 900 wells were evaluated. Well locations and water levels were plotted on the Kings Subbasin map. Well water level elevations that appeared inconsistent with the majority of other wells in an area were not used. Wells with significantly different water levels may be pumping from the confined aquifer below the Corcoran Clay. In some locations where a well reading was significantly different than other wells in the immediate vicinity, it was discarded because it was believed that these readings were erroneous or anomalous. Elevation of water in well contours were generated utilizing ArcGIS software and reviewed and edited for consistency. If ground surface elevations were provided with the water level data, those elevations were used to generate the water surface elevation. For wells that did not have ground or measuring point elevations, the ground surface from the State's Digital Elevation Model was used.

At the time of this memo, spring data in the unconfined aquifer outside the western boundary within the Westlands Water District (WWD) was limited. There was also limited data in the western portion of the North Fork Kings GSA for the Spring of 1997.

A copy of the Spring 1997 and Spring 2012 water level contours for the entire Kings Subbasin are included in Attachment 1 to this Technical Memorandum. Water level readings for each of the wells used in the contour generation are included in Attachment 2.

Storage Change Calculation Method

Technical Memorandum 2 identified the specific yield values to be used in the storage change calculation, and the unique specific yield areas are shown in the Attachments to TM2. Specific yield values also vary by depth and TM2 describes unique values at depth zones from 0'-50', 50'-100', 100'-200' and 200'-300'. The storage change was estimated based on the water above 300' below the groundwater surface.

The process for estimating the groundwater storage change for the range of years being evaluated included the following steps:

1. The final wells selected for the water surface elevation review were used to create depth to water surfaces. The depth to water contour maps are included as Attachment 3.
2. Using the depth to water surfaces, the average depth value was determined for each unique Specific Yield area. The average depth was determined using ArcGIS Spatial Analyst.
3. For each Specific Yield area, the average depth to water of that area was used to determine the height of water within each specific yield depth zone.
4. The height of water in each depth zone was multiplied by the specific yield for that depth zone and then by the total acreage within that Specific Yield area. Specific Yield values were zeroed and storage volume not calculated for areas below base of unconfined aquifer.
5. Values for each depth zone were added to determine Specific Yield area total.
6. The Specific Yield area totals for each GSA area were added to determine the GSA total for that year.
7. Steps 1 through 6 were repeated for the ending year being considered.
8. The total volume determined for the starting year was subtracted from the total volume determined for the ending year to determine the total change in volume between the two years.
9. The difference between the two years was divided by the number of years in the range to estimate the average annual storage change per year.

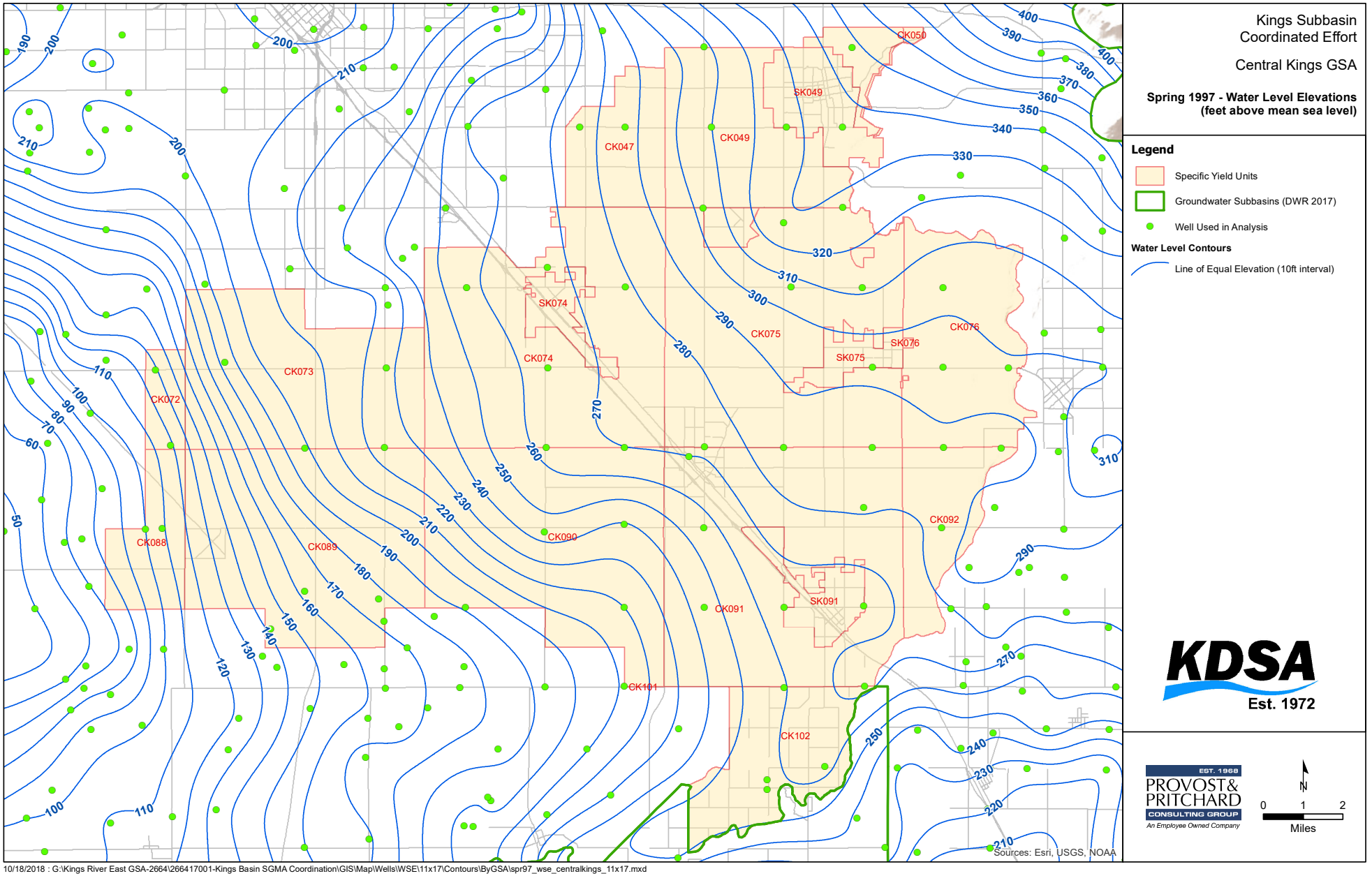
Attachment 4 is a table showing the values used in the storage change estimation. The table is sorted by unique Specific Yield area and shows the average depth to water used for that area, along with the total volume calculated for the two years considered, and the difference between the total for the two years considered. Refer to the figures in Attachment 4 of TM2 for a map of the location of the unique Specific Yield areas within each GSA.

Results of Initial Estimation

The calculated storage change for the entire basin from Spring 1997 to Spring 2012 was calculated to be approximately 1,827,000AF. Dividing that by the 15-year base period, the average annual change was estimated to be approximately 122,000AF/yr. The table below shows the total storage change by year per GSA for the Spring 1997 to Spring 2012 base period with values rounded to the nearest thousand acre-feet.

GSA	Estimated Storage Change per Year Spr 1997 to Spr 2012 (WY 96/97-10/11)
Central/South	-17,000
James	-5,000
Kings River East	-11,000
McMullin	-16,000
North Fork Kings	-49,000
North Kings	-24,000
Total	-122,000

Attachment 1
Elevation of Water in Wells Contour Maps



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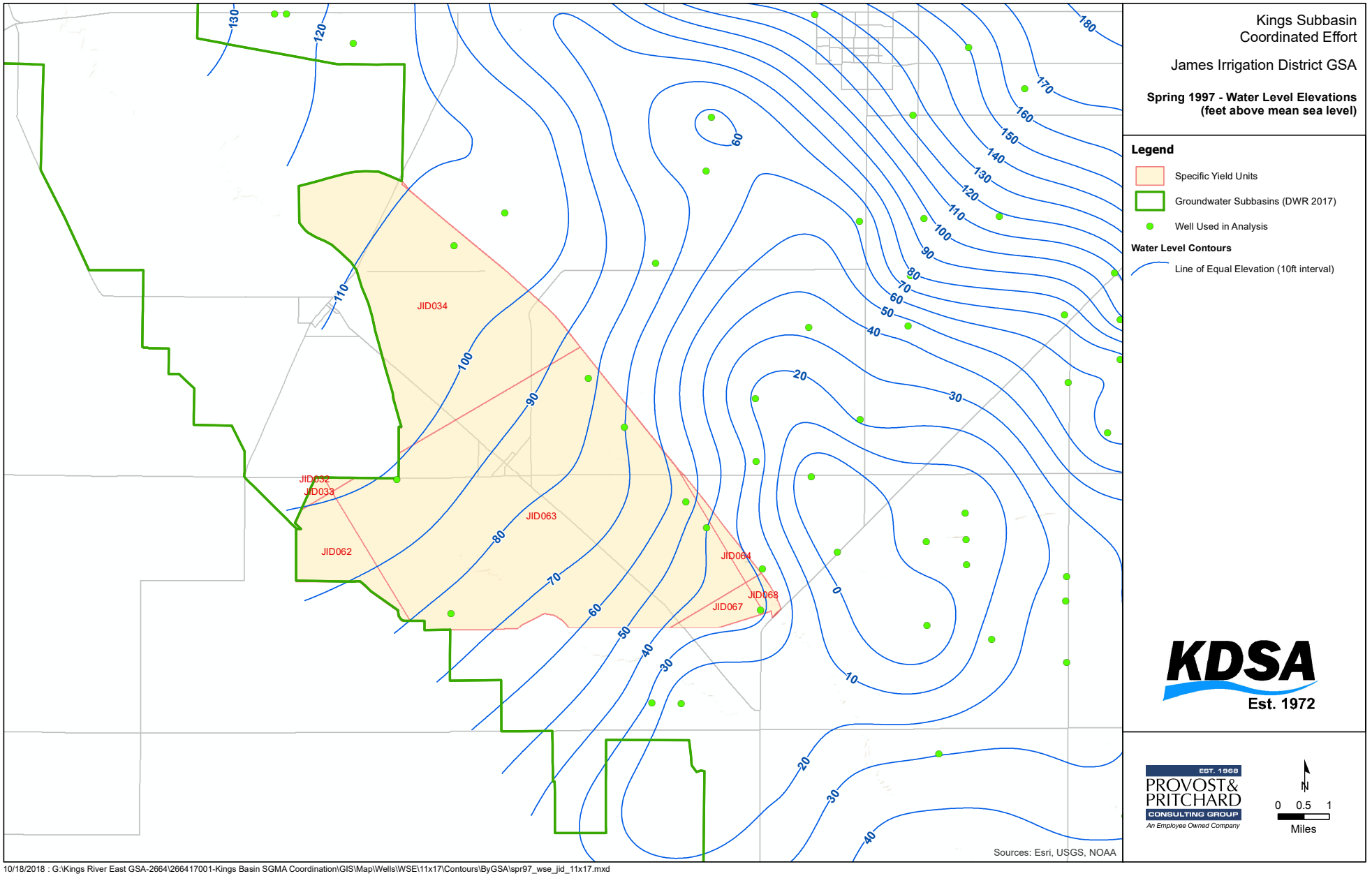

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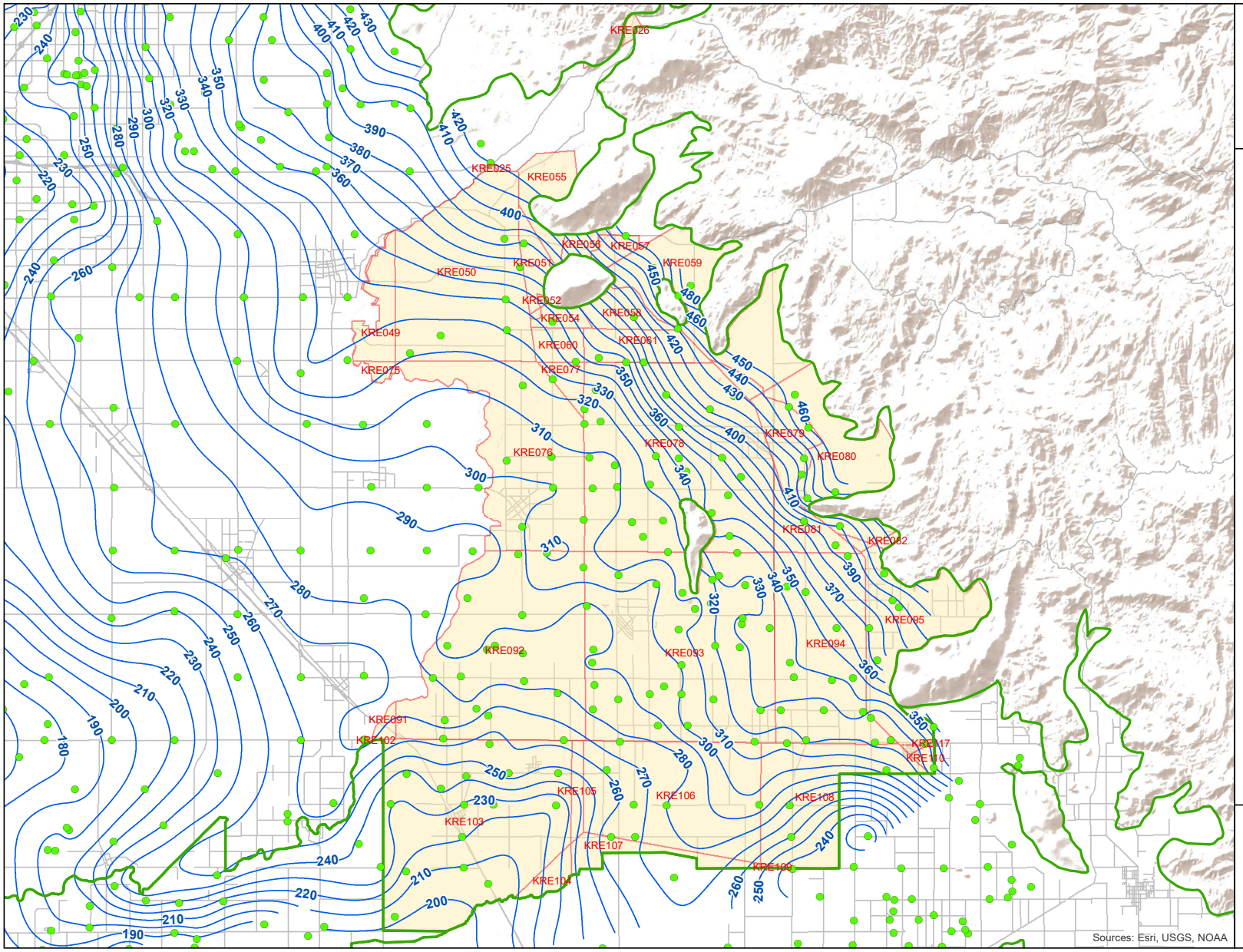

Kings Subbasin
Coordinated Effort

Kings River East GSA

Spring 1997- Water Level Elevations (feet above mean sea level)

Legend

- Specific Yield Units
- Groundwater Subbasins (DWR 2017)
- Well Used in Analysis

Water Level Contours

- Line of Equal Elevation (10ft interval)

KDSA
Est. 1972

EST. 1968
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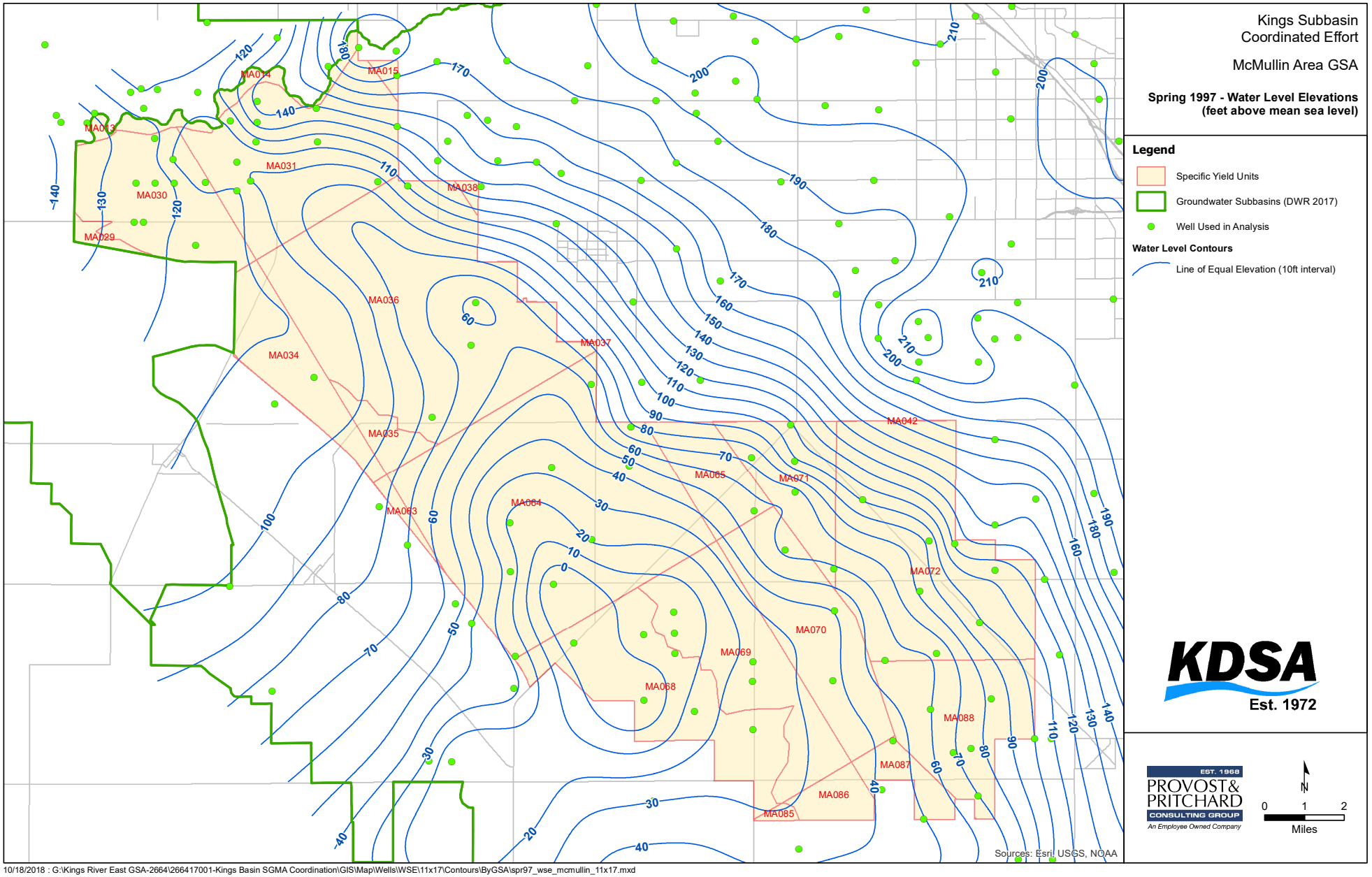

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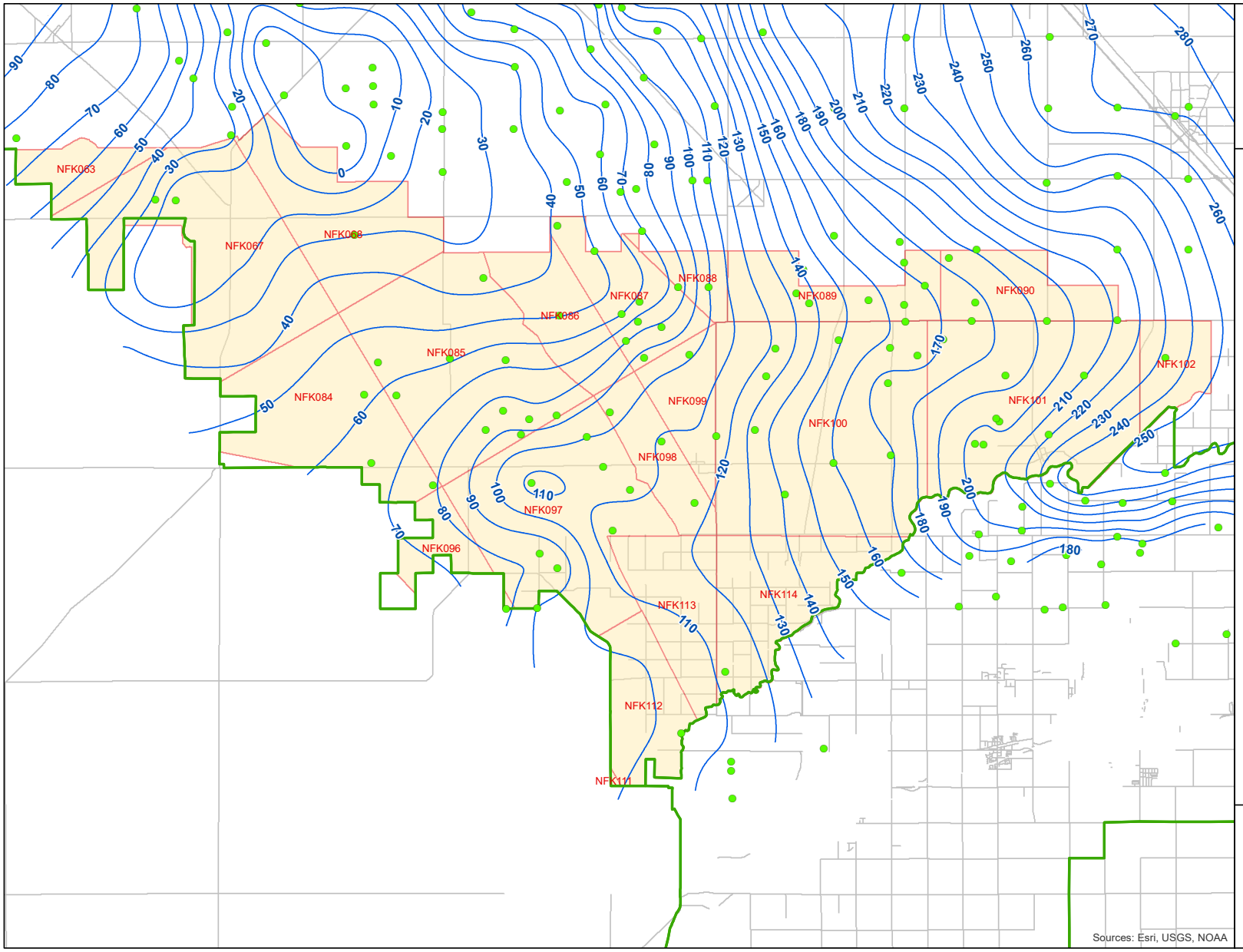

Kings Subbasin
Coordinated Effort

North Fork Kings GSA

Spring 1997 - Water Level Elevations (feet above mean sea level)

Legend

- Specific Yield Units
- Groundwater Subbasins (DWR 2017)
- Well Used in Analysis

Water Level Contours

- Line of Equal Elevation (10ft interval)

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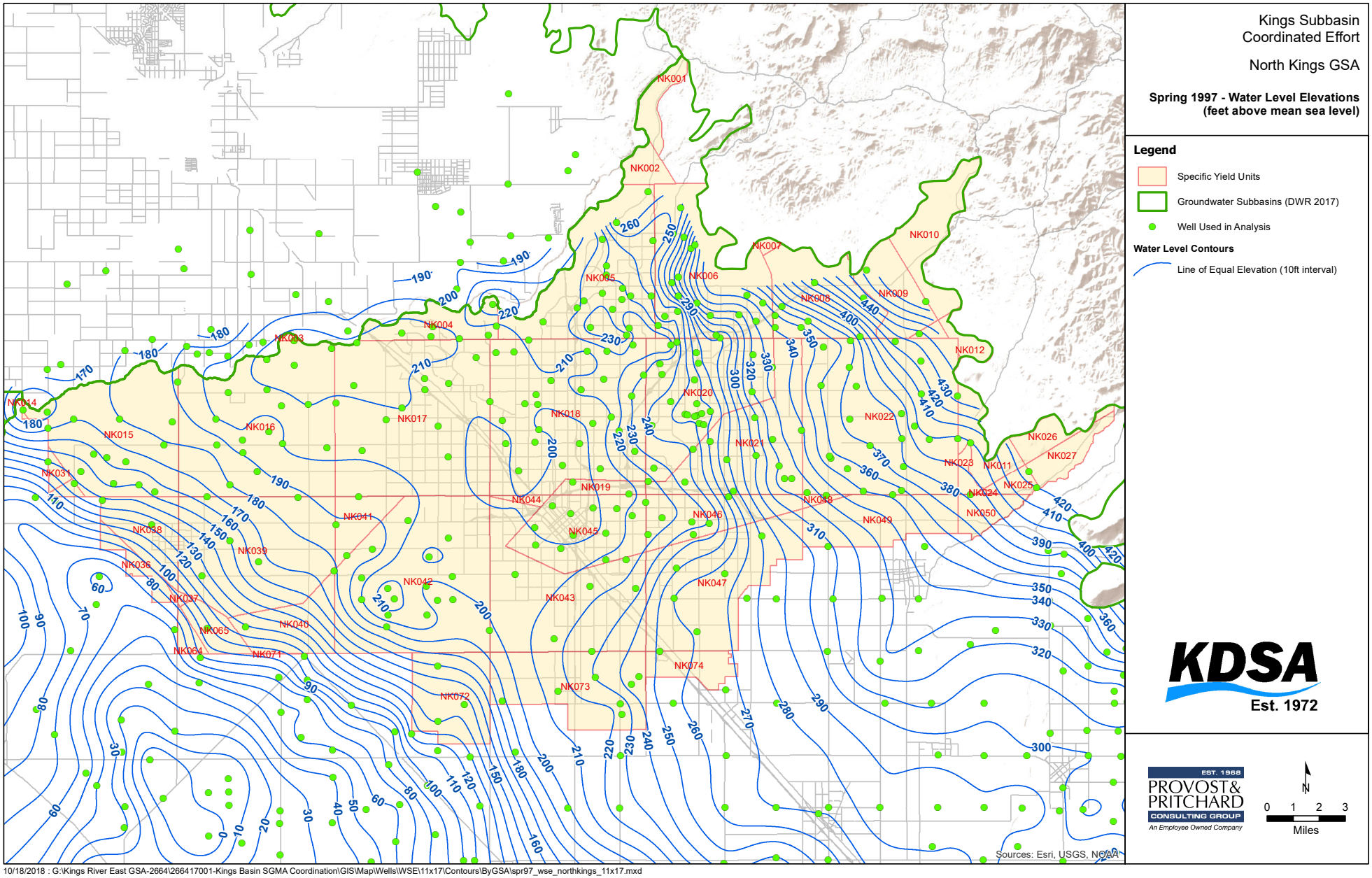
Kings Subbasin
Coordinated Effort
North Kings GSA
Spring 1997 - Water Level Elevations
(feet above mean sea level)
Legend
Specific Yield Units
Groundwater Subbasins (DWR 2017)
Well Used in Analysis
Water Level Contours
Line of Equal Elevation (10ft interval)
KDSA
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Sources: Esri, USGS, NOAA
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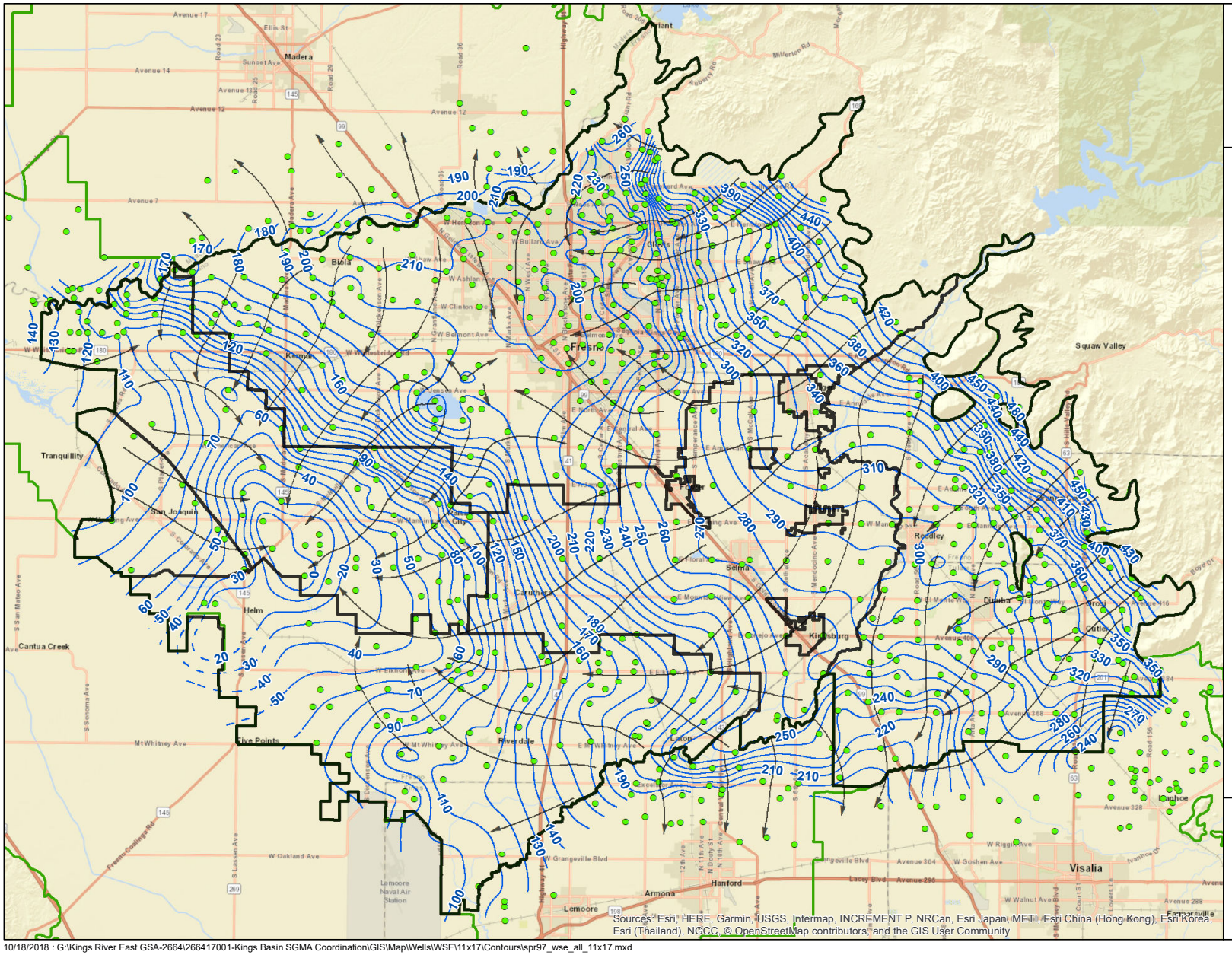

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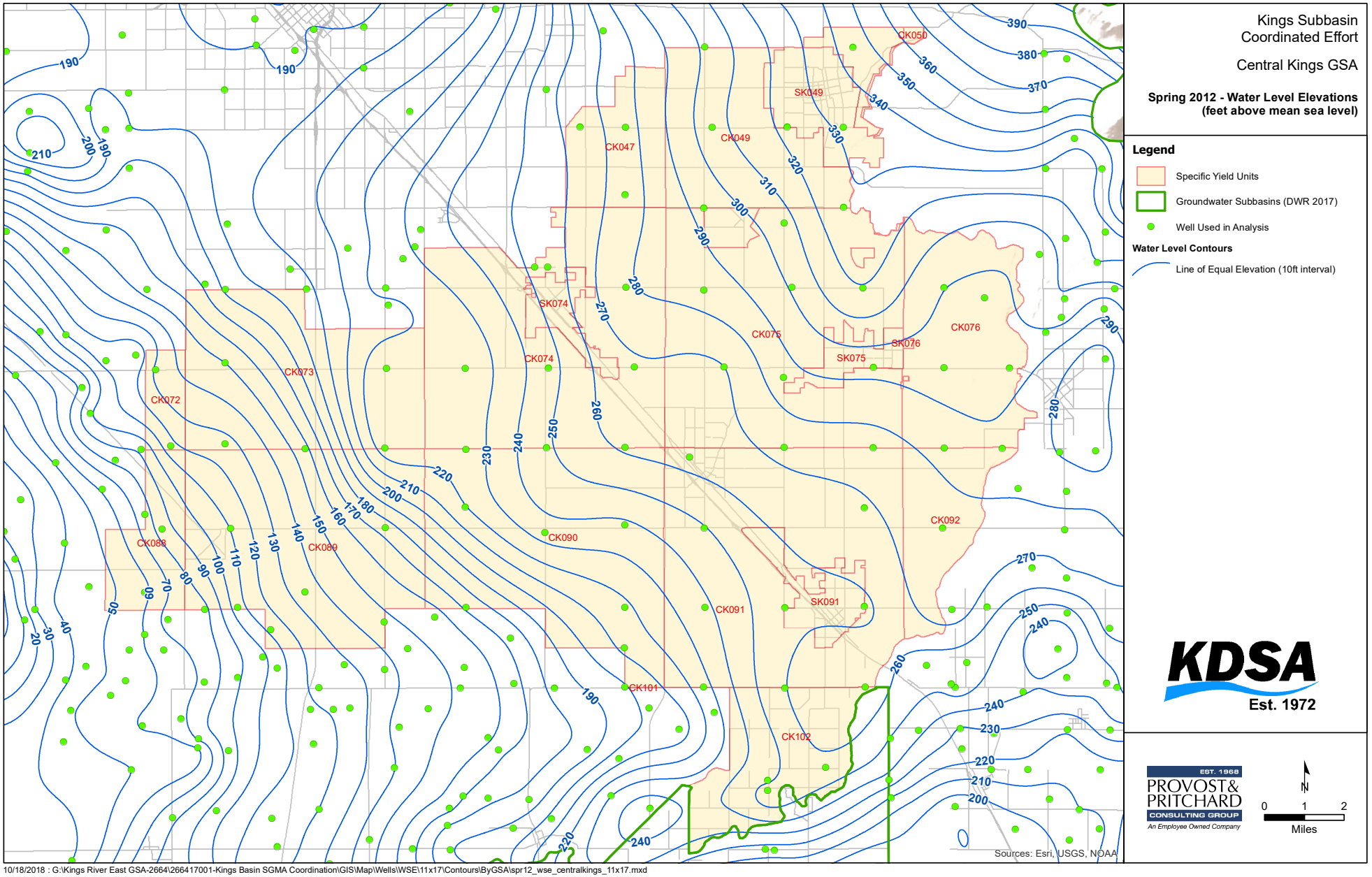

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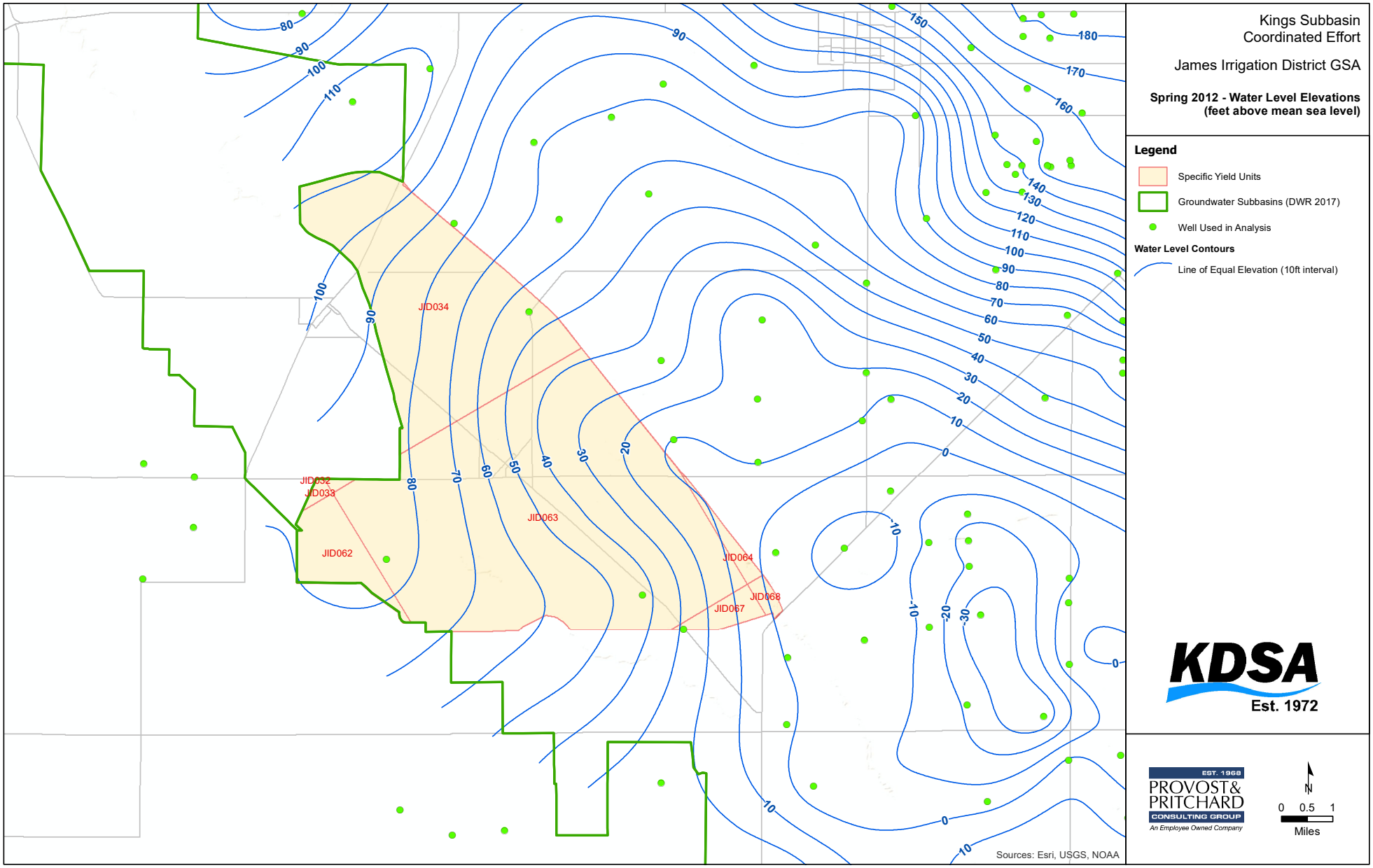

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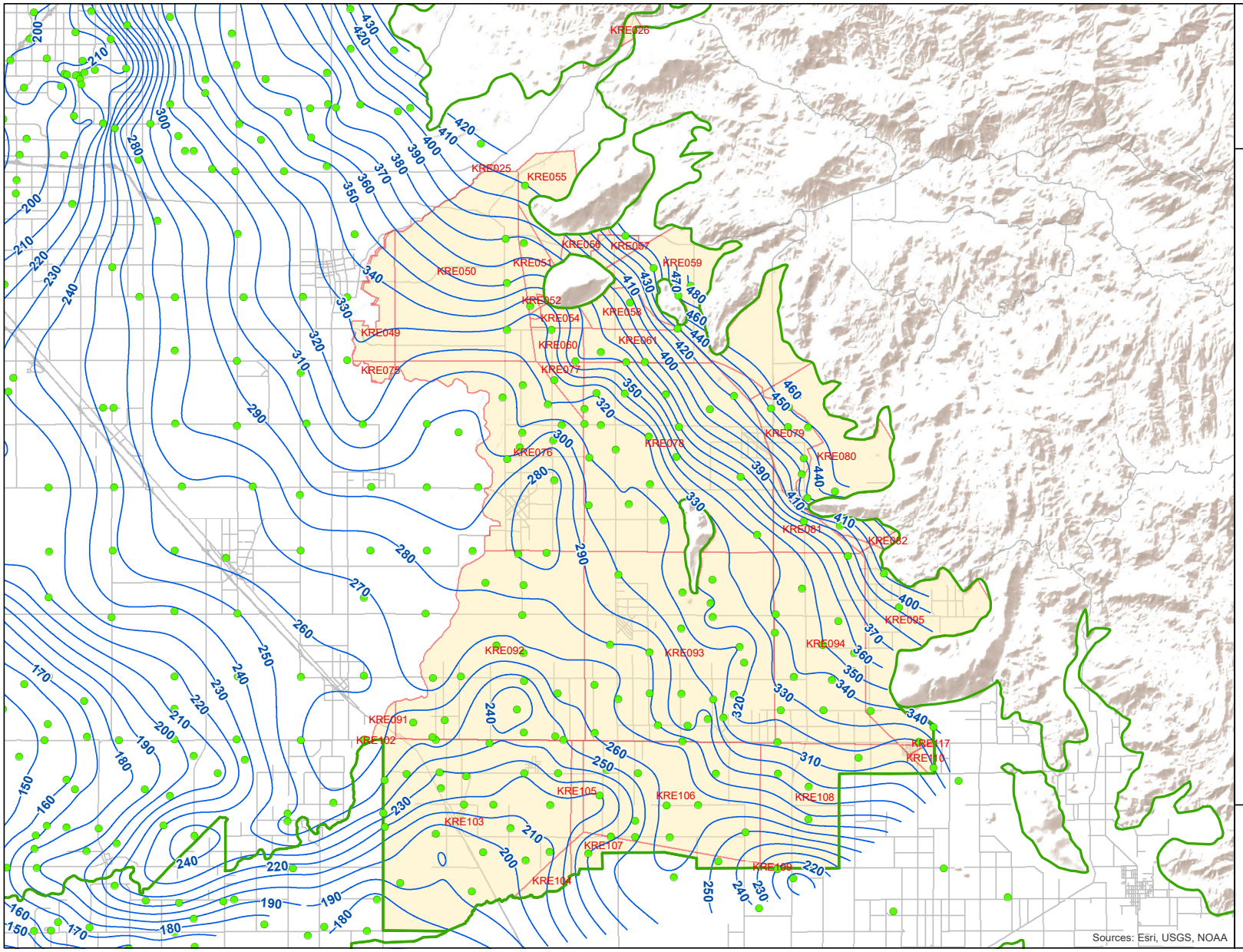

Kings Subbasin
Coordinated Effort

Kings River East GSA

Spring 2012 - Water Level Elevations (feet above mean sea level)

Legend

- Specific Yield Units
- Groundwater Subbasins (DWR 2017)
- Well Used in Analysis

Water Level Contours

- Line of Equal Elevation (10ft interval)

KDSA
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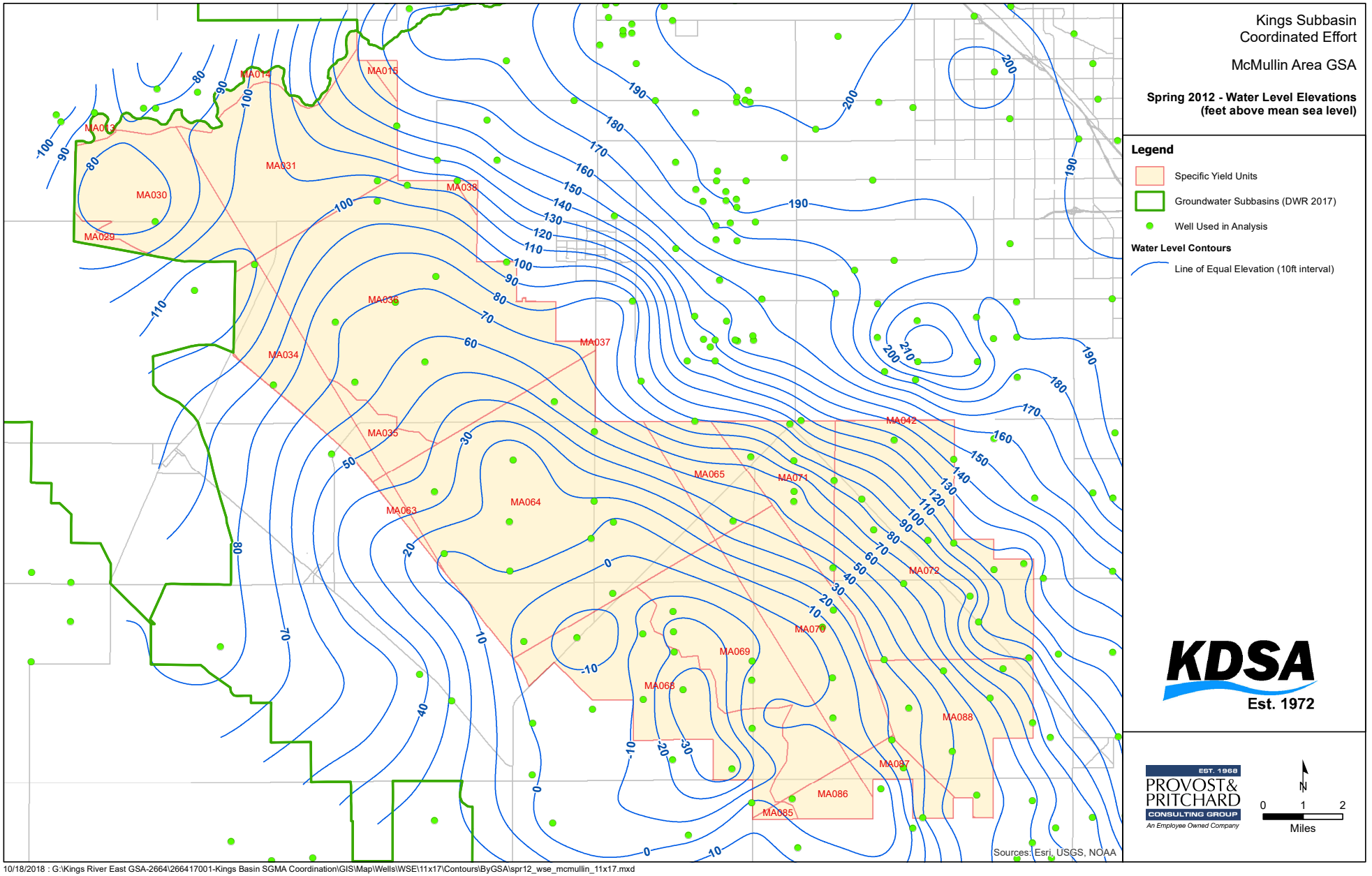

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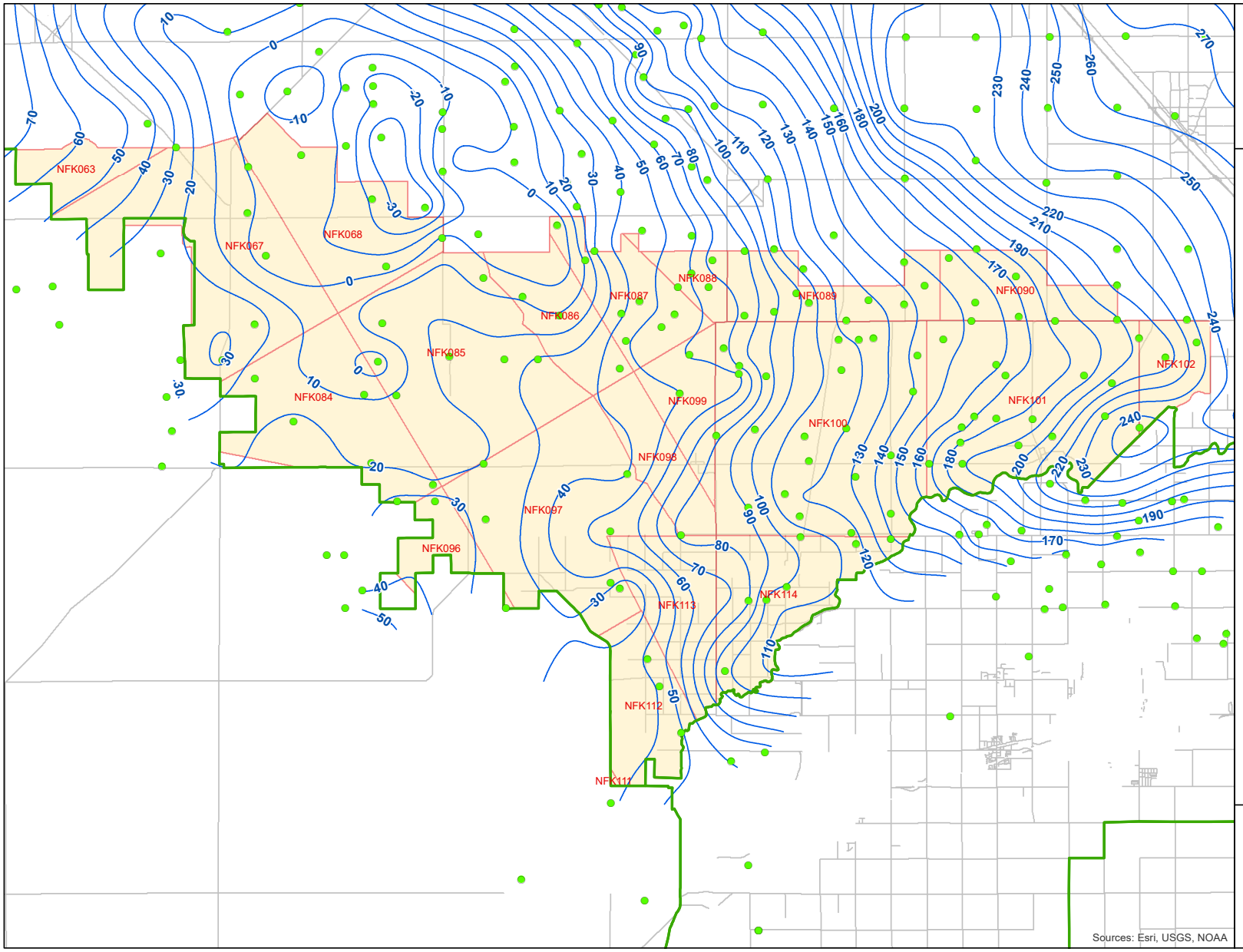

Kings Subbasin
Coordinated Effort

North Fork Kings GSA

Spring 2012 - Water Level Elevations (feet above mean sea level)

Legend

- Specific Yield Units
- Groundwater Subbasins (DWR 2017)
- Well Used in Analysis

Water Level Contours

- Line of Equal Elevation (10ft interval)

KDSA
Est. 1972

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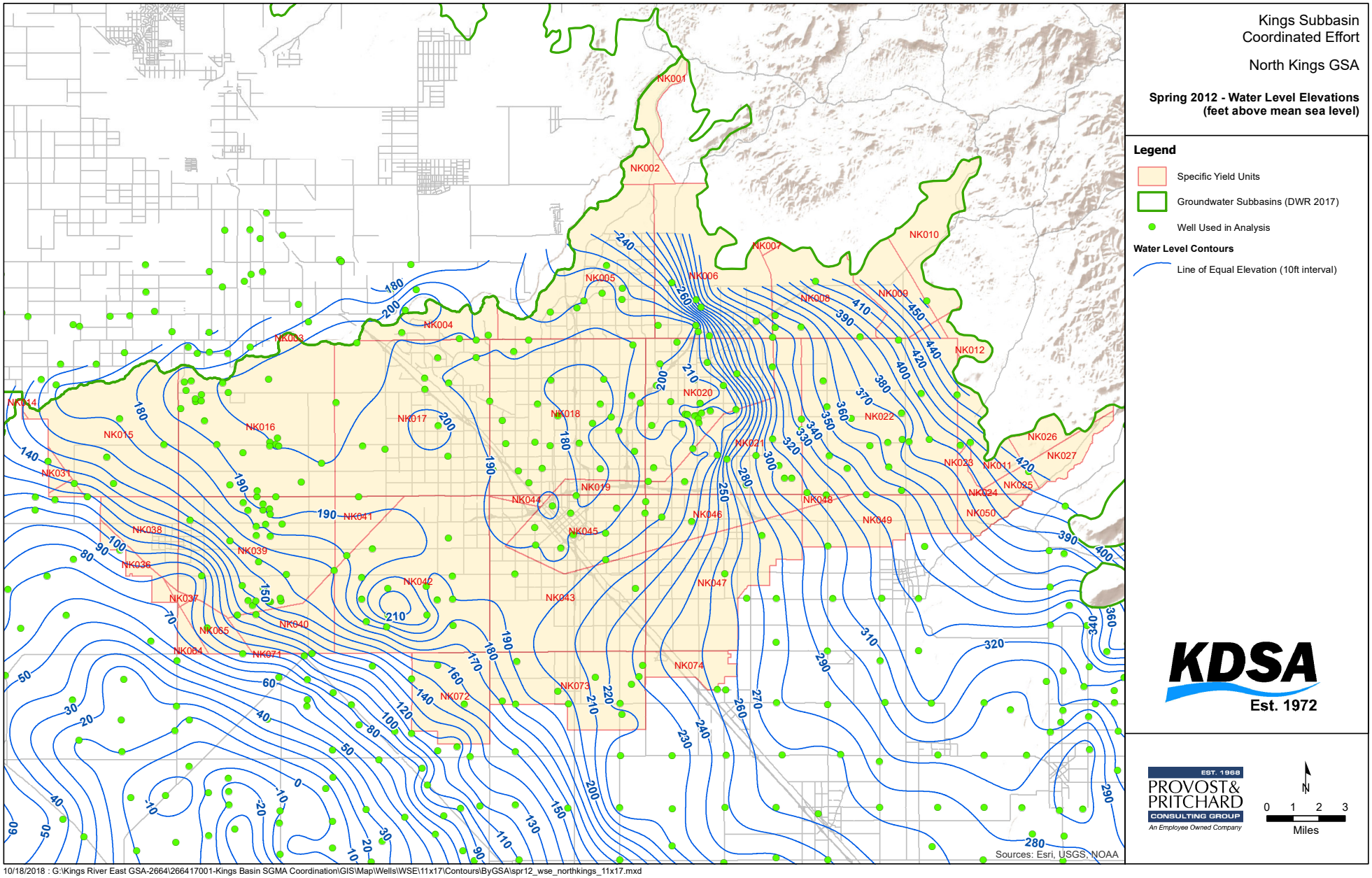
Kings Subbasin
Coordinated Effort
North Kings GSA
Spring 2012 - Water Level Elevations
(feet above mean sea level)
Legend
Specific Yield Units
Groundwater Subbasins (DWR 2017)
Well Used in Analysis
Water Level Contours
Line of Equal Elevation (10ft interval)
KDSA
Est. 1972
EST. 1968
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Sources: Esri, USGS, NOAA
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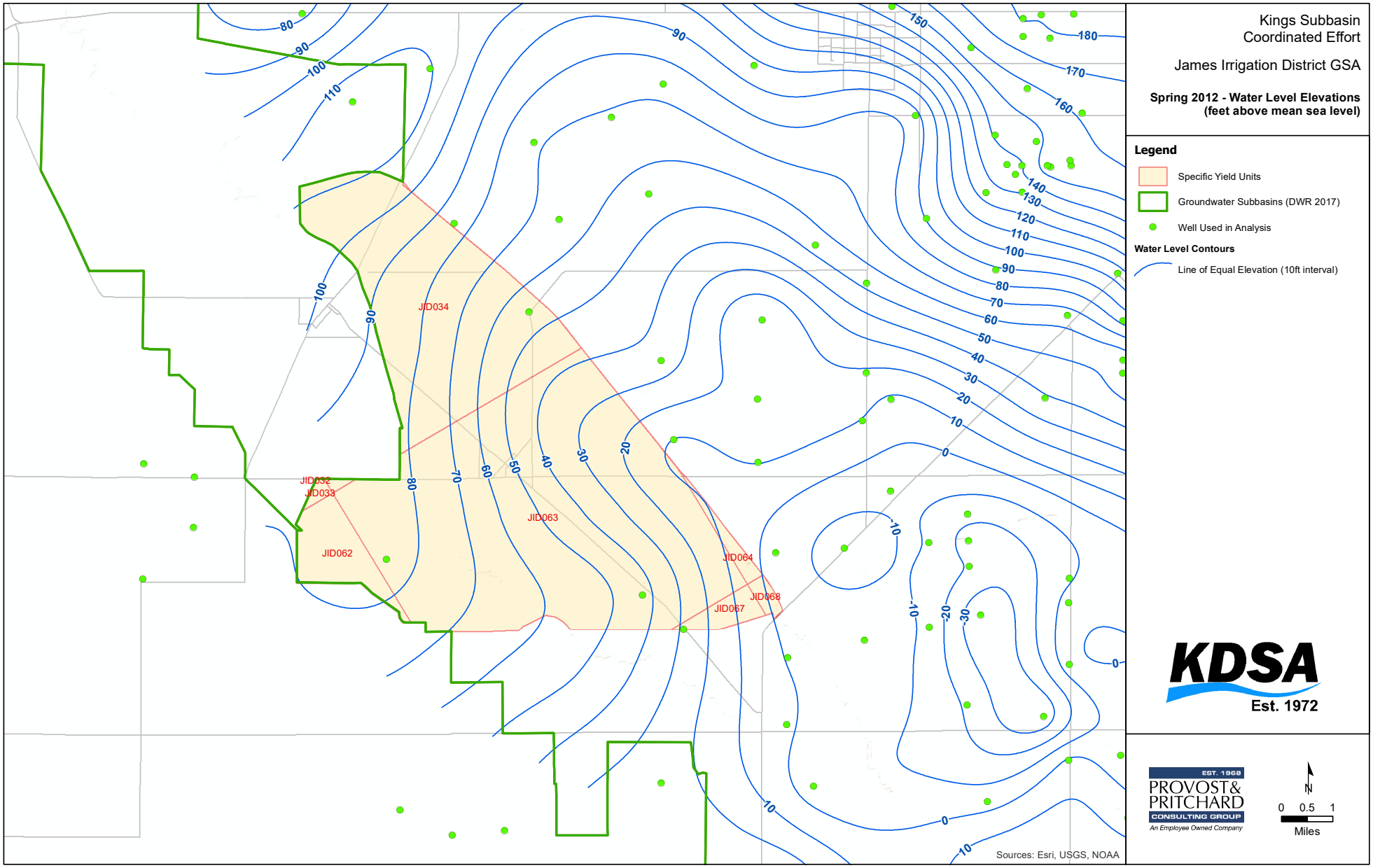

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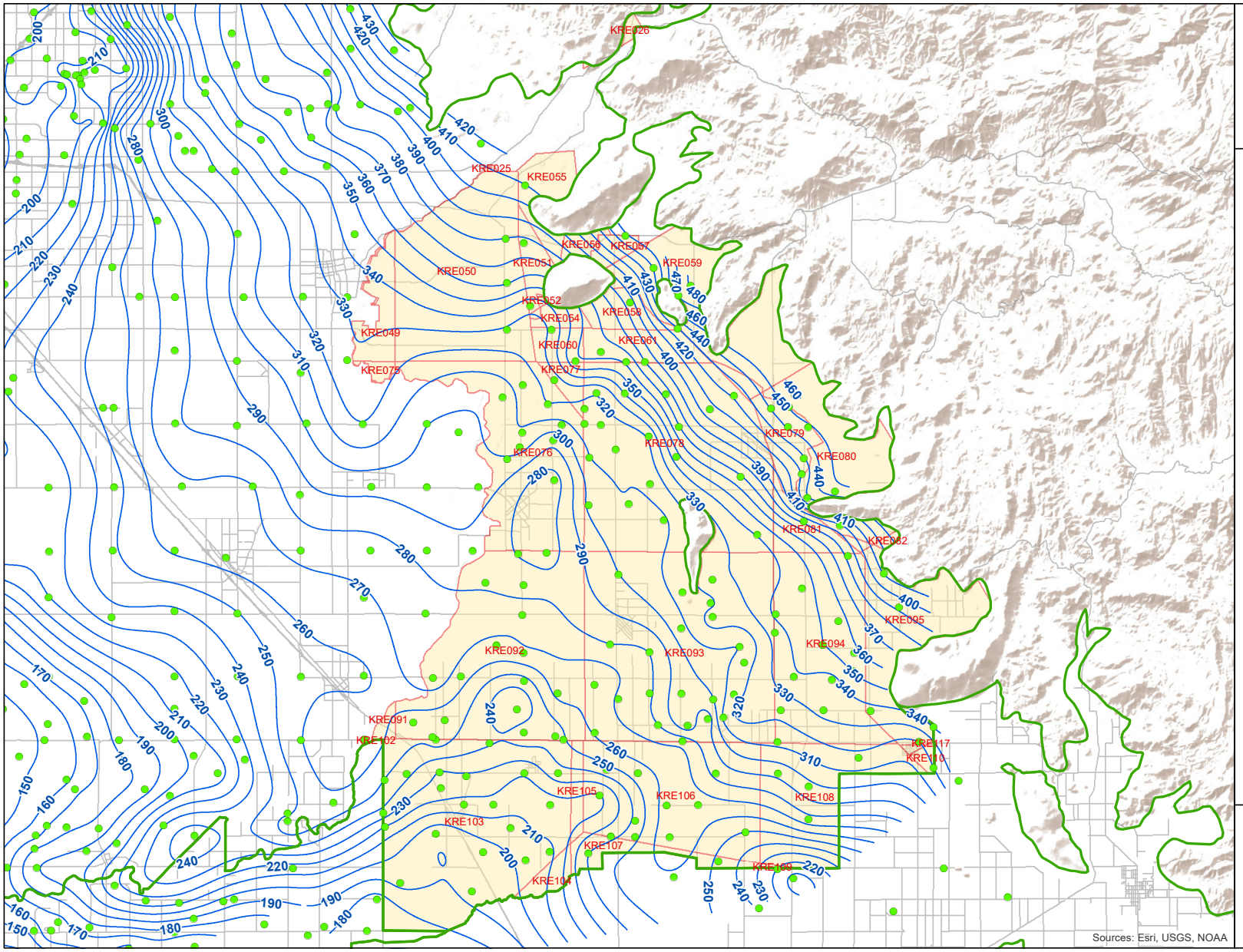

Kings Subbasin
Coordinated Effort

Kings River East GSA

Spring 2012 - Water Level Elevations
(feet above mean sea level)

Legend

- Specific Yield Units
- Groundwater Subbasins (DWR 2017)
- Well Used in Analysis

Water Level Contours

- Line of Equal Elevation (10ft interval)

KDSA
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Sources: Esri, USGS, NOAA

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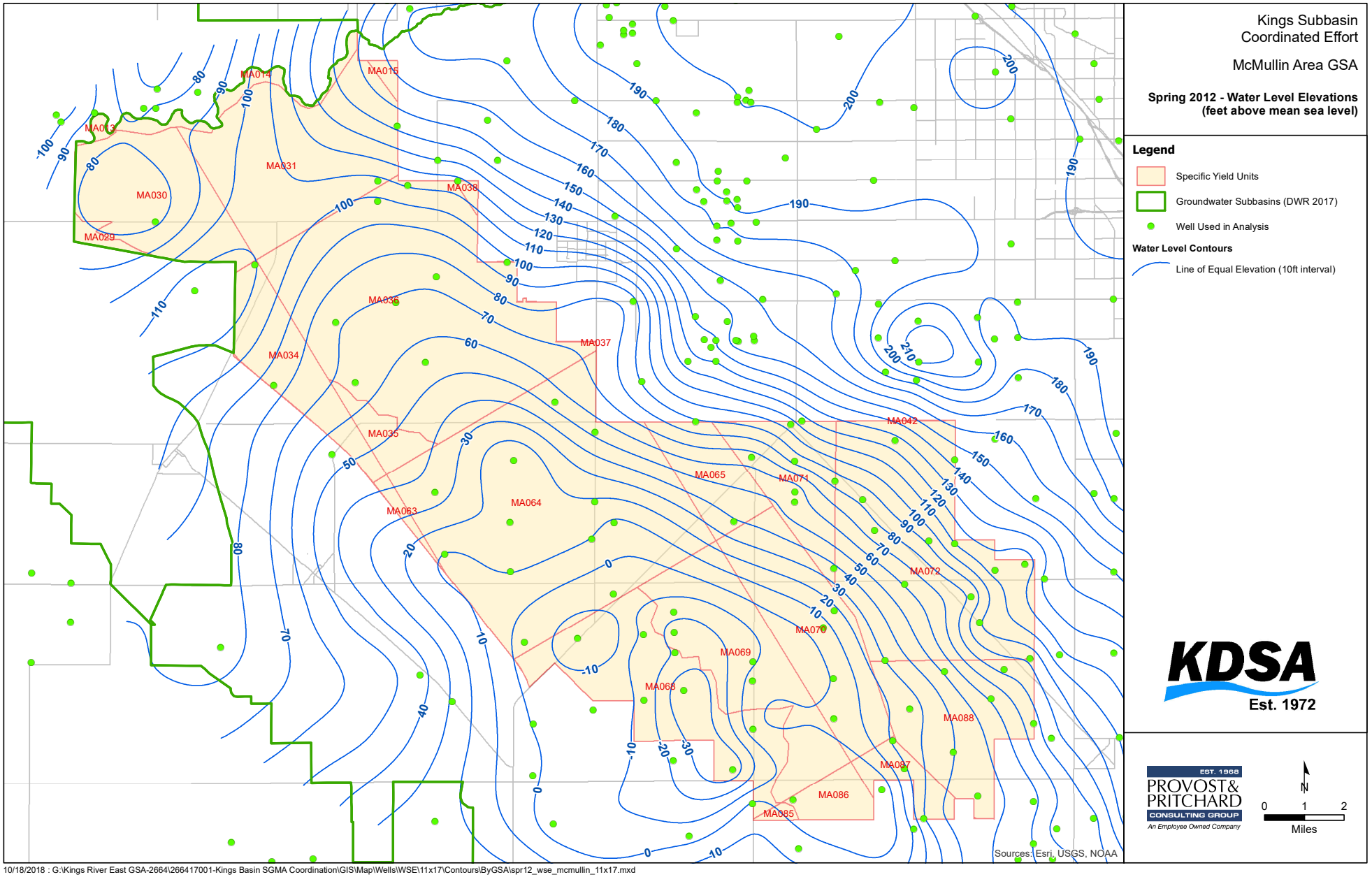

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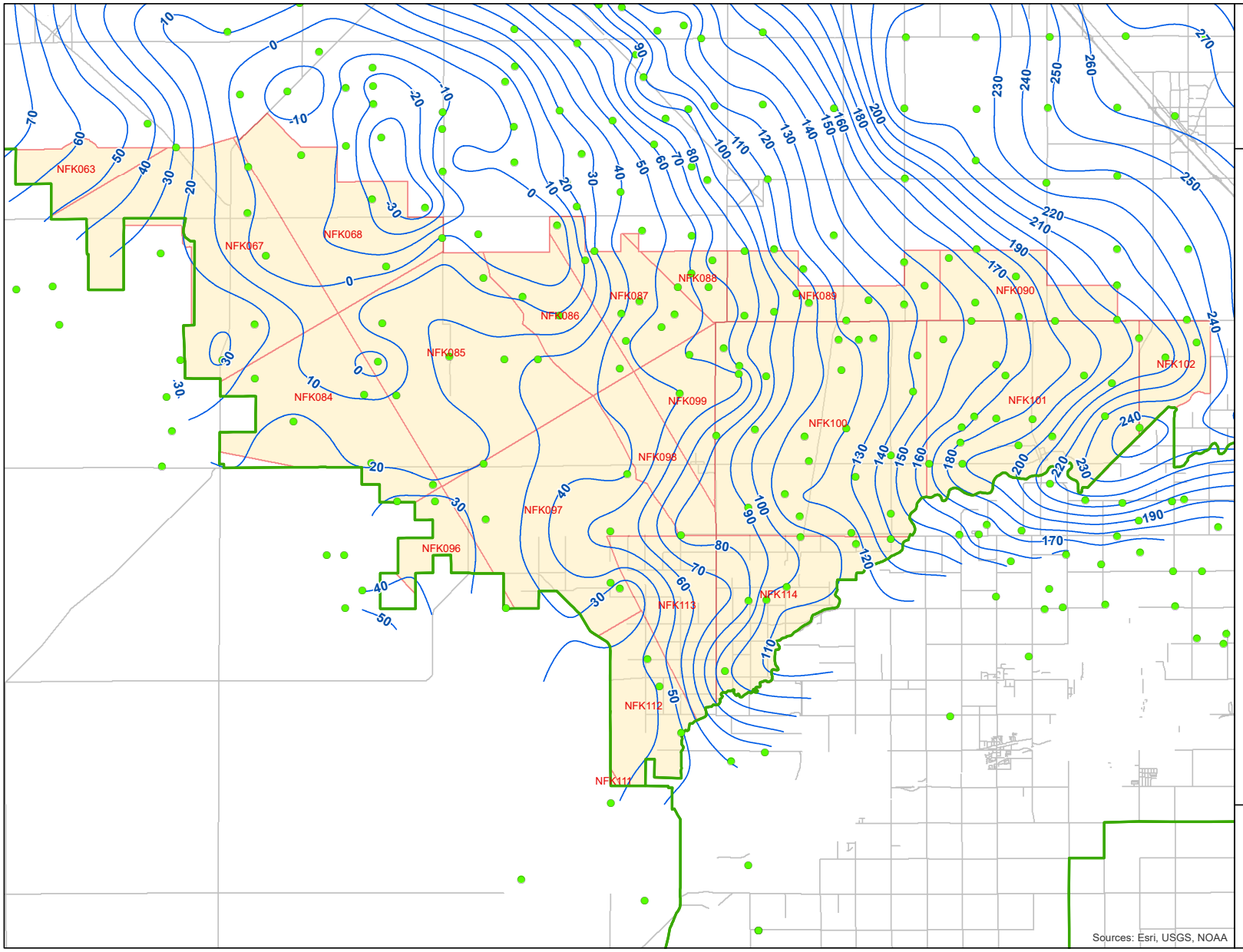

Kings Subbasin
Coordinated Effort

North Fork Kings GSA

Spring 2012 - Water Level Elevations (feet above mean sea level)

Legend

- Specific Yield Units
- Groundwater Subbasins (DWR 2017)
- Well Used in Analysis

Water Level Contours

- Line of Equal Elevation (10ft interval)

KDSA
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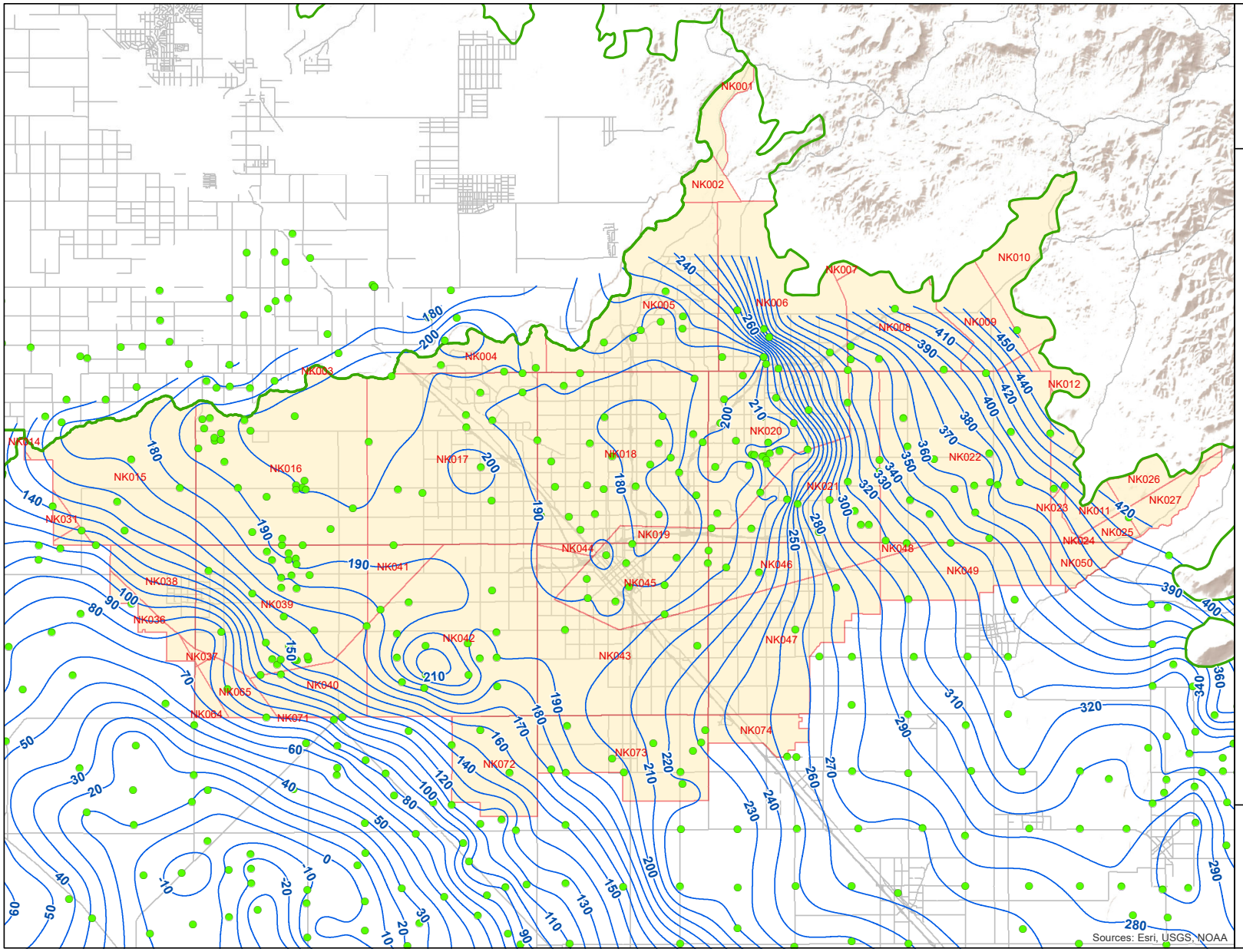

Kings Subbasin
Coordinated Effort

North Kings GSA

Spring 2012 - Water Level Elevations (feet above mean sea level)

Legend

- Specific Yield Units
- Groundwater Subbasins (DWR 2017)
- Well Used in Analysis

Water Level Contours

- Line of Equal Elevation (10ft interval)

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Est. 1972

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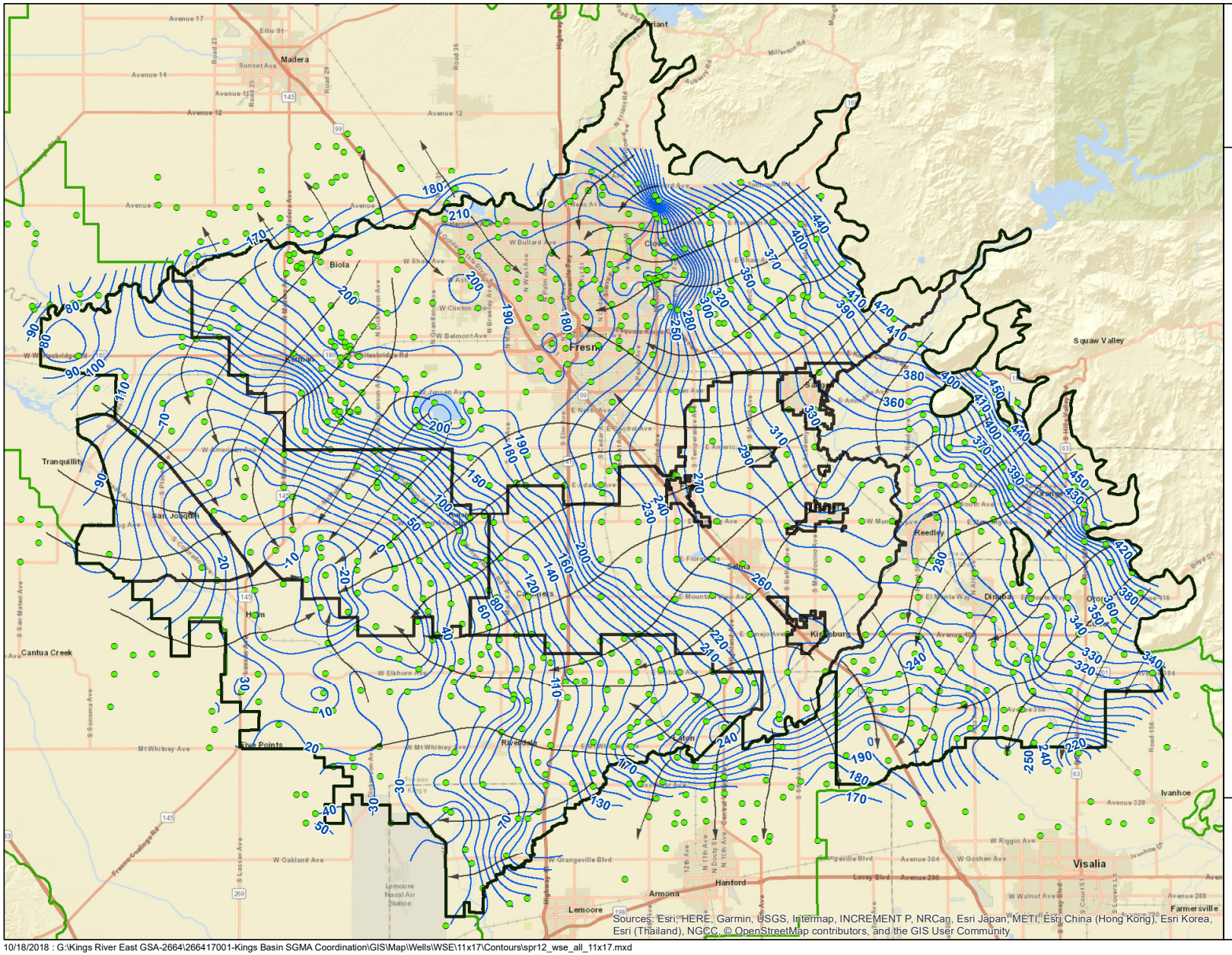
Kings Subbasin
Coordinated Effort
Kings Coordinated Effort GSAs
Spring 2012 - Water Level Elevations
(feet above mean sea level)
Legend
Kings Coordinated Effort GSAs
Groundwater Subbasins (DWR 2017)
Well Used in Analysis
Water Level Contours
Line of Equal Elevation (10ft interval)
Direction of Groundwater Flow
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CONSULTING GROUP
An Employee Owned Company
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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
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Attachment 2

Well Water Level Data used in Contour Maps

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
CK047	CID	Central Kings GSA	CID05	T14S R21E 25	329.4	42.8	53.5	286.6	275.9
CK047	CID	Central Kings GSA	CID04	T14S R21E 27	322.0	46.0	57.3	276.0	264.7
CK047	CID	Central Kings GSA	CID15	T14S R21E 36	326.6		51.5		275.1
CK049	DWR	Central Kings GSA	367211N1195432W001	T14S R22E 14	376.8		28.7		348.1
CK049	CID	Central Kings GSA	CID09	T14S R22E 14	374.4	26.8	29.6	347.6	344.8
CK049	DWR	Central Kings GSA	366922N1196110W001	T14S R22E 29	345.0		36.5		308.5
CK049	CID	Central Kings GSA	CID06	T14S R22E 29	342.4	32.5	36.6	309.9	305.8
CK049	CID	Central Kings GSA	CID13	T15S R22E 02	352.4	24.7	24.7	327.7	327.7
CK072	DWR	Central Kings GSA	366052N1198624W001	T15S R19E 25	248.0		113.5		134.5
CK072	CID	Central Kings GSA	CID71	T15S R19E 25	246.0	117.0	114.5	129.0	131.5
CK072	DWR	Central Kings GSA	365774N1198516W001	T15S R19E 36	245.6	127.0	129.1	118.6	116.5
CK073	CID	Central Kings GSA	CID73	T15S R20E 08	261.5	80.0	80.0	181.5	181.5
CK073	CID	Central Kings GSA	CID74	T15S R20E 20	253.8	70.1	103.7	183.7	150.1
CK073	DWR	Central Kings GSA	366049N1197543W001	T15S R20E 24	277.4		76.3		201.1
CK073	CID	Central Kings GSA	CID78	T15S R20E 25	275.2	47.8	47.8	227.4	227.4
CK073	CID	Central Kings GSA	CID69	T15S R20E 32	248.2		121.8		126.4
CK073	CID	Central Kings GSA	CID67	T16S R20E 01	266.4	42.2	42.2	224.2	224.2
CK074	DWR	Central Kings GSA	366344N1197177W001	T15S R21E 08	294.8	37.5		257.3	
CK074	FID	Central Kings GSA	15S21E10M001MX	T15S R21E 10	305.7	38.9	51.0	266.8	254.7
CK074	CID	Central Kings GSA	CID16	T15S R21E 12	318.8	40.3	40.3	278.5	278.5
CK074	DWR	Central Kings GSA	366053N1196788W001	T15S R21E 22	302.5		53.6		248.9
CK074	CID	Central Kings GSA	CID01	T15S R21E 24	303.0		34.7		268.3
CK074	CID	Central Kings GSA	CID81	T15S R21E 27	301.5	37.5	55.1	264.0	246.4
CK074	CID	Central Kings GSA	CID79	T15S R21E 30	286.4	59.1	62.7	227.3	223.7
CK074	DWR	Central Kings GSA	365761N1197188W001	T15S R21E 31	283.7		55.6		228.1
CK075	CID	Central Kings GSA	CID12	T15S R22E 03	341.0	13.4	34.7	327.6	306.3
CK075	CID	Central Kings GSA	CID14	T15S R22E 06	334.0	31.4	41.0	302.6	293.0
CK075	CID	Central Kings GSA	CID19	T15S R22E 14	347.3	35.7	28.0	311.6	319.3
CK075	CID	Central Kings GSA	CID18	T15S R22E 15	338.3	31.8	37.2	306.6	301.1
CK075	DWR	Central Kings GSA	366339N1196096W001	T15S R22E 17	329.0		44.3		284.7
CK075	CID	Central Kings GSA	CID17	T15S R22E 18	329.7		45.0		284.7
CK075	CID	Central Kings GSA	CID26	T15S R22E 20	309.3		39.3		270.0
CK075	CID	Central Kings GSA	CID25	T15S R22E 28	327.3		41.7		285.6
CK075	DWR	Central Kings GSA	365764N1196104W001	T16S R22E 05	311.6	40.0		271.6	
CK076	DWR	Central Kings GSA	366339N1195027W001	T15S R23E 17	358.7		54.8		303.9
CK076	CID	Central Kings GSA	CID21	T15S R23E 17	359.0		61.2		297.8
CK076	CID	Central Kings GSA	CID20	T15S R23E 18	355.9	53.1	55.6	302.9	300.3
CK076	CID	Central Kings GSA	CID22	T15S R23E 21	346.1	47.2	51.9	298.9	294.2
CK076	DWR	Central Kings GSA	366044N1194732W001	T15S R23E 28	347.1		50.4		296.7
CK076	CID	Central Kings GSA	CID23	T15S R23E 29	341.6	45.7	45.7	295.9	295.9
CK088	CID	Central Kings GSA	CID70	T16S R19E 01	242.5	102.2	138.0	140.3	104.5
CK088	DWR	Central Kings GSA	365471N1198554W001	T16S R19E 13	237.7	129.0	153.0	108.7	84.7
CK088	CID	Central Kings GSA	CID55	T16S R19E 13	234.0	134.0	134.0	100.0	100.0
CK088	CID	Central Kings GSA	CID54	T16S R19E 24	215.7		158.0		57.7
CK089	CID	Central Kings GSA	CID68	T16S R20E 04	260.6	62.1	103.0	198.5	157.6
CK089	CID	Central Kings GSA	CID58	T16S R20E 12	264.8	87.8	89.9	177.1	174.9
CK089	CID	Central Kings GSA	CID56	T16S R20E 17	248.4	132.4	138.0	116.0	110.4
CK089	CID	Central Kings GSA	CID50	T16S R20E 20	240.0		135.1		104.9
CK089	CID	Central Kings GSA	CID49	T16S R20E 21	256.7	94.4	121.8	162.3	134.9
CK089	DWR	Central Kings GSA	365216N1197577W001	T16S R20E 23	257.5	80.1		177.4	
CK089	CID	Central Kings GSA	CID48	T16S R20E 23	237.5	78.5	107.7	159.0	129.8
CK089	DWR	Central Kings GSA	365132N1197554W001	T16S R20E 26	254.7	82.4	107.4	172.3	147.3
CK089	DWR	Central Kings GSA	365105N1198066W001	T16S R20E 28	243.9	102.3	131.5	141.6	112.4
CK090	CID	Central Kings GSA	CID64	T16S R21E 01	307.4	37.5	46.2	269.9	261.2
CK090	CID	Central Kings GSA	CID65	T16S R21E 03	295.2	32.7	46.7	262.5	248.5
CK090	CID	Central Kings GSA	CID66	T16S R21E 05	281.5		56.6		224.9
CK090	CID	Central Kings GSA	CID59	T16S R21E 07	276.9		57.4		219.5
CK090	DWR	Central Kings GSA	365469N1196471W001	T16S R21E 11	291.0		50.0		241.0
CK090	CID	Central Kings GSA	CID63	T16S R21E 12	288.4	48.9	50.0	239.5	238.4
CK090	CID	Central Kings GSA	CID60	T16S R21E 16	295.2	51.1	61.1	244.1	234.1
CK090	DWR	Central Kings GSA	365183N1197185W001	T16S R21E 19	265.5		92.0		173.5
CK090	CID	Central Kings GSA	CID62	T16S R21E 25	279.2	59.1	61.2	220.1	218.0
CK090	CID	Central Kings GSA	CID47	T16S R21E 29	263.4	72.1	92.0	191.2	171.4
CK091	CID	Central Kings GSA	CID29	T16S R22E 01	324.2	43.3	48.5	280.9	275.7
CK091	CID	Central Kings GSA	CID28	T16S R22E 04	317.2	29.8	43.9	287.4	273.3
CK091	CID	Central Kings GSA	CID27	T16S R22E 06	308.0	38.1	45.0	269.9	263.0
CK091	DWR	Central Kings GSA	365500N1195400W001	T16S R22E 11	316.5		43.2		273.3
CK091	CID	Central Kings GSA	CID35	T16S R22E 12	314.2	33.4	45.2	280.7	269.0

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
CK091	CID	Central Kings GSA	CID38	T16S R22E 18	297.2	40.9	47.6	256.3	249.6
CK091	CID	Central Kings GSA	CID34	T16S R22E 24	296.8	31.7	38.0	265.1	258.8
CK091	CID	Central Kings GSA	CID39	T16S R22E 29	285.2	40.2	47.1	245.0	238.1
CK091	CID	Central Kings GSA	CID43	T16S R22E 31	276.7		50.5		226.2
CK092	CID	Central Kings GSA	CID31	T16S R23E 04	326.6	41.7	39.0	284.9	287.6
CK092	CID	Central Kings GSA	CID30	T16S R23E 05	329.2	40.7	45.9	288.5	283.3
CK092	CID	Central Kings GSA	CID32	T16S R23E 18	317.6	34.9	41.0	282.7	276.6
CK102	CID	Central Kings GSA	CID41	T16S R22E 36	290.0	17.6	24.2	272.4	265.8
CK102	CID	Central Kings GSA	CID42	T17S R22E 03	284.6	25.2	25.2	259.4	259.4
CK102	DWR	Central Kings GSA	364600N1195568W001	T17S R22E 11	285.7	23.0	29.2	262.7	256.5
CK102	DWR	Central Kings GSA	364517N1195829W001	T17S R22E 16	278.7	20.5	24.4	258.2	254.3
CK102	DWR	Central Kings GSA	364553N1195829W001	T17S R22E 16	278.7	21.0	30.2	257.7	248.5
JID034	DWR	JID	366685N1202060W001	T14S R16E 35	168.5	62.3		106.2	
JID034	DWR	JID	366502N1201782W001	T15S R16E 01	167.8		113.5		54.3
JID063	DWR	JID	366022N1202260W003	T15S R16E 28	171.1	72.5		98.6	
JID063	DWR	JID	366022N1202260W004	T15S R16E 28	171.1	72.8		98.3	
JID063	DWR	JID	365808N1202249W001	T15S R16E 33	172.6		89.6		83.0
JID063	JID	JID	15S17E18B001MX	T15S R17E 18	173.0	90.6	103.3	82.4	69.7
JID063	JID	JID	15S17E20C001MX	T15S R17E 20	176.0	105.8	121.0	70.2	55.0
JID063	DWR	JID	365960N1201241W001	T15S R17E 28	181.6	127.1		54.5	
JID063	DWR	JID	365813N1201460W002	T15S R17E 32	177.7	16.1		161.6	
JID063	DWR	JID	365888N1201168W001	T15S R17E 33	181.1	140.9		40.2	
JID063	DWR	JID	365642N1202068W001	T16S R16E 02	178.2	101.8		76.4	
JID063	DWR	JID	365700N1201400W001	T16S R17E 05	174.5		131.2		43.3
JID067	DWR	JID	365655N1200977W001	T16S R17E 03	186.7	155.2		31.5	
JID067	KRCD	JID	B02	T16S R17E 09	178.6		150.0		28.6
KRE050	DWR	Kings River East GSA	367144N1194477W001	T14S R23E 15	395.6		9.7		385.9
KRE050	DWR	Kings River East GSA	367186N1194574W001	T14S R23E 15	394.6	9.9		384.7	
KRE050	AID	Kings River East GSA	B014A	T14S R23E 15	394.7		15.0		379.7
KRE050	DWR	Kings River East GSA	367056N1194485W001	T14S R23E 22	382.6	17.4		365.2	
KRE050	AID	Kings River East GSA	B015A	T14S R23E 22	382.5		22.1		360.5
KRE050	DWR	Kings River East GSA	366908N1194568W001	T14S R23E 27	366.0	25.4		340.6	
KRE050	DWR	Kings River East GSA	366664N1195118W001	T14S R23E 31	335.6	14.5		321.1	
KRE050	DWR	Kings River East GSA	366744N1194943W001	T14S R23E 32	337.6	12.5		325.1	
KRE050	DWR	Kings River East GSA	366767N1194568W001	T14S R23E 34	361.6	30.7		330.9	
KRE050	AID	Kings River East GSA	H020A	T14S R23E 34	361.5	30.7	33.1	330.8	328.4
KRE051	AID	Kings River East GSA	B013A	T14S R23E 14	414.7		11.1		403.6
KRE051	AID	Kings River East GSA	B013B	T14S R23E 14	390.7	11.2	14.0	379.5	376.7
KRE051	AID	Kings River East GSA	B018A	T14S R23E 26	364.5		30.1		334.4
KRE054	DWR	Kings River East GSA	366806N1194302W001	T14S R23E 25	397.6	51.8		345.8	
KRE055	AID	Kings River East GSA	B009A	T14S R23E 02	418.6		9.1		409.5
KRE057	OCID	Kings River East GSA	14S24E17C001MX	T14S R24E 17	462.8	2.2	15.2	460.6	447.6
KRE058	OCID	Kings River East GSA	14S24E28R001MX	T14S R24E 28	436.2	5.4	7.2	430.8	429.0
KRE058	OCID	Kings River East GSA	14S24E29C001MX	T14S R24E 29	432.0	41.0	36.5	391.0	395.5
KRE058	OCID	Kings River East GSA	14S24E29K001MX	T14S R24E 29	430.4	28.7	23.1	401.7	407.3
KRE059	OCID	Kings River East GSA	14S24E21D001MX	T14S R24E 21	450.2	0.3	9.2	449.9	441.0
KRE059	OCID	Kings River East GSA	14S24E21H001MX	T14S R24E 21	464.0		45.2		418.8
KRE059	OCID	Kings River East GSA	14S24E22L001MX	T14S R24E 22	486.8	1.0	5.8	485.8	481.0
KRE059	OCID	Kings River East GSA	14S24E22N001MX	T14S R24E 22	487.8	14.1	17.0	473.7	470.8
KRE059	DWR	Kings River East GSA	366763N1193582W002	T14S R24E 28	435.7		5.1		430.6
KRE060	AID	Kings River East GSA	H021A	T14S R23E 35	397.6		65.0		332.6
KRE060	AID	Kings River East GSA	H021B	T14S R23E 35	383.3		64.1		319.2
KRE060	DWR	Kings River East GSA	366625N1194163W001	T14S R23E 36	393.6	49.4		344.2	
KRE060	AID	Kings River East GSA	H026A	T15S R23E 01	393.7	49.4	37.1	344.3	356.6
KRE061	DWR	Kings River East GSA	366636N1194038W001	T14S R24E 31	397.6	41.9		355.7	
KRE061	AID	Kings River East GSA	B024A	T14S R24E 31	409.4		45.0		364.4
KRE061	DWR	Kings River East GSA	366616N1193874W001	T15S R24E 05	400.6	44.9		355.7	
KRE076	AID	Kings River East GSA	H027A	T15S R23E 02	376.6	59.8	62.1	316.8	314.5
KRE076	DWR	Kings River East GSA	366500N1194600W001	T15S R23E 03	370.5		61.7		308.8
KRE076	AID	Kings River East GSA	H029A	T15S R23E 10	366.8		62.1		304.7
KRE076	AID	Kings River East GSA	H030A	T15S R23E 11	376.6		57.1		319.5
KRE076	DWR	Kings River East GSA	366339N1194132W001	T15S R23E 12	373.6	60.7		312.9	
KRE076	AID	Kings River East GSA	H031B	T15S R23E 12	376.6	60.7	60.1	315.9	316.6
KRE076	AID	Kings River East GSA	H032A	T15S R23E 13	371.7		65.0		306.7
KRE076	AID	Kings River East GSA	H033A	T15S R23E 13	360.6		67.1		293.5
KRE076	AID	Kings River East GSA	H034A	T15S R23E 14	366.8		58.0		308.8
KRE076	AID	Kings River East GSA	H034B	T15S R23E 15	360.6		57.1		303.5
KRE076	DWR	Kings River East GSA	366169N1194568W001	T15S R23E 22	356.6	54.9		301.7	

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
KRE076	AID	Kings River East GSA	H035A	T15S R23E 22	356.6		58.1		298.6
KRE076	DWR	Kings River East GSA	366183N1194313W001	T15S R23E 23	360.6	53.9		306.7	
KRE076	DWR	Kings River East GSA	366044N1194304W001	T15S R23E 24	351.7	51.9		299.8	
KRE076	DWR	Kings River East GSA	366075N1194304W001	T15S R23E 24	353.6	55.0		298.6	
KRE076	DWR	Kings River East GSA	366183N1194299W001	T15S R23E 24	359.6	54.5		305.1	
KRE076	AID	Kings River East GSA	I037A	T15S R23E 24	351.7		75.0		276.7
KRE076	DWR	Kings River East GSA	365894N1194132W001	T15S R23E 25	348.6	42.9		305.7	
KRE076	DWR	Kings River East GSA	365864N1194482W001	T15S R23E 35	342.6	43.4		299.2	
KRE076	DWR	Kings River East GSA	365753N1194268W001	T15S R23E 36	337.6	27.0		310.6	
KRE077	DWR	Kings River East GSA	366539N1194302W001	T15S R23E 01	382.6	55.6		327.0	
KRE077	AID	Kings River East GSA	H026B	T15S R23E 01	382.5		57.1		325.5
KRE078	DWR	Kings River East GSA	366613N1193782W002	T15S R24E 05	401.6	16.8		384.8	
KRE078	AID	Kings River East GSA	I045A	T15S R24E 05	402.9	44.9	41.1	358.0	361.8
KRE078	AID	Kings River East GSA	I045B	T15S R24E 05	401.6		22.1		379.5
KRE078	DWR	Kings River East GSA	366489N1194057W001	T15S R24E 06	385.6	58.6		327.0	
KRE078	DWR	Kings River East GSA	366344N1194032W001	T15S R24E 07	375.6	59.7		315.9	
KRE078	DWR	Kings River East GSA	366403N1194129W001	T15S R24E 07	378.6	62.0		316.6	
KRE078	AID	Kings River East GSA	H031A	T15S R24E 07	379.9	63.0	62.0	316.9	317.9
KRE078	AID	Kings River East GSA	I047A	T15S R24E 07	385.5		64.0		321.5
KRE078	AID	Kings River East GSA	I054A	T15S R24E 07	375.7		59.1		316.6
KRE078	AID	Kings River East GSA	I048A	T15S R24E 08	386.5		46.1		340.4
KRE078	DWR	Kings River East GSA	366324N1193588W001	T15S R24E 09	397.6	26.9		370.7	
KRE078	DWR	Kings River East GSA	366468N1193677W001	T15S R24E 09	400.6	14.0		386.6	
KRE078	AID	Kings River East GSA	H049A	T15S R24E 09	400.4	11.8	26.1	388.6	374.3
KRE078	OCID	Kings River East GSA	15S24E10H001MX	T15S R24E 10	415.6	3.5	9.3	412.1	406.3
KRE078	OCID	Kings River East GSA	15S24E11A001MX	T15S R24E 11	429.9	2.6	8.6	427.3	421.3
KRE078	AID	Kings River East GSA	J052A	T15S R24E 15	397.3	27.9	28.1	369.4	369.2
KRE078	DWR	Kings River East GSA	366186N1193721W001	T15S R24E 16	382.6	52.0		330.6	
KRE078	AID	Kings River East GSA	I053A	T15S R24E 16	383.2		61.1		322.1
KRE078	AID	Kings River East GSA	J052B	T15S R24E 16	382.5	53.0	85.0	329.5	297.5
KRE078	DWR	Kings River East GSA	366300N1193800W001	T15S R24E 17	382.8		60.6		322.2
KRE078	AID	Kings River East GSA	I054B	T15S R24E 18	369.2		57.1		312.1
KRE078	DWR	Kings River East GSA	366144N1193952W001	T15S R24E 19	366.6	58.0		308.6	
KRE078	DWR	Kings River East GSA	366175N1194104W001	T15S R24E 19	367.6	55.6		312.0	
KRE078	AID	Kings River East GSA	I055A	T15S R24E 19	365.6	56.6	56.0	309.0	309.6
KRE078	DWR	Kings River East GSA	366044N1193938W001	T15S R24E 20	361.6	52.4		309.2	
KRE078	AID	Kings River East GSA	J057A	T15S R24E 21	390.7		45.0		345.7
KRE078	AID	Kings River East GSA	J057B	T15S R24E 21	372.7	50.5	60.0	322.2	312.7
KRE078	DWR	Kings River East GSA	366113N1193543W001	T15S R24E 22	387.6	44.5		343.1	
KRE078	DWR	Kings River East GSA	366174N1193585W001	T15S R24E 22	390.6	44.9		345.7	
KRE078	OCID	Kings River East GSA	15S24E23C001MX	T15S R24E 23	406.4	35.5		370.9	
KRE078	OCID	Kings River East GSA	15S24E23J001MX	T15S R24E 23	411.3	37.6	42.6	373.7	368.7
KRE078	DWR	Kings River East GSA	366171N1193338W001	T15S R24E 23	405.7	35.5		370.2	
KRE078	OCID	Kings River East GSA	15S24E26B001MX	T15S R24E 26	404.9	48.4		356.5	
KRE078	DWR	Kings River East GSA	365918N1193410W001	T15S R24E 27	398.7	43.0		355.7	
KRE078	AID	Kings River East GSA	H060A	T15S R24E 27	396.7	43.0	46.0	353.7	350.6
KRE078	DWR	Kings River East GSA	366036N1193721W001	T15S R24E 28	372.6	50.5		322.1	
KRE078	AID	Kings River East GSA	J062A	T15S R24E 29	361.5		52.1		309.4
KRE078	DWR	Kings River East GSA	366000N1194100W001	T15S R24E 30	352.6		46.5		306.1
KRE078	DWR	Kings River East GSA	366039N1194079W001	T15S R24E 30	357.6	52.6		305.0	
KRE078	AID	Kings River East GSA	I063A	T15S R24E 30	348.8		47.0		301.8
KRE078	DWR	Kings River East GSA	365817N1193793W001	T15S R24E 32	358.6	40.5		318.1	
KRE078	DWR	Kings River East GSA	365889N1193863W001	T15S R24E 32	362.6	48.0		314.6	
KRE078	AID	Kings River East GSA	M065A	T15S R24E 32	361.2	48.0	47.0	313.2	314.2
KRE078	DWR	Kings River East GSA	365889N1193677W001	T15S R24E 33	366.6	54.2		312.4	
KRE078	AID	Kings River East GSA	M066A	T15S R24E 33	367.8		59.1		308.7
KRE078	DWR	Kings River East GSA	365816N1193299W001	T15S R24E 35	393.7	54.0		339.7	
KRE078	OCID	Kings River East GSA	15S24E36F001MX	T15S R24E 36	406.6	69.6	66.0	337.0	340.6
KRE078	AID	Kings River East GSA	T102A	T16S R24E 02	392.7	56.9	100.0	335.8	292.7
KRE078	AID	Kings River East GSA	M104A	T16S R24E 04	355.6	42.0		313.6	
KRE079	OCID	Kings River East GSA	15S24E12H001MX	T15S R24E 12	444.7		4.0		440.7
KRE079	OCID	Kings River East GSA	15S25E07G001MX	T15S R25E 07	459.4	8.3	8.8	451.1	450.6
KRE079	OCID	Kings River East GSA	15S25E17D001MX	T15S R25E 17	464.5		16.7		447.8
KRE079	DWR	Kings River East GSA	366310N1192843W001	T15S R25E 17	464.7	4.7		460.0	
KRE079	OCID	Kings River East GSA	15S25E18C001MX	T15S R25E 18	447.5		6.6		440.9
KRE079	OCID	Kings River East GSA	15S25E19A001MX	T15S R25E 19	458.7	29.5	29.5	429.2	429.2
KRE079	OCID	Kings River East GSA	15S25E19J001MX	T15S R25E 19	453.6	30.1	32.6	423.5	421.0
KRE080	OCID	Kings River East GSA	15S25E06Q001MX	T15S R25E 06	466.1	11.0	6.7	455.1	459.4

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
KRE080	OCID	Kings River East GSA	15S25E29A001MX	T15S R25E 29	464.0	12.0	19.8	452.0	444.2
KRE080	OCID	Kings River East GSA	15S25E29E001MX	T15S R25E 29	438.8	7.2	10.3	431.6	428.5
KRE080	DWR	Kings River East GSA	365985N1192852W001	T15S R25E 30	438.8		8.8		430.0
KRE080	OCID	Kings River East GSA	15S25E33D001MX	T15S R25E 33	426.6	25.6	28.5	401.0	398.1
KRE080	DWR	Kings River East GSA	365857N1192670W001	T15S R25E 33	427.1	25.6		401.5	
KRE081	OCID	Kings River East GSA	15S25E31A001MX	T15S R25E 31	426.8	36.5	44.1	390.3	382.7
KRE081	OCID	Kings River East GSA	15S25E32F001MX	T15S R25E 32	415.0	34.2		362.8	
KRE081	DWR	Kings River East GSA	365771N1192695W001	T15S R25E 32	410.7	15.6		395.1	
KRE092	DWR	Kings River East GSA	365675N1194135W001	T16S R23E 01	341.6	35.6		306.0	
KRE092	AID	Kings River East GSA	I072A	T16S R23E 02	337.6	27.0	61.1	310.6	276.5
KRE092	AID	Kings River East GSA	I073A	T16S R23E 03	336.6	40.7	57.1	295.9	279.6
KRE092	DWR	Kings River East GSA	365542N1194807W001	T16S R23E 09	312.6	20.9		291.7	
KRE092	AID	Kings River East GSA	K075A	T16S R23E 09	330.4		49.0		281.4
KRE092	AID	Kings River East GSA	K075B	T16S R23E 09	315.0	20.9	90.0	294.1	225.0
KRE092	DWR	Kings River East GSA	365500N1194500W001	T16S R23E 10	323.6		53.9		269.7
KRE092	AID	Kings River East GSA	I077A	T16S R23E 11	330.7		46.0		284.7
KRE092	AID	Kings River East GSA	J079A	T16S R23E 13	323.5		85.0		238.5
KRE092	DWR	Kings River East GSA	365450N1194504W001	T16S R23E 15	324.7	31.8		292.9	
KRE092	AID	Kings River East GSA	K081A	T16S R23E 15	327.8	32.8	55.1	295.0	272.7
KRE092	DWR	Kings River East GSA	365319N1194913W001	T16S R23E 20	312.7	19.0		293.7	
KRE092	AID	Kings River East GSA	K084A	T16S R23E 20	314.6		60.1		254.6
KRE092	DWR	Kings River East GSA	365300N1194688W001	T16S R23E 21	318.7	30.5		288.2	
KRE092	DWR	Kings River East GSA	365319N1194641W002	T16S R23E 22	319.7	33.5		286.2	
KRE092	AID	Kings River East GSA	K086A	T16S R23E 22	319.6		52.1		267.5
KRE092	DWR	Kings River East GSA	365283N1194482W001	T16S R23E 23	316.7	32.8		283.9	
KRE092	AID	Kings River East GSA	K086B	T16S R23E 23	316.6		49.1		267.5
KRE092	DWR	Kings River East GSA	365094N1194302W001	T16S R23E 25	313.7	34.6		279.1	
KRE092	AID	Kings River East GSA	J089A	T16S R23E 25	313.6	34.6	51.1	279.0	262.5
KRE092	AID	Kings River East GSA	I090A	T16S R23E 26	314.6	32.0	68.0	282.6	246.6
KRE092	DWR	Kings River East GSA	365136N1194491W001	T16S R23E 27	311.7	32.0		279.7	
KRE092	DWR	Kings River East GSA	365178N1194846W001	T16S R23E 28	308.3	29.0		279.3	
KRE092	AID	Kings River East GSA	K085A	T16S R23E 28	311.7	29.0	47.0	282.7	264.7
KRE092	AID	Kings River East GSA	K093A	T16S R23E 29	300.5	20.7	25.1	279.8	275.4
KRE092	AID	Kings River East GSA	K095A	T16S R23E 31	297.6		42.1		255.5
KRE092	DWR	Kings River East GSA	364892N1194941W001	T16S R23E 32	298.7	34.6		264.1	
KRE092	DWR	Kings River East GSA	364900N1195000W001	T16S R23E 32	296.7		44.3		252.4
KRE092	DWR	Kings River East GSA	365003N1194935W001	T16S R23E 32	303.7	29.9		273.8	
KRE092	AID	Kings River East GSA	W096A	T16S R23E 32	302.8	29.4	48.0	273.4	254.8
KRE092	DWR	Kings River East GSA	364997N1194682W001	T16S R23E 33	303.7	37.8		265.9	
KRE092	DWR	Kings River East GSA	365031N1194749W001	T16S R23E 33	305.7	29.0		276.7	
KRE092	AID	Kings River East GSA	K097A	T16S R23E 33	298.9		100.0		198.9
KRE092	AID	Kings River East GSA	K098A	T16S R23E 34	308.7		78.0		230.7
KRE092	AID	Kings River East GSA	K098B	T16S R23E 35	304.8		60.0		244.7
KRE092	DWR	Kings River East GSA	364900N1194300W001	T16S R23E 36	304.5		60.3		244.2
KRE092	AID	Kings River East GSA	W100A	T16S R23E 36	304.8	41.6	56.0	263.2	248.8
KRE093	DWR	Kings River East GSA	365600N1193400W001	T16S R24E 02	371.3		44.9		326.4
KRE093	DWR	Kings River East GSA	365631N1193360W001	T16S R24E 02	376.7	41.5		335.2	
KRE093	AID	Kings River East GSA	M103A	T16S R24E 02	372.7	52.9	46.1	319.8	326.6
KRE093	AID	Kings River East GSA	M105A	T16S R24E 05	339.9	31.5	40.1	308.4	299.8
KRE093	DWR	Kings River East GSA	365744N1194121W001	T16S R24E 06	348.6	24.0		324.6	
KRE093	AID	Kings River East GSA	M106A	T16S R24E 06	332.7		70.0		262.7
KRE093	DWR	Kings River East GSA	365500N1194116W001	T16S R24E 07	329.1	40.0		289.1	
KRE093	DWR	Kings River East GSA	365597N1193718W001	T16S R24E 09	350.6	51.5		299.1	
KRE093	DWR	Kings River East GSA	365481N1193499W001	T16S R24E 10	358.2	51.5		306.7	
KRE093	DWR	Kings River East GSA	365525N1193410W001	T16S R24E 10	367.7	50.9		316.8	
KRE093	DWR	Kings River East GSA	365561N1193582W001	T16S R24E 10	357.7	56.9		300.8	
KRE093	AID	Kings River East GSA	J110A	T16S R24E 10	357.6	44.5	43.1	313.1	314.5
KRE093	AID	Kings River East GSA	M110A	T16S R24E 10	367.8	50.9	49.0	316.9	318.7
KRE093	DWR	Kings River East GSA	365592N1193224W001	T16S R24E 12	379.7	51.6		328.1	
KRE093	AID	Kings River East GSA	D112A	T16S R24E 12	378.6	51.6		327.0	
KRE093	DWR	Kings River East GSA	365392N1193074W001	T16S R24E 13	360.2	29.5		330.7	
KRE093	AID	Kings River East GSA	T113B	T16S R24E 13	358.6		24.1		334.5
KRE093	DWR	Kings River East GSA	365314N1193385W001	T16S R24E 14	349.7	29.8		319.9	
KRE093	DWR	Kings River East GSA	365411N1193232W001	T16S R24E 14	362.7	30.5		332.2	
KRE093	DWR	Kings River East GSA	365439N1193227W001	T16S R24E 14	362.7	32.0		330.7	
KRE093	AID	Kings River East GSA	M115A	T16S R24E 14	362.5		39.1		323.5
KRE093	DWR	Kings River East GSA	365386N1193593W001	T16S R24E 16	349.7	40.6		309.1	
KRE093	AID	Kings River East GSA	M116A	T16S R24E 16	349.7		43.1		306.6

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
KRE093	AID	Kings River East GSA	M118A	T16S R24E 18	326.8		47.1		279.7
KRE093	DWR	Kings River East GSA	365239N1194088W001	T16S R24E 19	318.7	27.5		291.2	
KRE093	DWR	Kings River East GSA	365297N1194079W001	T16S R24E 19	320.7	31.8		288.9	
KRE093	AID	Kings River East GSA	M120A	T16S R24E 20	337.6		57.1		280.5
KRE093	DWR	Kings River East GSA	365236N1193591W001	T16S R24E 21	338.7	37.5		301.2	
KRE093	AID	Kings River East GSA	D121A	T16S R24E 21	338.6	37.5		301.1	
KRE093	AID	Kings River East GSA	O123A	T16S R24E 23	352.7	24.2	42.0	328.5	310.7
KRE093	AID	Kings River East GSA	O123B	T16S R24E 23	346.8		31.1		315.7
KRE093	AID	Kings River East GSA	O126A	T16S R24E 26	337.6		22.0		315.6
KRE093	AID	Kings River East GSA	O127A	T16S R24E 26	331.7	19.0	32.0	312.7	299.7
KRE093	AID	Kings River East GSA	O128A	T16S R24E 27	329.7	29.2	34.0	300.5	295.7
KRE093	DWR	Kings River East GSA	365089N1193588W001	T16S R24E 28	327.8		32.5		295.3
KRE093	DWR	Kings River East GSA	365128N1193679W001	T16S R24E 28	327.2	35.0		292.2	
KRE093	DWR	Kings River East GSA	365144N1193777W001	T16S R24E 29	328.7	34.0		294.7	
KRE093	AID	Kings River East GSA	O129A	T16S R24E 29	328.7	34.0	50.1	294.7	278.7
KRE093	DWR	Kings River East GSA	365058N1193952W001	T16S R24E 30	316.7	33.8		282.9	
KRE093	AID	Kings River East GSA	M130A	T16S R24E 30	314.6	29.5	54.1	285.1	260.5
KRE093	AID	Kings River East GSA	M130B	T16S R24E 30	318.6	33.8	47.0	284.8	271.5
KRE093	DWR	Kings River East GSA	365022N1194085W001	T16S R24E 31	309.7	28.0		281.7	
KRE093	AID	Kings River East GSA	M131A	T16S R24E 31	306.8		46.0		260.8
KRE093	DWR	Kings River East GSA	364928N1193724W001	T16S R24E 33	315.7	28.6		287.1	
KRE093	AID	Kings River East GSA	O133A	T16S R24E 33	315.6	28.6	36.1	287.0	279.6
KRE093	AID	Kings River East GSA	O134A	T16S R24E 34	323.8		38.1		285.7
KRE093	AID	Kings River East GSA	O134B	T16S R24E 34	319.6	17.5	25.1	302.1	294.4
KRE093	AID	Kings River East GSA	O135A	T16S R24E 35	327.8		16.0		311.7
KRE093	AID	Kings River East GSA	T136A	T16S R24E 36	338.6	9.2	42.1	329.4	296.5
KRE093	AID	Kings River East GSA	T199A	T17S R24E 01	328.7	12.0		316.7	
KRE093	AID	Kings River East GSA	O201A	T17S R24E 03	309.7		35.1		274.6
KRE094	OCID	Kings River East GSA	16S25E04C001MX	T16S R25E 04	418.5	24.7	35.9	393.8	382.6
KRE094	DWR	Kings River East GSA	365721N1192620W001	T16S R25E 04	418.3		35.4		382.9
KRE094	DWR	Kings River East GSA	365447N1193041W001	T16S R25E 07	371.5		63.3		308.2
KRE094	DWR	Kings River East GSA	365591N1193007W001	T16S R25E 07	383.7	40.2		343.5	
KRE094	AID	Kings River East GSA	T139A	T16S R25E 07	385.3	40.2	60.0	345.1	325.3
KRE094	AID	Kings River East GSA	T139B	T16S R25E 07	385.8		40.0		345.8
KRE094	AID	Kings River East GSA	T139C	T16S R25E 07	369.8		28.1		341.7
KRE094	DWR	Kings River East GSA	365557N1192867W001	T16S R25E 08	385.7	31.5		354.2	
KRE094	DWR	Kings River East GSA	365388N1192692W001	T16S R25E 17	382.7	25.4		357.3	
KRE094	AID	Kings River East GSA	T143A	T16S R25E 17	382.5		27.1		355.5
KRE094	AID	Kings River East GSA	T143B	T16S R25E 17	373.6		24.1		349.5
KRE094	DWR	Kings River East GSA	365231N1192959W001	T16S R25E 19	357.7	18.8		338.9	
KRE094	AID	Kings River East GSA	T145A	T16S R25E 19	356.4	18.8	18.1	337.6	338.3
KRE094	DWR	Kings River East GSA	365153N1192731W001	T16S R25E 20	367.2		29.1		338.1
KRE094	DWR	Kings River East GSA	365160N1192601W001	T16S R25E 21	372.7	29.2		343.5	
KRE094	AID	Kings River East GSA	T147A	T16S R25E 21	383.5		26.0		357.5
KRE094	AID	Kings River East GSA	T147B	T16S R25E 21	375.1		24.1		351.0
KRE094	DWR	Kings River East GSA	365142N1192690W001	T16S R25E 29	364.7	27.0		337.7	
KRE094	AID	Kings River East GSA	T151A	T16S R25E 29	366.8	27.9	29.1	338.9	337.7
KRE094	DWR	Kings River East GSA	364875N1192870W001	T16S R25E 31	341.7	21.0		320.7	
KRE094	DWR	Kings River East GSA	365011N1192976W001	T16S R25E 31	344.7	16.8		327.9	
KRE094	AID	Kings River East GSA	T153A	T16S R25E 31	343.5	16.8	21.0	326.7	322.5
KRE094	DWR	Kings River East GSA	365008N1192801W001	T16S R25E 32	352.7	27.8		324.9	
KRE094	AID	Kings River East GSA	T154A	T16S R25E 32	354.5	28.8	22.0	325.7	332.5
KRE094	DWR	Kings River East GSA	365003N1192545W001	T16S R25E 33	360.7	26.5		334.2	
KRE094	DWR	Kings River East GSA	364881N1192390W001	T16S R25E 34	346.7	22.0		324.7	
KRE094	DWR	Kings River East GSA	364975N1192501W001	T16S R25E 34	356.7	34.0		322.7	
KRE094	AID	Kings River East GSA	X156A	T16S R25E 34	346.8	24.0		322.8	
KRE094	DWR	Kings River East GSA	364861N1192478W001	T17S R25E 03	346.7	25.0		321.7	
KRE094	DWR	Kings River East GSA	364864N1192981W001	T17S R25E 06	335.7	22.9		312.8	
KRE094	AID	Kings River East GSA	X229A	T17S R25E 06	333.7		21.1		312.6
KRE095	OCID	Kings River East GSA	16S25E03K001MX	T16S R25E 03	436.8	21.5	26.2	415.3	410.6
KRE095	DWR	Kings River East GSA	365632N1192417W001	T16S R25E 03	432.7	21.5		411.2	
KRE095	OCID	Kings River East GSA	16S25E10J001MX	T16S R25E 10	422.6	25.7	30.4	396.9	392.2
KRE095	DWR	Kings River East GSA	365513N1192370W001	T16S R25E 10	422.7	25.7		397.0	
KRE095	DWR	Kings River East GSA	365388N1192506W001	T16S R25E 15	397.7	26.5		371.2	
KRE095	OCID	Kings River East GSA	16S25E22E001MX	T16S R25E 22	389.6	15.5		374.1	
KRE095	AID	Kings River East GSA	X155A	T16S R25E 34	361.9		25.1		336.8
KRE095	AID	Kings River East GSA	X157A	T16S R25E 35	357.6		37.1		320.5
KRE095	DWR	Kings River East GSA	364852N1192192W001	T17S R25E 01	357.7	21.3		336.4	

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
KRE103	DWR	Kings River East GSA	364878N1194210W001	T17S R23E 01	304.7	41.6		263.1	
KRE103	DWR	Kings River East GSA	364881N1194399W001	T17S R23E 02	303.7	66.5		237.2	
KRE103	AID	Kings River East GSA	W166A	T17S R23E 03	298.6	41.4	58.0	257.2	240.6
KRE103	AID	Kings River East GSA	W168A	T17S R23E 05	298.6		45.0		253.5
KRE103	DWR	Kings River East GSA	364731N1195149W001	T17S R23E 07	291.7	54.0	49.4	237.7	242.3
KRE103	AID	Kings River East GSA	W159A	T17S R23E 07	292.6		43.1		249.5
KRE103	DWR	Kings River East GSA	364664N1194954W001	T17S R23E 08	290.7	49.0	63.9	241.7	226.8
KRE103	AID	Kings River East GSA	W171A	T17S R23E 08	292.6		63.1		229.6
KRE103	DWR	Kings River East GSA	364594N1194832W001	T17S R23E 09	287.7	73.0		214.7	
KRE103	DWR	Kings River East GSA	364733N1194816W001	T17S R23E 09	294.2	50.3		243.9	
KRE103	AID	Kings River East GSA	W172A	T17S R23E 09	292.6	50.8	64.1	241.8	228.5
KRE103	DWR	Kings River East GSA	364733N1194568W001	T17S R23E 10	294.2	40.2		254.0	
KRE103	AID	Kings River East GSA	K174A	T17S R23E 11	297.6		76.1		221.5
KRE103	AID	Kings River East GSA	W175A	T17S R23E 12	297.6	51.5	62.0	246.1	235.5
KRE103	DWR	Kings River East GSA	364583N1194299W001	T17S R23E 13	290.7	67.0		223.7	
KRE103	AID	Kings River East GSA	X176A	T17S R23E 13	290.7		75.1		215.6
KRE103	DWR	Kings River East GSA	364586N1194646W001	T17S R23E 15	287.7	61.5		226.2	
KRE103	AID	Kings River East GSA	W178A	T17S R23E 15	287.7	61.5	71.1	226.2	216.6
KRE103	AID	Kings River East GSA	W178B	T17S R23E 15	283.6		78.1		205.5
KRE103	AID	Kings River East GSA	W179A	T17S R23E 16	287.7	58.5	72.1	229.2	215.7
KRE103	DWR	Kings River East GSA	364500N1195000W001	T17S R23E 17	283.5		90.8		192.7
KRE103	AID	Kings River East GSA	W180A	T17S R23E 17	285.8		92.0		193.7
KRE103	DWR	Kings River East GSA	364544N1195277W001	T17S R23E 18	286.7	41.5		245.2	
KRE103	DWR	Kings River East GSA	364594N1195241W001	T17S R23E 18	287.7	57.0		230.7	
KRE103	AID	Kings River East GSA	W181A	T17S R23E 18	277.6		58.0		219.5
KRE103	DWR	Kings River East GSA	364442N1194835W001	T17S R23E 21	285.7	64.9		220.8	
KRE103	AID	Kings River East GSA	X184A	T17S R23E 21	277.6	68.0	100.0	209.6	177.6
KRE103	AID	Kings River East GSA	X185A	T17S R23E 22	280.8		84.0		196.8
KRE103	AID	Kings River East GSA	X186A	T17S R23E 23	287.7		78.0		209.7
KRE103	AID	Kings River East GSA	X186B	T17S R23E 23	280.5		78.1		202.4
KRE103	AID	Kings River East GSA	X187A	T17S R23E 24	282.8		75.1		207.7
KRE103	DWR	Kings River East GSA	364225N1194688W001	T17S R23E 27	273.2	68.5		204.7	
KRE103	AID	Kings River East GSA	X191A	T17S R23E 28	272.6		80.0		192.6
KRE103	DWR	Kings River East GSA	364286N1195154W001	T17S R23E 30	278.7	61.9		216.8	
KRE103	DWR	Kings River East GSA	364303N1195146W001	T17S R23E 30	278.7	69.0	83.6	209.7	195.1
KRE103	AID	Kings River East GSA	W193A	T17S R23E 30	278.5		86.0		192.5
KRE103	DWR	Kings River East GSA	364078N1195221W001	T17S R23E 31	272.7	70.0		202.7	
KRE104	AID	Kings River East GSA	X189A	T17S R23E 26	277.6		111.0		166.6
KRE106	AID	Kings River East GSA	X209A	T17S R24E 02	313.6		31.0		282.6
KRE106	AID	Kings River East GSA	O201B	T17S R24E 03	297.6	18.0	42.0	279.6	255.5
KRE106	DWR	Kings River East GSA	364875N1193932W001	T17S R24E 05	306.7	29.2		277.5	
KRE106	AID	Kings River East GSA	M203A	T17S R24E 05	299.5	37.8	53.1	261.7	246.4
KRE106	AID	Kings River East GSA	M205A	T17S R24E 07	294.6		75.1		219.5
KRE106	AID	Kings River East GSA	O202A	T17S R24E 09	300.5		45.1		255.4
KRE106	DWR	Kings River East GSA	364581N1193496W001	T17S R24E 10	304.3		40.7		263.6
KRE106	DWR	Kings River East GSA	364581N1193513W001	T17S R24E 10	304.7	35.0		269.7	
KRE106	AID	Kings River East GSA	X201A	T17S R24E 12	318.5	23.7		294.8	
KRE106	AID	Kings River East GSA	X211A	T17S R24E 13	312.7		63.1		249.6
KRE106	AID	Kings River East GSA	X213A	T17S R24E 14	306.4	6.9	41.0	299.5	265.4
KRE106	DWR	Kings River East GSA	364578N1193502W001	T17S R24E 15	305.7	6.9		298.8	
KRE106	DWR	Kings River East GSA	364575N1193679W001	T17S R24E 16	298.7	19.8		278.9	
KRE106	AID	Kings River East GSA	X214A	T17S R24E 16	299.9	19.8	36.0	280.1	263.8
KRE106	AID	Kings River East GSA	X215A	T17S R24E 16	292.6		50.1		242.5
KRE106	DWR	Kings River East GSA	364583N1193857W001	T17S R24E 17	294.7	30.8		263.9	
KRE106	DWR	Kings River East GSA	364425N1193860W001	T17S R24E 20	292.7	24.0		268.7	
KRE106	AID	Kings River East GSA	X218B	T17S R24E 20	292.7	24.0	45.1	268.7	247.6
KRE106	AID	Kings River East GSA	X220A	T17S R24E 22	297.1		31.1		266.1
KRE107	DWR	Kings River East GSA	364400N1194100W001	T17S R24E 19	285.1		46.2		238.9
KRE107	AID	Kings River East GSA	X217A	T17S R24E 19	286.7		47.1		239.6
KRE107	DWR	Kings River East GSA	364439N1193993W001	T17S R24E 20	289.7	22.7		267.0	
KRE107	AID	Kings River East GSA	X218A	T17S R24E 20	289.7	22.7	52.0	267.0	237.7
KRE107	AID	Kings River East GSA	X221A	T17S R24E 23	307.7		60.0		247.7
KRE108	DWR	Kings River East GSA	364736N1192415W001	T17S R25E 03	340.7	36.0		304.7	
KRE108	AID	Kings River East GSA	X226A	T17S R25E 03	346.8		30.0		316.8
KRE108	AID	Kings River East GSA	X227A	T17S R25E 04	336.6		56.0		280.6
KRE108	AID	Kings River East GSA	X230A	T17S R25E 06	324.8		32.0		292.8
KRE108	DWR	Kings River East GSA	364700N1192900W001	T17S R25E 08	304.3		30.8		273.5
KRE108	AID	Kings River East GSA	X231A	T17S R25E 08	327.8		31.1		296.7

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
KRE108	AID	Kings River East GSA	X234A	T17S R25E 17	323.8		48.1		275.8
KRE108	AID	Kings River East GSA	X234B	T17S R25E 17	327.8		74.1		253.6
KRE108	DWR	Kings River East GSA	364433N1192959W001	T17S R25E 18	323.7	64.0		259.7	
KRE108	DWR	Kings River East GSA	364575N1192967W001	T17S R25E 18	327.7	50.8		276.9	
KRE110	AID	Kings River East GSA	X224A	T17S R25E 01	357.0	18.6	37.0	338.4	319.9
MA015	FID	McMullin Area GSA	13S17E19H001MX	T13S R17E 19	205.3	34.5		170.8	
MA030	DWR	McMullin Area GSA	367646N1202604W001	T13S R16E 30	177.4	55.1		122.3	
MA030	DWR	McMullin Area GSA	367571N1202521W001	T13S R16E 32	177.4	67.6		109.8	
MA030	DWR	McMullin Area GSA	367488N1202374W001	T14S R16E 04	172.9	66.9		106.0	
MA030	DWR	McMullin Area GSA	367413N1202504W001	T14S R16E 05	169.5	58.7		110.8	
MA030	DWR	McMullin Area GSA	367418N1202513W001	T14S R16E 05	169.5	62.1		107.4	
MA030	DWR	McMullin Area GSA	367485N1202516W001	T14S R16E 05	173.4	54.8		118.6	
MA030	DWR	McMullin Area GSA	367485N1202602W001	T14S R16E 06	172.4	45.9		126.5	
MA030	DWR	McMullin Area GSA	367485N1202688W001	T14S R16E 06	172.4	48.6		123.8	
MA030	DWR	McMullin Area GSA	367341N1202654W001	T14S R16E 07	167.5	43.7		123.8	
MA030	DWR	McMullin Area GSA	367341N1202696W001	T14S R16E 07	167.5	41.6		125.9	
MA030	KRCD	McMullin Area GSA	A01	T14S R16E 07	162.6		84.0		78.6
MA030	DWR	McMullin Area GSA	367260N1202418W001	T14S R16E 08	170.5	53.8		116.7	
MA031	DWR	McMullin Area GSA	367707N1201910W001	T13S R16E 26	193.4	81.7		111.7	
MA031	DWR	McMullin Area GSA	367757N1201874W001	T13S R16E 26	193.4	54.5		138.9	
MA031	DWR	McMullin Area GSA	367707N1202141W001	T13S R16E 27	185.9	52.5		133.4	
MA031	DWR	McMullin Area GSA	367782N1202141W001	T13S R16E 27	188.4	46.0		142.4	
MA031	DWR	McMullin Area GSA	367710N1202263W001	T13S R16E 28	182.4	68.6		113.8	
MA031	DWR	McMullin Area GSA	367560N1202232W001	T13S R16E 33	178.4	76.9		101.5	
MA031	DWR	McMullin Area GSA	367596N1202329W001	T13S R16E 33	177.4	79.8		97.6	
MA031	DWR	McMullin Area GSA	367635N1202146W001	T13S R16E 34	184.4	68.1		116.3	
MA031	DWR	McMullin Area GSA	367635N1201868W001	T13S R16E 36	192.4	78.4		114.0	
MA031	FID	McMullin Area GSA	13S17E30J001MX	T13S R17E 29	203.2	63.1	61.2	140.1	142.0
MA031	DWR	McMullin Area GSA	367493N1202171W001	T14S R16E 03	179.4	79.2		100.2	
MA031	DWR	McMullin Area GSA	367457N1202232W001	T14S R16E 04	176.5	66.3		110.2	
MA031	DWR	McMullin Area GSA	367463N1202324W001	T14S R16E 04	172.4	78.6		93.8	
MA031	FID	McMullin Area GSA	14S17E06B001MX	T14S R17E 06	196.5	99.8	89.0	96.7	107.5
MA034	KRCD	McMullin Area GSA	A05	T14S R16E 15	171.4		61.0		110.4
MA034	DWR	McMullin Area GSA	366780N1201882W001	T14S R16E 26	174.5	64.6		109.9	
MA034	DWR	McMullin Area GSA	366900N1202000W001	T14S R16E 26	171.0		67.0		104.0
MA034	KRCD	McMullin Area GSA	A07	T14S R16E 26	170.8		67.0		103.8
MA034	KRCD	McMullin Area GSA	A09	T14S R16E 34	165.3		81.0		84.3
MA035	JID	McMullin Area GSA	14S17E31R001MX	T14S R17E 31	180.0	134.3		45.7	
MA035	KRCD	McMullin Area GSA	A24	T15S R17E 06	175.3		170.0		5.3
MA036	DWR	McMullin Area GSA	367200N1202100W001	T14S R16E 15	171.0		88.0		83.0
MA036	KRCD	McMullin Area GSA	A08	T14S R16E 24	176.7		105.0		71.7
MA036	KRCD	McMullin Area GSA	A10	T14S R16E 36	177.9		112.0		65.9
MA036	FID	McMullin Area GSA	14S17E04R001MX	T14S R17E 04	205.2	100.7		104.5	
MA036	DWR	McMullin Area GSA	367352N1201146W001	T14S R17E 04	207.7	100.7		107.0	
MA036	FID	McMullin Area GSA	14S17E05C001MX	T14S R17E 05	202.9	92.3	92.0	110.6	110.9
MA036	KRCD	McMullin Area GSA	A12	T14S R17E 06	197.4		99.0		98.4
MA036	DWR	McMullin Area GSA	367318N1201466W002	T14S R17E 08	197.5	73.4		124.1	
MA036	DWR	McMullin Area GSA	367200N1201000W001	T14S R17E 15	210.0		113.0		97.0
MA036	KRCD	McMullin Area GSA	A13	T14S R17E 15	210.3		113.0		97.3
MA036	DWR	McMullin Area GSA	367100N1201500W001	T14S R17E 17	188.0		119.0		69.0
MA036	KRCD	McMullin Area GSA	A14	T14S R17E 17	196.7		123.0		73.7
MA036	KRCD	McMullin Area GSA	A15	T14S R17E 19	187.7		119.0		68.7
MA036	DWR	McMullin Area GSA	367052N1201152W001	T14S R17E 21	203.5	145.0		58.5	
MA036	JID	McMullin Area GSA	14S17E28A001MX	T14S R17E 28	195.0	129.3		65.7	
MA036	DWR	McMullin Area GSA	366893N1201171W001	T14S R17E 28	197.5	129.3		68.2	
MA036	KRCD	McMullin Area GSA	A20	T14S R17E 29	187.7		132.0		55.7
MA036	DWR	McMullin Area GSA	366652N1201516W001	T14S R17E 31	182.5	134.3		48.2	
MA036	JID	McMullin Area GSA	14S17E32R001MX	T14S R17E 32	184.5	108.5		76.0	
MA038	KRCD	McMullin Area GSA	A11	T14S R17E 04	208.4		91.0		117.4
MA063	JID	McMullin Area GSA	15S17E07J001MX	T15S R17E 07	175.0	52.8		122.2	
MA063	DWR	McMullin Area GSA	366180N1201457W001	T15S R17E 17	173.6		123.4		50.2
MA064	DWR	McMullin Area GSA	366700N1200800W001	T14S R17E 35	201.0		147.0		54.0
MA064	KRCD	McMullin Area GSA	A21	T14S R17E 35	201.1		147.0		54.1
MA064	JID	McMullin Area GSA	14S17E36A001MX	T14S R17E 36	207.0	144.6		62.4	
MA064	DWR	McMullin Area GSA	366763N1200610W001	T14S R17E 36	209.5	144.6		64.9	
MA064	KRCD	McMullin Area GSA	A22	T15S R17E 01	204.5		152.0		52.5
MA064	DWR	McMullin Area GSA	366500N1201000W001	T15S R17E 03	191.0		179.0		12.0
MA064	KRCD	McMullin Area GSA	A23	T15S R17E 03	191.1		179.0		12.1

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
MA064	KRCD	McMullin Area GSA	A25	T15S R17E 08	178.6		144.0		34.6
MA064	JID	McMullin Area GSA	15S17E11A001MX	T15S R17E 11	195.0	162.3		32.7	
MA064	JID	McMullin Area GSA	15S17E13R001MX	T15S R17E 13	193.0	171.8	183.5	21.2	9.5
MA064	KRCD	McMullin Area GSA	A26	T15S R17E 13	196.7		178.0		18.7
MA064	JID	McMullin Area GSA	15S17E15J001MX	T15S R17E 15	187.0	168.5	168.1	18.5	18.9
MA064	DWR	McMullin Area GSA	366255N1200977W001	T15S R17E 15	189.6	168.5		21.1	
MA064	KRCD	McMullin Area GSA	A28	T15S R17E 21	177.8		168.0		9.8
MA064	JID	McMullin Area GSA	15S17E22J001MX	T15S R17E 22	186.0	160.9	175.8	25.1	10.2
MA064	DWR	McMullin Area GSA	366077N1200982W001	T15S R17E 22	188.6	160.9		27.7	
MA064	DWR	McMullin Area GSA	366032N1200799W001	T15S R17E 26	191.6	198.6		-7.0	
MA064	DWR	McMullin Area GSA	365771N1200971W001	T15S R17E 35	184.7	157.4		27.3	
MA064	DWR	McMullin Area GSA	365800N1200900W001	T15S R17E 35	180.0		184.0		-4.0
MA064	DWR	McMullin Area GSA	365888N1200796W001	T15S R17E 35	190.1	230.3		-40.2	
MA064	KRCD	McMullin Area GSA	A30	T15S R17E 35	180.2		184.0		-3.8
MA064	JID	McMullin Area GSA	15S18E06A001MX	T15S R18E 06	207.0	128.8		78.2	
MA064	DWR	McMullin Area GSA	366596N1200432W001	T15S R18E 06	209.6	128.8		80.8	
MA064	JID	McMullin Area GSA	15S18E07A001MX	T15S R18E 07	204.0	157.8		46.2	
MA064	DWR	McMullin Area GSA	366471N1200435W001	T15S R18E 07	206.6	157.8		48.8	
MA064	JID	McMullin Area GSA	15S18E17C001MX	T15S R18E 17	203.0	208.6		-5.6	
MA064	DWR	McMullin Area GSA	366327N1200360W001	T15S R18E 17	205.6	208.6		-3.0	
MA064	DWR	McMullin Area GSA	366300N1200600W001	T15S R18E 18	197.0		178.0		19.0
MA064	KRCD	McMullin Area GSA	A39	T15S R18E 18	197.6		189.0		8.6
MA064	JID	McMullin Area GSA	15S18E19R001MX	T15S R18E 19	195.5		96.3		99.2
MA064	KRCD	McMullin Area GSA	A42	T15S R18E 30	193.3		201.0		-7.7
MA065	DWR	McMullin Area GSA	366600N1200200W001	T15S R18E 04	216.0		128.0		88.0
MA065	KRCD	McMullin Area GSA	A34	T15S R18E 04	216.3		128.0		88.3
MA065	DWR	McMullin Area GSA	366257N1199943W001	T15S R18E 15	210.7		221.7		-11.0
MA065	DWR	McMullin Area GSA	366299N1199893W001	T15S R18E 15	214.6	157.0		57.6	
MA065	KRCD	McMullin Area GSA	A37	T15S R18E 15	208.8		170.0		38.8
MA068	DWR	McMullin Area GSA	365818N1200707W001	T15S R17E 36	192.6	197.9		-5.3	
MA068	KRCD	McMullin Area GSA	A31	T15S R17E 36	186.4		200.0		-13.6
MA068	DWR	McMullin Area GSA	365849N1200393W001	T15S R18E 32	202.6	196.0	213.6	6.6	-11.0
MA068	DWR	McMullin Area GSA	365782N1200252W001	T15S R18E 33	200.6	196.0	221.7	4.6	-21.1
MA068	DWR	McMullin Area GSA	365677N1200210W001	T16S R18E 04	199.7	181.0	187.3	18.7	12.4
MA068	KRCD	McMullin Area GSA	A54	T16S R18E 04	192.3		229.0		-36.7
MA068	DWR	McMullin Area GSA	365610N1200391W001	T16S R18E 08	193.7	202.0	207.1	-8.3	-13.4
MA068	DWR	McMullin Area GSA	365571N1200163W001	T16S R18E 09	200.7	186.0		14.7	
MA068	DWR	McMullin Area GSA	365505N1199899W001	T16S R18E 10	204.7	182.0	209.9	22.7	-5.2
MA068	KRCD	McMullin Area GSA	A56	T16S R18E 10	196.3		237.0		-40.7
MA068	DWR	McMullin Area GSA	365400N1200000W001	T16S R18E 15	195.0		230.0		-35.0
MA068	KRCD	McMullin Area GSA	A58	T16S R18E 15	194.9		230.0		-35.2
MA069	DWR	McMullin Area GSA	366077N1199982W001	T15S R18E 22	212.6	292.7		-80.1	
MA069	DWR	McMullin Area GSA	365930N1200257W001	T15S R18E 29	202.6	200.0	218.6	2.6	-16.0
MA069	DWR	McMullin Area GSA	365855N1200254W001	T15S R18E 32	202.6	198.0	227.1	4.6	-24.5
MA069	DWR	McMullin Area GSA	365680N1199902W001	T16S R18E 03	208.7	182.5	215.3	26.2	-6.7
MA069	DWR	McMullin Area GSA	365749N1199899W001	T16S R18E 03	208.7	185.0	219.6	23.7	-11.0
MA070	DWR	McMullin Area GSA	366257N1199893W001	T15S R18E 15	212.6	182.4		30.2	
MA070	DWR	McMullin Area GSA	366157N1199754W001	T15S R18E 23	216.6	154.9		61.7	
MA070	KRCD	McMullin Area GSA	A44	T15S R18E 36	215.4		209.0		6.4
MA070	DWR	McMullin Area GSA	365935N1199532W001	T15S R19E 30	222.6	182.0	205.0	40.6	17.6
MA070	DWR	McMullin Area GSA	365682N1199538W001	T16S R18E 01	219.2	182.0		37.2	
MA070	KRCD	McMullin Area GSA	A53	T16S R18E 01	213.0		212.0		1.0
MA070	DWR	McMullin Area GSA	365700N1199500W001	T16S R19E 06	213.0		212.0		1.0
MA070	DWR	McMullin Area GSA	365543N1199535W001	T16S R19E 07	214.7		212.1		2.6
MA071	KRCD	McMullin Area GSA	A32	T15S R18E 01	228.0		113.0		115.1
MA071	FID	McMullin Area GSA	15S18E02A001MX	T15S R18E 02	222.7	114.1	117.8	108.6	104.9
MA071	JID	McMullin Area GSA	15S18E03R001MX	T15S R18E 03	217.0	143.3	151.2	73.7	65.8
MA071	DWR	McMullin Area GSA	366366N1199710W001	T15S R18E 12	222.6	156.0	167.9	66.6	54.7
MA071	DWR	McMullin Area GSA	366477N1199710W001	T15S R18E 12	224.6	127.0	141.8	97.6	82.8
MA071	DWR	McMullin Area GSA	366300N1199700W001	T15S R18E 13	219.0		163.0		56.0
MA071	KRCD	McMullin Area GSA	A36	T15S R18E 13	218.6		163.0		55.6
MA071	DWR	McMullin Area GSA	366088N1199535W001	T15S R18E 24	226.6	168.0	189.1	58.6	37.5
MA071	KRCD	McMullin Area GSA	A35	T15S R19E 07	224.4		140.0		84.4
MA072	KRCD	McMullin Area GSA	A45	T15S R19E 05	232.3		106.0		126.3
MA072	DWR	McMullin Area GSA	366338N1199404W001	T15S R19E 07	225.6	125.0	142.7	100.6	82.9
MA072	KRCD	McMullin Area GSA	A46	T15S R19E 10	240.1		97.0		143.2
MA072	KRCD	McMullin Area GSA	A48	T15S R19E 18	228.0		152.0		76.0
MA072	DWR	McMullin Area GSA	366080N1199521W001	T15S R19E 19	226.6	161.0		65.6	

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
MA072	DWR	McMullin Area GSA	366188N1199104W001	T15S R19E 21	234.6	141.0	142.0	93.6	92.6
MA072	DWR	McMullin Area GSA	366177N1198988W001	T15S R19E 22	237.6	116.0	128.0	121.6	109.6
MA072	DWR	McMullin Area GSA	366082N1198807W001	T15S R19E 23	244.6	130.5	130.5	114.1	114.1
MA072	KRCD	McMullin Area GSA	A49	T15S R19E 23	247.6		133.0		114.6
MA072	KRCD	McMullin Area GSA	A50	T15S R19E 27	238.8		156.0		82.8
MA072	DWR	McMullin Area GSA	366007N1199146W001	T15S R19E 28	232.6	151.0		81.6	
MA072	KRCD	McMullin Area GSA	A51	T15S R19E 29	229.8		169.0		60.8
MA072	DWR	McMullin Area GSA	365782N1199071W001	T15S R19E 33	230.6	168.0		62.6	
MA072	DWR	McMullin Area GSA	365891N1198877W001	T15S R19E 34	237.6	139.0	139.0	98.6	98.6
MA072	KRCD	McMullin Area GSA	A52	T16S R19E 02	242.5		150.0		92.5
MA072	DWR	McMullin Area GSA	365755N1199304W001	T16S R19E 05	225.6	169.0	195.7	56.6	29.9
MA086	KRCD	McMullin Area GSA	A59	T16S R18E 23	203.0		210.0		-7.0
MA087	DWR	McMullin Area GSA	365463N1199268W001	T16S R19E 17	218.0	176.0	199.6	44.7	21.1
MA087	KRCD	McMullin Area GSA	A63	T16S R19E 17	217.4		199.0		18.4
MA087	DWR	McMullin Area GSA	365180N1199129W001	T16S R19E 21	220.0	173.0	194.0	49.7	28.7
MA087	DWR	McMullin Area GSA	365213N1199060W001	T16S R19E 21	220.0		162.2		60.5
MA088	DWR	McMullin Area GSA	365721N1198766W001	T16S R19E 02	242.6		160.0		82.6
MA088	KRCD	McMullin Area GSA	A60	T16S R19E 04	230.5		179.0		51.5
MA088	KRCD	McMullin Area GSA	A61	T16S R19E 08	224.7		199.0		25.7
MA088	DWR	McMullin Area GSA	365577N1199099W001	T16S R19E 09	227.7	168.0		59.7	
MA088	DWR	McMullin Area GSA	365616N1198824W001	T16S R19E 10	232.7	150.0	171.0	82.7	61.7
MA088	KRCD	McMullin Area GSA	A62	T16S R19E 12	238.1		162.0		76.1
MA088	DWR	McMullin Area GSA	365435N1198916W001	T16S R19E 15	230.7	155.0		75.7	
MA088	DWR	McMullin Area GSA	365421N1198996W001	T16S R19E 16	227.7	159.0	188.0	68.7	39.7
MA088	DWR	McMullin Area GSA	365263N1198885W001	T16S R19E 22	225.0	158.0	182.0	69.7	45.7
NFK067	KRCD	North Fork Kings GSA	B03	T16S R17E 11	179.5		180.0		-0.5
NFK067	KRCD	North Fork Kings GSA	B05	T16S R17E 14	182.4		181.0		1.4
NFK067	DWR	North Fork Kings GSA	365388N1201257W001	T16S R17E 16	184.7	173.1		11.6	
NFK067	DWR	North Fork Kings GSA	365391N1201360W001	T16S R17E 17	183.7	156.2		27.5	
NFK067	DWR	North Fork Kings GSA	365300N1200900W001	T16S R17E 23	182.0		181.0		1.0
NFK067	KRCD	North Fork Kings GSA	B09	T16S R17E 26	185.4		190.0		-4.6
NFK067	DWR	North Fork Kings GSA	365000N1201100W001	T16S R17E 34	190.0		129.0		61.0
NFK067	KRCD	North Fork Kings GSA	B11	T16S R17E 34	190.3		129.0		61.3
NFK067	KRCD	North Fork Kings GSA	B12	T16S R17E 35	193.0		168.0		25.0
NFK067	KRCD	North Fork Kings GSA	B21	T17S R17E 02	198.9		168.0		30.9
NFK067	DWR	North Fork Kings GSA	364700N1201000W001	T17S R17E 11	199.0		168.0		31.0
NFK068	KRCD	North Fork Kings GSA	B04	T16S R17E 12	183.9		189.0		-5.1
NFK068	DWR	North Fork Kings GSA	365396N1200077W001	T16S R18E 16	197.7	159.0	219.8	38.7	-22.1
NFK068	KRCD	North Fork Kings GSA	B13	T16S R18E 17	189.3		211.0		-21.7
NFK068	DWR	North Fork Kings GSA	365246N1200349W001	T16S R18E 20	192.7	163.0		29.7	
NFK068	DWR	North Fork Kings GSA	365235N1199902W001	T16S R18E 22	207.7		206.7		1.0
NFK068	KRCD	North Fork Kings GSA	B17	T16S R18E 28	191.3		195.0		-3.7
NFK084	KRCD	North Fork Kings GSA	B22	T17S R17E 11	199.2		186.0		13.2
NFK084	DWR	North Fork Kings GSA	364593N1200299W001	T17S R18E 09	200.8	142.0	192.1	58.8	8.7
NFK084	DWR	North Fork Kings GSA	364449N1200488W001	T17S R18E 17	207.8		113.1		94.7
NFK084	DWR	North Fork Kings GSA	364452N1200485W001	T17S R18E 17	207.8		121.5		86.3
NFK084	DWR	North Fork Kings GSA	364482N1200657W001	T17S R18E 18	206.8		184.8		22.0
NFK084	DWR	North Fork Kings GSA	364313N1200263W001	T17S R18E 21	207.8	143.0	188.8	64.8	19.0
NFK084	KRCD	North Fork Kings GSA	B28	T17S R18E 21	202.3		222.0		-19.7
NFK084	DWR	North Fork Kings GSA	364224N1199949W001	T17S R18E 26	206.8	128.0	184.6	78.8	22.2
NFK084	KRCD	North Fork Kings GSA	B31	T17S R18E 27	208.0		176.0		32.0
NFK085	DWR	North Fork Kings GSA	365071N1199693W001	T16S R18E 25	207.7	172.0	202.1	35.7	5.6
NFK085	DWR	North Fork Kings GSA	364893N1200127W001	T16S R18E 33	198.7	138.0	178.2	60.7	20.5
NFK085	DWR	North Fork Kings GSA	364900N1200200W001	T16S R18E 33	193.0		176.0		17.0
NFK085	KRCD	North Fork Kings GSA	B18	T16S R18E 33	192.6		176.0		16.6
NFK085	DWR	North Fork Kings GSA	364743N1199863W001	T17S R18E 02	201.8	143.0	178.3	58.8	23.5
NFK085	KRCD	North Fork Kings GSA	B23	T17S R18E 02	197.9		174.0		23.9
NFK085	DWR	North Fork Kings GSA	364591N1200135W001	T17S R18E 09	197.8	136.0	186.6	61.8	11.2
NFK085	DWR	North Fork Kings GSA	364727N1200229W001	T17S R18E 09	196.8	140.0	200.0	56.8	-3.2
NFK085	DWR	North Fork Kings GSA	364700N1199600W001	T17S R18E 12	205.0		181.0		24.0
NFK085	DWR	North Fork Kings GSA	364449N1199682W001	T17S R18E 13	204.8	119.0		85.8	
NFK085	DWR	North Fork Kings GSA	364527N1199593W001	T17S R18E 13	204.8	120.0		84.8	
NFK085	DWR	North Fork Kings GSA	364441N1199752W001	T17S R18E 24	203.8		29.4		174.4
NFK085	DWR	North Fork Kings GSA	364735N1199579W001	T17S R19E 07	207.8	140.5	197.7	67.3	10.1
NFK085	DWR	North Fork Kings GSA	364738N1199416W001	T17S R19E 07	207.8	122.0	177.1	85.8	30.7
NFK085	KRCD	North Fork Kings GSA	B33	T17S R19E 07	205.4		181.0		24.4
NFK085	DWR	North Fork Kings GSA	364510N1199321W001	T17S R19E 17	207.8	122.0		85.8	
NFK085	DWR	North Fork Kings GSA	364493N1199460W001	T17S R19E 18	205.8	121.0		84.8	

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
NFK085	DWR	North Fork Kings GSA	364432N1199502W001	T17S R19E 19	206.8	115.0		91.8	
NFK086	KRCD	North Fork Kings GSA	B20	T16S R19E 31	209.6		201.0		8.6
NFK086	DWR	North Fork Kings GSA	364916N1199307W001	T16S R19E 32	215.0	168.0	206.5	49.7	11.2
NFK086	DWR	North Fork Kings GSA	364700N1198400W002	T17S R19E 10	212.0		167.0		45.0
NFK087	DWR	North Fork Kings GSA	365285N1199318W001	T16S R19E 20	215.0	176.0	224.0	41.7	-6.3
NFK087	DWR	North Fork Kings GSA	365035N1199127W001	T16S R19E 28	220.0	163.0		59.7	
NFK087	DWR	North Fork Kings GSA	365100N1199200W001	T16S R19E 29	218.0		206.0		12.0
NFK087	KRCD	North Fork Kings GSA	A64	T16S R19E 29	218.2		206.0		12.2
NFK087	DWR	North Fork Kings GSA	364893N1198907W001	T16S R19E 34	220.0	149.0		73.7	
NFK087	DWR	North Fork Kings GSA	364924N1198991W001	T16S R19E 34	222.7	163.0	184.0	59.7	38.7
NFK087	DWR	North Fork Kings GSA	364974N1198899W001	T16S R19E 34	222.7	160.0	177.6	62.7	45.1
NFK087	DWR	North Fork Kings GSA	364921N1198721W001	T16S R19E 35	227.7		175.8		51.9
NFK087	DWR	North Fork Kings GSA	364868N1198788W001	T17S R19E 02	227.7	145.4	174.4	82.3	53.3
NFK087	DWR	North Fork Kings GSA	364813N1198968W001	T17S R19E 03	220.0	140.6	171.5	79.4	48.5
NFK087	DWR	North Fork Kings GSA	364738N1198874W001	T17S R19E 10	222.7	123.9	156.8	98.8	65.9
NFK087	DWR	North Fork Kings GSA	364743N1198877W001	T17S R19E 10	222.7	130.0	161.1	92.7	61.6
NFK088	DWR	North Fork Kings GSA	365088N1198635W001	T16S R19E 25	233.7		173.4		60.3
NFK088	DWR	North Fork Kings GSA	365143N1198529W001	T16S R19E 25	236.7		163.4		73.3
NFK088	DWR	North Fork Kings GSA	365032N1198704W001	T16S R19E 35	228.7	153.8	171.9	74.9	56.8
NFK088	DWR	North Fork Kings GSA	365032N1198549W001	T16S R19E 36	232.7	133.2	167.9	99.5	64.8
NFK089	DWR	North Fork Kings GSA	365180N1198363W001	T16S R20E 30	242.7		164.7		78.0
NFK089	DWR	North Fork Kings GSA	364916N1198366W001	T16S R20E 31	237.7	139.4	165.1	98.3	72.6
NFK089	DWR	North Fork Kings GSA	365035N1198363W001	T16S R20E 31	238.7	146.3		92.4	
NFK089	DWR	North Fork Kings GSA	364932N1198216W001	T16S R20E 32	237.7		149.1		88.6
NFK089	DWR	North Fork Kings GSA	365007N1198102W001	T16S R20E 32	239.7	106.3	141.6	133.4	98.1
NFK089	DWR	North Fork Kings GSA	364966N1198038W001	T16S R20E 33	242.7	105.6	138.0	137.1	104.7
NFK089	DWR	North Fork Kings GSA	364902N1197907W001	T16S R20E 34	238.0		119.9		118.1
NFK089	DWR	North Fork Kings GSA	364977N1197735W001	T16S R20E 34	247.7	91.6	119.0	156.1	128.7
NFK089	CID	North Fork Kings GSA	CID51	T16S R20E 34	243.5	114.4	120.1	129.1	123.4
NFK089	DWR	North Fork Kings GSA	364960N1197554W001	T16S R20E 35	249.7	85.2	113.7	164.5	136.0
NFK089	DWR	North Fork Kings GSA	365036N1197449W001	T16S R20E 36	252.7	82.6	105.5	170.1	147.2
NFK090	KRCD	North Fork Kings GSA	A65	T16S R21E 28	265.7		92.0		173.7
NFK090	DWR	North Fork Kings GSA	365150N1197327W001	T16S R21E 30	257.7	73.7	101.7	184.0	156.0
NFK090	DWR	North Fork Kings GSA	364967N1197193W001	T16S R21E 31	257.7	80.0	104.6	177.7	153.1
NFK090	DWR	North Fork Kings GSA	364908N1196971W001	T16S R21E 33	261.3		94.5		166.8
NFK090	KRCD	North Fork Kings GSA	A67	T16S R21E 35	275.1		63.0		212.2
NFK090	CID	North Fork Kings GSA	CID45	T17S R21E 03	262.0	68.9	68.9	193.1	193.1
NFK096	KRCD	North Fork Kings GSA	B30	T17S R18E 26	201.0		167.0		34.0
NFK096	DWR	North Fork Kings GSA	363719N1199579W001	T18S R19E 07	220.9	143.0	198.0	77.9	22.9
NFK097	KRCD	North Fork Kings GSA	B29	T17S R18E 24	200.2		180.0		20.2
NFK097	KRCD	North Fork Kings GSA	B32	T17S R18E 36	203.8		178.0		25.8
NFK097	DWR	North Fork Kings GSA	364421N1199168W001	T17S R19E 21	212.8	113.0		99.8	
NFK097	DWR	North Fork Kings GSA	364205N1198949W001	T17S R19E 27	216.8	110.0		106.8	
NFK097	DWR	North Fork Kings GSA	364268N1198963W001	T17S R19E 27	217.8		177.6		40.2
NFK097	DWR	North Fork Kings GSA	364299N1199085W001	T17S R19E 28	210.8	108.0		102.8	
NFK097	DWR	North Fork Kings GSA	364199N1199496W001	T17S R19E 30	202.8		122.0		80.8
NFK097	DWR	North Fork Kings GSA	364232N1199449W001	T17S R19E 30	206.8	95.0		111.8	
NFK097	DWR	North Fork Kings GSA	364033N1199049W001	T17S R19E 34	212.8		160.0		52.8
NFK097	DWR	North Fork Kings GSA	364039N1199038W001	T17S R19E 34	212.8	96.0		116.8	
NFK097	DWR	North Fork Kings GSA	363883N1199318W001	T18S R19E 05	212.8	129.0		83.8	
NFK097	DWR	North Fork Kings GSA	363944N1199407W001	T18S R19E 05	206.8	124.0		82.8	
NFK097	DWR	North Fork Kings GSA	363722N1199421W001	T18S R19E 07	217.8	128.0	208.0	89.8	9.8
NFK097	DWR	North Fork Kings GSA	363722N1199504W001	T18S R19E 07	221.8		214.0		7.8
NFK097	DWR	North Fork Kings GSA	363800N1199000W001	T18S R19E 10	203.0		178.6		24.4
NFK097	DWR	North Fork Kings GSA	363800N1199010W001	T18S R19E 10	212.8	4.0	4.9	208.8	207.9
NFK097	LID	North Fork Kings GSA	LID26	T18S R19E 10	213.9		180.0		33.9
NFK097	KRCD	North Fork Kings GSA	B38	TNul Rl> l>	202.4		189.0		13.4
NFK098	DWR	North Fork Kings GSA	364521N1199052W001	T17S R19E 16	212.8	117.0		95.8	
NFK098	DWR	North Fork Kings GSA	364402N1198788W001	T17S R19E 23	220.8	110.0		110.8	
NFK098	DWR	North Fork Kings GSA	364149N1198621W001	T17S R19E 36	221.8	105.0		116.8	
NFK098	LID	North Fork Kings GSA	LID18	T18S R19E 01	221.5		140.0		81.5
NFK099	DWR	North Fork Kings GSA	364757N1198646W001	T17S R19E 01	227.7	129.0	167.2	98.7	60.5
NFK099	KRCD	North Fork Kings GSA	B37	T17S R19E 14	217.1		167.0		50.1
NFK100	DWR	North Fork Kings GSA	364750N1197488W001	T17S R20E 01	247.7	82.4	104.1	165.3	143.6
NFK100	DWR	North Fork Kings GSA	364891N1197549W001	T17S R20E 01	245.7	83.0	85.5	162.7	160.2
NFK100	DWR	North Fork Kings GSA	364782N1197627W001	T17S R20E 02	242.7	80.7		162.0	
NFK100	DWR	North Fork Kings GSA	364816N1197785W001	T17S R20E 02	237.7		116.6		121.1
NFK100	DWR	North Fork Kings GSA	364821N1197710W001	T17S R20E 02	241.7		117.3		124.4

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
NFK100	DWR	North Fork Kings GSA	364816N1197888W001	T17S R20E 03	235.7	86.8	117.9	148.9	117.8
NFK100	DWR	North Fork Kings GSA	364857N1198038W001	T17S R20E 04	234.7		171.8		62.9
NFK100	DWR	North Fork Kings GSA	364782N1198210W001	T17S R20E 05	236.7	114.8		121.9	
NFK100	DWR	North Fork Kings GSA	364782N1198471W001	T17S R20E 06	232.7		165.3		67.4
NFK100	DWR	North Fork Kings GSA	364677N1198396W001	T17S R20E 07	227.7		167.5		60.2
NFK100	DWR	North Fork Kings GSA	364700N1198400W001	T17S R20E 07	231.0		160.0		71.0
NFK100	KRCD	North Fork Kings GSA	B40	T17S R20E 07	231.3		160.0		71.3
NFK100	DWR	North Fork Kings GSA	364668N1198257W001	T17S R20E 08	232.7	107.2	148.1	125.5	84.6
NFK100	DWR	North Fork Kings GSA	364688N1197988W001	T17S R20E 09	232.7		104.5		128.2
NFK100	DWR	North Fork Kings GSA	364691N1197874W001	T17S R20E 10	235.7		121.5		114.2
NFK100	DWR	North Fork Kings GSA	364638N1197638W001	T17S R20E 11	242.7	68.8	96.5	173.9	146.2
NFK100	DWR	North Fork Kings GSA	364603N1197510W001	T17S R20E 12	242.7		102.9		139.8
NFK100	LID	North Fork Kings GSA	LID05	T17S R20E 15	233.1		113.0		120.1
NFK100	KRCD	North Fork Kings GSA	B42	T17S R20E 17	228.8		175.0		53.8
NFK100	DWR	North Fork Kings GSA	364424N1198510W001	T17S R20E 19	222.8	109.0	145.3	113.8	77.5
NFK100	DWR	North Fork Kings GSA	364449N1198313W001	T17S R20E 20	225.8	91.8	131.3	134.0	94.5
NFK100	LID	North Fork Kings GSA	LID10	T17S R20E 21	230.9		116.0		114.9
NFK100	LID	North Fork Kings GSA	LID11	T17S R20E 21	232.6		118.0		114.6
NFK100	DWR	North Fork Kings GSA	364313N1197916W001	T17S R20E 22	237.8	78.1	103.0	159.7	134.8
NFK100	DWR	North Fork Kings GSA	364343N1197624W001	T17S R20E 24	235.0	68.7	92.7	169.0	145.0
NFK100	DWR	North Fork Kings GSA	364255N1197804W001	T17S R20E 26	237.8	79.0	106.0	158.8	131.8
NFK100	DWR	North Fork Kings GSA	364185N1198163W001	T17S R20E 28	232.8	91.7	116.0	141.1	116.8
NFK100	DWR	North Fork Kings GSA	364300N1198000W001	T17S R20E 28	229.8		121.3		108.5
NFK100	LID	North Fork Kings GSA	LID16	T17S R20E 31	226.7		136.0		90.7
NFK100	DWR	North Fork Kings GSA	364163N1198007W001	T17S R20E 33	233.8		16.9		216.9
NFK100	LID	North Fork Kings GSA	LID12	T17S R20E 33	233.6		118.0		115.6
NFK100	LID	North Fork Kings GSA	LID09	T17S R20E 34	237.8		121.0		116.8
NFK100	LID	North Fork Kings GSA	LID06	T17S R20E 36	242.8		99.0		143.8
NFK101	KRCD	North Fork Kings GSA	A69	T17S R21E 03	265.0		82.0		183.1
NFK101	CID	North Fork Kings GSA	CID46	T17S R21E 05	252.2	76.1	101.1	176.1	151.1
NFK101	DWR	North Fork Kings GSA	364817N1197357W001	T17S R21E 06	252.7	81.8	104.5	170.9	148.2
NFK101	KRCD	North Fork Kings GSA	A70	T17S R21E 08	255.2		97.0		158.2
NFK101	DWR	North Fork Kings GSA	364667N1197041W001	T17S R21E 09	252.7	67.1	85.6	185.6	167.1
NFK101	DWR	North Fork Kings GSA	364667N1196641W001	T17S R21E 11	259.7	50.3	73.3	209.4	186.4
NFK101	KRCD	North Fork Kings GSA	A72	T17S R21E 12	263.0		57.0		206.0
NFK101	DWR	North Fork Kings GSA	364500N1196535W001	T17S R21E 13	262.7	32.2	33.1	230.5	229.6
NFK101	KRCD	North Fork Kings GSA	A73	T17S R21E 15	252.6		68.0		184.6
NFK101	DWR	North Fork Kings GSA	364481N1197074W002	T17S R21E 16	251.7	54.1		197.6	
NFK101	DWR	North Fork Kings GSA	364492N1197088W001	T17S R21E 17	251.7	53.0	74.0	198.7	177.7
NFK101	DWR	North Fork Kings GSA	364500N1197200W001	T17S R21E 17	245.2		75.8		169.4
NFK101	LID	North Fork Kings GSA	LID02	T17S R21E 17	245.7		78.0		167.7
NFK101	DWR	North Fork Kings GSA	364394N1197271W001	T17S R21E 19	247.7		68.1		179.6
NFK101	DWR	North Fork Kings GSA	364386N1197154W001	T17S R21E 20	250.7	47.5		203.2	
NFK101	DWR	North Fork Kings GSA	364389N1197196W001	T17S R21E 20	249.7	47.4	88.3	202.3	161.4
NFK101	LID	North Fork Kings GSA	LID01	T17S R21E 21	252.6		60.0		192.6
NFK101	DWR	North Fork Kings GSA	364417N1196804W001	T17S R21E 22	255.7		52.6		203.1
NFK101	DWR	North Fork Kings GSA	364428N1196821W001	T17S R21E 22	255.2	36.7		218.5	
NFK101	DWR	North Fork Kings GSA	364306N1197260W001	T17S R21E 29	249.7		60.9		188.8
NFK101	LID	North Fork Kings GSA	LID03	T17S R21E 30	246.7		79.0		167.7
NFK102	KRCD	North Fork Kings GSA	A68	T17S R21E 01	271.4		69.0		202.4
NFK102	KRCD	North Fork Kings GSA	A74	T17S R22E 05	279.5		53.0		226.5
NFK102	DWR	North Fork Kings GSA	364739N1196227W001	T17S R22E 07	272.7	40.5	67.1	232.2	205.6
NFK102	DWR	North Fork Kings GSA	364453N1196360W001	T17S R22E 19	269.7		24.9		244.8
NFK112	LID	North Fork Kings GSA	LID24	T18S R19E 23	212.9		171.0		41.9
NFK112	DWR	North Fork Kings GSA	363400N1198800W001	T18S R19E 26	206.5		164.6		41.9
NFK112	DWR	North Fork Kings GSA	363208N1198691W002	T18S R19E 36	213.8	111.0	165.0	102.8	48.8
NFK112	DWR	North Fork Kings GSA	363133N1199046W001	T19S R19E 03	218.9	94.5		124.4	
NFK113	DWR	North Fork Kings GSA	363981N1198804W001	T18S R19E 02	217.8		9.3		208.5
NFK113	DWR	North Fork Kings GSA	363667N1198832W001	T18S R19E 14	215.8	3.6	5.3	212.2	210.5
NFK114	DWR	North Fork Kings GSA	364002N1197624W001	T18S R20E 01	242.8		109.0		133.8
NFK114	LID	North Fork Kings GSA	LID07	T18S R20E 01	242.8		104.0		138.8
NFK114	LID	North Fork Kings GSA	LID08	T18S R20E 02	240.8		124.0		116.8
NFK114	DWR	North Fork Kings GSA	364000N1198100W001	T18S R20E 04	226.1		130.0		96.1
NFK114	DWR	North Fork Kings GSA	364008N1196907W001	T18S R20E 04	248.6		75.4		175.4
NFK114	LID	North Fork Kings GSA	LID14	T18S R20E 04	235.9		131.0		104.9
NFK114	LID	North Fork Kings GSA	LID23	T18S R20E 07	225.7		146.0		79.7
NFK114	LID	North Fork Kings GSA	LID21	T18S R20E 08	227.7		127.0		100.7
NFK114	DWR	North Fork Kings GSA	363794N1198157W001	T18S R20E 09	230.8		11.1		219.7

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
NFK114	LID	North Fork Kings GSA	LID22	T18S R20E 09	235.9		135.0		100.9
NFK114	DWR	North Fork Kings GSA	363700N1198300W001	T18S R20E 17	214.6		144.5		70.1
NFK114	DWR	North Fork Kings GSA	363728N1198296W001	T18S R20E 17	227.3		4.9		222.4
NFK114	DWR	North Fork Kings GSA	363461N1198468W001	T18S R20E 19	219.8	108.0	123.0	111.8	96.8
NK004	DWR	North Kings GSA	368566N1198421W001	T12S R19E 25	257.5	28.9		228.6	
NK004	City of Fresno	North Kings GSA	12S19E33P001MX	T12S R19E 33	300.9	85.5	98.6	215.4	202.3
NK004	City of Fresno	North Kings GSA	12S19E34L001MX	T12S R19E 34	315.4	104.7		210.7	
NK004	FID	North Kings GSA	12S19E34P001MX	T12S R19E 34	317.8	101.1		216.7	
NK004	City of Fresno	North Kings GSA	12S19E35Q001MX	T12S R19E 35	323.1	113.6	124.9	209.5	198.2
NK004	City of Fresno	North Kings GSA	12S19E36J001MX	T12S R19E 36	331.8	123.3	147.9	208.5	183.9
NK004	City of Fresno	North Kings GSA	12S19E36Q001MX	T12S R19E 36	332.1	127.4	140.2	204.7	191.9
NK004	DWR	North Kings GSA	368400N1198400W001	T12S R19E 36	292.0		83.1		208.9
NK005	DWR	North Kings GSA	369188N1197341W001	T12S R20E 01	317.5	48.7		268.8	
NK005	DWR	North Kings GSA	369018N1197560W002	T12S R20E 11	364.5	104.5		260.0	
NK005	DWR	North Kings GSA	368916N1197307W001	T12S R20E 13	389.5	145.3		244.2	
NK005	City of Fresno	North Kings GSA	12S20E15A001MX	T12S R20E 15	361.3	136.6		224.7	
NK005	City of Fresno	North Kings GSA	12S20E23D001MX	T12S R20E 23	364.4	133.5	149.7	230.9	214.7
NK005	City of Fresno	North Kings GSA	12S20E23M001MX	T12S R20E 23	354.2	123.8		230.4	
NK005	DWR	North Kings GSA	368610N1197321W001	T12S R20E 25	368.5	127.4		241.1	
NK005	DWR	North Kings GSA	368610N1197463W001	T12S R20E 25	364.5	131.7		232.8	
NK005	City of Fresno	North Kings GSA	12S20E26A001MX	T12S R20E 26	373.0	144.4	166.3	228.6	206.7
NK005	City of Fresno	North Kings GSA	12S20E26K001MX	T12S R20E 26	360.2	135.5	154.6	224.7	205.6
NK005	DWR	North Kings GSA	368538N1197588W001	T12S R20E 26	355.5	128.4		227.1	
NK005	City of Fresno	North Kings GSA	12S20E27H001MX	T12S R20E 27	367.0	138.0	175.9	229.0	191.1
NK005	City of Fresno	North Kings GSA	12S20E27L001MX	T12S R20E 27	358.0	135.8	158.0	222.2	200.0
NK005	City of Fresno	North Kings GSA	12S20E27N001MX	T12S R20E 27	351.0	132.4	152.8	218.6	198.2
NK005	City of Fresno	North Kings GSA	12S20E32A001MX	T12S R20E 32	346.5		143.0		203.5
NK005	DWR	North Kings GSA	368466N1198071W001	T12S R20E 32	343.5	126.3		217.2	
NK005	City of Fresno	North Kings GSA	12S20E34K001MX	T12S R20E 34	360.1	126.0	151.0	234.1	209.1
NK005	DWR	North Kings GSA	368393N1197810W001	T12S R20E 34	342.5	81.3		261.2	
NK005	DWR	North Kings GSA	368393N1197493W001	T12S R20E 35	352.5	121.0		231.5	
NK005	City of Fresno	North Kings GSA	12S20E36M001MX	T12S R20E 36	349.9	134.6	162.1	215.3	187.8
NK005	DWR	North Kings GSA	368432N1197321W001	T12S R20E 36	362.5		181.7		180.8
NK006	DWR	North Kings GSA	369099N1197113W001	T12S R21E 07	408.0	149.9		258.1	
NK006	DWR	North Kings GSA	12S21E16B001MX	T12S R21E 16	400.0	17.8		382.2	
NK006	DWR	North Kings GSA	368874N1197043W001	T12S R21E 17	390.5	83.1		307.4	
NK006	DWR	North Kings GSA	368893N1197016W001	T12S R21E 17	391.5	72.5		319.0	
NK006	DWR	North Kings GSA	368938N1197091W001	T12S R21E 17	396.5	114.4		282.1	
NK006	DWR	North Kings GSA	368955N1197168W001	T12S R21E 18	394.5	139.3		255.2	
NK006	DWR	North Kings GSA	368682N1197177W001	T12S R21E 19	375.5	92.2	130.1	283.3	245.4
NK006	DWR	North Kings GSA	368716N1197132W001	T12S R21E 19	380.5	81.4		299.1	
NK006	DWR	North Kings GSA	368571N1196546W001	T12S R21E 26	396.3	48.1		348.2	
NK006	DWR	North Kings GSA	368607N1196654W001	T12S R21E 27	398.5	51.0		347.5	
NK006	DWR	North Kings GSA	368613N1196657W001	T12S R21E 27	392.5	48.0		344.5	
NK006	DWR	North Kings GSA	12S21E29K001MX	T12S R21E 29	379.0		90.1		288.9
NK006	DWR	North Kings GSA	368546N1196974W001	T12S R21E 29	379.5		91.5		288.0
NK006	DWR	North Kings GSA	368571N1197002W001	T12S R21E 29	381.5	66.4	89.1	315.1	292.4
NK006	DWR	North Kings GSA	368610N1197132W001	T12S R21E 30	376.5	94.5		282.0	
NK006	City of Clovis	North Kings GSA	12S21E31M001MX	T12S R21E 31	361.5	131.0	167.5	230.5	194.0
NK006	City of Clovis	North Kings GSA	13S21E30Q001MX	T12S R21E 31	370.0	126.3		243.7	
NK006	DWR	North Kings GSA	368463N1197113W001	T12S R21E 31	369.5	95.7		273.8	
NK006	DWR	North Kings GSA	368499N1197227W001	T12S R21E 31	365.5	118.0		247.5	
NK006	City of Clovis	North Kings GSA	12S21E32K001MX	T12S R21E 32	370.1	143.0	165.0	227.1	205.1
NK006	City of Clovis	North Kings GSA	12S21E32Q001MX	T12S R21E 32	370.5	128.0	154.0	242.5	216.5
NK006	DWR	North Kings GSA	368377N1197024W001	T12S R21E 32	368.5	81.7		286.8	
NK006	FID	North Kings GSA	12S21E33P001MX	T12S R21E 33	374.2	93.1		281.1	
NK006	City of Clovis	North Kings GSA	12S21E33P002MX	T12S R21E 33	371.2	113.0	131.8	258.2	239.4
NK006	DWR	North Kings GSA	368377N1196843W001	T12S R21E 33	376.5	93.1		283.4	
NK006	DWR	North Kings GSA	368393N1196871W001	T12S R21E 33	372.5	86.0		286.5	
NK006	DWR	North Kings GSA	368499N1196910W001	T12S R21E 33	378.5	67.3		311.2	
NK006	FID	North Kings GSA	12S21E34D001MX	T12S R21E 34	387.7	70.0		317.7	
NK006	DWR	North Kings GSA	12S21E34H001MX	T12S R21E 34	390.0		61.3		328.7
NK006	DWR	North Kings GSA	368468N1196593W001	T12S R21E 34	392.5	59.7	60.3	332.8	332.2
NK006	DWR	North Kings GSA	368510N1196713W001	T12S R21E 34	390.2	70.0		320.2	
NK008	DWR	North Kings GSA	368552N1196413W001	T12S R21E 26	412.6	47.7		364.9	
NK008	DWR	North Kings GSA	12S21E35Q001MX	T12S R21E 35	419.0		66.9		352.1
NK008	DWR	North Kings GSA	368377N1196479W001	T12S R21E 35	395.1		66.4		328.7
NK008	DWR	North Kings GSA	368432N1196460W001	T12S R21E 35	401.6	60.4	64.1	341.2	337.5

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
NK008	DWR	North Kings GSA	368499N1196460W001	T12S R21E 35	404.6	56.7	58.2	347.9	346.3
NK008	DWR	North Kings GSA	368433N1196282W001	T12S R21E 36	411.6	61.9	64.1	349.7	347.5
NK008	DWR	North Kings GSA	368469N1196232W001	T12S R21E 36	421.6	60.2		361.4	
NK008	DWR	North Kings GSA	12S22E19N001MX	T12S R22E 19	438.0		26.6		411.4
NK008	DWR	North Kings GSA	368683N1196185W001	T12S R22E 19	440.6	20.8	25.6	419.8	415.0
NK008	DWR	North Kings GSA	368597N1195846W001	T12S R22E 29	464.6	19.8		444.8	
NK008	DWR	North Kings GSA	12S22E32R001MX	T12S R22E 32	438.0		53.1		384.9
NK008	DWR	North Kings GSA	368378N1195871W001	T12S R22E 32	433.6	46.9	52.6	386.7	381.0
NK009	DWR	North Kings GSA	368750N1195824W001	T12S R22E 21	475.6	11.7		463.9	
NK009	DWR	North Kings GSA	368572N1195413W001	T12S R22E 26	487.6	9.0	21.8	478.6	465.8
NK010	DWR	North Kings GSA	12S22E26L001MX	T12S R22E 26	485.0		21.8		463.2
NK011	DWR	North Kings GSA	368394N1195460W001	T12S R22E 35	447.6	10.0		437.6	
NK011	FID	North Kings GSA	13S23E19N001MX	T13S R23E 19	410.3	11.7		398.6	
NK011	FID	North Kings GSA	13S23E30B001MX	T13S R23E 30	410.8	10.9	5.2	399.9	405.6
NK011	DWR	North Kings GSA	367772N1195179W001	T13S R23E 30	408.6	5.6	13.2	403.0	395.4
NK011	DWR	North Kings GSA	367789N1195107W001	T13S R23E 30	414.0	10.6		403.4	
NK015	FID	North Kings GSA	13S17E12J001MX	T13S R17E 12	244.2	52.5	46.1	191.7	198.1
NK015	FID	North Kings GSA	13S17E13H001MX	T13S R17E 13	242.3		44.0		198.3
NK015	DWR	North Kings GSA	368077N1201163W001	T13S R17E 16	220.4	30.5		189.9	
NK015	DWR	North Kings GSA	367966N1201513W001	T13S R17E 18	199.4	16.3		183.1	
NK015	DWR	North Kings GSA	367977N1201682W001	T13S R17E 18	197.4	8.7		188.7	
NK015	DWR	North Kings GSA	367932N1201510W001	T13S R17E 19	211.4	15.7		195.7	
NK015	FID	North Kings GSA	13S17E20A001MX	T13S R17E 20	209.9	39.2		170.7	
NK015	FID	North Kings GSA	13S17E22B001MX	T13S R17E 22	221.9	42.2	50.5	179.7	171.4
NK015	DWR	North Kings GSA	367785N1200704W001	T13S R17E 24	234.0		52.2		181.8
NK015	DWR	North Kings GSA	367913N1200646W001	T13S R17E 24	242.4	58.2		184.2	
NK015	FID	North Kings GSA	13S17E25C001MX	T13S R17E 25	231.8	52.9	53.1	178.9	178.8
NK015	FID	North Kings GSA	13S17E27L001MX	T13S R17E 27	215.6	53.5	58.6	162.1	157.0
NK015	DWR	North Kings GSA	367691N1200968W001	T13S R17E 27	223.5	59.3		164.2	
NK015	DWR	North Kings GSA	367700N1201100W001	T13S R17E 27	217.0		58.2		158.8
NK015	DWR	North Kings GSA	367732N1201191W001	T13S R17E 28	215.4	58.2		157.2	
NK015	DWR	North Kings GSA	367638N1201279W001	T13S R17E 33	213.5	68.9		144.6	
NK015	FID	North Kings GSA	13S17E34L001MX	T13S R17E 34	214.7	62.8	68.8	151.9	145.9
NK015	DWR	North Kings GSA	367568N1201057W001	T13S R17E 34	217.8	62.7		155.1	
NK015	DWR	North Kings GSA	367563N1200877W001	T13S R17E 35	222.5	71.9		150.6	
NK015	FID	North Kings GSA	13S17E36N001MX	T13S R17E 36	220.6	66.9		153.7	
NK016	DWR	North Kings GSA	368321N1199541W001	T13S R18E 01	284.4	67.7		216.7	
NK016	DWR	North Kings GSA	368227N1199799W001	T13S R18E 02	272.4	59.1		213.3	
NK016	DWR	North Kings GSA	368363N1199802W001	T13S R18E 02	262.4	47.0		215.4	
NK016	DWR	North Kings GSA	368260N1199991W001	T13S R18E 03	267.4	52.6		214.8	
NK016	FID	North Kings GSA	13S18E07K001MX	T13S R18E 07	248.9		54.0		194.9
NK016	FID	North Kings GSA	13S18E07L001MX	T13S R18E 07	245.2		51.0		194.2
NK016	FID	North Kings GSA	13S18E07P002MX	T13S R18E 07	247.4		51.5		195.9
NK016	FID	North Kings GSA	13S18E08K001MX	T13S R18E 08	256.8		55.5		201.3
NK016	DWR	North Kings GSA	368074N1200260W001	T13S R18E 08	255.0		51.0		204.0
NK016	DWR	North Kings GSA	368196N1200160W001	T13S R18E 09	257.4	35.0		222.4	
NK016	FID	North Kings GSA	13S18E10L001MX	T13S R18E 10	261.4	62.9	54.8	198.5	206.6
NK016	DWR	North Kings GSA	368093N1199988W001	T13S R18E 10	260.4	51.4		209.0	
NK016	FID	North Kings GSA	13S18E11J001MX	T13S R18E 11	271.5	67.5		204.0	
NK016	DWR	North Kings GSA	368146N1199716W001	T13S R18E 11	273.9	67.5		206.4	
NK016	DWR	North Kings GSA	368010N1199704W002	T13S R18E 13	268.9	58.8		210.1	
NK016	DWR	North Kings GSA	368002N1199888W001	T13S R18E 15	263.4	57.4		206.0	
NK016	FID	North Kings GSA	13S18E17A001MX	T13S R18E 17	253.2	48.6	51.0	204.6	202.2
NK016	FID	North Kings GSA	13S18E18A001MX	T13S R18E 18	253.7		57.0		196.7
NK016	FID	North Kings GSA	13S18E18A002MX	T13S R18E 18	253.9		58.5		195.4
NK016	FID	North Kings GSA	13S18E18A003MX	T13S R18E 18	250.0		50.0		200.0
NK016	FID	North Kings GSA	13S18E18G002MX	T13S R18E 18	253.6		59.0		194.6
NK016	FID	North Kings GSA	13S18E18G003MX	T13S R18E 18	249.0		53.0		196.0
NK016	FID	North Kings GSA	13S18E18G004MX	T13S R18E 18	244.9		47.0		197.9
NK016	FID	North Kings GSA	13S18E18H002MX	T13S R18E 18	253.2		57.0		196.2
NK016	FID	North Kings GSA	13S18E18M001MX	T13S R18E 18	244.1		47.0		197.1
NK016	FID	North Kings GSA	13S18E18M002MX	T13S R18E 18	245.2		52.0		193.2
NK016	FID	North Kings GSA	13S18E19A001MX	T13S R18E 19	244.6		47.0		197.6
NK016	FID	North Kings GSA	13S18E20D001MX	T13S R18E 20	244.7		51.0		193.7
NK016	DWR	North Kings GSA	367930N1200343W001	T13S R18E 20	247.4	47.9		199.5	
NK016	DWR	North Kings GSA	367813N1200160W001	T13S R18E 21	246.9	49.3		197.6	
NK016	FID	North Kings GSA	13S18E22P002MX	T13S R18E 22	255.4		71.0		184.4
NK016	FID	North Kings GSA	13S18E22Q002MX	T13S R18E 22	254.9		55.0		199.9

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
NK016	FID	North Kings GSA	13S18E22R001MX	T13S R18E 22	260.3		63.0		197.3
NK016	FID	North Kings GSA	13S18E22R002MX	T13S R18E 22	260.7		63.0		197.7
NK016	FID	North Kings GSA	13S18E22R003MX	T13S R18E 22	261.5		59.0		202.5
NK016	DWR	North Kings GSA	367857N1199977W001	T13S R18E 22	247.9	53.7		194.2	
NK016	FID	North Kings GSA	13S18E23N001MX	T13S R18E 23	255.1	55.2	49.0	199.9	206.1
NK016	FID	North Kings GSA	13S18E25B001MX	T13S R18E 25	265.9	63.4		202.5	
NK016	FID	North Kings GSA	13S18E25K001MX	T13S R18E 25	261.0		61.0		200.0
NK016	DWR	North Kings GSA	367782N1199585W001	T13S R18E 25	268.4	63.4		205.0	
NK016	FID	North Kings GSA	13S18E27A001MX	T13S R18E 27	257.0		56.0		201.0
NK016	FID	North Kings GSA	13S18E27B001MX	T13S R18E 27	256.7		54.0		202.7
NK016	FID	North Kings GSA	13S18E27B003MX	T13S R18E 27	254.7		56.0		198.7
NK016	FID	North Kings GSA	13S18E28F001MX	T13S R18E 28	243.1	52.1	47.7	191.0	195.4
NK016	DWR	North Kings GSA	367700N1200200W001	T13S R18E 28	245.0		46.0		199.0
NK016	FID	North Kings GSA	13S18E29C001MX	T13S R18E 29	238.5	53.8	48.0	184.7	190.5
NK016	DWR	North Kings GSA	367499N1200410W001	T13S R18E 32	233.8	64.5		169.3	
NK016	FID	North Kings GSA	13S18E33M001MX	T13S R18E 33	237.3	57.5	51.5	179.8	185.8
NK016	FID	North Kings GSA	13S18E34K001MX	T13S R18E 34	242.7		43.1		199.6
NK016	FID	North Kings GSA	13S18E34N001MX	T13S R18E 34	243.1		50.0		193.1
NK016	DWR	North Kings GSA	367638N1200057W001	T13S R18E 34	247.5	58.7		188.8	
NK016	FID	North Kings GSA	13S18E35G001MX	T13S R18E 35	253.2		58.0		195.3
NK016	FID	North Kings GSA	14S18E05D001MX	T14S R18E 05	230.5	64.7		165.8	
NK017	City of Fresno	North Kings GSA	13S19E01C001MX	T13S R19E 01	329.3		129.9		199.4
NK017	City of Fresno	North Kings GSA	13S19E01L001MX	T13S R19E 01	312.8	105.7	123.2	207.1	189.6
NK017	City of Fresno	North Kings GSA	13S19E02M001MX	T13S R19E 02	314.4		120.3		194.1
NK017	FID	North Kings GSA	13S19E06A001MX	T13S R19E 06	291.2	76.8	82.0	214.4	209.2
NK017	FID	North Kings GSA	13S19E07R001MX	T13S R19E 07	279.4	66.0		213.4	
NK017	City of Fresno	North Kings GSA	13S19E10F001MX	T13S R19E 10	304.4	99.1	113.3	205.3	191.1
NK017	City of Fresno	North Kings GSA	13S19E10Q001MX	T13S R19E 10	298.0	90.3	104.2	207.7	193.8
NK017	City of Fresno	North Kings GSA	13S19E11L001MX	T13S R19E 11	304.7	100.4	115.0	204.3	189.7
NK017	DWR	North Kings GSA	367991N1199052W001	T13S R19E 16	292.5	82.4		210.1	
NK017	FID	North Kings GSA	13S19E18E001MX	T13S R19E 18	273.4	65.4		208.0	
NK017	FID	North Kings GSA	13S19E18E002MX	T13S R19E 18	274.2		69.4		204.8
NK017	FID	North Kings GSA	13S19E21D001MX	T13S R19E 21	282.9	75.7		207.2	
NK017	FID	North Kings GSA	13S19E23E001MX	T13S R19E 23	284.6	80.8	81.0	203.8	203.6
NK017	DWR	North Kings GSA	367899N1198799W001	T13S R19E 23	287.0		80.1		207.0
NK017	City of Fresno	North Kings GSA	13S19E26L001MX	T13S R19E 26	279.3	76.6	82.6	202.7	196.7
NK017	FID	North Kings GSA	13S19E27R001MX	T13S R19E 27	390.0	74.2		315.8	
NK017	FID	North Kings GSA	13S19E29A001MX	T13S R19E 29	266.9		71.7		195.2
NK017	FID	North Kings GSA	13S19E29D001MX	T13S R19E 29	268.2		71.3		196.9
NK017	FID	North Kings GSA	13S19E29E001MX	T13S R19E 29	268.0	66.7		201.3	
NK018	City of Fresno	North Kings GSA	13S20E01G001MX	T13S R20E 01	348.4	132.5	158.5	215.9	189.9
NK018	City of Fresno	North Kings GSA	13S20E02G001MX	T13S R20E 02	345.2	127.1		218.1	
NK018	City of Fresno	North Kings GSA	13S20E03H001MX	T13S R20E 03	333.4	123.1		210.4	
NK018	City of Fresno	North Kings GSA	13S20E05B001MX	T13S R20E 05	338.7	126.6	145.6	212.1	193.1
NK018	City of Fresno	North Kings GSA	13S20E06H001MX	T13S R20E 06	329.3	123.4	137.5	205.9	191.8
NK018	City of Fresno	North Kings GSA	13S20E06M001MX	T13S R20E 06	326.5	124.1		202.4	
NK018	City of Fresno	North Kings GSA	13S20E09L001MX	T13S R20E 09	321.6	112.3	142.2	209.3	179.4
NK018	City of Fresno	North Kings GSA	13S20E10Q001MX	T13S R20E 10	327.5	116.0	142.4	211.5	185.1
NK018	City of Fresno	North Kings GSA	13S20E11L001MX	T13S R20E 11	329.2	116.0	150.0	213.2	179.2
NK018	FID	North Kings GSA	13S20E12H001MX	T13S R20E 12	343.4	113.4		230.0	
NK018	DWR	North Kings GSA	368191N1197363W001	T13S R20E 12	345.9	113.4		232.5	
NK018	City of Fresno	North Kings GSA	13S20E13C001MX	T13S R20E 13	335.2	105.1	140.4	230.1	194.8
NK018	City of Fresno	North Kings GSA	13S20E13H001MX	T13S R20E 13	335.6		135.1		200.5
NK018	City of Fresno	North Kings GSA	13S20E14L001MX	T13S R20E 14	312.9		141.3		171.6
NK018	City of Fresno	North Kings GSA	13S20E16Q001MX	T13S R20E 16	312.4		131.3		181.1
NK018	City of Fresno	North Kings GSA	13S20E17A001MX	T13S R20E 17	319.9	113.3		206.6	
NK018	City of Fresno	North Kings GSA	13S20E17J001MX	T13S R20E 17	317.0	114.9	135.7	202.1	181.3
NK018	City of Fresno	North Kings GSA	13S20E17L001MX	T13S R20E 17	319.0	112.6		206.4	
NK018	City of Fresno	North Kings GSA	13S20E18E001MX	T13S R20E 18	304.0	102.2	119.6	201.8	184.4
NK018	City of Fresno	North Kings GSA	13S20E19C001MX	T13S R20E 19	307.6	105.4	124.5	202.2	183.1
NK018	City of Fresno	North Kings GSA	13S20E20J001MX	T13S R20E 20	304.4	104.4	138.3	200.0	166.1
NK018	City of Fresno	North Kings GSA	13S20E20R001MX	T13S R20E 20	300.2	90.8	115.8	209.4	184.4
NK018	City of Fresno	North Kings GSA	13S20E22H001MX	T13S R20E 22	320.6	118.1	141.9	202.6	178.7
NK018	City of Fresno	North Kings GSA	13S20E23B001MX	T13S R20E 23	324.7	114.1	142.9	210.6	181.8
NK018	City of Fresno	North Kings GSA	13S20E23J001MX	T13S R20E 23	322.2	101.0	131.5	221.1	190.7
NK018	City of Fresno	North Kings GSA	13S20E25G001MX	T13S R20E 25	321.9	95.1	130.4	226.8	191.5
NK018	City of Fresno	North Kings GSA	13S20E26P001MX	T13S R20E 26	307.9	104.1	129.8	203.9	178.1
NK018	City of Fresno	North Kings GSA	13S20E27C001MX	T13S R20E 27	310.1	113.0	130.9	197.1	179.2

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
NK018	City of Fresno	North Kings GSA	13S20E28C001MX	T13S R20E 28	307.0		125.2		181.8
NK018	City of Fresno	North Kings GSA	13S20E28N001MX	T13S R20E 28	299.5	90.0	112.8	209.5	186.7
NK018	City of Fresno	North Kings GSA	13S20E28R001MX	T13S R20E 28	300.8	105.8		195.0	
NK018	City of Fresno	North Kings GSA	13S20E30B001MX	T13S R20E 30	304.0	106.1	118.1	197.9	185.9
NK018	City of Fresno	North Kings GSA	13S20E31D001MX	T13S R20E 31	292.4		102.5		189.9
NK018	City of Fresno	North Kings GSA	13S20E32D001MX	T13S R20E 32	293.3	91.6	106.9	201.7	186.4
NK018	City of Fresno	North Kings GSA	13S20E32K001MX	T13S R20E 32	292.1		107.3		184.8
NK019	DWR	North Kings GSA	367577N1197868W001	T13S R20E 34	300.7	103.9		196.8	
NK019	City of Fresno	North Kings GSA	13S20E36P001MX	T13S R20E 36	306.5	99.0		207.5	
NK020	DWR	North Kings GSA	368282N1196616W001	T13S R21E 02	384.5	62.2		322.3	
NK020	City of Clovis	North Kings GSA	13S21E09D001MX	T13S R21E 04	359.9	93.5		266.4	
NK020	City of Clovis	North Kings GSA	13S21E05E001MX	T13S R21E 05	364.6	130.0	169.8	234.6	194.9
NK020	City of Clovis	North Kings GSA	13S21E05J001MX	T13S R21E 05	361.3	96.3		265.0	
NK020	City of Clovis	North Kings GSA	13S21E06H001MX	T13S R21E 06	358.0	140.6		217.4	
NK020	City of Clovis	North Kings GSA	13S21E06P001MX	T13S R21E 06	354.8	120.5	155.5	234.3	199.3
NK020	City of Clovis	North Kings GSA	13S21E07G001MX	T13S R21E 07	345.8	111.4		234.4	
NK020	City of Clovis	North Kings GSA	13S21E07P001MX	T13S R21E 07	345.0		146.3		198.8
NK020	City of Clovis	North Kings GSA	13S21E08J001MX	T13S R21E 08	355.0	101.0	146.0	254.0	209.0
NK020	City of Clovis	North Kings GSA	13S21E09C001MX	T13S R21E 09	360.7	107.0	134.0	253.7	226.7
NK020	City of Clovis	North Kings GSA	13S21E09R001MX	T13S R21E 09	365.0	125.5	147.8	239.5	217.3
NK020	City of Clovis	North Kings GSA	13S21E10G001MX	T13S R21E 10	373.1		107.5		265.6
NK020	DWR	North Kings GSA	368211N1196482W001	T13S R21E 11	388.5	57.3	62.8	331.2	325.7
NK020	FID	North Kings GSA	13S21E14D001MX	T13S R21E 14	378.0	58.6		319.4	
NK020	City of Clovis	North Kings GSA	13S21E15L001MX	T13S R21E 15	357.0		137.0		220.0
NK020	City of Clovis	North Kings GSA	13S21E16M001MX	T13S R21E 16	354.8	126.0	150.0	228.8	204.8
NK020	City of Clovis	North Kings GSA	13S21E16N001MX	T13S R21E 16	347.6	93.0	124.8	254.6	222.9
NK020	City of Clovis	North Kings GSA	13S21E16N002MX	T13S R21E 16	347.0	98.0	127.0	249.0	220.0
NK020	City of Clovis	North Kings GSA	13S21E16P001MX	T13S R21E 16	354.7	95.8	128.0	258.9	226.7
NK020	City of Clovis	North Kings GSA	13S21E17J001MX	T13S R21E 17	355.0	96.5		258.5	
NK020	City of Clovis	North Kings GSA	13S21E17Q001MX	T13S R21E 17	345.5	91.0	131.8	254.5	213.8
NK020	City of Clovis	North Kings GSA	13S21E17Q002MX	T13S R21E 17	349.4	97.0	135.5	252.4	213.9
NK020	City of Clovis	North Kings GSA	13S21E18H001MX	T13S R21E 18	343.0	97.7	139.0	245.3	204.0
NK020	City of Fresno	North Kings GSA	13S21E19E001MX	T13S R21E 19	334.8	93.0	129.8	241.8	205.0
NK020	City of Clovis	North Kings GSA	13S21E20A001MX	T13S R21E 20	347.0	94.5	128.5	252.5	218.5
NK020	City of Clovis	North Kings GSA	13S21E20A002MX	T13S R21E 20	347.0	94.0	131.8	253.0	215.3
NK020	City of Clovis	North Kings GSA	13S21E20F001MX	T13S R21E 20	338.0		141.0		197.0
NK020	City of Clovis	North Kings GSA	13S21E21E001MX	T13S R21E 21	347.0	95.5	126.0	251.5	221.0
NK020	City of Clovis	North Kings GSA	13S21E21E002MX	T13S R21E 21	347.0	90.8		256.2	
NK020	City of Fresno	North Kings GSA	13S21E30P001MX	T13S R21E 30	318.9	93.1	124.1	225.8	194.8
NK020	City of Fresno	North Kings GSA	13S21E31E001MX	T13S R21E 31	312.2	95.1	119.4	217.1	192.8
NK021	DWR	North Kings GSA	367958N1196482W001	T13S R21E 14	372.5		45.3		327.2
NK021	City of Fresno	North Kings GSA	13S21E21P001MX	T13S R21E 21	340.0	78.0		261.9	
NK021	FID	North Kings GSA	13S21E23D001MX	T13S R21E 23	362.0	53.8		308.2	
NK021	DWR	North Kings GSA	367811N1196482W001	T13S R21E 23	356.5	32.8	44.9	323.7	311.6
NK021	DWR	North Kings GSA	367936N1196593W001	T13S R21E 23	364.5	53.6		310.9	
NK021	FID	North Kings GSA	13S21E24J001MX	T13S R21E 24	370.8	32.3	40.6	338.5	330.2
NK021	DWR	North Kings GSA	367664N1196438W001	T13S R21E 25	356.5	36.6	53.8	319.9	302.7
NK021	FID	North Kings GSA	13S21E26M001MX	T13S R21E 26	348.1	47.8	58.3	300.3	289.9
NK021	DWR	North Kings GSA	367700N1196799W001	T13S R21E 27	341.5	62.8	82.2	278.7	259.3
NK021	City of Fresno	North Kings GSA	13S21E28G001MX	T13S R21E 28	338.7	96.9	119.2	241.8	219.5
NK021	City of Fresno	North Kings GSA	13S21E29H001MX	T13S R21E 29	335.3	93.1	124.4	242.3	210.9
NK021	City of Fresno	North Kings GSA	13S21E32G001MX	T13S R21E 32	327.7	93.1	122.2	234.7	205.5
NK021	DWR	North Kings GSA	367522N1196754W001	T13S R21E 34	336.5	61.1		275.4	
NK021	DWR	North Kings GSA	367556N1196666W001	T13S R21E 34	340.5		64.3		276.2
NK021	DWR	North Kings GSA	367594N1196349W001	T13S R21E 36	353.5	27.9	47.1	325.6	306.4
NK021	DWR	North Kings GSA	367594N1196399W001	T13S R21E 36	354.5	28.2	46.6	326.3	307.9
NK021	DWR	North Kings GSA	367922N1196279W001	T13S R22E 19	374.5		37.9		336.6
NK022	DWR	North Kings GSA	368244N1195449W001	T13S R22E 02	447.6	23.0	26.3	424.6	421.3
NK022	DWR	North Kings GSA	13S22E03B001MX	T13S R22E 03	434.0		24.9		409.1
NK022	DWR	North Kings GSA	368353N1195627W001	T13S R22E 03	436.6	12.0	23.9	424.6	412.7
NK022	DWR	North Kings GSA	13S22E05A001MX	T13S R22E 05	420.0	51.6		368.4	
NK022	DWR	North Kings GSA	368322N1196127W001	T13S R22E 06	417.6	63.1		354.5	
NK022	FID	North Kings GSA	13S22E07R001MX	T13S R22E 07	391.6	31.5	45.5	360.1	346.1
NK022	DWR	North Kings GSA	368106N1196143W001	T13S R22E 07	394.0		45.0		349.0
NK022	DWR	North Kings GSA	368133N1196127W001	T13S R22E 07	393.6	27.0	39.1	366.6	354.5
NK022	DWR	North Kings GSA	368211N1195946W001	T13S R22E 08	414.6	45.2		369.4	
NK022	DWR	North Kings GSA	368103N1195899W001	T13S R22E 09	405.6	30.6		375.0	
NK022	FID	North Kings GSA	13S22E13A001MX	T13S R22E 13	436.6	3.0		433.6	

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
NK022	DWR	North Kings GSA	368053N1195199W001	T13S R22E 13	442.6		8.4		434.2
NK022	DWR	North Kings GSA	368061N1195449W001	T13S R22E 14	436.6	25.3	31.9	411.3	404.7
NK022	DWR	North Kings GSA	367953N1195585W001	T13S R22E 15	415.6	30.5	41.6	385.1	375.0
NK022	DWR	North Kings GSA	367989N1196102W001	T13S R22E 18	392.6		39.9		352.2
NK022	DWR	North Kings GSA	13S22E20A001MX	T13S R22E 20	380.0		16.9		363.1
NK022	DWR	North Kings GSA	367922N1195946W001	T13S R22E 20	382.6	9.5	15.9	373.1	366.7
NK022	DWR	North Kings GSA	13S22E22R001MX	T13S R22E 22	393.0		27.9		365.1
NK022	DWR	North Kings GSA	367811N1195585W001	T13S R22E 22	395.6	15.2	26.9	380.4	368.7
NK022	DWR	North Kings GSA	13S22E23R001MX	T13S R22E 23	405.0	6.5	15.9	398.5	389.1
NK022	DWR	North Kings GSA	367881N1195496W001	T13S R22E 23	407.6	10.3	24.9	397.3	316.6
NK022	DWR	North Kings GSA	367789N1195382W001	T13S R22E 26	406.6		14.9		391.7
NK022	DWR	North Kings GSA	367792N1195535W001	T13S R22E 26	402.6		22.8		379.8
NK022	FID	North Kings GSA	13S22E27R001MX	T13S R22E 27	390.0	11.9		378.1	
NK022	DWR	North Kings GSA	367653N1195677W001	T13S R22E 27	387.6	9.6	27.1	378.0	360.5
NK022	DWR	North Kings GSA	367789N1195682W001	T13S R22E 27	393.6		31.7		361.9
NK022	DWR	North Kings GSA	367772N1195807W001	T13S R22E 28	385.6	15.8	29.9	369.8	355.7
NK022	DWR	North Kings GSA	367703N1196077W001	T13S R22E 29	376.5	20.4	37.4	356.1	339.1
NK022	DWR	North Kings GSA	367717N1196088W001	T13S R22E 29	376.5	19.7	38.8	356.8	337.7
NK022	FID	North Kings GSA	13S22E31N001MX	T13S R22E 31	356.5	31.9	47.5	324.6	309.1
NK022	DWR	North Kings GSA	367522N1196216W001	T13S R22E 31	361.5	28.0	45.4	333.5	316.1
NK022	FID	North Kings GSA	13S22E32A001MX	T13S R22E 32	370.8	15.8	34.7	355.0	336.1
NK022	DWR	North Kings GSA	367644N1195963W001	T13S R22E 32	373.0		33.3		339.7
NK022	DWR	North Kings GSA	367522N1195854W001	T13S R22E 33	378.6	28.7		349.9	
NK022	DWR	North Kings GSA	367522N1195588W001	T13S R22E 34	386.6	28.1	38.9	358.5	347.7
NK022	FID	North Kings GSA	14S22E03C001MX	T14S R22E 03	379.7	27.7		352.0	
NK022	DWR	North Kings GSA	367500N1195832W001	T14S R22E 04	378.6		42.2		336.4
NK025	DWR	North Kings GSA	367606N1194707W001	T13S R23E 33	434.0		12.9		421.1
NK025	DWR	North Kings GSA	367536N1194652W001	T13S R23E 34	428.6	8.7		419.9	
NK027	FID	North Kings GSA	13S23E33B001MX	T13S R23E 33	431.8	7.0	13.9	424.8	417.9
NK036	FID	North Kings GSA	13S17E33M001MX	T13S R17E 33	210.1	72.2	80.4	137.9	129.7
NK038	DWR	North Kings GSA	367474N1201129W001	T14S R17E 03	212.5	75.0		137.5	
NK038	DWR	North Kings GSA	367341N1200788W001	T14S R17E 11	217.5	93.7		123.8	
NK039	FID	North Kings GSA	14S18E02B001MX	T14S R18E 02	249.7	61.8		187.9	
NK039	FID	North Kings GSA	14S18E03B001MX	T14S R18E 03	245.6		49.1		196.5
NK039	FID	North Kings GSA	14S18E03D001MX	T14S R18E 03	241.0		46.0		195.0
NK039	FID	North Kings GSA	14S18E03E001MX	T14S R18E 03	249.5		52.0		197.5
NK039	FID	North Kings GSA	14S18E03E002MX	T14S R18E 03	248.3		69.5		178.8
NK039	FID	North Kings GSA	14S18E03F001MX	T14S R18E 03	250.1		56.0		194.1
NK039	FID	North Kings GSA	14S18E03G001MX	T14S R18E 03	250.1		44.0		206.1
NK039	FID	North Kings GSA	14S18E03G002MX	T14S R18E 03	248.8		67.0		181.8
NK039	FID	North Kings GSA	14S18E03K001MX	T14S R18E 03	249.9		70.0		179.9
NK039	FID	North Kings GSA	14S18E03K002MX	T14S R18E 03	241.7		50.0		191.7
NK039	FID	North Kings GSA	14S18E03L001MX	T14S R18E 03	239.1		50.5		188.6
NK039	FID	North Kings GSA	14S18E04B001MX	T14S R18E 04	239.3	69.0		170.3	
NK039	FID	North Kings GSA	14S18E04G001MX	T14S R18E 04	238.4		51.3		187.1
NK039	FID	North Kings GSA	14S18E04J001MX	T14S R18E 04	237.9		51.0		186.9
NK039	FID	North Kings GSA	14S18E04K001MX	T14S R18E 04	237.4		55.0		182.4
NK039	FID	North Kings GSA	14S18E06P001MX	T14S R18E 06	224.2		76.3		148.0
NK039	FID	North Kings GSA	14S18E09H001MX	T14S R18E 09	236.3	66.3	61.2	170.0	175.1
NK039	FID	North Kings GSA	14S18E09M001MX	T14S R18E 09	226.3	76.2	68.2	150.1	158.2
NK039	FID	North Kings GSA	14S18E10A001MX	T14S R18E 10	243.6		58.0		185.6
NK039	FID	North Kings GSA	14S18E10C001MX	T14S R18E 10	240.3		59.0		181.3
NK039	FID	North Kings GSA	14S18E10D001MX	T14S R18E 10	234.7		54.3		180.4
NK039	FID	North Kings GSA	14S18E10K001MX	T14S R18E 10	240.8		62.5		178.3
NK039	FID	North Kings GSA	14S18E14N001MX	T14S R18E 14	234.2		73.0		161.2
NK039	FID	North Kings GSA	14S18E15M001MX	T14S R18E 15	230.9	65.2	73.0	165.7	157.9
NK039	FID	North Kings GSA	14S18E19A001MX	T14S R18E 19	215.9	91.3	128.7	124.6	87.2
NK039	FID	North Kings GSA	14S18E21F001MX	T14S R18E 21	226.1		85.0		141.1
NK039	FID	North Kings GSA	14S18E21Q001MX	T14S R18E 21	226.2		88.0		138.2
NK039	FID	North Kings GSA	14S18E22N002MX	T14S R18E 21	227.5		75.0		152.5
NK039	FID	North Kings GSA	14S18E22J001MX	T14S R18E 22	229.6		81.0		148.6
NK039	FID	North Kings GSA	14S18E22L001MX	T14S R18E 22	230.4		83.0		147.4
NK039	FID	North Kings GSA	14S18E22P001MX	T14S R18E 22	235.8		93.0		142.8
NK039	FID	North Kings GSA	14S18E22Q001MX	T14S R18E 22			90.0		910.0
NK039	FID	North Kings GSA	14S18E22R001MX	T14S R18E 22	231.2		75.0		156.2
NK039	FID	North Kings GSA	14S18E22R002MX	T14S R18E 22	233.3		77.0		156.3
NK039	FID	North Kings GSA	14S18E26C001MX	T14S R18E 26	228.4		115.0		113.4
NK039	FID	North Kings GSA	14S18E22P002MX	T14S R18E 27	235.3		81.0		154.3

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
NK039	FID	North Kings GSA	14S18E27B001MX	T14S R18E 27	228.0		74.0		154.0
NK039	FID	North Kings GSA	14S18E27B002MX	T14S R18E 27	228.1		83.0		145.1
NK039	FID	North Kings GSA	14S18E22N001MX	T14S R18E 28	235.5		96.0		139.5
NK039	FID	North Kings GSA	14S18E28A001MX	T14S R18E 28	227.2		88.0		139.2
NK039	FID	North Kings GSA	14S18E29J001MX	T14S R18E 29	218.7		81.0		137.7
NK040	FID	North Kings GSA	14S18E27M001MX	T14S R18E 28	226.7		96.0		130.7
NK040	FID	North Kings GSA	14S18E28L001MX	T14S R18E 28	222.0		98.0		124.0
NK040	FID	North Kings GSA	14S18E28Q001MX	T14S R18E 33	226.3	108.0		118.3	
NK040	FID	North Kings GSA	14S19E18N001MX	T14S R19E 18	238.8	60.2	68.2	178.6	170.6
NK040	DWR	North Kings GSA	367088N1199521W001	T14S R19E 18	240.7	60.2		180.5	
NK041	FID	North Kings GSA	14S19E06A001MX	T14S R19E 06	254.8	60.1	59.2	194.7	195.6
NK041	FID	North Kings GSA	14S19E07D001MX	T14S R19E 07	248.3	59.9		188.4	
NK041	DWR	North Kings GSA	367346N1199516W001	T14S R19E 07	250.8	60.8		190.0	
NK041	FID	North Kings GSA	14S19E18G001MX	T14S R19E 18	243.6	58.4	63.0	185.2	180.6
NK042	FID	North Kings GSA	14S19E03Q001MX	T14S R19E 03	264.7		96.8		167.9
NK042	DWR	North Kings GSA	367355N1198988W001	T14S R19E 03	264.9	64.2		200.7	
NK042	FID	North Kings GSA	14S19E04R001MX	T14S R19E 04	262.4	64.2		198.2	
NK042	FID	North Kings GSA	14S19E11L001MX	T14S R19E 11	272.7	66.8	80.8	205.9	192.0
NK042	FID	North Kings GSA	14S19E15G001MX	T14S R19E 15	252.6	41.3		211.3	
NK042	FID	North Kings GSA	14S19E17C001MX	T14S R19E 17	249.9	64.7	67.9	185.2	182.0
NK042	Fresno Clovis RWRF	North Kings GSA	14S19E20D001MX	T14S R19E 20	244.1	48.0	56.0	196.1	188.1
NK042	Fresno Clovis RWRF	North Kings GSA	14S19E20N001MX	T14S R19E 20	238.7	38.9	43.8	199.8	194.9
NK042	Fresno Clovis RWRF	North Kings GSA	14S19E21M001MX	T14S R19E 21	249.9	37.2	42.5	212.7	207.4
NK042	Fresno Clovis RWRF	North Kings GSA	14S19E21P001MX	T14S R19E 21	243.7	31.9	49.7	211.8	194.0
NK042	Fresno Clovis RWRF	North Kings GSA	14S19E22G001MX	T14S R19E 22	251.5	52.9	61.0	198.6	190.5
NK042	Fresno Clovis RWRF	North Kings GSA	14S19E23B001MX	T14S R19E 23	258.2	52.5	65.3	205.7	192.9
NK042	Fresno Clovis RWRF	North Kings GSA	14S19E23Q001MX	T14S R19E 23	254.4	58.2	65.0	196.2	189.3
NK042	FID	North Kings GSA	14S19E26D001MX	T14S R19E 26	251.5	49.9	68.0	193.7	183.5
NK042	Fresno Clovis RWRF	North Kings GSA	14S19E26Q001MX	T14S R19E 26	250.1		72.4		177.7
NK042	Fresno Clovis RWRF	North Kings GSA	14S19E27K001MX	T14S R19E 27	250.9	45.4	49.0	205.5	201.8
NK042	Fresno Clovis RWRF	North Kings GSA	14S19E28M001MX	T14S R19E 28	248.9	42.0	38.8	206.9	210.1
NK042	DWR	North Kings GSA	366768N1199160W001	T14S R19E 29	237.0		54.3		182.7
NK042	FID	North Kings GSA	14S19E32D001MX	T14S R19E 32	234.4		108.2		126.2
NK042	FID	North Kings GSA	14S19E33D001MX	T14S R19E 33	239.5	47.7	55.0	191.8	184.5
NK042	FID	North Kings GSA	14S20E31D001MX	T14S R20E 31	258.1	59.4		198.7	
NK043	City of Fresno	North Kings GSA	14S20E13F001MX	T14S R20E 13	291.8	76.6		215.2	
NK043	DWR	North Kings GSA	367063N1198335W001	T14S R20E 18	269.0		76.0		193.0
NK043	FID	North Kings GSA	14S20E19A001MX	T14S R20E 19	267.4	67.1	76.5	200.3	190.9
NK043	City of Fresno	North Kings GSA	14S20E22J001MX	T14S R20E 22	282.5	65.8		216.7	
NK043	City of Fresno	North Kings GSA	14S20E24K001MX	T14S R20E 24	294.7	68.3	77.9	226.4	216.8
NK043	FID	North Kings GSA	14S20E33F001MX	T14S R20E 33	271.1	54.2		216.9	
NK043	FID	North Kings GSA	15S20E03A001MX	T15S R20E 03	0.0	52.2		227.4	
NK043	DWR	North Kings GSA	366635N1197735W001	T15S R20E 03	282.6	52.2		230.4	
NK044	City of Fresno	North Kings GSA	14S20E04E001MX	T14S R20E 04	287.0	111.6	123.1	175.4	163.9
NK045	City of Fresno	North Kings GSA	14S20E01J001MX	T14S R20E 01	312.6	105.1	116.0	207.6	196.6
NK045	DWR	North Kings GSA	367391N1197457W001	T14S R20E 01	313.5	101.0		212.5	
NK045	City of Fresno	North Kings GSA	14S20E02J001MX	T14S R20E 02	302.4	97.1	114.5	205.3	187.9
NK045	City of Fresno	North Kings GSA	14S20E03C001MX	T14S R20E 03	296.5		116.3		180.2
NK045	City of Fresno	North Kings GSA	14S20E03J001MX	T14S R20E 03	295.2	96.8		198.4	
NK045	City of Fresno	North Kings GSA	14S20E03M001MX	T14S R20E 03	293.8	99.0	111.5	194.8	182.3
NK045	City of Fresno	North Kings GSA	14S20E04F001MX	T14S R20E 04	288.0	90.6	94.9	197.4	193.1
NK045	City of Fresno	North Kings GSA	14S20E08H001MX	T14S R20E 08	279.1	79.3	93.2	199.8	185.9
NK045	City of Fresno	North Kings GSA	14S20E08R001MX	T14S R20E 08	279.9	79.2	90.0	200.7	189.9
NK045	City of Fresno	North Kings GSA	14S20E10M001MX	T14S R20E 10	291.4	93.9	100.8	197.5	190.6
NK045	City of Fresno	North Kings GSA	14S20E11F001MX	T14S R20E 11	295.4	93.0	104.3	202.4	191.1
NK045	City of Fresno	North Kings GSA	14S20E14L001MX	T14S R20E 14	288.1	76.1	87.4	212.0	200.7
NK045	City of Fresno	North Kings GSA	14S20E16A001MX	T14S R20E 16	283.4	82.3	95.1	201.1	188.3
NK046	FID	North Kings GSA	14S21E03D001MX	T14S R21E 03	333.0	67.2		265.8	
NK046	City of Fresno	North Kings GSA	14S21E06E001MX	T14S R21E 06	310.1	97.0	116.1	213.1	194.0
NK046	City of Fresno	North Kings GSA	14S21E06Q001MX	T14S R21E 06	309.6	93.4	109.4	216.2	200.2
NK046	City of Fresno	North Kings GSA	14S21E07M001MX	T14S R21E 07	302.8	86.0		216.8	
NK046	City of Fresno	North Kings GSA	14S21E08A001MX	T14S R21E 08	320.5	95.3	104.1	225.2	216.4
NK046	City of Fresno	North Kings GSA	14S21E08J001MX	T14S R21E 08	317.1	82.0		235.1	
NK046	City of Fresno	North Kings GSA	14S21E09C001MX	T14S R21E 09	320.1	88.9		231.2	
NK047	FID	North Kings GSA	14S21E11L001MX	T14S R21E 11	334.2	52.9	62.4	281.3	271.8
NK047	City of Fresno	North Kings GSA	14S21E17E001MX	T14S R21E 17	307.5	88.2		219.3	
NK047	City of Fresno	North Kings GSA	14S21E17N001MX	T14S R21E 17	314.5	66.4		248.1	
NK047	FID	North Kings GSA	14S21E22D001MX	T14S R21E 22	317.8	53.4	61.2	264.4	256.6

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
NK047	FID	North Kings GSA	14S21E29D001MX	T14S R21E 29	302.0		42.1		259.9
NK047	DWR	North Kings GSA	366927N1197171W001	T14S R21E 30	305.0		18.0		287.0
NK047	FID	North Kings GSA	14S21E32H001MX	T14S R21E 32	306.7	45.6		261.1	
NK047	FID	North Kings GSA	15S21E06B001MX	T15S R21E 06	297.1	45.7		251.4	
NK048	FID	North Kings GSA	14S22E06A001MX	T14S R22E 06	362.2	28.9	46.9	333.3	315.3
NK049	FID	North Kings GSA	14S22E08N001MX	T14S R22E 08	349.7	41.7	48.0	308.0	301.7
NK049	CID	North Kings GSA	CID07	T14S R22E 08	348.8	41.1	41.1	307.7	307.7
NK050	FID	North Kings GSA	14S23E06C001MX	T14S R23E 06	409.4	27.1		382.3	
NK065	FID	North Kings GSA	14S18E32D001MX	T14S R18E 32	212.3	115.3	121.7	97.0	90.6
NK072	FID	North Kings GSA	15S19E02M001MX	T15S R19E 02	242.9	73.2	85.3	169.7	157.6
NK072	CID	North Kings GSA	CID72	T15S R19E 12	249.6	104.5	95.8	145.1	153.8
NK072	FID	North Kings GSA	15S19E14M001MX	T15S R19E 14	241.3	100.7		140.6	
NK073	FID	North Kings GSA	15S20E01J001MX	T15S R20E 01	292.7		58.8		233.9
NK073	FID	North Kings GSA	15S20E01R001MX	T15S R20E 01	290.1	45.3	59.0	244.8	231.1
NK073	FID	North Kings GSA	15S20E02N001MX	T15S R20E 02	279.6	49.2	66.2	230.4	213.4
NK073	FID	North Kings GSA	15S20E05E001MX	T15S R20E 05	260.8		68.4		192.4
NK073	FID	North Kings GSA	15S20E07Q001MX	T15S R20E 07	252.2	65.0	80.3	187.2	171.9
NK073	FID	North Kings GSA	15S20E09K001MX	T15S R20E 09	270.9	56.2	73.1	214.7	197.9
NK073	CID	North Kings GSA	CID76	T15S R20E 10	272.8	72.7	74.8	200.1	198.0
NK073	FID	North Kings GSA	15S20E12F001MX	T15S R20E 12	288.9	44.2	62.5	244.7	226.4
NK073	CID	North Kings GSA	CID77	T15S R20E 12	275.2	59.0	59.0	224.4	224.4
NK073	FID	North Kings GSA	15S20E13E001MX	T15S R20E 13	282.1	58.4	65.0	223.7	217.1
NK074	DWR	North Kings GSA	366632N1197271W001	T15S R21E 06	300.2	45.6		254.6	
NK074	CID	North Kings GSA	CID02	T15S R21E 09	303.7		51.6		252.1
SK049	CID	South Kings GSA	CID11	T14S R22E 22	354.6	28.1	32.1	326.5	322.5
SK049	CID	South Kings GSA	CID10	T14S R22E 26	366.2	29.9	34.8	336.3	331.4
SK075	CID	South Kings GSA	CID24	T15S R22E 24	338.7	45.5	45.5	293.2	293.2
SK091	DWR	South Kings GSA	365183N1195754W001	T16S R22E 22	300.7		41.2		259.5
SK091	CID	South Kings GSA	CID40	T16S R22E 27	297.9	33.5	41.2	264.4	256.7
Outside of Study Area	DWR	Outside of Study Area	369260N1199141W001	T11S R19E 32	320.0	139.2	156.2	183.2	166.2
Outside of Study Area	DWR	Outside of Study Area	369302N1198943W001	T11S R19E 33	331.9	194.6		137.3	
Outside of Study Area	DWR	Outside of Study Area	369735N1198307W001	T11S R20E 18	391.4	151.5		239.9	
Outside of Study Area	DWR	Outside of Study Area	369396N1197843W001	T11S R20E 27	405.0	217.8		187.2	
Outside of Study Area	DWR	Outside of Study Area	369235N1198313W001	T11S R20E 31	383.4	262.3		121.1	
Outside of Study Area	DWR	Outside of Study Area	369375N1198168W001	T11S R20E 32	387.0		330.8		54.9
Outside of Study Area	DWR	Outside of Study Area	369307N1197896W001	T11S R20E 33	392.5	249.2		143.3	
Outside of Study Area	DWR	Outside of Study Area	368368N1203291W001	T12S R15E 33	162.4	42.6	52.8	119.8	109.6
Outside of Study Area	DWR	Outside of Study Area	368368N1203099W001	T12S R15E 34	166.4		69.9		96.5
Outside of Study Area	DWR	Outside of Study Area	368732N1201835W001	T12S R16E 23	204.9		113.5		91.4
Outside of Study Area	DWR	Outside of Study Area	368516N1201829W001	T12S R16E 26	202.4		107.1		95.3
Outside of Study Area	DWR	Outside of Study Area	368438N1202621W001	T12S R16E 31	179.9	90.0	119.1	89.9	60.8
Outside of Study Area	DWR	Outside of Study Area	368496N1201649W001	T12S R16E 36	208.4		97.5		110.9
Outside of Study Area	DWR	Outside of Study Area	368874N1200604W001	T12S R17E 13	252.4	98.0		154.4	
Outside of Study Area	MID	Outside of Study Area	12S17E14L001MX	T12S R17E 14	241.0		115.9		125.1
Outside of Study Area	DWR	Outside of Study Area	368896N1200846W001	T12S R17E 14	243.4		115.4		128.0
Outside of Study Area	DWR	Outside of Study Area	368849N1200927W001	T12S R17E 15	238.4		104.0		134.4
Outside of Study Area	DWR	Outside of Study Area	368680N1201377W001	T12S R17E 20	220.4	88.7		131.7	
Outside of Study Area	DWR	Outside of Study Area	368752N1201107W001	T12S R17E 21	230.4	87.3		143.1	
Outside of Study Area	DWR	Outside of Study Area	368785N1200832W001	T12S R17E 23	239.4		115.9		123.5
Outside of Study Area	DWR	Outside of Study Area	368766N1200566W001	T12S R17E 24	248.4	83.4		165.0	
Outside of Study Area	MID	Outside of Study Area	12S17E26B001MX	T12S R17E 26	235.0		87.1		147.9
Outside of Study Area	MID	Outside of Study Area	12S17E26R001MX	T12S R17E 26	233.0		82.8		150.2
Outside of Study Area	DWR	Outside of Study Area	368516N1200888W001	T12S R17E 26	235.4		81.8		153.6
Outside of Study Area	DWR	Outside of Study Area	368649N1200841W001	T12S R17E 26	237.4		86.1		151.3
Outside of Study Area	DWR	Outside of Study Area	368655N1200777W001	T12S R17E 26	239.4		96.6		142.8
Outside of Study Area	DWR	Outside of Study Area	368507N1201468W001	T12S R17E 31	214.4		91.6		122.8
Outside of Study Area	MID	Outside of Study Area	12S17E32G001MX	T12S R17E 32	217.0		97.8		119.2
Outside of Study Area	DWR	Outside of Study Area	368441N1201291W001	T12S R17E 32	219.4		96.8		122.6
Outside of Study Area	MID	Outside of Study Area	12S17E34D001MX	T12S R17E 34	225.0		92.7		132.3
Outside of Study Area	DWR	Outside of Study Area	368502N1200941W001	T12S R17E 34	232.4		90.7		141.7
Outside of Study Area	DWR	Outside of Study Area	368371N1200785W001	T12S R17E 35	241.4	68.2		173.2	
Outside of Study Area	MID	Outside of Study Area	12S17E36K001MX	T12S R17E 36	243.0		79.0		164.0
Outside of Study Area	DWR	Outside of Study Area	368418N1200632W001	T12S R17E 36	245.4		78.5		166.9
Outside of Study Area	DWR	Outside of Study Area	368977N1200282W001	T12S R18E 08	262.4		115.8		146.6
Outside of Study Area	DWR	Outside of Study Area	368980N1200107W001	T12S R18E 09	267.4	95.8	113.5	171.6	153.9
Outside of Study Area	DWR	Outside of Study Area	369074N1199993W001	T12S R18E 10	267.4		121.0		146.4
Outside of Study Area	DWR	Outside of Study Area	368960N1199629W001	T12S R18E 12	282.4	101.8	152.6	180.6	129.8
Outside of Study Area	MID	Outside of Study Area	12S18E13R001MX	T12S R18E 13	288.0		115.7		172.3

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
Outside of Study Area	DWR	Outside of Study Area	368952N1199879W001	T12S R18E 15	275.4		130.9		144.5
Outside of Study Area	MID	Outside of Study Area	12S18E16A001MX	T12S R18E 16	268.0		108.9		159.1
Outside of Study Area	DWR	Outside of Study Area	368913N1200018W001	T12S R18E 16	270.4		107.9		162.5
Outside of Study Area	MID	Outside of Study Area	12S18E19H001MX	T12S R18E 19	251.0		98.3		152.7
Outside of Study Area	DWR	Outside of Study Area	368752N1200377W001	T12S R18E 19	253.4		97.8		155.6
Outside of Study Area	DWR	Outside of Study Area	368663N1200299W001	T12S R18E 20	258.4		92.7		165.7
Outside of Study Area	MID	Outside of Study Area	12S18E21P001MX	T12S R18E 21	267.0		102.4		164.6
Outside of Study Area	DWR	Outside of Study Area	368732N1200099W001	T12S R18E 21	267.4	85.5	100.4	181.9	167.0
Outside of Study Area	DWR	Outside of Study Area	368747N1200019W001	T12S R18E 21	269.4		101.4		168.0
Outside of Study Area	DWR	Outside of Study Area	368805N1199474W001	T12S R18E 24	290.4		115.2		175.2
Outside of Study Area	DWR	Outside of Study Area	368805N1199474W002	T12S R18E 24	290.4		119.1		171.3
Outside of Study Area	DWR	Outside of Study Area	368582N1199563W001	T12S R18E 25	284.4	88.1		196.3	
Outside of Study Area	MID	Outside of Study Area	12S18E26L001MX	T12S R18E 26	276.0		98.0		178.0
Outside of Study Area	DWR	Outside of Study Area	368582N1199752W001	T12S R18E 26	278.4		97.5		180.9
Outside of Study Area	DWR	Outside of Study Area	368621N1199788W001	T12S R18E 26	277.4	89.5		187.9	
Outside of Study Area	MID	Outside of Study Area	12S18E31J001MX	T12S R18E 31	254.0		84.7		169.3
Outside of Study Area	DWR	Outside of Study Area	368427N1200377W001	T12S R18E 31	256.4	83.6		172.8	
Outside of Study Area	MID	Outside of Study Area	12S18E35G001MX	T12S R18E 35	278.0		86.0		192.0
Outside of Study Area	DWR	Outside of Study Area	368471N1199696W001	T12S R18E 35	280.4		85.0		195.4
Outside of Study Area	DWR	Outside of Study Area	369110N1198816W001	T12S R19E 03	332.9	195.0		137.9	
Outside of Study Area	DWR	Outside of Study Area	369082N1198641W001	T12S R19E 11	340.4	199.8		140.6	
Outside of Study Area	DWR	Outside of Study Area	368910N1198577W001	T12S R19E 14	339.4	180.8		158.6	
Outside of Study Area	DWR	Outside of Study Area	368810N1199385W001	T12S R19E 18	295.9		118.2		177.7
Outside of Study Area	MID	Outside of Study Area	12S19E20D001MX	T12S R19E 20	293.0		133.3		159.7
Outside of Study Area	DWR	Outside of Study Area	368788N1199121W001	T12S R19E 20	304.4	105.4		199.0	
Outside of Study Area	DWR	Outside of Study Area	368793N1199252W001	T12S R19E 20	295.4		132.3		163.1
Outside of Study Area	MID	Outside of Study Area	12S19E21B001MX	T12S R19E 21	300.0		127.8		172.2
Outside of Study Area	DWR	Outside of Study Area	368788N1198977W001	T12S R19E 21	302.4	96.8		205.6	
Outside of Study Area	DWR	Outside of Study Area	368799N1198646W001	T12S R19E 23	330.0	134.3		195.7	
Outside of Study Area	DWR	Outside of Study Area	368652N1198671W001	T12S R19E 26	326.5	127.0		199.5	
Outside of Study Area	MID	Outside of Study Area	12S19E28A001MX	T12S R19E 28	307.5		102.5		205.0
Outside of Study Area	DWR	Outside of Study Area	368532N1199029W001	T12S R19E 28	307.5		93.7		213.8
Outside of Study Area	DWR	Outside of Study Area	368657N1198971W001	T12S R19E 28	309.9		100.0		209.9
Outside of Study Area	MID	Outside of Study Area	12S19E29A001MX	T12S R19E 29	301.0		120.7		180.3
Outside of Study Area	DWR	Outside of Study Area	368638N1199129W001	T12S R19E 29	303.4		120.2		183.2
Outside of Study Area	DWR	Outside of Study Area	368418N1199427W001	T12S R19E 31	288.4	84.4		204.0	
Outside of Study Area	DWR	Outside of Study Area	369107N1198121W001	T12S R20E 05	363.6		267.7		95.9
Outside of Study Area	DWR	Outside of Study Area	368899N1198079W001	T12S R20E 17	365.5	164.9		200.6	
Outside of Study Area	DWR	Outside of Study Area	368935N1198035W001	T12S R20E 17	367.5	174.2		193.3	
Outside of Study Area	DWR	Outside of Study Area	368946N1198296W001	T12S R20E 18	355.0	191.2		163.8	
Outside of Study Area	DWR	Outside of Study Area	368805N1198346W001	T12S R20E 19	348.0	164.0		184.0	
Outside of Study Area	DWR	Outside of Study Area	368291N1203016W001	T13S R15E 02	166.9		69.2		97.7
Outside of Study Area	DWR	Outside of Study Area	368213N1203027W001	T13S R15E 11	166.4		71.7		94.7
Outside of Study Area	DWR	Outside of Study Area	367985N1203102W001	T13S R15E 14	166.4	43.4		123.0	
Outside of Study Area	DWR	Outside of Study Area	367796N1203729W001	T13S R15E 19	130.0		38.4		91.6
Outside of Study Area	DWR	Outside of Study Area	367805N1203718W001	T13S R15E 19	157.4	9.3		148.1	
Outside of Study Area	DWR	Outside of Study Area	367807N1203722W001	T13S R15E 19	153.3		109.7		38.3
Outside of Study Area	DWR	Outside of Study Area	367807N1203722W002	T13S R15E 19	153.3		65.3		82.7
Outside of Study Area	DWR	Outside of Study Area	367807N1203722W003	T13S R15E 19	153.3		22.8		125.2
Outside of Study Area	DWR	Outside of Study Area	367813N1203736W001	T13S R15E 19	129.6		25.3		104.3
Outside of Study Area	DWR	Outside of Study Area	367882N1203566W001	T13S R15E 20	162.4	26.0	40.6	136.4	121.8
Outside of Study Area	DWR	Outside of Study Area	367882N1203579W001	T13S R15E 20	162.4		61.0		101.4
Outside of Study Area	DWR	Outside of Study Area	367824N1203377W001	T13S R15E 21	163.4	18.3		145.1	
Outside of Study Area	DWR	Outside of Study Area	367702N1202910W001	T13S R15E 25	172.4	38.8		133.6	
Outside of Study Area	DWR	Outside of Study Area	367738N1202877W001	T13S R15E 25	172.4	43.6	83.6	128.8	88.8
Outside of Study Area	DWR	Outside of Study Area	367705N1203029W001	T13S R15E 26	172.4	36.0	71.4	136.4	101.0
Outside of Study Area	DWR	Outside of Study Area	367730N1203049W001	T13S R15E 26	172.4	35.9	62.1	136.5	110.3
Outside of Study Area	DWR	Outside of Study Area	368268N1202735W001	T13S R16E 06	173.4	96.2		77.2	
Outside of Study Area	DWR	Outside of Study Area	368013N1202052W001	T13S R16E 15	191.4	62.3		129.1	
Outside of Study Area	DWR	Outside of Study Area	368068N1202368W001	T13S R16E 16	180.4	88.9		91.5	
Outside of Study Area	DWR	Outside of Study Area	367813N1202713W001	T13S R16E 19	172.4	59.4		113.0	
Outside of Study Area	DWR	Outside of Study Area	367827N1202666W001	T13S R16E 19	163.0	66.2		109.2	
Outside of Study Area	DWR	Outside of Study Area	367824N1202593W001	T13S R16E 20	177.4	65.7	106.4	111.7	71.0
Outside of Study Area	DWR	Outside of Study Area	367813N1202410W001	T13S R16E 21	182.4	67.4	99.0	115.0	83.4
Outside of Study Area	DWR	Outside of Study Area	367910N1201821W001	T13S R16E 24	192.4	27.8		164.6	
Outside of Study Area	DWR	Outside of Study Area	367755N1202599W001	T13S R16E 30	177.4		96.0		81.4
Outside of Study Area	DWR	Outside of Study Area	367755N1202654W001	T13S R16E 30	177.4	61.3	99.6	116.1	77.8
Outside of Study Area	MID	Outside of Study Area	13S17E03J001MX	T13S R17E 03	232.0		70.0		162.0

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
Outside of Study Area	DWR	Outside of Study Area	368310N1200974W001	T13S R17E 03	234.4	55.0	70.0	179.4	164.4
Outside of Study Area	MID	Outside of Study Area	13S17E04R001MX	T13S R17E 04	222.0		60.3		161.7
Outside of Study Area	DWR	Outside of Study Area	368257N1201154W001	T13S R17E 04	224.4		59.8		164.6
Outside of Study Area	DWR	Outside of Study Area	368232N1201421W001	T13S R17E 05	214.4	53.6	63.8	160.8	150.6
Outside of Study Area	DWR	Outside of Study Area	368146N1201554W001	T13S R17E 07	208.4		53.7		154.7
Outside of Study Area	DWR	Outside of Study Area	368205N1201513W001	T13S R17E 07	211.4	48.0		163.4	
Outside of Study Area	DWR	Outside of Study Area	368118N1201452W001	T13S R17E 08	209.4		41.3		168.1
Outside of Study Area	DWR	Outside of Study Area	368355N1200016W001	T13S R18E 03	267.4	60.6		206.8	
Outside of Study Area	MID	Outside of Study Area	13S18E04H001MX	T13S R18E 04	261.0		72.1		188.9
Outside of Study Area	DWR	Outside of Study Area	368341N1200113W001	T13S R18E 04	264.4	62.6	72.3	201.8	192.1
Outside of Study Area	MID	Outside of Study Area	13S18E05J001MX	T13S R18E 05	259.0		75.7		183.3
Outside of Study Area	DWR	Outside of Study Area	368280N1200260W001	T13S R18E 05	261.4	63.5		197.9	
Outside of Study Area	DWR	Outside of Study Area	368299N1200388W001	T13S R18E 05	254.9	60.4	74.7	194.5	180.2
Outside of Study Area	MID	Outside of Study Area	13S18E06F001MX	T13S R18E 06	246.0		62.5		183.5
Outside of Study Area	DWR	Outside of Study Area	368293N1200474W001	T13S R18E 06	252.4	58.5	70.8	193.9	181.6
Outside of Study Area	DWR	Outside of Study Area	368332N1200546W001	T13S R18E 06	248.4	58.7	61.0	189.7	187.4
Outside of Study Area	DWR	Outside of Study Area	366857N1202799W003	T14S R15E 25	162.5	8.7		153.8	
Outside of Study Area	DWR	Outside of Study Area	367100N1202400W001	T14S R16E 16	162.0		46.0		116.0
Outside of Study Area	KRCD	Outside of Study Area	A06	T14S R16E 17	161.9		46.0		115.9
Outside of Study Area	DWR	Outside of Study Area	367193N1193882W001	T14S R24E 08	462.8		13.9		448.9
Outside of Study Area	DWR	Outside of Study Area	366022N1203168W001	T15S R15E 22	177.6		74.0		103.6
Outside of Study Area	DWR	Outside of Study Area	366072N1203154W001	T15S R15E 23	175.6		57.0		118.6
Outside of Study Area	DWR	Outside of Study Area	366032N1202976W001	T15S R15E 24	171.6		71.0		100.6
Outside of Study Area	DWR	Outside of Study Area	365883N1202888W001	T15S R15E 25	180.6		179.0		1.6
Outside of Study Area	DWR	Outside of Study Area	365883N1202893W001	T15S R15E 25	182.6		98.0		84.6
Outside of Study Area	DWR	Outside of Study Area	365889N1203238W001	T15S R15E 27	190.6		100.0		90.6
Outside of Study Area	DWR	Outside of Study Area	365739N1203252W001	T15S R15E 34	207.6		133.0		74.6
Outside of Study Area	DWR	Outside of Study Area	365741N1203017W001	T15S R15E 35	198.0		262.0		-64.0
Outside of Study Area	DWR	Outside of Study Area	365742N1203077W001	T15S R15E 35	201.6		130.0		71.6
Outside of Study Area	DWR	Outside of Study Area	365742N1203157W001	T15S R15E 35	204.6		95.5		109.1
Outside of Study Area	DWR	Outside of Study Area	365742N1202785W001	T15S R16E 31	189.6		114.2		75.4
Outside of Study Area	DWR	Outside of Study Area	365739N1202791W001	T16S R16E 06	189.6		263.1		-73.5
Outside of Study Area	DWR	Outside of Study Area	365039N1201882W001	T16S R16E 25	197.8		161.0		36.8
Outside of Study Area	DWR	Outside of Study Area	365094N1202249W001	T16S R16E 28	212.8		161.0		51.8
Outside of Study Area	DWR	Outside of Study Area	364875N1202246W001	T16S R16E 34	227.8		184.0		43.8
Outside of Study Area	DWR	Outside of Study Area	365022N1202066W001	T16S R16E 35	204.8		160.0		44.8
Outside of Study Area	DWR	Outside of Study Area	364877N1201848W001	T16S R16E 36	206.8		183.0		23.8
Outside of Study Area	KRCD	Outside of Study Area	B08	T16S R17E 28	186.4		162.0		24.4
Outside of Study Area	CID	Outside of Study Area	CID44	T16S R21E 36	268.7	57.2	69.6	211.5	199.1
Outside of Study Area	DWR	Outside of Study Area	364930N1192142W001	T16S R25E 36	370.7	12.5	30.3	358.2	340.4
Outside of Study Area	DWR	Outside of Study Area	364617N1202291W001	T17S R16E 10	243.9		207.0		36.9
Outside of Study Area	DWR	Outside of Study Area	364734N1201382W001	T17S R17E 04	203.8		152.0		51.8
Outside of Study Area	DWR	Outside of Study Area	364814N1201249W001	T17S R17E 04	202.8		179.0		23.8
Outside of Study Area	DWR	Outside of Study Area	364732N1201569W001	T17S R17E 05	206.8		142.0		64.8
Outside of Study Area	DWR	Outside of Study Area	364439N1201277W001	T17S R17E 16	204.9		186.0		18.9
Outside of Study Area	DWR	Outside of Study Area	364583N1201304W001	T17S R17E 16	210.9		177.0		33.9
Outside of Study Area	DWR	Outside of Study Area	364300N1201221W001	T17S R17E 21	225.9		255.0		-29.1
Outside of Study Area	DWR	Outside of Study Area	364439N1201277W002	T17S R17E 21	227.9		195.0		32.9
Outside of Study Area	DWR	Outside of Study Area	364158N1200485W001	T17S R18E 29	220.9		179.6		41.3
Outside of Study Area	DWR	Outside of Study Area	364014N1197460W002	T17S R20E 36	245.8	16.2		229.6	
Outside of Study Area	DWR	Outside of Study Area	364225N1196816W001	T17S R21E 27	257.7	22.0	40.6	235.7	217.1
Outside of Study Area	DWR	Outside of Study Area	364017N1197277W001	T17S R21E 31	246.8	69.4	92.9	177.4	153.9
Outside of Study Area	DWR	Outside of Study Area	364019N1197179W001	T17S R21E 32	247.8	51.5	79.9	196.3	167.9
Outside of Study Area	DWR	Outside of Study Area	364058N1197138W001	T17S R21E 32	248.7		81.5		167.2
Outside of Study Area	DWR	Outside of Study Area	364033N1196960W001	T17S R21E 33	249.7	50.5	73.4	199.3	176.3
Outside of Study Area	DWR	Outside of Study Area	364131N1196957W001	T17S R21E 33	253.7	47.0		206.7	
Outside of Study Area	DWR	Outside of Study Area	364156N1196638W001	T17S R21E 35	260.7	25.0	44.7	235.7	216.0
Outside of Study Area	DWR	Outside of Study Area	364144N1196449W001	T17S R21E 36	265.7	37.6	54.7	228.1	211.0
Outside of Study Area	AID	Outside of Study Area	W160A	T17S R22E 13	287.4		52.1		235.3
Outside of Study Area	DWR	Outside of Study Area	364378N1195324W001	T17S R22E 24	280.7	83.0		197.7	
Outside of Study Area	DWR	Outside of Study Area	364411N1195424W001	T17S R22E 24	280.2	41.6		238.6	
Outside of Study Area	DWR	Outside of Study Area	364306N1195299W001	T17S R22E 25	277.7	40.5		237.2	
Outside of Study Area	DWR	Outside of Study Area	364300N1195800W001	T17S R22E 27	272.5		57.2		215.3
Outside of Study Area	DWR	Outside of Study Area	364303N1195841W001	T17S R22E 28	275.7		59.5		216.2
Outside of Study Area	DWR	Outside of Study Area	364269N1196232W001	T17S R22E 30	267.7	18.5		249.2	
Outside of Study Area	DWR	Outside of Study Area	364072N1196366W001	T17S R22E 31	261.7		73.6		188.1
Outside of Study Area	DWR	Outside of Study Area	364150N1196196W001	T17S R22E 31	264.7	48.0	68.2	216.7	196.5
Outside of Study Area	DWR	Outside of Study Area	364158N1196135W001	T17S R22E 32	265.2		70.4		194.8

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
Outside of Study Area	DWR	Outside of Study Area	364044N1195963W001	T17S R22E 33	268.7	81.5	94.0	187.2	174.7
Outside of Study Area	DWR	Outside of Study Area	364031N1195624W001	T17S R22E 35	268.7	67.5	86.4	201.2	182.3
Outside of Study Area	DWR	Outside of Study Area	364158N1195516W001	T17S R22E 35	272.7	95.5		177.2	
Outside of Study Area	DWR	Outside of Study Area	364064N1195293W001	T17S R22E 36	270.7	99.0		171.7	
Outside of Study Area	AID	Outside of Study Area	W163A	T17S R22E 36	272.6		96.1		176.5
Outside of Study Area	DWR	Outside of Study Area	364049N1194573W001	T17S R23E 34	276.2		30.0		241.0
Outside of Study Area	DWR	Outside of Study Area	364339N1193952W001	T17S R24E 20	287.7		14.5		273.2
Outside of Study Area	DWR	Outside of Study Area	364250N1193629W001	T17S R24E 27	296.7	23.7	38.2	273.0	258.5
Outside of Study Area	DWR	Outside of Study Area	364125N1193588W001	T17S R24E 34	299.7		33.5		266.7
Outside of Study Area	DWR	Outside of Study Area	364106N1193145W001	T17S R24E 36	314.5		76.5		238.2
Outside of Study Area	DWR	Outside of Study Area	364718N1192151W001	T17S R25E 01	355.9	18.6		337.3	
Outside of Study Area	DWR	Outside of Study Area	364717N1192506W001	T17S R25E 10	337.7	42.0		295.7	
Outside of Study Area	AID	Outside of Study Area	X225A	T17S R25E 11	347.1		75.1		272.1
Outside of Study Area	DWR	Outside of Study Area	364605N1192059W001	T17S R25E 12	356.7	38.0		318.7	
Outside of Study Area	DWR	Outside of Study Area	364433N1192523W001	T17S R25E 15	342.7	118.0		224.7	
Outside of Study Area	DWR	Outside of Study Area	364292N1192606W001	T17S R25E 21	339.2	98.0		241.2	
Outside of Study Area	DWR	Outside of Study Area	364281N1192092W001	T17S R25E 25	367.7	70.7	84.6	297.0	283.1
Outside of Study Area	DWR	Outside of Study Area	364144N1192276W001	T17S R25E 26	358.7	83.7		275.0	
Outside of Study Area	DWR	Outside of Study Area	364153N1192420W001	T17S R25E 26	352.7	93.0		259.7	
Outside of Study Area	DWR	Outside of Study Area	364283N1192334W001	T17S R25E 26	353.7	89.2		264.5	
Outside of Study Area	DWR	Outside of Study Area	364156N1192798W001	T17S R25E 29	327.7	87.5		240.2	
Outside of Study Area	DWR	Outside of Study Area	364242N1192948W001	T17S R25E 29	320.7		110.0		208.0
Outside of Study Area	DWR	Outside of Study Area	364283N1192953W001	T17S R25E 29	323.7	88.4		235.3	
Outside of Study Area	AID	Outside of Study Area	X236A	T17S R25E 30	323.8		104.1		219.7
Outside of Study Area	DWR	Outside of Study Area	364047N1192606W001	T17S R25E 33	341.7	88.0		253.7	
Outside of Study Area	DWR	Outside of Study Area	364050N1192401W001	T17S R25E 35	351.7	87.0		264.7	
Outside of Study Area	DWR	Outside of Study Area	364086N1192381W001	T17S R25E 35	353.2	87.9	111.1	265.3	242.1
Outside of Study Area	DWR	Outside of Study Area	364139N1192376W001	T17S R25E 35	357.7	87.6		270.1	
Outside of Study Area	DWR	Outside of Study Area	364047N1192237W001	T17S R25E 36	362.7	75.3		287.4	
Outside of Study Area	DWR	Outside of Study Area	364069N1192151W001	T17S R25E 36	367.7	78.0		289.7	
Outside of Study Area	DWR	Outside of Study Area	364752N1191662W001	T17S R26E 04	410.7	5.5		405.2	
Outside of Study Area	DWR	Outside of Study Area	364788N1191653W001	T17S R26E 04	405.6	8.0		397.6	
Outside of Study Area	DWR	Outside of Study Area	364682N1192001W001	T17S R26E 07	362.7	18.0	29.6	344.7	333.1
Outside of Study Area	DWR	Outside of Study Area	364577N1191884W001	T17S R26E 08	366.7	23.5		343.2	
Outside of Study Area	DWR	Outside of Study Area	364502N1191909W001	T17S R26E 18	371.7	39.0		332.7	
Outside of Study Area	DWR	Outside of Study Area	364288N1191842W001	T17S R26E 20	387.7	39.6		348.1	
Outside of Study Area	DWR	Outside of Study Area	364388N1191703W001	T17S R26E 21	396.7	19.2		377.5	
Outside of Study Area	DWR	Outside of Study Area	364396N1191703W001	T17S R26E 21	396.7		27.1		369.6
Outside of Study Area	DWR	Outside of Study Area	364174N1191703W001	T17S R26E 28	403.7	40.8		362.9	
Outside of Study Area	DWR	Outside of Study Area	364193N1191595W001	T17S R26E 28	414.7	42.3		372.4	
Outside of Study Area	DWR	Outside of Study Area	364227N1191706W001	T17S R26E 28	402.7	32.3		370.4	
Outside of Study Area	DWR	Outside of Study Area	364141N1191831W001	T17S R26E 29	388.7	61.2		327.5	
Outside of Study Area	DWR	Outside of Study Area	364146N1191728W001	T17S R26E 29	399.7	33.7	41.5	366.0	358.2
Outside of Study Area	DWR	Outside of Study Area	364000N1191973W001	T17S R26E 31	378.7	73.2		305.5	
Outside of Study Area	DWR	Outside of Study Area	364039N1191987W001	T17S R26E 31	377.7	74.3		303.4	
Outside of Study Area	DWR	Outside of Study Area	363865N1200377W001	T18S R18E 05	237.9		167.0		70.9
Outside of Study Area	DWR	Outside of Study Area	363936N1200399W001	T18S R18E 05	233.9		205.0		28.9
Outside of Study Area	DWR	Outside of Study Area	363936N1200488W001	T18S R18E 05	231.9		206.0		25.9
Outside of Study Area	DWR	Outside of Study Area	363717N1200393W001	T18S R18E 08	243.9		191.4		52.5
Outside of Study Area	DWR	Outside of Study Area	363794N1200307W001	T18S R18E 09	237.9		198.1		39.8
Outside of Study Area	DWR	Outside of Study Area	363575N1199766W001	T18S R18E 13	231.9		161.0		71.9
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Outside of Study Area	DWR	Outside of Study Area	363927N1197477W001	T18S R20E 01	242.8		19.8		223.0
Outside of Study Area	DWR	Outside of Study Area	363863N1197571W001	T18S R20E 12	241.8	77.9		163.9	
Outside of Study Area	DWR	Outside of Study Area	363481N1197810W001	T18S R20E 22	235.8		13.8		222.0
Outside of Study Area	DWR	Outside of Study Area	363500N1197800W001	T18S R20E 23	220.8		152.4		68.4
Outside of Study Area	DWR	Outside of Study Area	363500N1197800W002	T18S R20E 23	220.8		151.9		68.9
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Outside of Study Area	DWR	Outside of Study Area	363342N1197629W001	T18S R20E 26	238.8		18.8		220.0
Outside of Study Area	DWR	Outside of Study Area	363425N1197785W001	T18S R20E 26	237.8		14.4		223.4
Outside of Study Area	DWR	Outside of Study Area	363300N1198510W001	T18S R20E 30	216.8	2.9	5.0	213.9	211.8
Outside of Study Area	DWR	Outside of Study Area	363144N1197968W001	T18S R20E 34	227.8	99.2	109.0	128.6	118.8
Outside of Study Area	DWR	Outside of Study Area	363194N1197610W001	T18S R20E 36	235.8		17.4		218.4
Outside of Study Area	DWR	Outside of Study Area	364008N1196477W001	T18S R21E 01	263.2	71.5	88.4	191.7	174.8
Outside of Study Area	DWR	Outside of Study Area	363894N1196557W001	T18S R21E 02	262.2	86.0	101.9	176.2	160.3
Outside of Study Area	DWR	Outside of Study Area	363933N1196735W001	T18S R21E 03	258.7	86.0	101.7	172.8	157.0
Outside of Study Area	DWR	Outside of Study Area	363908N1197016W001	T18S R21E 04	248.8	65.5	94.1	183.3	154.7
Outside of Study Area	DWR	Outside of Study Area	363931N1197227W001	T18S R21E 05	245.8	60.0		185.8	

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
Outside of Study Area	DWR	Outside of Study Area	363722N1197282W001	T18S R21E 07	242.8	81.0	24.4	161.8	218.4
Outside of Study Area	DWR	Outside of Study Area	363764N1197093W001	T18S R21E 08	246.8	75.0	123.8	171.8	123.0
Outside of Study Area	DWR	Outside of Study Area	363719N1196754W001	T18S R21E 10	256.8	91.0	108.5	165.8	148.3
Outside of Study Area	DWR	Outside of Study Area	363794N1196821W001	T18S R21E 10	253.8	93.0	98.6	160.8	155.2
Outside of Study Area	DWR	Outside of Study Area	363728N1196538W001	T18S R21E 12	255.7	93.0	106.7	162.8	149.0
Outside of Study Area	DWR	Outside of Study Area	363711N1196846W001	T18S R21E 15	254.8	86.5	102.8	168.3	152.0
Outside of Study Area	DWR	Outside of Study Area	363675N1197041W001	T18S R21E 16	247.8	23.0	30.7	224.8	217.1
Outside of Study Area	DWR	Outside of Study Area	363603N1197266W001	T18S R21E 17	240.8		19.6		221.2
Outside of Study Area	DWR	Outside of Study Area	363675N1197188W001	T18S R21E 17	247.8	19.0	23.5	228.8	224.3
Outside of Study Area	DWR	Outside of Study Area	363681N1197127W001	T18S R21E 17	247.8	26.0	29.9	221.8	217.9
Outside of Study Area	DWR	Outside of Study Area	363519N1197279W001	T18S R21E 19	242.8	17.5	19.5	225.3	223.3
Outside of Study Area	DWR	Outside of Study Area	363431N1197163W001	T18S R21E 20	246.8		28.4		218.4
Outside of Study Area	DWR	Outside of Study Area	363517N1196927W001	T18S R21E 21	252.8		135.5		117.3
Outside of Study Area	DWR	Outside of Study Area	363417N1196979W001	T18S R21E 28	230.2		30.6		215.2
Outside of Study Area	DWR	Outside of Study Area	363388N1197438W001	T18S R21E 30	239.8		16.0		223.8
Outside of Study Area	DWR	Outside of Study Area	363274N1197327W001	T18S R21E 31	241.8	109.0	135.2	132.8	106.6
Outside of Study Area	DWR	Outside of Study Area	364011N1195379W001	T18S R22E 01	268.7		95.6		173.1
Outside of Study Area	DWR	Outside of Study Area	363911N1195799W001	T18S R22E 03	267.7	92.7	96.8	175.0	170.9
Outside of Study Area	DWR	Outside of Study Area	363992N1195716W001	T18S R22E 03	268.7	73.0	88.2	195.7	180.5
Outside of Study Area	DWR	Outside of Study Area	363942N1196360W002	T18S R22E 06	262.7	89.0	103.0	173.7	159.7
Outside of Study Area	DWR	Outside of Study Area	363978N1196349W001	T18S R22E 06	263.2	76.0		187.2	
Outside of Study Area	DWR	Outside of Study Area	363864N1196193W001	T18S R22E 07	262.7		102.5		160.2
Outside of Study Area	DWR	Outside of Study Area	363722N1196182W001	T18S R22E 08	262.7		115.0		147.7
Outside of Study Area	DWR	Outside of Study Area	363864N1196046W001	T18S R22E 08	261.7	106.0	105.2	155.7	156.5
Outside of Study Area	DWR	Outside of Study Area	363608N1195924W001	T18S R22E 16	260.7	105.0	127.0	155.7	133.7
Outside of Study Area	DWR	Outside of Study Area	363589N1196074W001	T18S R22E 17	257.7		127.9		129.8
Outside of Study Area	DWR	Outside of Study Area	363569N1196182W001	T18S R22E 20	257.8	107.5		150.3	
Outside of Study Area	DWR	Outside of Study Area	363567N1195938W001	T18S R22E 21	259.7		126.8		132.9
Outside of Study Area	DWR	Outside of Study Area	363556N1195654W001	T18S R22E 22	259.7	104.0		155.7	
Outside of Study Area	DWR	Outside of Study Area	363572N1195468W001	T18S R22E 24	258.0	78.0	101.5	180.0	156.5
Outside of Study Area	DWR	Outside of Study Area	363386N1195563W001	T18S R22E 26	256.7		97.4		159.3
Outside of Study Area	DWR	Outside of Study Area	363856N1194443W001	T18S R23E 02	278.5	64.5	89.5	214.2	186.5
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Outside of Study Area	DWR	Outside of Study Area	363853N1194291W001	T18S R23E 12	282.7	53.0		229.7	
Outside of Study Area	DWR	Outside of Study Area	363683N1194399W001	T18S R23E 14	280.7	83.5	108.0	197.2	170.0
Outside of Study Area	DWR	Outside of Study Area	363703N1194577W001	T18S R23E 15	274.3	95.0	112.4	179.3	161.9
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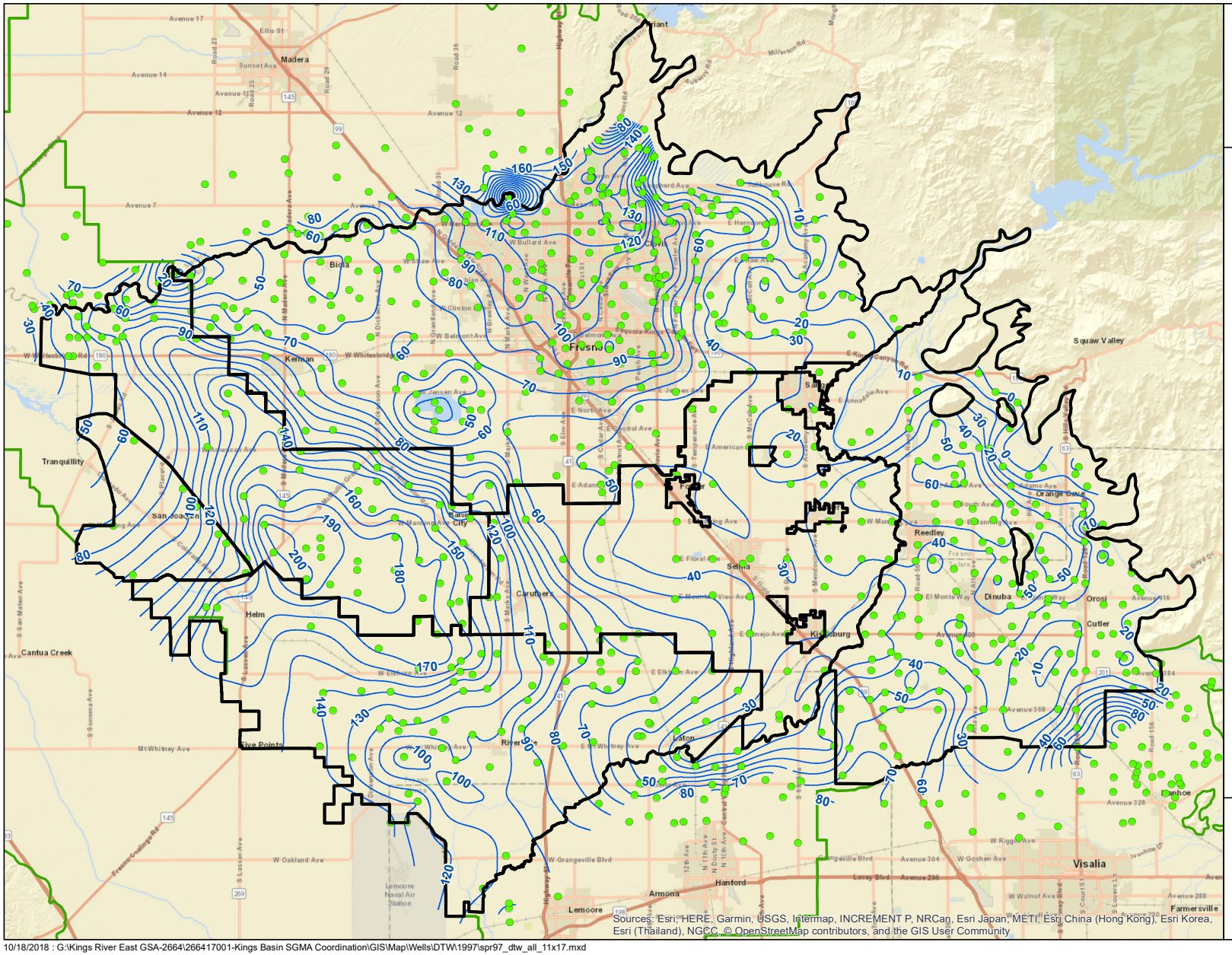
Outside of Study Area	DWR	Outside of Study Area	363417N1194818W001	T18S R23E 28	263.0		106.0		157.0
Outside of Study Area	DWR	Outside of Study Area	363414N1195068W001	T18S R23E 29	258.7		84.8		173.9
Outside of Study Area	DWR	Outside of Study Area	363426N1195264W001	T18S R23E 30	256.0		182.0		70.0
Outside of Study Area	DWR	Outside of Study Area	363928N1193326W001	T18S R24E 02	313.7	49.0		264.7	
Outside of Study Area	DWR	Outside of Study Area	363906N1193685W001	T18S R24E 04	303.7	39.5		264.2	
Outside of Study Area	DWR	Outside of Study Area	363928N1194038W001	T18S R24E 06	290.7	47.5		243.2	
Outside of Study Area	DWR	Outside of Study Area	363789N1194041W001	T18S R24E 07	292.2		77.5		212.0
Outside of Study Area	DWR	Outside of Study Area	363750N1193502W001	T18S R24E 10	312.2	49.5	62.5	262.7	247.0
Outside of Study Area	DWR	Outside of Study Area	363601N1193320W001	T18S R24E 13	316.9		65.0		254.0
Outside of Study Area	DWR	Outside of Study Area	363667N1193148W001	T18S R24E 13	324.4	47.0	51.0	275.7	269.0
Outside of Study Area	DWR	Outside of Study Area	363581N1193521W001	T18S R24E 15	312.7	68.0		244.7	
Outside of Study Area	DWR	Outside of Study Area	363633N1193971W001	T18S R24E 17	295.7	62.5		233.2	
Outside of Study Area	DWR	Outside of Study Area	363922N1192106W001	T18S R25E 01	369.7	79.9		289.8	
Outside of Study Area	DWR	Outside of Study Area	363928N1192295W001	T18S R25E 02	357.7	77.4		280.3	
Outside of Study Area	DWR	Outside of Study Area	363989N1192381W001	T18S R25E 02	357.7	86.1		271.6	
Outside of Study Area	DWR	Outside of Study Area	363933N1192615W001	T18S R25E 04	342.7	81.0		261.7	
Outside of Study Area	DWR	Outside of Study Area	363864N1192834W001	T18S R25E 05	333.3		81.0		249.5
Outside of Study Area	DWR	Outside of Study Area	363944N1192926W001	T18S R25E 05	327.7	71.0		256.7	
Outside of Study Area	DWR	Outside of Study Area	363711N1192250W001	T18S R25E 12	397.7		60.0		335.0
Outside of Study Area	DWR	Outside of Study Area	363692N1192520W001	T18S R25E 15	348.1	58.0	64.0	290.7	282.0
Outside of Study Area	DWR	Outside of Study Area	363703N1192434W001	T18S R25E 15	351.7	61.0		290.7	
Outside of Study Area	DWR	Outside of Study Area	363706N1192665W001	T18S R25E 16	343.1		77.0		264.0
Outside of Study Area	DWR	Outside of Study Area	363889N1192017W001	T18S R26E 06	371.7	70.7		301.0	
Outside of Study Area	DWR	Outside of Study Area	363981N1191956W001	T18S R26E 06	382.7	78.0		304.7	
Outside of Study Area	DWR	Outside of Study Area	363992N1192051W001	T18S R26E 06	373.7	75.9		297.8	
Outside of Study Area	DWR	Outside of Study Area	363822N1192045W001	T18S R26E 07	367.7	63.4		304.3	
Outside of Study Area	DWR	Outside of Study Area	362925N1199046W001	T19S R19E 10	224.8		184.0		38.9
Outside of Study Area	DWR	Outside of Study Area	362611N1199496W001	T19S R19E 19	248.9		215.7		33.2
Outside of Study Area	DWR	Outside of Study Area	362522N1198877W001	T19S R19E 27	220.9		173.4		47.5
Outside of Study Area	DWR	Outside of Study Area	363128N1198266W001	T19S R20E 05	217.8		151.5		66.3

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
Outside of Study Area	DWR	Outside of Study Area	363053N1198438W001	T19S R20E 06	214.8	97.8	110.6	117.0	104.2
Outside of Study Area	DWR	Outside of Study Area	363092N1198438W001	T19S R20E 06	215.8	101.9	155.4	113.9	60.4
Outside of Study Area	DWR	Outside of Study Area	362942N1198432W001	T19S R20E 07	212.8	97.7		115.1	
Outside of Study Area	DWR	Outside of Study Area	362667N1198352W001	T19S R20E 19	212.9		156.0		56.9
Outside of Study Area	DWR	Outside of Study Area	362692N1197932W001	T19S R20E 22	222.8		14.9		207.9
Outside of Study Area	DWR	Outside of Study Area	362400N1198300W001	T19S R20E 32	198.6		187.8		10.8
Outside of Study Area	DWR	Outside of Study Area	362400N1198300W002	T19S R20E 32	198.6		187.2		11.4

Attachment 3

Depth to Water Contour Maps



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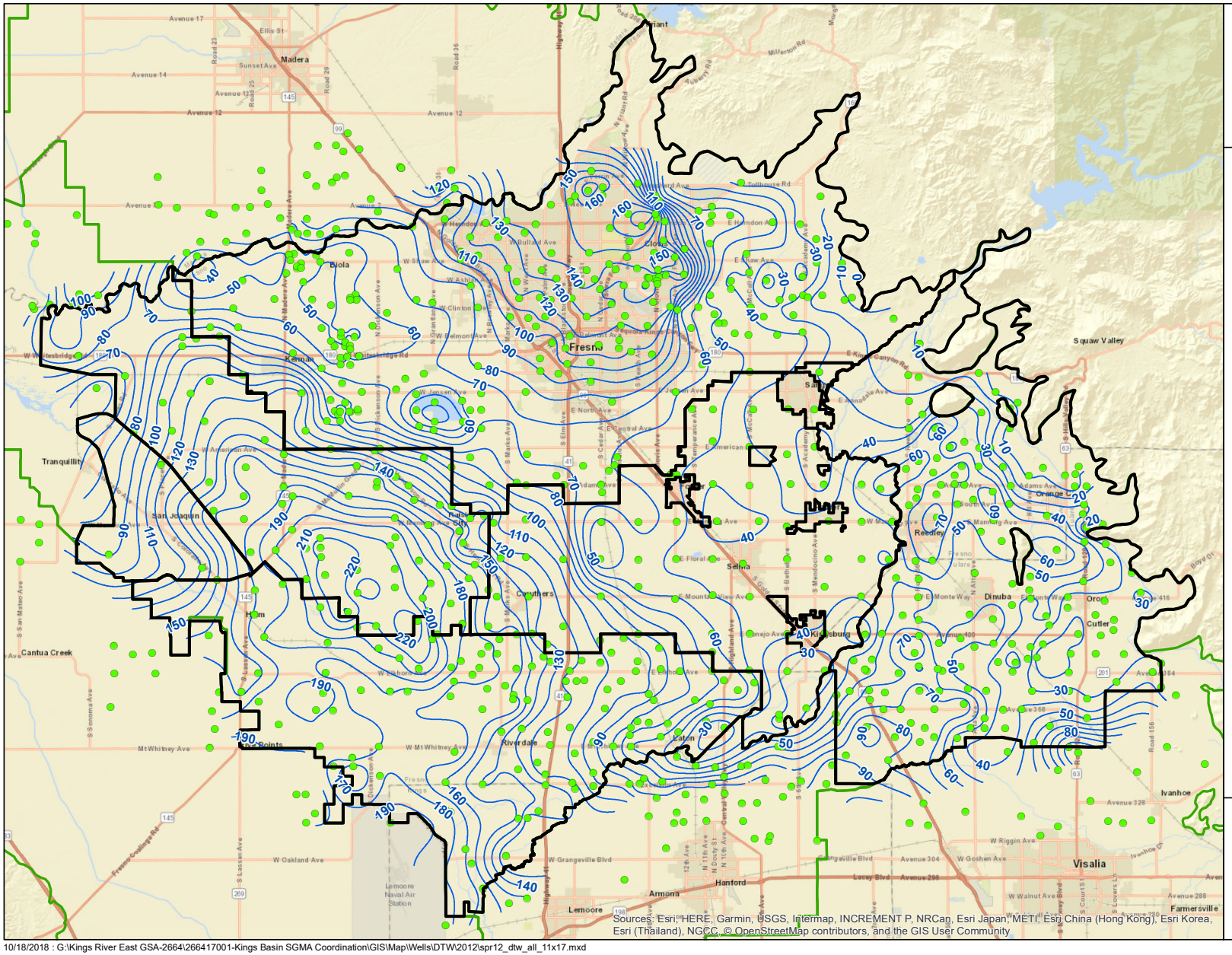

Kings Subbasin
Coordinated Effort

Kings Coordinated Effort GSAs

Spring 2012 - Depth to Water in Wells (feet below ground surface)

Legend

- Kings Coordinated Effort GSAs
- Groundwater Subbasins (DWR 2017)
- Well Used in Analysis

Water Level Contours

- Line of Equal Depth (10ft interval)

KDSA
Est. 1972

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

N

0 2 4
Miles

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Attachment 4

Storage Change Estimation Tables

Central Kings GSA											
SY Unit	SY Source	SY10to50	SY50to100	SY100to200	SY200to300	Acres	SPR 1997 DTW AVE	1997 GW STORAGE (AF)	SPR 2012 DTW AVE	2012 GW STORAGE (AF)	SPR 1997 to SPR 2012 Change (AF)
CK047	USGS WSP 1469	0.159	0.127	0.085	0.141	4,747	42	143,269	53	135,675	-7,595
CK049	USGS WSP 1469	0.178	0.158	0.104	0.147	10,333	30	377,428	37	365,539	-11,889
CK050	USGS WSP 1469	0.178	0.158	0.104	0.159	115	25	4,448	24	4,469	21
CK072	USGS WSP 1469	0.130	0.109	0.139	0.117	1,598	118	36,828	119	36,685	-143
CK073	USGS WSP 1469	0.138	0.134	0.134	0.142	13,442	62	438,946	82	403,341	-35,605
CK074	USGS WSP 1469	0.138	0.134	0.134	0.145	19,177	38	694,167	51	662,143	-32,024
CK075	USGS WSP 1469	0.173	0.131	0.121	0.157	20,186	35	745,232	40	729,729	-15,503
CK076	USGS WSP 1469	0.127	0.138	0.094	0.134	9,895	47	297,769	50	294,019	-3,749
CK088	USGS WSP 1469	0.155	0.139	0.157	0.120	3,844	135	85,493	157	72,182	-13,311
CK089	USGS WSP 1469	0.122	0.138	0.148	0.000	17,282	86	289,935	113	223,728	-66,207
CK090	USGS WSP 1469	0.155	0.135	0.128	0.143	17,929	52	601,268	61	579,657	-21,611
CK091	USGS WSP 1469	0.156	0.137	0.141	0.148	20,442	35	779,805	43	754,025	-25,780
CK092	USGS WSP 1469	0.147	0.126	0.141	0.131	4,850	32	174,998	40	169,924	-5,073
CK102	USGS WSP 1469	0.104	0.085	0.133	0.111	7,060	23	222,369	32	215,450	-6,918
						150,902		4,891,955		4,646,566	-245,389

Notes: 1) Specific Yield values zeroed and storage volume not calculated for areas below base of unconfined aquifer.

Total Change in Storage (AF) =	-245,389
Years in Range =	15
Average Change per Year (AF) =	-16,359
Average Change per Year (AF, Rounded 1,000s) =	-16,000

James ID GSA											
SY Unit	SY Source	SY10to50	SY50to100	SY100to200	SY200to300	Acres	SPR 1997 DTW AVE	1997 GW STORAGE (AF)	SPR 2012 DTW AVE	2012 GW STORAGE (AF)	SPR 1997 to SPR 2012 Change (AF)
JID032	USGS PP 1401-D	0.100	0.100	0.100	0.100	1	70	32	84	30	-2
JID033	USGS PP 1401-D	0.100	0.100	0.100	0.100	103	70	2,354	84	2,214	-140
JID034	KDSA	0.110	0.110	0.110	0.110	8,971	64	233,029	84	213,102	-19,927
JID062	KDSA	0.100	0.100	0.100	0.100	1,425	80	31,377	92	29,610	-1,767
JID063	KDSA	0.120	0.120	0.120	0.120	17,595	100	421,564	122	376,585	-44,978
JID064	KDSA	0.126	0.126	0.126	0.126	303	146	5,882	172	4,898	-984
JID067	KDSA	0.125	0.125	0.125	0.125	481	150	9,014	165	8,117	-897
JID068	USGS PP 1401-D	0.130	0.130	0.130	0.130	180	156	3,364	179	2,838	-526
						29,058		706,615		637,394	-69,221

Notes: 1) Specific Yield values zeroed and storage volume not calculated for areas below base of unconfined aquifer.

Total Change in Storage (AF) =	-69,221
Years in Range =	15
Average Change per Year (AF) =	-4,615
Average Change per Year (AF, Rounded 1,000s) =	-5,000

Kings River East GSA											
SY Unit	SY Source	SY10to50	SY50to100	SY100to200	SY200to300	Acres	SPR 1997 DTW AVE	1997 GW STORAGE (AF)	SPR 2012 DTW AVE	2012 GW STORAGE (AF)	SPR 1997 to SPR 2012 Change (AF)
KRE025	USGS PP 1401-D	0.180	0.180	0.180	0.000	40	9	1,357	14	1,325	-32
KRE049	USGS WSP 1469	0.178	0.158	0.104	0.147	2,275	23	85,980	31	82,697	-3,283
KRE050	USGS WSP 1469	0.178	0.158	0.104	0.000	13,801	17	332,429	26	311,591	-20,839
KRE051	USGS PP 1401-D	0.180	0.180	0.180	0.000	1,181	21	38,137	20	38,328	191
KRE052	Page and LeBlanc 1969	0.061	0.061	0.061	0.000	53	40	517	35	535	17
KRE053	USGS PP 1401-D	0.130	0.130	0.130	0.000	55	43	1,111	41	1,128	17
KRE054	Page and LeBlanc 1969	0.061	0.061	0.061	0.000	660	48	6,131	53	5,913	-217
KRE055	AID	0.125	0.125	0.125	0.000	2,155	10	51,193	12	50,640	-553
KRE056	AID	0.115	0.115	0.115	0.000	542	13	11,634	19	11,263	-371
KRE057	OCID	0.078	0.078	0.080	0.000	668	9	10,103	20	9,519	-584
KRE058	Page and LeBlanc 1969	0.065	0.065	0.065	0.000	2,001	24	22,938	31	22,039	-899
KRE059	USGS PP 1401-D	0.070	0.000	0.000	0.000	7,583	5	23,828	11	20,687	-3,141
KRE060	USGS WSP 1469	0.069	0.090	0.066	0.102	1,124	50	23,917	54	23,522	-396
KRE061	USGS WSP 1469	0.069	0.090	0.066	0.000	2,431	23	31,594	27	30,877	-716
KRE075	USGS WSP 1469	0.173	0.131	0.121	0.157	331	24	12,861	31	12,460	-401
KRE076	USGS WSP 1469	0.127	0.138	0.094	0.134	12,213	50	363,388	60	346,335	-17,053
KRE077	USGS WSP 1469	0.069	0.090	0.066	0.095	856	56	17,163	53	17,378	215
KRE078	USGS WSP 1469	0.069	0.090	0.066	0.000	20,839	39	246,887	43	240,898	-5,989
KRE079	Page and LeBlanc 1969	0.074	0.074	0.074	0.000	2,497	19	33,374	19	33,533	159
KRE080	USGS PP 1401-D	0.060	0.000	0.000	0.000	6,010	16	12,154	21	10,636	-1,519
KRE081	USGS WSP 1469	0.069	0.090	0.066	0.000	2,020	35	24,571	46	22,984	-1,587
KRE082	USGS PP 1401-D	0.060	0.060	0.060	0.000	236	24	2,493	29	2,419	-74
KRE091	USGS WSP 1469	0.156	0.137	0.141	0.148	360	23	14,385	33	13,838	-547
KRE092	USGS WSP 1469	0.147	0.126	0.141	0.000	18,236	32	421,242	51	368,978	-52,265
KRE093	USGS WSP 1469	0.068	0.080	0.055	0.000	22,806	33	242,748	41	231,109	-11,639
KRE094	USGS WSP 1469	0.056	0.080	0.055	0.000	11,499	27	124,254	28	123,128	-1,127
KRE095	Page and LeBlanc 1969	0.074	0.074	0.074	0.000	7,285	23	95,461	29	92,341	-3,121
KRE102	USGS WSP 1469	0.104	0.085	0.133	0.111	3	23	79	29	77	-2
KRE103	USGS WSP 1469	0.104	0.085	0.120	0.000	19,983	58	310,297	74	284,717	-25,580
KRE104	USGS WSP 1469	0.096	0.086	0.077	0.000	857	56	9,819	68	8,979	-841
KRE105	USGS WSP 1469	0.104	0.085	0.120	0.000	737	49	12,056	65	11,037	-1,019
KRE106	USGS WSP 1469	0.068	0.080	0.055	0.000	12,058	24	135,598	45	118,350	-17,247
KRE107	USGS WSP 1469	0.086	0.102	0.065	0.000	1,741	32	22,894	51	20,072	-2,823
KRE108	USGS WSP 1469	0.068	0.080	0.055	0.000	7,691	50	72,763	48	74,266	1,504
KRE109	USGS WSP 1469	0.097	0.104	0.079	0.000	57	73	607	99	454	-153
KRE110	USGS PP 1401-D	0.074	0.074	0.074	0.000	295	21	3,905	38	3,541	-364
KRE117	Page and LeBlanc 1969	0.074	0.074	0.074	0.000	14	18	192	35	175	-18
						183,192		2,820,061		2,647,765	-172,296

Notes: 1) Specific Yield values zeroed and storage volume not calculated for areas below base of unconfined aquifer.

Total Change in Storage (AF) =	-172,296
Years in Range =	15
Average Change per Year (AF) =	-11,486
Average Change per Year (AF, Rounded 1,000s) =	-11,000

McMullin Area GSA											
SY Unit	SY Source	SY10to50	SY50to100	SY100to200	SY200to300	Acres	SPR 1997 DTW AVE	1997 GW STORAGE (AF)	SPR 2012 DTW AVE	2012 GW STORAGE (AF)	SPR 1997 to SPR 2012 Change (AF)
MA013	USGS WSP 1469	0.155	0.119	0.158	0.133	171	42	6,216	87	5,232	-984
MA014	USGS WSP 1469	0.100	0.078	0.081	0.133	1,166	50	29,464	83	26,529	-2,935
MA015	USGS WSP 1469	0.103	0.069	0.088	0.106	253	29	6,326	46	5,883	-442
MA029	USGS PP 1401-D	0.160	0.160	0.160	0.160	414	36	17,474	79	14,660	-2,814
MA030	Page and LeBlanc 1969	0.134	0.134	0.134	0.134	6,568	50	220,031	82	191,800	-28,231
MA031	Page and LeBlanc 1969	0.128	0.128	0.128	0.128	10,065	72	293,461	73	291,850	-1,611
MA034	KDSA	0.110	0.110	0.110	0.110	4,151	66	106,993	84	98,412	-8,581
MA035	USGS PP 1401-D	0.110	0.110	0.110	0.110	1,290	88	30,080	125	24,854	-5,226
MA036	Page and LeBlanc 1969	0.115	0.115	0.115	0.115	19,957	110	435,002	118	418,523	-16,480
MA037	Page and LeBlanc 1969	0.116	0.116	0.116	0.116	0	0	0	0	0	0
MA038	USGS WSP 1469	0.096	0.157	0.160	0.112	170	81	5,137	93	4,811	-326
MA042	USGS WSP 1469	0.130	0.109	0.139	0.119	19	0	0	0	0	0
MA063	KDSA	0.120	0.120	0.120	0.120	373	101	8,902	142	7,069	-1,833
MA064	KDSA	0.126	0.126	0.126	0.126	21,269	159	378,784	170	347,085	-31,699
MA065	Page and LeBlanc 1969	0.104	0.104	0.104	0.104	2,997	150	46,676	156	44,976	-1,700
MA068	USGS PP 1401-D	0.130	0.130	0.130	0.130	8,576	190	122,708	211	99,308	-23,400
MA069	Page and LeBlanc 1969	0.109	0.109	0.109	0.109	7,629	186	94,483	214	71,294	-23,188
MA070	Page and LeBlanc 1969	0.116	0.116	0.116	0.116	7,181	175	104,063	202	82,017	-22,047
MA071	USGS WSP 1469	0.130	0.109	0.139	0.102	4,233	138	79,407	149	73,190	-6,217
MA072	USGS WSP 1469	0.130	0.109	0.139	0.117	14,476	133	305,046	145	279,719	-25,328
MA085	USGS PP 1401-D	0.110	0.110	0.110	0.110	198	175	2,715	205	2,058	-657
MA086	Page and LeBlanc 1969	0.116	0.116	0.116	0.116	1,326	178	18,702	219	12,399	-6,303
MA087	Page and LeBlanc 1969	0.116	0.116	0.116	0.116	1,467	173	21,616	201	16,878	-4,738
MA088	USGS WSP 1469	0.155	0.139	0.157	0.120	6,629	159	122,463	182	98,437	-24,026
						120,577		2,455,747		2,216,980	-238,767

Notes: 1) Specific Yield values zeroed and storage volume not calculated for areas below base of unconfined aquifer.

Total Change in Storage (AF) =	-238,767
Years in Range =	15
Average Change per Year (AF) =	-15,918
Average Change per Year (AF, Rounded 1,000s) =	-16,000

North Fork Kings GSA											
SY Unit	SY Source	SY10to50	SY50to100	SY100to200	SY200to300	Acres	SPR 1997 DTW AVE	1997 GW STORAGE (AF)	SPR 2012 DTW AVE	2012 GW STORAGE (AF)	SPR 1997 to SPR 2012 Change (AF)
NFK063	KDSA	0.120	0.120	0.120	0.120	2,773	120	59,988	132	55,896	-4,092
NFK067	KDSA	0.125	0.125	0.125	0.125	16,262	161	282,547	169	265,641	-16,906
NFK068	USGS PP 1401-D	0.130	0.130	0.130	0.130	9,547	170	161,625	197	128,227	-33,399
NFK084	USGS PP 1401-D	0.120	0.120	0.120	0.120	11,019	147	202,970	188	148,076	-54,894
NFK085	USGS PP 1401-D	0.110	0.110	0.110	0.110	16,075	141	280,525	183	207,347	-73,178
NFK086	Page and LeBlanc 1969	0.116	0.116	0.116	0.116	5,237	161	84,621	197	62,787	-21,834
NFK087	Page and LeBlanc 1969	0.116	0.116	0.116	0.116	5,523	159	90,612	185	73,632	-16,980
NFK088	USGS WSP 1469	0.155	0.139	0.157	0.120	1,891	141	40,262	170	31,592	-8,670
NFK089	USGS WSP 1469	0.122	0.138	0.148	0.139	5,778	101	165,286	133	137,458	-27,828
NFK090	USGS WSP 1469	0.155	0.135	0.128	0.143	5,117	73	157,549	91	144,924	-12,625
NFK096	USGS PP 1401-D	0.130	0.130	0.130	0.130	2,376	137	50,451	174	38,981	-11,470
NFK097	USGS PP 1401-D	0.120	0.120	0.120	0.120	15,060	112	340,403	176	223,752	-116,650
NFK098	Page and LeBlanc 1969	0.133	0.133	0.133	0.133	4,082	111	102,754	160	76,144	-26,610
NFK099	Page and LeBlanc 1969	0.114	0.114	0.114	0.114	3,876	118	80,377	162	61,138	-19,238
NFK100	USGS WSP 1469	0.183	0.119	0.133	0.113	22,931	87	599,625	122	497,606	-102,019
NFK101	USGS WSP 1469	0.173	0.162	0.133	0.135	17,049	52	589,422	71	537,519	-51,903
NFK102	USGS WSP 1469	0.104	0.085	0.133	0.111	3,195	36	96,207	54	90,422	-5,785
NFK111	USGS PP 1401-D	0.080	0.080	0.080	0.080	46	116	679	183	432	-248
NFK112	USGS PP 1401-D	0.120	0.120	0.120	0.120	5,393	115	119,406	173	81,904	-37,503
NFK113	USGS WSP 1469	0.150	0.096	0.150	0.133	6,112	105	168,090	154	123,894	-44,196
NFK114	USGS WSP 1469	0.150	0.096	0.150	0.133	8,485	96	243,046	132	199,309	-43,737
						167,824		3,916,445		3,186,680	-729,765

Notes: 1) Specific Yield values zeroed and storage volume not calculated for areas below base of unconfined aquifer.

2) NFK063 Spring 2012 DTW Average estimated from 2011 and 2013 values

Total Change in Storage (AF) =	-729,765
Years in Range =	15
Average Change per Year (AF) =	-48,651
Average Change per Year (AF, Rounded 1,000s) =	-49,000

North Kings GSA											
SY Unit	SY Source	SY10to50	SY50to100	SY100to200	SY200to300	Acres	SPR 1997 DTW AVE	1997 GW STORAGE (AF)	SPR 2012 DTW AVE	2012 GW STORAGE (AF)	SPR 1997 to SPR 2012 Change (AF)
NK003	USGS WSP 1469	0.103	0.108	0.130	0.105	99	50	2,860	76	2,575	-285
NK004	USGS WSP 1469	0.156	0.151	0.103	0.155	3,613	97	94,730	115	87,604	-7,125
NK005	USGS WSP 1469	0.135	0.117	0.153	0.145	13,847	129	351,516	149	308,775	-42,740
NK006	USGS WSP 1469	0.112	0.131	0.139	0.000	12,544	91	189,440	101	172,744	-16,697
NK008	Page and LeBlanc 1969	0.076	0.076	0.076	0.000	7,640	41	92,336	47	88,775	-3,560
NK009	USGS PP 1401-D	0.060	0.000	0.000	0.000	4,122	11	9,591	26	5,881	-3,710
NK011	USGS PP 1401-D	0.090	0.000	0.000	0.000	3,268	10	11,712	10	11,891	179
NK015	USGS WSP 1469	0.103	0.069	0.088	0.106	13,899	52	315,911	54	313,597	-2,315
NK016	USGS WSP 1469	0.118	0.102	0.126	0.117	20,498	56	589,516	57	587,879	-1,637
NK017	USGS WSP 1469	0.145	0.135	0.143	0.143	22,802	81	710,869	88	688,586	-22,283
NK018	USGS WSP 1469	0.106	0.122	0.109	0.134	21,788	109	507,237	133	452,167	-55,071
NK019	USGS WSP 1469	0.084	0.070	0.064	0.069	1,220	100	16,224	120	14,697	-1,527
NK020	USGS WSP 1469	0.106	0.122	0.109	0.100	11,846	92	259,758	129	210,704	-49,054
NK021	USGS WSP 1469	0.084	0.070	0.064	0.000	11,243	57	106,067	77	89,929	-16,138
NK022	USGS WSP 1469	0.074	0.075	0.044	0.000	23,051	24	232,630	33	217,386	-15,244
NK023	Page and LeBlanc 1969	0.143	0.143	0.143	0.000	656	20	16,865	19	17,024	159
NK024	Page and LeBlanc 1969	0.122	0.122	0.122	0.000	57	24	1,225	20	1,252	27
NK025	USGS PP 1401-D	0.180	0.180	0.180	0.000	894	13	30,086	15	29,687	-399
NK026	USGS PP 1401-D	0.060	0.000	0.000	0.000	1,542	0	0	0	0	0
NK027	PandP	0.060	0.060	0.060	0.000	2,078	0	0	0	0	0
NK031	Page and LeBlanc 1969	0.128	0.128	0.128	0.128	557	69	16,501	69	16,443	-58
NK036	Page and LeBlanc 1969	0.115	0.115	0.115	0.115	1,750	115	37,153	114	37,440	287
NK037	Page and LeBlanc 1969	0.116	0.116	0.116	0.116	204	120	4,260	136	3,870	-390
NK038	USGS WSP 1469	0.096	0.157	0.160	0.112	4,346	95	121,423	97	120,217	-1,207
NK039	USGS WSP 1469	0.096	0.157	0.160	0.115	15,591	74	493,550	77	485,425	-8,124
NK040	USGS WSP 1469	0.130	0.109	0.139	0.115	4,754	94	124,015	92	124,845	830
NK041	USGS WSP 1469	0.145	0.135	0.143	0.118	2,350	62	73,401	63	73,131	-270
NK042	USGS WSP 1469	0.130	0.109	0.139	0.119	20,571	57	626,495	67	604,696	-21,800
NK043	USGS WSP 1469	0.159	0.127	0.085	0.125	14,993	63	384,675	75	362,623	-22,052
NK044	USGS WSP 1469	0.106	0.122	0.109	0.134	359	86	9,349	98	8,815	-534
NK045	USGS WSP 1469	0.084	0.070	0.064	0.083	7,694	88	119,356	101	112,520	-6,836
NK046	USGS WSP 1469	0.084	0.070	0.064	0.104	5,190	77	95,628	90	90,812	-4,816
NK047	USGS WSP 1469	0.159	0.127	0.085	0.141	13,232	53	378,421	66	356,300	-22,121
NK048	USGS WSP 1469	0.074	0.075	0.044	0.105	315	32	6,302	48	5,937	-365
NK049	USGS WSP 1469	0.178	0.158	0.104	0.147	6,571	33	236,782	42	226,470	-10,312
NK050	USGS WSP 1469	0.178	0.158	0.104	0.000	1,863	24	42,812	21	43,691	879
NK064	KDSA	0.126	0.126	0.126	0.126	753	133	15,823	137	15,497	-326
NK065	Page and LeBlanc 1969	0.104	0.104	0.104	0.104	1,981	116	37,815	123	36,433	-1,382
NK071	USGS WSP 1469	0.130	0.109	0.139	0.102	9	127	175	126	177	2
NK072	USGS WSP 1469	0.130	0.109	0.139	0.117	6,406	90	170,630	97	165,810	-4,820
NK073	USGS WSP 1469	0.138	0.134	0.134	0.142	9,589	55	323,029	68	305,824	-17,204
NK074	USGS WSP 1469	0.138	0.134	0.134	0.145	2,386	43	84,986	55	81,005	-3,981
						298,168		6,941,155		6,579,133	-362,022

Notes: 1) Specific Yield values zeroed and storage volume not calculated for areas below base of unconfined aquifer.

Total Change in Storage (AF) =	-362,022
Years in Range =	15
Average Change per Year (AF) =	-24,135
Average Change per Year (AF, Rounded 1,000s) =	-24,000

South Kings GSA											
SY Unit	SY Source	SY10to50	SY50to100	SY100to200	SY200to300	Acres	SPR 1997 DTW AVE	1997 GW STORAGE (AF)	SPR 2012 DTW AVE	2012 GW STORAGE (AF)	SPR 1997 to SPR 2012 Change (AF)
SK049	USGS WSP 1469	0.178	0.158	0.104	0.147	3,561	29	130,580	34	127,660	-2,920
SK074	USGS WSP 1469	0.138	0.134	0.134	0.145	1,603	39	57,940	49	55,747	-2,193
SK075	USGS WSP 1469	0.173	0.131	0.121	0.157	2,412	36	88,598	41	86,702	-1,896
SK076	USGS WSP 1469	0.127	0.138	0.094	0.134	48	47	1,455	45	1,465	10
SK091	USGS WSP 1469	0.156	0.137	0.141	0.148	2,245	32	86,530	40	83,768	-2,762
						9,870		365,104		355,343	-9,761

Notes: 1) Specific Yield values zeroed and storage volume not calculated for areas below base of unconfined aquifer.

Total Change in Storage (AF) =	-9,761
Years in Range =	15
Average Change per Year (AF) =	-651
Average Change per Year (AF, Rounded 1,000s) =	-1,000

Technical Memorandum 5
Estimation of Groundwater Flows at Boundaries

This Technical Memorandum (TM) summarizes the process used to estimate the groundwater flows at internal Kings Subbasin GSA boundaries and between the neighboring groundwater basins. The flow estimates are for the unconfined groundwater of the Kings Subbasin and for the spring of years 1925 and 1997 to 2012 with the exception of 2010 (hereafter 1997 to 2012). Groundwater Contours were not generated in 2010 due to a significant data gap in Central Kings that year. This TM does not evaluate the unconfined boundary flow between the Central and South Kings GSAs. Excluding the South and Central boundaries, there are 9 unique internal boundaries between Kings Subbasin GSAs as shown in Attachment 1. There are 12 external boundaries between Kings Subbasin GSAs and GSAs in the neighboring groundwater basins. The internal boundaries between the Kings Subbasin GSAs were split into 86 flow segments (segment numbers 0 to 85) where groundwater flows were estimated between the Kings Subbasin GSAs, Attachment 2. The external boundaries were split into 83 external flow segments (segment numbers 100 through 182) as shown in Attachment 2.

Groundwater flows across segments along the Kings and San Joaquin Rivers are, at this time, assumed to be zero, and while estimates of transmissivity and changes in aquifer thickness are provided for the flow segments along the rivers where data is available, these flows are assigned a zero value in the tabulated data.

Groundwater flow was estimated across these segments, excluding the flow segments along the rivers, for springs of 1925, and 1997 to 2012, as discussed below and shown in Attachment 3. The estimated flows by segment were then grouped by shared GSA boundaries and direction of flow. The tables showing the grouped data are included as Attachment 4. The estimated unconfined flows from spring 1925, and the average flows from 1997 to 2012 for Kings Subbasin GSAs with shared boundaries were summarized as shown in Table 1. Table 1 also provides summaries of estimated unconfined flows between the Kings Subbasin and the neighboring groundwater basins.

Flow Segments

The internal flow segments primarily follow the boundaries between the basin's GSAs and generally are aligned along GSA boundaries (Attachment 2). In a few areas where a boundary changes direction multiple times over a short distance, the flow segments were simplified by making a straight line across the boundary, e.g. segments 6, 23, 62, 63 are some of the simplified flow segments. Where the Kings River or the San Joaquin River are the boundary between GSA's (both internal and external), flow segments were assigned based on reaches of the river that generally trend in the same direction. Transmissivity values were estimated for the segments. Changes in estimated transmissivity were used to refine the boundaries into the 86 internal flow segments and KDSA provided estimates of transmissivity along the external flow segments. See Attachment 2 for the groundwater contour maps, and Attachment 3 for the tabulated data.

Groundwater Flow

Darcy's law

Darcy's Law is commonly used to calculate groundwater flows. For lateral groundwater flows, the equation used is:

$$Q = TIL$$

where: $Q\ is$ groundwater flow in gallons per day (gpd)

T: transmissivity in gallons per day/foot (gpd per foot)
I: hydraulic gradient (feet per mile)
L: width of flow (miles).

Transmissivity is a factor indicating the ability of the aquifer to transmit groundwater flow laterally. It is equal to the thickness of water-producing strata multiplied by the hydraulic conductivity of these strata. Transmissivity is best determined from the results of aquifer tests but is also commonly estimated from specific capacity (pumping rate divided by drawdown) values. Both the hydraulic gradient, or water-level slope, and the width of flow are best determined from detailed (i.e. 10-foot or less contour interval) water-level elevation maps.

In estimating groundwater flow the following simplifying assumptions were made:

- Spring water levels represent the most static water level conditions and are the best levels to use to estimate groundwater flows,
- The aquifer is relatively homogenous and isotropic

The following discusses the components of Darcy's Law and describes the methods and data sources used to estimate the flow equation components in the Kings Subbasin and along the Subbasin boundaries. It is important to note that groundwater flow estimates under this effort are only being done for the unconfined groundwater and for the springs of 1925, and 1997 to 2012. The base of the unconfined aquifer was developed in TM 1. Groundwater flow was estimated across the flow segments and then the flows across the segments were grouped to develop estimated groundwater flows between the Kings Subbasin GSAs and between the Kings Subbasin GSAs and GSAs in the neighboring groundwater basins.

Transmissivity Estimates (T)

Both drawdown and recovery water-level measurements are normally made for aquifer tests. Pumping rates and pumpage are normally measured with a totalizing flowmeter. The aquifer tests for large capacity wells tapping alluvial deposits commonly comprise pumping at a constant rate (constant discharge test) for periods ranging from about 8 to 24 hours. Drawdown and recovery water-level measurements are commonly plotted on a semi-logarithmic scale (depth to water on an arithmetic scale versus time on a log scale). For tests where the pumping level doesn't stabilize, a corrected recovery plot is prepared. Such aquifer tests are commonly done on new wells, to help design the optimum pump for the well. Drawdown measurements are affected by well losses, and thus recovery plots are normally given more weight in determining the transmissivity.

Transmissivity values are available for dozens of tests on wells tapping the shallow unconfined groundwater and for dozens of other tests on wells tapping the deeper confined groundwater.

Transmissivity values derived from aquifer tests in much of the Kings Basin range from as low as about 10,000 gpd per foot to as high as about 300,000 gpd per foot.

Specific Capacity

In the absence of aquifer test results, the specific capacities can be used to estimate transmissivities. Specific capacity is the pumping rate divided by the drawdown. Davis, Lofgren, and Mack (1964) in U.S. Geological Survey Water-Supply Paper 1618 (WSP 1618) provided specific capacity values by township and range for much of the San Joaquin Valley, including the Kings Subbasin. These values were collected during 1955-56, and were presented in Table 3 of that paper. An important factor is that as of that time, most of the wells that were evaluated in the Kings Subbasin had been drilled by the cable-tool method and tapped the shallow unconfined groundwater. Most of these were open-bottom wells, consisting of a blank (non-perforated) steel well casing, with a large open hole below the bottom of the casing. Such wells were highly efficient, meaning the well losses were small or insignificant. Well losses are primarily due to turbulent flow as the groundwater nears the perforations in a well, and possibly within the gravel pack, for gravel packed wells. Most large capacity wells drilled since 1965 in the Kings Subbasin were drilled by the reverse rotary method and have perforated casings and gravel packs. Such wells usually have significant well losses, which reduces the specific capacities compared to the transmissivities.

Thomasson et al. (1960) developed conversion factors between specific capacity and transmissivity in U.S. Geological Survey Water-Supply Paper 1464. A conversion factor of 1,500 has commonly been used to multiply times the specific capacity to estimate the transmissivity for unconfined aquifers in the San Joaquin Valley. A value of 2,000 is commonly used for confined aquifers in the valley. Specific capacities in Table 3 in WSP 1618 for townships in the Kings Subbasin usually ranged from about 40 to 90 gpm per foot. Using a conversion factor of 1,500, this would indicate a range in transmissivity from about 60,000 to 135,000 gpd per foot. Lower specific capacities (10 to 30 gpm per foot) are common in the eastern part of the Kings Basin in the interfan area. Some of the highest specific capacities for wells tapping the shallow unconfined groundwater in the Kings Basin were in the north part of the Fresno Urban Area. Carollo Engineers and Harshbarger and Associates (1969) indicated specific capacities exceeding 100 gpm per foot over a large area within several miles of the San Joaquin River. They determined transmissivities from two aquifer tests in northwest Fresno and by converting specific capacity values for wells elsewhere in Fresno. Transmissivities in the Fresno Urban Area as of 1969 ranged from 60,000 gpd per foot in part of the area southwest of Highway 99 to 300,000 gpd per foot near the San Joaquin River. The higher values aren't indicated by specific capacity values averaged over whole townships, because they generally are found only in part of a particular township.

The internal estimated flows presented in Attachment 3 are based primarily on transmissivities estimated from specific capacity values in WSP 1618 with some refinements where KDSA had aquifer test results (shown in italicized text) or additional data was provided (also italicized). KDSA provided estimates of transmissivity for the majority of the external flow segments (also italicized). Pump tests were provided by the following entities; Fresno Irrigation District, James Irrigation District, Kings River Conservation District, Fowler Packing, City of Kingsburg, City of Fowler, City of Fresno, and the City of Sanger. These data were used to refine estimates of transmissivity. The resultant recommended transmissivity values incorporate estimates of transmissivity from the more recent pump test data, pump tests data from KDSA, and the data from USGS 1618.

Transmissivity Adjustments for Aquifer Thickness Changes

As mentioned above, transmissivity is equal to the thickness of water-producing strata multiplied by the hydraulic conductivity of these strata, therefore the estimates of transmissivity were adjusted for changing aquifer thickness over time. The general approach was to assume that the spring 1925 water level map is a reasonable representation of the pre-development saturated thickness of the Kings Subbasin aquifer. The difference between the base of unconfined groundwater and the water level contours was assumed to represent the thickness of the unconfined aquifer for a given year or set of years. Estimates of transmissivity from the various sources were adjusted as follows;

- WSP 1618 – the spring 1962 Department of Water Resources (DWR), Lines of Equal Elevation of Water in Wells, was assumed to reasonably represent aquifer thickness from when WSP 1618 was published in 1964. Therefore, the aquifer thickness from 1962 was used to decrease the WSP 1618 estimated transmissivity values for use in the spring 1997 to spring 2012 flow calculations. The percent change from 1962 to the 1997-2012 time period was based on the average of the 1962 to 1999 percent change and the 1962 to 2011 percent change. Conversely, the WSP 1618 estimated transmissivities were adjusted up, i.e., the aquifer was thicker, for the 1925 flow calculations.
- Recent Estimates of Transmissivity – Both KDSA estimated transmissivities and estimates from supplied pump test data are thought to be reasonable estimates for use in the spring 1997 to spring 2012 flow calculations as this is more recent data. However, these estimates of transmissivity were increased for the 1925 flow calculations by an amount commensurate with the average percent thickness change from 1925 to 1999 and 1925 to 2011.

Hydraulic Gradient (I)

The hydraulic gradient or water-level slope (slope) at each segment was estimated from groundwater elevation surfaces and flow lines showing the direction of groundwater flow for the years discussed in TM4. ArcGIS provided an average slope across each flow segment using the continuous groundwater elevation surfaces which has a 200 by 200-foot grid cell size. ArcGIS was also used to determine the direction of flow, which is used to estimate the flow segment length (L) perpendicular to flow direction, as discussed below.

Flow Segment Length (L)

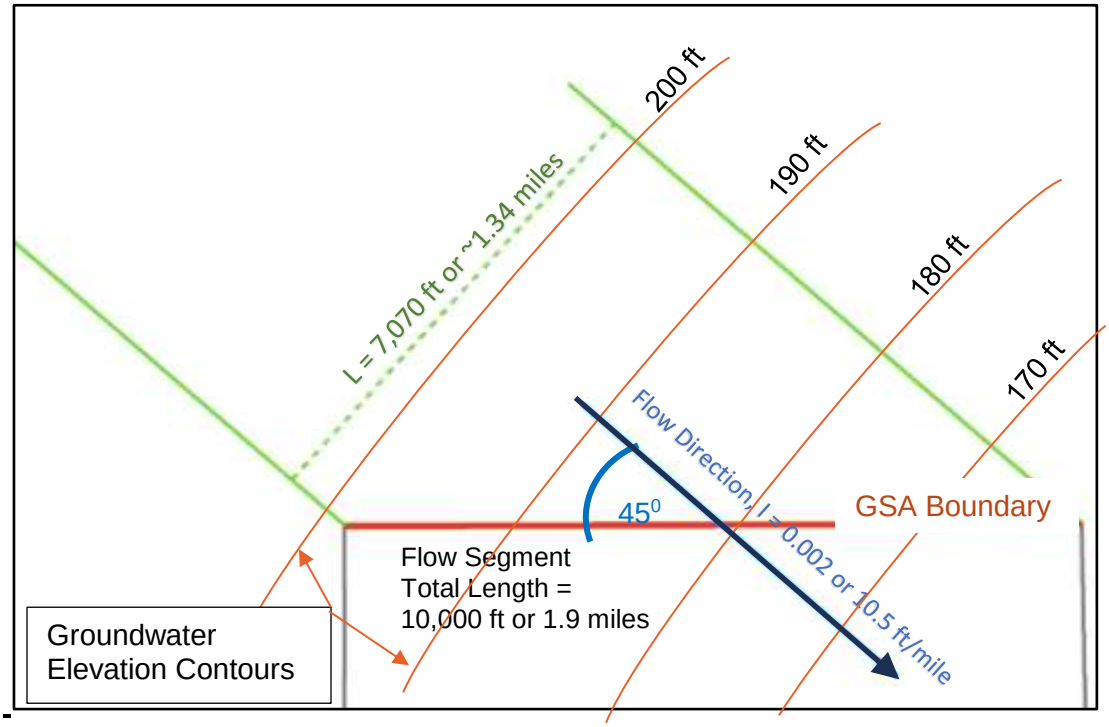
Groundwater flows are calculated in the direction of maximum water slope (perpendicular to water-level contours). With very few exceptions, if any, the direction of groundwater flow was not perpendicular to the flow segment. Therefore, the length of the flow segment perpendicular to maximum slope was calculated based on the angle between the flow segment and the direction of maximum slope. For example, assume a 10,000-foot-long flow segment that is oriented east to west, and a maximum slope direction across it to the southeast. This results in a 45-degree (45^o) angle between the orientation of the flow segment and the maximum slope direction. An example of how the resultant length (L) perpendicular to flow is calculated is as follows:

Flow segment length perpendicular to flow (L) = sine 45^o X Flow Segment Length (10,000 feet)
Therefore,

L = 0.707 X 10,000 feet = **7,070 feet**.

Method of Flow Calculation

Figure 1, below, illustrates the visual components of groundwater flow for a hypothetical scenario in which flow is at a 45° angle to the flow segment, the gradient is 0.002 or 10.5 feet per mile, and the total length of the flow segment is 10,000 feet or about 1.9 miles. This example calculation uses a transmissivity value of 80,000 gpd/ft.



As discussed and shown above the length perpendicular to flow in this scenario is 7,070 feet. Therefore, the annual groundwater flow (Q) using Darcy's Law would be calculated as follows

Q = TIL

Where Q is the estimated annual flow across the flow segment,

Transmissivity (T) = 80,000 gpd/ft

Hydraulic Gradient (I) = 0.002 or 10.5 ft/mile,

Flow Segment Length (L) = 7,070 ft or 1.34 miles.

Therefore,

Q = 80,000 gpd/ft X 10.5 ft/mile X 1.34 miles, which equals about 1,125,600 gallons per day (gpd). This value is then converted to acre-feet per year (AF/year) using the following conversion

1,125,600 gallons/day X 365 days/year = **1,260 AF/year**.

325,851 gallons/acre-foot

While this is a hypothetical example, the values used, and the resulting estimated flow are within the ranges of flow listed in Attachment 3. The first column in Attachment 3 list the GSA from which flow originates and the second column is the GSA receiving the flow. Attachment 4 groups the data by flows across boundaries, and Table 1, below, provides the net estimated flow between Kings Subbasin GSAs and between the Kings Subbasin and the neighboring basins.

Years Analyzed

Boundary flow estimates were done for the following years based on the spring groundwater elevation contours;

- 1997 to 2012 because these are the years in the hydrologic base period developed in TM 3-hydrologic period and used in TM 4-storage change.
- 1925 because historical flow was credited to the GSA receiving that flow between the Kings Subbasin GSAs.

Groundwater elevation contour maps from spring data are available for years 1925 and 1997 to 2011 as developed in TM 4. The groundwater elevation contours and the wells used in a given year's groundwater contours are shown on the maps along with flow segments, Attachment 2.

Data Gaps

In addition to the lack of estimated groundwater contours in 2010, data gaps are mainly from the lack of complete groundwater contour coverage on the 1925 Department of Public Works and 1962 DWR maps (both years maps referred to as DWR). The main impact of the data gaps on the 1925 and 1962 DWR maps is that flows could not be estimated along these segments in 1925 nor could transmissivity values be adjusted for changes in aquifer thickness. On the 1925 DWR map, groundwater contours do not extend to the San Joaquin River as well they do not cover the area, with a few exceptions, on the west side of the Subbasin. In addition, the contours do not cover a few segments along the Kings and San Joaquin Rivers near the foothills. As flows are estimated to be zero along the rivers, this does not appear to affect the estimated flows between the Kings Subbasin and the Madera Subbasin on the north. The lack of coverage along the west side of the basin did not allow for complete estimate of flows in 1925 there, however unconfined water level slopes at that time in that part of the valley were probably fairly flat and flows to or from the Kings Subbasin in the west were likely small. It should be noted that the main reason for estimating flows in 1925 was to give credit to the internal GSAs for historical flows, as discussed in TM 4. There is a lack of coverage on the 1962 DWR map mainly on the southwest part of the Subbasin and along the upper reaches of the Kings and San Joaquin Rivers. Estimates of flows from 1962 are not included here therefore the main impact to the data was lack of coverage to completely estimate changes in aquifer thickness. There is also a data gap in the area south and east of Helm in 1997. Contour maps from DWR around this time and the maps prepared for this effort were reviewed to provide reasonable estimates of groundwater contours in this area around this time. The resultant contours appear to be representative of groundwater conditions in this area in spring 1997. In general, groundwater level data was relatively sparse in JID GSA for most years and in the Laguna area until 2011.

Results

Table 1, below, shows the estimated net internal and external unconfined groundwater flows, based on available data, for Kings Subbasin GSAs for 1925 and the average from 1997 to 2012.

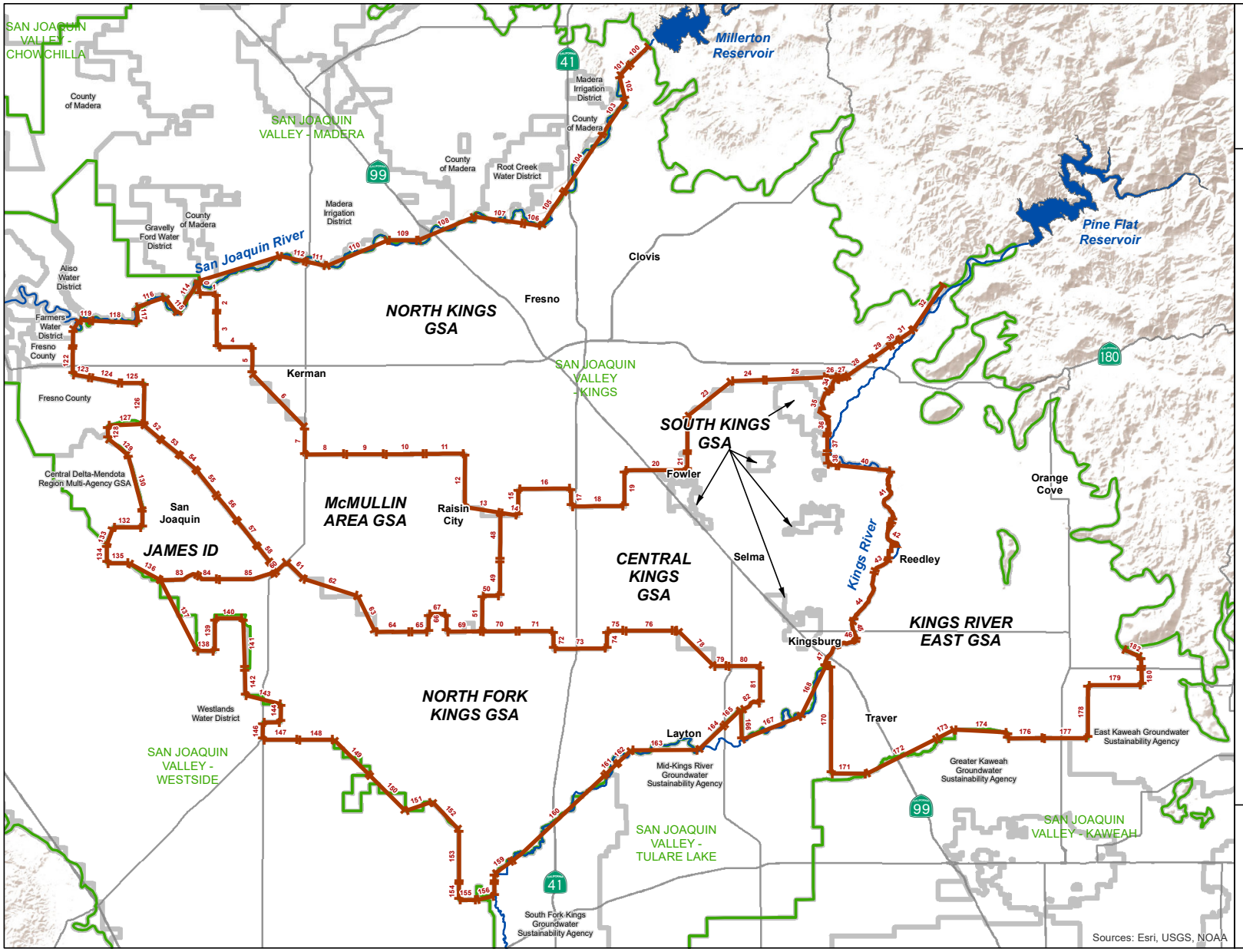
As well, Table 1 has estimates of internal and external flows between the Kings Subbasin and the neighboring basins for 1925 and the average from 1997 to 2012. Flows between South Kings GSA and Central Kings GSA were not estimated as work under this contract is being done for the six initial GSAs. The flow estimates below, and the estimated flows by segment (Attachment 3) and by groups (Attachment 4), are likely within about +- 30%. It is important to note that flows in the deeper confined groundwater are not included in the net flows below. Estimates of the deep groundwater flows, were data is available, are being prepared as a separate TM.

Table 1 - Kings Subbasin, Estimated Net Flows for Kings Subbasin GSAs and between the Kings Subbasin and neighboring basins.

GSA	Average Internal (Kings GSAs to Kings GSAs) Boundary Flows Spring 1997 to Spring 2012 (AF)	[1/]Average External (Kings Subbasin to Neighboring Basins) Boundary Flows Spring 1997 to Spring 2012 (AF)	Average Internal (Kings GSAs to Kings GSAs) Boundary Flows Spring 1925 (AF)	[1/]Average External (Kings Subbasin to Neighboring Basins) Boundary Flows Spring 1925 (AF)
Central/South	-20,400	400	-10,500	-600
James	-19,200	7,700	2,500	0
Kings River East	0	-2,100	0	0
McMullin	91,700	6,300	16,600	-300
North Fork Kings	14,900	1,400	13,600	500
North Kings	-67,000	0	-22,200	0
[1/] - External Flow Estimates are draft as of 10-24-19				

Attachment 1

Kings Subbasin and Boundary Flow Segments



Kings Subbasin Coordinated Effort

Kings Coordinated Effort GSAs

Boundary Flow Segments

Legend

- Groundwater Subbasins (DWR 2017)
- GSA
- Boundary Flow Segment (Segment ID)

KDSA Est. 1972

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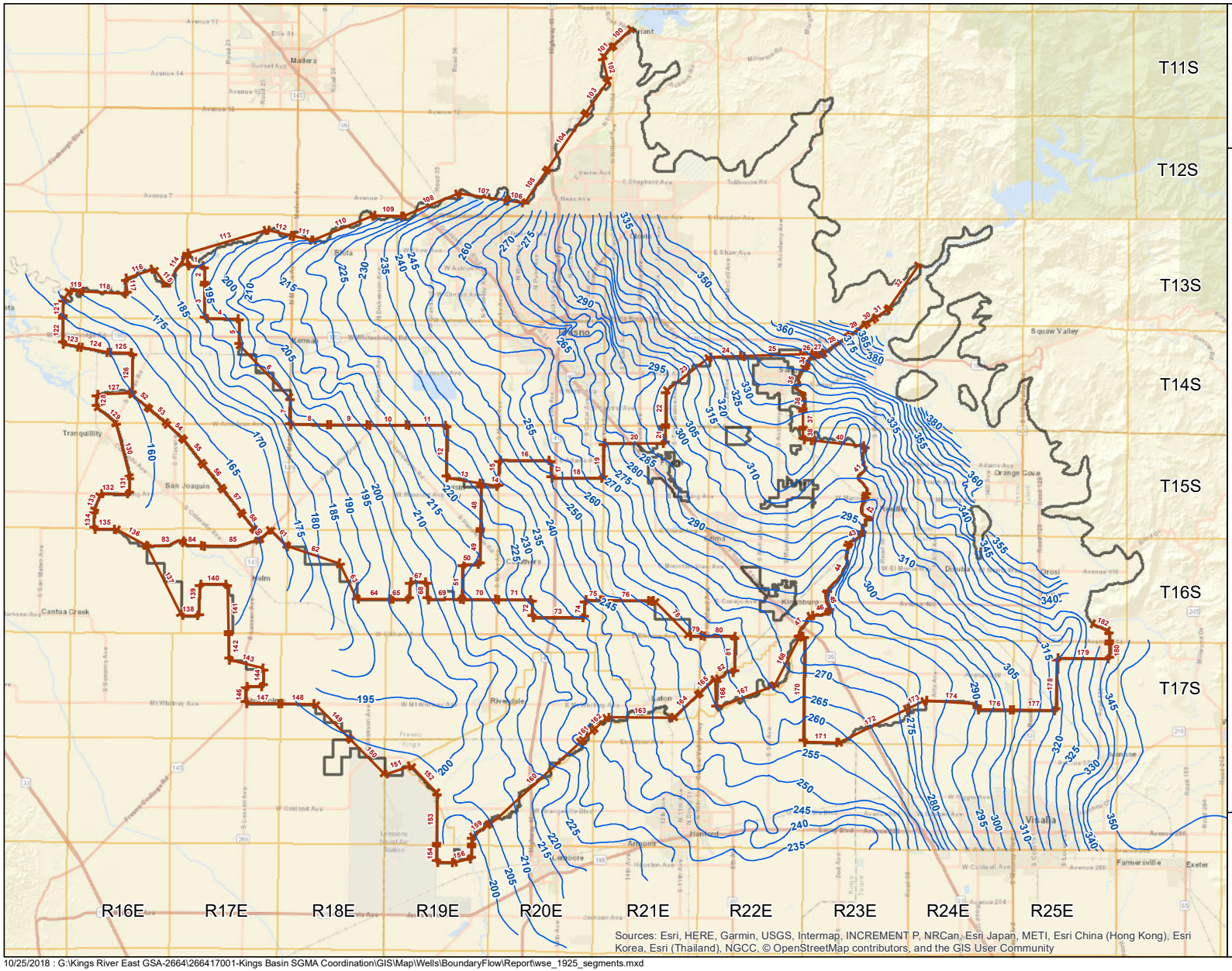
Attachment 2

Groundwater Elevation Contour Maps
(With Flow Segments)



Kings Subbasin
Coordinated Effort

Kings Coordinated Effort GSAs

Fall 1925
Groundwater Elevation Contours

Legend

- Kings Subbasin GSAs
- Township/Range
- Boundary Flow Segment (Segment ID)

Water Level Contours*

- Line of Equal Elevation (10ft interval)

**State of California Department of Public Works, Divisions of Engineering and Irrigation and of Water Rights*

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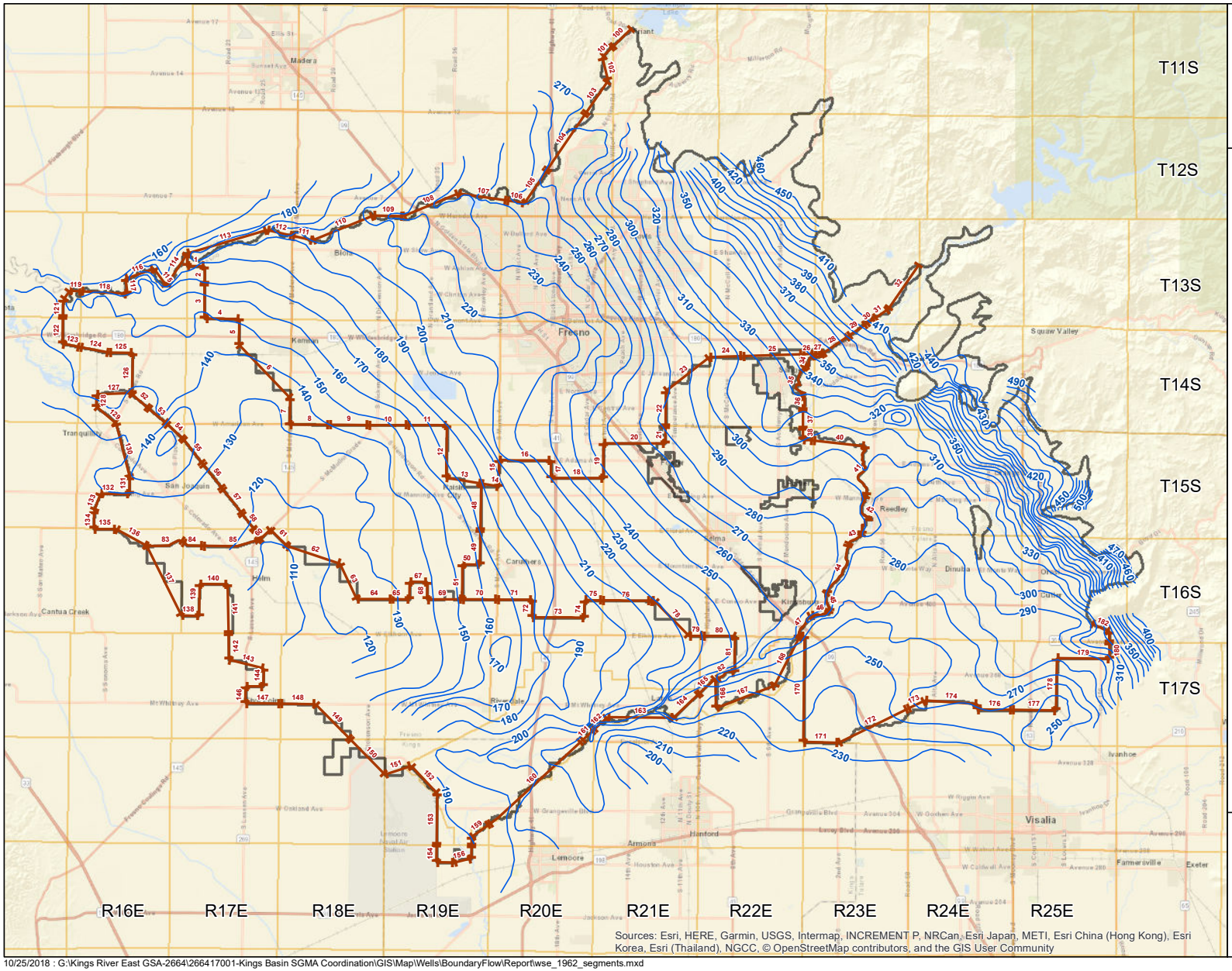

Kings Subbasin
Coordinated Effort

Kings Coordinated Effort GSAs

Spring 1962
Groundwater Elevation Contours

Legend

- Kings Subbasin GSAs
- Township/Range
- Boundary Flow Segment (Segment ID)

Water Level Contours*

- Line of Equal Elevation (10ft interval)

**California Department of Water Resources, Lines of Equal Elevation of Water in Wells, San Joaquin Valley*

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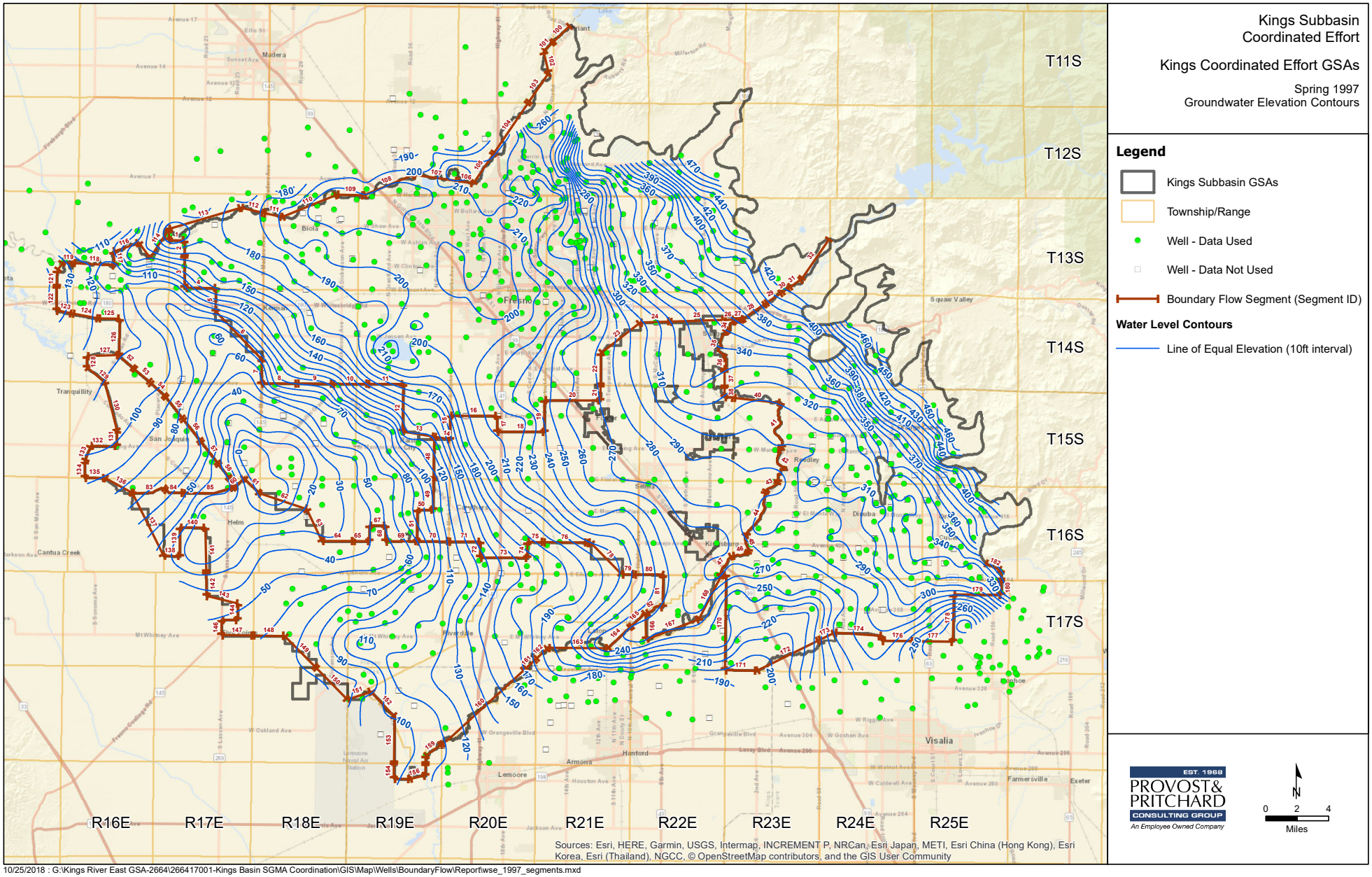

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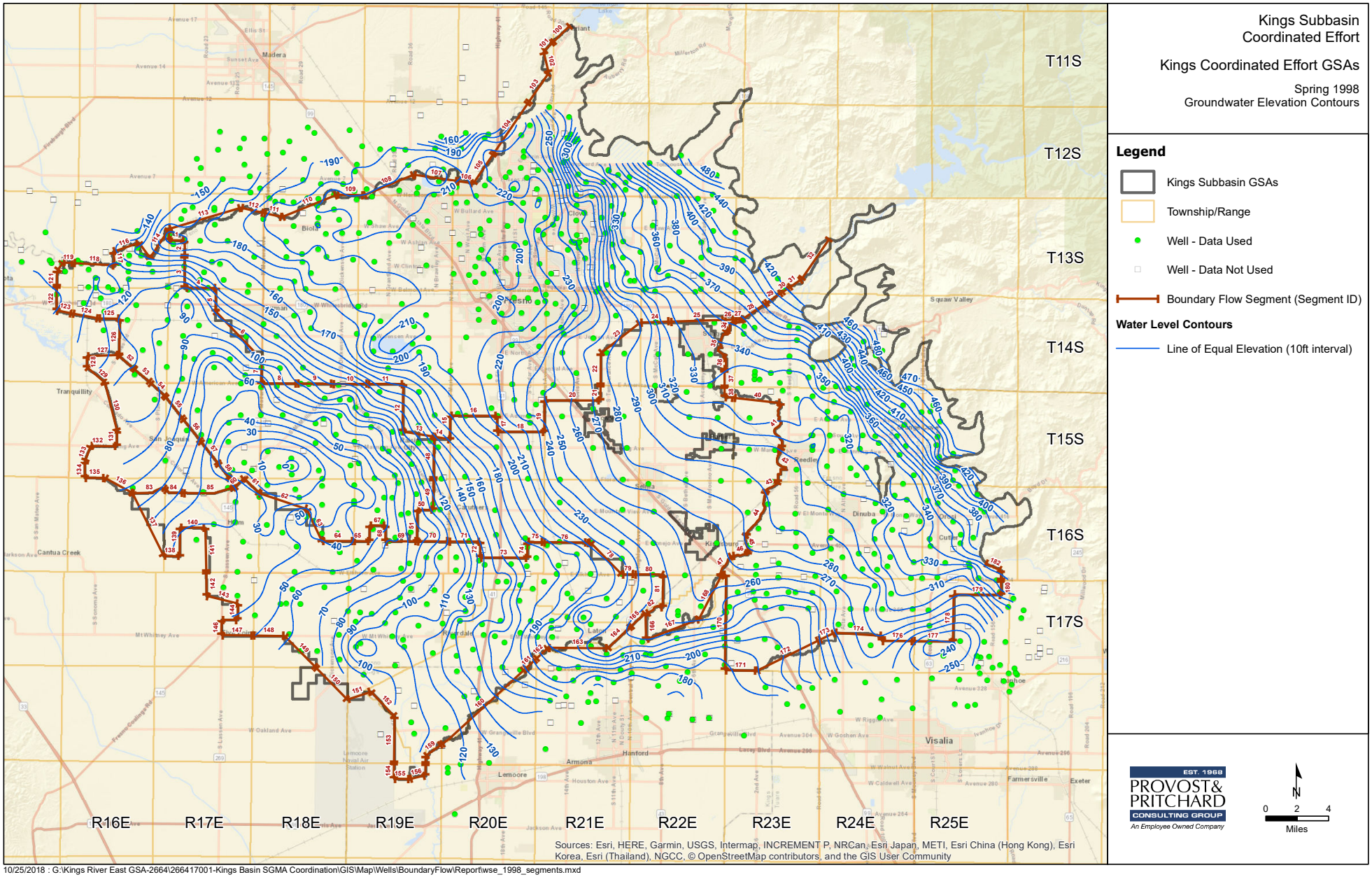

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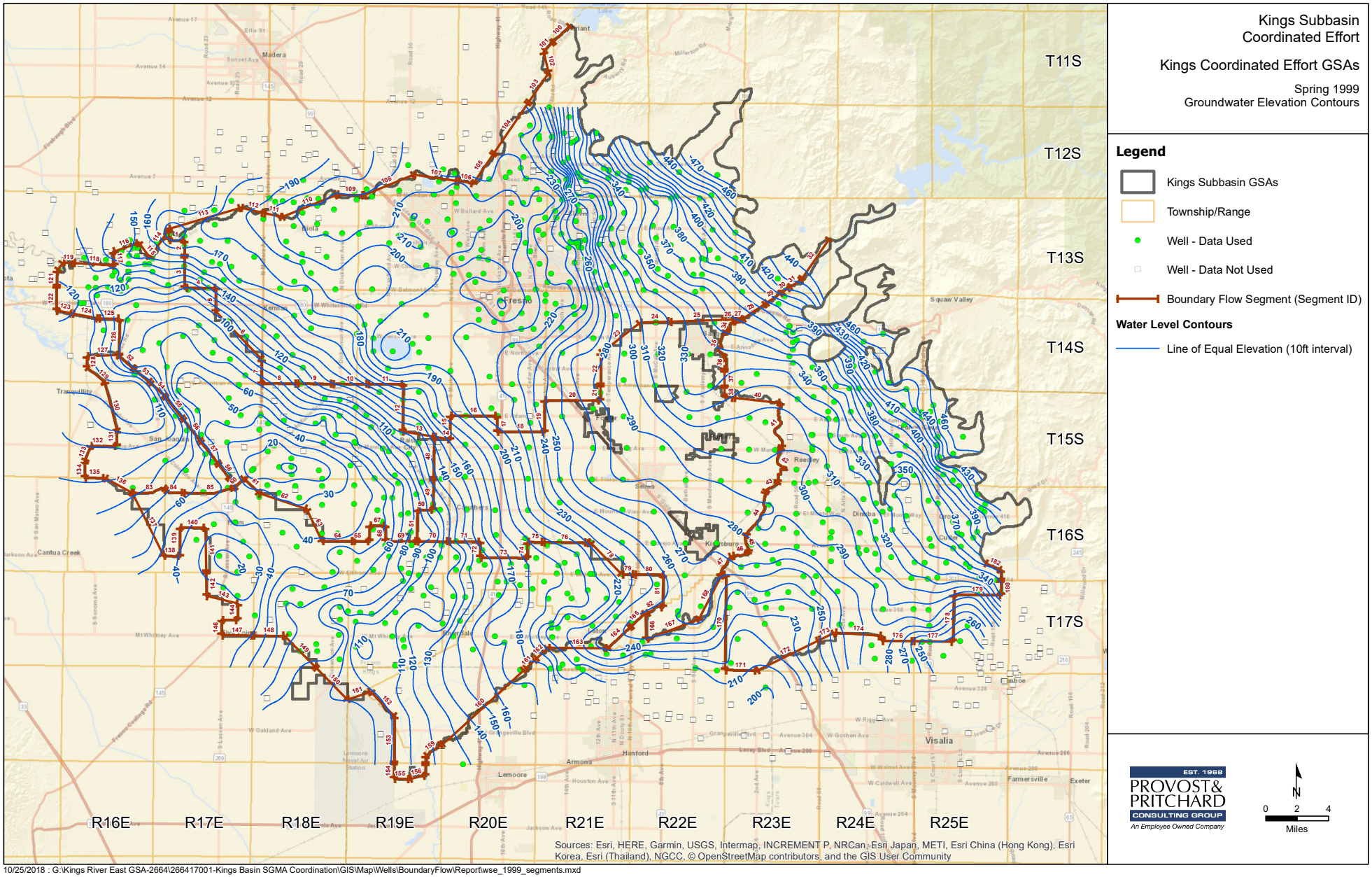

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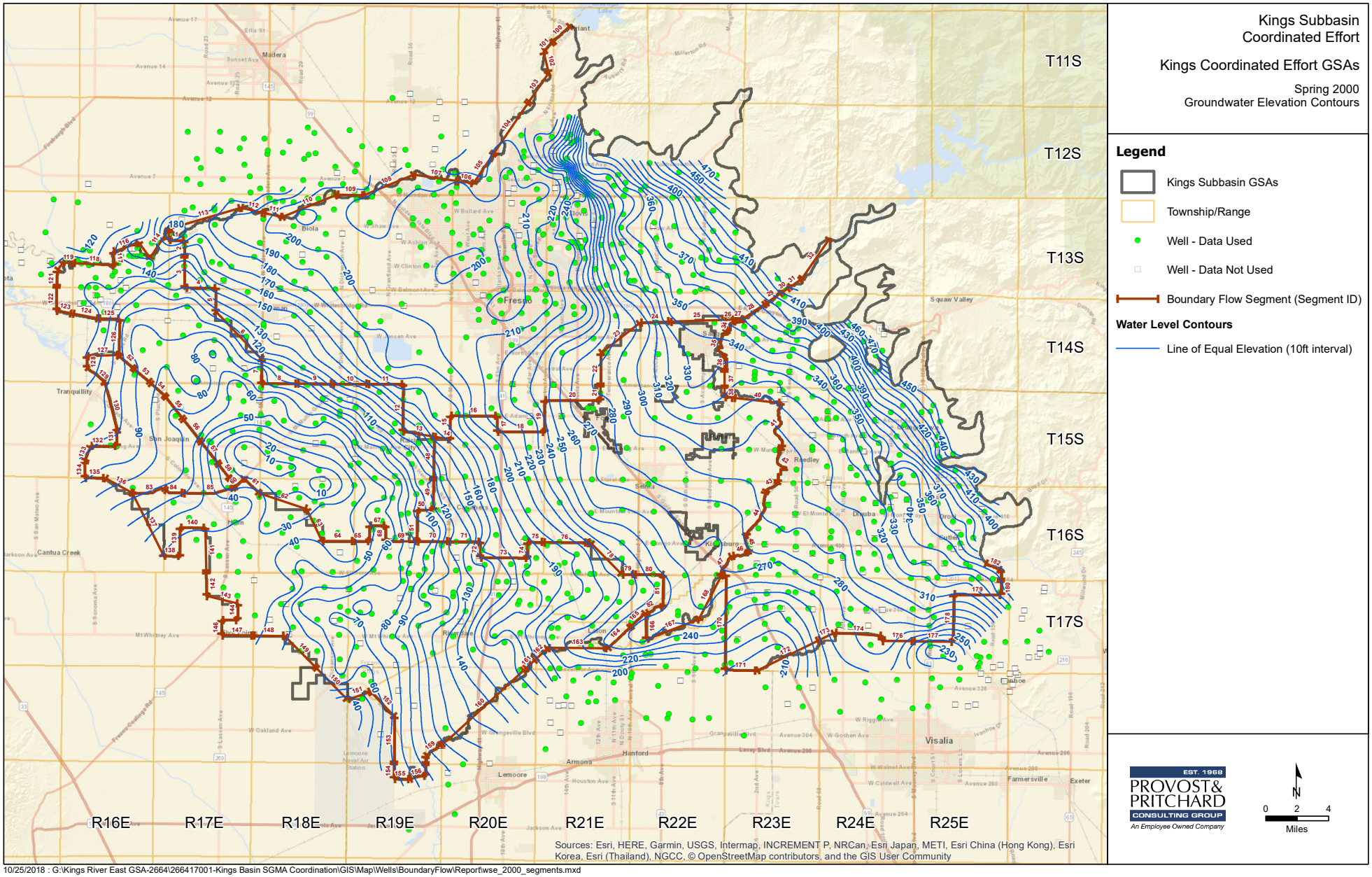

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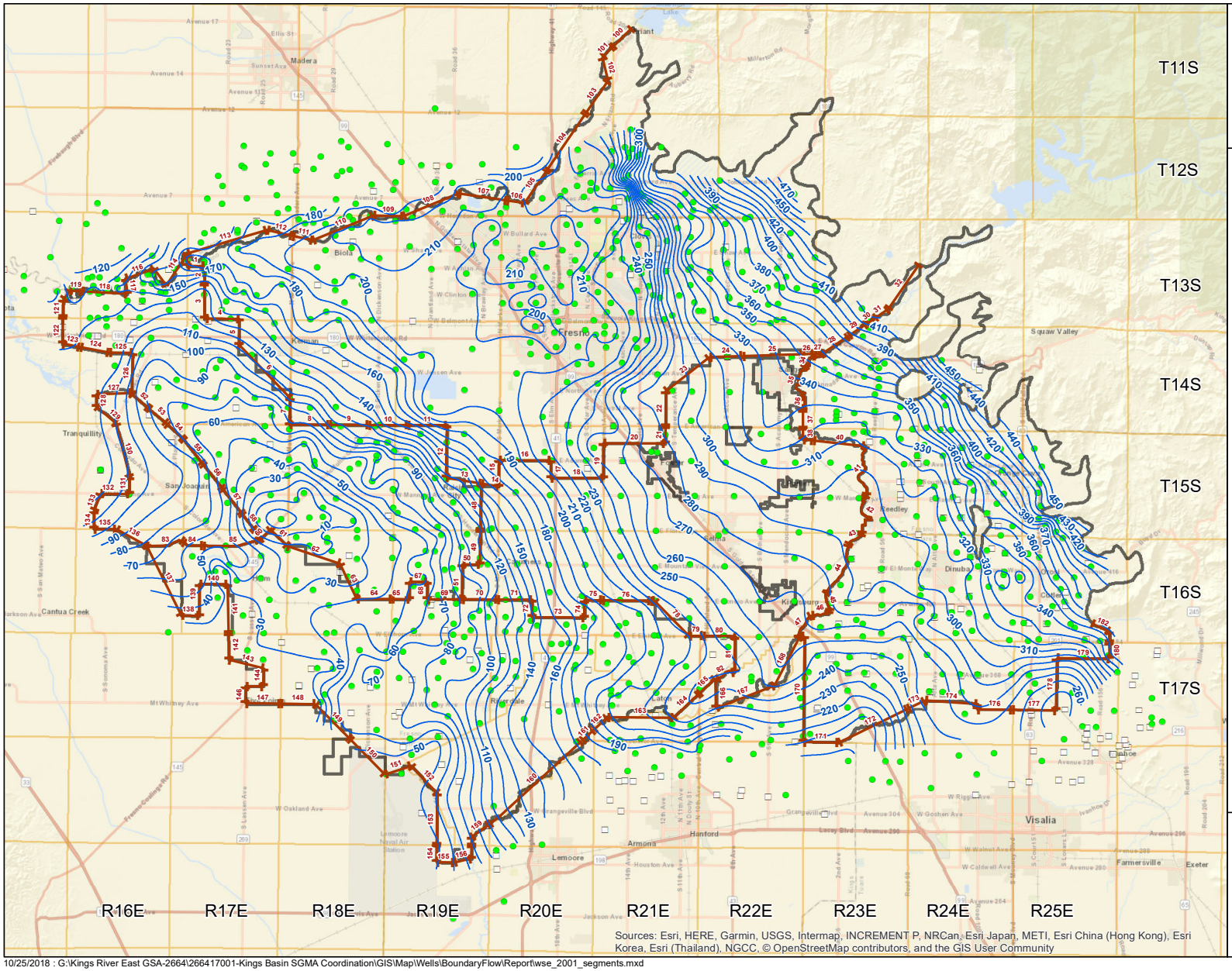

Kings Subbasin
Coordinated Effort

Kings Coordinated Effort GSAs

Spring 2001
Groundwater Elevation Contours

Legend

- Kings Subbasin GSAs
- Township/Range
- Well - Data Used
- Well - Data Not Used
- Boundary Flow Segment (Segment ID)

Water Level Contours

- Line of Equal Elevation (10ft interval)

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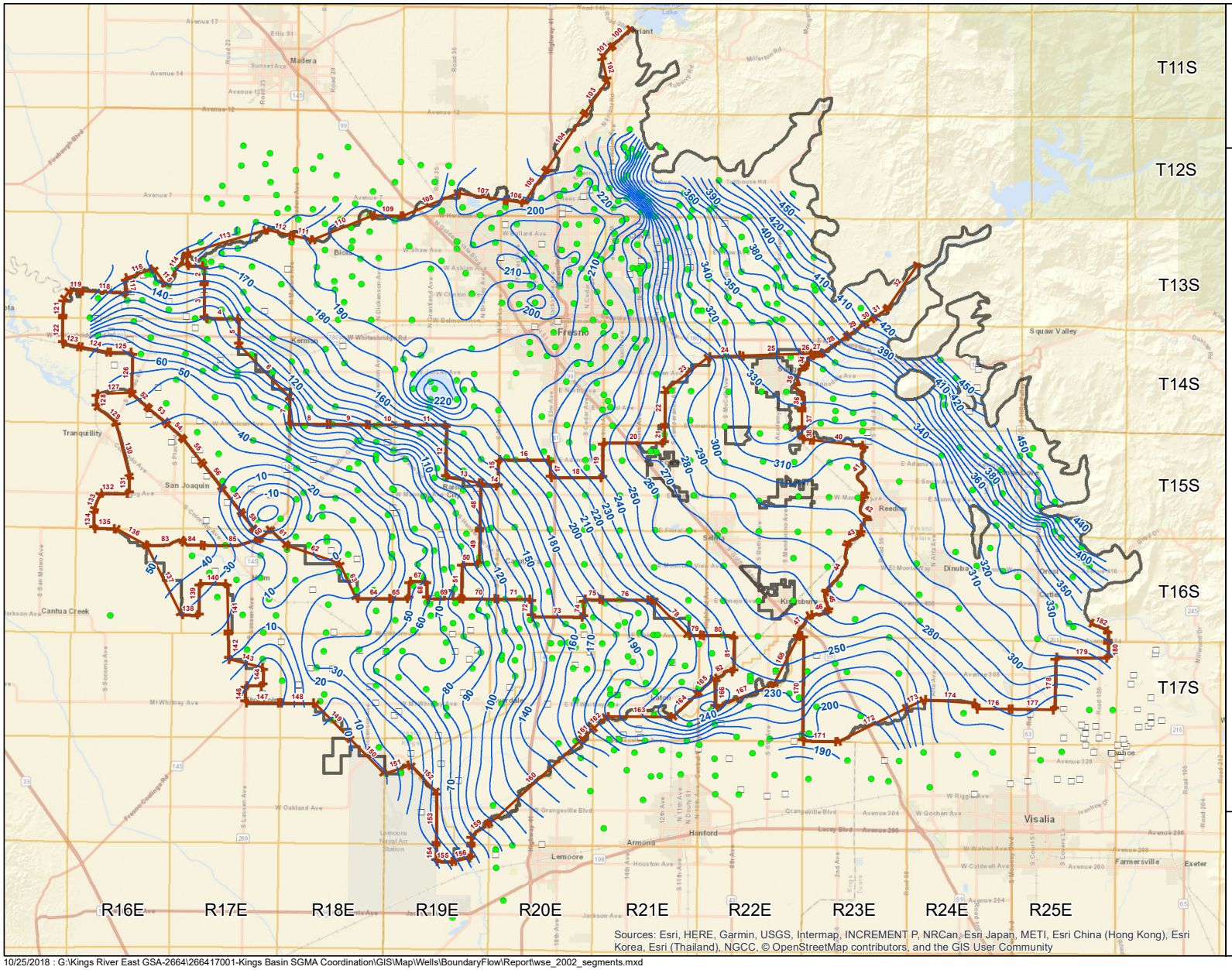

Kings Subbasin
Coordinated Effort

Kings Coordinated Effort GSAs

Spring 2002
Groundwater Elevation Contours

Legend

- Kings Subbasin GSAs
- Township/Range
- Well - Data Used
- Well - Data Not Used
- Boundary Flow Segment (Segment ID)

Water Level Contours

- Line of Equal Elevation (10ft interval)

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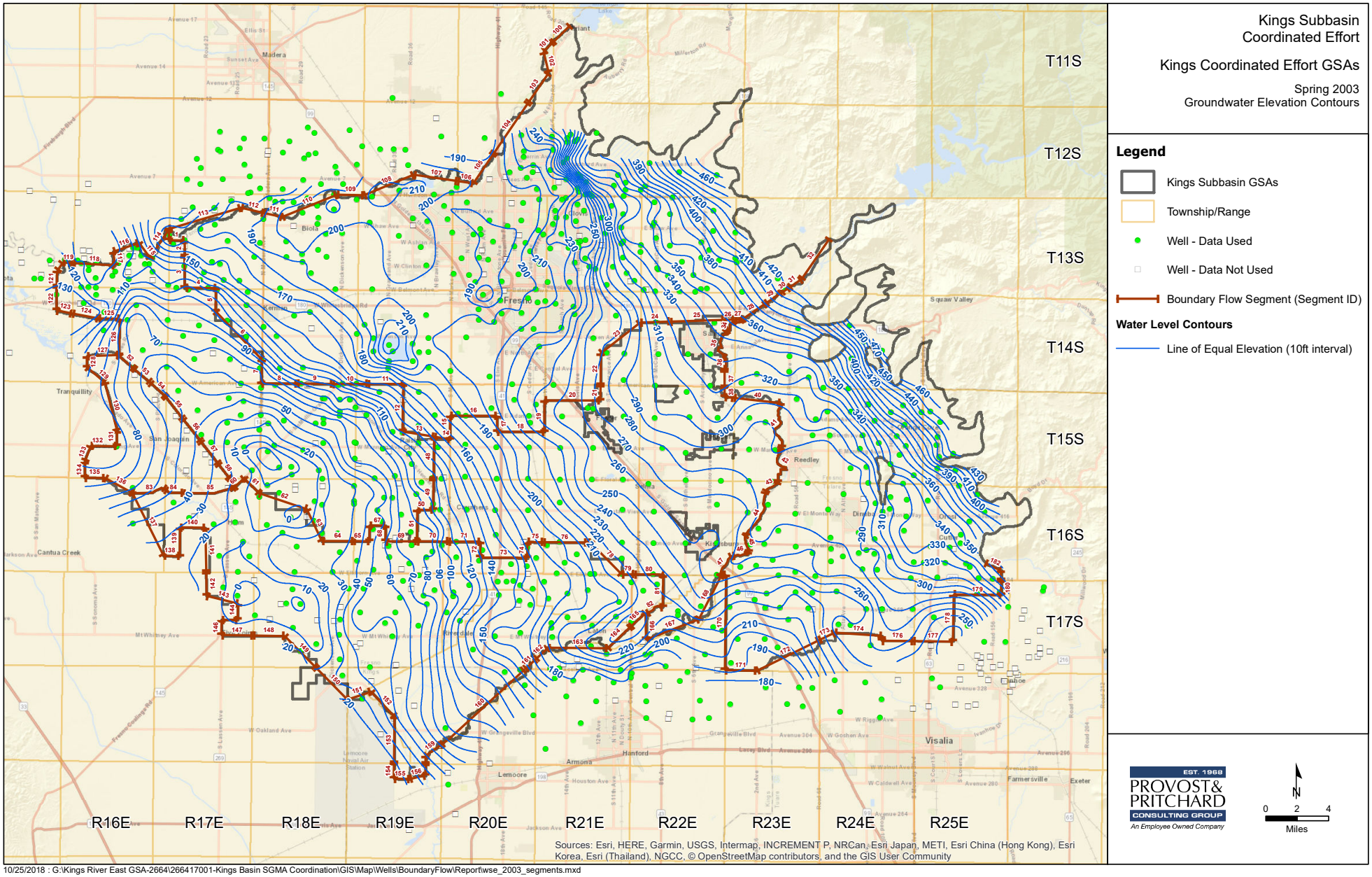

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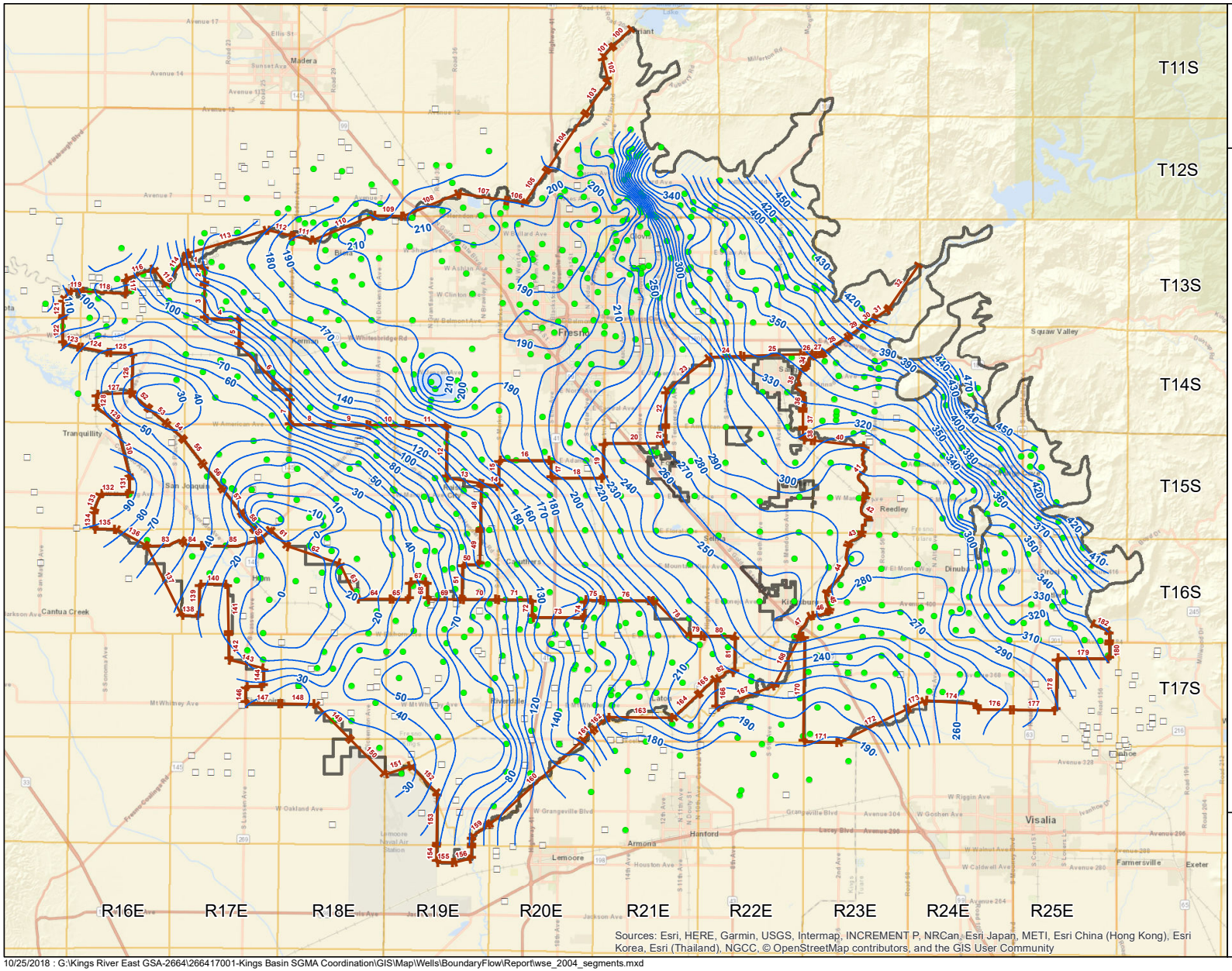

Kings Subbasin
Coordinated Effort

Kings Coordinated Effort GSAs

Spring 2004
Groundwater Elevation Contours

Legend

- Kings Subbasin GSAs
- Township/Range
- Well - Data Used
- Well - Data Not Used
- Boundary Flow Segment (Segment ID)

Water Level Contours

- Line of Equal Elevation (10ft interval)

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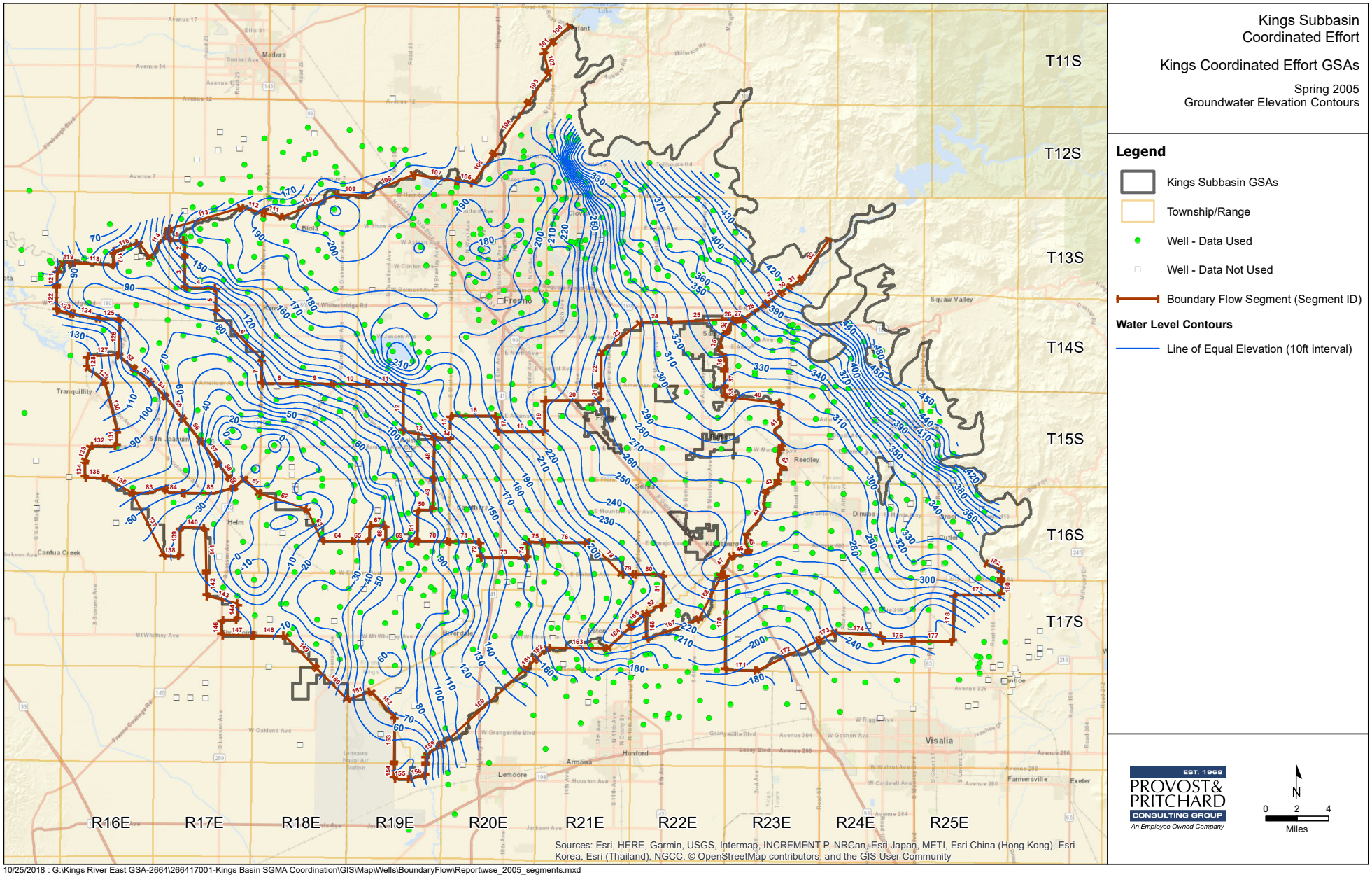

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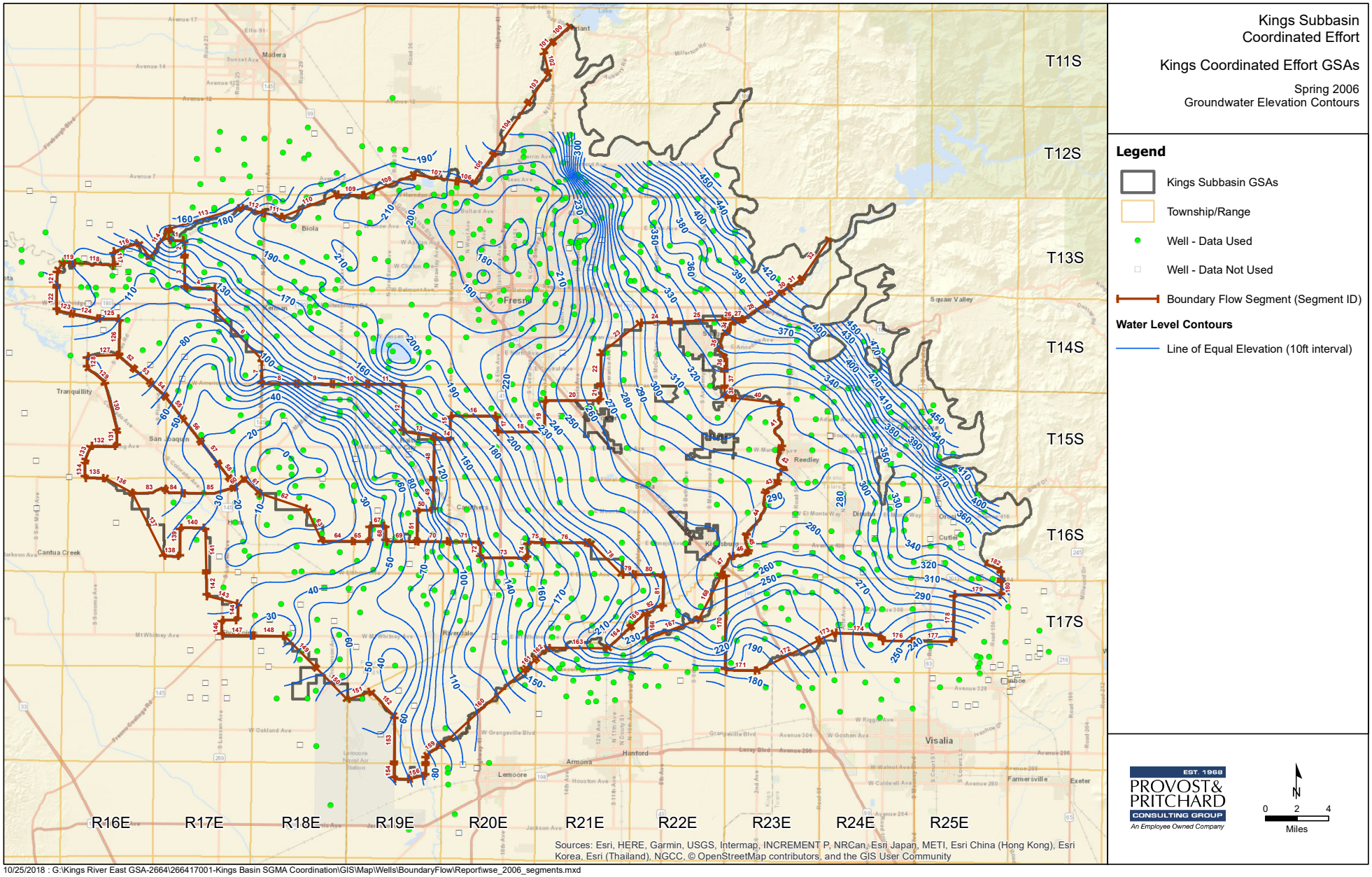

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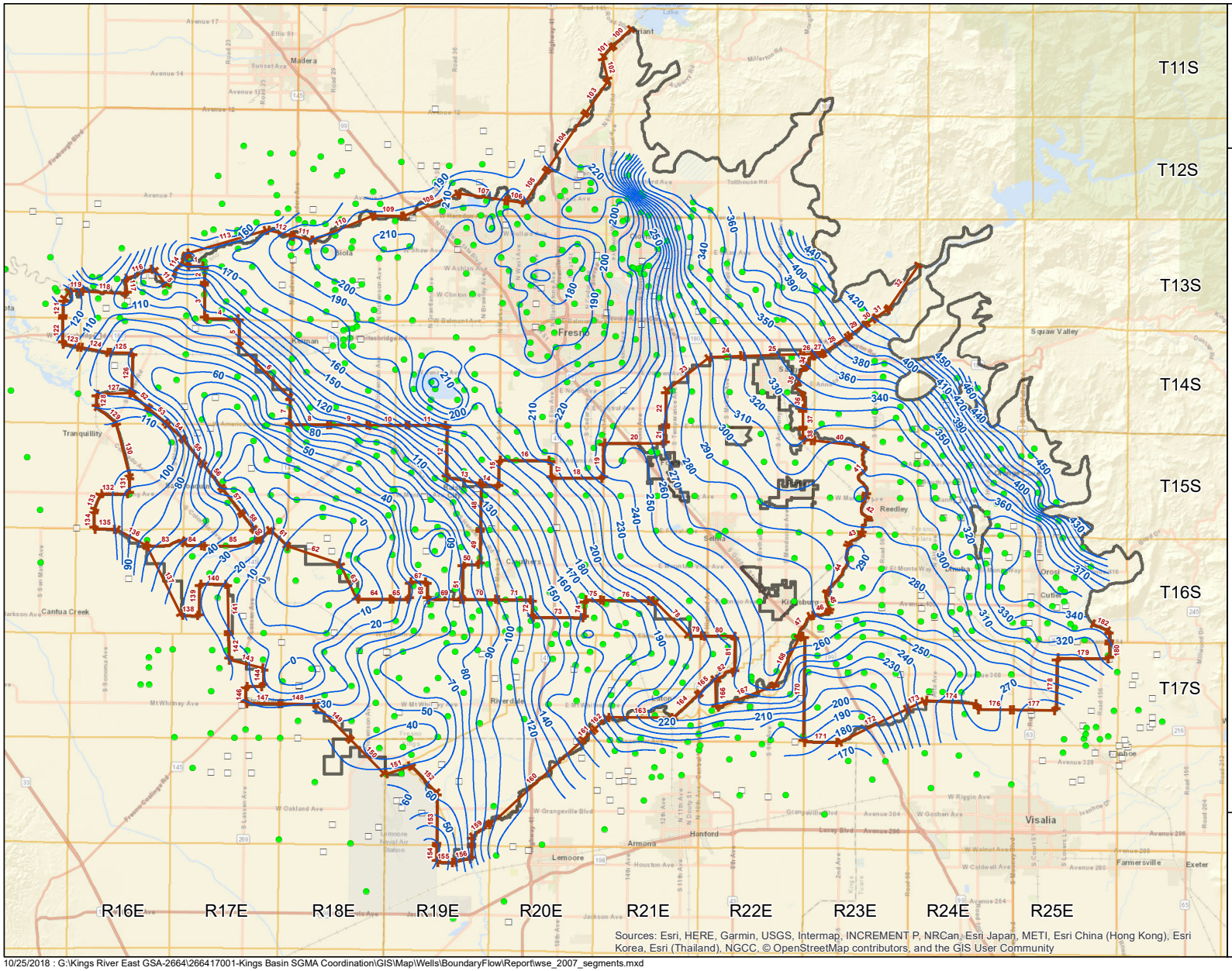

Kings Subbasin
Coordinated Effort

Kings Coordinated Effort GSAs

Spring 2007
Groundwater Elevation Contours

Legend

- Kings Subbasin GSAs
- Township/Range
- Well - Data Used
- Well - Data Not Used
- Boundary Flow Segment (Segment ID)

Water Level Contours

- Line of Equal Elevation (10ft interval)

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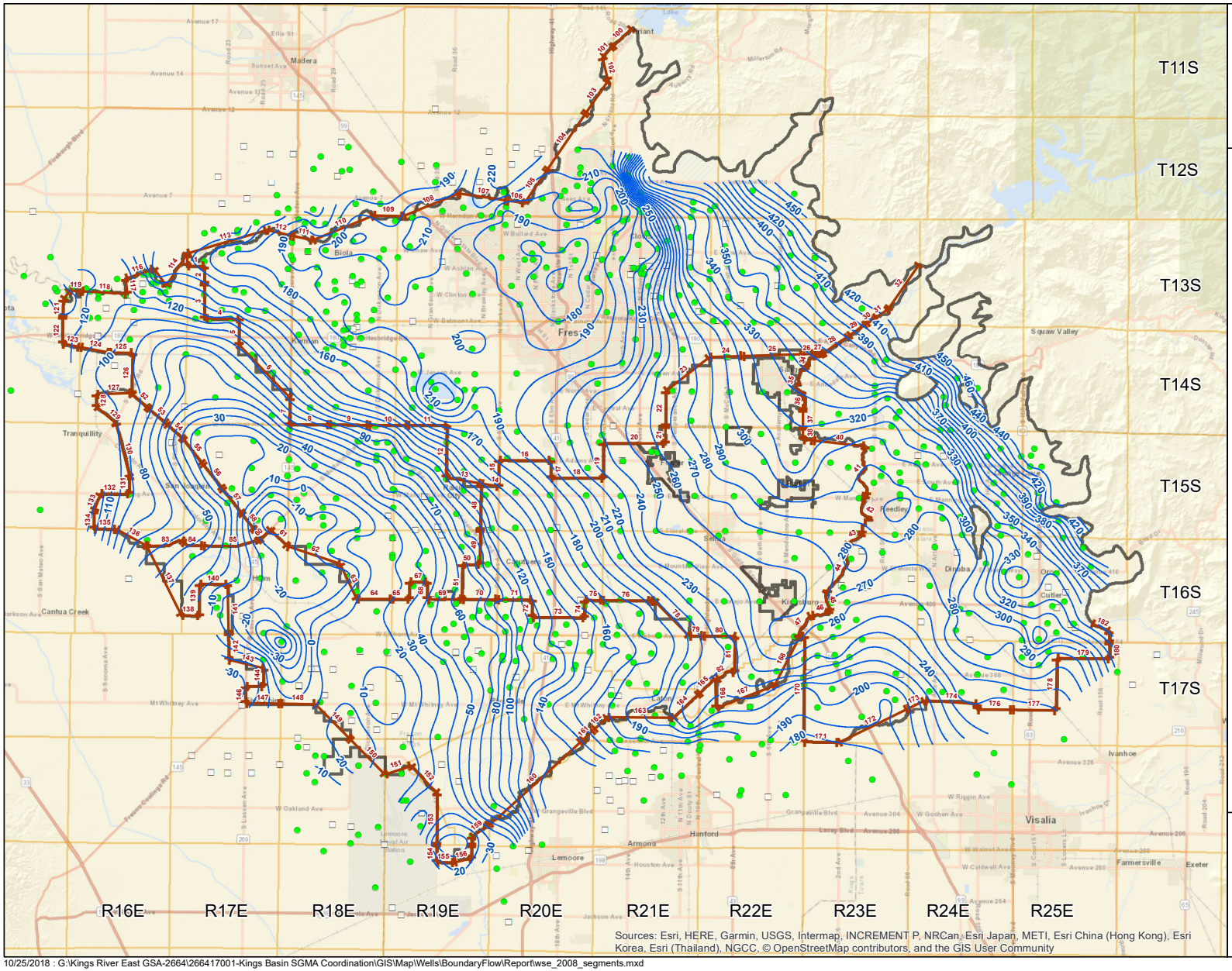

Kings Subbasin Coordinated Effort

Kings Coordinated Effort GSAs

Spring 2008
Groundwater Elevation Contours

Legend

- Kings Subbasin GSAs
- Township/Range
- Well - Data Used
- Well - Data Not Used
- Boundary Flow Segment (Segment ID)

Water Level Contours

- Line of Equal Elevation (10ft interval)

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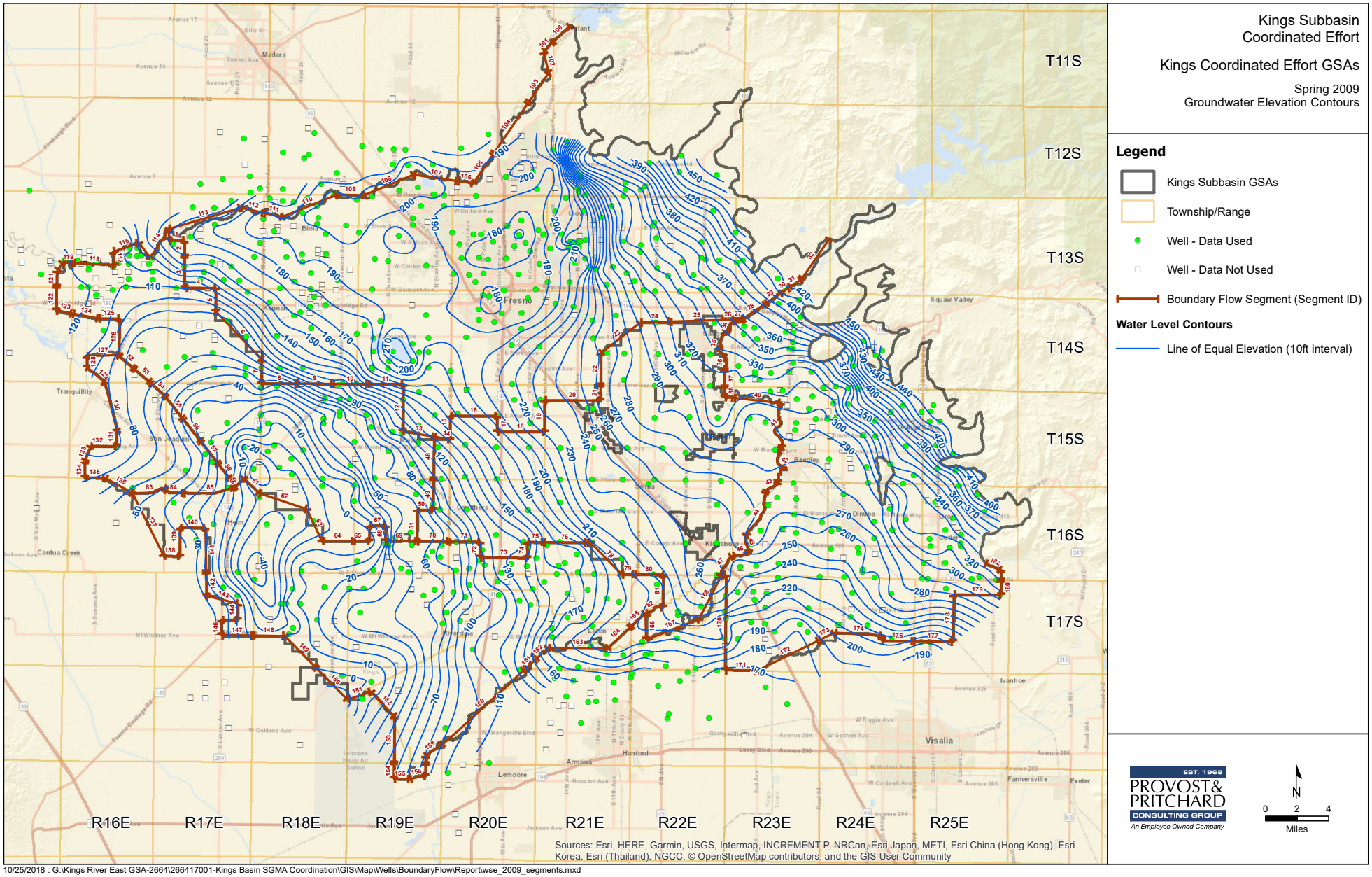

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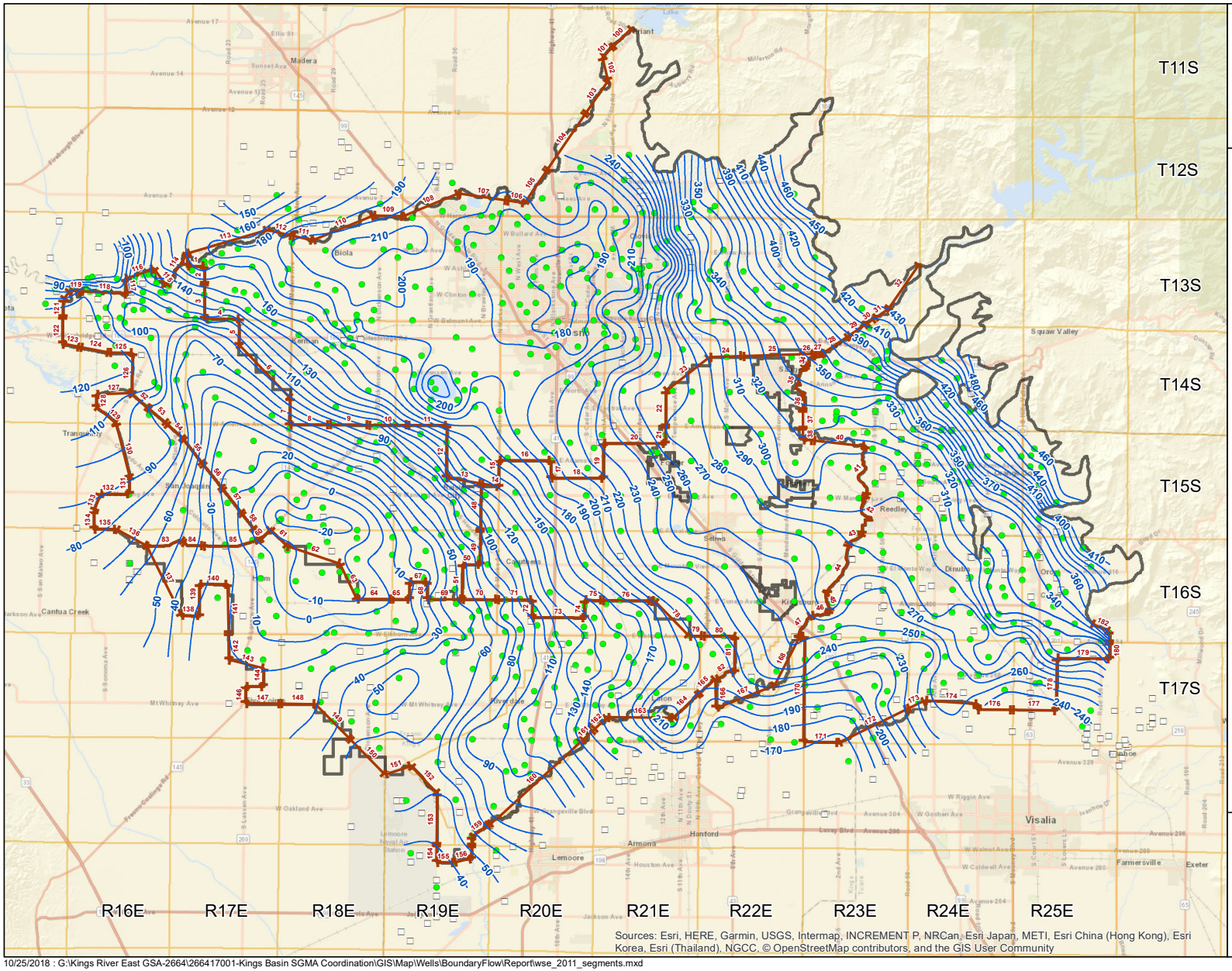

Kings Subbasin
Coordinated Effort

Kings Coordinated Effort GSAs

Spring 2011
Groundwater Elevation Contours

Legend

- Kings Subbasin GSAs
- Township/Range
- Well - Data Used
- Well - Data Not Used
- Boundary Flow Segment (Segment ID)

Water Level Contours

- Line of Equal Elevation (10ft interval)

EST. 1968
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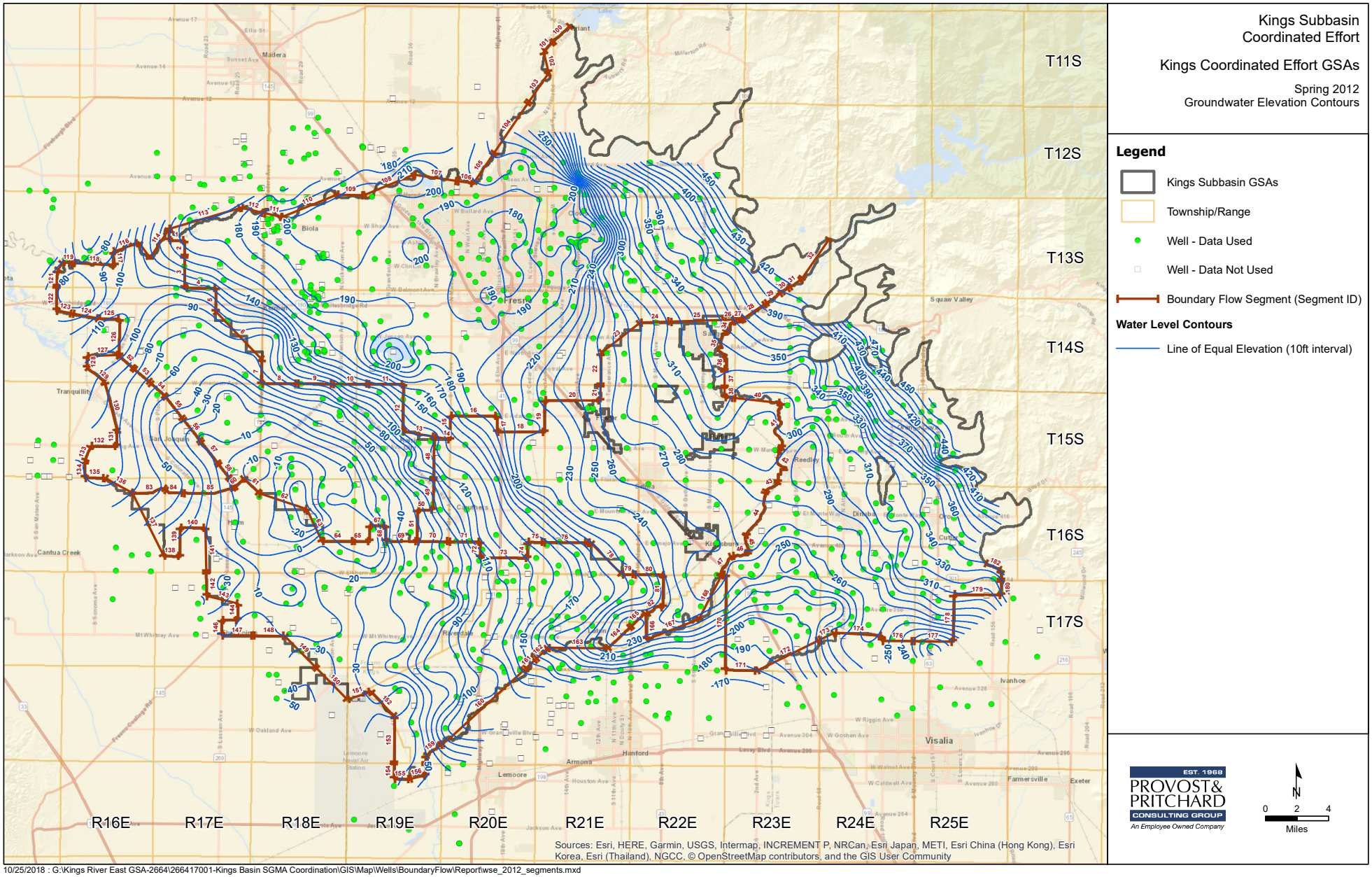

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Attachment 3
Estimated Flows
by Flow Segment

Internal

Attachment 3 - 1925 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Percent Thickness Change (1925-1962)	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	McMullin	0	96,000	0%	96,000	3,958	N/A	N/A	N/A	180.1	N/A	0.1	N/A	N/A	N/A	N/A	0.0
McMullin	North Kings	1	96,000	0%	96,000	5,250	0.0014	7.2	326.5	90.6	146.5	90.6	55.9	0.97	4,345	569407	638
North Kings	McMullin	2	96,000	0%	96,000	5,317	0.0009	4.7	306.2	180.0	126.2	0.0	53.8	0.94	4,291	370329	415
North Kings	McMullin	3	96,000	9%	104,664	10,532	0.0012	6.2	252.4	180.1	72.4	0.1	72.3	1.26	10,034	1241269	1,390
North Kings	McMullin	4	97,000	11%	107,882	11,871	0.0012	6.5	222.8	90.9	42.8	90.9	48.1	0.84	8,837	1175417	1,317
North Kings	McMullin	5	98,000	12%	110,151	7,744	0.0013	6.7	242.9	181.4	62.9	1.4	61.6	1.07	6,810	952896	1,067
North Kings	McMullin	6	98,000	14%	111,980	22,487	0.0015	7.9	231.8	136.3	51.8	136.3	84.5	1.47	22,382	3744207	4,194
North Kings	McMullin	7	***120,000***	30%	156,443	8,027	0.0019	10.0	241.1	180.7	61.1	0.7	60.3	1.05	6,972	2069735	2,318
North Kings	McMullin	8	120,000	15%	138,005	11,936	0.0010	5.3	222.9	90.3	42.9	90.3	47.4	0.83	8,789	1226468	1,374
North Kings	McMullin	9	120,000	17%	140,615	11,887	0.0012	6.2	228.9	90.6	48.9	90.6	41.7	0.73	7,910	1308078	1,465
North Kings	McMullin	10	120,000	20%	144,000	11,937	0.0012	6.3	234.0	90.0	54.0	90.0	36.0	0.63	7,024	1201798	1,346
North Kings	McMullin	11	***182,000***	24%	225,600	11,909	0.0012	6.1	243.5	90.2	63.5	90.2	26.7	0.47	5,356	1389608	1,557
North Kings	McMullin	12	***115,000***	33%	152,561	15,873	0.0009	5.0	228.2	180.9	48.2	0.9	47.3	0.82	11,658	1670316	1,871
North Kings	McMullin	13	98,000	17%	115,047	10,744	0.0010	5.4	228.9	279.5	48.9	99.5	50.6	0.88	8,303	972610	1,089
North Kings	Central Kings	14	98,000	18%	115,693	5,348	0.0012	6.4	236.7	279.5	56.7	99.5	42.9	0.75	3,637	507031	568
Central Kings	North Kings	15	91,000	18%	107,133	7,944	0.0012	6.3	234.8	0.9	54.8	0.9	53.9	0.94	6,415	819893	918
North Kings	Central Kings	16	83,000	14%	94,379	15,707	0.0014	7.4	233.5	90.3	53.5	90.3	36.8	0.64	9,413	1248892	1,399
North Kings	Central Kings	17	83,000	12%	92,826	5,303	0.0015	8.1	224.7	179.9	44.7	179.9	44.8	0.78	3,736	534360	599
North Kings	Central Kings	18	83,000	11%	91,882	15,829	0.0014	7.3	252.0	90.2	72.0	90.2	18.2	0.32	4,931	622616	697
Central Kings	North Kings	19	89,000	7%	95,598	10,569	0.0012	6.1	241.0	0.5	61.0	0.5	60.5	1.06	9,202	1019562	1,142
North Kings	Central Kings	20	95,000	7%	101,874	18,685	0.0012	6.1	251.2	90.3	71.2	90.3	19.1	0.33	6,119	721644	808
Central Kings	North Kings	21	95,000	7%	101,616	5,292	0.0010	5.2	235.3	1.1	55.3	1.1	54.1	0.94	4,288	431034	483
Central Kings	North Kings	22	111,000	8%	119,488	10,632	0.0011	5.6	269.4	0.3	89.4	0.3	89.1	1.56	10,631	1352421	1,515
Central Kings	North Kings	23	111,000	8%	119,421	16,792	0.0016	8.5	265.2	232.2	85.2	52.2	33.1	0.58	9,160	1759125	1,970
North Kings	Central Kings	24	80,000	9%	87,321	9,989	0.0019	10.2	226.3	268.3	46.3	88.3	41.9	0.73	6,677	1129040	1,265
North Kings	Central Kings	25	***100,000***	2%	102,287	18,219	0.0017	8.9	204.7	268.3	24.7	88.3	63.6	1.11	16,316	2825881	3,165
North Kings	Central Kings	26	***95,000***	-3%	92,232	3,430	0.0020	10.6	212.1	268.3	32.1	88.3	56.2	0.98	2,850	529778	593
North Kings	Central Kings	27	***95,000***	-3%	92,589	2,653	0.0020	10.8	226.6	268.3	46.6	88.3	41.7	0.73	1,765	332924	373
North Kings	Kings River East	28	***95,000***	-4%	91,321	9,490	0.0022	11.8	222.6	235.8	42.6	55.8	13.2	0.23	2,166	442939	0
North Kings	Kings River East	29	59,000	0%	59,000	6,424	0.0033	17.4	205.9	235.8	25.9	55.8	29.9	0.52	3,198	622060	0
North Kings	Kings River East	30	30,000	0%	30,000	3,027	N/A	N/A	N/A	235.8	N/A	55.8	N/A	N/A	N/A	N/A	0
North Kings	Kings River East	31	30,000	0%	30,000	5,071	N/A	N/A	N/A	235.8	N/A	55.8	N/A	N/A	N/A	N/A	0
North Kings	Kings River East	32	30,000	0%	30,000	16,502	N/A	N/A	N/A	34.6	N/A	34.6	N/A	N/A	N/A	N/A	0
Central Kings	Kings River East	33	***95,000***	-2%	92,845	2,895	0.0021	10.9	227.9	255.3	47.9	75.3	27.4	0.48	1,332	255048	0
Kings River East	Central Kings	34	***95,000***	-3%	91,935	4,909	0.0021	11.2	213.9	220.0	33.9	40.0	6.1	0.11	521	101401	0
Kings River East	Central Kings	35	80,000	1%	80,552	13,736	0.0012	6.1	183.5	189.4	3.5	9.4	5.9	0.10	1,402	130069	0
Kings River East	Central Kings	36	80,000	2%	81,498	5,888	0.0012	6.6	181.9	349.5	1.9	169.5	12.4	0.22	1,268	128321	0
Central Kings	Kings River East	37	80,000	3%	82,083	5,428	0.0008	4.0	153.7	360.0	153.7	180.0	26.3	0.46	2,405	150486	0
Central Kings	Kings River East	38	95,000	4%	98,979	3,460	0.0005	2.7	140.3	360.0	140.3	180.0	39.6	0.69	2,207	112193	0
Kings River East	Central Kings	39	95,000	5%	99,803	3,116	0.0005	2.8	140.5	96.4	140.5	96.4	44.0	0.77	2,166	113758	0
Central Kings	Kings River East	40	90,000	4%	93,718	15,843	0.0010	5.1	110.7	96.4	110.7	96.4	14.3	0.25	3,907	350528	0
Kings River East	Central Kings	41	90,000	5%	94,773	17,844	0.0018	9.3	220.6	178.6	40.6	178.6	41.9	0.73	11,926	1987904	0
Kings River East	Central Kings	42	90,000	5%	94,373	17,872	0.0011	6.1	231.8	186.7	51.8	6.7	45.2	0.79	12,678	1373464	0
Kings River East	Central Kings	43	78,000	1%	78,710	5,653	0.0021	11.0	245.4	229.9	65.4	49.9	15.5	0.27	1,510	247516	0
Central Kings	Kings River East	44	78,000	0%	78,304	16,793	0.0010	5.2	302.6	203.7	122.6	23.7	81.1	1.42	16,592	1281838	0
Central Kings	Kings River East	45	***120,000***	3%	123,231	6,008	0.0004	2.3	248.9	173.3	68.9	173.3	75.6	1.32	5,819	318502	0
Central Kings	Kings River East	46	***120,000***	6%	126,794	6,400	0.0008	4.1	228.9	254.6	48.9	74.6	25.7	0.45	2,773	275970	0
Kings River East	Central Kings	47	***120,000***	8%	129,202	7,877	0.0004	2.2	216.7	211.1	36.7	31.1	5.6	0.10	771	42127	0
Central Kings	McMullin	48	98,000	17%	114,926	14,924	0.0012	6.4	240.6	180.8	60.6	0.8	59.8	1.04	12,897	1791906	2,007
Central Kings	McMullin	49	75,000	17%	87,722	10,541	0.0009	4.5	258.4	180.8	78.4	0.8	77.6	1.35	10,294	768314	861
Central Kings	McMullin	50	75,000	17%	87,420	5,264	0.0009	4.7	294.5	270.3	114.5	90.3	24.2	0.42	2,157	169038	189
Central Kings	McMullin	51	75,000	16%	87,132	10,654	0.0013	6.7	267.2	180.7	87.2	0.7	86.5	1.51	10,634	1183332	1,326
McMullin	James	52	128,000	4%	133,710	6,877	0.0004	2.2	241.2	132.3	61.2	132.3	71.1	1.24	6,507	363723	407
McMullin	James	53	128,000	5%	134,092	7,174	0.0004	2.3	242.3	130.2	62.3	130.2	68.0	1.19	6,651	384523	431
McMullin	James	54	107,000	3%	110,724	6,829	0.0003	1.8	242.3	132.7	62.3	132.7	70.5	1.23	6,435	242034	271
McMullin	James	55	***112,000***	21%	135,327	9,572	0.0003	1.4	237.7	141.8	57.7	141.8	84.1	1.47	9,521	347849	390
McMullin	James	56	***112,000***	27%	142,029	9,617	0.0002	1.1	241.2	141.6	61.2	141.6	80.4	1.40	9,483	274696	308
McMullin	James	57	128,000	9%	139,602	9,585	0.0002	0.9	257.2	142.0	77.2	142.0	64.7	1.13	8,669	211710	237
McMullin	James	58	128,000	10%	140,734	6,153	0.0002	0.9	254.0	142.2	74.0	142.2	68.2	1.19	5,714	136907	153
McMullin	James	59	125,000	11%	138,859	3,455	0.0003	1.7	257.1	152.8	77.1	152.8	75.7	1.32	3,348	151369	170
North Fork Kings	McMullin	60	125,000	12%	140,121	4,656	0.0007	3.9	257.3	227.4	77.3	47.4	29.9	0.52	2,319	240225	269
McMullin	North Fork Kings	61	125,000	13%	141,375	7,115	0.0008	4.0	253.0	315.0	73.0	135.0	62.0	1.08	6,283	677352	759
McMullin	North Fork Kings	62	123,000	14%	140,276	16,815	0.0009	4.8	252.5	288.4	72.5	108.4	35.8	0.63	9,844	1253467	1,404
McMullin	North Fork Kings	63	123,000	14%	140,645	11,841	0.0010	5.2	277.4	334.5	97.4	154.5	57.0	1.00	9,935	1373126	1,538
North Fork Kings	McMullin	64	123,000	16%	142,135	10,574	0.0005	2.5	270.5	270.1	90.5	90.1	0.4	0.01	67	4555	5
McMullin	North Fork Kings	65	75,000	16%	86,909	5,349	0.0006	2.9	261.5	270.8	81.5	90.8	9.3	0.16	866	41608	47
North Fork Kings	McMullin	66	75,000	16%	86,946	5,277	0.0006	3.1	260.9	180.5	80.9	0.5	80.4	1.40	5,203	267577	300

Attachment 3 - 1925 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Percent Thickness Change (1925 1962)	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
McMullin	North Fork Kings	67	75,000	16%	87,073	5,354	0.0009	4.8	258.1	270.1	78.1	90.1	12.0	0.21	1,111	88642	99
McMullin	North Fork Kings	68	75,000	16%	86,992	5,258	0.0010	5.4	256.5	0.8	76.5	0.8	75.7	1.32	5,095	450261	504
McMullin	North Fork Kings	69	75,000	16%	86,884	10,633	0.0010	5.5	249.5	270.2	69.5	90.2	20.7	0.36	3,754	340563	381
Central Kings	North Fork Kings	70	75,000	17%	87,409	10,594	0.0009	4.9	243.6	270.3	63.6	90.3	26.6	0.46	4,745	382966	429
Central Kings	North Fork Kings	71	73,000	20%	87,739	10,677	0.0011	5.6	235.8	270.4	55.8	90.4	34.6	0.60	6,057	559450	627
Central Kings	North Fork Kings	72	73,000	19%	86,969	5,277	0.0009	5.0	228.1	0.5	48.1	0.5	47.6	0.83	3,895	321289	360
Central Kings	North Fork Kings	73	73,000	19%	86,689	15,835	0.0007	3.9	214.2	270.4	34.2	90.4	56.2	0.98	13,161	848581	951
North Fork Kings	Central Kings	74	73,000	22%	88,999	5,273	0.0010	5.1	206.3	180.4	26.3	0.4	25.9	0.45	2,305	198812	223
Central Kings	North Fork Kings	75	73,000	23%	89,753	5,321	0.0019	10.1	218.7	270.3	38.7	90.3	51.6	0.90	4,172	718679	805
Central Kings	North Fork Kings	76	93,000	21%	112,496	14,584	0.0015	7.7	211.2	270.7	31.2	90.7	59.5	1.04	12,565	2053186	2,300
Central Kings	North Fork Kings	77	93,000	16%	107,744	1,334	0.0010	5.4	213.6	270.8	33.6	90.8	57.1	1.00	1,121	122532	137
Central Kings	North Fork Kings	78	93,000	15%	107,255	14,877	0.0010	5.4	226.4	315.4	46.4	135.4	89.0	1.55	14,874	1631268	1,827
Central Kings	North Fork Kings	79	***118,000***	19%	140,762	4,185	0.0009	5.0	213.1	270.3	33.1	90.3	57.1	1.00	3,516	468448	525
Central Kings	North Fork Kings	80	***118,000***	15%	135,230	9,772	0.0006	3.0	214.1	271.5	34.1	91.5	57.3	1.00	8,224	626251	701
Central Kings	North Fork Kings	81	***118,000***	12%	132,353	10,682	0.0007	3.5	253.2	0.7	73.2	0.7	72.5	1.26	10,186	902845	1,011
Central Kings	North Fork Kings	82	***118,000***	13%	133,503	6,290	0.0007	3.5	256.1	68.3	76.1	68.3	7.8	0.14	852	75603	85
North Fork Kings	James	83	86,000	0%	86,000	11,628	N/A	N/A	N/A	263.5	N/A	83.5	N/A	N/A	N/A	N/A	N/A
North Fork Kings	James	84	87,000	0%	87,000	6,538	0.0001	0.7	291.0	281.3	111.0	101.3	9.7	0.17	1,106	12224	14
North Fork Kings	James	85	87,000	0%	87,000	18,139	0.0002	0.8	273.8	263.8	93.8	83.8	10.0	0.17	3,139	42613	48

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 1997 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	McMullin	0	96,000	N/A	96,000	3958	0.0033	17.6	261.9	180.1	81.9	0.1	81.8	1.43	3,918	1257021	1,408
North Kings	McMullin	1	96,000	N/A	96,000	5,250	0.0044	23.2	167.7	90.6	167.7	90.6	77.1	1.35	5,118	2154387	2,413
McMullin	North Kings	2	96,000	N/A	96,000	5,317	0.0045	23.8	166.0	180.0	166.0	0.0	14.0	0.24	1,286	555493	622
North Kings	McMullin	3	96,000	6%	90,147	10,532	0.0053	28.2	203.4	180.1	23.4	0.1	23.3	0.41	4,162	2003096	2,244
North Kings	McMullin	4	97,000	9%	88,161	11,871	0.0053	28.1	213.0	90.9	33.0	90.9	57.9	1.01	10,060	4712580	5,279
North Kings	McMullin	5	98,000	10%	88,337	7,744	0.0059	31.3	197.5	181.4	17.5	1.4	16.1	0.28	2,151	1125398	1,261
North Kings	McMullin	6	98,000	12%	86,236	22,487	0.0051	27.0	215.7	136.3	35.7	136.3	79.5	1.39	22,108	9751615	10,923
North Kings	McMullin	7	***120,000***	16%	120,000	8,027	0.0052	27.5	245.0	180.7	65.0	0.7	64.3	1.12	7,232	4521414	5,065
North Kings	McMullin	8	120,000	17%	99,359	11,936	0.0050	26.5	215.1	90.3	35.1	90.3	55.2	0.96	9,800	4882441	5,469
North Kings	McMullin	9	120,000	13%	104,129	11,887	0.0054	28.4	198.9	90.6	18.9	90.6	71.7	1.25	11,286	6316432	7,075
North Kings	McMullin	10	120,000	9%	109,054	11,937	0.0056	29.3	223.0	90.0	43.0	90.0	47.0	0.82	8,730	5285521	5,921
North Kings	McMullin	11	***182,000***	4%	182,000	11,909	0.0051	27.0	204.5	90.2	24.5	90.2	65.7	1.15	10,854	10089509	11,302
North Kings	McMullin	12	***115,000***	13%	115,000	15,873	0.0050	26.4	226.1	180.9	46.1	0.9	45.2	0.79	11,256	6477158	7,255
North Kings	McMullin	13	98,000	18%	80,494	10,744	0.0044	23.0	209.4	279.5	29.4	99.5	70.1	1.22	10,104	3546861	3,973
North Kings	Central Kings	14	98,000	17%	81,042	5,348	0.0054	28.7	242.0	279.5	62.0	99.5	37.5	0.65	3,254	1431639	1,604
Central Kings	North Kings	15	91,000	14%	78,480	7,944	0.0064	33.6	252.4	0.9	72.4	0.9	71.5	1.25	7,534	3763330	4,215
North Kings	Central Kings	16	83,000	11%	73,698	15,707	0.0030	15.6	246.5	90.3	66.5	90.3	23.7	0.41	6,320	1376280	1,542
North Kings	Central Kings	17	83,000	10%	74,984	5,303	0.0012	6.3	224.2	179.9	44.2	179.9	44.3	0.77	3,702	329849	369
North Kings	Central Kings	18	83,000	9%	75,507	15,829	0.0019	9.8	255.9	90.2	75.9	90.2	14.3	0.25	3,907	548352	614
Central Kings	North Kings	19	89,000	6%	83,730	10,569	0.0027	14.4	257.9	0.5	77.9	0.5	77.4	1.35	10,314	2358987	2,642
Central Kings	North Kings	20	95,000	4%	91,507	18,685	0.0013	6.8	276.9	90.3	96.9	90.3	6.6	0.12	2,161	256388	287
Central Kings	North Kings	21	95,000	1%	93,861	5,292	0.0015	7.8	260.6	1.1	80.6	1.1	79.4	1.39	5,202	718279	805
Central Kings	North Kings	22	111,000	3%	108,001	10,632	0.0016	8.6	270.9	0.3	90.9	0.3	89.4	1.56	10,632	1873515	2,099
Central Kings	North Kings	23	111,000	3%	107,937	16,792	0.0020	10.3	267.8	232.2	87.8	52.2	35.6	0.62	9,786	2063972	2,312
North Kings	Central Kings	24	80,000	-2%	81,808	9,989	0.0026	13.5	235.0	268.3	55.0	88.3	33.3	0.58	5,481	1144257	1,282
North Kings	Central Kings	25	***100,000***	-4%	100,000	18,219	0.0023	12.0	233.5	268.3	53.5	88.3	34.8	0.61	10,394	2352754	2,635
North Kings	Central Kings	26	***95,000***	-3%	95,000	3,430	0.0024	12.5	217.6	268.3	37.6	88.3	50.7	0.88	2,654	598362	670
North Kings	Central Kings	27	***95,000***	-3%	95,000	2,653	0.0026	13.7	216.5	268.3	36.5	88.3	51.8	0.90	2,084	514309	576
North Kings	Kings River East	28	***95,000***	-5%	95,000	9,490	0.0034	17.9	224.9	235.8	44.9	55.8	10.8	0.19	1,782	573275	0
North Kings	Kings River East	29	59,000	N/A	59,000	6,424	0.0032	17.1	217.2	235.8	37.2	55.8	18.6	0.32	2,046	390576	0
North Kings	Kings River East	30	30,000	N/A	30,000	3,027	0.0028	14.6	206.5	235.8	26.5	55.8	29.3	0.51	1,481	122463	0
North Kings	Kings River East	31	30,000	N/A	30,000	5,071	N/A	N/A	N/A	235.8	N/A	55.8	N/A	N/A	N/A	N/A	0
Kings River East	North Kings	32	30,000	N/A	30,000	16,502	N/A	N/A	N/A	34.6	N/A	34.6	N/A	N/A	N/A	N/A	0
Central Kings	Kings River East	33	***95,000***	-3%	95,000	2,895	0.0026	13.9	215.8	255.3	35.8	75.3	39.5	0.69	1,841	459428	0
Kings River East	Central Kings	34	***95,000***	-3%	95,000	4,909	0.0023	12.0	211.2	220.0	31.2	40.0	8.8	0.15	752	162140	0
Kings River East	Central Kings	35	80,000	-3%	82,389	13,736	0.0015	7.7	197.7	189.4	17.7	9.4	8.4	0.15	1,995	240983	0
Central Kings	Kings River East	36	80,000	-3%	82,432	5,888	0.0013	7.1	161.3	349.5	161.3	169.5	8.2	0.14	843	93236	0
Central Kings	Kings River East	37	80,000	-4%	83,016	5,428	0.0015	7.7	148.3	360.0	148.3	180.0	31.7	0.55	2,853	343553	0
Central Kings	Kings River East	38	95,000	-4%	99,209	3,460	0.0016	8.2	142.5	360.0	142.5	180.0	37.5	0.65	2,104	325107	0
Kings River East	Central Kings	39	95,000	-5%	99,384	3,116	0.0016	8.4	141.5	96.4	141.5	96.4	45.1	0.79	2,206	348722	0
Kings River East	Central Kings	40	90,000	-3%	93,041	15,843	0.0015	7.8	171.2	96.4	171.2	96.4	74.7	1.30	15,283	2098747	0
Kings River East	Central Kings	41	90,000	-2%	91,624	17,844	0.0008	4.2	197.9	178.6	17.9	178.6	19.3	0.34	5,891	424510	0
Kings River East	Central Kings	42	90,000	-3%	92,338	17,872	0.0014	7.2	211.5	186.7	31.5	6.7	24.8	0.43	7,505	941402	0
Kings River East	Central Kings	43	78,000	-2%	79,423	5,653	0.0012	6.2	327.4	229.9	147.4	49.9	82.4	1.44	5,603	518619	0
Kings River East	Central Kings	44	78,000	-1%	78,916	16,793	0.0018	9.7	292.3	203.7	112.3	23.7	88.6	1.55	16,788	2436669	0
Kings River East	Central Kings	45	***120,000***	3%	120,000	6,008	0.0018	9.3	233.3	173.3	53.3	173.3	60.0	1.05	5,203	1100660	0
Central Kings	Kings River East	46	***120,000***	6%	120,000	6,400	0.0010	5.5	237.3	254.6	57.3	74.6	17.3	0.30	1,905	237430	0
Central Kings	Kings River East	47	***120,000***	8%	120,000	7,877	0.0010	5.2	122.8	211.1	122.8	31.1	88.3	1.54	7,873	926685	0
Central Kings	McMullin	48	98,000	23%	75,891	14,924	0.0038	19.8	238.0	180.8	58.0	0.8	57.1	1.00	12,534	3570579	4,000
Central Kings	McMullin	49	75,000	27%	54,886	10,541	0.0035	18.7	255.7	180.8	75.7	0.8	74.9	1.31	10,175	1974534	2,212
McMullin	Central Kings	50	75,000	27%	54,997	5,264	0.0031	16.1	265.0	270.3	85.0	90.3	5.3	0.09	490	82333	92
Central Kings	McMullin	51	75,000	26%	55,425	10,654	0.0031	16.4	249.3	180.7	69.3	0.7	68.6	1.20	9,920	1709511	1,915
McMullin	James	52	128,000	11%	114,224	6,877	0.0005	2.8	160.4	132.3	160.4	132.3	28.1	0.49	3,235	194435	218
McMullin	James	53	128,000	11%	114,064	7,174	0.0009	5.0	184.9	130.2	4.9	130.2	54.6	0.95	5,849	633106	709
McMullin	James	54	107,000	13%	92,969	6,829	0.0015	7.8	144.5	132.7	144.5	132.7	11.8	0.21	1,401	191422	214
James	McMullin	55	***112,000***	16%	112,000	9,572	0.0024	12.5	112.4	141.8	112.4	141.8	29.4	0.51	4,693	1246176	1,396
James	McMullin	56	***112,000***	19%	112,000	9,617	0.0032	16.8	85.1	141.6	85.1	141.6	56.5	0.99	8,018	2852430	3,195
James	McMullin	57	128,000	22%	99,217	9,585	0.0040	20.9	93.3	142.0	93.3	142.0	48.7	0.85	7,203	2834470	3,175
James	McMullin	58	128,000	24%	97,258	6,153	0.0032	16.9	69.9	142.2	69.9	142.2	72.3	1.26	5,863	1827985	2,048
James	McMullin	59	125,000	24%	95,517	3,455	0.0039	20.7	79.4	152.8	79.4	152.8	73.3	1.28	3,310	1239130	1,388
McMullin	North Fork Kings	60	125,000	25%	93,183	4,656	0.0045	23.5	77.7	227.4	77.7	47.4	30.4	0.53	2,353	976114	1,093
North Fork Kings	McMullin	61	125,000	27%	91,501	7,115	0.0031	16.6	65.3	315.0	65.3	135.0	69.7	1.22	6,674	1922778	2,154
North Fork Kings	McMullin	62	123,000	29%	87,645	16,815	0.0025	13.3	340.7	288.4	160.7	108.4	52.3	0.91	13,310	2941939	3,295
North Fork Kings	McMullin	63	123,000	31%	85,245	11,841	0.0011	5.9	357.4	334.5	177.4	154.5	23.0	0.40	4,621	437790	490
North Fork Kings	McMullin	64	123,000	29%	86,845	10,574	0.0010	5.2	343.9	270.1	163.9	90.1	73.8	1.29	10,151	864757	969
North Fork Kings	McMullin	65	75,000	30%	52,395	5,349	0.0010	5.5	290.9	270.8	110.9	90.8	20.1	0.35	1,838	100153	112
North Fork Kings	McMullin	66	75,000	31%	51,830	5,277	0.0015	7.9	271.3	180.5	91.3	0.5	89.3	1.56	5,277	408083	457

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McMullin	North Fork Kings	67	75,000	32%	51,283	5,354	0.0021	10.9	265.9	270.1	85.9	90.1	4.2	0.07	390	41208	46
McMullin	North Fork Kings	68	75,000	30%	52,225	5,258	0.0022	11.4	253.0	0.8	73.0	0.8	72.2	1.26	5,007	563671	631
McMullin	North Fork Kings	69	75,000	26%	55,265	10,633	0.0025	13.3	240.1	270.2	60.1	90.2	30.0	0.52	5,324	742075	831
Central Kings	North Fork Kings	70	75,000	26%	55,396	10,594	0.0042	22.2	249.6	270.3	69.6	90.3	20.7	0.36	3,737	870986	976
Central Kings	North Fork Kings	71	73,000	25%	54,577	10,677	0.0032	17.1	251.0	270.4	71.0	90.4	19.4	0.34	3,544	626868	702
Central Kings	North Fork Kings	72	73,000	25%	54,969	5,277	0.0032	16.8	240.3	0.5	60.3	0.5	59.8	1.04	4,559	797983	894
Central Kings	North Fork Kings	73	73,000	25%	54,623	15,835	0.0023	12.4	233.8	270.4	53.8	90.4	36.6	0.64	9,434	1208779	1,354
North Fork Kings	Central Kings	74	73,000	23%	56,203	5,273	0.0022	11.7	220.8	180.4	40.8	0.4	40.4	0.70	3,415	423473	474
Central Kings	North Fork Kings	75	73,000	20%	58,546	5,321	0.0026	13.5	217.9	270.3	37.9	90.3	52.4	0.91	4,217	631676	708
Central Kings	North Fork Kings	76	93,000	14%	80,296	14,584	0.0031	16.3	211.0	270.7	31.0	90.7	59.7	1.04	12,591	3126797	3,502
Central Kings	North Fork Kings	77	93,000	6%	87,498	1,334	0.0033	17.5	203.6	270.8	23.6	90.8	67.1	1.17	1,229	356922	400
Central Kings	North Fork Kings	78	93,000	6%	87,676	14,877	0.0021	11.1	232.0	315.4	52.0	135.4	83.4	1.46	14,778	2726280	3,054
North Fork Kings	Central Kings	79	***118,000***	6%	118,000	4,185	0.0026	13.6	271.0	270.3	91.0	90.3	0.7	0.01	53	16217	18
Central Kings	North Fork Kings	80	***118,000***	4%	118,000	9,772	0.0025	13.0	267.6	271.5	87.6	91.5	3.9	0.07	664	193640	217
Central Kings	North Fork Kings	81	***118,000***	6%	118,000	10,682	0.0021	11.0	284.5	0.7	104.5	0.7	76.2	1.33	10,374	2541646	2,847
Central Kings	North Fork Kings	82	***118,000***	14%	118,000	6,290	0.0022	11.7	312.7	68.3	132.7	68.3	64.3	1.12	5,670	1488492	1,667
James	North Fork Kings	83	86,000	N/A	86,000	11,628	0.0015	8.2	138.5	263.5	138.5	83.5	55.0	0.96	9,524	1265315	1,417
James	North Fork Kings	84	87,000	N/A	87,000	6,538	0.0022	11.8	132.3	281.3	132.3	101.3	31.0	0.54	3,368	652821	731
James	North Fork Kings	85	87,000	N/A	87,000	18,139	0.0029	15.6	136.0	263.8	136.0	83.8	52.2	0.91	14,336	3676999	4,119

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North Kings	McMullin	0	96,000	N/A	96,000	3958	0.0027	14.2	302.15	180.1	122.2	0.1	58.0	1.01	3,356	865828	970
North Kings	McMullin	1	96,000	N/A	96,000	5,250	0.0012	6.5	163.15	90.6	163.1	90.6	72.5	1.27	5,008	588078	659
McMullin	North Kings	2	96,000	N/A	96,000	5,317	0.0043	22.6	163.50	180.0	163.5	0.0	16.5	0.29	1,510	619424	694
North Kings	McMullin	3	96,000	6%	90,147	10,532	0.0057	30.0	188.50	180.1	8.5	0.1	8.4	0.15	1,534	785783	880
North Kings	McMullin	4	97,000	9%	88,161	11,871	0.0067	35.4	209.57	90.9	29.6	90.9	61.4	1.07	10,419	6156622	6,896
North Kings	McMullin	5	98,000	10%	88,337	7,744	0.0051	26.7	227.20	181.4	47.2	1.4	45.8	0.80	5,554	2479168	2,777
North Kings	McMullin	6	98,000	12%	86,236	22,487	0.0037	19.3	218.27	136.3	38.3	136.3	82.0	1.43	22,268	7027006	7,871
North Kings	McMullin	7	***120,000***	16%	120,000	8,027	0.0052	27.3	199.79	180.7	19.8	0.7	19.0	0.33	2,618	1626785	1,822
North Kings	McMullin	8	120,000	17%	99,359	11,936	0.0039	20.8	234.72	90.3	54.7	90.3	35.6	0.62	6,941	2718959	3,046
North Kings	McMullin	9	120,000	13%	104,129	11,887	0.0035	18.3	208.18	90.6	28.2	90.6	62.4	1.09	10,537	3812183	4,270
North Kings	McMullin	10	120,000	9%	109,054	11,937	0.0055	29.2	195.96	90.0	16.0	90.0	74.1	1.29	11,480	6933657	7,767
North Kings	McMullin	11	***182,000***	4%	182,000	11,909	0.0041	21.8	202.71	90.2	22.7	90.2	67.5	1.18	11,002	8275757	9,270
North Kings	McMullin	12	***115,000***	13%	115,000	15,873	0.0042	22.1	227.57	180.9	47.6	0.9	46.7	0.81	11,543	5548421	6,215
North Kings	McMullin	13	98,000	18%	80,494	10,744	0.0038	20.2	235.78	279.5	55.8	99.5	43.8	0.76	7,430	2293536	2,569
North Kings	Central Kings	14	98,000	17%	81,042	5,348	0.0042	22.2	226.08	279.5	46.1	99.5	53.4	0.93	4,296	1465560	1,642
Central Kings	North Kings	15	91,000	14%	78,480	7,944	0.0031	16.6	226.40	0.9	46.4	0.9	45.5	0.79	5,664	1396590	1,564
North Kings	Central Kings	16	83,000	11%	73,698	15,707	0.0025	13.3	240.40	90.3	60.4	90.3	29.9	0.52	7,825	1454213	1,629
North Kings	Central Kings	17	83,000	10%	74,984	5,303	0.0028	15.0	228.61	179.9	48.6	179.9	48.7	0.85	3,984	850948	953
North Kings	Central Kings	18	83,000	9%	75,507	15,829	0.0026	13.9	232.47	90.2	52.5	90.2	37.7	0.66	9,677	1926237	2,158
Central Kings	North Kings	19	89,000	6%	83,730	10,569	0.0024	12.5	239.34	0.5	59.3	0.5	58.8	1.03	9,043	1794541	2,010
Central Kings	North Kings	20	95,000	4%	91,507	18,685	0.0013	6.8	270.25	90.3	90.2	90.3	0.0	0.00	15	1801	2
Central Kings	North Kings	21	95,000	1%	93,861	5,292	0.0015	7.7	259.00	1.1	79.0	1.1	77.9	1.36	5,174	705010	790
Central Kings	North Kings	22	111,000	3%	108,001	10,632	0.0016	8.2	274.20	0.3	94.2	0.3	86.1	1.50	10,608	1787625	2,002
Central Kings	North Kings	23	111,000	3%	107,937	16,792	0.0018	9.3	284.46	232.2	104.5	52.2	52.3	0.91	13,284	2518255	2,821
North Kings	Central Kings	24	80,000	-2%	81,808	9,989	0.0041	21.5	242.65	268.3	62.6	88.3	25.6	0.45	4,321	1437882	1,611
North Kings	Central Kings	25	***100,000***	-4%	100,000	18,219	0.0017	9.0	224.24	268.3	44.2	88.3	44.0	0.77	12,665	2168132	2,429
North Kings	Central Kings	26	***95,000***	-3%	95,000	3,430	0.0023	12.2	203.10	268.3	23.1	88.3	65.2	1.14	3,113	683914	766
North Kings	Central Kings	27	***95,000***	-3%	95,000	2,653	0.0029	15.3	211.64	268.3	31.6	88.3	56.6	0.99	2,216	608933	682
North Kings	Kings River East	28	***95,000***	-5%	95,000	9,490	0.0038	19.9	225.49	235.8	45.5	55.8	10.3	0.18	1,691	604970	0
North Kings	Kings River East	29	59,000	N/A	59,000	6,424	0.0033	17.4	223.36	235.8	43.4	55.8	12.4	0.22	1,379	268792	0
North Kings	Kings River East	30	30,000	N/A	30,000	3,027	0.0026	14.0	222.44	235.8	42.4	55.8	13.3	0.23	697	55436	0
Kings River East	North Kings	31	30,000	N/A	30,000	5,071	N/A	N/A	N/A	235.8	N/A	55.8	N/A	N/A	N/A	N/A	0
Kings River East	North Kings	32	30,000	N/A	30,000	16,502	N/A	N/A	N/A	34.6	N/A	34.6	N/A	N/A	N/A	N/A	0
Central Kings	Kings River East	33	***95,000***	-3%	95,000	2,895	0.0028	14.9	211.22	255.3	31.2	75.3	44.1	0.77	2,015	541909	0
Kings River East	Central Kings	34	***95,000***	-3%	95,000	4,909	0.0020	10.4	201.00	220.0	21.0	40.0	19.0	0.33	1,596	299165	0
Central Kings	Kings River East	35	80,000	-3%	82,389	13,736	0.0011	5.7	188.16	189.4	8.2	9.4	1.2	0.02	286	25264	0
Central Kings	Kings River East	36	80,000	-3%	82,432	5,888	0.0011	6.0	159.00	349.5	159.0	169.5	10.5	0.18	1,071	101009	0
Central Kings	Kings River East	37	80,000	-4%	83,016	5,428	0.0012	6.4	142.00	360.0	142.0	180.0	38.0	0.66	3,339	336028	0
Central Kings	Kings River East	38	95,000	-4%	99,209	3,460	0.0010	5.5	152.58	360.0	152.6	180.0	27.4	0.48	1,591	163086	0
Kings River East	Central Kings	39	95,000	-5%	99,384	3,116	0.0006	3.1	188.41	96.4	8.4	96.4	88.0	1.54	3,114	181197	0
Central Kings	Kings River East	40	90,000	-3%	93,041	15,843	0.0004	2.2	353.55	96.4	173.5	96.4	77.1	1.35	15,444	595692	0
Central Kings	Kings River East	41	90,000	-2%	91,624	17,844	0.0015	8.1	171.92	178.6	171.9	178.6	6.7	0.12	2,080	293864	0
Kings River East	Central Kings	42	90,000	-3%	92,338	17,872	0.0013	6.7	237.33	186.7	57.3	6.7	50.7	0.88	13,824	1615335	0
Kings River East	Central Kings	43	78,000	-2%	79,423	5,653	0.0007	3.8	260.29	229.9	80.3	49.9	30.4	0.53	2,863	165385	0
Kings River East	Central Kings	44	78,000	-1%	78,916	16,793	0.0011	5.7	261.54	203.7	81.5	23.7	57.8	1.01	14,210	1221199	0
Kings River East	Central Kings	45	***120,000***	3%	120,000	6,008	0.0013	6.7	243.06	173.3	63.1	173.3	69.7	1.22	5,636	852424	0
Central Kings	Kings River East	46	***120,000***	6%	120,000	6,400	0.0014	7.1	226.81	254.6	46.8	74.6	27.8	0.49	2,985	483937	0
Kings River East	Central Kings	47	***120,000***	8%	120,000	7,877	0.0011	5.7	234.51	211.1	54.5	31.1	23.4	0.41	3,133	408205	0
Central Kings	McMullin	48	98,000	23%	75,891	14,924	0.0040	20.9	236.61	180.8	56.6	0.8	55.8	0.97	12,340	3701926	4,147
Central Kings	McMullin	49	75,000	27%	54,886	10,541	0.0041	21.7	246.96	180.8	67.0	0.8	66.1	1.15	9,641	2178401	2,440
McMullin	Central Kings	50	75,000	27%	54,997	5,264	0.0038	20.1	250.80	270.3	70.8	90.3	19.5	0.34	1,761	369178	414
Central Kings	McMullin	51	75,000	26%	55,425	10,654	0.0020	10.3	254.47	180.7	74.5	0.7	73.8	1.29	10,230	1107702	1,241
James	McMullin	52	128,000	11%	114,224	6,877	0.0012	6.3	125.10	132.3	125.1	132.3	7.2	0.13	862	117216	131
James	McMullin	53	128,000	11%	114,064	7,174	0.0011	5.9	124.27	130.2	124.3	130.2	6.0	0.10	747	95866	107
James	McMullin	54	107,000	13%	92,969	6,829	0.0012	6.5	77.74	132.7	77.7	132.7	55.0	0.96	5,591	641901	719
James	McMullin	55	***112,000***	16%	112,000	9,572	0.0027	14.2	101.03	141.8	101.0	141.8	40.7	0.71	6,247	1879275	2,105
James	McMullin	56	***112,000***	19%	112,000	9,617	0.0027	14.3	98.13	141.6	98.1	141.6	43.5	0.76	6,621	2014600	2,257
James	McMullin	57	128,000	22%	99,217	9,585	0.0038	20.0	96.20	142.0	96.2	142.0	45.8	0.80	6,869	2583044	2,893
James	McMullin	58	128,000	24%	97,258	6,153	0.0048	25.4	49.14	142.2	49.1	142.2	87.0	1.52	6,145	2876168	3,222
James	McMullin	59	125,000	24%	95,517	3,455	0.0044	23.0	45.79	152.8	45.8	152.8	73.0	1.27	3,304	1373142	1,538
North Fork Kings	McMullin	60	125,000	25%	93,183	4,656	0.0036	18.9	40.93	227.4	40.9	47.4	6.5	0.11	524	174373	195
North Fork Kings	McMullin	61	125,000	27%	91,501	7,115	0.0035	18.4	35.07	315.0	35.1	135.0	80.1	1.40	7,008	2229125	2,497
North Fork Kings	McMullin	62	123,000	29%	87,645	16,815	0.0042	22.0	11.97	288.4	12.0	108.4	83.6	1.46	16,710	6090185	6,822
North Fork Kings	McMullin	63	123,000	31%	85,245	11,841	0.0048	25.1	47.59	334.5	47.6	154.5	73.1	1.28	11,330	4589643	5,141
North Fork Kings	McMullin	64	123,000	29%	86,845	10,574	0.0012	6.5	347.19	270.1	167.2	90.1	77.1	1.34	10,305	1106564	1,240
North Fork Kings	McMullin	65	75,000	30%	52,395	5,349	0.0013	7.1	296.39	270.8	116.4	90.8	25.6	0.45	2,309	162547	182
North Fork Kings	McMullin	66	75,000	31%	51,830	5,277	0.0012	6.6	329.54	180.5	149.5	0.5	31.0	0.54	2,717	175464	197

Attachment 3 - 1998 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Fork Kings	McMullin	67	75,000	32%	51,283	5,354	0.0013	7.0	285.19	270.1	105.2	90.1	15.1	0.26	1,392	94387	106
McMullin	North Fork Kings	68	75,000	30%	52,225	5,258	0.0028	14.8	309.40	0.8	129.4	0.8	51.4	0.90	4,107	603002	675
McMullin	North Fork Kings	69	75,000	26%	55,265	10,633	0.0025	13.1	299.86	270.2	119.9	90.2	29.7	0.52	5,264	721017	808
North Fork Kings	Central Kings	70	75,000	26%	55,396	10,594	0.0027	14.4	294.46	270.3	114.5	90.3	24.2	0.42	4,343	653974	733
Central Kings	North Fork Kings	71	73,000	25%	54,577	10,677	0.0040	21.3	255.81	270.4	75.8	90.4	14.6	0.25	2,687	591944	663
Central Kings	North Fork Kings	72	73,000	25%	54,969	5,277	0.0042	22.1	254.67	0.5	74.7	0.5	74.1	1.29	5,076	1168456	1,309
Central Kings	North Fork Kings	73	73,000	25%	54,623	15,835	0.0026	13.8	240.14	270.4	60.1	90.4	30.3	0.53	7,979	1140433	1,277
North Fork Kings	Central Kings	74	73,000	23%	56,203	5,273	0.0016	8.7	197.20	180.4	17.2	0.4	16.8	0.29	1,522	141127	158
Central Kings	North Fork Kings	75	73,000	20%	58,546	5,321	0.0026	13.7	206.00	270.3	26.0	90.3	64.3	1.12	4,795	729514	817
Central Kings	North Fork Kings	76	93,000	14%	80,296	14,584	0.0034	18.1	211.26	270.7	31.3	90.7	59.4	1.04	12,554	3449707	3,864
Central Kings	North Fork Kings	77	93,000	6%	87,498	1,334	0.0042	22.2	219.56	270.8	39.6	90.8	51.2	0.89	1,040	383195	429
Central Kings	North Fork Kings	78	93,000	6%	87,676	14,877	0.0028	14.9	231.08	315.4	51.1	135.4	84.3	1.47	14,804	3660550	4,100
Central Kings	North Fork Kings	79	***118,000***	6%	118,000	4,185	0.0027	14.0	266.33	270.3	86.3	90.3	3.9	0.07	287	90059	101
Central Kings	North Fork Kings	80	***118,000***	4%	118,000	9,772	0.0022	11.8	260.00	271.5	80.0	91.5	11.5	0.20	1,940	513751	575
Central Kings	North Fork Kings	81	***118,000***	6%	118,000	10,682	0.0016	8.3	273.48	0.7	93.5	0.7	87.2	1.52	10,670	1986808	2,226
Central Kings	North Fork Kings	82	***118,000***	14%	118,000	6,290	0.0014	7.6	302.28	68.3	122.3	68.3	53.9	0.94	5,085	867032	971
James	North Fork Kings	83	86,000	N/A	86,000	11,628	0.0015	8.1	139.00	263.5	139.0	83.5	55.5	0.97	9,585	1260036	1,411
James	North Fork Kings	84	87,000	N/A	87,000	6,538	0.0018	9.7	126.90	281.3	126.9	101.3	25.6	0.45	2,828	454359	509
North Fork Kings	James	85	87,000	N/A	87,000	18,139	0.0012	6.3	80.49	263.8	80.5	83.8	3.3	0.06	1,042	108207	121

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 1999 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	McMullin	0	96,000	0%	96,000	3958	0.0030	15.8	253.17	180.1	73.2	0.1	73.1	1.28	3,787	1089757	1,221
North Kings	McMullin	1	96,000	0%	96,000	5,250	0.0033	17.3	174.83	90.6	174.8	90.6	84.2	1.47	5,223	1639707	1,837
McMullin	North Kings	2	96,000	0%	96,000	5,317	0.0035	18.4	170.96	180.0	171.0	0.0	9.0	0.16	836	279235	313
North Kings	McMullin	3	96,000	6%	90,147	10,532	0.0047	24.7	179.53	180.1	179.5	0.1	0.6	0.01	109	46063	52
North Kings	McMullin	4	97,000	9%	88,161	11,871	0.0053	28.1	198.70	90.9	18.7	90.9	72.2	1.26	11,305	5295062	5,931
North Kings	McMullin	5	98,000	10%	88,337	7,744	0.0050	26.6	213.29	181.4	33.3	1.4	31.9	0.56	4,094	1819049	2,038
North Kings	McMullin	6	98,000	12%	86,236	22,487	0.0042	22.4	224.35	136.3	44.3	136.3	88.1	1.54	22,474	8228178	9,217
North Kings	McMullin	7	***120,000***	0%	120,000	8,027	0.0042	22.0	211.70	180.7	31.7	0.7	31.0	0.54	4,128	2062020	2,310
North Kings	McMullin	8	120,000	17%	99,359	11,936	0.0039	20.5	219.09	90.3	39.1	90.3	51.2	0.89	9,300	3584478	4,015
North Kings	McMullin	9	120,000	13%	104,129	11,887	0.0035	18.5	214.03	90.6	34.0	90.6	56.6	0.99	9,921	3628515	4,064
North Kings	McMullin	10	120,000	9%	109,054	11,937	0.0048	25.1	202.96	90.0	23.0	90.0	67.1	1.17	10,995	5696548	6,381
North Kings	McMullin	11	***182,000***	0%	182,000	11,909	0.0054	28.6	193.61	90.2	13.6	90.2	76.6	1.34	11,584	11410834	12,782
North Kings	McMullin	12	***115,000***	0%	115,000	15,873	0.0036	18.9	188.86	180.9	8.9	0.9	7.9	0.14	2,194	903144	1,012
North Kings	McMullin	13	98,000	18%	80,494	10,744	0.0038	20.2	223.40	279.5	43.4	99.5	56.1	0.98	8,921	2746798	3,077
North Kings	Central Kings	14	98,000	17%	81,042	5,348	0.0045	23.9	232.85	279.5	52.9	99.5	46.7	0.81	3,891	1428497	1,600
Central Kings	North Kings	15	91,000	14%	78,480	7,944	0.0038	20.1	222.50	0.9	42.5	0.9	41.6	0.73	5,272	1576839	1,766
North Kings	Central Kings	16	83,000	11%	73,698	15,707	0.0028	14.8	221.70	90.3	41.7	90.3	48.6	0.85	11,778	2441165	2,734
North Kings	Central Kings	17	83,000	10%	74,984	5,303	0.0025	13.1	215.67	179.9	35.7	179.9	35.8	0.62	3,099	578218	648
North Kings	Central Kings	18	83,000	9%	75,507	15,829	0.0026	13.6	239.08	90.2	59.1	90.2	31.1	0.54	8,169	1593519	1,785
Central Kings	North Kings	19	89,000	6%	83,730	10,569	0.0025	13.2	258.41	0.5	78.4	0.5	77.9	1.36	10,334	2168883	2,429
North Kings	Central Kings	20	95,000	4%	91,507	18,685	0.0018	9.3	252.56	90.3	72.6	90.3	17.7	0.31	5,691	921109	1,032
Central Kings	North Kings	21	95,000	1%	93,861	5,292	0.0017	8.8	249.83	1.1	69.8	1.1	68.7	1.20	4,930	774934	868
Central Kings	North Kings	22	111,000	3%	108,001	10,632	0.0017	9.0	285.66	0.3	105.7	0.3	74.6	1.30	10,252	1877937	2,104
Central Kings	North Kings	23	111,000	3%	107,937	16,792	0.0027	14.4	277.89	232.2	97.9	52.2	45.7	0.80	12,021	3526569	3,950
North Kings	Central Kings	24	80,000	-2%	81,808	9,989	0.0015	7.9	280.25	268.3	100.3	88.3	12.0	0.21	2,072	252718	283
North Kings	Central Kings	25	***100,000***	0%	100,000	18,219	0.0020	10.8	240.40	268.3	60.4	88.3	27.9	0.49	8,520	1740194	1,949
North Kings	Central Kings	26	***95,000***	0%	95,000	3,430	0.0017	9.0	212.18	268.3	32.2	88.3	56.1	0.98	2,847	460774	*516*
North Kings	Central Kings	27	***95,000***	0%	95,000	2,653	0.0021	10.9	207.55	268.3	27.5	88.3	60.7	1.06	2,314	455512	*510*
North Kings	Kings River East	28	***95,000***	0%	95,000	9,490	0.0030	15.7	210.03	235.8	30.0	55.8	25.7	0.45	4,119	1159977	0
North Kings	Kings River East	29	59,000	0%	59,000	6,424	0.0047	25.0	203.35	235.8	23.4	55.8	32.4	0.57	3,442	961761	0
North Kings	Kings River East	30	30,000	0%	30,000	3,027	0.0048	25.3	192.31	235.8	12.3	55.8	43.4	0.76	2,082	299326	0
North Kings	Kings River East	31	30,000	0%	30,000	5,071	0.0029	15.3	193.27	235.8	13.3	55.8	42.5	0.74	3,426	297534	0
Kings River East	North Kings	32	30,000	0%	30,000	16,502	0.0020	10.4	242.34	34.6	62.3	34.6	27.7	0.48	7,678	454655	0
Central Kings	Kings River East	33	***95,000***	0%	95,000	2,895	0.0021	11.0	205.76	255.3	25.8	75.3	49.6	0.87	2,203	435203	0
Central Kings	Kings River East	34	***95,000***	0%	95,000	4,909	0.0017	9.2	200.35	220.0	20.3	40.0	19.6	0.34	1,648	273814	0
Kings River East	Central Kings	35	80,000	-3%	82,389	13,736	0.0016	8.6	196.97	189.4	17.0	9.4	7.6	0.13	1,822	245719	0
Central Kings	Kings River East	36	80,000	-3%	82,432	5,888	0.0011	5.8	170.80	349.5	170.8	169.5	1.3	0.02	135	12169	0
Central Kings	Kings River East	37	80,000	-4%	83,016	5,428	0.0012	6.5	140.85	360.0	140.8	180.0	39.1	0.68	3,424	350822	0
Central Kings	Kings River East	38	95,000	-4%	99,209	3,460	0.0017	9.1	143.57	360.0	143.6	180.0	36.4	0.64	2,052	352363	0
Kings River East	Central Kings	39	95,000	-5%	99,384	3,116	0.0017	9.0	149.87	96.4	149.9	96.4	53.4	0.93	2,503	422149	0
Kings River East	Central Kings	40	90,000	-3%	93,041	15,843	0.0013	7.1	172.38	96.4	172.4	96.4	75.9	1.33	15,369	1915796	0
Kings River East	Central Kings	41	90,000	-2%	91,624	17,844	0.0008	4.4	199.32	178.6	19.3	178.6	20.7	0.36	6,311	481843	0
Central Kings	Kings River East	42	90,000	-3%	92,338	17,872	0.0005	2.4	152.06	186.7	152.1	6.7	34.6	0.60	10,149	433965	0
Central Kings	Kings River East	43	78,000	-2%	79,423	5,653	0.0009	4.6	177.74	229.9	177.7	49.9	52.1	0.91	4,462	309143	0
Kings River East	Central Kings	44	78,000	-1%	78,916	16,793	0.0010	5.0	251.23	203.7	71.2	23.7	47.5	0.83	12,378	933122	0
Kings River East	Central Kings	45	***120,000***	0%	120,000	6,008	0.0013	6.8	200.97	173.3	21.0	173.3	27.6	0.48	2,787	428076	0
Central Kings	Kings River East	46	***120,000***	0%	120,000	6,400	0.0005	2.8	198.91	254.6	18.9	74.6	55.7	0.97	5,287	336448	0
Central Kings	Kings River East	47	***120,000***	0%	120,000	7,877	0.0015	7.9	190.74	211.1	10.7	31.1	20.3	0.35	2,736	492712	0
Central Kings	McMullin	48	98,000	23%	75,891	14,924	0.0042	22.1	245.87	180.8	65.9	0.8	65.0	1.14	13,530	4297932	4,814
Central Kings	McMullin	49	75,000	27%	54,886	10,541	0.0040	21.1	251.77	180.8	71.8	0.8	71.0	1.24	9,964	2189172	2,452
McMullin	Central Kings	50	75,000	27%	54,997	5,264	0.0043	22.8	259.62	270.3	79.6	90.3	10.7	0.19	979	233110	261
Central Kings	McMullin	51	75,000	26%	55,425	10,654	0.0024	12.6	294.55	180.7	114.6	0.7	66.1	1.15	9,744	1289887	1,445
James	McMullin	52	128,000	11%	114,224	6,877	0.0051	26.8	56.57	132.3	56.6	132.3	75.7	1.32	6,665	3862859	4,327
James	McMullin	53	128,000	11%	114,064	7,174	0.0080	42.5	25.63	130.2	25.6	130.2	75.4	1.32	6,941	6373256	7,139
James	McMullin	54	107,000	13%	92,969	6,829	0.0075	39.8	56.80	132.7	56.8	132.7	75.9	1.32	6,623	4637493	5,195
James	McMullin	55	***112,000***	0%	112,000	9,572	0.0079	41.7	55.40	141.8	55.4	141.8	86.4	1.51	9,553	8440025	9,454
James	McMullin	56	***112,000***	0%	112,000	9,617	0.0074	39.0	72.69	141.6	72.7	141.6	68.9	1.20	8,975	7418327	8,310
James	McMullin	57	128,000	22%	99,217	9,585	0.0046	24.3	66.77	142.0	66.8	142.0	75.2	1.31	9,268	4223395	4,731
James	McMullin	58	128,000	24%	97,258	6,153	0.0027	14.0	52.05	142.2	52.1	142.2	89.9	1.57	6,153	1587601	1,778
James	McMullin	59	125,000	24%	95,517	3,455	0.0033	17.5	69.74	152.8	69.7	152.8	83.0	1.45	3,429	1087759	1,218
McMullin	North Fork Kings	60	125,000	25%	93,183	4,656	0.0036	19.0	65.31	227.4	65.3	47.4	17.9	0.31	1,432	481325	539
North Fork Kings	McMullin	61	125,000	27%	91,501	7,115	0.0029	15.3	22.52	315.0	22.5	135.0	67.5	1.18	6,574	1741388	1,951
North Fork Kings	McMullin	62	123,000	29%	87,645	16,815	0.0016	8.3	13.08	288.4	13.1	108.4	84.7	1.48	16,744	2299587	2,576
North Fork Kings	McMullin	63	123,000	31%	85,245	11,841	0.0009	4.5	358.92	334.5	178.9	154.5	24.5	0.43	4,901	356286	399
North Fork Kings	McMullin	64	123,000	29%	86,845	10,574	0.0030	15.8	352.40	270.1	172.4	90.1	82.3	1.44	10,477	2716397	3,043
North Fork Kings	McMullin	65	75,000	30%	52,395	5,349	0.0013	6.8	333.11	270.8	153.1	90.8	62.3	1.09	4,735	318590	357
North Fork Kings	McMullin	66	75,000	31%	51,830	5,277	0.0011	5.9	306.54	180.5	126.5	0.5	54.0	0.94	4,269	248095	278

Attachment 3 - 1999 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Fork Kings	McMullin	67	75,000	32%	51,283	5,354	0.0014	7.6	305.94	270.1	125.9	90.1	35.8	0.63	3,133	232163	260
McMullin	North Fork Kings	68	75,000	30%	52,225	5,258	0.0026	13.8	283.65	0.8	103.6	0.8	77.1	1.35	5,125	700861	785
North Fork Kings	McMullin	69	75,000	26%	55,265	10,633	0.0034	17.7	301.42	270.2	121.4	90.2	31.2	0.55	5,514	1021328	1,144
North Fork Kings	Central Kings	70	75,000	26%	55,396	10,594	0.0036	19.1	301.81	270.3	121.8	90.3	31.6	0.55	5,543	1111193	1,245
Central Kings	North Fork Kings	71	73,000	25%	54,577	10,677	0.0037	19.7	244.01	270.4	64.0	90.4	26.4	0.46	4,744	966933	1,083
Central Kings	North Fork Kings	72	73,000	25%	54,969	5,277	0.0027	14.1	239.91	0.5	59.9	0.5	59.4	1.04	4,541	666526	747
Central Kings	North Fork Kings	73	73,000	25%	54,623	15,835	0.0027	14.3	234.65	270.4	54.7	90.4	35.8	0.62	9,252	1370502	1,535
North Fork Kings	Central Kings	74	73,000	23%	56,203	5,273	0.0020	10.5	230.12	180.4	50.1	0.4	49.7	0.87	4,022	449647	504
Central Kings	North Fork Kings	75	73,000	20%	58,546	5,321	0.0022	11.6	223.54	270.3	43.5	90.3	46.8	0.82	3,878	499791	560
Central Kings	North Fork Kings	76	93,000	14%	80,296	14,584	0.0031	16.4	213.47	270.7	33.5	90.7	57.2	1.00	12,259	3063816	3,432
Central Kings	North Fork Kings	77	93,000	6%	87,498	1,334	0.0041	21.6	226.00	270.8	46.0	90.8	44.8	0.78	939	336355	377
Central Kings	North Fork Kings	78	93,000	6%	87,676	14,877	0.0024	12.7	227.83	315.4	47.8	135.4	87.6	1.53	14,863	3128890	3,505
Central Kings	North Fork Kings	79	***118,000***	0%	118,000	4,185	0.0020	10.7	244.46	270.3	64.5	90.3	25.8	0.45	1,822	436539	489
Central Kings	North Fork Kings	80	***118,000***	0%	118,000	9,772	0.0020	10.7	240.68	271.5	60.7	91.5	30.8	0.54	5,000	1194726	1,338
Central Kings	North Fork Kings	81	***118,000***	0%	118,000	10,682	0.0021	10.9	285.22	0.7	105.2	0.7	75.5	1.32	10,341	2519883	2,823
Central Kings	North Fork Kings	82	***118,000***	0%	118,000	6,290	0.0018	9.2	329.00	68.3	149.0	68.3	80.7	1.41	6,207	1282920	1,437
James	North Fork Kings	83	86,000	0%	86,000	11,628	0.0016	8.5	136.80	263.5	136.8	83.5	53.3	0.93	9,326	1287004	1,442
James	North Fork Kings	84	87,000	0%	87,000	6,538	0.0017	9.2	130.42	281.3	130.4	101.3	29.2	0.51	3,185	481349	539
James	North Fork Kings	85	87,000	0%	87,000	18,139	0.0016	8.7	107.17	263.8	107.2	83.8	23.4	0.41	7,198	1032911	1,157

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2000 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	McMullin	0	96,000	0%	96,000	3958	0.0036	19.2	252.26	180.1	72.3	0.1	72.1	1.26	3,767	1316144	1,474
North Kings	McMullin	1	96,000	0%	96,000	5,250	0.0052	27.6	171.44	90.6	171.4	90.6	80.8	1.41	5,183	2599198	2,911
McMullin	North Kings	2	96,000	0%	96,000	5,317	0.0051	26.9	163.75	180.0	163.8	0.0	16.2	0.28	1,488	727123	814
McMullin	North Kings	3	96,000	6%	90,147	10,532	0.0025	13.3	175.91	180.1	175.9	0.1	4.2	0.07	775	176460	198
North Kings	McMullin	4	97,000	9%	88,161	11,871	0.0036	19.1	213.03	90.9	33.0	90.9	57.9	1.01	10,057	3204712	3,590
North Kings	McMullin	5	98,000	10%	88,337	7,744	0.0041	21.5	208.67	181.4	28.7	1.4	27.3	0.48	3,551	1278284	1,432
North Kings	McMullin	6	98,000	12%	86,236	22,487	0.0046	24.1	219.43	136.3	39.4	136.3	83.2	1.45	22,327	8773951	9,828
North Kings	McMullin	7	***120,000***	0%	120,000	8,027	0.0053	28.1	248.07	180.7	68.1	0.7	67.3	1.17	7,406	4736176	5,305
North Kings	McMullin	8	120,000	17%	99,359	11,936	0.0034	17.8	221.39	90.3	41.4	90.3	48.9	0.85	8,994	3020576	3,383
North Kings	McMullin	9	120,000	13%	104,129	11,887	0.0051	27.1	209.28	90.6	29.3	90.6	61.3	1.07	10,429	5576807	6,247
North Kings	McMullin	10	120,000	9%	109,054	11,937	0.0045	23.7	208.73	90.0	28.7	90.0	61.3	1.07	10,472	5132508	5,749
North Kings	McMullin	11	***182,000***	0%	182,000	11,909	0.0046	24.5	202.31	90.2	22.3	90.2	67.9	1.19	11,034	9313783	10,433
North Kings	McMullin	12	***115,000***	0%	115,000	15,873	0.0036	19.0	207.43	180.9	27.4	0.9	26.5	0.46	7,086	2928485	3,280
North Kings	McMullin	13	98,000	18%	80,494	10,744	0.0042	22.4	224.17	279.5	44.2	99.5	55.4	0.97	8,841	3017778	3,380
North Kings	Central Kings	14	98,000	17%	81,042	5,348	0.0033	17.6	224.78	279.5	44.8	99.5	54.7	0.96	4,367	1182023	1,324
Central Kings	North Kings	15	91,000	14%	78,480	7,944	0.0021	11.1	230.63	0.9	50.6	0.9	49.7	0.87	6,059	995993	1,116
North Kings	Central Kings	16	83,000	11%	73,698	15,707	0.0029	15.3	254.07	90.3	74.1	90.3	16.2	0.28	4,382	933441	1,046
North Kings	Central Kings	17	83,000	10%	74,984	5,303	0.0025	13.2	232.08	179.9	52.1	179.9	52.2	0.91	4,188	783069	877
North Kings	Central Kings	18	83,000	9%	75,507	15,829	0.0022	11.5	244.65	90.2	64.6	90.2	25.5	0.45	6,816	1122827	1,258
Central Kings	North Kings	19	89,000	6%	83,730	10,569	0.0030	15.9	253.91	0.5	73.9	0.5	73.4	1.28	10,128	2558578	2,866
North Kings	Central Kings	20	95,000	4%	91,507	18,685	0.0021	10.9	239.17	90.3	59.2	90.3	31.1	0.54	9,660	1829021	2,049
Central Kings	North Kings	21	95,000	1%	93,861	5,292	0.0015	7.9	221.42	1.1	41.4	1.1	40.3	0.70	3,422	480575	538
Central Kings	North Kings	22	111,000	3%	108,001	10,632	0.0015	8.1	284.60	0.3	104.6	0.3	75.7	1.32	10,302	1709951	1,915
Central Kings	North Kings	23	111,000	3%	107,937	16,792	0.0020	10.7	284.66	232.2	104.7	52.2	52.5	0.92	13,320	2902665	3,251
North Kings	Central Kings	24	80,000	-2%	81,808	9,989	0.0049	25.7	237.48	268.3	57.5	88.3	30.8	0.54	5,114	2034316	2,279
North Kings	Central Kings	25	***100,000***	0%	100,000	18,219	0.0015	7.8	211.63	268.3	31.6	88.3	56.7	0.99	15,220	2253350	2,524
North Kings	Central Kings	26	***95,000***	0%	95,000	3,430	0.0019	10.3	215.38	268.3	35.4	88.3	52.9	0.92	2,736	505829	567
North Kings	Central Kings	27	***95,000***	0%	95,000	2,653	0.0024	12.7	220.62	268.3	40.6	88.3	47.7	0.83	1,961	446384	500
North Kings	Kings River East	28	***95,000***	0%	95,000	9,490	0.0028	14.9	222.71	235.8	42.7	55.8	13.0	0.23	2,142	575379	0
North Kings	Kings River East	29	59,000	0%	59,000	6,424	0.0042	22.3	211.18	235.8	31.2	55.8	24.6	0.43	2,672	665426	0
North Kings	Kings River East	30	30,000	0%	30,000	3,027	0.0039	20.8	201.17	235.8	21.2	55.8	34.6	0.60	1,718	202787	0
North Kings	Kings River East	31	30,000	0%	30,000	5,071	N/A	N/A	N/A	235.8	N/A	55.8	N/A	N/A	N/A	N/A	0
Kings River East	North Kings	32	30,000	0%	30,000	16,502	N/A	N/A	N/A	34.6	N/A	34.6	N/A	N/A	N/A	N/A	0
Central Kings	Kings River East	33	***95,000***	0%	95,000	2,895	0.0025	13.0	219.88	255.3	39.9	75.3	35.4	0.62	1,679	392911	0
Central Kings	Kings River East	34	***95,000***	0%	95,000	4,909	0.0021	10.9	207.13	220.0	27.1	40.0	12.8	0.22	1,091	212996	0
Kings River East	Central Kings	35	80,000	-3%	82,389	13,736	0.0014	7.4	179.90	189.4	179.9	9.4	9.5	0.16	2,256	259878	0
Central Kings	Kings River East	36	80,000	-3%	82,432	5,888	0.0010	5.4	157.68	349.5	157.7	169.5	11.8	0.21	1,204	101745	0
Central Kings	Kings River East	37	80,000	-4%	83,016	5,428	0.0014	7.2	131.82	360.0	131.8	180.0	48.1	0.84	4,042	459847	0
Central Kings	Kings River East	38	95,000	-4%	99,209	3,460	0.0016	8.5	133.60	360.0	133.6	180.0	46.4	0.81	2,504	400824	0
Kings River East	Central Kings	39	95,000	-5%	99,384	3,116	0.0015	8.1	137.50	96.4	137.5	96.4	41.1	0.72	2,047	311729	0
Kings River East	Central Kings	40	90,000	-3%	93,041	15,843	0.0015	8.1	172.81	96.4	172.8	96.4	76.4	1.33	15,397	2204537	0
Kings River East	Central Kings	41	90,000	-2%	91,624	17,844	0.0013	6.9	223.93	178.6	43.9	178.6	45.3	0.79	12,688	1529077	0
Kings River East	Central Kings	42	90,000	-3%	92,338	17,872	0.0006	3.3	248.36	186.7	68.4	6.7	61.7	1.08	15,736	899564	0
Kings River East	Central Kings	43	78,000	-2%	79,423	5,653	0.0008	4.5	307.94	229.9	127.9	49.9	78.1	1.36	5,531	371596	0
Kings River East	Central Kings	44	78,000	-1%	78,916	16,793	0.0015	7.8	265.25	203.7	85.2	23.7	61.5	1.07	14,759	1712251	0
Kings River East	Central Kings	45	***120,000***	0%	120,000	6,008	0.0014	7.2	241.61	173.3	61.6	173.3	68.3	1.19	5,581	915298	0
Central Kings	Kings River East	46	***120,000***	0%	120,000	6,400	0.0010	5.3	227.60	254.6	47.6	74.6	27.0	0.47	2,908	347725	0
Kings River East	Central Kings	47	***120,000***	0%	120,000	7,877	0.0009	4.5	235.69	211.1	55.7	31.1	24.6	0.43	3,282	335422	0
Central Kings	McMullin	48	98,000	23%	75,891	14,924	0.0049	26.0	237.21	180.8	57.2	0.8	56.4	0.98	12,427	4646827	5,205
Central Kings	McMullin	49	75,000	27%	54,886	10,541	0.0040	21.3	263.26	180.8	83.3	0.8	82.4	1.44	10,450	2314122	2,592
McMullin	Central Kings	50	75,000	27%	54,997	5,264	0.0029	15.3	256.32	270.3	76.3	90.3	14.0	0.24	1,275	203165	228
Central Kings	McMullin	51	75,000	26%	55,425	10,654	0.0017	9.0	236.37	180.7	56.4	0.7	55.7	0.97	8,799	833188	933
James	McMullin	52	128,000	11%	114,224	6,877	0.0026	13.8	80.09	132.3	80.1	132.3	52.2	0.91	5,435	1626485	1,822
James	McMullin	53	128,000	11%	114,064	7,174	0.0018	9.6	96.52	130.2	96.5	130.2	33.7	0.59	3,984	824511	924
James	McMullin	54	107,000	13%	92,969	6,829	0.0012	6.2	112.86	132.7	112.9	132.7	19.8	0.35	2,319	254189	285
McMullin	James	55	***112,000***	0%	112,000	9,572	0.0008	4.3	176.94	141.8	176.9	141.8	35.2	0.61	5,514	508220	569
James	McMullin	56	***112,000***	0%	112,000	9,617	0.0016	8.4	133.42	141.6	133.4	141.6	8.2	0.14	1,374	243605	273
James	McMullin	57	128,000	22%	99,217	9,585	0.0040	21.2	92.85	142.0	92.9	142.0	49.1	0.86	7,248	2885741	3,232
James	McMullin	58	128,000	24%	97,258	6,153	0.0022	11.5	71.73	142.2	71.7	142.2	70.4	1.23	5,798	1226015	1,373
James	McMullin	59	125,000	24%	95,517	3,455	0.0015	8.1	19.50	152.8	19.5	152.8	46.7	0.82	2,515	370669	415
North Fork Kings	McMullin	60	125,000	25%	93,183	4,656	0.0025	13.2	355.69	227.4	175.7	47.4	51.7	0.90	3,654	851341	954
North Fork Kings	McMullin	61	125,000	27%	91,501	7,115	0.0031	16.5	16.99	315.0	17.0	135.0	62.0	1.08	6,281	1796363	2,012
North Fork Kings	McMullin	62	123,000	29%	87,645	16,815	0.0017	9.0	3.82	288.4	3.8	108.4	75.4	1.32	16,276	2432995	2,725
North Fork Kings	McMullin	63	123,000	31%	85,245	11,841	0.0010	5.3	347.48	334.5	167.5	154.5	13.0	0.23	2,665	227557	255
North Fork Kings	McMullin	64	123,000	29%	86,845	10,574	0.0006	3.3	12.62	270.1	12.6	90.1	77.5	1.35	10,324	557702	625
McMullin	North Fork Kings	65	75,000	30%	52,395	5,349	0.0018	9.5	267.04	270.8	87.0	90.8	3.8	0.07	352	33169	37
North Fork Kings	McMullin	66	75,000	31%	51,830	5,277	0.0016	8.4	261.64	180.5	81.6	0.5	81.1	1.42	5,214	429147	481

Attachment 3 - 2000 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
McMullin	North Fork Kings	67	75,000	32%	51,283	5,354	0.0012	6.3	235.01	270.1	55.0	90.1	35.1	0.61	3,080	187489	210
McMullin	North Fork Kings	68	75,000	30%	52,225	5,258	0.0016	8.2	295.14	0.8	115.1	0.8	65.6	1.15	4,789	389679	436
North Fork Kings	McMullin	69	75,000	26%	55,265	10,633	0.0025	13.5	286.03	270.2	106.0	90.2	15.8	0.28	2,902	408731	458
North Fork Kings	Central Kings	70	75,000	26%	55,396	10,594	0.0039	20.8	293.00	270.3	113.0	90.3	22.7	0.40	4,096	892612	1,000
North Fork Kings	Central Kings	71	73,000	25%	54,577	10,677	0.0035	18.4	308.42	270.4	128.4	90.4	38.0	0.66	6,578	1250531	1,401
Central Kings	North Fork Kings	72	73,000	25%	54,969	5,277	0.0056	29.8	257.84	0.5	77.8	0.5	77.3	1.35	5,148	1598516	1,791
Central Kings	North Fork Kings	73	73,000	25%	54,623	15,835	0.0031	16.3	221.12	270.4	41.1	90.4	49.3	0.86	12,002	2028512	2,272
North Fork Kings	Central Kings	74	73,000	23%	56,203	5,273	0.0026	13.7	233.54	180.4	53.5	0.4	53.1	0.93	4,218	613088	687
Central Kings	North Fork Kings	75	73,000	20%	58,546	5,321	0.0022	11.7	224.08	270.3	44.1	90.3	46.2	0.81	3,843	497512	557
Central Kings	North Fork Kings	76	93,000	14%	80,296	14,584	0.0028	15.0	216.19	270.7	36.2	90.7	54.5	0.95	11,871	2708078	3,033
Central Kings	North Fork Kings	77	93,000	6%	87,498	1,334	0.0042	22.0	221.43	270.8	41.4	90.8	49.3	0.86	1,012	368106	412
Central Kings	North Fork Kings	78	93,000	6%	87,676	14,877	0.0023	12.1	224.87	315.4	44.9	135.4	89.5	1.56	14,876	2993064	3,353
Central Kings	North Fork Kings	79	***118,000***	0%	118,000	4,185	0.0023	12.0	236.20	270.3	56.2	90.3	34.1	0.59	2,344	629589	705
Central Kings	North Fork Kings	80	***118,000***	0%	118,000	9,772	0.0024	12.5	230.52	271.5	50.5	91.5	40.9	0.71	6,402	1783855	1,998
Central Kings	North Fork Kings	81	***118,000***	0%	118,000	10,682	0.0018	9.7	272.53	0.7	92.5	0.7	88.2	1.54	10,677	2315527	2,594
Central Kings	North Fork Kings	82	***118,000***	0%	118,000	6,290	0.0019	10.0	324.72	68.3	144.7	68.3	76.4	1.33	6,113	1363135	1,527
James	North Fork Kings	83	86,000	0%	86,000	11,628	0.0016	8.5	157.07	263.5	157.1	83.5	73.6	1.28	11,155	1553312	1,740
James	North Fork Kings	84	87,000	0%	87,000	6,538	0.0020	10.4	153.88	281.3	153.9	101.3	52.6	0.92	5,195	893984	1,001
North Fork Kings	James	85	87,000	0%	87,000	18,139	0.0025	13.3	74.06	263.8	74.1	83.8	9.7	0.17	3,065	670817	751

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2001 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	McMullin	0	96,000	0%	96,000	3958	0.0040	21.0	274.78	180.1	94.8	0.1	85.4	1.49	3,945	1507717	1,689
North Kings	McMullin	1	96,000	0%	96,000	5,250	0.0064	33.7	193.66	90.6	13.7	90.6	76.9	1.34	5,114	3130001	3,506
McMullin	North Kings	2	96,000	0%	96,000	5,317	0.0092	48.8	178.19	180.0	178.2	0.0	1.8	0.03	168	148801	167
North Kings	McMullin	3	96,000	6%	90,147	10,532	0.0025	13.1	237.06	180.1	57.1	0.1	56.9	0.99	8,827	1967045	2,203
North Kings	McMullin	4	97,000	9%	88,161	11,871	0.0028	14.5	210.27	90.9	30.3	90.9	60.7	1.06	10,350	2513801	2,816
North Kings	McMullin	5	98,000	10%	88,337	7,744	0.0032	16.8	197.73	181.4	17.7	1.4	16.4	0.29	2,181	612526	686
North Kings	McMullin	6	98,000	12%	86,236	22,487	0.0042	22.3	218.29	136.3	38.3	136.3	82.0	1.43	22,269	8127501	9,104
North Kings	McMullin	7	***120,000***	0%	120,000	8,027	0.0036	18.9	213.31	180.7	33.3	0.7	32.6	0.57	4,320	1853475	2,076
North Kings	McMullin	8	120,000	17%	99,359	11,936	0.0043	22.8	198.85	90.3	18.8	90.3	71.4	1.25	11,315	4858115	5,442
North Kings	McMullin	9	120,000	13%	104,129	11,887	0.0036	19.2	206.02	90.6	26.0	90.6	64.6	1.13	10,737	4062099	4,550
North Kings	McMullin	10	120,000	9%	109,054	11,937	0.0057	30.0	210.73	90.0	30.7	90.0	59.3	1.04	10,266	6369804	7,135
North Kings	McMullin	11	***182,000***	0%	182,000	11,909	0.0066	34.8	199.71	90.2	19.7	90.2	70.5	1.23	11,225	13469419	15,088
North Kings	McMullin	12	***115,000***	0%	115,000	15,873	0.0042	22.3	205.86	180.9	25.9	0.9	24.9	0.44	6,694	3256716	3,648
North Kings	McMullin	13	98,000	18%	80,494	10,744	0.0042	22.3	224.32	279.5	44.3	99.5	55.2	0.96	8,824	3003451	3,364
North Kings	Central Kings	14	98,000	17%	81,042	5,348	0.0035	18.3	227.85	279.5	47.9	99.5	51.7	0.90	4,195	1178301	1,320
Central Kings	North Kings	15	91,000	14%	78,480	7,944	0.0026	13.9	221.35	0.9	41.3	0.9	40.4	0.71	5,151	1062580	1,190
North Kings	Central Kings	16	83,000	11%	73,698	15,707	0.0028	14.9	237.49	90.3	57.5	90.3	32.8	0.57	8,505	1763053	1,975
North Kings	Central Kings	17	83,000	10%	74,984	5,303	0.0027	14.4	228.29	179.9	48.3	179.9	48.4	0.84	3,964	809997	907
North Kings	Central Kings	18	83,000	9%	75,507	15,829	0.0028	14.6	233.29	90.2	53.3	90.2	36.9	0.64	9,495	1985069	2,224
Central Kings	North Kings	19	89,000	6%	83,730	10,569	0.0020	10.7	219.25	0.5	39.3	0.5	38.7	0.68	6,615	1117836	1,252
Central Kings	North Kings	20	95,000	4%	91,507	18,685	0.0016	8.5	303.34	90.3	123.3	90.3	33.0	0.58	10,187	1505598	1,686
Central Kings	North Kings	21	95,000	1%	93,861	5,292	0.0017	8.8	243.46	1.1	63.5	1.1	62.3	1.09	4,687	736750	825
Central Kings	North Kings	22	111,000	3%	108,001	10,632	0.0010	5.5	301.48	0.3	121.5	0.3	58.8	1.03	9,096	1022181	1,145
Central Kings	North Kings	23	111,000	3%	107,937	16,792	0.0017	8.8	241.71	232.2	61.7	52.2	9.5	0.17	2,783	501543	562
North Kings	Central Kings	24	80,000	-2%	81,808	9,989	0.0018	9.7	231.48	268.3	51.5	88.3	36.8	0.64	5,984	896543	1,004
North Kings	Central Kings	25	***100,000***	0%	100,000	18,219	0.0018	9.4	238.86	268.3	58.9	88.3	29.4	0.51	8,950	1594185	1,786
North Kings	Central Kings	26	***95,000***	0%	95,000	3,430	0.0018	9.5	220.50	268.3	40.5	88.3	47.8	0.83	2,540	433820	*486*
North Kings	Central Kings	27	***95,000***	0%	95,000	2,653	0.0022	11.5	221.91	268.3	41.9	88.3	46.4	0.81	1,920	398623	*447*
North Kings	Kings River East	28	***95,000***	0%	95,000	9,490	0.0029	15.2	221.67	235.8	41.7	55.8	14.1	0.25	2,310	633532	0
North Kings	Kings River East	29	59,000	0%	59,000	6,424	0.0044	23.0	206.10	235.8	26.1	55.8	29.7	0.52	3,178	815876	0
North Kings	Kings River East	30	30,000	0%	30,000	3,027	0.0043	22.5	190.88	235.8	10.9	55.8	44.9	0.78	2,136	272499	0
North Kings	Kings River East	31	30,000	0%	30,000	5,071	N/A	N/A	N/A	235.8	N/A	55.8	N/A	N/A	N/A	N/A	0
Kings River East	North Kings	32	30,000	0%	30,000	16,502	N/A	N/A	N/A	34.6	N/A	34.6	N/A	N/A	N/A	N/A	0
Central Kings	Kings River East	33	***95,000***	0%	95,000	2,895	0.0022	11.7	220.50	255.3	40.5	75.3	34.8	0.61	1,653	348952	0
Central Kings	Kings River East	34	***95,000***	0%	95,000	4,909	0.0018	9.7	212.56	220.0	32.6	40.0	7.4	0.13	633	110808	0
Central Kings	Kings River East	35	80,000	-3%	82,389	13,736	0.0014	7.2	189.26	189.4	9.3	9.4	0.1	0.00	21	2415	0
Central Kings	Kings River East	36	80,000	-3%	82,432	5,888	0.0011	6.0	170.29	349.5	170.3	169.5	0.8	0.01	83	7826	0
Central Kings	Kings River East	37	80,000	-4%	83,016	5,428	0.0013	6.9	143.28	360.0	143.3	180.0	36.7	0.64	3,242	353732	0
Central Kings	Kings River East	38	95,000	-4%	99,209	3,460	0.0015	7.9	139.11	360.0	139.1	180.0	40.8	0.71	2,263	336963	0
Kings River East	Central Kings	39	95,000	-5%	99,384	3,116	0.0015	7.7	141.50	96.4	141.5	96.4	45.1	0.79	2,206	320524	0
Kings River East	Central Kings	40	90,000	-3%	93,041	15,843	0.0014	7.5	171.68	96.4	171.7	96.4	75.2	1.31	15,320	2012900	0
Kings River East	Central Kings	41	90,000	-2%	91,624	17,844	0.0010	5.3	209.54	178.6	29.5	178.6	30.9	0.54	9,172	836952	0
Kings River East	Central Kings	42	90,000	-3%	92,338	17,872	0.0007	3.6	244.74	186.7	64.7	6.7	58.1	1.01	15,168	964975	0
Kings River East	Central Kings	43	78,000	-2%	79,423	5,653	0.0006	3.0	284.71	229.9	104.7	49.9	54.9	0.96	4,622	210534	0
Kings River East	Central Kings	44	78,000	-1%	78,916	16,793	0.0012	6.6	260.84	203.7	80.8	23.7	57.1	1.00	14,098	1390613	0
Kings River East	Central Kings	45	***120,000***	0%	120,000	6,008	0.0013	7.1	249.87	173.3	69.9	173.3	76.5	1.34	5,843	945934	0
Central Kings	Kings River East	46	***120,000***	0%	120,000	6,400	0.0010	5.0	237.56	254.6	57.6	74.6	17.1	0.30	1,878	215395	0
Kings River East	Central Kings	47	***120,000***	0%	120,000	7,877	0.0011	5.7	230.67	211.1	50.7	31.1	19.6	0.34	2,643	344705	0
Central Kings	McMullin	48	98,000	23%	75,891	14,924	0.0053	28.2	237.56	180.8	57.6	0.8	56.7	0.99	12,477	5065351	5,674
Central Kings	McMullin	49	75,000	27%	54,886	10,541	0.0031	16.5	260.93	180.8	80.9	0.8	80.1	1.40	10,385	1777442	1,991
McMullin	Central Kings	50	75,000	27%	54,997	5,264	0.0029	15.4	246.10	270.3	66.1	90.3	24.2	0.42	2,161	345622	387
Central Kings	McMullin	51	75,000	26%	55,425	10,654	0.0019	10.0	235.84	180.7	55.8	0.7	55.1	0.96	8,743	916072	1,026
James	McMullin	52	128,000	11%	114,224	6,877	0.0032	16.9	81.78	132.3	81.8	132.3	50.5	0.88	5,308	1944244	2,178
James	McMullin	53	128,000	11%	114,064	7,174	0.0023	12.0	66.92	130.2	66.9	130.2	63.3	1.11	6,410	1665630	1,866
James	McMullin	54	107,000	13%	92,969	6,829	0.0025	13.1	52.97	132.7	53.0	132.7	79.7	1.39	6,720	1551689	1,738
James	McMullin	55	***112,000***	0%	112,000	9,572	0.0039	20.8	48.41	141.8	48.4	141.8	86.6	1.51	9,556	4221603	4,729
James	McMullin	56	***112,000***	0%	112,000	9,617	0.0040	21.1	76.63	141.6	76.6	141.6	65.0	1.13	8,716	3900762	4,369
James	McMullin	57	128,000	22%	99,217	9,585	0.0048	25.1	82.28	142.0	82.3	142.0	59.7	1.04	8,276	3905850	4,375
James	McMullin	58	128,000	24%	97,258	6,153	0.0053	28.2	73.49	142.2	73.5	142.2	68.7	1.20	5,733	2974188	3,332
James	McMullin	59	125,000	24%	95,517	3,455	0.0053	28.0	38.68	152.8	38.7	152.8	65.9	1.15	3,153	1594462	1,786
North Fork Kings	McMullin	60	125,000	25%	93,183	4,656	0.0050	26.3	26.27	227.4	26.3	47.4	21.1	0.37	1,678	778352	872
North Fork Kings	McMullin	61	125,000	27%	91,501	7,115	0.0041	21.8	9.59	315.0	9.6	135.0	54.6	0.95	5,798	2192756	2,456
North Fork Kings	McMullin	62	123,000	29%	87,645	16,815	0.0015	8.1	358.52	288.4	178.5	108.4	70.2	1.22	15,816	2125761	2,381
North Fork Kings	McMullin	63	123,000	31%	85,245	11,841	0.0016	8.7	57.81	334.5	57.8	154.5	83.3	1.45	11,761	1653864	1,853
North Fork Kings	McMullin	64	123,000	29%	86,845	10,574	0.0020	10.4	338.56	270.1	158.6	90.1	68.4	1.19	9,833	1686765	1,889
North Fork Kings	McMullin	65	75,000	30%	52,395	5,349	0.0014	7.4	296.73	270.8	116.7	90.8	25.9	0.45	2,338	172742	193
North Fork Kings	McMullin	66	75,000	31%	51,830	5,277	0.0012	6.3	296.42	180.5	116.4	0.5	64.1	1.12	4,747	294724	330

Attachment 3 - 2001 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Fork Kings	McMullin	67	75,000	32%	51,283	5,354	0.0015	7.9	337.33	270.1	157.3	90.1	67.2	1.17	4,936	377023	422
McMullin	North Fork Kings	68	75,000	30%	52,225	5,258	0.0029	15.3	296.62	0.8	116.6	0.8	64.1	1.12	4,731	715177	801
McMullin	North Fork Kings	69	75,000	26%	55,265	10,633	0.0021	11.0	267.28	270.2	87.3	90.2	2.9	0.05	539	62104	70
North Fork Kings	Central Kings	70	75,000	26%	55,396	10,594	0.0035	18.4	293.50	270.3	113.5	90.3	23.3	0.41	4,182	808091	905
Central Kings	North Fork Kings	71	73,000	25%	54,577	10,677	0.0029	15.5	273.16	270.4	93.2	90.4	2.8	0.05	516	82520	92
Central Kings	North Fork Kings	72	73,000	25%	54,969	5,277	0.0047	25.0	256.36	0.5	76.4	0.5	75.8	1.32	5,116	1333824	1,494
Central Kings	North Fork Kings	73	73,000	25%	54,623	15,835	0.0025	13.3	252.81	270.4	72.8	90.4	17.6	0.31	4,785	658763	738
North Fork Kings	Central Kings	74	73,000	23%	56,203	5,273	0.0025	13.5	233.61	180.4	53.6	0.4	53.2	0.93	4,222	605018	678
Central Kings	North Fork Kings	75	73,000	20%	58,546	5,321	0.0035	18.4	212.50	270.3	32.5	90.3	57.8	1.01	4,504	921207	1,032
Central Kings	North Fork Kings	76	93,000	14%	80,296	14,584	0.0031	16.5	213.13	270.7	33.1	90.7	57.5	1.00	12,306	3096235	3,468
Central Kings	North Fork Kings	77	93,000	6%	87,498	1,334	0.0043	22.8	221.00	270.8	41.0	90.8	49.8	0.87	1,018	384451	431
Central Kings	North Fork Kings	78	93,000	6%	87,676	14,877	0.0027	14.1	223.04	315.4	43.0	135.4	87.6	1.53	14,864	3488284	3,907
Central Kings	North Fork Kings	79	***118,000***	0%	118,000	4,185	0.0027	14.3	240.16	270.3	60.2	90.3	30.1	0.53	2,100	670045	751
Central Kings	North Fork Kings	80	***118,000***	0%	118,000	9,772	0.0024	12.4	228.88	271.5	48.9	91.5	42.6	0.74	6,611	1836003	2,057
Central Kings	North Fork Kings	81	***118,000***	0%	118,000	10,682	0.0011	6.0	247.82	0.7	67.8	0.7	67.1	1.17	9,842	1318967	1,477
Central Kings	North Fork Kings	82	***118,000***	0%	118,000	6,290	0.0004	2.3	351.06	68.3	171.1	68.3	77.3	1.35	6,136	316122	354
James	North Fork Kings	83	86,000	0%	86,000	11,628	0.0020	10.5	137.20	263.5	137.2	83.5	53.7	0.94	9,374	1607678	1,801
James	North Fork Kings	84	87,000	0%	87,000	6,538	0.0024	12.8	143.96	281.3	144.0	101.3	42.7	0.75	4,433	932689	1,045
James	North Fork Kings	85	87,000	0%	87,000	18,139	0.0028	15.0	85.84	263.8	85.8	83.8	2.1	0.04	649	160091	179

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2002 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	McMullin	0	96,000	0%	96,000	3958	0.0017	8.8	279.55	180.1	99.5	0.1	80.6	1.41	3,905	627817	703
North Kings	McMullin	1	96,000	0%	96,000	5,250	0.0031	16.3	217.13	90.6	37.1	90.6	53.5	0.93	4,219	1246491	1,396
North Kings	McMullin	2	96,000	0%	96,000	5,317	0.0054	28.6	184.15	180.0	4.1	0.0	4.1	0.07	385	199665	224
McMullin	North Kings	3	96,000	6%	90,147	10,532	0.0036	18.8	167.65	180.1	167.7	0.1	12.5	0.22	2,275	730700	818
North Kings	McMullin	4	97,000	9%	88,161	11,871	0.0034	17.8	217.81	90.9	37.8	90.9	53.1	0.93	9,496	2820241	3,159
North Kings	McMullin	5	98,000	10%	88,337	7,744	0.0038	20.1	215.31	181.4	35.3	1.4	33.9	0.59	4,323	1455219	1,630
North Kings	McMullin	6	98,000	12%	86,236	22,487	0.0038	19.9	203.09	136.3	23.1	136.3	66.8	1.17	20,671	6732697	7,542
North Kings	McMullin	7	***120,000***	0%	120,000	8,027	0.0049	26.0	246.68	180.7	66.7	0.7	65.9	1.15	7,329	4329923	4,850
North Kings	McMullin	8	120,000	17%	99,359	11,936	0.0042	22.1	214.12	90.3	34.1	90.3	56.2	0.98	9,914	4119830	4,615
North Kings	McMullin	9	120,000	13%	104,129	11,887	0.0053	28.0	195.67	90.6	15.7	90.6	74.9	1.31	11,478	6344575	7,107
North Kings	McMullin	10	120,000	9%	109,054	11,937	0.0047	25.0	208.45	90.0	28.5	90.0	61.6	1.07	10,499	5420557	6,072
North Kings	McMullin	11	***182,000***	0%	182,000	11,909	0.0055	29.1	209.21	90.2	29.2	90.2	61.0	1.06	10,415	10444847	11,700
North Kings	McMullin	12	***115,000***	0%	115,000	15,873	0.0044	23.3	218.33	180.9	38.3	0.9	37.4	0.65	9,644	4903972	5,493
North Kings	McMullin	13	98,000	18%	80,494	10,744	0.0045	23.5	213.37	279.5	33.4	99.5	66.2	1.15	9,828	3525605	3,949
North Kings	Central Kings	14	98,000	17%	81,042	5,348	0.0043	22.7	227.50	279.5	47.5	99.5	52.0	0.91	4,216	1466261	1,642
Central Kings	North Kings	15	91,000	14%	78,480	7,944	0.0034	17.9	222.37	0.9	42.4	0.9	41.4	0.72	5,258	1396171	1,564
North Kings	Central Kings	16	83,000	11%	73,698	15,707	0.0028	14.7	234.00	90.3	54.0	90.3	36.3	0.63	9,293	1907380	2,137
North Kings	Central Kings	17	83,000	10%	74,984	5,303	0.0030	15.8	235.29	179.9	55.3	179.9	55.4	0.97	4,364	978479	1,096
North Kings	Central Kings	18	83,000	9%	75,507	15,829	0.0028	15.0	229.30	90.2	49.3	90.2	40.9	0.71	10,354	2215914	2,482
Central Kings	North Kings	19	89,000	6%	83,730	10,569	0.0019	10.2	252.28	0.5	72.3	0.5	71.8	1.25	10,038	1626913	1,822
North Kings	Central Kings	20	95,000	4%	91,507	18,685	0.0016	8.7	261.48	90.3	81.5	90.3	8.8	0.15	2,864	431614	483
Central Kings	North Kings	21	95,000	1%	93,861	5,292	0.0014	7.5	247.53	1.1	67.5	1.1	66.4	1.16	4,849	644555	722
Central Kings	North Kings	22	111,000	3%	108,001	10,632	0.0020	10.3	280.07	0.3	100.1	0.3	80.2	1.40	10,478	2214039	2,480
Central Kings	North Kings	23	111,000	3%	107,937	16,792	0.0013	7.1	272.24	232.2	92.2	52.2	40.1	0.70	10,808	1569601	1,758
North Kings	Central Kings	24	80,000	-2%	81,808	9,989	0.0053	28.2	231.13	268.3	51.1	88.3	37.1	0.65	6,032	2638536	2,956
North Kings	Central Kings	25	***100,000***	0%	100,000	18,219	0.0011	5.9	257.99	268.3	78.0	88.3	10.3	0.18	3,254	364306	408
North Kings	Central Kings	26	***95,000***	0%	95,000	3,430	0.0019	10.1	219.40	268.3	39.4	88.3	48.9	0.85	2,584	471505	*528*
North Kings	Central Kings	27	***95,000***	0%	95,000	2,653	0.0025	13.1	217.29	268.3	37.3	88.3	51.0	0.89	2,061	484785	*543*
North Kings	Kings River East	28	***95,000***	0%	95,000	9,490	0.0033	17.7	221.03	235.8	41.0	55.8	14.7	0.26	2,413	766386	0
North Kings	Kings River East	29	59,000	0%	59,000	6,424	0.0035	18.7	218.44	235.8	38.4	55.8	17.3	0.30	1,912	399292	0
North Kings	Kings River East	30	30,000	0%	30,000	3,027	0.0025	13.4	214.44	235.8	34.4	55.8	21.3	0.37	1,100	83904	0
North Kings	Kings River East	31	30,000	0%	30,000	5,071	N/A	N/A	N/A	235.8	N/A	55.8	N/A	N/A	N/A	N/A	0
Kings River East	North Kings	32	30,000	0%	30,000	16,502	N/A	N/A	N/A	34.6	N/A	34.6	N/A	N/A	N/A	N/A	0
Central Kings	Kings River East	33	***95,000***	0%	95,000	2,895	0.0025	13.1	215.54	255.3	35.5	75.3	39.8	0.69	1,853	436316	0
Central Kings	Kings River East	34	***95,000***	0%	95,000	4,909	0.0019	10.0	207.14	220.0	27.1	40.0	12.8	0.22	1,090	195509	0
Kings River East	Central Kings	35	80,000	-3%	82,389	13,736	0.0013	7.1	193.31	189.4	13.3	9.4	4.0	0.07	948	104787	0
Kings River East	Central Kings	36	80,000	-3%	82,432	5,888	0.0014	7.4	169.71	349.5	169.7	169.5	0.2	0.00	23	2638	0
Central Kings	Kings River East	37	80,000	-4%	83,016	5,428	0.0014	7.2	148.16	360.0	148.2	180.0	31.8	0.56	2,860	323108	0
Central Kings	Kings River East	38	95,000	-4%	99,209	3,460	0.0014	7.2	134.33	360.0	134.3	180.0	45.6	0.80	2,473	336566	0
Kings River East	Central Kings	39	95,000	-5%	99,384	3,116	0.0015	7.7	133.83	96.4	133.8	96.4	37.4	0.65	1,892	275625	0
Kings River East	Central Kings	40	90,000	-3%	93,041	15,843	0.0017	9.2	166.48	96.4	166.5	96.4	70.0	1.22	14,892	2401247	0
Kings River East	Central Kings	41	90,000	-2%	91,624	17,844	0.0011	5.6	216.18	178.6	36.2	178.6	37.6	0.66	10,881	1048846	0
Kings River East	Central Kings	42	90,000	-3%	92,338	17,872	0.0007	3.9	233.49	186.7	53.5	6.7	46.8	0.82	13,033	882043	0
Central Kings	Kings River East	43	78,000	-2%	79,423	5,653	0.0007	3.9	213.99	229.9	34.0	49.9	15.9	0.28	1,546	90948	0
Kings River East	Central Kings	44	78,000	-1%	78,916	16,793	0.0007	4.0	258.31	203.7	78.3	23.7	54.6	0.95	13,683	808318	0
Kings River East	Central Kings	45	***120,000***	0%	120,000	6,008	0.0018	9.5	232.29	173.3	52.3	173.3	59.0	1.03	5,148	1114980	0
Central Kings	Kings River East	46	***120,000***	0%	120,000	6,400	0.0020	10.3	223.15	254.6	43.2	74.6	31.5	0.55	3,341	784927	0
Central Kings	Kings River East	47	***120,000***	0%	120,000	7,877	0.0009	5.0	204.67	211.1	24.7	31.1	6.4	0.11	878	98947	0
Central Kings	McMullin	48	98,000	23%	75,891	14,924	0.0048	25.3	238.22	180.8	58.2	0.8	57.4	1.00	12,572	4578859	5,129
Central Kings	McMullin	49	75,000	27%	54,886	10,541	0.0034	17.9	264.94	180.8	84.9	0.8	84.1	1.47	10,486	1950422	2,185
McMullin	Central Kings	50	75,000	27%	54,997	5,264	0.0032	16.9	254.73	270.3	74.7	90.3	15.6	0.27	1,417	249432	279
Central Kings	McMullin	51	75,000	26%	55,425	10,654	0.0016	8.5	294.34	180.7	114.3	0.7	66.4	1.16	9,760	871233	976
McMullin	James	52	128,000	11%	114,224	6,877	0.0011	5.9	154.78	132.3	154.8	132.3	22.5	0.39	2,630	332904	373
McMullin	James	53	128,000	11%	114,064	7,174	0.0012	6.2	159.14	130.2	159.1	130.2	28.9	0.50	3,466	467523	524
McMullin	James	54	107,000	13%	92,969	6,829	0.0012	6.2	153.58	132.7	153.6	132.7	20.9	0.36	2,434	264518	296
McMullin	James	55	***112,000***	0%	112,000	9,572	0.0004	2.0	246.13	141.8	66.1	141.8	75.6	1.32	9,273	400438	449
James	McMullin	56	***112,000***	0%	112,000	9,617	0.0006	2.9	43.14	141.6	43.1	141.6	81.5	1.42	9,512	594102	665
James	McMullin	57	128,000	22%	99,217	9,585	0.0031	16.1	102.97	142.0	103.0	142.0	39.0	0.68	6,034	1827053	2,047
James	McMullin	58	128,000	24%	97,258	6,153	0.0046	24.3	62.59	142.2	62.6	142.2	79.6	1.39	6,052	2709688	3,035
James	McMullin	59	125,000	24%	95,517	3,455	0.0049	26.1	24.41	152.8	24.4	152.8	51.6	0.90	2,708	1276772	1,430
North Fork Kings	McMullin	60	125,000	25%	93,183	4,656	0.0043	22.5	8.46	227.4	8.5	47.4	38.9	0.68	2,926	1161453	1,301
North Fork Kings	McMullin	61	125,000	27%	91,501	7,115	0.0030	15.7	352.90	315.0	172.9	135.0	37.9	0.66	4,369	1188974	1,332
North Fork Kings	McMullin	62	123,000	29%	87,645	16,815	0.0019	9.9	24.15	288.4	24.1	108.4	84.2	1.47	16,730	2761881	3,094
North Fork Kings	McMullin	63	123,000	31%	85,245	11,841	0.0020	10.7	14.34	334.5	14.3	154.5	39.9	0.70	7,590	1312025	1,470
North Fork Kings	McMullin	64	123,000	29%	86,845	10,574	0.0022	11.6	313.35	270.1	133.4	90.1	43.2	0.75	7,241	1381907	1,548
North Fork Kings	McMullin	65	75,000	30%	52,395	5,349	0.0020	10.5	286.76	270.8	106.8	90.8	15.9	0.28	1,469	152803	171
North Fork Kings	McMullin	66	75,000	31%	51,830	5,277	0.0021	11.1	288.27	180.5	108.3	0.5	72.3	1.26	5,026	548194	614

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Fork Kings	McMullin	67	75,000	32%	51,283	5,354	0.0018	9.7	314.52	270.1	134.5	90.1	44.4	0.77	3,746	352964	395
McMullin	North Fork Kings	68	75,000	30%	52,225	5,258	0.0024	12.6	295.56	0.8	115.6	0.8	65.2	1.14	4,773	595904	667
North Fork Kings	McMullin	69	75,000	26%	55,265	10,633	0.0031	16.5	310.23	270.2	130.2	90.2	40.0	0.70	6,842	1180888	1,323
North Fork Kings	Central Kings	70	75,000	26%	55,396	10,594	0.0030	16.0	323.19	270.3	143.2	90.3	52.9	0.92	8,454	1423428	1,594
Central Kings	North Fork Kings	71	73,000	25%	54,577	10,677	0.0028	14.6	253.06	270.4	73.1	90.4	17.3	0.30	3,179	480201	538
Central Kings	North Fork Kings	72	73,000	25%	54,969	5,277	0.0043	22.6	267.49	0.5	87.5	0.5	86.9	1.52	5,270	1239539	1,388
Central Kings	North Fork Kings	73	73,000	25%	54,623	15,835	0.0024	12.8	228.65	270.4	48.6	90.4	41.8	0.73	10,545	1394044	1,562
North Fork Kings	Central Kings	74	73,000	23%	56,203	5,273	0.0028	15.0	229.29	180.4	49.3	0.4	48.9	0.85	3,971	635475	712
Central Kings	North Fork Kings	75	73,000	20%	58,546	5,321	0.0023	12.4	229.77	270.3	49.8	90.3	40.6	0.71	3,460	475785	533
Central Kings	North Fork Kings	76	93,000	14%	80,296	14,584	0.0033	17.6	210.22	270.7	30.2	90.7	60.4	1.06	12,687	3396097	3,804
Central Kings	North Fork Kings	77	93,000	6%	87,498	1,334	0.0047	24.6	222.00	270.8	42.0	90.8	48.8	0.85	1,003	408678	458
Central Kings	North Fork Kings	78	93,000	6%	87,676	14,877	0.0028	14.7	226.74	315.4	46.7	135.4	88.7	1.55	14,873	3634400	4,071
Central Kings	North Fork Kings	79	***118,000***	0%	118,000	4,185	0.0023	12.4	243.81	270.3	63.8	90.3	26.5	0.46	1,865	515872	578
Central Kings	North Fork Kings	80	***118,000***	0%	118,000	9,772	0.0020	10.7	251.64	271.5	71.6	91.5	19.8	0.35	3,312	791311	886
Central Kings	North Fork Kings	81	***118,000***	0%	118,000	10,682	0.0012	6.3	238.44	0.7	58.4	0.7	57.7	1.01	9,034	1273609	1,427
Central Kings	North Fork Kings	82	***118,000***	0%	118,000	6,290	0.0012	6.3	264.50	68.3	84.5	68.3	16.2	0.28	1,751	245398	275
North Fork Kings	James	83	86,000	0%	86,000	11,628	N/A	N/A	85.55	263.5	85.5	83.5	2.1	0.04	421	N/A	N/A
James	North Fork Kings	84	87,000	0%	87,000	6,538	N/A	N/A	98.86	281.3	98.9	101.3	2.4	0.04	273	N/A	N/A
North Fork Kings	James	85	87,000	0%	87,000	18,139	0.0030	15.8	54.88	263.8	54.9	83.8	28.9	0.50	8,768	2282316	2,557

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2003 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	McMullin	0	96,000	0%	96,000	3958	0.0026	13.6	283.34	180.1	103.3	0.1	76.8	1.34	3,854	953,392	1,068
North Kings	McMullin	1	96,000	0%	96,000	5,250	0.0026	13.9	159.92	90.6	159.9	90.6	69.3	1.21	4,912	1,239,233	1,388
McMullin	North Kings	2	96,000	0%	96,000	5,317	0.0035	18.6	174.09	180.0	174.1	0.0	5.9	0.10	547	185,436	208
McMullin	North Kings	3	96,000	6%	90,147	10,532	0.0042	22.0	179.47	180.1	179.5	0.1	0.7	0.01	121	45,511	51
North Kings	McMullin	4	97,000	9%	88,161	11,871	0.0051	27.2	194.10	90.9	14.1	90.9	76.8	1.34	11,559	5,246,683	5,877
North Kings	McMullin	5	98,000	10%	88,337	7,744	0.0037	19.6	213.68	181.4	33.7	1.4	32.3	0.56	4,139	1,358,870	1,522
North Kings	McMullin	6	98,000	12%	86,236	22,487	0.0047	24.6	223.00	136.3	43.0	136.3	86.7	1.51	22,450	9,010,790	10,093
North Kings	McMullin	7	***120,000***	0%	120,000	8,027	0.0045	23.8	236.36	180.7	56.4	0.7	55.6	0.97	6,624	3,576,785	4,007
North Kings	McMullin	8	120,000	17%	99,359	11,936	0.0048	25.5	203.94	90.3	23.9	90.3	66.3	1.16	10,933	5,238,921	5,868
North Kings	McMullin	9	120,000	13%	104,129	11,887	0.0052	27.7	196.60	90.6	16.6	90.6	74.0	1.29	11,427	6,231,355	6,980
North Kings	McMullin	10	120,000	9%	109,054	11,937	0.0071	37.7	204.32	90.0	24.3	90.0	65.7	1.15	10,881	8,474,057	9,492
North Kings	McMullin	11	***182,000***	0%	182,000	11,909	0.0048	25.1	198.84	90.2	18.8	90.2	71.4	1.25	11,284	9,774,173	10,948
North Kings	McMullin	12	***115,000***	0%	115,000	15,873	0.0040	20.9	221.53	180.9	41.5	0.9	40.6	0.71	10,332	4,706,940	5,272
North Kings	McMullin	13	98,000	18%	80,494	10,744	0.0037	19.8	219.55	279.5	39.6	99.5	60.0	1.05	9,303	2,807,801	3,145
North Kings	Central Kings	14	98,000	17%	81,042	5,348	0.0038	20.3	226.27	279.5	46.3	99.5	53.3	0.93	4,285	1,335,831	1,496
Central Kings	North Kings	15	91,000	14%	78,480	7,944	0.0034	17.8	224.75	0.9	44.8	0.9	43.8	0.76	5,501	1,456,561	1,632
North Kings	Central Kings	16	83,000	11%	73,698	15,707	0.0026	13.7	235.00	90.3	55.0	90.3	35.3	0.62	9,071	1,730,090	1,938
North Kings	Central Kings	17	83,000	10%	74,984	5,303	0.0030	16.1	237.06	179.9	57.1	179.9	57.2	1.00	4,455	1,016,372	1,138
North Kings	Central Kings	18	83,000	9%	75,507	15,829	0.0033	17.5	222.56	90.2	42.6	90.2	47.6	0.83	11,688	2,929,573	3,282
Central Kings	North Kings	19	89,000	6%	83,730	10,569	0.0020	10.6	250.84	0.5	70.8	0.5	70.3	1.23	9,952	1,671,589	1,872
Central Kings	North Kings	20	95,000	4%	91,507	18,685	0.0017	9.1	286.54	90.3	106.5	90.3	16.2	0.28	5,225	826,272	926
Central Kings	North Kings	21	95,000	1%	93,861	5,292	0.0021	11.0	266.80	1.1	86.8	1.1	85.7	1.50	5,277	1,030,732	1,155
Central Kings	North Kings	22	111,000	3%	108,001	10,632	0.0019	10.1	280.36	0.3	100.4	0.3	79.9	1.40	10,469	2,163,428	2,423
Central Kings	North Kings	23	111,000	3%	107,937	16,792	0.0022	11.5	287.39	232.2	107.4	52.2	55.2	0.96	13,793	3,239,849	3,629
North Kings	Central Kings	24	80,000	-2%	81,808	9,989	0.0030	15.7	253.38	268.3	73.4	88.3	14.9	0.26	2,569	626,569	702
North Kings	Central Kings	25	***100,000***	0%	100,000	18,219	0.0017	9.1	236.04	268.3	56.0	88.3	32.2	0.56	9,720	1,680,652	1,883
North Kings	Central Kings	26	***95,000***	0%	95,000	3,430	0.0022	11.8	222.92	268.3	42.9	88.3	45.4	0.79	2,440	520,076	583
North Kings	Central Kings	27	***95,000***	0%	95,000	2,653	0.0027	14.2	216.42	268.3	36.4	88.3	51.9	0.91	2,086	531,878	596
North Kings	Kings River East	28	***95,000***	0%	95,000	9,490	0.0035	18.7	219.77	235.8	39.8	55.8	16.0	0.28	2,614	879,557	0
North Kings	Kings River East	29	59,000	0%	59,000	6,424	0.0036	18.8	220.13	235.8	40.1	55.8	15.6	0.27	1,731	364,225	0
North Kings	Kings River East	30	30,000	0%	30,000	3,027	0.0028	14.6	212.53	235.8	32.5	55.8	23.2	0.41	1,194	98,876	0
North Kings	Kings River East	31	30,000	0%	30,000	5,071	N/A	N/A	N/A	235.8	N/A	55.8	N/A	N/A	N/A	N/A	0
Kings River East	North Kings	32	30,000	0%	30,000	16,502	N/A	N/A	N/A	34.6	N/A	34.6	N/A	N/A	N/A	N/A	0
Central Kings	Kings River East	33	***95,000***	0%	95,000	2,895	0.0026	13.9	215.60	255.3	35.6	75.3	39.7	0.69	1,850	463,889	0
Central Kings	Kings River East	34	***95,000***	0%	95,000	4,909	0.0021	11.0	213.58	220.0	33.6	40.0	6.4	0.11	546	107,634	0
Kings River East	Central Kings	35	80,000	-3%	82,389	13,736	0.0013	7.0	198.14	189.4	18.1	9.4	8.8	0.15	2,098	227,639	0
Kings River East	Central Kings	36	80,000	-3%	82,432	5,888	0.0011	5.9	176.17	349.5	176.2	169.5	6.7	0.12	686	63,143	0
Central Kings	Kings River East	37	80,000	-4%	83,016	5,428	0.0012	6.3	159.07	360.0	159.1	180.0	20.9	0.36	1,935	192,564	0
Central Kings	Kings River East	38	95,000	-4%	99,209	3,460	0.0012	6.3	139.09	360.0	139.1	180.0	40.9	0.71	2,264	266,867	0
Kings River East	Central Kings	39	95,000	-5%	99,384	3,116	0.0016	8.7	129.42	96.4	129.4	96.4	33.0	0.58	1,696	276,227	0
Kings River East	Central Kings	40	90,000	-3%	93,041	15,843	0.0022	11.7	163.00	96.4	163.0	96.4	66.6	1.16	14,535	2,997,064	0
Kings River East	Central Kings	41	90,000	-2%	91,624	17,844	0.0010	5.1	223.46	178.6	43.5	178.6	44.9	0.78	12,585	1,120,593	0
Central Kings	Kings River East	42	90,000	-3%	92,338	17,872	0.0004	2.0	186.34	186.7	6.3	6.7	0.3	0.01	99	3,558	0
Kings River East	Central Kings	43	78,000	-2%	79,423	5,653	0.0007	3.9	308.54	229.9	128.5	49.9	78.7	1.37	5,543	321,968	0
Kings River East	Central Kings	44	78,000	-1%	78,916	16,793	0.0022	11.6	278.75	203.7	98.7	23.7	75.0	1.31	16,221	2,809,200	0
Kings River East	Central Kings	45	***120,000***	0%	120,000	6,008	0.0016	8.5	237.60	173.3	57.6	173.3	64.3	1.12	5,412	1,048,077	0
Central Kings	Kings River East	46	***120,000***	0%	120,000	6,400	0.0009	4.5	220.05	254.6	40.0	74.6	34.6	0.60	3,631	375,155	0
Kings River East	Central Kings	47	***120,000***	0%	120,000	7,877	0.0009	4.8	244.79	211.1	64.8	31.1	33.7	0.59	4,374	473,600	0
Central Kings	McMullin	48	98,000	23%	75,891	14,924	0.0038	19.8	234.65	180.8	54.6	0.8	53.8	0.94	12,046	3,430,340	3,842
Central Kings	McMullin	49	75,000	27%	54,886	10,541	0.0029	15.4	259.96	180.8	80.0	0.8	79.1	1.38	10,353	1,655,689	1,855
McMullin	Central Kings	50	75,000	27%	54,997	5,264	0.0033	17.2	252.86	270.3	72.9	90.3	17.5	0.31	1,581	283,263	317
McMullin	Central Kings	51	75,000	26%	55,425	10,654	0.0013	6.7	165.10	180.7	165.1	0.7	15.6	0.27	2,864	200,566	225
James	McMullin	52	128,000	11%	114,224	6,877	0.0026	13.9	93.00	132.3	93.0	132.3	39.3	0.69	4,356	1,307,075	1,464
James	McMullin	53	128,000	11%	114,064	7,174	0.0021	11.0	93.13	130.2	93.1	130.2	37.1	0.65	4,329	1,029,820	1,154
James	McMullin	54	107,000	13%	92,969	6,829	0.0016	8.3	59.17	132.7	59.2	132.7	73.5	1.28	6,549	954,934	1,070
James	McMullin	55	***112,000***	0%	112,000	9,572	0.0015	8.1	63.43	141.8	63.4	141.8	78.3	1.37	9,375	1,608,301	1,802
James	McMullin	56	***112,000***	0%	112,000	9,617	0.0017	8.8	99.45	141.6	99.4	141.6	42.2	0.74	6,458	1,210,622	1,356
James	McMullin	57	128,000	22%	99,217	9,585	0.0017	9.1	91.65	142.0	91.6	142.0	50.3	0.88	7,378	1,261,235	1,413
James	McMullin	58	128,000	24%	97,258	6,153	0.0017	9.0	83.85	142.2	83.9	142.2	58.3	1.02	5,237	866,867	971
James	McMullin	59	125,000	24%	95,517	3,455	0.0015	7.8	104.00	152.8	104.0	152.8	48.8	0.85	2,599	364,889	409
McMullin	North Fork Kings	60	125,000	25%	93,183	4,656	0.0016	8.4	109.30	227.4	109.3	47.4	61.9	1.08	4,107	611,499	685
North Fork Kings	McMullin	61	125,000	27%	91,501	7,115	0.0019	9.9	102.99	315.0	103.0	135.0	32.0	0.56	3,773	646,605	724
North Fork Kings	McMullin	62	123,000	29%	87,645	16,815	0.0015	8.0	215.99	288.4	36.0	108.4	72.4	1.26	16,026	2,133,322	2,390
McMullin	North Fork Kings	63	123,000	31%	85,245	11,841	0.0021	10.9	309.49	334.5	129.5	154.5	25.0	0.44	5,002	878,903	984
North Fork Kings	McMullin	64	123,000	29%	86,845	10,574	0.0013	6.8	312.97	270.1	133.0	90.1	42.8	0.75	7,188	806,068	903
North Fork Kings	McMullin	65	75,000	30%	52,395	5,349	0.0024	12.8	281.44	270.8	101.4	90.8	10.6	0.19	986	125,381	140
North Fork Kings	McMullin	66	75,000	31%	51,830	5,277	0.0023	12.2	283.46	180.5	103.5	0.5	77.1	1.34	5,143	614,109	688

Attachment 3 - 2003 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Fork Kings	McMullin	67	75,000	32%	51,283	5,354	0.0021	10.9	294.46	270.1	114.5	90.1	24.3	0.42	2,207	233,968	262
McMullin	North Fork Kings	68	75,000	30%	52,225	5,258	0.0032	17.2	291.77	0.8	111.8	0.8	69.0	1.20	4,908	833,006	933
North Fork Kings	McMullin	69	75,000	26%	55,265	10,633	0.0021	11.0	311.05	270.2	131.0	90.2	40.9	0.71	6,957	799,586	896
North Fork Kings	Central Kings	70	75,000	26%	55,396	10,594	0.0035	18.5	314.66	270.3	134.7	90.3	44.4	0.77	7,412	1,436,961	1,610
Central Kings	North Fork Kings	71	73,000	25%	54,577	10,677	0.0027	14.4	253.06	270.4	73.1	90.4	17.3	0.30	3,180	472,381	529
Central Kings	North Fork Kings	72	73,000	25%	54,969	5,277	0.0033	17.7	250.07	0.5	70.1	0.5	69.5	1.21	4,944	909,606	1,019
Central Kings	North Fork Kings	73	73,000	25%	54,623	15,835	0.0027	14.4	236.34	270.4	56.3	90.4	34.1	0.59	8,868	1,320,339	1,479
North Fork Kings	Central Kings	74	73,000	23%	56,203	5,273	0.0034	17.8	245.25	180.4	65.3	0.4	64.8	1.13	4,772	903,012	1,012
Central Kings	North Fork Kings	75	73,000	20%	58,546	5,321	0.0019	10.0	237.71	270.3	57.7	90.3	32.6	0.57	2,868	318,180	356
Central Kings	North Fork Kings	76	93,000	14%	80,296	14,584	0.0022	11.5	229.93	270.7	49.9	90.7	40.7	0.71	9,517	1,670,883	1,872
Central Kings	North Fork Kings	77	93,000	6%	87,498	1,334	0.0032	17.1	235.00	270.8	55.0	90.8	35.8	0.62	780	220,343	247
Central Kings	North Fork Kings	78	93,000	6%	87,676	14,877	0.0021	11.3	233.96	315.4	54.0	135.4	81.4	1.42	14,711	2,768,140	3,101
Central Kings	North Fork Kings	79	***118,000***	0%	118,000	4,185	0.0021	11.2	231.94	270.3	51.9	90.3	38.3	0.67	2,596	646,895	725
Central Kings	North Fork Kings	80	***118,000***	0%	118,000	9,772	0.0020	10.4	230.48	271.5	50.5	91.5	41.0	0.72	6,408	1,495,549	1,675
Central Kings	North Fork Kings	81	***118,000***	0%	118,000	10,682	0.0015	8.1	205.12	0.7	25.1	0.7	24.4	0.43	4,416	801,969	898
North Fork Kings	Central Kings	82	***118,000***	0%	118,000	6,290	0.0010	5.2	115.91	68.3	115.9	68.3	47.6	0.83	4,643	537,238	602
James	North Fork Kings	83	86,000	0%	86,000	11,628	0.0024	12.4	141.94	263.5	141.9	83.5	58.5	1.02	9,910	2,006,382	2,247
James	North Fork Kings	84	87,000	0%	87,000	6,538	0.0018	9.7	127.04	281.3	127.0	101.3	25.8	0.45	2,843	455,782	511
James	North Fork Kings	85	87,000	0%	87,000	18,139	0.0016	8.6	108.86	263.8	108.9	83.8	25.1	0.44	7,688	1089868	1,221

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2004 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	McMullin	0	96,000	0%	96,000	3958	0.0048	25.4	257.50	180.1	77.5	0.1	77.4	1.35	3,862	1780670	1,995
North Kings	McMullin	1	96,000	0%	96,000	5,250	0.0047	24.6	250.09	90.6	70.1	90.6	20.5	0.36	1,839	822495	921
North Kings	McMullin	2	96,000	0%	96,000	5,317	0.0049	26.0	219.31	180.0	39.3	0.0	39.3	0.69	3,368	1592028	1,783
North Kings	McMullin	3	96,000	6%	90,147	10,532	0.0042	22.1	222.47	180.1	42.5	0.1	42.3	0.74	7,094	2672561	2,994
North Kings	McMullin	4	97,000	9%	88,161	11,871	0.0055	29.3	202.04	90.9	22.0	90.9	68.9	1.20	11,075	5412047	6,062
North Kings	McMullin	5	98,000	10%	88,337	7,744	0.0050	26.4	210.50	181.4	30.5	1.4	29.1	0.51	3,770	1661968	1,862
North Kings	McMullin	6	98,000	12%	86,236	22,487	0.0049	25.8	224.86	136.3	44.9	136.3	88.6	1.55	22,480	9470205	10,608
North Kings	McMullin	7	***120,000***	0%	120,000	8,027	0.0048	25.5	230.80	180.7	50.8	0.7	50.1	0.87	6,153	3559759	3,987
North Kings	McMullin	8	120,000	17%	99,359	11,936	0.0050	26.2	212.36	90.3	32.4	90.3	57.9	1.01	10,114	4994208	5,594
North Kings	McMullin	9	120,000	13%	104,129	11,887	0.0054	28.4	195.17	90.6	15.2	90.6	75.4	1.32	11,505	6437680	7,211
North Kings	McMullin	10	120,000	9%	109,054	11,937	0.0050	26.2	209.81	90.0	29.8	90.0	60.2	1.05	10,362	5612555	6,287
North Kings	McMullin	11	***182,000***	0%	182,000	11,909	0.0043	22.7	205.75	90.2	25.7	90.2	64.5	1.13	10,745	8398861	9,408
North Kings	McMullin	12	***115,000***	0%	115,000	15,873	0.0043	22.7	221.94	180.9	41.9	0.9	41.0	0.72	10,419	5156951	5,777
North Kings	McMullin	13	98,000	18%	80,494	10,744	0.0039	20.6	223.61	279.5	43.6	99.5	55.9	0.98	8,900	2796331	3,132
North Kings	Central Kings	14	98,000	17%	81,042	5,348	0.0045	23.9	217.63	279.5	37.6	99.5	61.9	1.08	4,717	1731638	1,940
Central Kings	North Kings	15	91,000	14%	78,480	7,944	0.0041	21.4	221.63	0.9	41.6	0.9	40.7	0.71	5,181	1650320	1,849
North Kings	Central Kings	16	83,000	11%	73,698	15,707	0.0026	13.8	228.84	90.3	48.8	90.3	41.4	0.72	10,394	2006270	2,247
North Kings	Central Kings	17	83,000	10%	74,984	5,303	0.0035	18.7	229.74	179.9	49.7	179.9	49.8	0.87	4,052	1078003	1,208
North Kings	Central Kings	18	83,000	9%	75,507	15,829	0.0028	14.9	233.36	90.2	53.4	90.2	36.8	0.64	9,481	2013547	2,255
Central Kings	North Kings	19	89,000	6%	83,730	10,569	0.0031	16.6	234.81	0.5	54.8	0.5	54.3	0.95	8,582	2257212	2,528
North Kings	Central Kings	20	95,000	4%	91,507	18,685	0.0014	7.3	255.35	90.3	75.4	90.3	14.9	0.26	4,819	611854	685
Central Kings	North Kings	21	95,000	1%	93,861	5,292	0.0020	10.3	258.75	1.1	78.7	1.1	77.6	1.35	5,169	950240	1,064
Central Kings	North Kings	22	111,000	3%	108,001	10,632	0.0026	13.5	282.35	0.3	102.4	0.3	77.9	1.36	10,398	2874257	3,220
Central Kings	North Kings	23	111,000	3%	107,937	16,792	0.0021	11.1	292.99	232.2	113.0	52.2	60.8	1.06	14,661	3327671	3,727
North Kings	Central Kings	24	80,000	-2%	81,808	9,989	0.0068	36.1	232.66	268.3	52.7	88.3	35.6	0.62	5,817	3254927	3,646
North Kings	Central Kings	25	***100,000***	0%	100,000	18,219	0.0014	7.6	199.40	268.3	19.4	88.3	68.9	1.20	16,996	2434014	2,726
North Kings	Central Kings	26	***95,000***	0%	95,000	3,430	0.0022	11.5	221.00	268.3	41.0	88.3	47.3	0.83	2,520	519836	582
North Kings	Central Kings	27	***95,000***	0%	95,000	2,653	0.0025	13.4	218.37	268.3	38.4	88.3	49.9	0.87	2,029	488764	547
North Kings	Kings River East	28	***95,000***	0%	95,000	9,490	0.0032	17.0	217.59	235.8	37.6	55.8	18.2	0.32	2,959	903798	0
North Kings	Kings River East	29	59,000	0%	59,000	6,424	0.0044	23.2	211.14	235.8	31.1	55.8	24.6	0.43	2,676	694398	0
North Kings	Kings River East	30	30,000	0%	30,000	3,027	0.0037	19.3	203.67	235.8	23.7	55.8	32.1	0.56	1,608	176520	0
North Kings	Kings River East	31	30,000	0%	30,000	5,071	N/A	N/A	N/A	235.8	N/A	55.8	N/A	N/A	N/A	N/A	0
Kings River East	North Kings	32	30,000	0%	30,000	16,502	N/A	N/A	N/A	34.6	N/A	34.6	N/A	N/A	N/A	N/A	0
Central Kings	Kings River East	33	***95,000***	0%	95,000	2,895	0.0025	13.1	217.93	255.3	37.9	75.3	37.4	0.65	1,758	413740	0
Central Kings	Kings River East	34	***95,000***	0%	95,000	4,909	0.0020	10.6	218.58	220.0	38.6	40.0	1.4	0.02	118	22672	0
Kings River East	Central Kings	35	80,000	-3%	82,389	13,736	0.0014	7.3	214.57	189.4	34.6	9.4	25.2	0.44	5,853	667293	0
Kings River East	Central Kings	36	80,000	-3%	82,432	5,888	0.0012	6.3	196.74	349.5	16.7	169.5	27.3	0.48	2,697	263249	0
Central Kings	Kings River East	37	80,000	-4%	83,016	5,428	0.0010	5.2	171.42	360.0	171.4	180.0	8.5	0.15	806	66461	0
Central Kings	Kings River East	38	95,000	-4%	99,209	3,460	0.0011	5.6	150.25	360.0	150.3	180.0	29.7	0.52	1,714	181682	0
Kings River East	Central Kings	39	95,000	-5%	99,384	3,116	0.0016	8.4	139.33	96.4	139.3	96.4	42.9	0.75	2,121	337293	0
Kings River East	Central Kings	40	90,000	-3%	93,041	15,843	0.0025	13.1	163.78	96.4	163.8	96.4	67.3	1.18	14,620	3383771	0
Kings River East	Central Kings	41	90,000	-2%	91,624	17,844	0.0009	5.0	193.02	178.6	13.0	178.6	14.4	0.25	4,440	382484	0
Central Kings	Kings River East	42	90,000	-3%	92,338	17,872	0.0006	3.2	182.84	186.7	2.8	6.7	3.8	0.07	1,192	67213	0
Kings River East	Central Kings	43	78,000	-2%	79,423	5,653	0.0012	6.5	325.09	229.9	145.1	49.9	84.8	1.48	5,629	553732	0
Kings River East	Central Kings	44	78,000	-1%	78,916	16,793	0.0024	12.4	281.37	203.7	101.4	23.7	77.6	1.35	16,403	3048265	0
Kings River East	Central Kings	45	***120,000***	0%	120,000	6,008	0.0018	9.6	242.53	173.3	62.5	173.3	69.2	1.21	5,617	1224350	0
Central Kings	Kings River East	46	***120,000***	0%	120,000	6,400	0.0012	6.1	227.84	254.6	47.8	74.6	26.8	0.47	2,884	400770	0
Kings River East	Central Kings	47	***120,000***	0%	120,000	7,877	0.0009	4.8	264.69	211.1	84.7	31.1	53.6	0.94	6,342	697526	0
Central Kings	McMullin	48	98,000	23%	75,891	14,924	0.0031	16.2	225.88	180.8	45.9	0.8	45.0	0.79	10,562	2452005	2,747
Central Kings	McMullin	49	75,000	27%	54,886	10,541	0.0024	12.5	258.99	180.8	79.0	0.8	78.2	1.36	10,318	1336586	1,497
McMullin	Central Kings	50	75,000	27%	54,997	5,264	0.0036	19.2	245.39	270.3	65.4	90.3	24.9	0.44	2,221	445129	499
Central Kings	McMullin	51	75,000	26%	55,425	10,654	0.0020	10.7	231.01	180.7	51.0	0.7	50.3	0.88	8,199	925135	1,036
James	McMullin	52	128,000	11%	114,224	6,877	0.0020	10.5	61.18	132.3	61.2	132.3	71.1	1.24	6,507	1471307	1,648
James	McMullin	53	128,000	11%	114,064	7,174	0.0026	14.0	16.26	130.2	16.3	130.2	66.0	1.15	6,554	1979448	2,217
James	McMullin	54	107,000	13%	92,969	6,829	0.0014	7.4	358.58	132.7	178.6	132.7	45.9	0.80	4,902	642153	719
James	McMullin	55	***112,000***	0%	112,000	9,572	0.0008	4.4	30.27	141.8	30.3	141.8	68.5	1.20	8,907	834174	934
James	McMullin	56	***112,000***	0%	112,000	9,617	0.0022	11.4	87.05	141.6	87.0	141.6	54.6	0.95	7,838	1899344	2,128
James	McMullin	57	128,000	22%	99,217	9,585	0.0040	21.0	92.15	142.0	92.2	142.0	49.8	0.87	7,324	2890329	3,238
James	McMullin	58	128,000	24%	97,258	6,153	0.0071	37.4	54.51	142.2	54.5	142.2	87.7	1.53	6,148	4238152	4,747
James	McMullin	59	125,000	24%	95,517	3,455	0.0059	31.1	69.16	152.8	69.2	152.8	83.6	1.46	3,433	1928707	2,160
McMullin	North Fork Kings	60	125,000	25%	93,183	4,656	0.0049	25.7	52.03	227.4	52.0	47.4	4.6	0.08	376	170573	191
North Fork Kings	McMullin	61	125,000	27%	91,501	7,115	0.0026	13.9	17.18	315.0	17.2	135.0	62.2	1.09	6,292	1518030	1,700
McMullin	North Fork Kings	62	123,000	29%	87,645	16,815	0.0023	12.3	274.38	288.4	94.4	108.4	14.0	0.24	4,063	829580	929
McMullin	North Fork Kings	63	123,000	31%	85,245	11,841	0.0017	9.0	185.92	334.5	5.9	154.5	31.4	0.55	6,178	895984	1,004
McMullin	North Fork Kings	64	123,000	29%	86,845	10,574	0.0011	6.0	226.75	270.1	46.8	90.1	43.4	0.76	7,262	719693	806
North Fork Kings	McMullin	65	75,000	30%	52,395	5,349	0.0019	10.0	292.45	270.8	112.5	90.8	21.6	0.38	1,972	195269	219
North Fork Kings	McMullin	66	75,000	31%	51,830	5,277	0.0018	9.4	274.51	180.5	94.5	0.5	86.0	1.50	5,264	486302	545

Attachment 3 - 2004 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
McMullin	North Fork Kings	67	75,000	32%	51,283	5,354	0.0020	10.6	251.20	270.1	71.2	90.1	18.9	0.33	1,736	179284	201
McMullin	North Fork Kings	68	75,000	30%	52,225	5,258	0.0017	9.2	261.59	0.8	81.6	0.8	80.8	1.41	5,191	473571	530
North Fork Kings	McMullin	69	75,000	26%	55,265	10,633	0.0028	14.7	273.37	270.2	93.4	90.2	3.2	0.06	591	90824	102
North Fork Kings	Central Kings	70	75,000	26%	55,396	10,594	0.0033	17.5	310.91	270.3	130.9	90.3	40.7	0.71	6,901	1269129	1,422
North Fork Kings	Central Kings	71	73,000	25%	54,577	10,677	0.0025	13.4	281.48	270.4	101.5	90.4	11.1	0.19	2,054	284766	319
Central Kings	North Fork Kings	72	73,000	25%	54,969	5,277	0.0031	16.1	270.50	0.5	90.5	0.5	90.0	1.57	5,277	885240	992
North Fork Kings	Central Kings	73	73,000	25%	54,623	15,835	0.0027	14.1	304.30	270.4	124.3	90.4	33.9	0.59	8,831	1288805	1,444
North Fork Kings	Central Kings	74	73,000	23%	56,203	5,273	0.0041	21.5	303.80	180.4	123.8	0.4	56.6	0.99	4,403	1008930	1,130
North Fork Kings	Central Kings	75	73,000	20%	58,546	5,321	0.0039	20.5	272.56	270.3	92.6	90.3	2.2	0.04	208	47182	53
Central Kings	North Fork Kings	76	93,000	14%	80,296	14,584	0.0030	16.1	241.49	270.7	61.5	90.7	29.2	0.51	7,111	1741413	1,951
Central Kings	North Fork Kings	77	93,000	6%	87,498	1,334	0.0036	19.1	231.60	270.8	51.6	90.8	39.2	0.68	842	266555	299
Central Kings	North Fork Kings	78	93,000	6%	87,676	14,877	0.0024	12.9	232.31	315.4	52.3	135.4	83.1	1.45	14,769	3165325	3,546
Central Kings	North Fork Kings	79	***118,000***	0%	118,000	4,185	0.0020	10.7	215.79	270.3	35.8	90.3	54.5	0.95	3,406	816808	915
Central Kings	North Fork Kings	80	***118,000***	0%	118,000	9,772	0.0025	13.3	231.84	271.5	51.8	91.5	39.6	0.69	6,230	1855240	2,078
Central Kings	North Fork Kings	81	***118,000***	0%	118,000	10,682	0.0020	10.7	215.50	0.7	35.5	0.7	34.8	0.61	6,097	1460157	1,636
North Fork Kings	Central Kings	82	***118,000***	0%	118,000	6,290	0.0014	7.5	192.33	68.3	12.3	68.3	56.0	0.98	5,216	877925	983
James	North Fork Kings	83	86,000	0%	86,000	11,628	0.0014	7.5	119.29	263.5	119.3	83.5	35.8	0.63	6,804	835905	936
James	North Fork Kings	84	87,000	0%	87,000	6,538	0.0018	9.4	113.56	281.3	113.6	101.3	12.3	0.21	1,392	215214	241
James	North Fork Kings	85	87,000	0%	87,000	18,139	0.0024	12.7	97.32	263.8	97.3	83.8	13.5	0.24	4,243	889807	997

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2005 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	McMullin	0	96,000	0%	96,000	3958	0.0051	27.1	268.40	180.1	88.4	0.1	88.3	1.54	3,956	1950756	2,185
North Kings	McMullin	1	96,000	0%	96,000	5,250	0.0054	28.3	244.29	90.6	64.3	90.6	26.3	0.46	2,327	1198528	1,343
North Kings	McMullin	2	96,000	0%	96,000	5,317	0.0048	25.1	208.04	180.0	28.0	0.0	28.0	0.49	2,499	1141715	1,279
North Kings	McMullin	3	96,000	6%	90,147	10,532	0.0043	22.9	225.24	180.1	45.2	0.1	45.1	0.79	7,462	2912479	3,262
North Kings	McMullin	4	97,000	9%	88,161	11,871	0.0061	32.3	190.15	90.9	10.2	90.9	80.8	1.41	11,718	6316143	7,075
North Kings	McMullin	5	98,000	10%	88,337	7,744	0.0047	24.8	213.71	181.4	33.7	1.4	32.3	0.56	4,143	1719024	1,926
North Kings	McMullin	6	98,000	12%	86,236	22,487	0.0049	25.9	224.36	136.3	44.4	136.3	88.1	1.54	22,474	9490946	10,631
North Kings	McMullin	7	***120,000***	0%	120,000	8,027	0.0042	22.4	242.82	180.7	62.8	0.7	62.1	1.08	7,092	3615284	4,050
North Kings	McMullin	8	120,000	17%	99,359	11,936	0.0030	15.6	217.88	90.3	37.9	90.3	52.4	0.91	9,456	2773740	3,107
North Kings	McMullin	9	120,000	13%	104,129	11,887	0.0044	23.3	190.74	90.6	10.7	90.6	79.9	1.39	11,701	5385850	6,033
North Kings	McMullin	10	120,000	9%	109,054	11,937	0.0052	27.5	205.94	90.0	25.9	90.0	64.1	1.12	10,739	6107403	6,841
North Kings	McMullin	11	***182,000***	0%	182,000	11,909	0.0053	28.2	209.45	90.2	29.4	90.2	60.8	1.06	10,391	10108790	11,323
North Kings	McMullin	12	***115,000***	0%	115,000	15,873	0.0038	20.2	218.71	180.9	38.7	0.9	37.8	0.66	9,727	4284076	4,799
North Kings	McMullin	13	98,000	18%	80,494	10,744	0.0033	17.6	229.49	279.5	49.5	99.5	50.0	0.87	8,235	2204846	2,470
North Kings	Central Kings	14	98,000	17%	81,042	5,348	0.0042	22.1	226.20	279.5	46.2	99.5	53.3	0.93	4,289	1455913	1,631
Central Kings	North Kings	15	91,000	14%	78,480	7,944	0.0034	18.2	220.29	0.9	40.3	0.9	39.4	0.69	5,039	1362687	1,526
North Kings	Central Kings	16	83,000	11%	73,698	15,707	0.0025	13.1	233.26	90.3	53.3	90.3	37.0	0.65	9,457	1732352	1,940
North Kings	Central Kings	17	83,000	10%	74,984	5,303	0.0031	16.3	235.16	179.9	55.2	179.9	55.3	0.96	4,357	1008204	1,129
North Kings	Central Kings	18	83,000	9%	75,507	15,829	0.0030	15.6	225.00	90.2	45.0	90.2	45.2	0.79	11,223	2504931	2,806
Central Kings	North Kings	19	89,000	6%	83,730	10,569	0.0019	10.1	260.91	0.5	80.9	0.5	80.4	1.40	10,421	1668322	1,869
Central Kings	North Kings	20	95,000	4%	91,507	18,685	0.0017	9.1	286.90	90.3	106.9	90.3	16.6	0.29	5,340	845837	947
Central Kings	North Kings	21	95,000	1%	93,861	5,292	0.0021	11.2	245.96	1.1	66.0	1.1	64.8	1.13	4,790	954998	1,070
Central Kings	North Kings	22	111,000	3%	108,001	10,632	0.0027	14.1	272.70	0.3	92.7	0.3	87.6	1.53	10,623	3063375	3,431
Central Kings	North Kings	23	111,000	3%	107,937	16,792	0.0023	12.3	280.09	232.2	100.1	52.2	47.9	0.84	12,464	3127880	3,504
North Kings	Central Kings	24	80,000	-2%	81,808	9,989	0.0036	18.7	247.00	268.3	67.0	88.3	21.3	0.37	3,626	1052948	1,179
North Kings	Central Kings	25	***100,000***	0%	100,000	18,219	0.0016	8.2	246.06	268.3	66.1	88.3	22.2	0.39	6,891	1071856	1,201
North Kings	Central Kings	26	***95,000***	0%	95,000	3,430	0.0021	11.0	222.44	268.3	42.4	88.3	45.8	0.80	2,460	488767	547
North Kings	Central Kings	27	***95,000***	0%	95,000	2,653	0.0026	13.8	222.29	268.3	42.3	88.3	46.0	0.80	1,908	473710	531
North Kings	Kings River East	28	***95,000***	0%	95,000	9,490	0.0036	18.9	223.97	235.8	44.0	55.8	11.8	0.21	1,939	660725	0
North Kings	Kings River East	29	59,000	0%	59,000	6,424	0.0038	20.2	222.72	235.8	42.7	55.8	13.0	0.23	1,449	327498	0
North Kings	Kings River East	30	30,000	0%	30,000	3,027	0.0024	12.8	216.00	235.8	36.0	55.8	19.8	0.34	1,023	74682	0
North Kings	Kings River East	31	30,000	0%	30,000	5,071	N/A	N/A	N/A	235.8	N/A	55.8	N/A	N/A	N/A	N/A	0
Kings River East	North Kings	32	30,000	0%	30,000	16,502	N/A	N/A	N/A	34.6	N/A	34.6	N/A	N/A	N/A	N/A	0
Central Kings	Kings River East	33	***95,000***	0%	95,000	2,895	0.0026	13.8	220.73	255.3	40.7	75.3	34.6	0.60	1,644	408940	0
Central Kings	Kings River East	34	***95,000***	0%	95,000	4,909	0.0020	10.7	214.06	220.0	34.1	40.0	5.9	0.10	505	97111	0
Central Kings	Kings River East	35	80,000	-3%	82,389	13,736	0.0015	7.8	185.73	189.4	5.7	9.4	3.6	0.06	867	105781	0
Central Kings	Kings River East	36	80,000	-3%	82,432	5,888	0.0015	8.0	150.74	349.5	150.7	169.5	18.7	0.33	1,893	235789	0
Central Kings	Kings River East	37	80,000	-4%	83,016	5,428	0.0012	6.4	134.71	360.0	134.7	180.0	45.2	0.79	3,854	386410	0
Central Kings	Kings River East	38	95,000	-4%	99,209	3,460	0.0013	6.7	130.00	360.0	130.0	180.0	50.0	0.87	2,649	334295	0
Kings River East	Central Kings	39	95,000	-5%	99,384	3,116	0.0017	8.7	128.25	96.4	128.3	96.4	31.8	0.56	1,643	270150	0
Kings River East	Central Kings	40	90,000	-3%	93,041	15,843	0.0019	10.1	163.87	96.4	163.9	96.4	67.4	1.18	14,629	2600509	0
Kings River East	Central Kings	41	90,000	-2%	91,624	17,844	0.0012	6.1	207.69	178.6	27.7	178.6	29.1	0.51	8,671	918948	0
Kings River East	Central Kings	42	90,000	-3%	92,338	17,872	0.0006	3.3	247.55	186.7	67.5	6.7	60.9	1.06	15,614	897868	0
Kings River East	Central Kings	43	78,000	-2%	79,423	5,653	0.0010	5.1	300.48	229.9	120.5	49.9	70.6	1.23	5,332	412645	0
Kings River East	Central Kings	44	78,000	-1%	78,916	16,793	0.0016	8.6	266.26	203.7	86.3	23.7	62.5	1.09	14,898	1911352	0
Kings River East	Central Kings	45	***120,000***	0%	120,000	6,008	0.0014	7.6	247.34	173.3	67.3	173.3	74.0	1.29	5,776	1000491	0
Central Kings	Kings River East	46	***120,000***	0%	120,000	6,400	0.0010	5.5	224.71	254.6	44.7	74.6	29.9	0.52	3,191	400266	0
Kings River East	Central Kings	47	***120,000***	0%	120,000	7,877	0.0007	3.6	289.94	211.1	109.9	31.1	78.9	1.38	7,729	639298	0
Central Kings	McMullin	48	98,000	23%	75,891	14,924	0.0040	21.4	233.34	180.8	53.3	0.8	52.5	0.92	11,842	3639610	4,077
Central Kings	McMullin	49	75,000	27%	54,886	10,541	0.0036	18.8	256.71	180.8	76.7	0.8	75.9	1.32	10,223	1993669	2,233
McMullin	Central Kings	50	75,000	27%	54,997	5,264	0.0022	11.5	255.37	270.3	75.4	90.3	15.0	0.26	1,360	163024	183
Central Kings	McMullin	51	75,000	26%	55,425	10,654	0.0017	9.1	272.75	180.7	92.8	0.7	87.9	1.53	10,647	1020831	1,143
James	McMullin	52	128,000	11%	114,224	6,877	0.0050	26.2	68.33	132.3	68.3	132.3	64.0	1.12	6,180	3497265	3,917
James	McMullin	53	128,000	11%	114,064	7,174	0.0046	24.5	32.94	130.2	32.9	130.2	82.7	1.44	7,115	3769489	4,222
James	McMullin	54	107,000	13%	92,969	6,829	0.0044	23.2	64.10	132.7	64.1	132.7	68.6	1.20	6,358	2592430	2,904
James	McMullin	55	***112,000***	0%	112,000	9,572	0.0038	20.1	91.64	141.8	91.6	141.8	50.1	0.87	7,346	3132488	3,509
James	McMullin	56	***112,000***	0%	112,000	9,617	0.0025	13.1	105.40	141.6	105.4	141.6	36.2	0.63	5,684	1574317	1,763
James	McMullin	57	128,000	22%	99,217	9,585	0.0045	23.6	75.70	142.0	75.7	142.0	66.3	1.16	8,776	3893778	4,362
James	McMullin	58	128,000	24%	97,258	6,153	0.0031	16.3	80.31	142.2	80.3	142.2	61.9	1.08	5,426	1632045	1,828
James	McMullin	59	125,000	24%	95,517	3,455	0.0027	14.4	86.50	152.8	86.5	152.8	66.3	1.16	3,163	824083	923
McMullin	North Fork Kings	60	125,000	25%	93,183	4,656	0.0025	13.1	73.08	227.4	73.1	47.4	25.7	0.45	2,018	465929	522
North Fork Kings	McMullin	61	125,000	27%	91,501	7,115	0.0022	11.8	21.89	315.0	21.9	135.0	66.9	1.17	6,544	1342653	1,504
McMullin	North Fork Kings	62	123,000	29%	87,645	16,815	0.0021	11.2	161.78	288.4	161.8	108.4	53.4	0.93	13,501	2510977	2,813
McMullin	North Fork Kings	63	123,000	31%	85,245	11,841	0.0030	15.7	284.84	334.5	104.8	154.5	49.6	0.87	9,022	2291464	2,567
North Fork Kings	McMullin	64	123,000	29%	86,845	10,574	0.0007	3.6	301.38	270.1	121.4	90.1	31.2	0.55	5,485	320801	359
North Fork Kings	McMullin	65	75,000	30%	52,395	5,349	0.0018	9.7	282.44	270.8	102.4	90.8	11.6	0.20	1,077	103760	116
North Fork Kings	McMullin	66	75,000	31%	51,830	5,277	0.0022	11.4	294.18	180.5	114.2	0.5	66.3	1.16	4,834	543139	608

Attachment 3 - 2005 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Fork Kings	McMullin	67	75,000	32%	51,283	5,354	0.0022	11.5	291.18	270.1	111.2	90.1	21.1	0.37	1,924	214678	240
McMullin	North Fork Kings	68	75,000	30%	52,225	5,258	0.0024	12.7	303.63	0.8	123.6	0.8	57.1	1.00	4,416	556764	624
North Fork Kings	McMullin	69	75,000	26%	55,265	10,633	0.0035	18.2	329.90	270.2	149.9	90.2	59.7	1.04	9,182	1751873	1,962
North Fork Kings	Central Kings	70	75,000	26%	55,396	10,594	0.0031	16.4	336.58	270.3	156.6	90.3	66.3	1.16	9,702	1668914	1,869
Central Kings	North Fork Kings	71	73,000	25%	54,577	10,677	0.0030	16.0	269.66	270.4	89.7	90.4	0.7	0.01	136	22477	25
Central Kings	North Fork Kings	72	73,000	25%	54,969	5,277	0.0036	18.8	239.38	0.5	59.4	0.5	58.8	1.03	4,516	882431	988
Central Kings	North Fork Kings	73	73,000	25%	54,623	15,835	0.0025	13.2	247.30	270.4	67.3	90.4	23.1	0.40	6,212	846010	948
North Fork Kings	Central Kings	74	73,000	23%	56,203	5,273	0.0028	14.6	237.72	180.4	57.7	0.4	57.3	1.00	4,437	688341	771
Central Kings	North Fork Kings	75	73,000	20%	58,546	5,321	0.0028	14.5	226.78	270.3	46.8	90.3	43.5	0.76	3,666	590241	661
Central Kings	North Fork Kings	76	93,000	14%	80,296	14,584	0.0028	14.6	223.62	270.7	43.6	90.7	47.1	0.82	10,675	2370631	2,655
Central Kings	North Fork Kings	77	93,000	6%	87,498	1,334	0.0039	20.4	223.50	270.8	43.5	90.8	47.3	0.82	980	330614	370
Central Kings	North Fork Kings	78	93,000	6%	87,676	14,877	0.0021	11.3	237.07	315.4	57.1	135.4	78.3	1.37	14,569	2721884	3,049
Central Kings	North Fork Kings	79	***118,000***	0%	118,000	4,185	0.0017	8.8	228.86	270.3	48.9	90.3	41.4	0.72	2,768	541331	606
Central Kings	North Fork Kings	80	***118,000***	0%	118,000	9,772	0.0024	12.9	233.58	271.5	53.6	91.5	37.9	0.66	5,998	1733357	1,942
Central Kings	North Fork Kings	81	***118,000***	0%	118,000	10,682	0.0016	8.7	254.23	0.7	74.2	0.7	73.5	1.28	10,244	1984821	2,223
Central Kings	North Fork Kings	82	***118,000***	0%	118,000	6,290	0.0006	3.3	352.23	68.3	172.2	68.3	76.1	1.33	6,107	452090	506
James	North Fork Kings	83	86,000	0%	86,000	11,628	0.0023	12.0	159.05	263.5	159.0	83.5	75.6	1.32	11,261	2208722	2,474
James	North Fork Kings	84	87,000	0%	87,000	6,538	0.0028	14.8	162.25	281.3	162.3	101.3	61.0	1.06	5,718	1397024	1,565
James	North Fork Kings	85	87,000	0%	87,000	18,139	0.0029	15.5	118.37	263.8	118.4	83.8	34.6	0.60	10,297	2626069	2,942

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2006 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	McMullin	0	96,000	0%	96,000	3958	0.0022	11.7	308.5	180.1	128.5	0.1	51.6	0.90	3,104	662017	742
North Kings	McMullin	1	96,000	0%	96,000	5,250	0.0032	16.9	161.5	90.6	161.5	90.6	70.9	1.24	4,962	1526606	1,710
McMullin	North Kings	2	96,000	0%	96,000	5,317	0.0053	27.9	159.2	180.0	159.2	0.0	20.8	0.36	1,889	957427	1,072
North Kings	McMullin	3	96,000	6%	90,147	10,532	0.0036	19.1	196.1	180.1	16.1	0.1	15.9	0.28	2,892	942343	1,056
North Kings	McMullin	4	97,000	9%	88,161	11,871	0.0049	25.7	194.0	90.9	14.0	90.9	77.0	1.34	11,564	4961791	5,558
North Kings	McMullin	5	98,000	10%	88,337	7,744	0.0033	17.2	216.9	181.4	36.9	1.4	35.6	0.62	4,504	1296207	1,452
North Kings	McMullin	6	98,000	12%	86,236	22,487	0.0040	21.4	217.1	136.3	37.1	136.3	80.9	1.41	22,201	7742806	8,673
McMullin	North Kings	7	***120,000***	0%	120,000	8,027	0.0032	16.8	184.1	180.7	4.1	0.7	3.3	0.06	465	177698	199
North Kings	McMullin	8	120,000	17%	99,359	11,936	0.0076	40.0	181.8	90.3	1.8	90.3	88.5	1.54	11,932	8972108	10,050
North Kings	McMullin	9	120,000	13%	104,129	11,887	0.0055	29.2	196.7	90.6	16.7	90.6	73.9	1.29	11,423	6574130	7,364
North Kings	McMullin	10	120,000	9%	109,054	11,937	0.0062	32.8	198.0	90.0	18.0	90.0	72.1	1.26	11,356	7688576	8,612
North Kings	McMullin	11	***182,000***	0%	182,000	11,909	0.0065	34.1	200.3	90.2	20.3	90.2	69.9	1.22	11,185	13158178	14,739
North Kings	McMullin	12	***115,000***	0%	115,000	15,873	0.0043	22.7	211.1	180.9	31.1	0.9	30.2	0.53	7,986	3951011	4,426
North Kings	McMullin	13	98,000	18%	80,494	10,744	0.0039	20.8	207.9	279.5	27.9	99.5	71.6	1.25	10,194	3235419	3,624
North Kings	Central Kings	14	98,000	17%	81,042	5,348	0.0052	27.3	220.0	279.5	40.0	99.5	59.6	1.04	4,611	1933711	2,166
Central Kings	North Kings	15	91,000	14%	78,480	7,944	0.0046	24.1	222.4	0.9	42.4	0.9	41.5	0.72	5,259	1880445	2,106
North Kings	Central Kings	16	83,000	11%	73,698	15,707	0.0029	15.4	222.5	90.3	42.5	90.3	47.8	0.83	11,631	2500811	2,801
North Kings	Central Kings	17	83,000	10%	74,984	5,303	0.0030	15.8	229.5	179.9	49.5	179.9	49.6	0.87	4,038	908016	1,017
North Kings	Central Kings	18	83,000	9%	75,507	15,829	0.0031	16.1	224.9	90.2	44.9	90.2	45.2	0.79	11,237	2588933	2,900
Central Kings	North Kings	19	89,000	6%	83,730	10,569	0.0022	11.8	238.1	0.5	58.1	0.5	57.6	1.01	8,925	1665663	1,866
North Kings	Central Kings	20	95,000	4%	91,507	18,685	0.0013	7.1	247.2	90.3	67.2	90.3	23.1	0.40	7,332	896029	1,004
Central Kings	North Kings	21	95,000	1%	93,861	5,292	0.0015	7.7	253.9	1.1	73.9	1.1	72.7	1.27	5,054	689557	772
Central Kings	North Kings	22	111,000	3%	108,001	10,632	0.0016	8.5	269.5	0.3	89.5	0.3	89.2	1.56	10,631	1837670	2,058
Central Kings	North Kings	23	111,000	3%	107,937	16,792	0.0022	11.4	269.7	232.2	89.7	52.2	37.5	0.65	10,226	2377633	2,663
North Kings	Central Kings	24	80,000	-2%	81,808	9,989	0.0024	12.8	263.9	268.3	83.9	88.3	4.4	0.08	759	151003	169
North Kings	Central Kings	25	***100,000***	0%	100,000	18,219	0.0021	10.9	247.9	268.3	67.9	88.3	20.4	0.36	6,349	1311550	1,469
North Kings	Central Kings	26	***95,000***	0%	95,000	3,430	0.0021	10.8	228.0	268.3	48.0	88.3	40.3	0.70	2,217	432206	*484*
North Kings	Central Kings	27	***95,000***	0%	95,000	2,653	0.0022	11.4	219.8	268.3	39.8	88.3	48.5	0.85	1,987	408944	*458*
North Kings	Kings River East	28	***95,000***	0%	95,000	9,490	0.0030	15.8	220.7	235.8	40.7	55.8	15.1	0.26	2,472	703471	0
North Kings	Kings River East	29	59,000	0%	59,000	6,424	0.0035	18.5	217.7	235.8	37.7	55.8	18.1	0.32	1,990	411995	0
North Kings	Kings River East	30	30,000	0%	30,000	3,027	0.0033	17.2	219.2	235.8	39.2	55.8	16.6	0.29	863	84151	0
North Kings	Kings River East	31	30,000	0%	30,000	5,071	N/A	N/A	N/A	235.8	N/A	55.8	N/A	N/A	N/A	N/A	0
Kings River East	North Kings	32	30,000	0%	30,000	16,502	N/A	N/A	N/A	34.6	N/A	34.6	N/A	N/A	N/A	N/A	0
Central Kings	Kings River East	33	***95,000***	0%	95,000	2,895	0.0022	11.5	218.6	255.3	38.6	75.3	36.7	0.64	1,730	358760	0
Kings River East	Central Kings	34	***95,000***	0%	95,000	4,909	0.0020	10.8	220.5	220.0	40.5	40.0	0.5	0.01	42	8154	0
Kings River East	Central Kings	35	80,000	-3%	82,389	13,736	0.0018	9.6	212.8	189.4	32.8	9.4	23.4	0.41	5,460	818664	0
Kings River East	Central Kings	36	80,000	-3%	82,432	5,888	0.0015	8.1	183.6	349.5	3.6	169.5	14.1	0.25	1,433	180421	0
Central Kings	Kings River East	37	80,000	-4%	83,016	5,428	0.0015	8.1	154.9	360.0	154.9	180.0	25.0	0.44	2,296	291540	0
Central Kings	Kings River East	38	95,000	-4%	99,209	3,460	0.0015	8.0	136.1	360.0	136.1	180.0	43.8	0.77	2,396	361708	0
Kings River East	Central Kings	39	95,000	-5%	99,384	3,116	0.0018	9.7	128.2	96.4	128.2	96.4	31.8	0.56	1,643	300591	0
Kings River East	Central Kings	40	90,000	-3%	93,041	15,843	0.0016	8.4	155.1	96.4	155.1	96.4	58.6	1.02	13,526	2003289	0
Kings River East	Central Kings	41	90,000	-2%	91,624	17,844	0.0004	2.3	220.6	178.6	40.6	178.6	42.0	0.73	11,943	466886	0
Kings River East	Central Kings	42	90,000	-3%	92,338	17,872	0.0008	4.2	211.0	186.7	31.0	6.7	24.4	0.43	7,378	546355	0
Kings River East	Central Kings	43	78,000	-2%	79,423	5,653	0.0008	4.2	302.8	229.9	122.8	49.9	72.9	1.27	5,404	338857	0
Kings River East	Central Kings	44	78,000	-1%	78,916	16,793	0.0017	8.9	273.7	203.7	93.7	23.7	70.0	1.22	15,777	2098311	0
Kings River East	Central Kings	45	***120,000***	0%	120,000	6,008	0.0015	8.1	247.3	173.3	67.3	173.3	74.0	1.29	5,775	1068218	0
Central Kings	Kings River East	46	***120,000***	0%	120,000	6,400	0.0012	6.2	221.9	254.6	41.9	74.6	32.7	0.57	3,456	488700	0
Kings River East	Central Kings	47	***120,000***	0%	120,000	7,877	0.0008	4.5	266.8	211.1	86.8	31.1	55.8	0.97	6,512	662011	0
Central Kings	McMullin	48	98,000	23%	75,891	14,924	0.0031	16.3	230.6	180.8	50.6	0.8	49.7	0.87	11,390	2666926	2,987
Central Kings	McMullin	49	75,000	27%	54,886	10,541	0.0058	30.4	256.3	180.8	76.3	0.8	75.5	1.32	10,206	3222392	3,610
McMullin	Central Kings	50	75,000	27%	54,997	5,264	0.0043	22.9	261.1	270.3	81.1	90.3	9.2	0.16	842	201249	225
Central Kings	McMullin	51	75,000	26%	55,425	10,654	0.0012	6.2	234.1	180.7	54.1	0.7	53.4	0.93	8,553	556066	623
McMullin	James	52	128,000	11%	114,224	6,877	0.0008	4.2	195.4	132.3	15.4	132.3	63.1	1.10	6,134	558248	625
McMullin	James	53	128,000	11%	114,064	7,174	0.0015	7.9	147.8	130.2	147.8	130.2	17.6	0.31	2,167	368008	412
James	McMullin	54	107,000	13%	92,969	6,829	0.0022	11.4	127.7	132.7	127.7	132.7	5.0	0.09	590	118672	133
James	McMullin	55	***112,000***	0%	112,000	9,572	0.0025	13.0	118.2	141.8	118.2	141.8	23.5	0.41	3,821	1056763	1,184
James	McMullin	56	***112,000***	0%	112,000	9,617	0.0018	9.7	108.6	141.6	108.6	141.6	33.0	0.58	5,239	1075817	1,205
James	McMullin	57	128,000	22%	99,217	9,585	0.0010	5.2	61.2	142.0	61.2	142.0	80.8	1.41	9,463	931389	1,043
James	McMullin	58	128,000	24%	97,258	6,153	0.0018	9.5	79.9	142.2	79.9	142.2	62.3	1.09	5,449	956039	1,071
James	McMullin	59	125,000	24%	95,517	3,455	0.0020	10.6	86.4	152.8	86.4	152.8	66.3	1.16	3,165	604197	677
McMullin	North Fork Kings	60	125,000	25%	93,183	4,656	0.0021	10.9	76.0	227.4	76.0	47.4	28.6	0.50	2,232	429849	481
North Fork Kings	McMullin	61	125,000	27%	91,501	7,115	0.0022	11.5	50.9	315.0	50.9	135.0	84.1	1.47	7,077	1409620	1,579
McMullin	North Fork Kings	62	123,000	29%	87,645	16,815	0.0010	5.1	128.7	288.4	128.7	108.4	20.3	0.35	5,838	489433	548
North Fork Kings	McMullin	63	123,000	31%	85,245	11,841	0.0015	7.9	344.0	334.5	164.0	154.5	9.5	0.17	1,949	247993	278
North Fork Kings	McMullin	64	123,000	29%	86,845	10,574	0.0013	6.9	338.3	270.1	158.3	90.1	68.1	1.19	9,813	1120993	1,256
North Fork Kings	McMullin	65	75,000	30%	52,395	5,349	0.0013	6.9	297.7	270.8	117.7	90.8	26.9	0.47	2,419	166273	186
North Fork Kings	McMullin	66	75,000	31%	51,830	5,277	0.0020	10.6	274.4	180.5	94.4	0.5	86.2	1.50	5,265	545608	611

Attachment 3 - 2006 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
McMullin	North Fork Kings	67	75,000	32%	51,283	5,354	0.0028	14.9	264.0	270.1	84.0	90.1	6.1	0.11	571	82726	93
McMullin	North Fork Kings	68	75,000	30%	52,225	5,258	0.0031	16.1	269.2	0.8	89.2	0.8	88.4	1.54	5,256	837592	938
McMullin	North Fork Kings	69	75,000	26%	55,265	10,633	0.0022	11.7	265.6	270.2	85.6	90.2	4.6	0.08	858	105242	118
North Fork Kings	Central Kings	70	75,000	26%	55,396	10,594	0.0034	17.9	279.6	270.3	99.6	90.3	9.4	0.16	1,726	324619	364
Central Kings	North Fork Kings	71	73,000	25%	54,577	10,677	0.0032	16.7	253.1	270.4	73.1	90.4	17.3	0.30	3,168	545270	611
Central Kings	North Fork Kings	72	73,000	25%	54,969	5,277	0.0036	19.3	233.7	0.5	53.7	0.5	53.2	0.93	4,224	847289	949
Central Kings	North Fork Kings	73	73,000	25%	54,623	15,835	0.0027	14.5	234.5	270.4	54.5	90.4	35.9	0.63	9,290	1392445	1,560
North Fork Kings	Central Kings	74	73,000	23%	56,203	5,273	0.0024	12.6	248.8	180.4	68.8	0.4	68.4	1.19	4,902	655475	734
Central Kings	North Fork Kings	75	73,000	20%	58,546	5,321	0.0023	12.2	254.8	270.3	74.8	90.3	15.6	0.27	1,429	194003	217
Central Kings	North Fork Kings	76	93,000	14%	80,296	14,584	0.0031	16.5	223.9	270.7	43.9	90.7	46.8	0.82	10,626	2665827	2,986
Central Kings	North Fork Kings	77	93,000	6%	87,498	1,334	0.0037	19.3	223.0	270.8	43.0	90.8	47.8	0.83	988	315568	353
Central Kings	North Fork Kings	78	93,000	6%	87,676	14,877	0.0026	13.8	225.3	315.4	45.3	135.4	89.9	1.57	14,877	3416514	3,827
Central Kings	North Fork Kings	79	***118,000***	0%	118,000	4,185	0.0027	14.1	225.7	270.3	45.7	90.3	44.6	0.78	2,937	924353	1,035
Central Kings	North Fork Kings	80	***118,000***	0%	118,000	9,772	0.0032	16.7	239.0	271.5	59.0	91.5	32.5	0.57	5,243	1959153	2,195
Central Kings	North Fork Kings	81	***118,000***	0%	118,000	10,682	0.0026	13.8	263.2	0.7	83.2	0.7	82.5	1.44	10,591	3258322	3,650
Central Kings	North Fork Kings	82	***118,000***	0%	118,000	6,290	0.0014	7.4	316.5	68.3	136.5	68.3	68.2	1.19	5,839	963523	1,079
James	North Fork Kings	83	86,000	0%	86,000	11,628	N/A	N/A	95.0	263.5	95.0	83.5	11.5	0.20	2,328	N/A	N/A
North Fork Kings	James	84	87,000	0%	87,000	6,538	0.0009	4.6	83.5	281.3	83.5	101.3	17.7	0.31	1,992	152339	171
James	North Fork Kings	85	87,000	0%	87,000	18,139	0.0017	8.9	94.5	263.8	94.5	83.8	10.7	0.19	3,376	494444	554

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2007 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	McMullin	0	96,000	0%	96,000	3958	0.0035	18.4	236.1	180.1	56.1	0.1	56.0	0.98	3,281	1097204	1,229
North Kings	McMullin	1	96,000	0%	96,000	5,250	0.0074	38.9	180.9	90.6	0.9	90.6	89.7	1.57	5,250	3714363	4,161
North Kings	McMullin	2	96,000	0%	96,000	5,317	0.0073	38.6	195.2	180.0	15.2	0.0	15.2	0.27	1,395	980360	1,098
North Kings	McMullin	3	96,000	6%	90,147	10,532	0.0024	12.7	215.0	180.1	35.0	0.1	34.9	0.61	6,020	1304143	1,461
North Kings	McMullin	4	97,000	9%	88,161	11,871	0.0037	19.8	192.1	90.9	12.1	90.9	78.9	1.38	11,648	3848119	4,310
North Kings	McMullin	5	98,000	10%	88,337	7,744	0.0049	26.0	220.7	181.4	40.7	1.4	39.3	0.69	4,907	2135415	2,392
North Kings	McMullin	6	98,000	12%	86,236	22,487	0.0049	25.6	219.0	136.3	39.0	136.3	82.7	1.44	22,304	9329274	10,450
North Kings	McMullin	7	***120,000***	0%	120,000	8,027	0.0039	20.4	220.6	180.7	40.6	0.7	39.9	0.70	5,147	2387737	2,675
North Kings	McMullin	8	120,000	17%	99,359	11,936	0.0049	25.8	210.1	90.3	30.1	90.3	60.2	1.05	10,356	5035179	5,640
North Kings	McMullin	9	120,000	13%	104,129	11,887	0.0057	30.3	193.0	90.6	13.0	90.6	77.6	1.35	11,609	6927972	7,760
North Kings	McMullin	10	120,000	9%	109,054	11,937	0.0061	32.4	205.3	90.0	25.3	90.0	64.7	1.13	10,796	7215003	8,082
North Kings	McMullin	11	***182,000***	0%	182,000	11,909	0.0064	33.8	202.5	90.2	22.5	90.2	67.7	1.18	11,019	12828444	14,370
North Kings	McMullin	12	***115,000***	0%	115,000	15,873	0.0045	23.8	211.0	180.9	31.0	0.9	30.1	0.53	7,959	4119045	4,614
North Kings	McMullin	13	98,000	18%	80,494	10,744	0.0047	24.8	221.0	279.5	41.0	99.5	58.5	1.02	9,160	3456686	3,872
North Kings	Central Kings	14	98,000	17%	81,042	5,348	0.0036	19.0	217.8	279.5	37.8	99.5	61.7	1.08	4,711	1376165	1,542
Central Kings	North Kings	15	91,000	14%	78,480	7,944	0.0031	16.4	216.4	0.9	36.4	0.9	35.4	0.62	4,606	1123435	1,258
North Kings	Central Kings	16	83,000	11%	73,698	15,707	0.0033	17.5	207.7	90.3	27.7	90.3	62.6	1.09	13,944	3400022	3,809
North Kings	Central Kings	17	83,000	10%	74,984	5,303	0.0026	13.8	217.4	179.9	37.4	179.9	37.5	0.65	3,226	631379	707
North Kings	Central Kings	18	83,000	9%	75,507	15,829	0.0037	19.8	226.9	90.2	46.9	90.2	43.2	0.75	10,841	3067813	3,436
Central Kings	North Kings	19	89,000	6%	83,730	10,569	0.0032	16.9	249.3	0.5	69.3	0.5	68.8	1.20	9,852	2639069	2,956
North Kings	Central Kings	20	95,000	4%	91,507	18,685	0.0018	9.5	245.8	90.3	65.8	90.3	24.5	0.43	7,753	1281745	1,436
Central Kings	North Kings	21	95,000	1%	93,861	5,292	0.0020	10.7	271.5	1.1	91.5	1.1	89.6	1.56	5,292	1008477	1,130
Central Kings	North Kings	22	111,000	3%	108,001	10,632	0.0017	8.9	279.5	0.3	99.5	0.3	80.8	1.41	10,497	1913844	2,144
Central Kings	North Kings	23	111,000	3%	107,937	16,792	0.0020	10.7	255.1	232.2	75.1	52.2	22.9	0.40	6,534	1429118	1,601
North Kings	Central Kings	24	80,000	-2%	81,808	9,989	0.0020	10.5	256.0	268.3	76.0	88.3	12.2	0.21	2,117	343361	385
North Kings	Central Kings	25	***100,000***	0%	100,000	18,219	0.0021	11.2	244.1	268.3	64.1	88.3	24.2	0.42	7,455	1575479	1,765
North Kings	Central Kings	26	***95,000***	0%	95,000	3,430	0.0024	12.8	230.8	268.3	50.8	88.3	37.5	0.65	2,087	481132	*539*
North Kings	Central Kings	27	***95,000***	0%	95,000	2,653	0.0028	14.8	231.1	268.3	51.1	88.3	37.1	0.65	1,602	425459	*477*
North Kings	Kings River East	28	***95,000***	0%	95,000	9,490	0.0031	16.3	230.9	235.8	50.9	55.8	4.9	0.09	812	237751	0
North Kings	Kings River East	29	59,000	0%	59,000	6,424	0.0029	15.4	221.3	235.8	41.3	55.8	14.5	0.25	1,606	275621	0
North Kings	Kings River East	30	30,000	0%	30,000	3,027	0.0026	13.7	215.0	235.8	35.0	55.8	20.8	0.36	1,073	83634	0
North Kings	Kings River East	31	30,000	0%	30,000	5,071	N/A	N/A	N/A	N/A	N/A	55.8	N/A	N/A	N/A	N/A	0
Kings River East	North Kings	32	30,000	0%	30,000	16,502	N/A	N/A	N/A	34.6	N/A	34.6	N/A	N/A	N/A	N/A	0
Central Kings	Kings River East	33	***95,000***	0%	95,000	2,895	0.0028	14.9	230.3	255.3	50.3	75.3	25.1	0.44	1,226	327696	0
Kings River East	Central Kings	34	***95,000***	0%	95,000	4,909	0.0024	12.8	227.3	220.0	47.3	40.0	7.3	0.13	626	143644	0
Kings River East	Central Kings	35	80,000	-3%	82,389	13,736	0.0018	9.3	215.2	189.4	35.2	9.4	25.8	0.45	5,978	864160	0
Kings River East	Central Kings	36	80,000	-3%	82,432	5,888	0.0013	6.7	198.7	349.5	18.7	169.5	29.2	0.51	2,874	301646	0
Central Kings	Kings River East	37	80,000	-4%	83,016	5,428	0.0011	5.7	167.4	360.0	167.4	180.0	12.5	0.22	1,179	106496	0
Central Kings	Kings River East	38	95,000	-4%	99,209	3,460	0.0012	6.5	144.1	360.0	144.1	180.0	35.9	0.63	2,028	248721	0
Kings River East	Central Kings	39	95,000	-5%	99,384	3,116	0.0015	8.1	136.3	96.4	136.3	96.4	39.9	0.70	1,997	303997	0
Kings River East	Central Kings	40	90,000	-3%	93,041	15,843	0.0020	10.4	171.1	96.4	171.1	96.4	74.6	1.30	15,277	2792823	0
Kings River East	Central Kings	41	90,000	-2%	91,624	17,844	0.0011	5.7	232.0	178.6	52.0	178.6	53.4	0.93	14,320	1409139	0
Central Kings	Kings River East	42	90,000	-3%	92,338	17,872	0.0011	5.8	161.7	186.7	161.7	6.7	25.0	0.44	7,541	770967	0
Kings River East	Central Kings	43	78,000	-2%	79,423	5,653	0.0004	2.2	315.9	229.9	135.9	49.9	86.0	1.50	5,639	185493	0
Kings River East	Central Kings	44	78,000	-1%	78,916	16,793	0.0017	8.9	273.3	203.7	93.3	23.7	69.6	1.21	15,737	2083672	0
Kings River East	Central Kings	45	***120,000***	0%	120,000	6,008	0.0017	9.1	239.0	173.3	59.0	173.3	65.6	1.15	5,473	1126161	0
Central Kings	Kings River East	46	***120,000***	0%	120,000	6,400	0.0015	7.8	211.6	254.6	31.6	74.6	43.0	0.75	4,367	774041	0
Kings River East	Central Kings	47	***120,000***	0%	120,000	7,877	0.0005	2.6	223.3	211.1	43.3	31.1	12.2	0.21	1,665	97600	0
Central Kings	McMullin	48	98,000	23%	75,891	14,924	0.0048	25.5	232.8	180.8	52.8	0.8	52.0	0.91	11,752	4301461	4,818
Central Kings	McMullin	49	75,000	27%	54,886	10,541	0.0038	20.3	255.0	180.8	75.0	0.8	74.2	1.29	10,143	2138402	2,395
McMullin	Central Kings	50	75,000	27%	54,997	5,264	0.0031	16.5	269.8	270.3	89.8	90.3	0.6	0.01	52	8999	10
Central Kings	McMullin	51	75,000	26%	55,425	10,654	0.0027	14.4	264.6	180.7	84.6	0.7	83.9	1.46	10,594	1599416	1,792
James	McMullin	52	128,000	11%	114,224	6,877	0.0047	25.0	23.2	132.3	23.2	132.3	70.9	1.24	6,501	3520719	3,944
James	McMullin	53	128,000	11%	114,064	7,174	0.0058	30.8	34.7	130.2	34.7	130.2	84.5	1.47	7,140	4755858	5,327
James	McMullin	54	107,000	13%	92,969	6,829	0.0061	32.4	57.8	132.7	57.8	132.7	74.9	1.31	6,595	3762616	4,215
James	McMullin	55	***112,000***	0%	112,000	9,572	0.0061	32.2	89.8	141.8	89.8	141.8	52.0	0.91	7,544	5146194	5,764
James	McMullin	56	***112,000***	0%	112,000	9,617	0.0057	30.1	79.5	141.6	79.5	141.6	62.2	1.08	8,504	5425755	6,078
James	McMullin	57	128,000	22%	99,217	9,585	0.0041	21.7	32.4	142.0	32.4	142.0	70.4	1.23	9,031	3674569	4,116
James	McMullin	58	128,000	24%	97,258	6,153	0.0029	15.2	67.6	142.2	67.6	142.2	74.6	1.30	5,932	1666071	1,866
James	McMullin	59	125,000	24%	95,517	3,455	0.0033	17.6	93.0	152.8	93.0	152.8	59.8	1.04	2,985	952994	1,067
McMullin	North Fork Kings	60	125,000	25%	93,183	4,656	0.0040	21.0	99.0	227.4	99.0	47.4	51.6	0.90	3,649	1354801	1,518
North Fork Kings	McMullin	61	125,000	27%	91,501	7,115	0.0039	20.5	110.2	315.0	110.2	135.0	24.8	0.43	2,984	1057718	1,185
McMullin	North Fork Kings	62	123,000	29%	87,645	16,815	0.0010	5.2	235.1	288.4	55.1	108.4	53.2	0.93	13,472	1154718	1,293
McMullin	North Fork Kings	63	123,000	31%	85,245	11,841	0.0023	12.2	274.1	334.5	94.1	154.5	60.4	1.05	10,296	2022405	2,265
North Fork Kings	McMullin	64	123,000	29%	86,845	10,574	0.0014	7.3	291.8	270.1	111.8	90.1	21.7	0.38	3,906	469426	526
North Fork Kings	McMullin	65	75,000	30%	52,395	5,349	0.0028	14.9	278.5	270.8	98.5	90.8	7.7	0.13	715	105851	119
North Fork Kings	McMullin	66	75,000	31%	51,830	5,277	0.0033	17.3	259.9	180.5	79.9	0.5	79.3	1.38	5,186	878399	984

Attachment 3 - 2007 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
McMullin	North Fork Kings	67	75,000	32%	51,283	5,354	0.0038	20.2	222.5	270.1	42.5	90.1	47.6	0.83	3,955	775269	868
McMullin	North Fork Kings	68	75,000	30%	52,225	5,258	0.0024	12.8	275.7	0.8	95.7	0.8	85.1	1.49	5,239	662023	742
North Fork Kings	McMullin	69	75,000	26%	55,265	10,633	0.0029	15.1	295.2	270.2	115.2	90.2	25.0	0.44	4,499	711054	796
Central Kings	North Fork Kings	70	75,000	26%	55,396	10,594	0.0030	15.6	248.9	270.3	68.9	90.3	21.4	0.37	3,865	633123	709
Central Kings	North Fork Kings	71	73,000	25%	54,577	10,677	0.0029	15.2	259.6	270.4	79.6	90.4	10.8	0.19	1,994	313711	351
Central Kings	North Fork Kings	72	73,000	25%	54,969	5,277	0.0045	23.8	252.8	0.5	72.8	0.5	72.2	1.26	5,026	1243541	1,393
Central Kings	North Fork Kings	73	73,000	25%	54,623	15,835	0.0029	15.3	253.3	270.4	73.3	90.4	17.1	0.30	4,644	735989	824
North Fork Kings	Central Kings	74	73,000	23%	56,203	5,273	0.0015	8.0	247.7	180.4	67.7	0.4	67.3	1.17	4,864	416316	466
Central Kings	North Fork Kings	75	73,000	20%	58,546	5,321	0.0021	11.3	237.8	270.3	57.8	90.3	32.5	0.57	2,861	358310	401
Central Kings	North Fork Kings	76	93,000	14%	80,296	14,584	0.0032	17.1	215.7	270.7	35.7	90.7	54.9	0.96	11,936	3111958	3,486
Central Kings	North Fork Kings	77	93,000	6%	87,498	1,334	0.0044	23.2	226.0	270.8	46.0	90.8	44.8	0.78	939	361407	405
Central Kings	North Fork Kings	78	93,000	6%	87,676	14,877	0.0028	14.8	232.7	315.4	52.7	135.4	82.7	1.44	14,755	3624493	4,060
Central Kings	North Fork Kings	79	***118,000***	0%	118,000	4,185	0.0026	13.6	248.1	270.3	68.1	90.3	22.2	0.39	1,580	481989	540
Central Kings	North Fork Kings	80	***118,000***	0%	118,000	9,772	0.0027	14.0	233.2	271.5	53.2	91.5	38.3	0.67	6,052	1899371	2,128
Central Kings	North Fork Kings	81	***118,000***	0%	118,000	10,682	0.0030	15.9	264.5	0.7	84.5	0.7	83.8	1.46	10,620	3767264	4,220
Central Kings	North Fork Kings	82	***118,000***	0%	118,000	6,290	0.0022	11.7	298.0	68.3	118.0	68.3	49.7	0.87	4,797	1257042	1,408
James	North Fork Kings	83	86,000	0%	86,000	11,628	0.0024	12.7	137.6	263.5	137.6	83.5	54.1	0.94	9,419	1945804	2,180
James	North Fork Kings	84	87,000	0%	87,000	6,538	0.0029	15.4	143.7	281.3	143.7	101.3	42.5	0.74	4,416	1121189	1,256
James	North Fork Kings	85	87,000	0%	87,000	18,139	0.0027	14.0	140.5	263.8	140.5	83.8	56.7	0.99	15,166	3509220	3,931

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2008 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	McMullin	0	96,000	0%	96,000	3958	0.0009	4.7	256.1	180.1	76.1	0.1	76.0	1.33	3,840	327690	367
North Kings	McMullin	1	96,000	0%	96,000	5,250	0.0022	11.7	218.5	90.6	38.5	90.6	52.1	0.91	4,143	883805	990
North Kings	McMullin	2	96,000	0%	96,000	5,317	0.0035	18.7	218.4	180.0	38.4	0.0	38.4	0.67	3,300	1123826	1,259
North Kings	McMullin	3	96,000	6%	90,147	10,532	0.0037	19.5	208.3	180.1	28.3	0.1	28.1	0.49	4,967	1652224	1,851
North Kings	McMullin	4	97,000	9%	88,161	11,871	0.0058	30.7	189.6	90.9	9.6	90.9	81.4	1.42	11,737	6020838	6,744
North Kings	McMullin	5	98,000	10%	88,337	7,744	0.0049	25.9	215.1	181.4	35.1	1.4	33.7	0.59	4,301	1866162	2,090
North Kings	McMullin	6	98,000	12%	86,236	22,487	0.0041	21.7	225.5	136.3	45.5	136.3	89.2	1.56	22,485	7962197	8,919
North Kings	McMullin	7	***120,000***	0%	120,000	8,027	0.0047	24.6	218.9	180.7	38.9	0.7	38.2	0.67	4,964	2777793	3,112
North Kings	McMullin	8	120,000	17%	99,359	11,936	0.0054	28.8	203.5	90.3	23.5	90.3	66.8	1.17	10,967	5934136	6,647
North Kings	McMullin	9	120,000	13%	104,129	11,887	0.0059	31.1	196.9	90.6	16.9	90.6	73.7	1.29	11,410	7007241	7,849
North Kings	McMullin	10	120,000	9%	109,054	11,937	0.0060	31.8	205.3	90.0	25.3	90.0	64.7	1.13	10,796	7096688	7,949
North Kings	McMullin	11	***182,000***	0%	182,000	11,909	0.0065	34.2	205.0	90.2	25.0	90.2	65.2	1.14	10,811	12751897	14,284
North Kings	McMullin	12	***115,000***	0%	115,000	15,873	0.0052	27.5	214.3	180.9	34.3	0.9	33.4	0.58	8,744	5228569	5,857
North Kings	McMullin	13	98,000	18%	80,494	10,744	0.0047	24.7	225.2	279.5	45.2	99.5	54.3	0.95	8,726	3283490	3,678
North Kings	Central Kings	14	98,000	17%	81,042	5,348	0.0038	20.0	219.3	279.5	39.3	99.5	60.2	1.05	4,640	1426781	1,598
Central Kings	North Kings	15	91,000	14%	78,480	7,944	0.0035	18.4	218.6	0.9	38.6	0.9	37.7	0.66	4,859	1325878	1,485
North Kings	Central Kings	16	83,000	11%	73,698	15,707	0.0030	15.7	224.2	90.3	44.2	90.3	46.1	0.80	11,310	2471438	2,768
North Kings	Central Kings	17	83,000	10%	74,984	5,303	0.0031	16.2	230.5	179.9	50.5	179.9	50.6	0.88	4,097	941429	1,055
North Kings	Central Kings	18	83,000	9%	75,507	15,829	0.0031	16.4	224.5	90.2	44.5	90.2	45.7	0.80	11,320	2655788	2,975
Central Kings	North Kings	19	89,000	6%	83,730	10,569	0.0021	11.2	238.1	0.5	58.1	0.5	57.6	1.01	8,922	1578751	1,768
North Kings	Central Kings	20	95,000	4%	91,507	18,685	0.0016	8.2	243.0	90.3	63.0	90.3	27.3	0.48	8,561	1214258	1,360
Central Kings	North Kings	21	95,000	1%	93,861	5,292	0.0016	8.7	254.0	1.1	74.0	1.1	72.8	1.27	5,056	782508	877
Central Kings	North Kings	22	111,000	3%	108,001	10,632	0.0015	8.0	278.4	0.3	98.4	0.3	81.8	1.43	10,525	1722555	1,930
Central Kings	North Kings	23	111,000	3%	107,937	16,792	0.0017	9.2	262.3	232.2	82.3	52.2	30.1	0.52	8,416	1578176	1,768
North Kings	Central Kings	24	80,000	-2%	81,808	9,989	0.0024	12.6	255.8	268.3	75.8	88.3	12.4	0.22	2,153	421678	472
North Kings	Central Kings	25	***100,000***	0%	100,000	18,219	0.0021	11.1	237.9	268.3	57.9	88.3	30.4	0.53	9,226	1941500	2,175
North Kings	Central Kings	26	***95,000***	0%	95,000	3,430	0.0025	13.2	218.9	268.3	38.9	88.3	49.4	0.86	2,602	619127	694
North Kings	Central Kings	27	***95,000***	0%	95,000	2,653	0.0025	13.4	213.3	268.3	33.3	88.3	54.9	0.96	2,172	525155	588
North Kings	Kings River East	28	***95,000***	0%	95,000	9,490	0.0030	15.8	215.3	235.8	35.3	55.8	20.5	0.36	3,319	940561	0
North Kings	Kings River East	29	59,000	0%	59,000	6,424	0.0035	18.4	214.5	235.8	34.5	55.8	21.3	0.37	2,332	480250	0
North Kings	Kings River East	30	30,000	0%	30,000	3,027	0.0033	17.5	212.4	235.8	32.4	55.8	23.4	0.41	1,201	119395	0
North Kings	Kings River East	31	30,000	0%	30,000	5,071	N/A	N/A	N/A	235.8	N/A	55.8	N/A	N/A	N/A	N/A	0
Kings River East	North Kings	32	30,000	0%	30,000	16,502	N/A	N/A	N/A	34.6	N/A	34.6	N/A	N/A	N/A	N/A	0
Central Kings	Kings River East	33	***95,000***	0%	95,000	2,895	0.0025	13.3	213.3	255.3	33.3	75.3	42.0	0.73	1,937	463042	0
Central Kings	Kings River East	34	***95,000***	0%	95,000	4,909	0.0023	12.1	216.4	220.0	36.4	40.0	3.6	0.06	306	66534	0
Kings River East	Central Kings	35	80,000	-3%	82,389	13,736	0.0014	7.6	215.2	189.4	35.2	9.4	25.8	0.45	5,985	714189	0
Kings River East	Central Kings	36	80,000	-3%	82,432	5,888	0.0012	6.3	205.7	349.5	25.7	169.5	36.2	0.63	3,478	341150	0
Kings River East	Central Kings	37	80,000	-4%	83,016	5,428	0.0011	5.7	193.9	360.0	13.9	180.0	14.0	0.24	1,310	116657	0
Central Kings	Kings River East	38	95,000	-4%	99,209	3,460	0.0007	3.9	160.0	360.0	160.0	180.0	19.9	0.35	1,178	86355	0
Kings River East	Central Kings	39	95,000	-5%	99,384	3,116	0.0013	6.6	134.1	96.4	134.1	96.4	37.6	0.66	1,903	237295	0
Kings River East	Central Kings	40	90,000	-3%	93,041	15,843	0.0022	11.4	150.1	96.4	150.1	96.4	53.7	0.94	12,761	2561090	0
Central Kings	Kings River East	41	90,000	-2%	91,624	17,844	0.0010	5.1	124.0	178.6	124.0	178.6	54.6	0.95	14,545	1291427	0
Central Kings	Kings River East	42	90,000	-3%	92,338	17,872	0.0011	5.7	181.7	186.7	1.7	6.7	5.0	0.09	1,552	155024	0
Kings River East	Central Kings	43	78,000	-2%	79,423	5,653	0.0008	4.0	327.4	229.9	147.4	49.9	82.4	1.44	5,603	337095	0
Kings River East	Central Kings	44	78,000	-1%	78,916	16,793	0.0017	8.9	277.5	203.7	97.5	23.7	73.8	1.29	16,126	2143337	0
Kings River East	Central Kings	45	***120,000***	0%	120,000	6,008	0.0012	6.3	234.4	173.3	54.4	173.3	61.0	1.07	5,256	754212	0
Central Kings	Kings River East	46	***120,000***	0%	120,000	6,400	0.0013	6.9	196.7	254.6	16.7	74.6	57.9	1.01	5,420	853304	0
Central Kings	Kings River East	47	***120,000***	0%	120,000	7,877	0.0007	3.9	116.9	211.1	116.9	31.1	85.8	1.50	7,856	702632	0
Central Kings	McMullin	48	98,000	23%	75,891	14,924	0.0050	26.5	232.7	180.8	52.7	0.8	51.8	0.90	11,735	4467670	5,004
Central Kings	McMullin	49	75,000	27%	54,886	10,541	0.0045	24.0	258.2	180.8	78.2	0.8	77.4	1.35	10,288	2564974	2,873
McMullin	Central Kings	50	75,000	27%	54,997	5,264	0.0040	21.1	264.3	270.3	84.3	90.3	6.1	0.11	557	122561	137
Central Kings	McMullin	51	75,000	26%	55,425	10,654	0.0017	8.9	305.1	180.7	125.1	0.7	55.6	0.97	8,790	817257	915
James	McMullin	52	128,000	11%	114,224	6,877	0.0018	9.5	90.2	132.3	90.2	132.3	42.1	0.74	4,615	947854	1,062
James	McMullin	53	128,000	11%	114,064	7,174	0.0039	20.8	114.7	130.2	114.7	130.2	15.6	0.27	1,927	864637	969
James	McMullin	54	107,000	13%	92,969	6,829	0.0043	22.9	110.2	132.7	110.2	132.7	22.5	0.39	2,616	1053674	1,180
James	McMullin	55	***112,000***	0%	112,000	9,572	0.0032	17.2	78.7	141.8	78.7	141.8	63.1	1.10	8,535	3105441	3,479
James	McMullin	56	***112,000***	0%	112,000	9,617	0.0034	17.7	64.5	141.6	64.5	141.6	77.1	1.35	9,374	3527494	3,951
James	McMullin	57	128,000	22%	99,217	9,585	0.0044	23.0	60.6	142.0	60.6	142.0	81.4	1.42	9,478	4104130	4,597
James	McMullin	58	128,000	24%	97,258	6,153	0.0056	29.5	92.7	142.2	92.7	142.2	49.4	0.86	4,675	2537288	2,842
James	McMullin	59	125,000	24%	95,517	3,455	0.0042	22.3	61.5	152.8	61.5	152.8	88.7	1.55	3,454	1390465	1,558
North Fork Kings	McMullin	60	125,000	25%	93,183	4,656	0.0028	14.8	41.2	227.4	41.2	47.4	6.2	0.11	503	131219	147
North Fork Kings	McMullin	61	125,000	27%	91,501	7,115	0.0018	9.3	346.9	315.0	166.9	135.0	31.9	0.56	3,760	604278	677
McMullin	North Fork Kings	62	123,000	29%	87,645	16,815	0.0026	13.5	238.7	288.4	58.7	108.4	49.6	0.87	12,813	2877046	3,223
McMullin	North Fork Kings	63	123,000	31%	85,245	11,841	0.0035	18.5	261.7	334.5	81.7	154.5	72.7	1.27	11,308	3386306	3,793
North Fork Kings	McMullin	64	123,000	29%	86,845	10,574	0.0012	6.1	300.5	270.1	120.5	90.1	30.4	0.53	5,349	536151	601
North Fork Kings	McMullin	65	75,000	30%	52,395	5,349	0.0018	9.3	309.9	270.8	129.9	90.8	39.1	0.68	3,371	311957	349
North Fork Kings	McMullin	66	75,000	31%	51,830	5,277	0.0017	9.2	289.3	180.5	109.3	0.5	71.2	1.24	4,997	452703	507

Attachment 3 - 2008 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
McMullin	North Fork Kings	67	75,000	32%	51,283	5,354	0.0020	10.7	267.0	270.1	87.0	90.1	3.1	0.05	292	30340	34
McMullin	North Fork Kings	68	75,000	30%	52,225	5,258	0.0034	18.0	290.4	0.8	110.4	0.8	70.3	1.23	4,952	881564	987
North Fork Kings	McMullin	69	75,000	26%	55,265	10,633	0.0024	12.5	301.9	270.2	121.9	90.2	31.7	0.55	5,590	731886	820
North Fork Kings	Central Kings	70	75,000	26%	55,396	10,594	0.0032	16.9	322.3	270.3	142.3	90.3	52.0	0.91	8,351	1478378	1,656
North Fork Kings	Central Kings	71	73,000	25%	54,577	10,677	0.0031	16.2	274.6	270.4	94.6	90.4	4.2	0.07	780	131066	147
Central Kings	North Fork Kings	72	73,000	25%	54,969	5,277	0.0029	15.6	247.7	0.5	67.7	0.5	67.1	1.17	4,863	787860	883
Central Kings	North Fork Kings	73	73,000	25%	54,623	15,835	0.0023	12.2	242.0	270.4	62.0	90.4	28.4	0.50	7,542	952829	1,067
North Fork Kings	Central Kings	74	73,000	23%	56,203	5,273	0.0027	14.5	219.8	180.4	39.8	0.4	39.4	0.69	3,345	514559	576
Central Kings	North Fork Kings	75	73,000	20%	58,546	5,321	0.0031	16.4	226.7	270.3	46.7	90.3	43.6	0.76	3,670	667935	748
Central Kings	North Fork Kings	76	93,000	14%	80,296	14,584	0.0029	15.1	220.7	270.7	40.7	90.7	49.9	0.87	11,160	2567222	2,876
Central Kings	North Fork Kings	77	93,000	6%	87,498	1,334	0.0039	20.6	227.9	270.8	47.9	90.8	42.9	0.75	908	309881	347
Central Kings	North Fork Kings	78	93,000	6%	87,676	14,877	0.0030	15.8	232.0	315.4	52.0	135.4	83.4	1.46	14,778	3867619	4,332
Central Kings	North Fork Kings	79	***118,000***	0%	118,000	4,185	0.0028	14.6	249.2	270.3	69.2	90.3	21.1	0.37	1,506	490549	549
Central Kings	North Fork Kings	80	***118,000***	0%	118,000	9,772	0.0027	14.2	235.7	271.5	55.7	91.5	35.7	0.62	5,704	1807110	2,024
Central Kings	North Fork Kings	81	***118,000***	0%	118,000	10,682	0.0029	15.3	258.9	0.7	78.9	0.7	78.2	1.37	10,458	3570246	3,999
Central Kings	North Fork Kings	82	***118,000***	0%	118,000	6,290	0.0015	7.9	282.0	68.3	102.0	68.3	33.6	0.59	3,482	616585	691
James	North Fork Kings	83	86,000	0%	86,000	11,628	0.0021	11.3	149.3	263.5	149.3	83.5	65.8	1.15	10,608	1955804	2,191
James	North Fork Kings	84	87,000	0%	87,000	6,538	0.0027	14.4	148.5	281.3	148.5	101.3	47.2	0.82	4,800	1135369	1,272
James	North Fork Kings	85	87,000	0%	87,000	18,139	0.0039	20.5	92.8	263.8	92.8	83.8	9.0	0.16	2,829	954679	1,069

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2009 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	McMullin	0	96,000	0%	96,000	3958	0.0027	14.3	288.05	180.1	108.1	0.1	72.1	1.26	3,766	980457	1,098
North Kings	McMullin	1	96,000	0%	96,000	5,250	0.0015	7.7	252.28	90.6	72.3	90.6	18.3	0.32	1,650	230849	259
North Kings	McMullin	2	96,000	0%	96,000	5,317	0.0017	8.9	201.19	180.0	21.2	0.0	21.2	0.37	1,922	309925	347
North Kings	McMullin	3	96,000	6%	90,147	10,532	0.0046	24.1	188.00	180.1	8.0	0.1	7.9	0.14	1,443	592844	664
North Kings	McMullin	4	97,000	9%	88,161	11,871	0.0042	22.1	198.87	90.9	18.9	90.9	72.1	1.26	11,294	4158519	4,658
North Kings	McMullin	5	98,000	10%	88,337	7,744	0.0047	24.9	207.50	181.4	27.5	1.4	26.1	0.46	3,410	1419278	1,590
North Kings	McMullin	6	98,000	12%	86,236	22,487	0.0035	18.4	223.35	136.3	43.3	136.3	87.1	1.52	22,458	6765309	7,578
North Kings	McMullin	7	***120,000***	0%	120,000	8,027	0.0044	23.1	203.43	180.7	23.4	0.7	22.7	0.40	3,095	1625084	1,820
North Kings	McMullin	8	120,000	17%	99,359	11,936	0.0069	36.4	182.06	90.3	2.1	90.3	88.2	1.54	11,930	8161694	9,142
North Kings	McMullin	9	120,000	13%	104,129	11,887	0.0065	34.1	200.50	90.6	20.5	90.6	70.1	1.22	11,178	7518826	8,422
North Kings	McMullin	10	120,000	9%	109,054	11,937	0.0058	30.6	207.79	90.0	27.8	90.0	62.3	1.09	10,565	6681284	7,484
North Kings	McMullin	11	***182,000***	0%	182,000	11,909	0.0070	37.1	199.44	90.2	19.4	90.2	70.8	1.24	11,244	14390462	16,119
North Kings	McMullin	12	***115,000***	0%	115,000	15,873	0.0048	25.4	212.81	180.9	32.8	0.9	31.9	0.56	8,388	4631888	5,188
North Kings	McMullin	13	98,000	18%	80,494	10,744	0.0045	23.8	218.48	279.5	38.5	99.5	61.1	1.07	9,402	3411992	3,822
North Kings	Central Kings	14	98,000	17%	81,042	5,348	0.0037	19.5	218.69	279.5	38.7	99.5	60.8	1.06	4,670	1399871	1,568
Central Kings	North Kings	15	91,000	14%	78,480	7,944	0.0037	19.6	226.00	0.9	46.0	0.9	45.1	0.79	5,625	1636708	1,833
North Kings	Central Kings	16	83,000	11%	73,698	15,707	0.0030	15.6	226.70	90.3	46.7	90.3	43.6	0.76	10,828	2357615	2,641
North Kings	Central Kings	17	83,000	10%	74,984	5,303	0.0030	15.6	229.00	179.9	49.0	179.9	49.1	0.86	4,008	887957	995
North Kings	Central Kings	18	83,000	9%	75,507	15,829	0.0032	16.8	222.00	90.2	42.0	90.2	48.2	0.84	11,792	2825520	3,165
Central Kings	North Kings	19	89,000	6%	83,730	10,569	0.0017	9.1	229.90	0.5	49.9	0.5	49.4	0.86	8,024	1161015	1,301
North Kings	Central Kings	20	95,000	4%	91,507	18,685	0.0017	9.1	241.62	90.3	61.6	90.3	28.7	0.50	8,968	1417805	1,588
Central Kings	North Kings	21	95,000	1%	93,861	5,292	0.0023	12.2	266.43	1.1	86.4	1.1	85.3	1.49	5,274	1142785	1,280
Central Kings	North Kings	22	111,000	3%	108,001	10,632	0.0019	9.8	271.39	0.3	91.4	0.3	88.9	1.55	10,630	2124320	2,380
Central Kings	North Kings	23	111,000	3%	107,937	16,792	0.0019	10.3	250.85	232.2	70.9	52.2	18.7	0.33	5,378	1127901	1,263
North Kings	Central Kings	24	80,000	-2%	81,808	9,989	0.0021	11.0	246.13	268.3	66.1	88.3	22.2	0.39	3,767	643917	721
North Kings	Central Kings	25	***100,000***	0%	100,000	18,219	0.0020	10.7	244.52	268.3	64.5	88.3	23.8	0.41	7,340	1480927	1,659
North Kings	Central Kings	26	***95,000***	0%	95,000	3,430	0.0025	13.3	230.60	268.3	50.6	88.3	37.7	0.66	2,096	502865	563
North Kings	Central Kings	27	***95,000***	0%	95,000	2,653	0.0025	13.4	224.00	268.3	44.0	88.3	44.3	0.77	1,852	446464	500
North Kings	Kings River East	28	***95,000***	0%	95,000	9,490	0.0031	16.2	214.65	235.8	34.6	55.8	21.1	0.37	3,418	996308	0
North Kings	Kings River East	29	59,000	0%	59,000	6,424	0.0046	24.3	211.07	235.8	31.1	55.8	24.7	0.43	2,683	729792	0
North Kings	Kings River East	30	30,000	0%	30,000	3,027	0.0035	18.3	201.55	235.8	21.6	55.8	34.2	0.60	1,701	177380	0
North Kings	Kings River East	31	30,000	0%	30,000	5,071	N/A	N/A	N/A	235.8	N/A	55.8	N/A	N/A	N/A	N/A	0
Kings River East	North Kings	32	30,000	0%	30,000	16,502	N/A	N/A	N/A	34.6	N/A	34.6	N/A	N/A	N/A	N/A	0
Central Kings	Kings River East	33	***95,000***	0%	95,000	2,895	0.0025	13.2	224.06	255.3	44.1	75.3	31.3	0.55	1,502	357919	0
Kings River East	Central Kings	34	***95,000***	0%	95,000	4,909	0.0024	12.6	226.59	220.0	46.6	40.0	6.6	0.12	566	127887	0
Kings River East	Central Kings	35	80,000	-3%	82,389	13,736	0.0017	9.1	203.22	189.4	23.2	9.4	13.9	0.24	3,293	466784	0
Kings River East	Central Kings	36	80,000	-3%	82,432	5,888	0.0013	7.1	173.75	349.5	173.7	169.5	4.3	0.07	438	48253	0
Kings River East	Central Kings	37	80,000	-4%	83,016	5,428	0.0004	2.3	197.69	360.0	17.7	180.0	17.7	0.31	1,653	60102	0
Central Kings	Kings River East	38	95,000	-4%	99,209	3,460	0.0005	2.4	177.27	360.0	177.3	180.0	2.7	0.05	162	7335	0
Kings River East	Central Kings	39	95,000	-5%	99,384	3,116	0.0014	7.2	137.87	96.4	137.9	96.4	41.4	0.72	2,062	278070	0
Kings River East	Central Kings	40	90,000	-3%	93,041	15,843	0.0028	15.0	170.03	96.4	170.0	96.4	73.6	1.28	15,198	4011202	0
Kings River East	Central Kings	41	90,000	-2%	91,624	17,844	0.0015	7.7	213.02	178.6	33.0	178.6	34.4	0.60	10,082	1348400	0
Central Kings	Kings River East	42	90,000	-3%	92,338	17,872	0.0011	5.7	164.77	186.7	164.8	6.7	21.9	0.38	6,662	663970	0
Central Kings	Kings River East	43	78,000	-2%	79,423	5,653	0.0009	4.5	150.25	229.9	150.3	49.9	79.6	1.39	5,560	377349	0
Kings River East	Central Kings	44	78,000	-1%	78,916	16,793	0.0009	4.6	262.70	203.7	82.7	23.7	59.0	1.03	14,388	995646	0
Kings River East	Central Kings	45	***120,000***	0%	120,000	6,008	0.0027	14.1	237.75	173.3	57.7	173.3	64.4	1.12	5,419	1734256	0
Central Kings	Kings River East	46	***120,000***	0%	120,000	6,400	0.0034	17.7	187.75	254.6	7.8	74.6	66.9	1.17	5,885	2368454	0
Central Kings	Kings River East	47	***120,000***	0%	120,000	7,877	0.0024	12.5	102.59	211.1	102.6	31.1	71.5	1.25	7,471	2129305	0
Central Kings	McMullin	48	98,000	23%	75,891	14,924	0.0034	17.7	222.91	180.8	42.9	0.8	42.1	0.73	10,002	2544216	2,850
Central Kings	McMullin	49	75,000	27%	54,886	10,541	0.0041	21.6	243.09	180.8	63.1	0.8	62.3	1.09	9,331	2095074	2,347
McMullin	Central Kings	50	75,000	27%	54,997	5,264	0.0037	19.6	249.20	270.3	69.2	90.3	21.1	0.37	1,898	387808	434
Central Kings	McMullin	51	75,000	26%	55,425	10,654	0.0014	7.4	259.49	180.7	79.5	0.7	78.8	1.38	10,451	809312	907
James	McMullin	52	128,000	11%	114,224	6,877	0.0022	11.4	92.71	132.3	92.7	132.3	39.6	0.69	4,382	1085151	1,216
James	McMullin	53	128,000	11%	114,064	7,174	0.0007	3.8	105.47	130.2	105.5	130.2	24.8	0.43	3,006	245840	275
James	McMullin	54	107,000	13%	92,969	6,829	0.0019	10.0	130.08	132.7	130.1	132.7	2.6	0.05	312	54683	61
James	McMullin	55	***112,000***	0%	112,000	9,572	0.0029	15.2	102.70	141.8	102.7	141.8	39.1	0.68	6,032	1941995	2,175
James	McMullin	56	***112,000***	0%	112,000	9,617	0.0033	17.6	65.41	141.6	65.4	141.6	76.2	1.33	9,340	3479882	3,898
James	McMullin	57	128,000	22%	99,217	9,585	0.0043	22.6	70.83	142.0	70.8	142.0	71.1	1.24	9,071	3844325	4,306
James	McMullin	58	128,000	24%	97,258	6,153	0.0034	18.1	89.41	142.2	89.4	142.2	52.8	0.92	4,899	1636339	1,833
James	McMullin	59	125,000	24%	95,517	3,455	0.0041	21.9	88.50	152.8	88.5	152.8	64.3	1.12	3,113	1231954	1,380
McMullin	North Fork Kings	60	125,000	25%	93,183	4,656	0.0049	25.7	84.17	227.4	84.2	47.4	36.8	0.64	2,787	1262012	1,414
North Fork Kings	McMullin	61	125,000	27%	91,501	7,115	0.0037	19.7	54.25	315.0	54.3	135.0	80.8	1.41	7,023	2400062	2,688
McMullin	North Fork Kings	62	123,000	29%	87,645	16,815	0.0009	4.7	227.57	288.4	47.6	108.4	60.8	1.06	14,679	1137660	1,274
McMullin	North Fork Kings	63	123,000	31%	85,245	11,841	0.0018	9.3	305.54	334.5	125.5	154.5	28.9	0.51	5,729	863195	967
North Fork Kings	McMullin	64	123,000	29%	86,845	10,574	0.0012	6.6	2.16	270.1	2.2	90.1	88.0	1.54	10,567	1147059	1,285
North Fork Kings	McMullin	65	75,000	30%	52,395	5,349	0.0011	5.8	309.36	270.8	129.4	90.8	38.5	0.67	3,333	191684	215
North Fork Kings	McMullin	66	75,000	31%	51,830	5,277	0.0028	15.0	244.10	180.5	64.1	0.5	63.6	1.11	4,726	696571	780

Attachment 3 - 2009 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
McMullin	North Fork Kings	67	75,000	32%	51,283	5,354	0.0053	28.1	236.86	270.1	56.9	90.1	33.3	0.58	2,937	802683	899
McMullin	North Fork Kings	68	75,000	30%	52,225	5,258	0.0079	41.9	259.90	0.8	79.9	0.8	79.1	1.38	5,164	2141649	2,399
North Fork Kings	McMullin	69	75,000	26%	55,265	10,633	0.0042	22.4	313.74	270.2	133.7	90.2	43.6	0.76	7,327	1720312	1,927
North Fork Kings	Central Kings	70	75,000	26%	55,396	10,594	0.0024	12.8	307.20	270.3	127.2	90.3	36.9	0.64	6,367	855879	959
Central Kings	North Fork Kings	71	73,000	25%	54,577	10,677	0.0036	19.2	261.54	270.4	81.5	90.4	8.8	0.15	1,642	325210	364
Central Kings	North Fork Kings	72	73,000	25%	54,969	5,277	0.0041	21.6	254.32	0.5	74.3	0.5	73.8	1.29	5,067	1137730	1,274
North Fork Kings	Central Kings	73	73,000	25%	54,623	15,835	0.0025	13.1	289.42	270.4	109.4	90.4	19.0	0.33	5,161	699993	784
North Fork Kings	Central Kings	74	73,000	23%	56,203	5,273	0.0039	20.7	279.81	180.4	99.8	0.4	80.6	1.41	5,202	1145789	1,283
Central Kings	North Fork Kings	75	73,000	20%	58,546	5,321	0.0046	24.3	258.75	270.3	78.8	90.3	11.6	0.20	1,068	287368	322
Central Kings	North Fork Kings	76	93,000	14%	80,296	14,584	0.0037	19.6	222.34	270.7	42.3	90.7	48.3	0.84	10,894	3254388	3,645
Central Kings	North Fork Kings	77	93,000	6%	87,498	1,334	0.0057	30.0	223.43	270.8	43.4	90.8	47.3	0.83	981	487580	546
Central Kings	North Fork Kings	78	93,000	6%	87,676	14,877	0.0033	17.5	233.59	315.4	53.6	135.4	81.8	1.43	14,725	4268098	4,781
Central Kings	North Fork Kings	79	***118,000***	0%	118,000	4,185	0.0021	11.3	242.62	270.3	62.6	90.3	27.6	0.48	1,942	491052	550
Central Kings	North Fork Kings	80	***118,000***	0%	118,000	9,772	0.0025	13.4	225.42	271.5	45.4	91.5	46.0	0.80	7,032	2109636	2,363
Central Kings	North Fork Kings	81	***118,000***	0%	118,000	10,682	0.0029	15.3	256.08	0.7	76.1	0.7	75.4	1.32	10,337	3537631	3,963
Central Kings	North Fork Kings	82	***118,000***	0%	118,000	6,290	0.0017	9.1	280.74	68.3	100.7	68.3	32.4	0.57	3,370	681785	764
James	North Fork Kings	83	86,000	0%	86,000	11,628	0.0019	10.1	149.38	263.5	149.4	83.5	65.9	1.15	10,615	1745721	1,955
James	North Fork Kings	84	87,000	0%	87,000	6,538	0.0025	13.3	146.00	281.3	146.0	101.3	44.7	0.78	4,602	1005685	1,127
James	North Fork Kings	85	87,000	0%	87,000	18,139	0.0029	15.2	112.17	263.8	112.2	83.8	28.4	0.50	8,624	2156351	2,415

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2011 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	McMullin	0	96,000	0%	96,000	3,958	0.0023	12.0	242.81	180.1	62.8	0.1	62.7	1.09	3,516	766410	858
North Kings	McMullin	1	96,000	0%	96,000	5,250	0.0021	11.1	216.67	90.6	36.7	90.6	53.9	0.94	4,244	857175	960
McMullin	North Kings	2	96,000	0%	96,000	5,317	0.0035	18.7	178.91	180.0	178.9	0.0	1.1	0.02	101	34347	38
North Kings	McMullin	3	96,000	6%	90,147	10,532	0.0040	21.0	195.38	180.1	15.4	0.1	15.3	0.27	2,771	992070	1,111
North Kings	McMullin	4	97,000	9%	88,161	11,871	0.0059	31.1	191.09	90.9	11.1	90.9	79.8	1.39	11,685	6058303	6,786
North Kings	McMullin	5	98,000	10%	88,337	7,744	0.0050	26.2	222.00	181.4	42.0	1.4	40.6	0.71	5,043	2213063	2,479
North Kings	McMullin	6	98,000	12%	86,236	22,487	0.0041	21.8	222.77	136.3	42.8	136.3	86.5	1.51	22,445	7977339	8,936
North Kings	McMullin	7	***120,000***	0%	120,000	8,027	0.0046	24.3	212.50	180.7	32.5	0.7	31.8	0.55	4,224	2330181	2,610
North Kings	McMullin	8	120,000	17%	99,359	11,936	0.0050	26.3	203.07	90.3	23.1	90.3	67.2	1.17	11,004	5440859	6,095
North Kings	McMullin	9	120,000	13%	104,129	11,887	0.0053	27.8	196.15	90.6	16.1	90.6	74.5	1.30	11,452	6268334	7,021
North Kings	McMullin	10	120,000	9%	109,054	11,937	0.0063	33.2	202.46	90.0	22.5	90.0	67.6	1.18	11,035	7563387	8,472
North Kings	McMullin	11	***182,000***	0%	182,000	11,909	0.0069	36.3	200.45	90.2	20.5	90.2	69.8	1.22	11,173	13972773	15,652
North Kings	McMullin	12	***115,000***	0%	115,000	15,873	0.0052	27.6	218.85	180.9	38.8	0.9	37.9	0.66	9,758	5859028	6,563
North Kings	McMullin	13	98,000	18%	80,494	10,744	0.0052	27.6	217.42	279.5	37.4	99.5	62.1	1.08	9,497	3995068	4,475
North Kings	Central Kings	14	98,000	17%	81,042	5,348	0.0037	19.8	208.23	279.5	28.2	99.5	71.3	1.24	5,065	1538060	1,723
Central Kings	North Kings	15	91,000	14%	78,480	7,944	0.0035	18.3	214.31	0.9	34.3	0.9	33.4	0.58	4,371	1191489	1,335
North Kings	Central Kings	16	83,000	11%	73,698	15,707	0.0030	15.9	224.55	90.3	44.6	90.3	45.7	0.80	11,245	2488887	2,788
North Kings	Central Kings	17	83,000	10%	74,984	5,303	0.0023	12.1	241.16	179.9	61.2	179.9	61.3	1.07	4,649	801943	898
North Kings	Central Kings	18	83,000	9%	75,507	15,829	0.0024	12.9	229.94	90.2	49.9	90.2	40.2	0.70	10,220	1878082	2,104
Central Kings	North Kings	19	89,000	6%	83,730	10,569	0.0020	10.3	229.86	0.5	49.9	0.5	49.4	0.86	8,019	1313588	1,471
North Kings	Central Kings	20	95,000	4%	91,507	18,685	0.0024	12.5	232.19	90.3	52.2	90.3	38.1	0.67	11,532	2504796	2,806
Central Kings	North Kings	21	95,000	1%	93,861	5,292	0.0018	9.8	252.49	1.1	72.5	1.1	71.4	1.25	5,014	869140	974
Central Kings	North Kings	22	111,000	3%	108,001	10,632	0.0011	5.7	307.08	0.3	127.1	0.3	53.2	0.93	8,515	995393	1,115
Central Kings	North Kings	23	111,000	3%	107,937	16,792	0.0020	10.7	268.28	232.2	88.3	52.2	36.1	0.63	9,896	2154475	2,413
North Kings	Central Kings	24	80,000	-2%	81,808	9,989	0.0024	12.5	257.96	268.3	78.0	88.3	10.3	0.18	1,789	345213	387
North Kings	Central Kings	25	***100,000***	0%	100,000	18,219	0.0020	10.6	246.12	268.3	66.1	88.3	22.2	0.39	6,871	1377924	1,543
North Kings	Central Kings	26	***95,000***	0%	95,000	3,430	0.0017	9.0	222.00	268.3	42.0	88.3	46.3	0.81	2,479	400966	449
North Kings	Central Kings	27	***95,000***	0%	95,000	2,653	0.0025	13.1	225.00	268.3	45.0	88.3	43.3	0.76	1,819	428597	480
North Kings	Kings River East	28	***95,000***	0%	95,000	9,490	0.0032	16.7	224.71	235.8	44.7	55.8	11.0	0.19	1,818	547656	0
North Kings	Kings River East	29	59,000	0%	59,000	6,424	0.0042	22.2	208.79	235.8	28.8	55.8	27.0	0.47	2,913	721373	0
North Kings	Kings River East	30	30,000	0%	30,000	3,027	0.0034	17.9	199.39	235.8	19.4	55.8	36.4	0.63	1,795	182813	0
North Kings	Kings River East	31	30,000	0%	30,000	5,071	0.0027	14.2	194.96	235.8	15.0	55.8	40.8	0.71	3,314	267980	0
North Kings	Kings River East	32	30,000	0%	30,000	16,502	N/A	N/A	N/A	34.6	N/A	34.6	N/A	N/A	N/A	N/A	0
Central Kings	Kings River East	33	***95,000***	0%	95,000	2,895	0.0025	13.0	223.53	255.3	43.5	75.3	31.8	0.56	1,526	356207	0
Central Kings	Kings River East	34	***95,000***	0%	95,000	4,909	0.0016	8.4	215.35	220.0	35.4	40.0	4.6	0.08	395	59789	0
Kings River East	Central Kings	35	80,000	-3%	82,389	13,736	0.0015	8.0	206.50	189.4	26.5	9.4	17.2	0.30	4,051	502587	0
Kings River East	Central Kings	36	80,000	-3%	82,432	5,888	0.0015	7.9	196.57	349.5	16.6	169.5	27.1	0.47	2,681	329243	0
Kings River East	Central Kings	37	80,000	-4%	83,016	5,428	0.0011	5.8	192.27	360.0	12.3	180.0	12.3	0.21	1,158	105717	0
Central Kings	Kings River East	38	95,000	-4%	99,209	3,460	0.0007	3.7	170.36	360.0	170.4	180.0	9.6	0.17	577	39648	0
Kings River East	Central Kings	39	95,000	-5%	99,384	3,116	0.0013	6.6	138.07	96.4	138.1	96.4	41.6	0.73	2,070	259088	0
Kings River East	Central Kings	40	90,000	-3%	93,041	15,843	0.0024	12.7	161.36	96.4	161.4	96.4	64.9	1.13	14,349	3218060	0
Central Kings	Kings River East	41	90,000	-2%	91,624	17,844	0.0008	4.4	175.89	178.6	175.9	178.6	2.7	0.05	848	65157	0
Central Kings	Kings River East	42	90,000	-3%	92,338	17,872	0.0009	5.0	167.42	186.7	167.4	6.7	19.2	0.34	5,890	515600	0
Central Kings	Kings River East	43	78,000	-2%	79,423	5,653	0.0011	5.7	190.02	229.9	10.0	49.9	39.8	0.70	3,621	307851	0
Central Kings	Kings River East	44	78,000	-1%	78,916	16,793	0.0007	3.6	178.33	203.7	178.3	23.7	25.4	0.44	7,208	384177	0
Kings River East	Central Kings	45	***120,000***	0%	120,000	6,008	0.0017	9.1	230.07	173.3	50.1	173.3	56.7	0.99	5,024	1042682	0
Central Kings	Kings River East	46	***120,000***	0%	120,000	6,400	0.0028	14.9	195.18	254.6	15.2	74.6	59.4	1.04	5,511	1869365	0
Kings River East	Central Kings	47	***120,000***	0%	120,000	7,877	0.0012	6.4	211.12	211.1	31.1	31.1	0.1	0.00	8	1105	0
Central Kings	McMullin	48	98,000	23%	75,891	14,924	0.0044	23.2	222.83	180.8	42.8	0.8	42.0	0.73	9,986	3326656	3,726
Central Kings	McMullin	49	75,000	27%	54,886	10,541	0.0043	22.9	252.35	180.8	72.3	0.8	71.5	1.25	9,998	2382977	2,669
McMullin	Central Kings	50	75,000	27%	54,997	5,264	0.0038	19.9	266.29	270.3	86.3	90.3	4.1	0.07	372	77071	86
Central Kings	McMullin	51	75,000	26%	55,425	10,654	0.0028	14.7	253.02	180.7	73.0	0.7	72.3	1.26	10,151	1571611	1,760
McMullin	James	52	128,000	11%	114,224	6,877	0.0031	16.4	141.08	132.3	141.1	132.3	8.8	0.15	1,050	373651	419
James	McMullin	53	128,000	11%	114,064	7,174	0.0015	7.7	68.85	130.2	68.8	130.2	61.4	1.07	6,298	1045686	1,171
James	McMullin	54	107,000	13%	92,969	6,829	0.0030	15.6	70.31	132.7	70.3	132.7	62.4	1.09	6,052	1667073	1,867
James	McMullin	55	***112,000***	0%	112,000	9,572	0.0049	25.9	97.41	141.8	97.4	141.8	44.4	0.77	6,692	3675959	4,118
James	McMullin	56	***112,000***	0%	112,000	9,617	0.0034	17.7	96.88	141.6	96.9	141.6	44.7	0.78	6,770	2544296	2,850
James	McMullin	57	128,000	22%	99,217	9,585	0.0022	11.6	85.76	142.0	85.8	142.0	56.2	0.98	7,967	1734242	1,943
James	McMullin	58	128,000	24%	97,258	6,153	0.0025	13.0	87.17	142.2	87.2	142.2	55.0	0.96	5,041	1211716	1,357
James	McMullin	59	125,000	24%	95,517	3,455	0.0021	11.0	59.03	152.8	59.0	152.8	86.2	1.51	3,447	683393	765
North Fork Kings	McMullin	60	125,000	25%	93,183	4,656	0.0021	10.8	45.59	227.4	45.6	47.4	1.8	0.03	146	27990	31
North Fork Kings	McMullin	61	125,000	27%	91,501	7,115	0.0020	10.7	34.21	315.0	34.2	135.0	79.2	1.38	6,989	1301855	1,458
McMullin	North Fork Kings	62	123,000	29%	87,645	16,815	0.0009	4.6	133.22	288.4	133.2	108.4	24.9	0.43	7,068	543160	608
McMullin	North Fork Kings	63	123,000	31%	85,245	11,841	0.0015	7.9	264.27	334.5	84.3	154.5	70.2	1.23	11,141	1414985	1,585
North Fork Kings	McMullin	64	123,000	29%	86,845	10,574	0.0015	7.8	302.78	270.1	122.8	90.1	32.6	0.57	5,704	728869	816
McMullin	North Fork Kings	65	75,000	30%	52,395	5,349	0.0015	8.0	263.29	270.8	83.3	90.8	7.5	0.13	701	55800	63
North Fork Kings	McMullin	66	75,000	31%	51,830	5,277	0.0017	9.2	256.92	180.5	76.9	0.5	76.4	1.33	5,129	462546	518

Attachment 3 - 2011 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
McMullin	North Fork Kings	67	75,000	32%	51,283	5,354	0.0017	8.7	266.18	270.1	86.2	90.1	3.9	0.07	368	31161	35
McMullin	North Fork Kings	68	75,000	30%	52,225	5,258	0.0043	22.8	292.90	0.8	112.9	0.8	67.9	1.18	4,870	1098342	1,230
McMullin	North Fork Kings	69	75,000	26%	55,265	10,633	0.0023	12.4	265.33	270.2	85.3	90.2	4.9	0.08	900	116578	131
Central Kings	North Fork Kings	70	75,000	26%	55,396	10,594	0.0026	13.8	247.25	270.3	67.3	90.3	23.0	0.40	4,140	600397	673
Central Kings	North Fork Kings	71	73,000	25%	54,577	10,677	0.0036	19.0	249.57	270.4	69.6	90.4	20.8	0.36	3,794	744370	834
Central Kings	North Fork Kings	72	73,000	25%	54,969	5,277	0.0033	17.4	229.70	0.5	49.7	0.5	49.2	0.86	3,992	723650	811
Central Kings	North Fork Kings	73	73,000	25%	54,623	15,835	0.0028	14.7	233.49	270.4	53.5	90.4	36.9	0.64	9,510	1450542	1,625
North Fork Kings	Central Kings	74	73,000	23%	56,203	5,273	0.0025	13.0	221.00	180.4	41.0	0.4	40.6	0.71	3,430	476331	534
Central Kings	North Fork Kings	75	73,000	20%	58,546	5,321	0.0027	14.3	216.50	270.3	36.5	90.3	53.8	0.94	4,295	682875	765
Central Kings	North Fork Kings	76	93,000	14%	80,296	14,584	0.0038	19.9	216.76	270.7	36.8	90.7	53.9	0.94	11,785	3566100	3,995
Central Kings	North Fork Kings	77	93,000	6%	87,498	1,334	0.0049	25.8	221.60	270.8	41.6	90.8	49.2	0.86	1,009	431594	483
Central Kings	North Fork Kings	78	93,000	6%	87,676	14,877	0.0030	15.7	231.74	315.4	51.7	135.4	83.7	1.46	14,786	3845923	4,308
Central Kings	North Fork Kings	79	***118,000***	0%	118,000	4,185	0.0022	11.4	234.46	270.3	54.5	90.3	35.8	0.62	2,449	624036	699
Central Kings	North Fork Kings	80	***118,000***	0%	118,000	9,772	0.0027	14.1	233.45	271.5	53.5	91.5	38.0	0.66	6,016	1892852	2,120
Central Kings	North Fork Kings	81	***118,000***	0%	118,000	10,682	0.0029	15.4	244.92	0.7	64.9	0.7	64.2	1.12	9,620	3306101	3,703
Central Kings	North Fork Kings	82	***118,000***	0%	118,000	6,290	0.0026	13.7	243.84	68.3	63.8	68.3	4.5	0.08	494	151491	170
James	North Fork Kings	83	86,000	0%	86,000	11,628	0.0017	8.9	114.52	263.5	114.5	83.5	31.0	0.54	5,997	868951	973
James	North Fork Kings	84	87,000	0%	87,000	6,538	0.0018	9.5	107.00	281.3	107.0	101.3	5.7	0.10	654	102668	115
North Fork Kings	James	85	87,000	0%	87,000	18,139	0.0023	12.0	67.73	263.8	67.7	83.8	16.1	0.28	5,017	992152	1,111

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2012 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	McMullin	0	96,000	0%	96,000	3958	0.0031	16.6	274.1	180.1	94.1	0.1	86.0	1.50	3,949	1193467	1,337
North Kings	McMullin	1	96,000	0%	96,000	5,250	0.0028	14.5	248.8	90.6	68.8	90.6	21.8	0.38	1,950	515242	577
North Kings	McMullin	2	96,000	0%	96,000	5,317	0.0027	14.5	225.4	180.0	45.4	0.0	45.4	0.79	3,789	996199	1,116
North Kings	McMullin	3	96,000	6%	90,147	10,532	0.0042	22.3	206.6	180.1	26.6	0.1	26.4	0.46	4,688	1784954	1,999
North Kings	McMullin	4	97,000	9%	88,161	11,871	0.0049	26.0	197.9	90.9	17.9	90.9	73.0	1.27	11,352	4933038	5,526
North Kings	McMullin	5	98,000	10%	88,337	7,744	0.0047	24.7	218.9	181.4	38.9	1.4	37.5	0.66	4,717	1950078	2,184
North Kings	McMullin	6	98,000	12%	86,236	22,487	0.0028	15.0	201.5	136.3	21.5	136.3	65.2	1.14	20,415	5006299	5,608
North Kings	McMullin	7	***120,000***	0%	120,000	8,027	0.0030	15.7	234.6	180.7	54.6	0.7	53.9	0.94	6,484	2314907	2,593
North Kings	McMullin	8	120,000	17%	99,359	11,936	0.0050	26.2	206.8	90.3	26.8	90.3	63.4	1.11	10,676	5270239	5,903
North Kings	McMullin	9	120,000	13%	104,129	11,887	0.0061	32.3	194.6	90.6	14.6	90.6	76.1	1.33	11,536	7345925	8,228
North Kings	McMullin	10	120,000	9%	109,054	11,937	0.0065	34.2	207.3	90.0	27.3	90.0	62.7	1.09	10,608	7498411	8,399
North Kings	McMullin	11	***182,000***	0%	182,000	11,909	0.0063	33.5	203.0	90.2	23.0	90.2	67.2	1.17	10,981	12678443	14,202
North Kings	McMullin	12	***115,000***	0%	115,000	15,873	0.0046	24.3	217.9	180.9	37.9	0.9	37.0	0.65	9,550	5062267	5,670
North Kings	McMullin	13	98,000	18%	80,494	10,744	0.0042	22.0	207.4	279.5	27.4	99.5	72.2	1.26	10,228	3428717	3,841
North Kings	Central Kings	14	98,000	17%	81,042	5,348	0.0043	22.7	249.0	279.5	69.0	99.5	30.6	0.53	2,719	947074	1,061
Central Kings	North Kings	15	91,000	14%	78,480	7,944	0.0037	19.4	232.7	0.9	52.7	0.9	51.8	0.90	6,242	1801017	2,017
North Kings	Central Kings	16	83,000	11%	73,698	15,707	0.0030	15.6	227.5	90.3	47.5	90.3	42.7	0.75	10,661	2320329	2,599
North Kings	Central Kings	17	83,000	10%	74,984	5,303	0.0027	14.0	243.8	179.9	63.8	179.9	63.9	1.12	4,762	948372	1,062
Central Kings	North Kings	18	83,000	9%	75,507	15,829	0.0021	11.3	288.0	90.2	108.0	90.2	17.8	0.31	4,843	780506	874
Central Kings	North Kings	19	89,000	6%	83,730	10,569	0.0016	8.5	232.6	0.5	52.6	0.5	52.1	0.91	8,335	1124774	1,260
North Kings	Central Kings	20	95,000	4%	91,507	18,685	0.0017	8.8	247.4	90.3	67.4	90.3	22.9	0.40	7,267	1114023	1,248
Central Kings	North Kings	21	95,000	1%	93,861	5,292	0.0020	10.4	270.5	1.1	90.5	1.1	89.4	1.56	5,292	974952	1,092
Central Kings	North Kings	22	111,000	3%	108,001	10,632	0.0018	9.6	264.6	0.3	84.6	0.3	84.3	1.47	10,580	2075411	2,325
Central Kings	North Kings	23	111,000	3%	107,937	16,792	0.0020	10.7	261.8	232.2	81.8	52.2	29.6	0.52	8,294	1812334	2,030
North Kings	Central Kings	24	80,000	-2%	81,808	9,989	0.0023	12.2	253.7	268.3	73.7	88.3	14.5	0.25	2,509	473406	530
North Kings	Central Kings	25	***100,000***	0%	100,000	18,219	0.0023	12.2	248.6	268.3	68.6	88.3	19.7	0.34	6,146	1423352	1,594
North Kings	Central Kings	26	***95,000***	0%	95,000	3,430	0.0028	14.7	233.3	268.3	53.3	88.3	35.0	0.61	1,966	521413	584
North Kings	Central Kings	27	***95,000***	0%	95,000	2,653	0.0030	16.0	227.5	268.3	47.5	88.3	40.8	0.71	1,734	498452	558
North Kings	Kings River East	28	***95,000***	0%	95,000	9,490	0.0030	15.7	224.2	235.8	44.2	55.8	11.6	0.20	1,901	535818	0
North Kings	Kings River East	29	59,000	0%	59,000	6,424	0.0024	12.9	211.3	235.8	31.3	55.8	24.4	0.43	2,655	382194	0
North Kings	Kings River East	30	30,000	0%	30,000	3,027	0.0028	14.6	205.7	235.8	25.7	55.8	30.0	0.52	1,514	125960	0
North Kings	Kings River East	31	30,000	0%	30,000	5,071	N/A	N/A	207.0	235.8	27.0	55.8	28.8	0.50	2,440	N/A	0
Kings River East	North Kings	32	30,000	0%	30,000	16,502	N/A	N/A	N/A	34.6	N/A	34.6	N/A	N/A	N/A	N/A	0
Central Kings	Kings River East	33	***95,000***	0%	95,000	2,895	0.0030	15.9	226.9	255.3	46.9	75.3	28.4	0.50	1,377	393741	0
Kings River East	Central Kings	34	***95,000***	0%	95,000	4,909	0.0027	14.1	226.9	220.0	46.9	40.0	6.9	0.12	591	149721	0
Kings River East	Central Kings	35	80,000	-3%	82,389	13,736	0.0017	9.1	215.9	189.4	35.9	9.4	26.5	0.46	6,137	867529	0
Kings River East	Central Kings	36	80,000	-3%	82,432	5,888	0.0010	5.1	193.8	349.5	13.8	169.5	24.3	0.42	2,420	194293	0
Central Kings	Kings River East	37	80,000	-4%	83,016	5,428	0.0011	5.6	141.4	360.0	141.4	180.0	38.6	0.67	3,384	299740	0
Central Kings	Kings River East	38	95,000	-4%	99,209	3,460	0.0015	7.9	122.5	360.0	122.5	180.0	57.5	1.00	2,917	435641	0
Kings River East	Central Kings	39	95,000	-5%	99,384	3,116	0.0020	10.3	119.5	96.4	119.5	96.4	23.1	0.40	1,221	237321	0
Kings River East	Central Kings	40	90,000	-3%	93,041	15,843	0.0018	9.5	156.0	96.4	156.0	96.4	59.5	1.04	13,656	2288643	0
Kings River East	Central Kings	41	90,000	-2%	91,624	17,844	0.0012	6.3	223.5	178.6	43.5	178.6	44.8	0.78	12,584	1385654	0
Central Kings	Kings River East	42	90,000	-3%	92,338	17,872	0.0016	8.4	119.9	186.7	119.9	6.7	66.8	1.17	16,425	2399630	0
Central Kings	Kings River East	43	78,000	-2%	79,423	5,653	0.0012	6.2	164.0	229.9	164.0	49.9	65.9	1.15	5,159	478456	0
Central Kings	Kings River East	44	78,000	-1%	78,916	16,793	0.0007	3.6	159.3	203.7	159.3	23.7	44.5	0.78	11,767	634452	0
Kings River East	Central Kings	45	***120,000***	0%	120,000	6,008	0.0019	10.1	221.2	173.3	41.2	173.3	47.9	0.84	4,459	1022453	0
Central Kings	Kings River East	46	***120,000***	0%	120,000	6,400	0.0026	13.6	190.8	254.6	10.8	74.6	63.8	1.11	5,743	1768512	0
Central Kings	Kings River East	47	***120,000***	0%	120,000	7,877	0.0011	6.0	119.3	211.1	119.3	31.1	88.2	1.54	7,873	1065103	0
Central Kings	McMullin	48	98,000	23%	75,891	14,924	0.0055	28.9	247.9	180.8	67.9	0.8	67.1	1.17	13,743	5712665	6,399
Central Kings	McMullin	49	75,000	27%	54,886	10,541	0.0051	26.8	246.6	180.8	66.6	0.8	65.7	1.15	9,611	2676678	2,998
McMullin	Central Kings	50	75,000	27%	54,997	5,264	0.0041	21.5	251.9	270.3	71.9	90.3	18.5	0.32	1,669	373748	419
Central Kings	McMullin	51	75,000	26%	55,425	10,654	0.0019	10.3	271.2	180.7	91.2	0.7	89.5	1.56	10,654	1150708	1,289
McMullin	James	52	128,000	11%	114,224	6,877	0.0028	15.0	132.7	132.3	132.7	132.3	0.4	0.01	47	15228	17
James	McMullin	53	128,000	11%	114,064	7,174	0.0025	13.4	129.6	130.2	129.6	130.2	0.6	0.01	80	23164	26
McMullin	James	54	107,000	13%	92,969	6,829	0.0022	11.8	143.0	132.7	143.0	132.7	10.3	0.18	1,221	253479	284
McMullin	James	55	***112,000***	0%	112,000	9,572	0.0021	10.9	158.9	141.8	158.9	141.8	17.2	0.30	2,827	653082	732
James	McMullin	56	***112,000***	0%	112,000	9,617	0.0025	13.4	130.3	141.6	130.3	141.6	11.3	0.20	1,891	539341	604
James	McMullin	57	128,000	22%	99,217	9,585	0.0016	8.3	59.0	142.0	59.0	142.0	83.0	1.45	9,514	1482595	1,661
James	McMullin	58	128,000	24%	97,258	6,153	0.0026	13.9	81.5	142.2	81.5	142.2	60.7	1.06	5,365	1374076	1,539
James	McMullin	59	125,000	24%	95,517	3,455	0.0022	11.5	71.5	152.8	71.5	152.8	81.3	1.42	3,415	709470	795
McMullin	North Fork Kings	60	125,000	25%	93,183	4,656	0.0015	7.9	58.2	227.4	58.2	47.4	10.8	0.19	874	121624	136
North Fork Kings	McMullin	61	125,000	27%	91,501	7,115	0.0012	6.1	23.5	315.0	23.5	135.0	68.5	1.20	6,619	704141	789
North Fork Kings	McMullin	62	123,000	29%	87,645	16,815	0.0021	11.0	72.1	288.4	72.1	108.4	36.3	0.63	9,954	1817907	2,036
McMullin	North Fork Kings	63	123,000	31%	85,245	11,841	0.0045	23.5	292.1	334.5	112.1	154.5	42.4	0.74	7,983	3029638	3,394
North Fork Kings	McMullin	64	123,000	29%	86,845	10,574	0.0025	13.4	29.4	270.1	29.4	90.1	60.7	1.06	9,223	2032014	2,276
North Fork Kings	McMullin	65	75,000	30%	52,395	5,349	0.0019	9.8	0.1	270.8	0.1	90.8	89.3	1.56	5,348	519109	581
North Fork Kings	McMullin	66	75,000	31%	51,830	5,277	0.0027	14.4	258.4	180.5	78.4	0.5	77.9	1.36	5,159	730844	819

Attachment 3 - 2012 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
McMullin	North Fork Kings	67	75,000	32%	51,283	5,354	0.0061	32.3	240.4	270.1	60.4	90.1	29.7	0.52	2,652	833030	933
McMullin	North Fork Kings	68	75,000	30%	52,225	5,258	0.0073	38.7	260.3	0.8	80.3	0.8	79.5	1.39	5,170	1979651	2,217
McMullin	North Fork Kings	69	75,000	26%	55,265	10,633	0.0032	17.0	264.2	270.2	84.2	90.2	6.0	0.10	1,104	196017	220
North Fork Kings	Central Kings	70	75,000	26%	55,396	10,594	0.0026	13.9	289.8	270.3	109.8	90.3	19.5	0.34	3,537	517175	579
Central Kings	North Fork Kings	71	73,000	25%	54,577	10,677	0.0044	23.4	243.9	270.4	63.9	90.4	26.5	0.46	4,761	1149793	1,288
Central Kings	North Fork Kings	72	73,000	25%	54,969	5,277	0.0046	24.2	229.7	0.5	49.7	0.5	49.2	0.86	3,994	1005754	1,127
Central Kings	North Fork Kings	73	73,000	25%	54,623	15,835	0.0030	16.0	233.6	270.4	53.6	90.4	36.8	0.64	9,476	1573159	1,762
North Fork Kings	Central Kings	74	73,000	23%	56,203	5,273	0.0025	13.0	223.7	180.4	43.7	0.4	43.3	0.76	3,618	499887	560
Central Kings	North Fork Kings	75	73,000	20%	58,546	5,321	0.0023	12.4	213.3	270.3	33.3	90.3	57.0	1.00	4,463	612981	687
Central Kings	North Fork Kings	76	93,000	14%	80,296	14,584	0.0044	23.0	216.5	270.7	36.5	90.7	54.2	0.95	11,823	4141967	4,640
Central Kings	North Fork Kings	77	93,000	6%	87,498	1,334	0.0042	22.0	218.5	270.8	38.5	90.8	52.3	0.91	1,055	385167	431
Central Kings	North Fork Kings	78	93,000	6%	87,676	14,877	0.0031	16.5	223.2	315.4	43.2	135.4	87.8	1.53	14,866	4075609	4,565
Central Kings	North Fork Kings	79	***118,000***	0%	118,000	4,185	0.0028	14.9	228.8	270.3	48.8	90.3	41.5	0.72	2,771	923999	1,035
Central Kings	North Fork Kings	80	***118,000***	0%	118,000	9,772	0.0036	19.1	239.6	271.5	59.6	91.5	31.8	0.56	5,152	2203915	2,469
Central Kings	North Fork Kings	81	***118,000***	0%	118,000	10,682	0.0034	18.1	279.1	0.7	99.1	0.7	81.6	1.42	10,568	4279275	4,793
Central Kings	North Fork Kings	82	***118,000***	0%	118,000	6,290	0.0030	16.1	326.7	68.3	146.7	68.3	78.3	1.37	6,160	2212730	2,479
James	North Fork Kings	83	86,000	0%	86,000	11,628	N/A	N/A	120.5	263.5	120.5	83.5	37.0	0.65	7,000	N/A	N/A
James	North Fork Kings	84	87,000	0%	87,000	6,538	0.0017	9.2	113.9	281.3	113.9	101.3	12.6	0.22	1,429	216379	242
James	North Fork Kings	85	87,000	0%	87,000	18,139	0.0029	15.2	88.8	263.8	88.8	83.8	5.0	0.09	1,585	395971	444

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

External

Attachment 3 - 1925 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Percent Thickness Change (1925-1962)	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (L) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	Madera County	100	30,000	N/A	N/A	8310.4	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	101	30,000	N/A	N/A	4325.1	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	102	30,000	N/A	N/A	7349.7	N/A	N/A	N/A	166.5	N/A	166.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	103	30,000	N/A	N/A	12097.8	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
North Kings	Madera County	104	***30,000***	N/A	N/A	20674.9	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
North Kings	Madera County	105	***93,000***	N/A	N/A	12121.9	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
North Kings	Madera County	106	***211,000***	N/A	N/A	5396.1	N/A	N/A	N/A	278.3	N/A	98.3	N/A	N/A	N/A	N/A	0
North Kings	Root Creek WD	107	***211,000***	N/A	N/A	14767.3	N/A	N/A	N/A	278.3	N/A	98.3	N/A	N/A	N/A	N/A	0
North Kings	Madera County	108	***237,000***	N/A	N/A	18127.3	N/A	N/A	N/A	247.8	N/A	67.8	N/A	N/A	N/A	N/A	0
North Kings	Madera ID	109	***237,000***	N/A	N/A	8977.7	N/A	N/A	N/A	270.9	N/A	90.9	N/A	N/A	N/A	N/A	0
North Kings	Madera ID	110	***237,000***	N/A	N/A	19839.8	N/A	N/A	N/A	248.0	N/A	68.0	N/A	N/A	N/A	N/A	0
North Kings	Madera ID	111	***184,000***	N/A	N/A	6346.9	N/A	N/A	N/A	282.4	N/A	102.4	N/A	N/A	N/A	N/A	0
North Kings	Madera ID	112	***184,000***	N/A	N/A	7833.8	N/A	N/A	N/A	282.4	N/A	102.4	N/A	N/A	N/A	N/A	0
North Kings	Madera ID	113	***184,000***	N/A	N/A	25138.2	N/A	N/A	N/A	253.7	N/A	73.7	N/A	N/A	N/A	N/A	0
McMullin	Aliso WD	114	***180,000***	N/A	N/A	11667.2	N/A	N/A	N/A	213.3	N/A	33.3	N/A	N/A	N/A	N/A	0
McMullin	Aliso WD	115	***180,000***	N/A	N/A	6284.1	N/A	N/A	N/A	323.7	N/A	143.7	N/A	N/A	N/A	N/A	0
McMullin	Aliso WD	116	***180,000***	N/A	N/A	9065.2	N/A	N/A	N/A	250.8	N/A	70.8	N/A	N/A	N/A	N/A	0
McMullin	Aliso WD	117	***180,000***	N/A	N/A	4645.4	N/A	N/A	N/A	173.6	N/A	173.6	N/A	N/A	N/A	N/A	0
McMullin	Aliso WD	118	***180,000***	N/A	N/A	13996.9	N/A	N/A	N/A	273.4	N/A	93.4	N/A	N/A	N/A	N/A	0
McMullin	Aliso WD	119	***180,000***	N/A	N/A	3456.2	N/A	N/A	N/A	273.4	N/A	93.4	N/A	N/A	N/A	N/A	0
McMullin	Farmer WD	120	***180,000***	N/A	N/A	3470.6	0.0008	4.1	249.7	215.4	69.7	35.4	34.3	0.60	1957	N/A	0
McMullin	Farmer WD	121	***175,000***	N/A	N/A	5165.0	0.0013	6.8	221.9	181.0	41.9	1.0	41.0	0.72	3387	N/A	N/A
McMullin	Fresno County	122	***175,000***	N/A	N/A	8089.5	N/A	N/A	N/A	181.0	N/A	1.0	N/A	N/A	N/A	N/A	N/A
McMullin	Fresno County	123	***175,000***	N/A	N/A	5472.0	N/A	N/A	N/A	101.0	N/A	101.0	N/A	N/A	N/A	N/A	N/A
Fresno County	McMullin	124	***175,000***	N/A	N/A	8939.7	N/A	N/A	N/A	101.0	N/A	101.0	N/A	N/A	N/A	N/A	N/A
McMullin	Fresno County	125	***175,000***	3%	179,375	7147.8	0.0006	3.0	247.8	90.6	67.8	90.6	22.8	0.40	2773	285979	320
McMullin	Fresno County	126	***175,000***	N/A	N/A	12139.4	0.0005	2.9	237.6	181.4	57.6	1.4	56.2	0.98	10085	N/A	N/A
James ID	Fresno County	127	***175,000***	N/A	N/A	10727.6	N/A	N/A	N/A	268.0	N/A	88.0	N/A	N/A	N/A	N/A	N/A
James ID	Fresno County	128	***171,000***	N/A	N/A	3722.6	N/A	N/A	N/A	180.0	N/A	180.0	N/A	N/A	N/A	N/A	N/A
James ID	Central Delta Mendota Regional Mulit Agency GSA	129	***171,000***	N/A	N/A	7865.6	N/A	N/A	N/A	130.8	N/A	130.8	N/A	N/A	N/A	N/A	N/A
James ID	Central Delta Mendota Regional Mulit Agency GSA	130	***171,000***	N/A	N/A	16667.1	N/A	N/A	N/A	165.8	N/A	165.8	N/A	N/A	N/A	N/A	N/A
James ID	Central Delta Mendota Regional Mulit Agency GSA	131	***171,000***	N/A	N/A	5212.2	N/A	N/A	N/A	180.8	N/A	0.8	N/A	N/A	N/A	N/A	N/A
James ID	Central Delta Mendota Regional Mulit Agency GSA	132	***171,000***	N/A	N/A	8711.3	N/A	N/A	N/A	270.5	N/A	90.5	N/A	N/A	N/A	N/A	N/A
James ID	Central Delta Mendota Regional Mulit Agency GSA	133	***171,000***	N/A	N/A	5559.6	N/A	N/A	N/A	200.4	N/A	20.4	N/A	N/A	N/A	N/A	N/A
James ID	Central Delta Mendota Regional Mulit Agency GSA	134	***171,000***	N/A	N/A	5435.6	N/A	N/A	N/A	180.8	N/A	0.8	N/A	N/A	N/A	N/A	N/A
James ID	Westlands WD	135	***87,000***	N/A	N/A	6701.1	N/A	N/A	N/A	90.6	N/A	90.6	N/A	N/A	N/A	N/A	N/A
James ID	Westlands WD	136	***87,000***	N/A	N/A	10529.2	N/A	N/A	N/A	118.7	N/A	118.7	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	137	***87,000***	N/A	N/A	23573.7	N/A	N/A	N/A	153.4	N/A	153.4	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	138	***90,000***	N/A	N/A	5362.7	N/A	N/A	N/A	91.6	N/A	91.6	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	139	***90,000***	N/A	N/A	9680.0	N/A	N/A	N/A	0.9	N/A	0.9	N/A	N/A	N/A	N/A	N/A
Westlands WD	North Fork Kings	140	***90,000***	N/A	N/A	8413.5	N/A	N/A	N/A	90.5	N/A	90.5	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	141	***90,000***	N/A	N/A	14877.4	N/A	N/A	N/A	178.8	N/A	178.8	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	142	***90,000***	N/A	N/A	7984.0	N/A	N/A	N/A	178.9	N/A	178.9	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	143	***90,000***	N/A	N/A	10906.7	N/A	N/A	N/A	104.2	N/A	104.2	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	144	***90,000***	N/A	N/A	5362.7	N/A	N/A	N/A	181.6	N/A	1.6	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	145	***90,000***	N/A	N/A	5361.1	N/A	N/A	N/A	269.2	N/A	89.2	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	146	***90,000***	N/A	N/A	5063.3	N/A	N/A	N/A	180.8	N/A	0.8	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	147	***60,000***	N/A	N/A	10639.8	N/A	N/A	N/A	90.8	N/A	90.8	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	148	***60,000***	N/A	N/A	10581.3	N/A	N/A	N/A	90.8	N/A	90.8	N/A	N/A	N/A	N/A	N/A
Westlands WD	North Fork Kings	149	***60,000***	N/A	N/A	14856.4	0.0005	2.5	24.3	135.4	24.3	135.4	68.9	1.20	13864	N/A	N/A
Westlands WD	North Fork Kings	150	***60,000***	N/A	N/A	15047.2	N/A	N/A	N/A	135.4	N/A	135.4	N/A	N/A	N/A	N/A	N/A
Westlands WD	North Fork Kings	151	***60,000***	N/A	N/A	8452.6	N/A	N/A	N/A	72.0	N/A	72.0	N/A	N/A	N/A	N/A	N/A
Westlands WD	North Fork Kings	152	***60,000***	N/A	N/A	11535.4	N/A	N/A	N/A	136.8	N/A	136.8	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	153	***60,000***	N/A	N/A	15489.2	N/A	N/A	N/A	180.8	N/A	0.8	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	154	***60,000***	N/A	N/A	5285.2	N/A	N/A	N/A	180.8	N/A	0.8	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	155	***90,000***	N/A	N/A	5361.1	N/A	N/A	N/A	90.8	N/A	90.8	N/A	N/A	N/A	N/A	N/A
South Fork Kings GSA	North Fork Kings	156	***90,000***	N/A	N/A	5346.1	N/A	N/A	N/A	77.1	N/A	77.1	N/A	N/A	N/A	N/A	N/A
South Fork Kings GSA	North Fork Kings	157	***90,000***	N/A	N/A	4074.8	N/A	N/A	N/A	0.7	N/A	0.7	N/A	N/A	N/A	N/A	0
South Fork Kings GSA	North Fork Kings	158	***90,000***	N/A	N/A	2477.5	N/A	N/A	N/A	0.7	N/A	0.7	N/A	N/A	N/A	N/A	0
North Fork Kings	South Fork Kings GSA	159	***90,000***	2%	91,573	6526.5	0.0007	3.7	257.7	54.4	77.7	54.4	23.3	0.41	2580	165647	0
North Fork Kings	South Fork Kings GSA	160	***90,000***	1%	91,051	37726.0	0.0008	4.0	241.3	48.0	61.3	48.0	13.3	0.23	8709	599723	0
Mid Kings River GSA	North Fork Kings	161	***90,000***	6%	95,273	4940.9	0.0006	3.2	301.3	47.3	121.3	47.3	74.0	1.29	4749	275894	0
Mid Kings River GSA	North Fork Kings	162	***90,000***	2%	92,201	5730.5	0.0009	4.9	295.7	47.3	115.7	47.3	68.4	1.19	5328	456389	0
North Fork Kings	Mid Kings River GSA	163	***90,000***	3%	92,484	19953.9	0.0007	3.8	269.4	90.4	89.4	90.4	1.0	0.02	358	24048	0
Mid Kings River GSA	North Fork Kings	164	***90,000***	10%	98,822	10560.8	0.0005	2.8	251.9	46.9	71.9	46.9	25.0	0.44	4467	234941	263
Mid Kings River GSA	North Fork Kings	165	***90,000***	3%	92,624	6769.4	0.0006	3.4	253.8	46.9	73.8	46.9	26.9	0.47	3058	179843	201
Central Kings	Mid Kings River GSA	166	***90,000***	11%	100,026	8937.1	0.0007	3.5	249.6	178.6	69.6	178.6	71.0	1.24	8450	556573	623
Central Kings	Mid Kings River GSA	167	***84,000***	11%	93,137	18901.3	0.0006	3.1	238.1	69.0	58.1	69.0	10.9	0.19	3575	194489	0
Mid Kings River GSA	Central Kings	168	***84,000***	N/A	N/A	16749.2	0.0007	3.8	247.6	27.2	67.6	27.2	40.4	0.70	10853	N/A	0
Kings River East	Mid Kings River GSA	169	***84,000***	N/A	N/A	1489.1	0.0006	3.3	251.8	90.0	71.8	90.0	18.2	0.32	465	N/A	N/A
Kings River East	Mid Kings River GSA	170	***84,000***	N/A	N/A	31942.3	0.0007	3.7	184.1	180.7	4.1	0.7	3.4	0.06	1895	N/A	N/A
Kings River East	Mid Kings River GSA	171	***99,000***	N/A	N/A	10649.1	0.0005	2.8	198.9	91.2	18.9	91.2	72.3	1.26	10143	N/A	N/A
Kings River East	Greater Kaweah GSA	172	***99,000***	N/A	N/A	23363.7	0.0007	3.8	238.0	64.0	58.0	64.0	6.0	0.10	2441	N/A	N/A
Greater Kaweah GSA	Kings River East	173	***99,000***	N/A	N/A	5805.0	0.0014	7.3	269.8	64.0	89.8	64.0	25.8	0.45	2530	N/A	N/A
Greater Kaweah GSA	Kings River East	174	***50,000***	N/A	N/A	15892.6	0.0006	3.1	284.7	93.8	104.7	93.8	11.0	0.19	3026	N/A	N/A
Kings River East	Greater Kaweah GSA	175	***40,000***	N/A	N/A	1714.0	0.0010	5.3	282.0	182.5	102.0	2.5	80.5	1.40	1690	N/A	N/A
Greater Kaweah GSA	Kings River East	176	***40,000***	N/A	N/A	10626.4	0.0012	6.1	276.7	90.5	96.7	90.5	6.2	0.11	1140	N/A	N/A
Greater Kaweah GSA	Kings River East	177	***40,000***	N/A	N/A	13273.9	0.0011	5.7	274.0	90.5	94.0	90.5	3.4	0.06	795	N/A	N/A
East Kaweah GSA	Kings River East	178	***20,000***	N/A	N/A	15785.5	0.0017	9.1	267.6	0.8	87.6	0.8	86.8	1.51	15761	N/A	N/A

Attachment 3 - 1925 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Percent Thickness Change (1925-1962)	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (L) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
East Kaweah GSA	Kings River East	179	***20,000***	N/A	N/A	16008.0	0.0014	7.6	297.5	90.5	117.5	90.5	26.9	0.47	7253	N/A	N/A
Kings River East	East Kaweah GSA	180	***20,000***	N/A	N/A	4996.5	N/A	N/A	N/A	359.0	N/A	179.0	N/A	N/A	N/A	N/A	N/A
Kings River East	East Kaweah GSA	181	***20,000***	N/A	N/A	3194.6	N/A	N/A	N/A	359.0	N/A	179.0	N/A	N/A	N/A	N/A	N/A
Kings River East	East Kaweah GSA	182	***20,000***	N/A	N/A	5861.0	N/A	N/A	N/A	295.6	N/A	115.6	N/A	N/A	N/A	N/A	N/A

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 1997 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	Madera County	100	30,000	N/A	30,000	8310.4	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	101	30,000	N/A	30,000	4325.1	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
Madera County	North Kings	102	30,000	N/A	30,000	7349.7	N/A	N/A	N/A	166.5	N/A	166.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	103	30,000	N/A	30,000	12097.8	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
North Kings	Madera County	104	***30,000***	N/A	30,000	20674.9	N/A	N/A	310.4	214.3	130.4	34.3	84.0	1.47	20560	N/A	0
North Kings	Madera County	105	***93,000***	25%	93,000	12121.9	0.0012	6.6	13.2	214.3	13.2	34.3	21.1	0.37	4371	506253	0
Madera County	North Kings	106	***211,000***	28%	211,000	5396.1	0.0032	16.7	181.6	278.3	1.6	98.3	83.3	1.45	5359	3586165	0
North Kings	Root Creek WD	107	***211,000***	13%	211,000	14767.3	0.0029	15.5	282.1	278.3	102.1	98.3	3.8	0.07	987	610166	0
North Kings	Madera County	108	***237,000***	5%	237,000	18127.3	0.0027	14.3	351.3	247.8	171.3	67.8	76.5	1.34	17627	11278873	0
North Kings	Madera ID	109	***237,000***	3%	237,000	8977.7	0.0023	12.0	11.3	270.9	11.3	90.9	79.7	1.39	8833	4741214	0
North Kings	Madera ID	110	***237,000***	0%	237,000	19839.8	0.0016	8.5	313.8	248.0	133.8	68.0	65.9	1.15	18104	6917640	0
Madera ID	North Kings	111	***184,000***	-1%	184,000	6346.9	0.0015	7.8	273.7	282.4	93.7	102.4	8.7	0.15	964	260997	0
North Kings	Madera ID	112	***184,000***	N/A	184,000	7833.8	0.0015	7.9	313.1	282.4	133.1	102.4	30.6	0.53	3992	1093038	0
North Kings	Madera ID	113	***184,000***	N/A	184,000	25138.2	0.0020	10.3	339.2	253.7	159.2	73.7	85.5	1.49	25061	8992186	0
McMullin	Aliso WD	114	***180,000***	N/A	180,000	11667.2	0.0048	25.6	231.7	213.3	51.7	33.3	18.5	0.32	3693	3219982	0
Aliso WD	McMullin	115	***180,000***	N/A	180,000	6284.1	0.0026	13.9	217.5	323.7	37.5	143.7	73.8	1.29	6034	2850998	0
McMullin	Aliso WD	116	***180,000***	N/A	180,000	9065.2	0.0041	21.8	295.4	250.8	115.4	70.8	44.6	0.78	6360	4724116	0
McMullin	Aliso WD	117	***180,000***	N/A	180,000	4645.4	0.0037	19.6	224.5	173.6	44.5	173.6	50.9	0.89	3607	2409653	0
Aliso WD	McMullin	118	***180,000***	N/A	180,000	13996.9	0.0026	13.7	96.7	273.4	96.7	93.4	3.2	0.06	790	370343	0
McMullin	Aliso WD	119	***180,000***	N/A	180,000	3456.2	0.0028	14.6	44.2	273.4	44.2	93.4	49.2	0.86	2616	1301242	0
Farmer WD	McMullin	120	***180,000***	N/A	180,000	3470.6	0.0014	7.6	58.9	215.4	58.9	35.4	23.5	0.41	1384	356201	0
Farmer WD	McMullin	121	***175,000***	N/A	175,000	5165.0	0.0014	7.2	91.3	181.0	91.3	1.0	89.7	1.57	5165	1239606	1389
Fresno County	McMullin	122	***175,000***	N/A	175,000	8089.5	0.0015	8.1	106.2	181.0	106.2	1.0	74.7	1.30	7804	2106301	2359
McMullin	Fresno County	123	***175,000***	N/A	175,000	5472.0	0.0011	5.7	114.7	101.0	114.7	101.0	13.7	0.24	1294	242342	271
Fresno County	McMullin	124	***175,000***	5%	175,000	8939.7	0.0011	5.6	98.7	101.0	98.7	101.0	2.3	0.04	363	67328	75
Fresno County	McMullin	125	***175,000***	8%	175,000	7147.8	0.0008	4.4	88.4	90.6	88.4	90.6	2.2	0.04	275	40091	45
Fresno County	McMullin	126	***175,000***	9%	175,000	12139.4	0.0007	3.9	104.6	181.4	104.6	1.4	76.8	1.34	11821	1532826	1717
Fresno County	James ID	127	***175,000***	6%	175,000	10727.6	0.0008	4.5	121.2	268.0	121.2	88.0	33.2	0.58	5875	866894	971
Fresno County	James ID	128	***171,000***	4%	171,000	3722.6	0.0008	4.1	127.0	180.0	127.0	180.0	53.0	0.93	2973	391824	439
Central Delta Mendota Regional Mulit Agency GSA	James ID	129	***171,000***	4%	171,000	7865.6	0.0009	4.8	123.9	130.8	123.9	130.8	6.9	0.12	939	146399	164
Central Delta Mendota Regional Mulit Agency GSA	James ID	130	***171,000***	5%	171,000	16667.1	0.0007	3.6	117.9	165.8	117.9	165.8	47.9	0.84	12365	1429380	1601
Central Delta Mendota Regional Mulit Agency GSA	James ID	131	***171,000***	8%	171,000	5212.2	0.0010	5.1	133.8	180.8	133.8	0.8	47.0	0.82	3812	633773	710
Central Delta Mendota Regional Mulit Agency GSA	James ID	132	***171,000***	N/A	171,000	8711.3	0.0009	4.5	151.3	270.5	151.3	90.5	60.8	1.06	7602	1107958	1241
Central Delta Mendota Regional Mulit Agency GSA	James ID	133	***171,000***	N/A	171,000	5559.6	0.0008	4.3	168.3	200.4	168.3	20.4	32.0	0.56	2950	409724	459
Central Delta Mendota Regional Mulit Agency GSA	James ID	134	***171,000***	N/A	171,000	5435.6	0.0011	5.7	164.3	180.8	164.3	0.8	16.5	0.29	1539	284739	319
James ID	Westlands WD	135	***87,000***	N/A	87,000	6701.1	0.0013	6.7	156.7	90.6	156.7	90.6	66.1	1.15	6125	677540	759
James ID	Westlands WD	136	***87,000***	N/A	87,000	10529.2	0.0015	8.1	144.2	118.7	144.2	118.7	25.5	0.44	4529	603469	676
Westlands WD	North Fork Kings	137	***87,000***	N/A	87,000	23573.7	0.0018	9.7	128.7	153.4	128.7	153.4	24.7	0.43	9844	1578657	1768
Westlands WD	North Fork Kings	138	***90,000***	N/A	90,000	5362.7	0.0019	10.2	83.4	91.6	83.4	91.6	8.2	0.14	765	132586	149
North Fork Kings	Westlands WD	139	***90,000***	N/A	90,000	9680.0	0.0029	15.2	103.7	0.9	103.7	0.9	77.2	1.35	9438	2445419	2739
North Fork Kings	Westlands WD	140	***90,000***	N/A	90,000	8413.5	0.0035	18.6	109.7	90.5	109.7	90.5	19.2	0.34	2771	879349	985
Westlands WD	North Fork Kings	141	***90,000***	N/A	90,000	14877.4	0.0017	8.8	35.4	178.8	35.4	178.8	36.5	0.64	8856	1331629	1492
Westlands WD	North Fork Kings	142	***90,000***	N/A	90,000	7984.0	0.0019	9.8	1.7	178.9	1.7	178.9	2.8	0.05	389	64955	73
Westlands WD	North Fork Kings	143	***90,000***	N/A	90,000	10906.7	0.0013	6.8	349.6	104.2	169.6	104.2	65.4	1.14	9913	1143910	1281
North Fork Kings	Westlands WD	144	***90,000***	N/A	90,000	5362.7	0.0011	5.9	332.2	181.6	152.2	1.6	29.4	0.51	2636	264893	297
North Fork Kings	Westlands WD	145	***90,000***	N/A	90,000	5361.1	0.0008	4.3	333.5	269.2	153.5	89.2	64.3	1.12	4831	351642	394
North Fork Kings	Westlands WD	146	***90,000***	N/A	90,000	5063.3	0.0006	3.3	335.0	180.8	155.0	0.8	25.8	0.45	2207	124570	140
Westlands WD	North Fork Kings	147	***60,000***	N/A	60,000	10639.8	0.0007	3.4	321.8	90.8	141.8	90.8	51.0	0.89	8270	322693	361
Westlands WD	North Fork Kings	148	***60,000***	N/A	60,000	10581.3	0.0008	4.0	312.4	90.8	132.4	90.8	41.6	0.73	7030	316684	355
North Fork Kings	Westlands WD	149	***60,000***	N/A	60,000	14856.4	0.0011	6.0	263.6	135.4	83.6	135.4	51.8	0.90	11676	794472	890
North Fork Kings	Westlands WD	150	***60,000***	N/A	60,000	15047.2	0.0014	7.5	239.6	135.4	59.6	135.4	75.8	1.32	14589	1242446	1392
Westlands WD	North Fork Kings	151	***60,000***	N/A	60,000	8452.6	0.0026	13.7	308.4	72.0	128.4	72.0	56.4	0.98	7039	1098617	1231
North Fork Kings	Westlands WD	152	***60,000***	N/A	60,000	11535.4	0.0014	7.3	267.6	136.8	87.6	136.8	49.2	0.86	8730	724298	811
North Fork Kings	Westlands WD	153	***60,000***	N/A	60,000	15489.2	0.0006	3.0	246.3	180.8	66.3	0.8	65.5	1.14	14098	481122	539
North Fork Kings	Westlands WD	154	***60,000***	N/A	60,000	5285.2	0.0008	4.3	288.6	180.8	108.6	0.8	72.2	1.26	5033	243711	273
Westlands WD	North Fork Kings	155	***90,000***	N/A	90,000	5361.1	0.0009	4.7	295.3	90.8	115.3	90.8	24.5	0.43	2224	177037	198
South Fork Kings GSA	North Fork Kings	156	***90,000***	N/A	90,000	5346.1	0.0010	5.4	296.5	77.1	116.5	77.1	39.4	0.69	3394	310749	348
South Fork Kings GSA	North Fork Kings	157	***90,000***	N/A	90,000	4074.8	0.0013	6.6	298.7	0.7	118.7	0.7	61.9	1.08	3596	405489	0
South Fork Kings GSA	North Fork Kings	158	***90,000***	N/A	90,000	2477.5	0.0011	5.8	297.1	0.7	117.1	0.7	63.6	1.11	2219	218715	0
South Fork Kings GSA	North Fork Kings	159	***90,000***	20%	90,000	6526.5	0.0011	5.7	270.5	54.4	90.5	54.4	36.1	0.63	3842	374626	0
South Fork Kings GSA	North Fork Kings	160	***90,000***	19%	90,000	37726.0	0.0017	9.2	246.3	48.0	66.3	48.0	18.3	0.32	11831	1847333	0
Mid Kings River GSA	North Fork Kings	161	***90,000***	18%	90,000	4940.9	0.0026	13.6	252.8	47.3	72.8	47.3	25.5	0.44	2125	493182	0
Mid Kings River GSA	North Fork Kings	162	***90,000***	17%	90,000	5730.5	0.0027	14.3	258.3	47.3	78.3	47.3	31.0	0.54	2950	719129	0
North Fork Kings	Mid Kings River GSA	163	***90,000***	8%	90,000	19953.9	0.0033	17.2	229.3	90.4	49.3	90.4	41.1	0.72	13116	3838445	0
Mid Kings River GSA	North Fork Kings	164	***90,000***	7%	90,000	10560.8	0.0015	8.0	253.3	46.9	73.3	46.9	26.4	0.46	4689	637005	714
Mid Kings River GSA	North Fork Kings	165	***90,000***	11%	90,000	6769.4	0.0027	14.2	328.0	46.9	148.0	46.9	78.9	1.38	6642	1613348	1807
Central Kings	Mid Kings River GSA	166	***90,000***	9%	90,000	8937.1	0.0018	9.7	17.1	178.6	17.1	178.6	18.5	0.32	2839	467913	524
Central Kings	Mid Kings River GSA	167	***84,000***	4%	84,000	18901.3	0.0032	16.8	160.5	69.0	160.5	69.0	88.5	1.54	18895	5063329	0
Central Kings	Mid Kings River GSA	168	***84,000***	4%	84,000	16749.2	0.0035	18.3	133.3	27.2	133.3	27.2	73.9	1.29	16094	4691890	0
Kings River East	Mid Kings River GSA	169	***84,000***	8%	84,000	1489.1	0.0031	16.5	135.0	90.0	135.0	90.0	45.0	0.79	1053	275797	309

Attachment 3 - 1997 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
Mid Kings River GSA	Kings River East	170	***84,000***	15%	84,000	31942.3	0.0036	19.0	119.0	180.7	119.0	0.7	61.6	1.08	28103	8501510	9523
Kings River East	Mid Kings River GSA	171	***99,000***	22%	99,000	10649.1	0.0012	6.4	182.3	91.2	2.3	91.2	88.9	1.55	10647	1275040	1428
Greater Kaweah GSA	Kings River East	172	***99,000***	19%	99,000	23363.7	0.0020	10.5	263.8	64.0	83.8	64.0	19.8	0.35	7926	1563550	1751
Greater Kaweah GSA	Kings River East	173	***99,000***	7%	99,000	5805.0	0.0044	23.1	261.4	64.0	81.4	64.0	17.4	0.30	1735	751251	842
Kings River East	Greater Kaweah GSA	174	***50,000***	-2%	50,000	15892.6	0.0014	7.5	231.6	93.8	51.6	93.8	42.1	0.74	10664	761061	852
Greater Kaweah GSA	Kings River East	175	***40,000***	-2%	40,000	1714.0	0.0014	7.2	174.4	182.5	174.4	2.5	8.1	0.14	242	13161	15
Kings River East	Greater Kaweah GSA	176	***40,000***	N/A	40,000	10626.4	0.0030	15.9	143.2	90.5	143.2	90.5	52.6	0.92	8447	1019431	1142
Kings River East	Greater Kaweah GSA	177	***40,000***	N/A	40,000	13273.9	0.0025	13.0	202.9	90.5	22.9	90.5	67.7	1.18	12279	1211867	1357
Kings River East	East Kaweah GSA	178	***20,000***	N/A	20,000	15785.5	0.0047	24.7	128.7	0.8	128.7	0.8	52.1	0.91	12463	1167681	1308
Kings River East	East Kaweah GSA	179	***20,000***	N/A	20,000	16008.0	0.0070	36.8	206.2	90.5	26.2	90.5	64.3	1.12	14423	2011322	2253
East Kaweah GSA	Kings River East	180	***20,000***	N/A	20,000	4996.5	0.0063	33.2	243.2	359.0	63.2	179.0	64.2	1.12	4499	565398	633
East Kaweah GSA	Kings River East	181	***20,000***	N/A	20,000	3194.6	0.0073	38.5	235.2	359.0	55.2	179.0	56.2	0.98	2655	387408	434
East Kaweah GSA	Kings River East	182	***20,000***	N/A	20,000	5861.0	0.0067	35.1	230.8	295.6	50.8	115.6	64.8	1.13	5303	705982	791

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 1998 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (L) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	Madera County	100	30,000	N/A	N/A	8310.4	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	101	30,000	N/A	N/A	4325.1	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	102	30,000	N/A	N/A	7349.7	N/A	N/A	N/A	166.5	N/A	166.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	103	30,000	N/A	N/A	12097.8	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
North Kings	Madera County	104	***30,000***	N/A	30,000	20674.9	0.0045	23.5	312.5	214.3	132.5	34.3	81.8	1.43	20465	2735091	0
North Kings	Madera County	105	***93,000***	25%	93,000	12121.9	0.0012	6.5	260.2	214.3	80.2	34.3	45.9	0.80	8698	989743	0
Madera County	North Kings	106	***211,000***	28%	211,000	5396.1	0.0012	6.2	201.0	278.3	21.0	98.3	77.3	1.35	5264	1300888	0
Root Creek WD	North Kings	107	***211,000***	13%	211,000	14767.3	0.0020	10.8	204.4	278.3	24.4	98.3	73.8	1.29	14183	6106035	0
North Kings	Madera County	108	***237,000***	5%	237,000	18127.3	0.0017	8.8	321.1	247.8	141.1	67.8	73.3	1.28	17361	6827086	0
North Kings	Madera ID	109	***237,000***	3%	237,000	8977.7	0.0032	16.8	12.2	270.9	12.2	90.9	78.7	1.37	8803	6636601	0
North Kings	Madera ID	110	***237,000***	0%	237,000	19839.8	0.0016	8.7	328.9	248.0	148.9	68.0	81.0	1.41	19593	7618705	0
North Kings	Madera ID	111	***184,000***	-1%	184,000	6346.9	0.0012	6.4	317.7	282.4	137.7	102.4	35.3	0.62	3663	818833	0
North Kings	Madera ID	112	***184,000***	N/A	184,000	7833.8	0.0023	12.2	329.0	282.4	149.0	102.4	46.6	0.81	5691	2414145	0
North Kings	Madera ID	113	***184,000***	N/A	184,000	25138.2	0.0028	14.9	332.4	253.7	152.4	73.7	78.8	1.37	24655	12776844	0
McMullin	Aliso WD	114	***180,000***	N/A	180,000	11667.2	0.0038	19.8	255.7	213.3	75.7	33.3	42.5	0.74	7875	5326202	0
Aliso WD	McMullin	115	***180,000***	N/A	180,000	6284.1	0.0025	13.4	263.9	323.7	83.9	143.7	59.8	1.04	5432	2478562	0
McMullin	Aliso WD	116	***180,000***	N/A	180,000	9065.2	0.0025	13.1	301.1	250.8	121.1	70.8	50.2	0.88	6968	3108696	0
McMullin	Aliso WD	117	***180,000***	N/A	180,000	4645.4	0.0024	12.8	194.8	173.6	14.8	173.6	21.2	0.37	1680	732006	0
Aliso WD	McMullin	118	***180,000***	N/A	180,000	13996.9	0.0012	6.5	139.7	273.4	139.7	93.4	46.3	0.81	10121	2255695	0
Aliso WD	McMullin	119	***180,000***	N/A	180,000	3456.2	0.0010	5.0	186.0	273.4	6.0	93.4	87.4	1.52	3453	591720	0
Farmer WD	McMullin	120	***180,000***	N/A	180,000	3470.6	0.0010	5.0	125.8	215.4	125.8	35.4	89.6	1.56	3471	595056	0
Farmer WD	McMullin	121	***175,000***	N/A	175,000	5165.0	0.0013	6.9	57.4	181.0	57.4	1.0	56.5	0.99	4306	981898	1100
Fresno County	McMullin	122	***175,000***	N/A	175,000	8089.5	0.0009	4.6	88.6	181.0	88.6	1.0	87.6	1.53	8082	1220640	1367
McMullin	Fresno County	123	***175,000***	N/A	175,000	5472.0	0.0010	5.3	122.5	101.0	122.5	101.0	21.5	0.38	2006	354675	397
McMullin	Fresno County	124	***175,000***	5%	175,000	8939.7	0.0014	7.2	100.7	101.0	100.7	101.0	0.4	0.01	57	13615	15
McMullin	Fresno County	125	***175,000***	8%	175,000	7147.8	0.0019	10.2	92.8	90.6	92.8	90.6	2.2	0.04	279	93910	105
Fresno County	McMullin	126	***175,000***	9%	175,000	12139.4	0.0019	10.1	77.9	181.4	77.9	1.4	76.5	1.34	11805	3950395	4425
Fresno County	James ID	127	***175,000***	6%	175,000	10727.6	0.0010	5.3	112.4	268.0	112.4	88.0	24.4	0.43	4429	775443	869
Fresno County	James ID	128	***171,000***	4%	171,000	3722.6	0.0010	5.1	136.6	180.0	136.6	180.0	43.4	0.76	2560	426255	477
James ID	Central Delta Mendota Regional Mulit Agency GSA	129	***171,000***	4%	171,000	7865.6	0.0012	6.2	141.5	130.8	141.5	130.8	10.7	0.19	1463	294365	330
James ID	Central Delta Mendota Regional Mulit Agency GSA	130	***171,000***	5%	171,000	16667.1	0.0010	5.3	165.3	165.8	165.3	165.8	0.4	0.01	129	22098	25
Central Delta Mendota Regional Mulit Agency GSA	James ID	131	***171,000***	8%	171,000	5212.2	0.0004	2.4	171.9	180.8	171.9	0.8	8.9	0.16	809	62156	70
Central Delta Mendota Regional Mulit Agency GSA	James ID	132	***171,000***	N/A	171,000	8711.3	0.0005	2.5	179.0	270.5	179.0	90.5	88.5	1.55	8708	712034	798
James ID	Central Delta Mendota Regional Mulit Agency GSA	133	***171,000***	N/A	171,000	5559.6	0.0006	3.4	192.9	200.4	12.9	20.4	7.5	0.13	726	79176	89
Central Delta Mendota Regional Mulit Agency GSA	James ID	134	***171,000***	N/A	171,000	5435.6	0.0008	4.4	173.6	180.8	173.6	0.8	7.2	0.13	680	95976	108
James ID	Westlands WD	135	***87,000***	N/A	87,000	6701.1	0.0011	6.0	165.8	90.6	165.8	90.6	75.2	1.31	6478	645749	723
James ID	Westlands WD	136	***87,000***	N/A	87,000	10529.2	0.0012	6.4	161.7	118.7	161.7	118.7	42.9	0.75	7170	750827	841
Westlands WD	North Fork Kings	137	***87,000***	N/A	87,000	23573.7	0.0016	8.7	126.5	153.4	126.5	153.4	26.9	0.47	10658	1526795	1710
North Fork Kings	Westlands WD	138	***90,000***	N/A	90,000	5362.7	0.0015	7.9	107.9	91.6	107.9	91.6	16.3	0.28	1506	201834	226
North Fork Kings	Westlands WD	139	***90,000***	N/A	90,000	9680.0	0.0012	6.6	120.7	0.9	120.7	0.9	60.1	1.05	8396	941523	1055
North Fork Kings	Westlands WD	140	***90,000***	N/A	90,000	8413.5	0.0012	6.5	162.0	90.5	162.0	90.5	71.5	1.25	7980	883135	989
Westlands WD	North Fork Kings	141	***90,000***	N/A	90,000	14877.4	0.0003	1.8	167.1	178.8	167.1	178.8	11.7	0.20	3026	90700	102
Westlands WD	North Fork Kings	142	***90,000***	N/A	90,000	7984.0	0.0003	1.6	27.3	178.9	27.3	178.9	28.3	0.49	3789	102345	115
Westlands WD	North Fork Kings	143	***90,000***	N/A	90,000	10906.7	0.0006	3.1	21.1	104.2	21.1	104.2	83.1	1.45	10828	575533	645
North Fork Kings	Westlands WD	144	***90,000***	N/A	90,000	5362.7	0.0011	5.9	337.2	181.6	157.2	1.6	24.4	0.43	2217	222903	250
North Fork Kings	Westlands WD	145	***90,000***	N/A	90,000	5361.1	0.0009	4.5	341.4	269.2	161.4	89.2	72.2	1.26	5105	393204	440
North Fork Kings	Westlands WD	146	***90,000***	N/A	90,000	5063.3	0.0007	3.7	346.4	180.8	166.4	0.8	14.4	0.25	1263	79093	89
Westlands WD	North Fork Kings	147	***60,000***	N/A	60,000	10639.8	0.0009	4.8	326.1	90.8	146.1	90.8	55.3	0.96	8744	477137	534
Westlands WD	North Fork Kings	148	***60,000***	N/A	60,000	10581.3	0.0011	5.7	312.0	90.8	132.0	90.8	41.2	0.72	6969	449424	503
North Fork Kings	Westlands WD	149	***60,000***	N/A	60,000	14856.4	0.0008	4.1	328.1	135.4	148.1	135.4	12.7	0.22	3258	153607	172
North Fork Kings	Westlands WD	150	***60,000***	N/A	60,000	15047.2	0.0010	5.4	248.4	135.4	68.4	135.4	67.0	1.17	13855	845650	947
Westlands WD	North Fork Kings	151	***60,000***	N/A	60,000	8452.6	0.0016	8.6	256.3	72.0	76.3	72.0	4.2	0.07	625	60909	68
North Fork Kings	Westlands WD	152	***60,000***	N/A	60,000	11535.4	0.0017	8.9	271.9	136.8	91.9	136.8	44.9	0.78	8144	821332	920
North Fork Kings	Westlands WD	153	***60,000***	N/A	60,000	15489.2	0.0012	6.2	292.3	180.8	112.3	0.8	68.6	1.20	14418	1022962	1146
North Fork Kings	Westlands WD	154	***60,000***	N/A	60,000	5285.2	0.0003	1.6	276.3	180.8	96.3	0.8	84.5	1.47	5261	93662	105
North Fork Kings	Westlands WD	155	***90,000***	N/A	90,000	5361.1	0.0003	1.6	254.0	90.8	74.0	90.8	16.8	0.29	1549	42683	48
South Fork Kings GSA	North Fork Kings	156	***90,000***	N/A	90,000	5346.1	0.0004	2.3	259.5	77.1	79.5	77.1	2.4	0.04	222	8678	10
South Fork Kings GSA	North Fork Kings	157	***90,000***	N/A	90,000	4074.8	0.0005	2.6	275.7	0.7	95.7	0.7	84.9	1.48	4059	180405	0
South Fork Kings GSA	North Fork Kings	158	***90,000***	N/A	90,000	2477.5	0.0004	2.3	289.2	0.7	109.2	0.7	71.5	1.25	2349	91672	0
South Fork Kings GSA	North Fork Kings	159	***90,000***	20%	90,000	6526.5	0.0005	2.9	296.1	54.4	116.1	54.4	61.7	1.08	5746	282991	0
South Fork Kings GSA	North Fork Kings	160	***90,000***	19%	90,000	37726.0	0.0019	10.0	240.3	48.0	60.3	48.0	12.3	0.21	8035	1369411	0
Mid Kings River GSA	North Fork Kings	161	***90,000***	18%	90,000	4940.9	0.0028	14.7	239.7	47.3	59.7	47.3	12.3	0.22	1056	265391	0
Mid Kings River GSA	North Fork Kings	162	***90,000***	17%	90,000	5730.5	0.0027	14.5	233.0	47.3	53.0	47.3	5.7	0.10	564	139439	0
North Fork Kings	Mid Kings River GSA	163	***90,000***	8%	90,000	19953.9	0.0021	10.9	221.7	90.4	41.7	90.4	48.8	0.85	15006	2780080	0
North Fork Kings	Mid Kings River GSA	164	***90,000***	7%	90,000	10560.8	0.0009	4.7	198.6	46.9	18.6	46.9	28.3	0.49	5003	401692	450
Mid Kings River GSA	North Fork Kings	165	***90,000***	11%	90,000	6769.4	0.0016	8.3	305.8	46.9	125.8	46.9	78.9	1.38	6643	936354	1049
Central Kings	Mid Kings River GSA	166	***90,000***	9%	90,000	8937.1	0.0013	7.0	246.1	178.6	66.1	178.6	67.5	1.18	8258	986134	1105
Central Kings	Mid Kings River GSA	167	***84,000***	4%	84,000	18901.3	0.0031	16.2	170.0	69.0	170.0	69.0	79.0	1.38	18551	4775509	0
Central Kings	Mid Kings River GSA	168	***84,000***	4%	84,000	16749.2	0.0012	6.4	163.2	27.2	163.2	27.2	44.1	0.77	11654	1178915	0
Kings River East	Mid Kings River GSA	169	***84,000***	8%	84,000	1489.1	0.0010	5.5	209.2	90.0	29.2	90.0	60.8	1.06	1300	113499	127
Mid Kings River GSA	Kings River East	170	***84,000***	15%	84,000	31942.3	0.0030	16.0	169.2	180.7	169.2	0.7	11.4	0.20	6333	1611592	1805
Kings River East	Mid Kings River GSA	171	***99,000***	22%	99,000	10649.1	0.0011	6.0	248.0	91.2	68.0	91.2	23.2	0.40	4190	469063	525
Greater Kaweah GSA	Kings River East	172	***99,000***	19%	99,000	23363.7	0.0019	10.1	269.8	64.0	89.8	64.0	25.8	0.45	10182	1919158	2150
Greater Kaweah GSA	Kings River East	173	***99,000***	7%	99,000	5805.0	0.0035	18.7	255.1	64.0	75.1	64.0	11.2	0.19	1124	394846	442
Kings River East	Greater Kaweah GSA	174	***50,000***	-2%	50,000	15892.6	0.0017	9.2	232.5	93.8	52.5	93.8	41.2	0.72	10477	912071	1022
Kings River East	Greater Kaweah GSA	175	***40,000***	-2%	40,000	1714.0	0.0019	9.9	163.5	182.5	163.5	2.5	18.9	0.33	556	41741	47

Attachment 3 - 1998 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (L) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
Kings River East	Greater Kaweah GSA	176	***40,000***	N/A	40,000	10626.4	0.0034	17.9	144.9	90.5	144.9	90.5	54.3	0.95	8634	1172845	1314
Kings River East	Greater Kaweah GSA	177	***40,000***	N/A	40,000	13273.9	0.0031	16.4	168.2	90.5	168.2	90.5	77.7	1.36	12970	1608319	1802
Kings River East	East Kaweah GSA	178	***20,000***	N/A	20,000	15785.5	0.0035	18.6	166.5	0.8	166.5	0.8	14.3	0.25	3895	274820	308
Kings River East	East Kaweah GSA	179	***20,000***	N/A	20,000	16008.0	0.0053	27.7	193.6	90.5	13.6	90.5	77.0	1.34	15595	1639195	1836
East Kaweah GSA	Kings River East	180	***20,000***	N/A	20,000	4996.5	0.0032	17.0	225.8	359.0	45.8	179.0	46.9	0.82	3646	234704	263
East Kaweah GSA	Kings River East	181	***20,000***	N/A	20,000	3194.6	0.0033	17.2	213.4	359.0	33.4	179.0	34.5	0.60	1809	117574	132
East Kaweah GSA	Kings River East	182	***20,000***	N/A	20,000	5861.0	0.0040	21.3	204.6	295.6	24.6	115.6	89.0	1.55	5860	472964	530

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 1999 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (L) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	Madera County	100	30,000	N/A	N/A	8310.4	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	101	30,000	N/A	N/A	4325.1	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	102	30,000	N/A	N/A	7349.7	N/A	N/A	N/A	166.5	N/A	166.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	103	30,000	N/A	N/A	12097.8	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
North Kings	Madera County	104	***30,000***	N/A	30,000	20674.9	0.0010	5.3	274.9	214.3	94.9	34.3	60.6	1.06	18014	540403	0
Madera County	North Kings	105	***93,000***	25%	93,000	12121.9	0.0012	6.3	154.0	214.3	154.0	34.3	60.3	1.05	10530	1159675	0
Madera County	North Kings	106	***211,000***	28%	211,000	5396.1	0.0034	17.8	195.6	278.3	15.6	98.3	82.7	1.44	5353	3808632	0
Root Creek WD	North Kings	107	***211,000***	13%	211,000	14767.3	0.0018	9.4	200.6	278.3	20.6	98.3	77.7	1.36	14426	5396415	0
North Kings	Madera County	108	***237,000***	5%	237,000	18127.3	0.0017	8.8	320.5	247.8	140.5	67.8	72.6	1.27	17302	6826725	0
North Kings	Madera ID	109	***237,000***	3%	237,000	8977.7	0.0024	12.5	356.9	270.9	176.9	90.9	85.9	1.50	8955	5010116	0
North Kings	Madera ID	110	***237,000***	0%	237,000	19839.8	0.0019	9.8	320.4	248.0	140.4	68.0	72.5	1.26	18916	8352762	0
Madera ID	North Kings	111	***184,000***	-1%	184,000	6346.9	0.0012	6.5	276.2	282.4	96.2	102.4	6.3	0.11	694	157461	0
North Kings	Madera ID	112	***184,000***	N/A	184,000	7833.8	0.0010	5.5	323.6	282.4	143.6	102.4	41.2	0.72	5159	991593	0
North Kings	Madera ID	113	***184,000***	N/A	184,000	25138.2	0.0023	12.0	338.5	253.7	158.5	73.7	84.8	1.48	25035	10471910	0
McMullin	Aliso WD	114	***180,000***	N/A	180,000	11667.2	0.0035	18.3	235.8	213.3	55.8	33.3	22.5	0.39	4462	2784620	0
Aliso WD	McMullin	115	***180,000***	N/A	180,000	6284.1	0.0021	11.0	213.9	323.7	33.9	143.7	70.2	1.23	5914	2213227	0
McMullin	Aliso WD	116	***180,000***	N/A	180,000	9065.2	0.0019	10.2	300.2	250.8	120.2	70.8	49.4	0.86	6883	2385477	0
McMullin	Aliso WD	117	***180,000***	N/A	180,000	4645.4	0.0031	16.5	213.7	173.6	33.7	173.6	40.2	0.70	2996	1683704	0
Aliso WD	McMullin	118	***180,000***	N/A	180,000	13996.9	0.0016	8.4	221.5	273.4	41.5	93.4	51.9	0.91	11014	3148211	0
Aliso WD	McMullin	119	***180,000***	N/A	180,000	3456.2	0.0005	2.8	249.7	273.4	69.7	93.4	23.7	0.41	1390	132429	0
McMullin	Farmers WD	120	***180,000***	N/A	180,000	3470.6	0.0005	2.7	241.3	215.4	61.3	35.4	25.9	0.45	1515	139271	0
McMullin	Farmers WD	121	***175,000***	N/A	175,000	5165.0	N/A	N/A	N/A	181.0	N/A	1.0	N/A	N/A	N/A	N/A	N/A
McMullin	Fresno County	122	***175,000***	N/A	175,000	8089.5	N/A	N/A	N/A	181.0	N/A	1.0	N/A	N/A	N/A	N/A	N/A
Fresno County	McMullin	123	***175,000***	N/A	175,000	5472.0	0.0011	5.7	331.8	101.0	151.8	101.0	50.8	0.89	4239	798536	894
McMullin	Fresno County	124	***175,000***	5%	175,000	8939.7	0.0017	9.1	47.3	101.0	47.3	101.0	53.7	0.94	7204	2167683	2428
Fresno County	McMullin	125	***175,000***	8%	175,000	7147.8	0.0030	15.9	80.7	90.6	80.7	90.6	9.8	0.17	1222	645639	723
Fresno County	McMullin	126	***175,000***	9%	175,000	12139.4	0.0030	16.0	97.0	181.4	97.0	1.4	84.4	1.47	12081	6399861	7169
James ID	Fresno County	127	***175,000***	6%	175,000	10727.6	0.0031	16.5	76.8	268.0	76.8	88.0	11.2	0.20	2092	1142080	1279
Fresno County	James ID	128	***171,000***	4%	171,000	3722.6	0.0022	11.4	66.3	180.0	66.3	180.0	66.3	1.16	3409	1254157	1405
Central Delta Mendota Regional Mulit Agency GSA	James ID	129	***171,000***	4%	171,000	7865.6	0.0018	9.7	56.7	130.8	56.7	130.8	74.1	1.29	7565	2383518	2670
James ID	Central Delta Mendota Regional Mulit Agency GSA	130	***171,000***	5%	171,000	16667.1	0.0015	8.1	236.8	165.8	56.8	165.8	71.0	1.24	15761	4146164	4644
James ID	Central Delta Mendota Regional Mulit Agency GSA	131	***171,000***	8%	171,000	5212.2	0.0019	10.1	189.2	180.8	9.2	0.8	8.4	0.15	760	247433	277
Central Delta Mendota Regional Mulit Agency GSA	James ID	132	***171,000***	N/A	171,000	8711.3	0.0014	7.6	185.0	270.5	5.0	90.5	85.5	1.49	8684	2144316	2402
Central Delta Mendota Regional Mulit Agency GSA	James ID	133	***171,000***	N/A	171,000	5559.6	0.0010	5.4	181.9	200.4	1.9	20.4	18.4	0.32	1757	308729	346
Central Delta Mendota Regional Mulit Agency GSA	James ID	134	***171,000***	N/A	171,000	5435.6	0.0007	3.8	179.8	180.8	179.8	0.8	1.0	0.02	97	11828	13
James ID	Westlands WD	135	***87,000***	N/A	87,000	6701.1	0.0006	3.1	175.4	90.6	175.4	90.6	84.8	1.48	6673	345117	387
James ID	Westlands WD	136	***87,000***	N/A	87,000	10529.2	0.0011	5.7	158.7	118.7	158.7	118.7	40.0	0.70	6764	630746	707
Westlands WD	North Fork Kings	137	***87,000***	N/A	87,000	23573.7	0.0019	9.9	126.0	153.4	126.0	153.4	27.3	0.48	10827	1769851	1982
North Fork Kings	Westlands WD	138	***90,000***	N/A	90,000	5362.7	0.0015	8.1	108.1	91.6	108.1	91.6	16.5	0.29	1520	209939	235
North Fork Kings	Westlands WD	139	***90,000***	N/A	90,000	9680.0	0.0013	6.7	114.2	0.9	114.2	0.9	66.6	1.16	8887	1014617	1137
North Fork Kings	Westlands WD	140	***90,000***	N/A	90,000	8413.5	0.0014	7.3	121.4	90.5	121.4	90.5	30.9	0.54	4321	538218	603
Westlands WD	North Fork Kings	141	***90,000***	N/A	90,000	14877.4	0.0019	9.8	94.8	178.8	94.8	178.8	84.0	1.47	14796	2475094	2772
Westlands WD	North Fork Kings	142	***90,000***	N/A	90,000	7984.0	0.0014	7.4	37.1	178.9	37.1	178.9	38.1	0.67	4930	619744	694
Westlands WD	North Fork Kings	143	***90,000***	N/A	90,000	10906.7	0.0009	4.8	44.4	104.2	44.4	104.2	59.9	1.04	9433	776002	869
Westlands WD	North Fork Kings	144	***90,000***	N/A	90,000	5362.7	0.0005	2.7	50.9	181.6	50.9	1.6	49.3	0.86	4063	189011	212
North Fork Kings	Westlands WD	145	***90,000***	N/A	90,000	5361.1	0.0004	2.3	77.3	269.2	77.3	89.2	11.9	0.21	1103	43814	49
Westlands WD	North Fork Kings	146	***90,000***	N/A	90,000	5063.3	0.0007	3.9	69.7	180.8	69.7	0.8	68.9	1.20	4724	310313	348
Westlands WD	North Fork Kings	147	***60,000***	N/A	60,000	10639.8	0.0011	5.7	347.1	90.8	167.1	90.8	76.3	1.33	10338	672340	753
Westlands WD	North Fork Kings	148	***60,000***	N/A	60,000	10581.3	0.0025	12.9	288.8	90.8	108.8	90.8	18.0	0.31	3268	480396	538
Westlands WD	North Fork Kings	149	***60,000***	N/A	60,000	14856.4	0.0010	5.5	325.7	135.4	145.7	135.4	10.3	0.18	2666	167148	187
North Fork Kings	Westlands WD	150	***60,000***	N/A	60,000	15047.2	0.0008	4.4	276.4	135.4	96.4	135.4	39.0	0.68	9475	471456	528
North Fork Kings	Westlands WD	151	***60,000***	N/A	60,000	8452.6	0.0013	7.1	205.2	72.0	25.2	72.0	46.8	0.82	6164	494998	554
North Fork Kings	Westlands WD	152	***60,000***	N/A	60,000	11535.4	0.0019	9.8	235.2	136.8	55.2	136.8	81.7	1.43	11413	1276398	1430
North Fork Kings	Westlands WD	153	***60,000***	N/A	60,000	15489.2	0.0019	10.1	263.9	180.8	83.9	0.8	83.1	1.45	15378	1757065	1968
North Fork Kings	Westlands WD	154	***60,000***	N/A	60,000	5285.2	N/A	N/A	N/A	180.8	N/A	0.8	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	155	***90,000***	N/A	90,000	5361.1	N/A	N/A	N/A	90.8	N/A	90.8	N/A	N/A	N/A	N/A	N/A
North Fork Kings	South Fork Kings GSA	156	***90,000***	N/A	90,000	5346.1	N/A	N/A	N/A	77.1	N/A	77.1	N/A	N/A	N/A	N/A	N/A
North Fork Kings	South Fork Kings GSA	157	***90,000***	N/A	90,000	4074.8	N/A	N/A	N/A	0.7	N/A	0.7	N/A	N/A	N/A	N/A	0
South Fork Kings GSA	North Fork Kings	158	***90,000***	N/A	90,000	2477.5	0.0012	6.5	265.5	0.7	85.5	0.7	84.8	1.48	2467	271306	0
South Fork Kings GSA	North Fork Kings	159	***90,000***	20%	90,000	6526.5	0.0011	5.9	260.0	54.4	80.0	54.4	25.6	0.45	2819	284744	0
North Fork Kings	South Fork Kings GSA	160	***90,000***	19%	90,000	37726.0	0.0015	8.1	221.3	48.0	41.3	48.0	6.7	0.12	4394	608775	0
North Fork Kings	Mid Kings River GSA	161	***90,000***	18%	90,000	4940.9	0.0014	7.5	169.8	47.3	169.8	47.3	57.6	1.00	4170	536527	0
North Fork Kings	Mid Kings River GSA	162	***90,000***	17%	90,000	5730.5	0.0036	19.0	211.5	47.3	31.5	47.3	15.9	0.28	1568	507653	0
North Fork Kings	Mid Kings River GSA	163	***90,000***	8%	90,000	19953.9	0.0030	15.6	215.9	90.4	35.9	90.4	54.5	0.95	16253	4331216	0
Mid Kings River GSA	North Fork Kings	164	***90,000***	7%	90,000	10560.8	0.0012	6.4	229.3	46.9	49.3	46.9	2.4	0.04	436	47361	53
Mid Kings River GSA	North Fork Kings	165	***90,000***	11%	90,000	6769.4	0.0014	7.5	318.6	46.9	138.6	46.9	88.3	1.54	6766	859762	963
Central Kings	Mid Kings River GSA	166	***90,000***	9%	90,000	8937.1	0.0013	6.6	261.3	178.6	81.3	178.6	82.8	1.44	8866	1001551	1122
Central Kings	Mid Kings River GSA	167	***84,000***	4%	84,000	18901.3	0.0023	12.2	178.3	69.0	178.3	69.0	70.7	1.23	17837	3470824	0
Central Kings	Mid Kings River GSA	168	***84,000***	4%	84,000	16749.2	0.0023	12.1	122.8	27.2	122.8	27.2	84.5	1.47	16671	3208172	0
Kings River East	Mid Kings River GSA	169	***84,000***	8%	84,000	1489.1	0.0022	11.8	160.7	90.0	160.7	90.0	70.7	1.23	1405	263258	295
Mid Kings River GSA	Kings River East	170	***84,000***	15%	84,000	31942.3	0.0030	15.6	131.7	180.7	131.7	0.7	49.0	0.86	24113	5994120	6714
Kings River East	Mid Kings River GSA	171	***99,000***	22%	99,000	10649.1	0.0015	8.0	149.3	91.2	149.3	91.2	58.1	1.01	9041	1360944	1524
Kings River East	Greater Kaweah GSA	172	***99,000***	19%	99,000	23363.7	0.0021	11.3	223.9	64.0	43.9	64.0	20.1	0.35	8024	1704609	1909
Greater Kaweah GSA	Kings River East	173	***99,000***	7%	99,000	5805.0	0.0030	15.8	268.1	64.0	88.1	64.0	24.2	0.42	2375	703125	788
Kings River East	Greater Kaweah GSA	174	***50,000***	-2%	50,000	15892.6	0.0015	7.8	249.3	93.8	69.3	93.8	24.4	0.43	6573	487405	546
Kings River East	Greater Kaweah GSA	175	***40,000***	-2%	40,000	1714.0	0.0010	5.4	157.8	182.5	157.8	2.5	24.7	0.43	717	29272	33
Kings River East	Greater Kaweah GSA	176	***40,000***	N/A	40,000	10626.4	0.0027	14.3	126.9	90.5	126.9	90.5	36.3	0.63	6297	680046	762
Kings River East	Greater Kaweah GSA	177	***40,000***	N/A	40,000	13273.9	0.0039	20.5	160.9	90.5	160.9	90.5	70.3	1.23	12500	1942796	2176
Kings River East	East Kaweah GSA	178	***20,000***	N/A	20,000	15785.5	0.0042	22.3	147.1	0.8	147.1	0.8	33.7	0.59	8766	741445	831
Kings River East	East Kaweah GSA	179	***20,000***	N/A	20,000	16008.0	0.0061	32.2	197.8	90.5	17.8	90.5	72.7	1.27	15284	1861338	2085
Kings River East	East Kaweah GSA	180	***20,000***	N/A	20,000	4996.5	N/A	N/A	N/A	359.0	N/A	179.0	N/A	N/A	N/A	N/A	N/A

Attachment 3 - 1999 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^{o})	Flow Direction converted to between 0 & 180^{o}	Segement Azimuth converted to between 0 & 180^{o}	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
Kings River East	East Kaweah GSA	181	***20,000***	N/A	20,000	3194.6	N/A	N/A	N/A	359.0	N/A	179.0	N/A	N/A	N/A	N/A	N/A
East Kaweah GSA	Kings River East	182	***20,000***	N/A	20,000	5861.0	0.0046	24.5	205.2	295.6	25.2	115.6	89.6	1.56	5861	544075	609

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2000 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (L) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	Madera County	100	30,000	N/A	30,000	8310.4	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	101	30,000	N/A	30,000	4325.1	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
Madera County	North Kings	102	30,000	N/A	30,000	7349.7	N/A	N/A	N/A	166.5	N/A	166.5	N/A	N/A	N/A	N/A	0
Madera County	North Kings	103	30,000	N/A	30,000	12097.8	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
Madera County	North Kings	104	***30,000***	N/A	30,000	20674.9	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
Madera County	North Kings	105	***93,000***	25%	93,000	12121.9	0.0012	6.4	152.1	214.3	152.1	34.3	62.2	1.09	10725	1212833	0
Madera County	North Kings	106	***211,000***	28%	211,000	5396.1	0.0029	15.5	198.6	278.3	18.6	98.3	79.7	1.39	5308	3287759	0
Root Creek WD	North Kings	107	***211,000***	13%	211,000	14767.3	0.0017	9.0	206.6	278.3	26.6	98.3	71.7	1.25	14022	5059090	0
North Kings	Madera County	108	***237,000***	5%	237,000	18127.3	0.0018	9.6	331.5	247.8	151.5	67.8	83.7	1.46	18018	7752917	0
North Kings	Madera ID	109	***237,000***	3%	237,000	8977.7	0.0025	13.1	349.4	270.9	169.4	90.9	78.4	1.37	8795	5153213	0
North Kings	Madera ID	110	***237,000***	0%	237,000	19839.8	0.0018	9.7	340.0	248.0	160.0	68.0	88.0	1.54	19827	8613435	0
North Kings	Madera ID	111	***184,000***	-1%	184,000	6346.9	0.0016	8.4	304.6	282.4	124.6	102.4	22.2	0.39	2397	704123	0
North Kings	Madera ID	112	***184,000***	N/A	184,000	7833.8	0.0025	13.1	340.7	282.4	160.7	102.4	58.2	1.02	6660	3050162	0
North Kings	Madera ID	113	***184,000***	N/A	184,000	25138.2	0.0025	13.3	348.4	253.7	168.4	73.7	85.2	1.49	25051	11602538	0
McMullin	Aliso WD	114	***180,000***	N/A	180,000	11667.2	0.0035	18.3	242.0	213.3	62.0	33.3	28.7	0.50	5597	3493754	0
McMullin	Aliso WD	115	***180,000***	N/A	180,000	6284.1	0.0021	11.1	116.3	323.7	116.3	143.7	27.4	0.48	2893	1092409	0
McMullin	Aliso WD	116	***180,000***	N/A	180,000	9065.2	0.0030	16.0	299.4	250.8	119.4	70.8	48.6	0.85	6796	3704968	0
McMullin	Aliso WD	117	***180,000***	N/A	180,000	4645.4	0.0022	11.7	215.6	173.6	35.6	173.6	42.1	0.73	3112	1241328	0
Aliso WD	McMullin	118	***180,000***	N/A	180,000	13996.9	0.0015	7.8	23.5	273.4	23.5	93.4	69.9	1.22	13146	3493083	0
McMullin	Aliso WD	119	***180,000***	N/A	180,000	3456.2	0.0021	11.1	332.3	273.4	152.3	93.4	58.9	1.03	2959	1117051	0
McMullin	Farmers WD	120	***180,000***	N/A	180,000	3470.6	0.0021	11.1	316.0	215.4	136.0	35.4	79.4	1.39	3411	1290962	0
McMullin	Farmers WD	121	***175,000***	N/A	175,000	5165.0	0.0011	5.7	332.4	181.0	152.4	1.0	28.6	0.50	2473	465214	521
Fresno County	McMullin	122	***175,000***	N/A	175,000	8089.5	0.0002	0.9	97.2	181.0	97.2	1.0	83.8	1.46	8042	241728	271
McMullin	Fresno County	123	***175,000***	N/A	175,000	5472.0	0.0003	1.6	106.0	101.0	106.0	101.0	5.0	0.09	475	25242	28
Fresno County	McMullin	124	***175,000***	5%	175,000	8939.7	0.0010	5.1	76.7	101.0	76.7	101.0	24.4	0.43	3689	624837	700
McMullin	Fresno County	125	***175,000***	8%	175,000	7147.8	0.0034	17.8	101.3	90.6	101.3	90.6	10.7	0.19	1322	780809	875
Fresno County	McMullin	126	***175,000***	9%	175,000	12139.4	0.0038	20.3	97.6	181.4	97.6	1.4	83.8	1.46	12068	8126988	9103
Fresno County	James ID	127	***175,000***	6%	175,000	10727.6	0.0024	12.8	99.0	268.0	99.0	88.0	11.0	0.19	2045	869458	974
Fresno County	James ID	128	***171,000***	4%	171,000	3722.6	0.0017	9.1	112.8	180.0	112.8	180.0	67.2	1.17	3431	1010503	1132
Central Delta Mendota Regional Mulit Agency GSA	James ID	129	***171,000***	4%	171,000	7865.6	0.0019	10.1	114.5	130.8	114.5	130.8	16.2	0.28	2199	722328	809
Central Delta Mendota Regional Mulit Agency GSA	James ID	130	***171,000***	5%	171,000	16667.1	0.0017	9.1	102.0	165.8	102.0	165.8	63.8	1.11	14954	4397001	4925
James ID	Central Delta Mendota Regional Mulit Agency GSA	131	***171,000***	8%	171,000	5212.2	0.0007	3.9	182.9	180.8	2.9	0.8	2.1	0.04	193	24120	27
Central Delta Mendota Regional Mulit Agency GSA	James ID	132	***171,000***	N/A	171,000	8711.3	0.0016	8.6	187.0	270.5	7.0	90.5	83.5	1.46	8655	2404397	2693
Central Delta Mendota Regional Mulit Agency GSA	James ID	133	***171,000***	N/A	171,000	5559.6	0.0017	8.9	138.1	200.4	138.1	20.4	62.3	1.09	4921	1412450	1582
Central Delta Mendota Regional Mulit Agency GSA	James ID	134	***171,000***	N/A	171,000	5435.6	0.0014	7.4	142.8	180.8	142.8	0.8	38.0	0.66	3348	807170	904
James ID	Westlands WD	135	***87,000***	N/A	87,000	6701.1	0.0014	7.5	147.0	90.6	147.0	90.6	56.4	0.98	5579	693990	777
James ID	Westlands WD	136	***87,000***	N/A	87,000	10529.2	0.0016	8.4	155.2	118.7	155.2	118.7	36.5	0.64	6262	861930	965
Westlands WD	North Fork Kings	137	***87,000***	N/A	87,000	23573.7	0.0015	7.7	140.7	153.4	140.7	153.4	12.6	0.22	5154	654443	733
North Fork Kings	Westlands WD	138	***90,000***	N/A	90,000	5362.7	0.0009	4.6	122.9	91.6	122.9	91.6	31.3	0.55	2783	216711	243
North Fork Kings	Westlands WD	139	***90,000***	N/A	90,000	9680.0	0.0011	5.6	137.0	0.9	137.0	0.9	43.9	0.77	6710	645145	723
North Fork Kings	Westlands WD	140	***90,000***	N/A	90,000	8413.5	0.0014	7.2	167.6	90.5	167.6	90.5	77.1	1.35	8201	1000935	1121
Westlands WD	North Fork Kings	141	***90,000***	N/A	90,000	14877.4	0.0006	3.3	149.9	178.8	149.9	178.8	28.9	0.50	7189	401473	450
Westlands WD	North Fork Kings	142	***90,000***	N/A	90,000	7984.0	0.0001	0.7	67.6	178.9	67.6	178.9	68.6	1.20	7436	93188	104
North Fork Kings	Westlands WD	143	***90,000***	N/A	90,000	10906.7	0.0004	1.9	111.1	104.2	111.1	104.2	6.9	0.12	1308	41343	46
North Fork Kings	Westlands WD	144	***90,000***	N/A	90,000	5362.7	0.0006	3.0	314.4	181.6	134.4	1.6	47.2	0.82	3933	203117	228
North Fork Kings	Westlands WD	145	***90,000***	N/A	90,000	5361.1	0.0004	2.4	341.1	269.2	161.1	89.2	71.9	1.25	5095	205952	231
North Fork Kings	Westlands WD	146	***90,000***	N/A	90,000	5063.3	0.0004	1.9	359.6	180.8	179.6	0.8	1.3	0.02	113	3684	4
Westlands WD	North Fork Kings	147	***60,000***	N/A	60,000	10639.8	0.0006	3.1	320.6	90.8	140.6	90.8	49.8	0.87	8127	290468	325
Westlands WD	North Fork Kings	148	***60,000***	N/A	60,000	10581.3	0.0011	5.8	297.3	90.8	117.3	90.8	26.5	0.46	4726	312893	350
North Fork Kings	Westlands WD	149	***60,000***	N/A	60,000	14856.4	0.0010	5.5	264.4	135.4	84.4	135.4	51.0	0.89	11541	719819	806
North Fork Kings	Westlands WD	150	***60,000***	N/A	60,000	15047.2	0.0033	17.5	201.5	135.4	21.5	135.4	66.1	1.15	13754	2738736	3068
North Fork Kings	Westlands WD	151	***60,000***	N/A	60,000	8452.6	0.0027	14.2	220.1	72.0	40.1	72.0	31.9	0.56	4466	722069	809
North Fork Kings	Westlands WD	152	***60,000***	N/A	60,000	11535.4	0.0028	14.8	256.1	136.8	76.1	136.8	60.7	1.06	10058	1689100	1892
North Fork Kings	Westlands WD	153	***60,000***	N/A	60,000	15489.2	0.0029	15.4	263.3	180.8	83.3	0.8	82.5	1.44	15357	2691713	3015
North Fork Kings	Westlands WD	154	***60,000***	N/A	60,000	5285.2	0.0023	12.2	249.3	180.8	69.3	0.8	68.5	1.20	4918	680058	762
North Fork Kings	Westlands WD	155	***90,000***	N/A	90,000	5361.1	0.0023	11.9	242.0	90.8	62.0	90.8	28.8	0.50	2582	524071	587
North Fork Kings	South Fork Kings GSA	156	***90,000***	N/A	90,000	5346.1	0.0021	11.4	237.3	77.1	57.3	77.1	19.8	0.35	1813	350781	393
South Fork Kings GSA	North Fork Kings	157	***90,000***	N/A	90,000	4074.8	0.0020	10.5	233.5	0.7	53.5	0.7	52.8	0.92	3248	583890	0
South Fork Kings GSA	North Fork Kings	158	***90,000***	N/A	90,000	2477.5	0.0020	10.6	233.7	0.7	53.7	0.7	53.1	0.93	1980	358745	0
North Fork Kings	South Fork Kings GSA	159	***90,000***	20%	90,000	6526.5	0.0019	10.1	229.1	54.4	49.1	54.4	5.3	0.09	607	104283	0
South Fork Kings GSA	North Fork Kings	160	***90,000***	19%	90,000	37726.0	0.0018	9.6	228.2	48.0	48.2	48.0	0.3	0.00	166	27218	0
Mid Kings River GSA	North Fork Kings	161	***90,000***	18%	90,000	4940.9	0.0026	13.8	238.1	47.3	58.1	47.3	10.8	0.19	924	217163	0
Mid Kings River GSA	North Fork Kings	162	***90,000***	17%	90,000	5730.5	0.0035	18.2	234.2	47.3	54.2	47.3	6.9	0.12	687	213552	0
North Fork Kings	Mid Kings River GSA	163	***90,000***	8%	90,000	19953.9	0.0024	12.7	214.5	90.4	34.5	90.4	56.0	0.98	16535	3567631	0
Mid Kings River GSA	North Fork Kings	164	***90,000***	7%	90,000	10560.8	0.0017	8.8	259.2	46.9	79.2	46.9	32.2	0.56	5634	843367	945
Mid Kings River GSA	North Fork Kings	165	***90,000***	11%	90,000	6769.4	0.0024	12.5	323.4	46.9	143.4	46.9	83.5	1.46	6726	1433709	1606
Mid Kings River GSA	Central Kings	166	***90,000***	9%	90,000	8937.1	0.0015	7.8	37.4	178.6	37.4	178.6	38.8	0.68	5602	741024	830
Central Kings	Mid Kings River GSA	167	***84,000***	4%	84,000	18901.3	0.0025	13.3	165.6	69.0	165.6	69.0	83.4	1.46	18775	3969608	0
Central Kings	Mid Kings River GSA	168	***84,000***	4%	84,000	16749.2	0.0012	6.1	159.0	27.2	159.0	27.2	48.2	0.84	12495	1218367	0
Kings River East	Mid Kings River GSA	169	***84,000***	8%	84,000	1489.1	0.0013	6.8	182.5	90.0	2.5	90.0	87.5	1.53	1488	160567	180
Mid Kings River GSA	Kings River East	170	***84,000***	15%	84,000	31942.3	0.0023	12.2	144.3	180.7	144.3	0.7	36.3	0.63	18925	3668051	4109
Kings River East	Mid Kings River GSA	171	***99,000***	22%	99,000	10649.1	0.0013	7.0	138.9	91.2	138.9	91.2	47.7	0.83	7882	1038007	1163
Greater Kaweah GSA	Kings River East	172	***99,000***	19%	99,000	23363.7	0.0021	11.3	241.2	64.0	61.2	64.0	2.8	0.05	1139	242368	271
Greater Kaweah GSA	Kings River East	173	***99,000***	7%	99,000	5805.0	0.0028	14.8	245.7	64.0	65.7	64.0	1.7	0.03	175	48424	54
Kings River East	Greater Kaweah GSA	174	***50,000***	-2%	50,000	15892.6	0.0010	5.1	232.0	93.8	52.0	93.8	41.8	0.73	10590	516309	578
Kings River East	Greater Kaweah GSA	175	***40,000***	-2%	40,000	1714.0	0.0009	4.7	162.8	182.5	162.8	2.5	19.7	0.34	578	20591	23
Kings River East	Greater Kaweah GSA	176	***40,000***	N/A	40,000	10626.4	0.0030	16.0	139.8	90.5	139.8	90.5	49.3	0.86	8052	978975	1097
Kings River East	Greater Kaweah GSA	177	***40,000***	N/A	40,000	13273.9	0.0059	31.1	174.7	90.5	174.7	90.5	84.1	1.47	13204	3108401	3482
East Kaweah GSA	Kings River East	178	***20,000***	N/A	20,000	15785.5	0.0044	23.1	183.4	0.8	3.4	0.8	2.6	0.05	715	62539	70
Kings River East	East Kaweah GSA	179	***20,000***	N/A	20,000	16008.0	0.0042	22.0	202.3	90.5	22.3	90.5	68.2	1.19	14865	1239994	1389
East Kaweah GSA	Kings River East	180	***20,000***	N/A	20,000	4996.5	0.0035	18.6	239.4	359.0	59.4	179.0	60.5	1.06	4348	306779	344

Attachment 3 - 2000 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^{o})	Flow Direction converted to between 0 & 180^{o}	Segement Azimuth converted to between 0 & 180^{o}	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
East Kaweah GSA	Kings River East	181	***20,000***	N/A	20,000	3194.6	0.0035	18.5	232.0	359.0	52.0	179.0	53.0	0.93	2553	178423	200
East Kaweah GSA	Kings River East	182	***20,000***	N/A	20,000	5861.0	0.0044	23.1	208.6	295.6	28.6	115.6	87.0	1.52	5853	512706	574

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2001 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (L) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	Madera County	100	30,000	N/A	30,000	8310.4	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	101	30,000	N/A	30,000	4325.1	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
Madera County	North Kings	102	30,000	N/A	30,000	7349.7	N/A	N/A	N/A	166.5	N/A	166.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	103	30,000	N/A	30,000	12097.8	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
North Kings	Madera County	104	***30,000***	N/A	30,000	20674.9	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
North Kings	Madera County	105	***93,000***	25%	93,000	12121.9	0.0023	12.3	306.7	214.3	126.7	34.3	87.6	1.53	12112	2631057	0
Madera County	North Kings	106	***211,000***	28%	211,000	5396.1	0.0018	9.4	213.8	278.3	33.8	98.3	64.5	1.13	4871	1834977	0
Root Creek WD	North Kings	107	***211,000***	13%	211,000	14767.3	0.0017	8.8	190.1	278.3	10.1	98.3	88.2	1.54	14760	5213527	0
North Kings	Madera County	108	***237,000***	5%	237,000	18127.3	0.0022	11.7	321.7	247.8	141.7	67.8	73.9	1.29	17415	9147321	0
North Kings	Madera ID	109	***237,000***	3%	237,000	8977.7	0.0040	20.9	5.7	270.8	5.7	90.9	85.2	1.49	8947	8378134	0
North Kings	Madera ID	110	***237,000***	0%	237,000	19839.8	0.0026	13.5	324.3	248.0	144.3	68.0	76.3	1.33	19279	11688237	0
North Kings	Madera ID	111	***184,000***	-1%	184,000	6346.9	0.0014	7.6	323.6	282.4	143.6	102.4	41.2	0.72	4179	1112523	0
North Kings	Madera ID	112	***184,000***	N/A	184,000	7833.8	0.0025	13.2	344.7	282.4	164.7	102.4	62.3	1.09	6934	3193668	0
North Kings	Madera ID	113	***184,000***	N/A	184,000	25138.2	0.0034	18.2	335.9	253.7	155.9	73.7	82.3	1.44	24910	15779559	0
Aliso WD	McMullin	114	***180,000***	N/A	180,000	11667.2	0.0034	17.8	217.1	213.3	37.1	33.3	3.9	0.07	784	475782	0
Aliso WD	McMullin	115	***180,000***	N/A	180,000	6284.1	0.0025	13.1	327.8	323.7	147.8	143.7	4.1	0.07	450	201122	0
McMullin	Aliso WD	116	***180,000***	N/A	180,000	9065.2	0.0035	18.5	304.4	250.8	124.4	70.8	53.5	0.93	7291	4606339	0
McMullin	Aliso WD	117	***180,000***	N/A	180,000	4645.4	0.0018	9.6	226.0	173.6	46.0	173.6	52.5	0.92	3683	1205080	0
McMullin	Aliso WD	118	***180,000***	N/A	180,000	13996.9	0.0019	10.2	310.9	273.4	130.9	93.4	37.5	0.65	8524	2972238	0
McMullin	Aliso WD	119	***180,000***	N/A	180,000	3456.2	0.0018	9.3	352.1	273.4	172.1	93.4	78.7	1.37	3389	1076428	0
Farmers WD	McMullin	120	***180,000***	N/A	180,000	3470.6	0.0028	14.6	76.7	215.4	76.7	35.4	41.4	0.72	2293	1144698	0
Farmers WD	McMullin	121	***175,000***	N/A	175,000	5165.0	0.0014	7.3	92.0	181.0	92.0	1.0	88.9	1.55	5164	1246475	1396
Fresno County	McMullin	122	***175,000***	N/A	175,000	8089.5	0.0005	2.4	152.8	181.0	152.8	1.0	28.2	0.49	3825	304624	341
McMullin	Fresno County	123	***175,000***	N/A	175,000	5472.0	0.0003	1.8	145.8	101.0	145.8	101.0	44.7	0.78	3852	232978	261
McMullin	Fresno County	124	***175,000***	5%	175,000	8939.7	0.0003	1.3	40.7	101.0	40.7	101.0	60.3	1.05	7766	344236	386
McMullin	Fresno County	125	***175,000***	8%	175,000	7147.8	0.0029	15.5	109.4	90.6	109.4	90.6	18.8	0.33	2302	1183446	1326
Fresno County	McMullin	126	***175,000***	9%	175,000	12139.4	0.0041	21.6	103.4	181.4	103.4	1.4	78.0	1.36	11873	8503790	9525
Fresno County	James ID	127	***175,000***	6%	175,000	10727.6	0.0026	14.0	99.0	268.0	99.0	88.0	11.0	0.19	2045	947202	1061
Fresno County	James ID	128	***171,000***	4%	171,000	3722.6	0.0016	8.4	90.8	180.0	90.8	180.0	89.2	1.56	3722	1015023	1137
Central Delta Mendota Regional Mulit Agency GSA	James ID	129	***171,000***	4%	171,000	7865.6	0.0022	11.4	87.7	130.8	87.7	130.8	43.1	0.75	5371	1991515	2231
Central Delta Mendota Regional Mulit Agency GSA	James ID	130	***171,000***	5%	171,000	16667.1	0.0023	11.9	80.9	165.8	80.9	165.8	84.8	1.48	16599	6412637	7183
Central Delta Mendota Regional Mulit Agency GSA	James ID	131	***171,000***	8%	171,000	5212.2	0.0019	9.8	112.0	180.8	112.0	0.8	68.9	1.20	4861	1550203	1736
Central Delta Mendota Regional Mulit Agency GSA	James ID	132	***171,000***	N/A	171,000	8711.3	0.0023	11.9	127.5	270.5	127.5	90.5	37.0	0.65	5244	2020569	2263
Central Delta Mendota Regional Mulit Agency GSA	James ID	133	***171,000***	N/A	171,000	5559.6	0.0021	11.1	139.6	200.4	139.6	20.4	60.8	1.06	4854	1743511	1953
Central Delta Mendota Regional Mulit Agency GSA	James ID	134	***171,000***	N/A	171,000	5435.6	0.0021	11.3	146.6	180.8	146.6	0.8	34.2	0.60	3055	1115019	1249
James ID	Westlands WD	135	***87,000***	N/A	87,000	6701.1	0.0025	13.4	148.2	90.6	148.2	90.6	57.5	1.00	5653	1248429	1398
James ID	Westlands WD	136	***87,000***	N/A	87,000	10529.2	0.0020	10.4	148.8	118.7	148.8	118.7	30.0	0.52	5270	906251	1015
North Fork Kings	Westlands WD	137	***87,000***	N/A	87,000	23573.7	0.0021	11.2	169.9	153.4	169.9	153.4	16.6	0.29	6723	1241550	1391
North Fork Kings	Westlands WD	138	***90,000***	N/A	90,000	5362.7	0.0020	10.8	178.3	91.6	178.3	91.6	86.8	1.51	5354	982357	1100
North Fork Kings	Westlands WD	139	***90,000***	N/A	90,000	9680.0	0.0025	13.0	149.5	0.9	149.5	0.9	31.4	0.55	5039	1119470	1254
Westlands WD	North Fork Kings	140	***90,000***	N/A	90,000	8413.5	0.0039	20.4	74.1	90.5	74.1	90.5	16.4	0.29	2378	827114	926
Westlands WD	North Fork Kings	141	***90,000***	N/A	90,000	14877.4	0.0013	6.8	84.7	178.8	84.7	178.8	85.8	1.50	14838	1711179	1917
North Fork Kings	Westlands WD	142	***90,000***	N/A	90,000	7984.0	0.0005	2.5	327.8	178.8	147.8	178.8	31.1	0.54	4128	173374	194
North Fork Kings	Westlands WD	143	***90,000***	N/A	90,000	10906.7	0.0005	2.7	176.0	104.2	176.0	104.2	71.8	1.25	10362	485309	544
Westlands WD	North Fork Kings	144	***90,000***	N/A	90,000	5362.7	N/A	N/A	N/A	181.6	N/A	1.6	N/A	N/A	N/A	N/A	N/A
Westlands WD	North Fork Kings	145	***90,000***	N/A	90,000	5361.1	N/A	N/A	N/A	269.2	N/A	89.2	N/A	N/A	N/A	N/A	N/A
Westlands WD	North Fork Kings	146	***90,000***	N/A	90,000	5063.3	N/A	N/A	N/A	180.8	N/A	0.8	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	147	***60,000***	N/A	60,000	10639.8	N/A	N/A	N/A	90.8	N/A	90.8	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	148	***60,000***	N/A	60,000	10581.3	N/A	N/A	N/A	90.8	N/A	90.8	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	149	***60,000***	N/A	60,000	14856.4	0.0041	21.9	254.9	135.4	74.9	135.4	60.5	1.06	12930	3214711	3601
North Fork Kings	Westlands WD	150	***60,000***	N/A	60,000	15047.2	0.0016	8.7	199.6	135.4	19.6	135.4	64.2	1.12	13547	1334826	1495
North Fork Kings	Westlands WD	151	***60,000***	N/A	60,000	8452.6	0.0013	6.6	291.0	72.0	111.0	72.0	39.0	0.68	5317	401609	450
Westlands WD	North Fork Kings	152	***60,000***	N/A	60,000	11535.4	0.0017	9.0	330.7	136.8	150.7	136.8	13.9	0.24	2767	281607	315
North Fork Kings	Westlands WD	153	***60,000***	N/A	60,000	15489.2	0.0026	13.9	258.0	180.8	78.0	0.8	77.2	1.35	15105	2390244	2677
North Fork Kings	Westlands WD	154	***60,000***	N/A	60,000	5285.2	0.0019	10.1	272.0	180.8	92.0	0.8	88.8	1.55	5284	603641	676
Westlands WD	North Fork Kings	155	***90,000***	N/A	90,000	5361.1	0.0021	11.0	274.9	90.8	94.9	90.8	4.1	0.07	386	72412	81
North Fork Kings	South Fork Kings GSA	156	***90,000***	N/A	90,000	5346.1	0.0026	13.7	256.7	77.1	76.7	77.1	0.4	0.01	37	8683	10
South Fork Kings GSA	North Fork Kings	157	***90,000***	N/A	90,000	4074.8	0.0030	15.9	249.5	0.7	69.5	0.7	68.8	1.20	3800	1029151	0
South Fork Kings GSA	North Fork Kings	158	***90,000***	N/A	90,000	2477.5	0.0032	16.6	250.4	0.7	70.4	0.7	69.7	1.22	2324	659111	0
South Fork Kings GSA	North Fork Kings	159	***90,000***	20%	90,000	6526.5	0.0030	15.7	246.6	54.4	66.6	54.4	12.2	0.21	1379	368389	0
South Fork Kings GSA	North Fork Kings	160	***90,000***	19%	90,000	37726.0	0.0020	10.7	239.9	48.0	59.9	48.0	11.9	0.21	7761	1421290	0
Mid Kings River GSA	North Fork Kings	161	***90,000***	18%	90,000	4940.9	0.0029	15.2	230.2	47.3	50.2	47.3	2.9	0.05	249	64556	0
Mid Kings River GSA	North Fork Kings	162	***90,000***	17%	90,000	5730.5	0.0033	17.5	234.7	47.3	54.7	47.3	7.4	0.13	737	219655	0
North Fork Kings	Mid Kings River GSA	163	***90,000***	8%	90,000	19953.9	0.0019	10.1	219.0	90.4	39.0	90.4	51.4	0.90	15599	2683785	0
North Fork Kings	Mid Kings River GSA	164	***90,000***	7%	90,000	10560.8	0.0011	5.8	221.9	46.9	41.9	46.9	5.0	0.09	920	91213	102
Mid Kings River GSA	North Fork Kings	165	***90,000***	11%	90,000	6769.4	0.0005	2.8	19.8	46.9	19.8	46.9	27.1	0.47	3083	146452	164
Mid Kings River GSA	Central Kings	166	***90,000***	9%	90,000	8937.1	0.0015	8.2	120.3	178.6	120.3	178.6	58.2	1.02	7598	1056706	1184
Central Kings	Mid Kings River GSA	167	***84,000***	4%	84,000	18901.3	0.0024	12.9	184.2	69.0	4.2	69.0	64.8	1.13	17103	3518760	0
Central Kings	Mid Kings River GSA	168	***84,000***	4%	84,000	16749.2	0.0013	6.8	160.5	27.2	160.5	27.2	46.7	0.82	12191	1324864	0
Kings River East	Mid Kings River GSA	169	***84,000***	8%	84,000	1489.1	0.0014	7.3	185.7	90.0	5.7	90.0	84.3	1.47	1482	171651	192
Mid Kings River GSA	Kings River East	170	***84,000***	15%	84,000	31942.3	0.0024	12.5	149.4	180.7	149.4	0.7	31.3	0.55	16594	3313077	3711

Kings River East	Mid Kings River GSA	171	***99,000***	22%	99,000	10649.1	0.0021	10.9	161.9	91.2	161.9	91.2	70.7	1.23	10050	2049286	2295
Kings River East	Greater Kaweah GSA	172	***99,000***	19%	99,000	23363.7	0.0026	13.7	214.9	64.0	34.9	64.0	29.0	0.51	11331	2909039	3259
Greater Kaweah GSA	Kings River East	173	***99,000***	7%	99,000	5805.0	0.0031	16.2	242.9	64.0	62.9	64.0	1.0	0.02	106	32135	36
Kings River East	Greater Kaweah GSA	174	***50,000***	-2%	50,000	15892.6	0.0015	8.1	233.7	93.8	53.7	93.8	40.1	0.70	10228	788607	883
Kings River East	Greater Kaweah GSA	175	***40,000***	-2%	40,000	1714.0	0.0017	8.9	187.0	182.5	7.0	2.5	4.5	0.08	135	9117	10
Kings River East	Greater Kaweah GSA	176	***40,000***	N/A	40,000	10626.4	0.0021	11.3	150.3	90.5	150.3	90.5	59.8	1.04	9185	785867	880
Kings River East	Greater Kaweah GSA	177	***40,000***	N/A	40,000	13273.9	0.0017	8.9	110.3	90.5	110.3	90.5	19.8	0.35	4490	303791	340
Kings River East	East Kaweah GSA	178	***20,000***	N/A	20,000	15785.5	0.0033	17.4	149.6	0.8	149.6	0.8	31.2	0.55	8189	539983	605
Kings River East	East Kaweah GSA	179	***20,000***	N/A	20,000	16008.0	0.0061	32.0	207.6	90.5	27.6	90.5	63.0	1.10	14257	1725488	1933
East Kaweah GSA	Kings River East	180	***20,000***	N/A	20,000	4996.5	0.0046	24.2	246.3	359.0	66.3	179.0	67.3	1.18	4610	423036	474
East Kaweah GSA	Kings River East	181	***20,000***	N/A	20,000	3194.6	0.0044	23.5	239.0	359.0	59.0	179.0	60.1	1.05	2769	246235	276
East Kaweah GSA	Kings River East	182	***20,000***	N/A	20,000	5861.0	0.0049	25.8	210.3	295.6	30.3	115.6	85.2	1.49	5841	571184	640

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2002 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (L) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	Madera County	100	30,000	N/A	30,000	8310.4	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	101	30,000	N/A	30,000	4325.1	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
Madera County	North Kings	102	30,000	N/A	30,000	7349.7	N/A	N/A	N/A	166.5	N/A	166.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	103	30,000	N/A	30,000	12097.8	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
Madera County	North Kings	104	***30,000***	N/A	30,000	20674.9	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
Madera County	North Kings	105	***93,000***	25%	93,000	12121.9	0.0014	7.4	188.0	214.3	8.0	34.3	26.3	0.46	5371	695668	0
Madera County	North Kings	106	***211,000***	28%	211,000	5396.1	0.0024	12.4	174.6	278.3	174.6	98.3	76.3	1.33	5244	2605573	0
Root Creek WD	North Kings	107	***211,000***	13%	211,000	14767.3	0.0009	4.8	193.6	278.3	13.6	98.3	84.7	1.48	14704	2827410	0
North Kings	Madera County	108	***237,000***	5%	237,000	18127.3	0.0016	8.5	316.5	247.8	136.5	67.8	68.7	1.20	16885	6466923	0
North Kings	Madera ID	109	***237,000***	3%	237,000	8977.7	0.0016	8.5	16.2	270.9	16.2	90.9	74.7	1.30	8661	3322159	0
North Kings	Madera ID	110	***237,000***	0%	237,000	19839.8	0.0015	7.9	298.4	248.0	118.4	68.0	50.4	0.88	15288	5452861	0
Madera ID	North Kings	111	***184,000***	-1%	184,000	6346.9	0.0012	6.1	248.8	282.4	68.8	102.4	33.6	0.59	3511	747029	0
North Kings	Madera ID	112	***184,000***	N/A	184,000	7833.8	0.0010	5.5	326.7	282.4	146.7	102.4	44.3	0.77	5469	1053455	0
North Kings	Madera ID	113	***184,000***	N/A	184,000	25138.2	0.0026	13.5	326.2	253.7	146.2	73.7	72.5	1.27	23976	11308734	0
McMullin	Aliso WD	114	***180,000***	N/A	180,000	11667.2	0.0017	9.1	229.5	213.3	49.5	33.3	16.2	0.28	3250	1011473	0
Aliso WD	McMullin	115	***180,000***	N/A	180,000	6284.1	0.0018	9.8	218.7	323.7	38.7	143.7	75.1	1.31	6072	2021064	0
Aliso WD	McMullin	116	***180,000***	N/A	180,000	9065.2	0.0018	9.4	200.6	250.8	20.6	70.8	50.2	0.88	6969	2227185	0
Aliso WD	McMullin	117	***180,000***	N/A	180,000	4645.4	0.0030	16.1	162.7	173.6	162.7	173.6	10.9	0.19	878	481100	0
Aliso WD	McMullin	118	***180,000***	N/A	180,000	13996.9	0.0036	19.2	146.9	273.4	146.9	93.4	53.5	0.93	11247	7356144	0
McMullin	Aliso WD	119	***180,000***	N/A	180,000	3456.2	N/A	N/A	N/A	273.4	N/A	93.4	N/A	N/A	N/A	N/A	0
McMullin	Farmers WD	120	***180,000***	N/A	180,000	3470.6	N/A	N/A	N/A	215.4	N/A	35.4	N/A	N/A	N/A	N/A	0
McMullin	Farmers WD	121	***175,000***	N/A	175,000	5165.0	N/A	N/A	N/A	181.0	N/A	1.0	N/A	N/A	N/A	N/A	N/A
McMullin	Fresno County	122	***175,000***	N/A	175,000	8089.5	N/A	N/A	N/A	181.0	N/A	1.0	N/A	N/A	N/A	N/A	N/A
Fresno County	McMullin	123	***175,000***	N/A	175,000	5472.0	N/A	N/A	N/A	101.0	N/A	101.0	N/A	N/A	N/A	N/A	N/A
McMullin	Fresno County	124	***175,000***	5%	175,000	8939.7	N/A	N/A	N/A	101.0	N/A	101.0	N/A	N/A	N/A	N/A	N/A
McMullin	Fresno County	125	***175,000***	8%	175,000	7147.8	0.0020	10.5	204.9	90.6	24.9	90.6	65.7	1.15	6515	2263087	2535
Fresno County	McMullin	126	***175,000***	9%	175,000	12139.4	0.0017	9.1	180.8	181.4	0.8	1.4	0.6	0.01	135	40798	46
Fresno County	James ID	127	***175,000***	6%	175,000	10727.6	N/A	N/A	N/A	268.0	N/A	88.0	N/A	N/A	N/A	N/A	N/A
Fresno County	James ID	128	***171,000***	4%	171,000	3722.6	N/A	N/A	N/A	180.0	N/A	180.0	N/A	N/A	N/A	N/A	N/A
James ID	Central Delta Mendota Regional Mulit Agency GSA	129	***171,000***	4%	171,000	7865.6	N/A	N/A	N/A	130.8	N/A	130.8	N/A	N/A	N/A	N/A	N/A
Central Delta Mendota Regional Mulit Agency GSA	James ID	130	***171,000***	5%	171,000	16667.1	N/A	N/A	N/A	165.8	N/A	165.8	N/A	N/A	N/A	N/A	N/A
Central Delta Mendota Regional Mulit Agency GSA	James ID	131	***171,000***	8%	171,000	5212.2	N/A	N/A	N/A	180.8	N/A	0.8	N/A	N/A	N/A	N/A	N/A
James ID	Central Delta Mendota Regional Mulit Agency GSA	132	***171,000***	N/A	171,000	8711.3	N/A	N/A	N/A	270.5	N/A	90.5	N/A	N/A	N/A	N/A	N/A
James ID	Central Delta Mendota Regional Mulit Agency GSA	133	***171,000***	N/A	171,000	5559.6	N/A	N/A	N/A	200.4	N/A	20.4	N/A	N/A	N/A	N/A	N/A
Central Delta Mendota Regional Mulit Agency GSA	James ID	134	***171,000***	N/A	171,000	5435.6	N/A	N/A	N/A	180.8	N/A	0.8	N/A	N/A	N/A	N/A	N/A
Westlands WD	James ID	135	***87,000***	N/A	87,000	6701.1	N/A	N/A	N/A	90.6	N/A	90.6	N/A	N/A	N/A	N/A	N/A
Westlands WD	James ID	136	***87,000***	N/A	87,000	10529.2	N/A	N/A	N/A	118.7	N/A	118.7	N/A	N/A	N/A	N/A	N/A
Westlands WD	North Fork Kings	137	***87,000***	N/A	87,000	23573.7	0.0011	5.8	118.6	153.4	118.6	153.4	34.7	0.61	13436	1288936	1444
North Fork Kings	Westlands WD	138	***90,000***	N/A	90,000	5362.7	0.0013	6.7	142.3	91.6	142.3	91.6	50.7	0.88	4147	470387	527
North Fork Kings	Westlands WD	139	***90,000***	N/A	90,000	9680.0	0.0013	6.8	139.2	0.9	139.2	0.9	41.7	0.73	6441	750880	841
North Fork Kings	Westlands WD	140	***90,000***	N/A	90,000	8413.5	0.0015	8.1	132.4	90.5	132.4	90.5	41.9	0.73	5613	770829	863
Westlands WD	North Fork Kings	141	***90,000***	N/A	90,000	14877.4	0.0009	4.7	121.1	178.8	121.1	178.8	57.8	1.01	12587	999425	1119
Westlands WD	North Fork Kings	142	***90,000***	N/A	90,000	7984.0	0.0013	6.8	141.4	178.9	141.4	178.9	37.6	0.66	4868	560688	628
North Fork Kings	Westlands WD	143	***90,000***	N/A	90,000	10906.7	0.0024	12.7	130.8	104.2	130.8	104.2	26.6	0.46	4883	1053390	1180
Westlands WD	North Fork Kings	144	***90,000***	N/A	90,000	5362.7	0.0013	6.8	121.5	181.6	121.5	1.6	60.1	1.05	4650	536634	601
Westlands WD	North Fork Kings	145	***90,000***	N/A	90,000	5361.1	0.0015	8.1	115.8	269.2	115.8	89.2	26.6	0.46	2400	330249	370
Westlands WD	North Fork Kings	146	***90,000***	N/A	90,000	5063.3	0.0014	7.3	103.2	180.8	103.2	0.8	77.7	1.36	4947	612043	686
Westlands WD	North Fork Kings	147	***60,000***	N/A	60,000	10639.8	0.0011	5.7	15.4	90.8	15.4	90.8	75.4	1.32	10298	672194	753
North Fork Kings	Westlands WD	148	***60,000***	N/A	60,000	10581.3	0.0029	15.1	259.7	90.8	79.7	90.8	11.1	0.19	2041	349985	392
North Fork Kings	Westlands WD	149	***60,000***	N/A	60,000	14856.4	0.0022	11.6	181.2	135.4	1.2	135.4	45.8	0.80	10650	1409572	1579
North Fork Kings	Westlands WD	150	***60,000***	N/A	60,000	15047.2	0.0023	12.0	241.7	135.4	61.7	135.4	73.7	1.29	14445	1966461	2203
Westlands WD	North Fork Kings	151	***60,000***	N/A	60,000	8452.6	0.0024	12.9	253.7	72.0	73.7	72.0	1.6	0.03	241	35184	39
North Fork Kings	Westlands WD	152	***60,000***	N/A	60,000	11535.4	0.0032	17.0	270.4	136.8	90.4	136.8	46.5	0.81	8362	1619916	1815
North Fork Kings	Westlands WD	153	***60,000***	N/A	60,000	15489.2	0.0031	16.4	250.5	180.8	70.5	0.8	69.7	1.22	14523	2708812	3034
North Fork Kings	Westlands WD	154	***60,000***	N/A	60,000	5285.2	0.0037	19.3	228.4	180.8	48.4	0.8	47.5	0.83	3899	855368	958
North Fork Kings	Westlands WD	155	***90,000***	N/A	90,000	5361.1	0.0036	19.3	231.3	90.8	51.3	90.8	39.5	0.69	3407	1118389	1253
North Fork Kings	South Fork Kings GSA	156	***90,000***	N/A	90,000	5346.1	0.0037	19.4	235.1	77.1	55.1	77.1	22.1	0.38	2008	664453	744
South Fork Kings GSA	North Fork Kings	157	***90,000***	N/A	90,000	4074.8	0.0033	17.6	233.0	0.7	53.0	0.7	52.3	0.91	3226	968634	0
South Fork Kings GSA	North Fork Kings	158	***90,000***	N/A	90,000	2477.5	0.0032	17.0	227.2	0.7	47.2	0.7	46.5	0.81	1799	522492	0
North Fork Kings	South Fork Kings GSA	159	***90,000***	20%	90,000	6526.5	0.0028	14.9	220.7	54.4	40.7	54.4	13.7	0.24	1544	393242	0
North Fork Kings	South Fork Kings GSA	160	***90,000***	19%	90,000	37726.0	0.0020	10.5	222.4	48.0	42.4	48.0	5.6	0.10	3676	657863	0
North Fork Kings	Mid Kings River GSA	161	***90,000***	18%	90,000	4940.9	0.0023	11.9	221.2	47.3	41.2	47.3	6.1	0.11	525	106441	0
Mid Kings River GSA	North Fork Kings	162	***90,000***	17%	90,000	5730.5	0.0033	17.3	233.5	47.3	53.5	47.3	6.1	0.11	614	180562	0
North Fork Kings	Mid Kings River GSA	163	***90,000***	8%	90,000	19953.9	0.0025	13.1	227.7	90.4	47.7	90.4	42.7	0.75	13534	3028150	0
Mid Kings River GSA	North Fork Kings	164	***90,000***	7%	90,000	10560.8	0.0029	15.2	306.4	46.9	126.4	46.9	79.5	1.39	10384	2697926	3022
Mid Kings River GSA	North Fork Kings	165	***90,000***	11%	90,000	6769.4	0.0035	18.5	316.6	46.9	136.6	46.9	89.7	1.57	6769	2137762	2395
Central Kings	Mid Kings River GSA	166	***90,000***	9%	90,000	8937.1	0.0028	14.6	352.0	178.6	172.0	178.6	6.5	0.11	1018	254124	285
Central Kings	Mid Kings River GSA	167	***84,000***	4%	84,000	18901.3	0.0029	15.5	142.6	69.0	142.6	69.0	73.6	1.28	18131	4465388	0
Central Kings	Mid Kings River GSA	168	***84,000***	4%	84,000	16749.2	0.0014	7.4	173.9	27.2	173.9	27.2	33.3	0.58	9205	1088710	0
Kings River East	Mid Kings River GSA	169	***84,000***	8%	84,000	1489.1	0.0005	2.7	191.1	90.0	11.1	90.0	78.9	1.38	1461	63783	71
Mid Kings River GSA	Kings River East	170	***84,000***	15%	84,000	31942.3	0.0024	12.6	156.3	180.7	156.3	0.7	24.4	0.43	13178	2644215	2962
Kings River East	Mid Kings River GSA	171	***99,000***	22%	99,000	10649.1	0.0018	9.6	181.0	91.2	1.0	91.2	89.8	1.57	10649	1925260	2157
Kings River East	Greater Kaweah GSA	172	***99,000***	19%	99,000	23363.7	0.0016	8.3	236.7	64.0	56.7	64.0	7.3	0.13	2967	461269	517
Greater Kaweah GSA	Kings River East	173	***99,000***	7%	99,000	5805.0	0.0027	14.4	261.4	64.0	81.4	64.0	17.5	0.30	1741	471350	528
Kings River East	Greater Kaweah GSA	174	***50,000***	-2%	50,000	15892.6	0.0015	7.7	246.7	93.8	66.7	93.8	27.1	0.47	7237	530536	594
Kings River East	Greater Kaweah GSA	175	***40,000***	-2%	40,000	1714.0	0.0010	5.3	203.0	182.5	23.0	2.5	20.5	0.36	601	24223	27
Kings River East	Greater Kaweah GSA	176	***40,000***	N/A	40,000	10626.4	0.0018	9.3	201.9	90.5	21.9	90.5	68.6	1.20	9894	697061	781
Kings River East	Greater Kaweah GSA	177	***40,000***	N/A	40,000	13273.9	0.0019	9.9	158.1	90.5	158.1	90.5	67.6	1.18	12269	916780	1027
Kings River East	East Kaweah GSA	178	***20,000***	N/A	20,000	15785.5	0.0029	15.6	164.4	0.8	164.4	0.8	16.4	0.29	4451	262613	294
Kings River East	East Kaweah GSA	179	***20,000***	N/A	20,000	16008.0	0.0033	17.2	198.6	90.5	18.6	90.5	72.0	1.26	15221	990721	1110
East Kaweah GSA	Kings River East	180	***20,000***	N/A	20,000	4996.5	0.0031	16.2	213.0	359.0	33.0	179.0	34.0	0.59	2797	171716	192

Attachment 3 - 2002 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^{o})	Flow Direction converted to between 0 & 180^{o}	Segement Azimuth converted to between 0 & 180^{o}	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
East Kaweah GSA	Kings River East	181	***20,000***	N/A	20,000	3194.6	0.0030	15.8	208.0	359.0	28.0	179.0	29.0	0.51	1551	93038	104
East Kaweah GSA	Kings River East	182	***20,000***	N/A	20,000	5861.0	0.0028	14.9	210.1	295.6	30.1	115.6	85.5	1.49	5843	330452	370

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2003 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (L) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	Madera County	100	30,000	N/A	30,000	8310.4	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	101	30,000	N/A	30,000	4325.1	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
Madera County	North Kings	102	30,000	N/A	30,000	7349.7	N/A	N/A	N/A	166.5	N/A	166.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	103	30,000	N/A	30,000	12097.8	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
North Kings	Madera County	104	***30,000***	N/A	30,000	20674.9	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
North Kings	Madera County	105	***93,000***	25%	93,000	12121.9	0.0013	6.7	2.7	214.3	2.7	34.3	31.7	0.55	6363	746616	0
North Kings	Madera County	106	***211,000***	28%	211,000	5396.1	0.0010	5.2	82.4	278.3	82.4	98.3	15.9	0.28	1476	307167	0
North Kings	Root Creek WD	107	***211,000***	13%	211,000	14767.3	0.0010	5.4	28.6	278.3	28.6	98.3	69.7	1.22	13852	2995412	0
North Kings	Madera County	108	***237,000***	5%	237,000	18127.3	0.0010	5.2	345.7	247.8	165.7	67.8	82.1	1.43	17957	4210285	0
Madera ID	North Kings	109	***237,000***	3%	237,000	8977.7	0.0019	9.9	341.3	270.9	161.3	90.9	70.4	1.23	8456	3762754	0
North Kings	Madera ID	110	***237,000***	0%	237,000	19839.8	0.0023	12.0	331.4	248.0	151.4	68.0	83.5	1.46	19711	10611030	0
North Kings	Madera ID	111	***184,000***	-1%	184,000	6346.9	0.0021	11.3	294.0	282.4	114.0	102.4	11.6	0.20	1273	501087	0
Madera ID	North Kings	112	***184,000***	N/A	184,000	7833.8	0.0016	8.5	339.3	282.4	159.3	102.4	56.8	0.99	6557	1932971	0
North Kings	Madera ID	113	***184,000***	N/A	184,000	25138.2	0.0027	14.4	334.5	253.7	154.5	73.7	80.8	1.41	24816	12416648	0
McMullin	Aliso WD	114	***180,000***	N/A	180,000	11667.2	0.0047	24.7	245.5	213.3	65.5	33.3	32.2	0.56	6224	5234054	0
Aliso WD	McMullin	115	***180,000***	N/A	180,000	6284.1	0.0044	23.3	231.8	323.7	51.8	143.7	88.2	1.54	6281	4986868	0
McMullin	Aliso WD	116	***180,000***	N/A	180,000	9065.2	0.0026	13.9	261.7	250.8	81.7	70.8	10.9	0.19	1715	811104	0
McMullin	Aliso WD	117	***180,000***	N/A	180,000	4645.4	0.0015	8.1	294.6	173.6	114.6	173.6	59.0	1.03	3981	1102357	0
Aliso WD	McMullin	118	***180,000***	N/A	180,000	13996.9	0.0019	10.3	346.7	273.4	166.7	93.4	73.3	1.28	13405	4685823	0
McMullin	Aliso WD	119	***180,000***	N/A	180,000	3456.2	0.0031	16.2	64.5	273.4	64.5	93.4	28.9	0.50	1670	924110	0
Farmers WD	McMullin	120	***180,000***	N/A	180,000	3470.6	0.0009	4.8	52.0	215.4	52.0	35.4	16.6	0.29	991	160886	0
Farmers WD	McMullin	121	***175,000***	N/A	175,000	5165.0	0.0008	4.0	2.6	181.0	2.6	1.0	1.6	0.03	149	19898	22
McMullin	Fresno County	122	***175,000***	N/A	175,000	8089.5	0.0010	5.3	329.7	181.0	149.7	1.0	31.3	0.55	4200	735231	824
McMullin	Fresno County	123	***175,000***	N/A	175,000	5472.0	0.0003	1.8	250.3	101.0	70.3	101.0	30.7	0.54	2797	163891	184
McMullin	Fresno County	124	***175,000***	5%	175,000	8939.7	0.0017	9.0	137.3	101.0	137.3	101.0	36.3	0.63	5293	1581821	1772
McMullin	Fresno County	125	***175,000***	8%	175,000	7147.8	0.0067	35.4	126.8	90.6	126.8	90.6	36.2	0.63	4221	4957959	5554
Fresno County	McMullin	126	***175,000***	9%	175,000	12139.4	0.0043	22.5	96.0	181.4	96.0	1.4	85.4	1.49	12101	9033848	10119
Fresno County	James ID	127	***175,000***	6%	175,000	10727.6	0.0026	13.8	102.8	268.0	102.8	88.0	14.8	0.26	2734	1253485	1404
Fresno County	James ID	128	***171,000***	4%	171,000	3722.6	0.0026	13.9	113.1	180.0	113.1	180.0	66.9	1.17	3423	1544468	1730
Central Delta Mendota Regional Mulit Agency GSA	James ID	129	***171,000***	4%	171,000	7865.6	0.0022	11.7	102.3	130.8	102.3	130.8	28.4	0.50	3745	1419164	1590
Central Delta Mendota Regional Mulit Agency GSA	James ID	130	***171,000***	5%	171,000	16667.1	0.0022	11.5	70.6	165.8	70.6	165.8	84.8	1.48	16598	6203103	6948
Central Delta Mendota Regional Mulit Agency GSA	James ID	131	***171,000***	8%	171,000	5212.2	0.0015	7.9	74.8	180.8	74.8	0.8	74.0	1.29	5011	1289102	1444
Central Delta Mendota Regional Mulit Agency GSA	James ID	132	***171,000***	N/A	171,000	8711.3	0.0008	4.1	140.4	270.5	140.4	90.5	49.9	0.87	6662	887949	995
Central Delta Mendota Regional Mulit Agency GSA	James ID	133	***171,000***	N/A	171,000	5559.6	0.0013	6.6	187.9	200.4	7.9	20.4	12.5	0.22	1206	258228	289
James ID	Central Delta Mendota Regional Mulit Agency GSA	134	***171,000***	N/A	171,000	5435.6	0.0013	7.1	189.5	180.8	9.5	0.8	8.7	0.15	824	189568	212
James ID	Westlands WD	135	***87,000***	N/A	87,000	6701.1	0.0017	9.2	176.6	90.6	176.6	90.6	85.9	1.50	6684	1012083	1134
James ID	Westlands WD	136	***87,000***	N/A	87,000	10529.2	0.0023	12.4	162.3	118.7	162.3	118.7	43.5	0.76	7253	1479265	1657
North Fork Kings	Westlands WD	137	***87,000***	N/A	87,000	23573.7	0.0017	9.2	162.0	153.4	162.0	153.4	8.7	0.15	3561	542097	607
North Fork Kings	Westlands WD	138	***90,000***	N/A	90,000	5362.7	0.0009	4.9	139.2	91.6	139.2	91.6	47.6	0.83	3963	330693	370
North Fork Kings	Westlands WD	139	***90,000***	N/A	90,000	9680.0	0.0010	5.3	136.2	0.9	136.2	0.9	44.7	0.78	6811	618645	693
North Fork Kings	Westlands WD	140	***90,000***	N/A	90,000	8413.5	0.0013	7.0	139.4	90.5	139.4	90.5	48.9	0.85	6338	751699	842
Westlands WD	North Fork Kings	141	***90,000***	N/A	90,000	14877.4	0.0011	5.8	100.9	178.8	100.9	178.8	78.0	1.36	14551	1435748	1608
Westlands WD	North Fork Kings	142	***90,000***	N/A	90,000	7984.0	0.0007	3.8	81.6	178.9	81.6	178.9	82.6	1.44	7918	516206	578
Westlands WD	North Fork Kings	143	***90,000***	N/A	90,000	10906.7	0.0019	10.0	80.8	104.2	80.8	104.2	23.5	0.41	4345	742300	831
Westlands WD	North Fork Kings	144	***90,000***	N/A	90,000	5362.7	0.0017	9.0	15.6	181.6	15.6	1.6	14.0	0.24	1298	198812	223
North Fork Kings	Westlands WD	145	***90,000***	N/A	90,000	5361.1	0.0013	7.0	33.1	269.2	33.1	89.2	56.1	0.98	4450	529774	593
Westlands WD	North Fork Kings	146	***90,000***	N/A	90,000	5063.3	0.0011	5.9	49.1	180.8	49.1	0.8	48.2	0.84	3776	380887	427
Westlands WD	North Fork Kings	147	***60,000***	N/A	60,000	10639.8	0.0009	4.7	8.4	90.8	8.4	90.8	82.4	1.44	10546	568634	637
Westlands WD	North Fork Kings	148	***60,000***	N/A	60,000	10581.3	0.0013	6.7	355.5	90.8	175.5	90.8	84.7	1.48	10536	807715	905
Westlands WD	North Fork Kings	149	***60,000***	N/A	60,000	14856.4	0.0019	10.1	34.7	135.4	34.7	135.4	79.3	1.38	14597	1673056	1874
North Fork Kings	Westlands WD	150	***60,000***	N/A	60,000	15047.2	0.0017	8.8	230.4	135.4	50.4	135.4	85.0	1.48	14990	1506344	1687
North Fork Kings	Westlands WD	151	***60,000***	N/A	60,000	8452.6	0.0022	11.7	221.5	72.0	41.5	72.0	30.5	0.53	4293	569944	638
North Fork Kings	Westlands WD	152	***60,000***	N/A	60,000	11535.4	0.0026	13.5	245.9	136.8	65.9	136.8	70.9	1.24	10901	1669321	1870
North Fork Kings	Westlands WD	153	***60,000***	N/A	60,000	15489.2	0.0032	16.7	236.8	180.8	56.8	0.8	55.9	0.98	12831	2433774	2726
North Fork Kings	Westlands WD	154	***60,000***	N/A	60,000	5285.2	0.0020	10.6	241.2	180.8	61.2	0.8	60.4	1.05	4594	553348	620
North Fork Kings	Westlands WD	155	***90,000***	N/A	90,000	5361.1	0.0021	10.8	243.5	90.8	63.5	90.8	27.3	0.48	2459	454487	509
North Fork Kings	South Fork Kings GSA	156	***90,000***	N/A	90,000	5346.1	0.0025	13.0	234.1	77.1	54.1	77.1	23.1	0.40	2094	462625	518
South Fork Kings GSA	North Fork Kings	157	***90,000***	N/A	90,000	4074.8	0.0028	14.9	228.0	0.7	48.0	0.7	47.3	0.83	2997	763616	0
South Fork Kings GSA	North Fork Kings	158	***90,000***	N/A	90,000	2477.5	0.0032	16.9	226.8	0.7	46.8	0.7	46.1	0.80	1785	512951	0
North Fork Kings	South Fork Kings GSA	159	***90,000***	20%	90,000	6526.5	0.0034	18.1	224.4	54.4	44.4	54.4	10.0	0.17	1132	349464	0
North Fork Kings	South Fork Kings GSA	160	***90,000***	19%	90,000	37726.0	0.0023	12.3	217.3	48.0	37.3	48.0	10.7	0.19	7016	1467991	0
Mid Kings River GSA	North Fork Kings	161	***90,000***	18%	90,000	4940.9	0.0035	18.2	238.2	47.3	58.2	47.3	10.8	0.19	926	287719	0
Mid Kings River GSA	North Fork Kings	162	***90,000***	17%	90,000	5730.5	0.0032	16.7	247.6	47.3	67.6	47.3	20.2	0.35	1980	563425	0
North Fork Kings	Mid Kings River GSA	163	***90,000***	8%	90,000	19953.9	0.0030	15.9	216.8	90.4	36.8	90.4	53.6	0.94	16066	4359774	0
North Fork Kings	Mid Kings River GSA	164	***90,000***	7%	90,000	10560.8	0.0013	6.8	189.3	46.9	9.3	46.9	37.6	0.66	6441	745994	836
North Fork Kings	Mid Kings River GSA	165	***90,000***	11%	90,000	6769.4	0.0012	6.5	86.1	46.9	86.1	46.9	39.2	0.68	4282	475264	532
Mid Kings River GSA	Central Kings	166	***90,000***	9%	90,000	8937.1	0.0032	16.9	106.3	178.6	106.3	178.6	72.3	1.26	8514	2452334	2747
Central Kings	Mid Kings River GSA	167	***84,000***	4%	84,000	18901.3	0.0035	18.5	173.1	69.0	173.1	69.0	75.9	1.32	18328	5385062	0
Central Kings	Mid Kings River GSA	168	***84,000***	4%	84,000	16749.2	0.0029	15.1	163.6	27.2	163.6	27.2	43.7	0.76	11567	2773629	0
Kings River East	Mid Kings River GSA	169	***84,000***	8%	84,000	1489.1	0.0025	13.1	164.6	90.0	164.6	90.0	74.6	1.30	1435	298664	335
Mid Kings River GSA	Kings River East	170	***84,000***	15%	84,000	31942.3	0.0029	15.3	149.1	180.7	149.1	0.7	31.6	0.55	16726	4072123	4561
Kings River East	Mid Kings River GSA	171	***99,000***	22%	99,000	10649.1	0.0021	11.3	164.2	91.2	164.2	91.2	73.0	1.27	10184	2158388	2418
Kings River East	Greater Kaweah GSA	172	***99,000***	19%	99,000	23363.7	0.0023	12.1	207.8	64.0	27.8	64.0	36.2	0.63	13798	3140639	3518
Greater Kaweah GSA	Kings River East	173	***99,000***	7%	99,000	5805.0	0.0032	16.9	244.7	64.0	64.7	64.0	0.8	0.01	79	25082	28
Kings River East	Greater Kaweah GSA	174	***50,000***	-2%	50,000	15892.6	0.0012	6.2	271.1	93.8	91.1	93.8	2.6	0.05	735	43300	49
Kings River East	Greater Kaweah GSA	175	***40,000***	-2%	40,000	1714.0	0.0013	6.6	224.2	182.5	44.2	2.5	41.7	0.73	1140	57398	64
Kings River East	Greater Kaweah GSA	176	***40,000***	N/A	40,000	10626.4	0.0019	10.2	162.7	90.5	162.7	90.5	72.2	1.26	10116	778267	872
Kings River East	Greater Kaweah GSA	177	***40,000***	N/A	40,000	13273.9	0.0017	9.1	103.4	90.5	103.4	90.5	12.9	0.22	2954	203823	228
East Kaweah GSA	Kings River East	178	***20,000***	N/A	20,000	15785.5	0.0031	16.5	226.8	0.8	46.8	0.8	46.0	0.80	11349	708576	794
Kings River East	East Kaweah GSA	179	***20,000***	N/A	20,000	16008.0	0.0059	31.1	200.0	90.5	20.0	90.5	70.5	1.23	15093	1775388	1989
East Kaweah GSA	Kings River East	180	***20,000***	N/A	20,000	4996.5	0.0054	28.4	222.5	359.0	42.5	179.0	43.5	0.76	3442	370789	415

Attachment 3 - 2003 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^{o})	Flow Direction converted to between 0 & 180^{o}	Segement Azimuth converted to between 0 & 180^{o}	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
East Kaweah GSA	Kings River East	181	***20,000***	N/A	20,000	3194.6	0.0042	22.4	225.2	359.0	45.2	179.0	46.2	0.81	2306	195613	219
East Kaweah GSA	Kings River East	182	***20,000***	N/A	20,000	5861.0	0.0043	22.5	226.8	295.6	46.8	115.6	68.8	1.20	5464	465707	522

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2004 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	Madera County	100	30,000	N/A	30,000	8310.4	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	101	30,000	N/A	30,000	4325.1	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
Madera County	North Kings	102	30,000	N/A	30,000	7349.7	N/A	N/A	N/A	166.5	N/A	166.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	103	30,000	N/A	30,000	12097.8	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
North Kings	Madera County	104	***30,000***	N/A	30,000	20674.9	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
Madera County	North Kings	105	***93,000***	25%	93,000	12121.9	0.0009	4.6	175.9	214.3	175.9	34.3	38.4	0.67	7533	604938	0
Madera County	North Kings	106	***211,000***	28%	211,000	5396.1	0.0015	7.8	193.7	278.3	13.7	98.3	84.5	1.48	5372	1681651	0
North Kings	Root Creek WD	107	***211,000***	13%	211,000	14767.3	0.0009	4.5	84.0	278.3	84.0	98.3	14.2	0.25	3631	659310	0
North Kings	Madera County	108	***237,000***	5%	237,000	18127.3	0.0013	6.9	341.6	247.8	161.6	67.8	86.2	1.50	18087	5603698	0
North Kings	Madera ID	109	***237,000***	3%	237,000	8977.7	0.0021	11.2	335.1	270.9	155.1	90.9	64.2	1.12	8082	4051789	0
North Kings	Madera ID	110	***237,000***	0%	237,000	19839.8	0.0030	16.1	336.5	248.0	156.5	68.0	88.5	1.55	19833	14312791	0
North Kings	Madera ID	111	***184,000***	-1%	184,000	6346.9	0.0019	10.2	328.7	282.4	148.7	102.4	46.2	0.81	4583	1624665	0
North Kings	Madera ID	112	***184,000***	N/A	184,000	7833.8	0.0028	14.9	317.7	282.4	137.7	102.4	35.3	0.62	4529	2356688	0
North Kings	Madera ID	113	***184,000***	N/A	184,000	25138.2	0.0023	11.9	318.1	253.7	138.1	73.7	64.5	1.12	22681	9443897	0
McMullin	Aliso WD	114	***180,000***	N/A	180,000	11667.2	0.0034	18.1	269.5	213.3	89.5	33.3	56.2	0.98	9698	5994887	0
Aliso WD	McMullin	115	***180,000***	N/A	180,000	6284.1	0.0017	8.7	276.2	323.7	96.2	143.7	47.4	0.83	4628	1379752	0
McMullin	Aliso WD	116	***180,000***	N/A	180,000	9065.2	0.0020	10.7	242.6	250.8	62.6	70.8	8.3	0.14	1301	475755	0
Aliso WD	McMullin	117	***180,000***	N/A	180,000	4645.4	0.0026	14.0	166.2	173.6	166.2	173.6	7.4	0.13	596	284085	0
Aliso WD	McMullin	118	***180,000***	N/A	180,000	13996.9	0.0014	7.6	123.2	273.4	123.2	93.4	29.8	0.52	6955	1797120	0
McMullin	Aliso WD	119	***180,000***	N/A	180,000	3456.2	0.0028	14.9	63.8	273.4	63.8	93.4	29.6	0.52	1708	867060	0
Farmers WD	McMullin	120	***180,000***	N/A	180,000	3470.6	0.0025	12.9	70.8	215.4	70.8	35.4	35.4	0.62	2012	887629	0
Farmers WD	McMullin	121	***175,000***	N/A	175,000	5165.0	0.0018	9.6	114.9	181.0	114.9	1.0	66.0	1.15	4720	1499872	1680
Fresno County	McMullin	122	***175,000***	N/A	175,000	8089.5	0.0024	12.9	151.6	181.0	151.6	1.0	29.4	0.51	3973	1697007	1901
McMullin	Fresno County	123	***175,000***	N/A	175,000	5472.0	0.0027	14.0	139.8	101.0	139.8	101.0	38.8	0.68	3429	1595768	1787
McMullin	Fresno County	124	***175,000***	5%	175,000	8939.7	0.0021	11.1	146.7	101.0	146.7	101.0	45.6	0.80	6392	2347039	2629
McMullin	Fresno County	125	***175,000***	8%	175,000	7147.8	0.0028	15.0	161.3	90.6	161.3	90.6	70.7	1.23	6744	3342227	3744
Fresno County	McMullin	126	***175,000***	9%	175,000	12139.4	0.0029	15.2	137.0	181.4	137.0	1.4	44.4	0.77	8494	4289764	4805
Fresno County	James ID	127	***175,000***	6%	175,000	10727.6	0.0028	14.9	95.4	268.0	95.4	88.0	7.4	0.13	1383	681384	763
Fresno County	James ID	128	***171,000***	4%	171,000	3722.6	0.0018	9.6	80.3	180.0	80.3	180.0	80.3	1.40	3669	1141422	1279
Central Delta Mendota Regional Mulit Agency GSA	James ID	129	***171,000***	4%	171,000	7865.6	0.0027	14.4	50.6	130.8	50.6	130.8	80.2	1.40	7750	3626284	4062
Central Delta Mendota Regional Mulit Agency GSA	James ID	130	***171,000***	5%	171,000	16667.1	0.0026	13.8	33.1	165.8	33.1	165.8	47.3	0.83	12257	5497153	6158
Central Delta Mendota Regional Mulit Agency GSA	James ID	131	***171,000***	8%	171,000	5212.2	0.0013	7.0	74.2	180.8	74.2	0.8	73.4	1.28	4996	1128300	1264
Central Delta Mendota Regional Mulit Agency GSA	James ID	132	***171,000***	N/A	171,000	8711.3	0.0006	3.2	112.0	270.5	112.0	90.5	21.5	0.38	3194	333482	374
Central Delta Mendota Regional Mulit Agency GSA	James ID	133	***171,000***	N/A	171,000	5559.6	0.0005	2.9	158.0	200.4	158.0	20.4	42.4	0.74	3747	350335	392
Central Delta Mendota Regional Mulit Agency GSA	James ID	134	***171,000***	N/A	171,000	5435.6	0.0012	6.5	165.5	180.8	165.5	0.8	15.3	0.27	1433	299678	336
James ID	Westlands WD	135	***87,000***	N/A	87,000	6701.1	0.0016	8.2	153.1	90.6	153.1	90.6	62.4	1.09	5939	802866	899
James ID	Westlands WD	136	***87,000***	N/A	87,000	10529.2	0.0019	9.9	135.3	118.7	135.3	118.7	16.6	0.29	3008	488934	548
Westlands WD	North Fork Kings	137	***87,000***	N/A	87,000	23573.7	0.0014	7.3	119.7	153.4	119.7	153.4	33.6	0.59	13051	1579793	1770
North Fork Kings	Westlands WD	138	***90,000***	N/A	90,000	5362.7	0.0014	7.3	97.7	91.6	97.7	91.6	6.1	0.11	569	70578	79
North Fork Kings	Westlands WD	139	***90,000***	N/A	90,000	9680.0	0.0018	9.3	102.4	0.9	102.4	0.9	78.5	1.37	9484	1502031	1682
North Fork Kings	Westlands WD	140	***90,000***	N/A	90,000	8413.5	0.0021	11.0	106.2	90.5	106.2	90.5	15.7	0.27	2272	427242	479
Westlands WD	North Fork Kings	141	***90,000***	N/A	90,000	14877.4	0.0016	8.4	83.8	178.8	83.8	178.8	84.9	1.48	14819	2134031	2390
Westlands WD	North Fork Kings	142	***90,000***	N/A	90,000	7984.0	0.0015	8.1	51.9	178.9	51.9	178.9	52.9	0.92	6371	874461	980
Westlands WD	North Fork Kings	143	***90,000***	N/A	90,000	10906.7	0.0021	11.1	31.1	104.2	31.1	104.2	73.2	1.28	10439	1972631	2210
North Fork Kings	Westlands WD	144	***90,000***	N/A	90,000	5362.7	0.0031	16.3	356.4	181.6	176.4	1.6	5.2	0.09	483	134164	150
North Fork Kings	Westlands WD	145	***90,000***	N/A	90,000	5361.1	0.0022	11.8	355.6	269.2	175.6	89.2	86.4	1.51	5350	1079292	1209
North Fork Kings	Westlands WD	146	***90,000***	N/A	90,000	5063.3	0.0013	6.9	346.9	180.8	166.9	0.8	13.9	0.24	1218	144145	161
Westlands WD	North Fork Kings	147	***60,000***	N/A	60,000	10639.8	0.0009	4.6	314.7	90.8	134.7	90.8	43.9	0.77	7372	385266	432
North Fork Kings	Westlands WD	148	***60,000***	N/A	60,000	10581.3	0.0012	6.3	141.7	90.8	141.7	90.8	50.9	0.89	8214	589272	660
North Fork Kings	Westlands WD	149	***60,000***	N/A	60,000	14856.4	0.0014	7.6	172.0	135.4	172.0	135.4	36.6	0.64	8860	765241	857
North Fork Kings	Westlands WD	150	***60,000***	N/A	60,000	15047.2	0.0006	3.1	230.3	135.4	50.3	135.4	85.1	1.49	14992	530675	594
Westlands WD	North Fork Kings	151	***60,000***	N/A	60,000	8452.6	0.0006	3.2	258.1	72.0	78.1	72.0	6.0	0.11	889	31965	36
North Fork Kings	Westlands WD	152	***60,000***	N/A	60,000	11535.4	0.0019	9.9	280.1	136.8	100.1	136.8	36.7	0.64	6891	773162	866
North Fork Kings	Westlands WD	153	***60,000***	N/A	60,000	15489.2	0.0024	12.5	287.9	180.8	107.9	0.8	72.9	1.27	14805	2111337	2365
North Fork Kings	Westlands WD	154	***60,000***	N/A	60,000	5285.2	N/A	N/A	N/A	180.8	N/A	0.8	N/A	N/A	N/A	N/A	N/A
Westlands WD	North Fork Kings	155	***90,000***	N/A	90,000	5361.1	N/A	N/A	N/A	90.8	N/A	90.8	N/A	N/A	N/A	N/A	N/A
South Fork Kings GSA	North Fork Kings	156	***90,000***	N/A	90,000	5346.1	N/A	N/A	N/A	77.1	N/A	77.1	N/A	N/A	N/A	N/A	N/A
South Fork Kings GSA	North Fork Kings	157	***90,000***	N/A	90,000	4074.8	N/A	N/A	N/A	0.7	N/A	0.7	N/A	N/A	N/A	N/A	0
South Fork Kings GSA	North Fork Kings	158	***90,000***	N/A	90,000	2477.5	0.0023	12.0	271.2	0.7	91.2	0.7	89.5	1.56	2477	504846	0
South Fork Kings GSA	North Fork Kings	159	***90,000***	20%	90,000	6526.5	0.0024	12.7	274.5	54.4	94.5	54.4	40.1	0.70	4203	907692	0
South Fork Kings GSA	North Fork Kings	160	***90,000***	19%	90,000	37726.0	0.0024	12.8	254.4	48.0	74.4	48.0	26.4	0.46	16771	3670499	0
Mid Kings River GSA	North Fork Kings	161	***90,000***	18%	90,000	4940.9	0.0029	15.2	226.4	47.3	46.4	47.3	0.9	0.02	81	21095	0
Mid Kings River GSA	North Fork Kings	162	***90,000***	17%	90,000	5730.5	0.0033	17.5	247.5	47.3	67.5	47.3	20.1	0.35	1971	589335	0
North Fork Kings	Mid Kings River GSA	163	***90,000***	8%	90,000	19953.9	0.0022	11.4	214.2	90.4	34.2	90.4	56.2	0.98	16579	3217269	0
North Fork Kings	Mid Kings River GSA	164	***90,000***	7%	90,000	10560.8	0.0011	5.6	184.1	46.9	4.1	46.9	42.8	0.75	7176	682525	765
North Fork Kings	Mid Kings River GSA	165	***90,000***	11%	90,000	6769.4	0.0011	5.6	145.6	46.9	145.6	46.9	81.3	1.42	6692	637644	714
Mid Kings River GSA	Central Kings	166	***90,000***	9%	90,000	8937.1	0.0019	10.2	153.0	178.6	153.0	178.6	25.5	0.45	3852	667381	748
Central Kings	Mid Kings River GSA	167	***84,000***	4%	84,000	18901.3	0.0025	13.4	173.7	69.0	173.7	69.0	75.3	1.31	18284	3894471	0
Central Kings	Mid Kings River GSA	168	***84,000***	4%	84,000	16749.2	0.0031	16.3	179.0	27.2	179.0	27.2	28.2	0.49	7922	2053564	0
Kings River East	Mid Kings River GSA	169	***84,000***	8%	84,000	1489.1	0.0020	10.7	169.1	90.0	169.1	90.0	79.1	1.38	1462	249180	279
Mid Kings River GSA	Kings River East	170	***84,000***	15%	84,000	31942.3	0.0025	13.1	146.4	180.7	146.4	0.7	34.3	0.60	18003	3737734	4187

Attachment 3 - 2004 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
Kings River East	Mid Kings River GSA	171	***99,000***	22%	99,000	10649.1	0.0015	7.9	167.3	91.2	167.3	91.2	76.1	1.33	10336	1537885	1723
Kings River East	Greater Kaweah GSA	172	***99,000***	19%	99,000	23363.7	0.0022	11.6	223.9	64.0	43.9	64.0	20.0	0.35	8004	1735978	1945
Greater Kaweah GSA	Kings River East	173	***99,000***	7%	99,000	5805.0	0.0025	13.2	263.7	64.0	83.7	64.0	19.7	0.34	1956	485197	543
Kings River East	Greater Kaweah GSA	174	***50,000***	-2%	50,000	15892.6	0.0013	7.0	272.9	93.8	92.9	93.8	0.9	0.02	242	16078	18
Kings River East	Greater Kaweah GSA	175	***40,000***	-2%	40,000	1714.0	0.0006	3.4	280.8	182.5	100.8	2.5	81.7	1.43	1696	43523	49
Greater Kaweah GSA	Kings River East	176	***40,000***	N/A	40,000	10626.4	0.0008	4.3	301.7	90.5	121.7	90.5	31.2	0.54	5502	178823	200
Greater Kaweah GSA	Kings River East	177	***40,000***	N/A	40,000	13273.9	0.0014	7.2	287.1	90.5	107.1	90.5	16.5	0.29	3775	205036	230
East Kaweah GSA	Kings River East	178	***20,000***	N/A	20,000	15785.5	0.0021	10.9	239.9	0.8	59.9	0.8	59.1	1.03	13549	558984	626
Kings River East	East Kaweah GSA	179	***20,000***	N/A	20,000	16008.0	0.0020	10.4	233.6	90.5	53.6	90.5	36.9	0.64	9617	380648	426
Kings River East	East Kaweah GSA	180	***20,000***	N/A	20,000	4996.5	N/A	N/A	N/A	359.0	N/A	179.0	N/A	N/A	N/A	N/A	N/A
Kings River East	East Kaweah GSA	181	***20,000***	N/A	20,000	3194.6	N/A	N/A	N/A	359.0	N/A	179.0	N/A	N/A	N/A	N/A	N/A
East Kaweah GSA	Kings River East	182	***20,000***	N/A	20,000	5861.0	0.0028	14.8	218.5	295.6	38.5	115.6	77.1	1.35	5713	320801	359

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2005 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (L) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	Madera County	100	30,000	N/A	30,000	8310.4	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	101	30,000	N/A	30,000	4325.1	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
Madera County	North Kings	102	30,000	N/A	30,000	7349.7	N/A	N/A	N/A	166.5	N/A	166.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	103	30,000	N/A	30,000	12097.8	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
Madera County	North Kings	104	***30,000***	N/A	30,000	20674.9	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
Madera County	North Kings	105	***93,000***	25%	93,000	12121.9	0.0013	6.7	180.3	214.3	0.3	34.3	34.0	0.59	6783	801564	0
Madera County	North Kings	106	***211,000***	28%	211,000	5396.1	0.0014	7.3	190.2	278.3	10.2	98.3	88.0	1.54	5393	1567942	0
Root Creek WD	North Kings	107	***211,000***	13%	211,000	14767.3	0.0009	5.0	106.3	278.3	106.3	98.3	8.0	0.14	2062	411142	0
North Kings	Madera County	108	***237,000***	5%	237,000	18127.3	0.0020	10.5	334.7	247.8	154.7	67.8	86.9	1.52	18101	8555274	0
North Kings	Madera ID	109	***237,000***	3%	237,000	8977.7	0.0033	17.6	10.6	270.9	10.6	90.9	80.3	1.40	8849	6999329	0
North Kings	Madera ID	110	***237,000***	0%	237,000	19839.8	0.0029	15.2	333.1	248.0	153.1	68.0	85.2	1.49	19769	13469603	0
North Kings	Madera ID	111	***184,000***	-1%	184,000	6346.9	0.0016	8.2	347.4	282.4	167.4	102.4	64.9	1.13	5749	1652821	0
North Kings	Madera ID	112	***184,000***	N/A	184,000	7833.8	0.0031	16.1	321.6	282.4	141.6	102.4	39.2	0.68	4952	2782741	0
North Kings	Madera ID	113	***184,000***	N/A	184,000	25138.2	0.0035	18.2	323.9	253.7	143.9	73.7	70.2	1.23	23656	15023509	0
McMullin	Aliso WD	114	***180,000***	N/A	180,000	11667.2	0.0044	23.3	253.7	213.3	73.7	33.3	40.4	0.71	7563	6017372	0
Aliso WD	McMullin	115	***180,000***	N/A	180,000	6284.1	0.0015	8.0	268.3	323.7	88.3	143.7	55.4	0.97	5171	1408671	0
McMullin	Aliso WD	116	***180,000***	N/A	180,000	9065.2	0.0028	15.0	319.4	250.8	139.4	70.8	68.6	1.20	8439	4308675	0
McMullin	Aliso WD	117	***180,000***	N/A	180,000	4645.4	0.0023	12.3	296.9	173.6	116.9	173.6	56.7	0.99	3881	1629949	0
Aliso WD	McMullin	118	***180,000***	N/A	180,000	13996.9	0.0019	10.2	343.2	273.4	163.2	93.4	69.7	1.22	13131	4551217	0
McMullin	Aliso WD	119	***180,000***	N/A	180,000	3456.2	0.0036	18.8	79.6	273.4	79.6	93.4	13.9	0.24	828	531927	0
Farmers WD	McMullin	120	***180,000***	N/A	180,000	3470.6	0.0044	23.0	99.7	215.4	99.7	35.4	64.3	1.12	3127	2449670	0
Farmers WD	McMullin	121	***175,000***	N/A	175,000	5165.0	0.0029	15.2	136.7	181.0	136.7	1.0	44.2	0.77	3603	1815731	2034
Fresno County	McMullin	122	***175,000***	N/A	175,000	8089.5	0.0018	9.6	66.9	181.0	66.9	1.0	65.9	1.15	7386	2340252	2621
Fresno County	McMullin	123	***175,000***	N/A	175,000	5472.0	0.0033	17.6	23.5	101.0	23.5	101.0	77.5	1.35	5343	3108274	3482
Fresno County	McMullin	124	***175,000***	5%	175,000	8939.7	0.0050	26.5	15.2	101.0	15.2	101.0	85.9	1.50	8916	7830777	8772
Fresno County	McMullin	125	***175,000***	8%	175,000	7147.8	0.0054	28.7	22.4	90.6	22.4	90.6	68.2	1.19	6636	6302363	7060
Fresno County	McMullin	126	***175,000***	9%	175,000	12139.4	0.0047	24.6	62.9	181.4	62.9	1.4	61.5	1.07	10669	8709605	9756
James ID	Fresno County	127	***175,000***	6%	175,000	10727.6	0.0038	20.3	76.9	268.0	76.9	88.0	11.1	0.19	2069	1392766	1560
Fresno County	James ID	128	***171,000***	4%	171,000	3722.6	0.0027	14.3	79.2	180.0	79.2	180.0	79.2	1.38	3656	1694101	1898
Central Delta Mendota Regional Mulit Agency GSA	James ID	129	***171,000***	4%	171,000	7865.6	0.0028	15.0	99.1	130.8	99.1	130.8	31.7	0.55	4133	2011847	2254
Central Delta Mendota Regional Mulit Agency GSA	James ID	130	***171,000***	5%	171,000	16667.1	0.0019	10.2	135.0	165.8	135.0	165.8	30.8	0.54	8535	2817531	3156
Central Delta Mendota Regional Mulit Agency GSA	James ID	131	***171,000***	8%	171,000	5212.2	0.0015	8.1	165.9	180.8	165.9	0.8	15.0	0.26	1346	352754	395
Central Delta Mendota Regional Mulit Agency GSA	James ID	132	***171,000***	N/A	171,000	8711.3	N/A	N/A	N/A	270.5	N/A	90.5	N/A	N/A	N/A	N/A	N/A
Central Delta Mendota Regional Mulit Agency GSA	James ID	133	***171,000***	N/A	171,000	5559.6	N/A	N/A	N/A	200.4	N/A	20.4	N/A	N/A	N/A	N/A	N/A
Central Delta Mendota Regional Mulit Agency GSA	James ID	134	***171,000***	N/A	171,000	5435.6	N/A	N/A	N/A	180.8	N/A	0.8	N/A	N/A	N/A	N/A	N/A
James ID	Westlands WD	135	***87,000***	N/A	87,000	6701.1	N/A	N/A	N/A	90.6	N/A	90.6	N/A	N/A	N/A	N/A	N/A
James ID	Westlands WD	136	***87,000***	N/A	87,000	10529.2	N/A	N/A	N/A	118.7	N/A	118.7	N/A	N/A	N/A	N/A	N/A
Westlands WD	North Fork Kings	137	***87,000***	N/A	87,000	23573.7	0.0014	7.6	126.7	153.4	126.7	153.4	26.6	0.46	10561	1329778	1490
Westlands WD	North Fork Kings	138	***90,000***	N/A	90,000	5362.7	0.0012	6.3	86.4	91.6	86.4	91.6	5.2	0.09	487	52562	59
North Fork Kings	Westlands WD	139	***90,000***	N/A	90,000	9680.0	0.0014	7.3	105.9	0.9	105.9	0.9	75.0	1.31	9349	1156590	1296
North Fork Kings	Westlands WD	140	***90,000***	N/A	90,000	8413.5	0.0020	10.5	118.3	90.5	118.3	90.5	27.8	0.49	3925	704805	789
Westlands WD	North Fork Kings	141	***90,000***	N/A	90,000	14877.4	0.0016	8.5	84.7	178.8	84.7	178.8	85.9	1.50	14839	2143475	2401
Westlands WD	North Fork Kings	142	***90,000***	N/A	90,000	7984.0	0.0016	8.7	47.2	178.9	47.2	178.9	48.3	0.84	5958	884003	990
Westlands WD	North Fork Kings	143	***90,000***	N/A	90,000	10906.7	0.0020	10.5	37.6	104.2	37.6	104.2	66.6	1.16	10010	1789535	2005
Westlands WD	North Fork Kings	144	***90,000***	N/A	90,000	5362.7	0.0018	9.4	50.9	181.6	50.9	1.6	49.3	0.86	4063	652220	731
North Fork Kings	Westlands WD	145	***90,000***	N/A	90,000	5361.1	N/A	N/A	N/A	269.2	N/A	89.2	N/A	N/A	N/A	N/A	N/A
Westlands WD	North Fork Kings	146	***90,000***	N/A	90,000	5063.3	N/A	N/A	N/A	180.8	N/A	0.8	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	147	***60,000***	N/A	60,000	10639.8	N/A	N/A	N/A	90.8	N/A	90.8	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	148	***60,000***	N/A	60,000	10581.3	0.0013	6.6	117.8	90.8	117.8	90.8	27.0	0.47	4808	363280	407
North Fork Kings	Westlands WD	149	***60,000***	N/A	60,000	14856.4	0.0009	4.6	218.9	135.4	38.9	135.4	83.5	1.46	14761	774268	867
North Fork Kings	Westlands WD	150	***60,000***	N/A	60,000	15047.2	0.0030	15.8	289.1	135.4	109.1	135.4	26.3	0.46	6670	1194985	1339
Westlands WD	North Fork Kings	151	***60,000***	N/A	60,000	8452.6	0.0027	14.1	263.8	72.0	83.8	72.0	11.8	0.21	1722	276617	310
North Fork Kings	Westlands WD	152	***60,000***	N/A	60,000	11535.4	0.0013	7.1	238.8	136.8	58.8	136.8	78.0	1.36	11284	908101	1017
Westlands WD	North Fork Kings	153	***60,000***	N/A	60,000	15489.2	0.0017	9.2	169.4	180.8	169.4	0.8	11.4	0.20	3058	319830	358
Westlands WD	North Fork Kings	154	***60,000***	N/A	60,000	5285.2	0.0009	4.7	167.7	180.8	167.7	0.8	13.2	0.23	1203	63943	72
North Fork Kings	Westlands WD	155	***90,000***	N/A	90,000	5361.1	0.0008	4.4	208.1	90.8	28.1	90.8	62.7	1.09	4765	356433	399
South Fork Kings GSA	North Fork Kings	156	***90,000***	N/A	90,000	5346.1	0.0020	10.7	261.5	77.1	81.5	77.1	4.4	0.08	409	74866	84
South Fork Kings GSA	North Fork Kings	157	***90,000***	N/A	90,000	4074.8	0.0037	19.4	276.9	0.7	96.9	0.7	83.8	1.46	4051	1337850	0
South Fork Kings GSA	North Fork Kings	158	***90,000***	N/A	90,000	2477.5	0.0036	19.2	274.9	0.7	94.9	0.7	85.7	1.50	2471	808984	0
South Fork Kings GSA	North Fork Kings	159	***90,000***	20%	90,000	6526.5	0.0057	29.9	254.1	54.4	74.1	54.4	19.6	0.34	2194	1117810	0
South Fork Kings GSA	North Fork Kings	160	***90,000***	19%	90,000	37726.0	0.0022	11.5	254.2	48.0	74.2	48.0	26.2	0.46	16638	3263069	0
North Fork Kings	Mid Kings River GSA	161	***90,000***	18%	90,000	4940.9	0.0017	9.0	217.0	47.3	37.0	47.3	10.3	0.18	884	135120	0
Mid Kings River GSA	North Fork Kings	162	***90,000***	17%	90,000	5730.5	0.0023	12.3	239.7	47.3	59.7	47.3	12.4	0.22	1226	256306	0
North Fork Kings	Mid Kings River GSA	163	***90,000***	8%	90,000	19953.9	0.0027	14.3	218.0	90.4	38.0	90.4	52.5	0.92	15820	3862888	0
North Fork Kings	Mid Kings River GSA	164	***90,000***	7%	90,000	10560.8	0.0026	13.6	201.1	46.9	21.1	46.9	25.8	0.45	4599	1062464	1190
North Fork Kings	Mid Kings River GSA	165	***90,000***	11%	90,000	6769.4	0.0012	6.3	73.5	46.9	73.5	46.9	26.6	0.46	3027	326600	366
Mid Kings River GSA	Central Kings	166	***90,000***	9%	90,000	8937.1	0.0030	15.7	123.1	178.6	123.1	178.6	55.5	0.97	7362	1966505	2203
Central Kings	Mid Kings River GSA	167	***84,000***	4%	84,000	18901.3	0.0028	14.9	187.1	69.0	7.1	69.0	61.9	1.08	16680	3956304	0
Central Kings	Mid Kings River GSA	168	***84,000***	4%	84,000	16749.2	0.0024	12.8	198.6	27.2	18.6	27.2	8.6	0.15	2512	512907	0
Kings River East	Mid Kings River GSA	169	***84,000***	8%	84,000	1489.1	0.0018	9.7	156.0	90.0	156.0	90.0	66.0	1.15	1360	210968	236
Mid Kings River GSA	Kings River East	170	***84,000***	15%	84,000	31942.3	0.0024	12.6	159.4	180.7	159.4	0.7	21.3	0.37	11588	2316414	2595

Attachment 3 - 2005 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
Kings River East	Mid Kings River GSA	171	***99,000***	22%	99,000	10649.1	0.0021	11.3	156.8	91.2	156.8	91.2	65.6	1.15	9699	2052565	2299
Kings River East	Greater Kaweah GSA	172	***99,000***	19%	99,000	23363.7	0.0020	10.6	213.3	64.0	33.3	64.0	30.7	0.54	11920	2358404	2642
Kings River East	Greater Kaweah GSA	173	***99,000***	7%	99,000	5805.0	0.0027	14.4	231.3	64.0	51.3	64.0	12.6	0.22	1269	343094	384
Kings River East	Greater Kaweah GSA	174	***50,000***	-2%	50,000	15892.6	0.0016	8.5	212.3	93.8	32.3	93.8	61.5	1.07	13966	1127007	1262
Kings River East	Greater Kaweah GSA	175	***40,000***	-2%	40,000	1714.0	0.0023	12.2	188.5	182.5	8.5	2.5	6.0	0.10	178	16471	18
Kings River East	Greater Kaweah GSA	176	***40,000***	N/A	40,000	10626.4	0.0031	16.6	178.7	90.5	178.7	90.5	88.2	1.54	10621	1334184	1494
Kings River East	Greater Kaweah GSA	177	***40,000***	N/A	40,000	13273.9	0.0018	9.7	167.5	90.5	167.5	90.5	77.0	1.34	12934	948689	1063
East Kaweah GSA	Kings River East	178	***20,000***	N/A	20,000	15785.5	0.0030	15.7	187.8	0.8	7.8	0.8	7.0	0.12	1928	114686	128
Kings River East	East Kaweah GSA	179	***20,000***	N/A	20,000	16008.0	0.0045	23.8	210.0	90.5	30.0	90.5	60.5	1.06	13937	1255131	1406
East Kaweah GSA	Kings River East	180	***20,000***	N/A	20,000	4996.5	0.0029	15.4	212.0	359.0	32.0	179.0	33.0	0.58	2724	158609	178
East Kaweah GSA	Kings River East	181	***20,000***	N/A	20,000	3194.6	0.0023	12.4	209.8	359.0	29.8	179.0	30.9	0.54	1639	76972	86
East Kaweah GSA	Kings River East	182	***20,000***	N/A	20,000	5861.0	0.0023	12.1	216.6	295.6	36.6	115.6	79.0	1.38	5754	263473	295

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2006 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (L) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	Madera County	100	30,000	N/A	30,000	8310.4	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	101	30,000	N/A	30,000	4325.1	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
Madera County	North Kings	102	30,000	N/A	30,000	7349.7	N/A	N/A	N/A	166.5	N/A	166.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	103	30,000	N/A	30,000	12097.8	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
Madera County	North Kings	104	***30,000***	N/A	30,000	20674.9	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
Madera County	North Kings	105	***93,000***	25%	93,000	12121.9	0.0015	7.7	200.4	214.3	20.4	34.3	14.0	0.24	2923	395281	0
Madera County	North Kings	106	***211,000***	28%	211,000	5396.1	0.0016	8.3	205.6	278.3	25.6	98.3	72.6	1.27	5151	1707706	0
North Kings	Root Creek WD	107	***211,000***	13%	211,000	14767.3	0.0013	7.1	68.7	278.3	68.7	98.3	29.6	0.52	7286	2061703	0
North Kings	Madera County	108	***237,000***	5%	237,000	18127.3	0.0010	5.1	1.3	247.8	1.3	67.8	66.5	1.16	16620	3786640	0
North Kings	Madera ID	109	***237,000***	3%	237,000	8977.7	0.0013	6.8	327.9	270.9	147.9	90.9	57.0	0.99	7528	2280943	0
North Kings	Madera ID	110	***237,000***	0%	237,000	19839.8	0.0020	10.8	323.8	248.0	143.8	68.0	75.8	1.32	19238	9299350	0
North Kings	Madera ID	111	***184,000***	-1%	184,000	6346.9	0.0027	14.2	16.7	282.4	16.7	102.4	85.8	1.50	6330	3135845	0
North Kings	Madera ID	112	***184,000***	N/A	184,000	7833.8	0.0041	21.7	327.2	282.4	147.2	102.4	44.8	0.78	5517	4170821	0
North Kings	Madera ID	113	***184,000***	N/A	184,000	25138.2	0.0048	25.2	345.1	253.7	165.1	73.7	88.6	1.55	25131	22076372	0
McMullin	Aliso WD	114	***180,000***	N/A	180,000	11667.2	0.0048	25.4	252.2	213.3	72.2	33.3	38.9	0.68	7322	6335135	0
Aliso WD	McMullin	115	***180,000***	N/A	180,000	6284.1	0.0047	24.9	210.3	323.7	30.3	143.7	66.6	1.16	5768	4893227	0
Aliso WD	McMullin	116	***180,000***	N/A	180,000	9065.2	0.0039	20.6	194.0	250.8	14.0	70.8	56.8	0.99	7588	5335414	0
Aliso WD	McMullin	117	***180,000***	N/A	180,000	4645.4	0.0019	10.1	146.3	173.6	146.3	173.6	27.3	0.48	2129	735370	0
Aliso WD	McMullin	118	***180,000***	N/A	180,000	13996.9	0.0008	4.1	113.4	273.4	113.4	93.4	20.0	0.35	4777	671860	0
McMullin	Aliso WD	119	***180,000***	N/A	180,000	3456.2	0.0024	12.9	90.7	273.4	90.7	93.4	2.7	0.05	162	71340	0
Farmers WD	McMullin	120	***180,000***	N/A	180,000	3470.6	0.0015	7.9	161.8	215.4	161.8	35.4	53.6	0.94	2795	751156	0
McMullin	Farmers WD	121	***175,000***	N/A	175,000	5165.0	0.0013	7.0	223.6	181.0	43.6	1.0	42.6	0.74	3496	806789	904
McMullin	Fresno County	122	***175,000***	N/A	175,000	8089.5	0.0008	4.1	242.1	181.0	62.1	1.0	61.1	1.07	7083	960908	1076
McMullin	Fresno County	123	***175,000***	N/A	175,000	5472.0	0.0011	5.8	196.6	101.0	16.6	101.0	84.4	1.47	5446	1050729	1177
McMullin	Fresno County	124	***175,000***	5%	175,000	8939.7	0.0019	9.8	166.0	101.0	166.0	101.0	65.0	1.13	8102	2635550	2952
McMullin	Fresno County	125	***175,000***	8%	175,000	7147.8	0.0022	11.8	137.6	90.6	137.6	90.6	47.0	0.82	5226	2052343	2299
Fresno County	McMullin	126	***175,000***	9%	175,000	12139.4	0.0008	4.1	154.5	181.4	154.5	1.4	26.9	0.47	5495	739116	828
Fresno County	James ID	127	***175,000***	6%	175,000	10727.6	0.0008	4.1	206.4	268.0	26.4	88.0	61.6	1.08	9440	1287813	1443
James ID	Fresno County	128	***171,000***	4%	171,000	3722.6	0.0007	3.5	200.2	180.0	20.2	180.0	20.2	0.35	1286	145151	163
James ID	Central Delta Mendota Regional Mulit Agency GSA	129	***171,000***	4%	171,000	7865.6	N/A	N/A	N/A	130.8	N/A	130.8	N/A	N/A	N/A	N/A	N/A
Central Delta Mendota Regional Mulit Agency GSA	James ID	130	***171,000***	5%	171,000	16667.1	N/A	N/A	N/A	165.8	N/A	165.8	N/A	N/A	N/A	N/A	N/A
Central Delta Mendota Regional Mulit Agency GSA	James ID	131	***171,000***	8%	171,000	5212.2	N/A	N/A	N/A	180.8	N/A	0.8	N/A	N/A	N/A	N/A	N/A
Central Delta Mendota Regional Mulit Agency GSA	James ID	132	***171,000***	N/A	171,000	8711.3	N/A	N/A	N/A	270.5	N/A	90.5	N/A	N/A	N/A	N/A	N/A
Central Delta Mendota Regional Mulit Agency GSA	James ID	133	***171,000***	N/A	171,000	5559.6	N/A	N/A	N/A	200.4	N/A	20.4	N/A	N/A	N/A	N/A	N/A
Central Delta Mendota Regional Mulit Agency GSA	James ID	134	***171,000***	N/A	171,000	5435.6	N/A	N/A	N/A	180.8	N/A	0.8	N/A	N/A	N/A	N/A	N/A
James ID	Westlands WD	135	***87,000***	N/A	87,000	6701.1	N/A	N/A	N/A	90.6	N/A	90.6	N/A	N/A	N/A	N/A	N/A
James ID	Westlands WD	136	***87,000***	N/A	87,000	10529.2	N/A	N/A	N/A	118.7	N/A	118.7	N/A	N/A	N/A	N/A	N/A
Westlands WD	North Fork Kings	137	***87,000***	N/A	87,000	23573.7	N/A	N/A	N/A	153.4	N/A	153.4	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	138	***90,000***	N/A	90,000	5362.7	N/A	N/A	N/A	91.6	N/A	91.6	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	139	***90,000***	N/A	90,000	9680.0	N/A	N/A	N/A	0.9	N/A	0.9	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	140	***90,000***	N/A	90,000	8413.5	0.0013	6.8	128.8	90.5	128.8	90.5	38.3	0.67	5211	606393	679
Westlands WD	North Fork Kings	141	***90,000***	N/A	90,000	14877.4	0.0008	4.0	106.6	178.8	106.6	178.8	72.2	1.26	14168	967582	1084
Westlands WD	North Fork Kings	142	***90,000***	N/A	90,000	7984.0	0.0005	2.6	57.3	178.9	57.3	178.9	58.4	1.02	6800	303952	340
Westlands WD	North Fork Kings	143	***90,000***	N/A	90,000	10906.7	0.0006	3.0	343.6	104.2	163.6	104.2	59.4	1.04	9390	485924	544
North Fork Kings	Westlands WD	144	***90,000***	N/A	90,000	5362.7	0.0004	2.2	323.5	181.6	143.5	1.6	38.1	0.67	3310	124165	139
North Fork Kings	Westlands WD	145	***90,000***	N/A	90,000	5361.1	0.0006	3.0	4.7	269.2	4.7	89.2	84.5	1.47	5336	275779	309
Westlands WD	North Fork Kings	146	***90,000***	N/A	90,000	5063.3	0.0009	4.9	12.1	180.8	12.1	0.8	11.2	0.20	984	81923	92
Westlands WD	North Fork Kings	147	***60,000***	N/A	60,000	10639.8	0.0009	4.7	55.9	90.8	55.9	90.8	34.9	0.61	6086	324083	363
North Fork Kings	Westlands WD	148	***60,000***	N/A	60,000	10581.3	0.0011	6.0	55.8	90.8	55.8	90.8	35.0	0.61	6071	414243	464
North Fork Kings	Westlands WD	149	***60,000***	N/A	60,000	14856.4	0.0028	15.0	310.3	135.4	130.3	135.4	5.1	0.09	1322	226060	253
North Fork Kings	Westlands WD	150	***60,000***	N/A	60,000	15047.2	0.0018	9.5	153.3	135.4	153.3	135.4	17.9	0.31	4623	501109	561
North Fork Kings	Westlands WD	151	***60,000***	N/A	60,000	8452.6	0.0014	7.4	167.3	72.0	167.3	72.0	84.8	1.48	8418	707475	792
Westlands WD	North Fork Kings	152	***60,000***	N/A	60,000	11535.4	0.0012	6.3	0.9	136.8	0.9	136.8	44.0	0.77	8019	576643	646
North Fork Kings	Westlands WD	153	***60,000***	N/A	60,000	15489.2	0.0018	9.4	272.5	180.8	92.5	0.8	88.3	1.54	15482	1662283	1862
North Fork Kings	Westlands WD	154	***60,000***	N/A	60,000	5285.2	0.0014	7.5	234.6	180.8	54.6	0.8	53.8	0.94	4264	361302	405
North Fork Kings	Westlands WD	155	***90,000***	N/A	90,000	5361.1	0.0020	10.5	238.0	90.8	58.0	90.8	32.8	0.57	2900	518785	581
North Fork Kings	South Fork Kings GSA	156	***90,000***	N/A	90,000	5346.1	0.0023	12.2	254.2	77.1	74.2	77.1	2.9	0.05	273	56854	64
South Fork Kings GSA	North Fork Kings	157	***90,000***	N/A	90,000	4074.8	0.0021	11.0	255.1	0.7	75.1	0.7	74.4	1.30	3925	737636	0
South Fork Kings GSA	North Fork Kings	158	***90,000***	N/A	90,000	2477.5	0.0021	10.9	246.8	0.7	66.8	0.7	66.2	1.15	2266	422407	0
North Fork Kings	South Fork Kings GSA	159	***90,000***	20%	90,000	6526.5	0.0021	11.2	233.5	54.4	53.5	54.4	1.0	0.02	108	20729	0
South Fork Kings GSA	North Fork Kings	160	***90,000***	19%	90,000	37726.0	0.0018	9.4	238.9	48.0	58.9	48.0	10.9	0.19	7121	1141143	0
Mid Kings River GSA	North Fork Kings	161	***90,000***	18%	90,000	4940.9	0.0022	11.6	230.0	47.3	50.0	47.3	2.7	0.05	231	45538	0
Mid Kings River GSA	North Fork Kings	162	***90,000***	17%	90,000	5730.5	0.0025	13.0	229.5	47.3	49.5	47.3	2.1	0.04	210	46785	0
North Fork Kings	Mid Kings River GSA	163	***90,000***	8%	90,000	19953.9	0.0032	16.7	214.5	90.4	34.5	90.4	56.0	0.98	16534	4705907	0
Mid Kings River GSA	North Fork Kings	164	***90,000***	7%	90,000	10560.8	0.0022	11.4	235.3	46.9	55.3	46.9	8.3	0.15	1534	299298	335
North Fork Kings	Mid Kings River GSA	165	***90,000***	11%	90,000	6769.4	0.0013	6.8	21.4	46.9	21.4	46.9	25.5	0.45	2917	339163	380
Mid Kings River GSA	Central Kings	166	***90,000***	9%	90,000	8937.1	0.0029	15.4	105.8	178.6	105.8	178.6	72.7	1.27	8534	2236200	2505
Central Kings	Mid Kings River GSA	167	***84,000***	4%	84,000	18901.3	0.0039	20.7	177.8	69.0	177.8	69.0	71.1	1.24	17887	5880571	0
Central Kings	Mid Kings River GSA	168	***84,000***	4%	84,000	16749.2	0.0019	10.0	173.0	27.2	173.0	27.2	34.3	0.60	9428	1503795	0
Kings River East	Mid Kings River GSA	169	***84,000***	8%	84,000	1489.1	0.0010	5.0	182.3	90.0	2.3	90.0	87.7	1.53	1488	119338	134
Mid Kings River GSA	Kings River East	170	***84,000***	15%	84,000	31942.3	0.0036	19.2	144.3	180.7	144.3	0.7	36.4	0.64	18953	5802890	6500
Kings River East	Mid Kings River GSA	171	***99,000***	22%	99,000	10649.1	0.0023	12.2	177.5	91.2	177.5	91.2	86.3	1.51	10627	2420978	2712
Kings River East	Greater Kaweah GSA	172	***99,000***	19%	99,000	23363.7	0.0020	10.4	222.7	64.0	42.7	64.0	21.3	0.37	8486	1651759	1850
Greater Kaweah GSA	Kings River East	173	***99,000***	7%	99,000	5805.0	0.0018	9.4	243.6	64.0	63.6	64.0	0.3	0.01	34	5954	7
Kings River East	Greater Kaweah GSA	174	***50,000***	-2%	50,000	15892.6	0.0024	12.7	243.7	93.8	63.7	93.8	30.0	0.52	7950	958633	1074
Kings River East	Greater Kaweah GSA	175	***40,000***	-2%	40,000	1714.0	0.0018	9.4	152.0	182.5	152.0	2.5	30.5	0.53	870	61704	69

Attachment 3 - 2006 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
Kings River East	Greater Kaweah GSA	176	***40,000***	N/A	40,000	10626.4	0.0030	15.7	137.3	90.5	137.3	90.5	46.8	0.82	7747	919875	1030
Kings River East	Greater Kaweah GSA	177	***40,000***	N/A	40,000	13273.9	0.0042	22.2	173.9	90.5	173.9	90.5	83.4	1.46	13186	2214074	2480
East Kaweah GSA	Kings River East	178	***20,000***	N/A	20,000	15785.5	0.0040	21.3	195.9	0.8	15.9	0.8	15.1	0.26	4107	330798	371
Kings River East	East Kaweah GSA	179	***20,000***	N/A	20,000	16008.0	0.0040	21.1	207.0	90.5	27.0	90.5	63.5	1.11	14331	1146229	1284
East Kaweah GSA	Kings River East	180	***20,000***	N/A	20,000	4996.5	0.0040	21.3	217.0	359.0	37.0	179.0	38.0	0.66	3079	248825	279
East Kaweah GSA	Kings River East	181	***20,000***	N/A	20,000	3194.6	0.0030	15.8	216.6	359.0	36.6	179.0	37.6	0.66	1950	116964	131
East Kaweah GSA	Kings River East	182	***20,000***	N/A	20,000	5861.0	0.0025	13.4	213.9	295.6	33.9	115.6	81.6	1.42	5799	293954	329

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2007 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	Madera County	100	30,000	N/A	30,000	8310.4	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	101	30,000	N/A	30,000	4325.1	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
Madera County	North Kings	102	30,000	N/A	30,000	7349.7	N/A	N/A	N/A	166.5	N/A	166.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	103	30,000	N/A	30,000	12097.8	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
North Kings	Madera County	104	***30,000***	N/A	30,000	20674.9	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
North Kings	Madera County	105	***93,000***	25%	93,000	12121.9	0.0009	4.7	235.7	214.3	55.7	34.3	21.3	0.37	4413	365805	0
Madera County	North Kings	106	***211,000***	28%	211,000	5396.1	0.0020	10.4	203.6	278.3	23.6	98.3	74.7	1.30	5205	2161355	0
Root Creek WD	North Kings	107	***211,000***	13%	211,000	14767.3	0.0017	9.2	136.5	278.3	136.5	98.3	38.2	0.67	9133	3339699	0
North Kings	Madera County	108	***237,000***	5%	237,000	18127.3	0.0020	10.8	303.8	247.8	123.8	67.8	56.0	0.98	15031	7275908	0
North Kings	Madera ID	109	***237,000***	3%	237,000	8977.7	0.0018	9.4	351.5	270.9	171.5	90.9	80.6	1.41	8856	3756030	0
North Kings	Madera ID	110	***237,000***	0%	237,000	19839.8	0.0023	12.0	335.5	248.0	155.5	68.0	87.5	1.53	19821	10653759	0
North Kings	Madera ID	111	***184,000***	-1%	184,000	6346.9	0.0016	8.6	356.3	282.4	176.3	102.4	73.8	1.29	6096	1825522	0
North Kings	Madera ID	112	***184,000***	N/A	184,000	7833.8	0.0040	21.1	333.2	282.4	153.2	102.4	50.8	0.89	6072	4461911	0
North Kings	Madera ID	113	***184,000***	N/A	184,000	25138.2	0.0040	21.0	347.2	253.7	167.2	73.7	86.4	1.51	25090	18391077	0
McMullin	Aliso WD	114	***180,000***	N/A	180,000	11667.2	0.0054	28.3	208.5	213.3	28.5	33.3	4.8	0.08	982	946417	0
Aliso WD	McMullin	115	***180,000***	N/A	180,000	6284.1	0.0031	16.2	184.4	323.7	4.4	143.7	40.7	0.71	4098	2264862	0
McMullin	Aliso WD	116	***180,000***	N/A	180,000	9065.2	0.0038	19.9	276.2	250.8	96.2	70.8	25.4	0.44	3883	2639294	0
McMullin	Aliso WD	117	***180,000***	N/A	180,000	4645.4	0.0016	8.6	306.0	173.6	126.0	173.6	47.5	0.83	3427	1000909	0
Aliso WD	McMullin	118	***180,000***	N/A	180,000	13996.9	0.0022	11.7	327.6	273.4	147.6	93.4	54.2	0.95	11352	4531118	0
McMullin	Aliso WD	119	***180,000***	N/A	180,000	3456.2	0.0046	24.0	59.2	273.4	59.2	93.4	34.2	0.60	1945	1594272	0
Farmers WD	McMullin	120	***180,000***	N/A	180,000	3470.6	0.0014	7.6	123.5	215.4	123.5	35.4	88.1	1.54	3469	899044	0
Farmers WD	McMullin	121	***175,000***	N/A	175,000	5165.0	0.0014	7.6	180.1	181.0	0.1	1.0	0.8	0.01	74	18537	21
Fresno County	McMullin	122	***175,000***	N/A	175,000	8089.5	0.0014	7.4	140.4	181.0	140.4	1.0	40.6	0.71	5261	1291216	1446
McMullin	Fresno County	123	***175,000***	N/A	175,000	5472.0	0.0022	11.7	121.9	101.0	121.9	101.0	20.9	0.37	1953	758616	850
McMullin	Fresno County	124	***175,000***	5%	175,000	8939.7	0.0028	14.8	118.8	101.0	118.8	101.0	17.8	0.31	2735	1344514	1506
McMullin	Fresno County	125	***175,000***	8%	175,000	7147.8	0.0020	10.3	115.3	90.6	115.3	90.6	24.7	0.43	2985	1023187	1146
Fresno County	McMullin	126	***175,000***	9%	175,000	12139.4	0.0022	11.5	62.0	181.4	62.0	1.4	60.6	1.06	10571	4018896	4502
James ID	Fresno County	127	***175,000***	6%	175,000	10727.6	0.0026	13.5	16.0	268.0	16.0	88.0	72.0	1.26	10203	4560177	5108
Fresno County	James ID	128	***171,000***	4%	171,000	3722.6	0.0022	11.5	16.3	180.0	16.3	180.0	16.3	0.28	1044	387841	434
Central Delta Mendota Regional Mulit Agency GSA	James ID	129	***171,000***	4%	171,000	7865.6	0.0023	11.9	355.9	130.8	175.9	130.8	45.1	0.79	5573	2153081	2412
James ID	Central Delta Mendota Regional Mulit Agency GSA	130	***171,000***	5%	171,000	16667.1	0.0013	6.7	229.4	165.8	49.4	165.8	63.6	1.11	14930	3220585	3608
Central Delta Mendota Regional Mulit Agency GSA	James ID	131	***171,000***	8%	171,000	5212.2	0.0020	10.4	150.6	180.8	150.6	0.8	30.2	0.53	2620	884439	991
Central Delta Mendota Regional Mulit Agency GSA	James ID	132	***171,000***	N/A	171,000	8711.3	0.0030	15.6	105.3	270.5	105.3	90.5	14.8	0.26	2226	1123657	1259
Central Delta Mendota Regional Mulit Agency GSA	James ID	133	***171,000***	N/A	171,000	5559.6	0.0037	19.5	78.1	200.4	78.1	20.4	57.7	1.01	4699	2964250	3320
Central Delta Mendota Regional Mulit Agency GSA	James ID	134	***171,000***	N/A	171,000	5435.6	0.0044	23.2	72.5	180.8	72.5	0.8	71.7	1.25	5161	3878103	4344
Westlands WD	James ID	135	***87,000***	N/A	87,000	6701.1	0.0050	26.3	79.4	90.6	79.4	90.6	11.2	0.20	1301	564686	633
Westlands WD	James ID	136	***87,000***	N/A	87,000	10529.2	0.0035	18.5	106.2	118.7	106.2	118.7	12.5	0.22	2280	695336	779
Westlands WD	North Fork Kings	137	***87,000***	N/A	87,000	23573.7	0.0020	10.4	107.9	153.4	107.9	153.4	45.5	0.79	16804	2884961	3232
Westlands WD	North Fork Kings	138	***90,000***	N/A	90,000	5362.7	0.0018	9.3	70.2	91.6	70.2	91.6	21.4	0.37	1954	310245	348
North Fork Kings	Westlands WD	139	***90,000***	N/A	90,000	9680.0	0.0020	10.5	88.9	0.9	88.9	0.9	88.0	1.54	9674	1735513	1944
North Fork Kings	Westlands WD	140	***90,000***	N/A	90,000	8413.5	0.0022	11.5	118.8	90.5	118.8	90.5	28.3	0.49	3986	783330	877
Westlands WD	North Fork Kings	141	***90,000***	N/A	90,000	14877.4	0.0020	10.5	90.0	178.8	90.0	178.8	88.8	1.55	14874	2652156	2971
Westlands WD	North Fork Kings	142	***90,000***	N/A	90,000	7984.0	0.0023	12.0	58.4	178.9	58.4	178.9	59.4	1.04	6875	1408361	1578
Westlands WD	North Fork Kings	143	***90,000***	N/A	90,000	10906.7	0.0020	10.6	82.2	104.2	82.2	104.2	22.0	0.38	4094	736331	825
Westlands WD	North Fork Kings	144	***90,000***	N/A	90,000	5362.7	0.0025	13.2	81.3	181.6	81.3	1.6	79.7	1.39	5276	1188487	1331
North Fork Kings	Westlands WD	145	***90,000***	N/A	90,000	5361.1	0.0024	12.5	58.1	269.2	58.1	89.2	31.1	0.54	2770	590351	661
Westlands WD	North Fork Kings	146	***90,000***	N/A	90,000	5063.3	0.0018	9.6	38.9	180.8	38.9	0.8	38.0	0.66	3120	511300	573
Westlands WD	North Fork Kings	147	***60,000***	N/A	60,000	10639.8	0.0034	18.1	9.9	90.8	9.9	90.8	80.9	1.41	10506	2165942	2426
Westlands WD	North Fork Kings	148	***60,000***	N/A	60,000	10581.3	0.0054	28.5	355.0	90.8	175.0	90.8	84.2	1.47	10527	3414879	3825
Westlands WD	North Fork Kings	149	***60,000***	N/A	60,000	14856.4	0.0022	11.4	29.5	135.4	29.5	135.4	74.1	1.29	14286	1842956	2064
Westlands WD	North Fork Kings	150	***60,000***	N/A	60,000	15047.2	0.0022	11.9	30.3	135.4	30.3	135.4	74.9	1.31	14526	1960435	2196
Westlands WD	North Fork Kings	151	***60,000***	N/A	60,000	8452.6	0.0024	12.6	351.7	72.0	171.7	72.0	80.4	1.40	8334	1192320	1336
North Fork Kings	Westlands WD	152	***60,000***	N/A	60,000	11535.4	0.0012	6.3	302.2	136.8	122.2	136.8	14.7	0.26	2919	209357	235
North Fork Kings	Westlands WD	153	***60,000***	N/A	60,000	15489.2	0.0025	13.2	215.8	180.8	35.8	0.8	35.0	0.61	8884	1328624	1488
North Fork Kings	Westlands WD	154	***60,000***	N/A	60,000	5285.2	0.0019	10.3	275.1	180.8	95.1	0.8	85.8	1.50	5271	615623	690
Westlands WD	North Fork Kings	155	***90,000***	N/A	90,000	5361.1	0.0031	16.5	280.6	90.8	100.6	90.8	9.8	0.17	910	255435	286
South Fork Kings GSA	North Fork Kings	156	***90,000***	N/A	90,000	5346.1	0.0048	25.5	263.2	77.1	83.2	77.1	6.1	0.11	567	246679	276
South Fork Kings GSA	North Fork Kings	157	***90,000***	N/A	90,000	4074.8	0.0054	28.3	262.5	0.7	82.5	0.7	81.8	1.43	4034	1943559	0
South Fork Kings GSA	North Fork Kings	158	***90,000***	N/A	90,000	2477.5	0.0051	26.9	268.7	0.7	88.7	0.7	88.1	1.54	2476	1136452	0
South Fork Kings GSA	North Fork Kings	159	***90,000***	20%	90,000	6526.5	0.0041	21.9	277.3	54.4	97.3	54.4	42.9	0.75	4441	1657354	0
South Fork Kings GSA	North Fork Kings	160	***90,000***	19%	90,000	37726.0	0.0018	9.7	261.1	48.0	81.1	48.0	33.1	0.58	20585	3392308	0
Mid Kings River GSA	North Fork Kings	161	***90,000***	18%	90,000	4940.9	0.0023	12.3	233.5	47.3	53.5	47.3	6.2	0.11	533	111469	0
Mid Kings River GSA	North Fork Kings	162	***90,000***	17%	90,000	5730.5	0.0038	20.1	240.3	47.3	60.3	47.3	13.0	0.23	1286	439811	0
North Fork Kings	Mid Kings River GSA	163	***90,000***	8%	90,000	19953.9	0.0030	16.0	212.8	90.4	32.8	90.4	57.7	1.01	16859	4605117	0
Mid Kings River GSA	North Fork Kings	164	***90,000***	7%	90,000	10560.8	0.0010	5.5	251.3	46.9	71.3	46.9	24.4	0.43	4365	409459	459
Mid Kings River GSA	North Fork Kings	165	***90,000***	11%	90,000	6769.4	0.0015	8.2	311.5	46.9	131.5	46.9	84.5	1.48	6739	936537	1049
Central Kings	Mid Kings River GSA	166	***90,000***	9%	90,000	8937.1	0.0014	7.3	241.1	178.6	61.1	178.6	62.5	1.09	7930	986904	1105
Central Kings	Mid Kings River GSA	167	***84,000***	4%	84,000	18901.3	0.0033	17.7	181.1	69.0	1.1	69.0	67.9	1.19	17513	4926850	0
Central Kings	Mid Kings River GSA	168	***84,000***	4%	84,000	16749.2	0.0027	14.5	137.6	27.2	137.6	27.2	69.7	1.22	15706	3620272	0
Kings River East	Mid Kings River GSA	169	***84,000***	8%	84,000	1489.1	0.0012	6.2	163.4	90.0	163.4	90.0	73.4	1.28	1427	139731	157
Mid Kings River GSA	Kings River East	170	***84,000***	15%	84,000	31942.3	0.0036	19.2	145.2	180.7	145.2	0.7	35.5	0.62	18539	5663549	6344
Kings River East	Mid Kings River GSA	171	***99,000***	22%	99,000	10649.1	0.0022	11.8	152.4	91.2	152.4	91.2	61.2	1.07	9329	2065223	2313
Kings River East	Greater Kaweah GSA	172	***99,000***	19%	99,000	23363.7	0.0028	14.8	209.1	64.0	29.1	64.0	34.9	0.61	13356	3699005	4143
Greater Kaweah GSA	Kings River East	173	***99,000***	7%	99,000	5805.0	0.0030	15.8	248.1	64.0	68.1	64.0	4.2	0.07	422	124911	140
Kings River East	Greater Kaweah GSA	174	***50,000***	-2%	50,000	15892.6	0.0020	10.5	262.0	93.8	82.0	93.8	11.8	0.21	3239	320851	359
Kings River East	Greater Kaweah GSA	175	***40,000***	-2%	40,000	1714.0	0.0007	3.7	186.9	182.5	6.9	2.5	4.4	0.08	132	3724	4

Attachment 3 - 2007 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^o	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
Kings River East	Greater Kaweah GSA	176	***40,000***	N/A	40,000	10626.4	0.0010	5.2	118.6	90.5	118.6	90.5	28.1	0.49	5004	197861	222
Kings River East	Greater Kaweah GSA	177	***40,000***	N/A	40,000	13273.9	0.0024	12.8	145.7	90.5	145.7	90.5	55.1	0.96	10891	1060007	1187
East Kaweah GSA	Kings River East	178	***20,000***	N/A	20,000	15785.5	0.0036	19.2	192.1	0.8	12.1	0.8	11.3	0.20	3093	224958	252
Kings River East	East Kaweah GSA	179	***20,000***	N/A	20,000	16008.0	0.0022	11.6	214.1	90.5	34.1	90.5	56.4	0.98	13333	586363	657
East Kaweah GSA	Kings River East	180	***20,000***	N/A	20,000	4996.5	0.0018	9.6	237.2	359.0	57.2	179.0	58.2	1.02	4248	154018	173
East Kaweah GSA	Kings River East	181	***20,000***	N/A	20,000	3194.6	0.0018	9.5	230.2	359.0	50.2	179.0	51.3	0.89	2492	89640	100
East Kaweah GSA	Kings River East	182	***20,000***	N/A	20,000	5861.0	0.0024	12.8	197.9	295.6	17.9	115.6	82.3	1.44	5808	281797	316

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2008 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (L) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	Madera County	100	30,000	N/A	30,000	8310.4	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	101	30,000	N/A	30,000	4325.1	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
Madera County	North Kings	102	30,000	N/A	30,000	7349.7	N/A	N/A	N/A	166.5	N/A	166.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	103	30,000	N/A	30,000	12097.8	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
Madera County	North Kings	104	***30,000***	N/A	30,000	20674.9	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
Madera County	North Kings	105	***93,000***	25%	93,000	12121.9	0.0022	11.7	157.1	214.3	157.1	34.3	57.3	1.00	10195	2101554	0
Madera County	North Kings	106	***211,000***	28%	211,000	5396.1	0.0037	19.4	173.6	278.3	173.6	98.3	75.4	1.32	5221	4053246	0
Root Creek WD	North Kings	107	***211,000***	13%	211,000	14767.3	0.0026	14.0	234.2	278.3	54.2	98.3	44.0	0.77	10266	5726215	0
North Kings	Madera County	108	***237,000***	5%	237,000	18127.3	0.0023	12.3	332.2	247.8	152.2	67.8	84.4	1.47	18041	9970604	0
North Kings	Madera ID	109	***237,000***	3%	237,000	8977.7	0.0018	9.7	344.4	270.8	164.4	90.9	73.5	1.28	8607	3749813	0
North Kings	Madera ID	110	***237,000***	0%	237,000	19839.8	0.0030	15.6	341.1	248.0	161.1	68.0	86.9	1.52	19811	13852477	0
North Kings	Madera ID	111	***184,000***	-1%	184,000	6346.9	0.0016	8.5	1.6	282.4	1.6	102.4	79.2	1.38	6234	1852441	0
North Kings	Madera ID	112	***184,000***	N/A	184,000	7833.8	0.0032	17.0	324.9	282.4	144.9	102.4	42.5	0.74	5291	3134727	0
North Kings	Madera ID	113	***184,000***	N/A	184,000	25138.2	0.0040	21.2	329.7	253.7	149.7	73.7	76.0	1.33	24394	18044365	0
Aliso WD	McMullin	114	***180,000***	N/A	180,000	11667.2	0.0026	13.6	195.6	213.3	15.6	33.3	17.7	0.31	3541	1639706	0
Aliso WD	McMullin	115	***180,000***	N/A	180,000	6284.1	0.0041	21.7	204.4	323.7	24.4	143.7	60.7	1.06	5480	4058053	0
Aliso WD	McMullin	116	***180,000***	N/A	180,000	9065.2	0.0042	22.4	247.8	250.8	67.8	70.8	3.0	0.05	479	366124	0
McMullin	Aliso WD	117	***180,000***	N/A	180,000	4645.4	0.0022	11.4	261.2	173.6	81.2	173.6	87.7	1.53	4642	1811737	0
Aliso WD	McMullin	118	***180,000***	N/A	180,000	13996.9	0.0017	9.0	158.8	273.4	158.8	93.4	65.4	1.14	12722	3894761	0
McMullin	Aliso WD	119	***180,000***	N/A	180,000	3456.2	0.0025	13.5	27.6	273.4	27.6	93.4	65.8	1.15	3153	1446621	0
Farmers WD	McMullin	120	***180,000***	N/A	180,000	3470.6	0.0026	13.9	19.5	215.4	19.5	35.4	15.9	0.28	948	450783	0
McMullin	Farmers WD	121	***175,000***	N/A	175,000	5165.0	0.0018	9.7	200.0	181.0	20.0	1.0	19.1	0.33	1689	543873	609
Fresno County	McMullin	122	***175,000***	N/A	175,000	8089.5	0.0010	5.4	131.3	181.0	131.3	1.0	49.7	0.87	6167	1111077	1245
Fresno County	McMullin	123	***175,000***	N/A	175,000	5472.0	0.0016	8.5	96.2	101.0	96.2	101.0	4.8	0.08	456	128372	144
McMullin	Fresno County	124	***175,000***	5%	175,000	8939.7	0.0018	9.7	128.8	101.0	128.8	101.0	27.8	0.49	4169	1339835	1501
McMullin	Fresno County	125	***175,000***	8%	175,000	7147.8	0.0016	8.4	119.1	90.6	119.1	90.6	28.5	0.50	3407	949458	1064
Fresno County	McMullin	126	***175,000***	9%	175,000	12139.4	0.0013	6.6	82.9	181.4	82.9	1.4	81.5	1.42	12007	2630299	2946
James ID	Fresno County	127	***175,000***	6%	175,000	10727.6	0.0013	6.8	55.6	268.0	55.6	88.0	32.4	0.57	5744	1290577	1446
Fresno County	James ID	128	***171,000***	4%	171,000	3722.6	0.0021	11.3	51.8	180.0	51.8	180.0	51.8	0.90	2924	1072024	1201
Central Delta Mendota Regional Mulit Agency GSA	James ID	129	***171,000***	4%	171,000	7865.6	0.0019	9.9	74.3	130.8	74.3	130.8	56.5	0.99	6560	2110340	2364
Central Delta Mendota Regional Mulit Agency GSA	James ID	130	***171,000***	5%	171,000	16667.1	0.0029	15.2	85.1	165.8	85.1	165.8	80.6	1.41	16446	8102042	9075
Central Delta Mendota Regional Mulit Agency GSA	James ID	131	***171,000***	8%	171,000	5212.2	0.0025	13.1	90.7	180.8	90.7	0.8	89.8	1.57	5212	2219292	2486
Central Delta Mendota Regional Mulit Agency GSA	James ID	132	***171,000***	N/A	171,000	8711.3	0.0036	19.2	97.7	270.5	97.7	90.5	7.2	0.13	1097	682926	765
Central Delta Mendota Regional Mulit Agency GSA	James ID	133	***171,000***	N/A	171,000	5559.6	0.0039	20.5	99.9	200.4	99.9	20.4	79.5	1.39	5466	3627455	4063
Central Delta Mendota Regional Mulit Agency GSA	James ID	134	***171,000***	N/A	171,000	5435.6	0.0039	20.8	103.4	180.8	103.4	0.8	77.3	1.35	5303	3567886	3997
James ID	Westlands WD	135	***87,000***	N/A	87,000	6701.1	0.0045	23.7	104.2	90.6	104.2	90.6	13.6	0.24	1572	613190	687
James ID	Westlands WD	136	***87,000***	N/A	87,000	10529.2	0.0029	15.1	126.2	118.7	126.2	118.7	7.5	0.13	1366	339987	381
Westlands WD	North Fork Kings	137	***87,000***	N/A	87,000	23573.7	N/A	N/A	N/A	153.4	N/A	153.4	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	138	***90,000***	N/A	90,000	5362.7	N/A	N/A	N/A	91.6	N/A	91.6	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	139	***90,000***	N/A	90,000	9680.0	N/A	N/A	N/A	0.9	N/A	0.9	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	140	***90,000***	N/A	90,000	8413.5	0.0035	18.3	147.6	90.5	147.6	90.5	57.1	1.00	7064	2208920	2474
Westlands WD	North Fork Kings	141	***90,000***	N/A	90,000	14877.4	0.0028	14.6	107.7	178.8	107.7	178.8	71.1	1.24	14076	3506007	3927
Westlands WD	North Fork Kings	142	***90,000***	N/A	90,000	7984.0	0.0035	18.6	34.4	178.9	34.4	178.9	35.5	0.62	4633	1468487	1645
Westlands WD	North Fork Kings	143	***90,000***	N/A	90,000	10906.7	0.0033	17.4	36.2	104.2	36.2	104.2	68.0	1.19	10114	3002537	3363
Westlands WD	North Fork Kings	144	***90,000***	N/A	90,000	5362.7	0.0043	22.5	79.6	181.6	79.6	1.6	78.0	1.36	5245	2010658	2252
North Fork Kings	Westlands WD	145	***90,000***	N/A	90,000	5361.1	0.0027	14.2	87.1	269.2	87.1	89.2	2.1	0.04	199	48158	54
Westlands WD	North Fork Kings	146	***90,000***	N/A	90,000	5063.3	0.0024	12.4	108.3	180.8	108.3	0.8	72.5	1.27	4830	1022948	1146
North Fork Kings	Westlands WD	147	***60,000***	N/A	60,000	10639.8	0.0022	11.6	93.1	90.8	93.1	90.8	2.3	0.04	432	56791	64
Westlands WD	North Fork Kings	148	***60,000***	N/A	60,000	10581.3	0.0017	8.8	346.1	90.8	166.1	90.8	75.3	1.31	10234	1024073	1147
North Fork Kings	Westlands WD	149	***60,000***	N/A	60,000	14856.4	0.0012	6.3	284.3	135.4	104.3	135.4	31.1	0.54	7670	551201	617
Westlands WD	North Fork Kings	150	***60,000***	N/A	60,000	15047.2	0.0012	6.1	84.1	135.4	84.1	135.4	51.3	0.90	11749	815231	913
North Fork Kings	Westlands WD	151	***60,000***	N/A	60,000	8452.6	0.0010	5.4	190.1	72.0	10.1	72.0	61.9	1.08	7459	455230	510
North Fork Kings	Westlands WD	152	***60,000***	N/A	60,000	11535.4	0.0019	10.0	294.7	136.8	114.7	136.8	22.1	0.39	4339	491089	550
Westlands WD	North Fork Kings	153	***60,000***	N/A	60,000	15489.2	0.0029	15.2	96.2	180.8	96.2	0.8	84.6	1.48	15422	2666892	2987
Westlands WD	North Fork Kings	154	***60,000***	N/A	60,000	5285.2	0.0051	27.2	65.8	180.8	65.8	0.8	65.0	1.13	4789	1478091	1656
Westlands WD	North Fork Kings	155	***90,000***	N/A	90,000	5361.1	0.0040	21.0	32.8	90.8	32.8	90.8	58.0	1.01	4545	1630691	1827
South Fork Kings GSA	North Fork Kings	156	***90,000***	N/A	90,000	5346.1	0.0025	13.4	330.1	77.1	150.1	77.1	73.0	1.27	5113	1167231	1307
South Fork Kings GSA	North Fork Kings	157	***90,000***	N/A	90,000	4074.8	0.0031	16.1	291.8	0.7	111.8	0.7	68.9	1.20	3801	1045870	0
South Fork Kings GSA	North Fork Kings	158	***90,000***	N/A	90,000	2477.5	0.0029	15.1	259.6	0.7	79.6	0.7	78.9	1.38	2431	624166	0
North Fork Kings	South Fork Kings GSA	159	***90,000***	20%	90,000	6526.5	0.0050	26.2	221.6	54.4	41.6	54.4	12.8	0.22	1444	643761	0
South Fork Kings GSA	North Fork Kings	160	***90,000***	19%	90,000	37726.0	0.0032	17.1	250.0	48.0	70.0	48.0	22.0	0.38	14146	4111490	0
North Fork Kings	Mid Kings River GSA	161	***90,000***	18%	90,000	4940.9	0.0028	15.0	226.4	47.3	46.4	47.3	0.9	0.02	79	20324	0
Mid Kings River GSA	North Fork Kings	162	***90,000***	17%	90,000	5730.5	0.0025	13.4	238.3	47.3	58.3	47.3	11.0	0.19	1091	250097	0
North Fork Kings	Mid Kings River GSA	163	***90,000***	8%	90,000	19953.9	0.0021	11.2	218.5	90.4	38.5	90.4	51.9	0.91	15710	2992702	0
Mid Kings River GSA	North Fork Kings	164	***90,000***	7%	90,000	10560.8	0.0018	9.2	283.0	46.9	103.0	46.9	56.1	0.98	8763	1380937	1547
Mid Kings River GSA	North Fork Kings	165	***90,000***	11%	90,000	6769.4	0.0006	3.1	7.7	46.9	7.7	46.9	39.2	0.68	4279	223523	250
Central Kings	Mid Kings River GSA	166	***90,000***	9%	90,000	8937.1	0.0010	5.2	205.9	178.6	25.9	178.6	27.3	0.48	4100	366070	410
Central Kings	Mid Kings River GSA	167	***84,000***	4%	84,000	18901.3	0.0027	14.5	169.9	69.0	169.9	69.0	79.1	1.38	18562	4274255	0
Central Kings	Mid Kings River GSA	168	***84,000***	4%	84,000	16749.2	0.0033	17.5	158.5	27.2	158.5	27.2	48.8	0.85	12601	3501363	0
Kings River East	Mid Kings River GSA	169	***84,000***	8%	84,000	1489.1	0.0022	11.6	132.0	90.0	132.0	90.0	42.0	0.73	996	183383	205
Mid Kings River GSA	Kings River East	170	***84,000***	15%	84,000	31942.3	0.0029	15.1	170.3	180.7	170.3	0.7	10.4	0.18	5773	1384521	1551

Attachment 3 - 2008 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
Kings River East	Mid Kings River GSA	171	***99,000***	22%	99,000	10649.1	0.0016	8.6	184.8	91.2	4.8	91.2	86.4	1.51	10628	1704168	1909
Kings River East	Greater Kaweah GSA	172	***99,000***	19%	99,000	23363.7	0.0014	7.3	209.3	64.0	29.3	64.0	34.7	0.60	13287	1809908	2027
Greater Kaweah GSA	Kings River East	173	***99,000***	7%	99,000	5805.0	0.0031	16.2	250.1	64.0	70.1	64.0	6.2	0.11	623	189758	213
Kings River East	Greater Kaweah GSA	174	***50,000***	-2%	50,000	15892.6	0.0030	15.6	217.7	93.8	37.7	93.8	56.0	0.98	13183	1946723	2181
Kings River East	Greater Kaweah GSA	175	***40,000***	-2%	40,000	1714.0	0.0013	6.7	177.0	182.5	177.0	2.5	5.5	0.10	164	8354	9
Kings River East	Greater Kaweah GSA	176	***40,000***	N/A	40,000	10626.4	0.0008	4.4	171.2	90.5	171.2	90.5	80.7	1.41	10486	352110	394
Kings River East	Greater Kaweah GSA	177	***40,000***	N/A	40,000	13273.9	0.0016	8.7	196.2	90.5	16.2	90.5	74.4	1.30	12783	843579	945
East Kaweah GSA	Kings River East	178	***20,000***	N/A	20,000	15785.5	0.0017	9.0	181.6	0.8	1.6	0.8	0.8	0.01	210	7157	8
Kings River East	East Kaweah GSA	179	***20,000***	N/A	20,000	16008.0	0.0039	20.4	211.5	90.5	31.5	90.5	59.1	1.03	13732	1060624	1188
East Kaweah GSA	Kings River East	180	***20,000***	N/A	20,000	4996.5	0.0045	23.8	234.0	359.0	54.0	179.0	55.0	0.96	4095	368650	413
East Kaweah GSA	Kings River East	181	***20,000***	N/A	20,000	3194.6	0.0046	24.1	222.1	359.0	42.1	179.0	43.2	0.75	2185	199178	223
East Kaweah GSA	Kings River East	182	***20,000***	N/A	20,000	5861.0	0.0045	23.9	216.9	295.6	36.9	115.6	78.7	1.37	5748	519486	582

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2009 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (L) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	Madera County	100	30,000	N/A	30,000	8310.4	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	101	30,000	N/A	30,000	4325.1	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
Madera County	North Kings	102	30,000	N/A	30,000	7349.7	N/A	N/A	N/A	166.5	N/A	166.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	103	30,000	N/A	30,000	12097.8	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
North Kings	Madera County	104	***30,000***	N/A	30,000	20674.9	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
North Kings	Madera County	105	***93,000***	25%	93,000	12121.9	0.0014	7.6	329.8	214.3	149.8	34.3	64.5	1.13	10943	1468065	0
North Kings	Madera County	106	***211,000***	28%	211,000	5396.1	0.0009	4.6	13.6	278.3	13.6	98.3	84.7	1.48	5373	987874	0
North Kings	Root Creek WD	107	***211,000***	13%	211,000	14767.3	0.0015	8.1	52.8	278.3	52.8	98.3	45.5	0.79	10534	3417436	0
North Kings	Madera County	108	***237,000***	5%	237,000	18127.3	0.0021	11.3	319.0	247.8	139.0	67.8	71.2	1.24	17161	8689783	0
North Kings	Madera ID	109	***237,000***	3%	237,000	8977.7	0.0021	10.9	352.3	270.9	172.3	90.9	81.4	1.42	8877	4353804	0
North Kings	Madera ID	110	***237,000***	0%	237,000	19839.8	0.0027	14.1	326.3	248.0	146.3	68.0	78.4	1.37	19433	12317967	0
North Kings	Madera ID	111	***184,000***	-1%	184,000	6346.9	0.0022	11.6	16.1	282.4	16.1	102.4	86.3	1.51	6334	2557256	0
North Kings	Madera ID	112	***184,000***	N/A	184,000	7833.8	0.0035	18.3	336.8	282.4	156.8	102.4	54.3	0.95	6365	4063914	0
North Kings	Madera ID	113	***184,000***	N/A	184,000	25138.2	0.0040	21.0	328.8	253.7	148.8	73.7	75.2	1.31	24299	17812858	0
McMullin	Aliso WD	114	***180,000***	N/A	180,000	11667.2	0.0032	17.0	246.2	213.3	66.2	33.3	32.9	0.57	6342	3682219	0
Aliso WD	McMullin	115	***180,000***	N/A	180,000	6284.1	0.0026	13.6	224.8	323.7	44.8	143.7	81.2	1.42	6209	2877465	0
McMullin	Aliso WD	116	***180,000***	N/A	180,000	9065.2	0.0029	15.1	292.9	250.8	112.9	70.8	42.0	0.73	6071	3122180	0
McMullin	Aliso WD	117	***180,000***	N/A	180,000	4645.4	0.0007	3.6	283.5	173.6	103.5	173.6	70.1	1.22	4367	532994	0
McMullin	Aliso WD	118	***180,000***	N/A	180,000	13996.9	0.0007	3.6	87.6	273.4	87.6	93.4	5.8	0.10	1415	175585	0
McMullin	Aliso WD	119	***180,000***	N/A	180,000	3456.2	0.0008	4.0	76.3	273.4	76.3	93.4	17.1	0.30	1016	138386	0
Farmers WD	McMullin	120	***180,000***	N/A	180,000	3470.6	0.0004	2.2	50.9	215.4	50.9	35.4	15.6	0.27	931	71241	0
Farmers WD	McMullin	121	***175,000***	N/A	175,000	5165.0	0.0003	1.7	25.4	181.0	25.4	1.0	24.5	0.43	2139	119950	134
Fresno County	McMullin	122	***175,000***	N/A	175,000	8089.5	0.0002	0.9	89.6	181.0	89.6	1.0	88.6	1.55	8087	238939	268
McMullin	Fresno County	123	***175,000***	N/A	175,000	5472.0	0.0005	2.8	141.5	101.0	141.5	101.0	40.5	0.71	3552	325924	365
McMullin	Fresno County	124	***175,000***	5%	175,000	8939.7	0.0008	4.3	113.7	101.0	113.7	101.0	12.7	0.22	1968	278170	312
McMullin	Fresno County	125	***175,000***	8%	175,000	7147.8	0.0017	9.1	104.4	90.6	104.4	90.6	13.8	0.24	1704	512010	574
Fresno County	McMullin	126	***175,000***	9%	175,000	12139.4	0.0031	16.1	114.4	181.4	114.4	1.4	67.0	1.17	11174	5975513	6693
Fresno County	James ID	127	***175,000***	6%	175,000	10727.6	0.0026	13.5	123.5	268.0	123.5	88.0	35.5	0.62	6234	2785354	3120
Fresno County	James ID	128	***171,000***	4%	171,000	3722.6	0.0018	9.3	131.2	180.0	131.2	180.0	48.8	0.85	2802	843972	945
Central Delta Mendota Regional Mulit Agency GSA	James ID	129	***171,000***	4%	171,000	7865.6	0.0017	9.2	108.8	130.8	108.8	130.8	22.0	0.38	2948	879177	985
Central Delta Mendota Regional Mulit Agency GSA	James ID	130	***171,000***	5%	171,000	16667.1	0.0018	9.6	79.3	165.8	79.3	165.8	86.5	1.51	16636	5187731	5811
Central Delta Mendota Regional Mulit Agency GSA	James ID	131	***171,000***	8%	171,000	5212.2	0.0014	7.4	90.1	180.8	90.1	0.8	89.3	1.56	5212	1251087	1401
Central Delta Mendota Regional Mulit Agency GSA	James ID	132	***171,000***	N/A	171,000	8711.3	0.0010	5.2	166.9	270.5	166.9	90.5	76.5	1.33	8469	1436479	1609
Central Delta Mendota Regional Mulit Agency GSA	James ID	133	***171,000***	N/A	171,000	5559.6	0.0010	5.4	198.0	200.4	18.0	20.4	2.4	0.04	230	40335	45
Central Delta Mendota Regional Mulit Agency GSA	James ID	134	***171,000***	N/A	171,000	5435.6	0.0011	6.0	178.2	180.8	178.2	0.8	2.6	0.05	249	48289	54
James ID	Westlands WD	135	***87,000***	N/A	87,000	6701.1	0.0016	8.6	159.9	90.6	159.9	90.6	69.2	1.21	6266	890082	997
James ID	Westlands WD	136	***87,000***	N/A	87,000	10529.2	0.0022	11.4	146.1	118.7	146.1	118.7	27.3	0.48	4834	909106	1018
Westlands WD	North Fork Kings	137	***87,000***	N/A	87,000	23573.7	0.0011	5.6	77.0	153.4	77.0	153.4	76.3	1.33	22905	2131177	2387
Westlands WD	North Fork Kings	138	***90,000***	N/A	90,000	5362.7	N/A	N/A	N/A	91.6	N/A	91.6	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	139	***90,000***	N/A	90,000	9680.0	0.0019	10.1	66.1	0.9	66.1	0.9	65.2	1.14	8788	1511077	1693
Westlands WD	North Fork Kings	140	***90,000***	N/A	90,000	8413.5	0.0025	13.3	54.9	90.5	54.9	90.5	35.6	0.62	4895	1108886	1242
Westlands WD	North Fork Kings	141	***90,000***	N/A	90,000	14877.4	0.0037	19.4	83.4	178.8	83.4	178.8	84.6	1.48	14811	4907318	5497
Westlands WD	North Fork Kings	142	***90,000***	N/A	90,000	7984.0	0.0033	17.5	69.9	178.9	69.9	178.9	71.0	1.24	7548	2254817	2526
Westlands WD	North Fork Kings	143	***90,000***	N/A	90,000	10906.7	0.0030	16.0	55.6	104.2	55.6	104.2	48.6	0.85	8185	2238777	2508
Westlands WD	North Fork Kings	144	***90,000***	N/A	90,000	5362.7	0.0038	20.1	82.4	181.6	82.4	1.6	80.8	1.41	5293	1814112	2032
Westlands WD	North Fork Kings	145	***90,000***	N/A	90,000	5361.1	0.0032	16.6	90.9	269.2	90.9	89.2	1.7	0.03	159	45248	51
Westlands WD	North Fork Kings	146	***90,000***	N/A	90,000	5063.3	0.0024	12.6	86.7	180.8	86.7	0.8	85.9	1.50	5050	1086998	1218
Westlands WD	North Fork Kings	147	***60,000***	N/A	60,000	10639.8	0.0030	15.6	65.8	90.8	65.8	90.8	25.0	0.44	4490	796946	893
Westlands WD	North Fork Kings	148	***60,000***	N/A	60,000	10581.3	0.0025	13.4	359.3	90.8	179.3	90.8	88.5	1.55	10578	1608889	1802
North Fork Kings	Westlands WD	149	***60,000***	N/A	60,000	14856.4	0.0012	6.4	225.3	135.4	45.3	135.4	89.9	1.57	14856	1079074	1209
North Fork Kings	Westlands WD	150	***60,000***	N/A	60,000	15047.2	0.0018	9.7	201.9	135.4	21.9	135.4	66.5	1.16	13795	1514471	1696
Westlands WD	North Fork Kings	151	***60,000***	N/A	60,000	8452.6	0.0028	14.9	288.6	72.0	108.6	72.0	36.6	0.64	5040	851537	954
North Fork Kings	Westlands WD	152	***60,000***	N/A	60,000	11535.4	0.0028	14.9	310.5	136.8	130.5	136.8	6.3	0.11	1267	214173	240
North Fork Kings	Westlands WD	153	***60,000***	N/A	60,000	15489.2	0.0028	14.6	295.7	180.8	115.7	0.8	65.2	1.14	14056	2333636	2614
North Fork Kings	Westlands WD	154	***60,000***	N/A	60,000	5285.2	0.0025	13.2	294.5	180.8	114.5	0.8	66.3	1.16	4840	728028	815
Westlands WD	North Fork Kings	155	***90,000***	N/A	90,000	5361.1	N/A	N/A	N/A	90.8	N/A	90.8	N/A	N/A	N/A	N/A	N/A
South Fork Kings GSA	North Fork Kings	156	***90,000***	N/A	90,000	5346.1	N/A	N/A	N/A	77.1	N/A	77.1	N/A	N/A	N/A	N/A	N/A
South Fork Kings GSA	North Fork Kings	157	***90,000***	N/A	90,000	4074.8	0.0026	13.8	287.8	0.7	107.8	0.7	72.9	1.27	3894	913866	0
South Fork Kings GSA	North Fork Kings	158	***90,000***	N/A	90,000	2477.5	0.0027	14.3	290.0	0.7	110.0	0.7	70.7	1.23	2338	571056	0
South Fork Kings GSA	North Fork Kings	159	***90,000***	20%	90,000	6526.5	0.0026	13.8	291.8	54.4	111.8	54.4	57.4	1.00	5497	1288599	0
South Fork Kings GSA	North Fork Kings	160	***90,000***	19%	90,000	37726.0	0.0019	9.9	271.6	48.0	91.6	48.0	43.7	0.76	26042	4392678	0
Mid Kings River GSA	North Fork Kings	161	***90,000***	18%	90,000	4940.9	0.0032	16.7	245.8	47.3	65.8	47.3	18.4	0.32	1563	445651	0
Mid Kings River GSA	North Fork Kings	162	***90,000***	17%	90,000	5730.5	0.0038	19.8	249.1	47.3	69.1	47.3	21.7	0.38	2122	717899	0
North Fork Kings	Mid Kings River GSA	163	***90,000***	8%	90,000	19953.9	0.0023	12.2	219.0	90.4	39.0	90.4	51.4	0.90	15595	3256108	0
North Fork Kings	Mid Kings River GSA	164	***90,000***	7%	90,000	10560.8	0.0007	3.6	211.5	46.9	31.5	46.9	15.4	0.27	2812	173693	195
Mid Kings River GSA	North Fork Kings	165	***90,000***	11%	90,000	6769.4	0.0011	5.6	295.2	46.9	115.2	46.9	68.3	1.19	6288	602915	675
Central Kings	Mid Kings River GSA	166	***90,000***	9%	90,000	8937.1	0.0014	7.2	230.3	178.6	50.3	178.6	51.7	0.90	7017	865887	970
Central Kings	Mid Kings River GSA	167	***84,000***	4%	84,000	18901.3	0.0032	16.8	179.7	69.0	179.7	69.0	69.3	1.21	17677	4723788	0
Central Kings	Mid Kings River GSA	168	***84,000***	4%	84,000	16749.2	0.0031	16.5	157.3	27.2	157.3	27.2	50.0	0.87	12824	3363803	0
Kings River East	Mid Kings River GSA	169	***84,000***	8%	84,000	1489.1	0.0035	18.4	99.5	90.0	99.5	90.0	9.5	0.17	246	72028	81
Mid Kings River GSA	Kings River East	170	***84,000***	15%	84,000	31942.3	0.0040	21.1	132.2	180.7	132.2	0.7	48.5	0.85	23923	8043150	9009

Attachment 3 - 2009 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
Kings River East	Mid Kings River GSA	171	***99,000***	22%	99,000	10649.1	0.0019	9.8	189.1	91.2	9.1	91.2	82.1	1.43	10547	1944569	2178
Kings River East	Greater Kaweah GSA	172	***99,000***	19%	99,000	23363.7	0.0011	5.6	204.2	64.0	24.2	64.0	39.7	0.69	14938	1570418	1759
Kings River East	Greater Kaweah GSA	173	***99,000***	7%	99,000	5805.0	0.0025	13.4	222.3	64.0	42.3	64.0	21.7	0.38	2142	536222	601
Kings River East	Greater Kaweah GSA	174	***50,000***	-2%	50,000	15892.6	0.0028	14.9	206.7	93.8	26.7	93.8	67.0	1.17	14633	2064385	2312
Kings River East	Greater Kaweah GSA	175	***40,000***	-2%	40,000	1714.0	0.0033	17.3	196.5	182.5	16.5	2.5	14.0	0.24	415	54315	61
Kings River East	Greater Kaweah GSA	176	***40,000***	N/A	40,000	10626.4	0.0043	22.4	177.7	90.5	177.7	90.5	87.2	1.52	10614	1805123	2022
Kings River East	Greater Kaweah GSA	177	***40,000***	N/A	40,000	13273.9	0.0043	22.7	190.1	90.5	10.1	90.5	80.4	1.40	13088	2255114	2526
East Kaweah GSA	Kings River East	178	***20,000***	N/A	20,000	15785.5	0.0044	23.2	205.3	0.8	25.3	0.8	24.5	0.43	6536	573120	642
Kings River East	East Kaweah GSA	179	***20,000***	N/A	20,000	16008.0	0.0036	18.9	205.3	90.5	25.3	90.5	65.2	1.14	14537	1042131	1167
Kings River East	East Kaweah GSA	180	***20,000***	N/A	20,000	4996.5	N/A	N/A	N/A	359.0	N/A	179.0	N/A	N/A	N/A	N/A	N/A
Kings River East	East Kaweah GSA	181	***20,000***	N/A	20,000	3194.6	N/A	N/A	N/A	359.0	N/A	179.0	N/A	N/A	N/A	N/A	N/A
East Kaweah GSA	Kings River East	182	***20,000***	N/A	20,000	5861.0	0.0034	17.8	213.9	295.6	33.9	115.6	81.7	1.43	5800	390285	437

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2011 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (L) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	Madera County	100	30,000	N/A	30,000	8310.4	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	101	30,000	N/A	30,000	4325.1	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	102	30,000	N/A	30,000	7349.7	N/A	N/A	N/A	166.5	N/A	166.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	103	30,000	N/A	30,000	12097.8	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
Madera County	North Kings	104	***30,000***	N/A	30,000	20674.9	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
Madera County	North Kings	105	***93,000***	25%	93,000	12121.9	0.0011	5.7	204.9	214.3	24.9	34.3	9.4	0.16	1977	199711	0
Madera County	North Kings	106	***211,000***	28%	211,000	5396.1	0.0019	9.9	201.4	278.3	21.4	98.3	76.8	1.34	5254	2086119	0
Root Creek WD	North Kings	107	***211,000***	13%	211,000	14767.3	0.0010	5.4	108.9	278.3	108.9	98.3	10.6	0.19	2728	588466	0
North Kings	Madera County	108	***237,000***	5%	237,000	18127.3	0.0009	4.8	321.8	247.8	141.8	67.8	74.0	1.29	17428	3728710	0
North Kings	Madera ID	109	***237,000***	3%	237,000	8977.7	0.0023	12.2	339.8	270.8	159.8	90.9	68.8	1.20	8372	4600718	0
North Kings	Madera ID	110	***237,000***	0%	237,000	19839.8	0.0028	14.5	346.3	248.0	166.3	68.0	81.6	1.42	19629	12802672	0
North Kings	Madera ID	111	***184,000***	-1%	184,000	6346.9	0.0022	11.5	340.8	282.4	160.8	102.4	58.3	1.02	5402	2169617	0
North Kings	Madera ID	112	***184,000***	N/A	184,000	7833.8	0.0037	19.7	320.9	282.4	140.9	102.4	38.5	0.67	4872	3339167	0
North Kings	Madera ID	113	***184,000***	N/A	184,000	25138.2	0.0028	15.0	323.5	253.7	143.5	73.7	69.8	1.22	23593	12301263	0
McMullin	Aliso WD	114	***180,000***	N/A	180,000	11667.2	0.0036	19.1	218.4	213.3	38.4	33.3	5.1	0.09	1043	678565	0
Aliso WD	McMullin	115	***180,000***	N/A	180,000	6284.1	0.0032	17.1	203.0	323.7	23.0	143.7	59.3	1.03	5403	3157330	0
McMullin	Aliso WD	116	***180,000***	N/A	180,000	9065.2	0.0050	26.2	270.7	250.8	90.7	70.8	19.9	0.35	3089	2762421	0
McMullin	Aliso WD	117	***180,000***	N/A	180,000	4645.4	0.0050	26.4	257.9	173.6	77.9	173.6	84.3	1.47	4623	4162513	0
McMullin	Aliso WD	118	***180,000***	N/A	180,000	13996.9	0.0030	15.6	7.6	273.4	7.6	93.4	85.9	1.50	13960	7445029	0
McMullin	Aliso WD	119	***180,000***	N/A	180,000	3456.2	0.0077	40.5	327.5	273.4	147.5	93.4	54.1	0.94	2799	3864773	0
McMullin	Farmers WD	120	***180,000***	N/A	180,000	3470.6	0.0057	29.9	346.2	215.4	166.2	35.4	49.2	0.86	2628	2678888	0
McMullin	Farmers WD	121	***175,000***	N/A	175,000	5165.0	0.0028	15.0	349.4	181.0	169.4	1.0	11.5	0.20	1033	514894	577
McMullin	Fresno County	122	***175,000***	N/A	175,000	8089.5	0.0005	2.8	276.9	181.0	96.9	1.0	84.0	1.47	8046	755180	846
McMullin	Fresno County	123	***175,000***	N/A	175,000	5472.0	0.0005	2.5	179.0	101.0	179.0	101.0	78.0	1.36	5352	434861	487
Fresno County	McMullin	124	***175,000***	5%	175,000	8939.7	0.0004	2.3	82.9	101.0	82.9	101.0	18.1	0.32	2773	211989	237
Fresno County	McMullin	125	***175,000***	8%	175,000	7147.8	0.0016	8.2	49.2	90.6	49.2	90.6	41.4	0.72	4725	1289186	1444
Fresno County	McMullin	126	***175,000***	9%	175,000	12139.4	0.0012	6.5	116.2	181.4	116.2	1.4	65.2	1.14	11022	2379940	2666
Fresno County	James ID	127	***175,000***	6%	175,000	10727.6	0.0015	7.9	155.0	268.0	155.0	88.0	66.9	1.17	9870	2587945	2899
Fresno County	James ID	128	***171,000***	4%	171,000	3722.6	0.0009	4.8	140.1	180.0	140.1	180.0	39.9	0.70	2390	372891	418
Central Delta Mendota Regional Mulit Agency GSA	James ID	129	***171,000***	4%	171,000	7865.6	0.0012	6.2	124.4	130.8	124.4	130.8	6.4	0.11	878	176494	198
Central Delta Mendota Regional Mulit Agency GSA	James ID	130	***171,000***	5%	171,000	16667.1	0.0010	5.2	138.7	165.8	138.7	165.8	27.1	0.47	7586	1279916	1434
Central Delta Mendota Regional Mulit Agency GSA	James ID	131	***171,000***	8%	171,000	5212.2	0.0014	7.5	149.1	180.8	149.1	0.8	31.7	0.55	2742	663532	743
Central Delta Mendota Regional Mulit Agency GSA	James ID	132	***171,000***	N/A	171,000	8711.3	0.0013	6.8	149.5	270.5	149.5	90.5	59.0	1.03	7465	1637793	1835
Central Delta Mendota Regional Mulit Agency GSA	James ID	133	***171,000***	N/A	171,000	5559.6	0.0010	5.4	153.9	200.4	153.9	20.4	46.4	0.81	4029	702511	787
Westlands WD	James ID	134	***171,000***	N/A	171,000	5435.6	0.0010	5.1	150.0	180.8	150.0	0.8	30.8	0.54	2782	458886	514
James ID	Westlands WD	135	***87,000***	N/A	87,000	6701.1	0.0011	6.0	140.6	90.6	140.6	90.6	49.9	0.87	5127	506466	567
James ID	Westlands WD	136	***87,000***	N/A	87,000	10529.2	0.0013	6.8	126.9	118.7	126.9	118.7	8.2	0.14	1497	167329	187
Westlands WD	North Fork Kings	137	***87,000***	N/A	87,000	23573.7	0.0016	8.7	111.7	153.4	111.7	153.4	41.7	0.73	15673	2244926	2515
North Fork Kings	Westlands WD	138	***90,000***	N/A	90,000	5362.7	0.0012	6.1	102.2	91.6	102.2	91.6	10.6	0.18	985	102952	115
North Fork Kings	Westlands WD	139	***90,000***	N/A	90,000	9680.0	0.0011	5.6	111.7	0.9	111.7	0.9	69.2	1.21	9048	856896	960
North Fork Kings	Westlands WD	140	***90,000***	N/A	90,000	8413.5	0.0014	7.2	106.2	90.5	106.2	90.5	15.7	0.27	2272	279203	313
Westlands WD	North Fork Kings	141	***90,000***	N/A	90,000	14877.4	0.0012	6.1	93.9	178.8	93.9	178.8	84.9	1.48	14819	1550633	1737
Westlands WD	North Fork Kings	142	***90,000***	N/A	90,000	7984.0	0.0009	4.7	74.4	178.8	74.4	178.8	75.4	1.32	7727	616590	691
Westlands WD	North Fork Kings	143	***90,000***	N/A	90,000	10906.7	0.0008	4.0	31.6	104.2	31.6	104.2	72.6	1.27	10407	705969	791
Westlands WD	North Fork Kings	144	***90,000***	N/A	90,000	5362.7	0.0008	4.3	0.9	181.6	0.9	1.6	0.7	0.01	62	4498	5
North Fork Kings	Westlands WD	145	***90,000***	N/A	90,000	5361.1	0.0005	2.4	356.6	269.2	176.6	89.2	87.4	1.53	5356	219313	246
North Fork Kings	Westlands WD	146	***90,000***	N/A	90,000	5063.3	0.0002	0.8	332.5	180.8	152.5	0.8	28.4	0.50	2405	32851	37
North Fork Kings	Westlands WD	147	***60,000***	N/A	60,000	10639.8	0.0001	0.6	275.3	90.8	95.3	90.8	4.5	0.08	839	5908	7
Westlands WD	North Fork Kings	148	***60,000***	N/A	60,000	10581.3	0.0005	2.5	305.3	90.8	125.3	90.8	34.5	0.60	5986	167828	188
North Fork Kings	Westlands WD	149	***60,000***	N/A	60,000	14856.4	0.0014	7.4	286.4	135.4	106.4	135.4	29.0	0.51	7198	607675	681
North Fork Kings	Westlands WD	150	***60,000***	N/A	60,000	15047.2	0.0010	5.1	269.4	135.4	89.4	135.4	46.0	0.80	10824	629791	705
North Fork Kings	Westlands WD	151	***60,000***	N/A	60,000	8452.6	0.0007	3.8	119.7	72.0	119.7	72.0	47.6	0.83	6244	271739	304
North Fork Kings	Westlands WD	152	***60,000***	N/A	60,000	11535.4	0.0007	3.6	166.2	136.8	166.2	136.8	29.4	0.51	5662	231157	259
North Fork Kings	Westlands WD	153	***60,000***	N/A	60,000	15489.2	0.0007	3.8	196.5	180.8	16.5	0.8	15.6	0.27	4175	181132	203
North Fork Kings	Westlands WD	154	***60,000***	N/A	60,000	5285.2	0.0008	4.1	222.1	180.8	42.1	0.8	41.3	0.72	3489	163204	183
North Fork Kings	Westlands WD	155	***90,000***	N/A	90,000	5361.1	0.0009	4.7	227.2	90.8	47.2	90.8	43.6	0.76	3695	295405	331
North Fork Kings	South Fork Kings GSA	156	***90,000***	N/A	90,000	5346.1	0.0014	7.3	228.5	77.1	48.5	77.1	28.6	0.50	2561	320507	359
South Fork Kings GSA	North Fork Kings	157	***90,000***	N/A	90,000	4074.8	0.0018	9.7	225.0	0.7	45.0	0.7	44.3	0.77	2848	470419	0
North Fork Kings	South Fork Kings GSA	158	***90,000***	N/A	90,000	2477.5	0.0021	11.3	228.1	0.7	48.1	0.7	47.4	0.83	1825	353006	0
North Fork Kings	South Fork Kings GSA	159	***90,000***	20%	90,000	6526.5	0.0026	13.5	228.2	54.4	48.2	54.4	6.2	0.11	704	161893	0
North Fork Kings	South Fork Kings GSA	160	***90,000***	19%	90,000	37726.0	0.0019	10.0	215.4	48.0	35.4	48.0	12.6	0.22	8241	1401359	0
Mid Kings River GSA	North Fork Kings	161	***90,000***	18%	90,000	4940.9	0.0023	12.2	239.1	47.3	59.1	47.3	11.8	0.21	1008	209908	0
Mid Kings River GSA	North Fork Kings	162	***90,000***	17%	90,000	5730.5	0.0020	10.7	248.4	47.3	68.4	47.3	21.1	0.37	2062	376759	0
North Fork Kings	Mid Kings River GSA	163	***90,000***	8%	90,000	19953.9	0.0028	14.6	236.8	90.4	56.8	90.4	33.7	0.59	11063	2753704	0
North Fork Kings	Mid Kings River GSA	164	***90,000***	7%	90,000	10560.8	0.0022	11.4	86.2	46.9	86.2	46.9	39.3	0.69	6684	1301038	1457
North Fork Kings	Mid Kings River GSA	165	***90,000***	11%	90,000	6769.4	0.0010	5.2	172.7	46.9	172.7	46.9	54.2	0.95	5494	483639	542
Central Kings	Mid Kings River GSA	166	***90,000***	9%	90,000	8937.1	0.0015	7.9	194.2	178.6	14.2	178.6	15.6	0.27	2407	325762	365
Central Kings	Mid Kings River GSA	167	***84,000***	4%	84,000	18901.3	0.0033	17.2	191.7	69.0	11.7	69.0	57.3	1.00	15910	4351792	0
Central Kings	Mid Kings River GSA	168	***84,000***	4%	84,000	16749.2	0.0020	10.6	176.3	27.2	176.3	27.2	31.0	0.54	8615	1457085	0
Kings River East	Mid Kings River GSA	169	***84,000***	8%	84,000	1489.1	0.0008	4.0	172.3	90.0	172.3	90.0	82.3	1.44	1476	94369	106
Mid Kings River GSA	Kings River East	170	***84,000***	15%	84,000	31942.3	0.0027	14.2	155.6	180.7	155.6	0.7	25.0	0.44	13513	3054499	3421

Attachment 3 - 2011 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
Kings River East	Mid Kings River GSA	171	***99,000***	22%	99,000	10649.1	0.0014	7.5	166.1	91.2	166.1	91.2	74.9	1.31	10280	1438760	1612
Kings River East	Greater Kaweah GSA	172	***99,000***	19%	99,000	23363.7	0.0029	15.1	237.5	64.0	57.5	64.0	6.4	0.11	2623	740959	830
Greater Kaweah GSA	Kings River East	173	***99,000***	7%	99,000	5805.0	0.0024	12.4	258.9	64.0	78.9	64.0	15.0	0.26	1500	349711	392
Kings River East	Greater Kaweah GSA	174	***50,000***	-2%	50,000	15892.6	0.0014	7.6	188.9	93.8	8.9	93.8	84.8	1.48	15828	1139706	1277
Greater Kaweah GSA	Kings River East	175	***40,000***	-2%	40,000	1714.0	0.0023	12.2	130.9	182.5	130.9	2.5	51.6	0.90	1343	124132	139
Kings River East	Greater Kaweah GSA	176	***40,000***	N/A	40,000	10626.4	0.0020	10.6	151.4	90.5	151.4	90.5	60.8	1.06	9280	745605	835
Kings River East	Greater Kaweah GSA	177	***40,000***	N/A	40,000	13273.9	0.0017	8.8	194.3	90.5	14.3	90.5	76.3	1.33	12895	857724	961
East Kaweah GSA	Kings River East	178	***20,000***	N/A	20,000	15785.5	0.0044	23.3	200.3	0.8	20.3	0.8	19.4	0.34	5256	463820	520
Kings River East	East Kaweah GSA	179	***20,000***	N/A	20,000	16008.0	0.0046	24.3	185.1	90.5	5.1	90.5	85.5	1.49	15958	1470723	1647
Kings River East	East Kaweah GSA	180	***20,000***	N/A	20,000	4996.5	N/A	N/A	N/A	359.0	N/A	179.0	N/A	N/A	N/A	N/A	N/A
Kings River East	East Kaweah GSA	181	***20,000***	N/A	20,000	3194.6	N/A	N/A	N/A	359.0	N/A	179.0	N/A	N/A	N/A	N/A	N/A
East Kaweah GSA	Kings River East	182	***20,000***	N/A	20,000	5861.0	0.0104	55.0	227.1	295.6	47.1	115.6	68.5	1.19	5452	1135892	1272

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2012 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360°)	Flow Direction converted to between 0 & 180°	Segement Azimuth converted to between 0 & 180°	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (L) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	Madera County	100	30,000	N/A	30,000	8310.4	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	101	30,000	N/A	30,000	4325.1	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
Madera County	North Kings	102	30,000	N/A	30,000	7349.7	N/A	N/A	N/A	166.5	N/A	166.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	103	30,000	N/A	30,000	12097.8	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
Madera County	North Kings	104	***30,000***	N/A	30,000	20674.9	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
North Kings	Madera County	105	***93,000***	25%	93,000	12121.9	0.0011	5.8	231.0	214.3	51.0	34.3	16.7	0.29	3486	353948	0
Madera County	North Kings	106	***211,000***	28%	211,000	5396.1	0.0013	7.1	210.4	278.3	30.4	98.3	67.8	1.18	4997	1416284	0
Root Creek WD	North Kings	107	***211,000***	13%	211,000	14767.3	0.0014	7.6	101.0	278.3	101.0	98.3	2.7	0.05	701	212276	0
North Kings	Madera County	108	***237,000***	5%	237,000	18127.3	0.0017	8.8	334.3	247.8	154.3	67.8	86.5	1.51	18093	7153562	0
North Kings	Madera ID	109	***237,000***	3%	237,000	8977.7	0.0021	11.3	334.5	270.9	154.5	90.9	63.6	1.11	8040	4067413	0
North Kings	Madera ID	110	***237,000***	0%	237,000	19839.8	0.0029	15.2	333.8	248.0	153.8	68.0	85.9	1.50	19788	13500915	0
North Kings	Madera ID	111	***184,000***	-1%	184,000	6346.9	0.0018	9.6	343.6	282.4	163.6	102.4	61.1	1.07	5558	1863218	0
North Kings	Madera ID	112	***184,000***	N/A	184,000	7833.8	0.0026	13.9	320.2	282.4	140.2	102.4	37.7	0.66	4794	2320700	0
North Kings	Madera ID	113	***184,000***	N/A	184,000	25138.2	0.0027	14.1	322.8	253.7	142.8	73.7	69.1	1.21	23485	11578277	0
McMullin	Aliso WD	114	***180,000***	N/A	180,000	11667.2	0.0031	16.3	263.2	213.3	83.2	33.3	49.9	0.87	8922	4950807	0
Aliso WD	McMullin	115	***180,000***	N/A	180,000	6284.1	0.0036	18.8	260.0	323.7	80.0	143.7	63.7	1.11	5633	3616535	0
McMullin	Aliso WD	116	***180,000***	N/A	180,000	9065.2	0.0034	18.1	283.9	250.8	103.9	70.8	33.1	0.58	4948	3058726	0
McMullin	Aliso WD	117	***180,000***	N/A	180,000	4645.4	0.0023	12.3	296.7	173.6	116.7	173.6	56.8	0.99	3888	1629666	0
McMullin	Aliso WD	118	***180,000***	N/A	180,000	13996.9	0.0015	7.7	320.6	273.4	140.6	93.4	47.2	0.82	10269	2697616	0
Aliso WD	McMullin	119	***180,000***	N/A	180,000	3456.2	0.0024	12.5	110.9	273.4	110.9	93.4	17.5	0.31	1039	441661	0
Farmers WD	McMullin	120	***180,000***	N/A	180,000	3470.6	0.0030	15.9	128.8	215.4	128.8	35.4	86.6	1.51	3465	1879712	0
Farmers WD	McMullin	121	***175,000***	N/A	175,000	5165.0	0.0025	13.2	117.4	181.0	117.4	1.0	63.6	1.11	4625	2026474	2270
Fresno County	McMullin	122	***175,000***	N/A	175,000	8089.5	0.0019	9.9	75.0	181.0	75.0	1.0	74.0	1.29	7776	2547003	2853
Fresno County	McMullin	123	***175,000***	N/A	175,000	5472.0	0.0020	10.5	17.3	101.0	17.3	101.0	83.7	1.46	5439	1894174	2122
Fresno County	McMullin	124	***175,000***	5%	175,000	8939.7	0.0035	18.6	338.3	101.0	158.3	101.0	57.2	1.00	7517	4637172	5194
Fresno County	McMullin	125	***175,000***	8%	175,000	7147.8	0.0026	13.9	340.8	90.6	160.8	90.6	70.2	1.23	6727	3095665	3468
Fresno County	McMullin	126	***175,000***	9%	175,000	12139.4	0.0018	9.7	96.3	181.4	96.3	1.4	85.1	1.48	12094	3879619	4346
Fresno County	James ID	127	***175,000***	6%	175,000	10727.6	0.0016	8.5	154.4	268.0	154.4	88.0	66.4	1.16	9832	2782155	3116
Fresno County	James ID	128	***171,000***	4%	171,000	3722.6	0.0008	4.1	147.8	180.0	147.8	180.0	32.2	0.56	1983	265902	298
Central Delta Mendota Regional Mulit Agency GSA	James ID	129	***171,000***	4%	171,000	7865.6	0.0018	9.6	126.5	130.8	126.5	130.8	4.3	0.07	587	183091	205
Central Delta Mendota Regional Mulit Agency GSA	James ID	130	***171,000***	5%	171,000	16667.1	0.0017	8.8	103.7	165.8	103.7	165.8	62.1	1.08	14731	4181103	4683
Central Delta Mendota Regional Mulit Agency GSA	James ID	131	***171,000***	8%	171,000	5212.2	0.0014	7.2	89.4	180.8	89.4	0.8	88.6	1.55	5211	1222625	1370
Central Delta Mendota Regional Mulit Agency GSA	James ID	132	***171,000***	N/A	171,000	8711.3	0.0006	3.2	133.7	270.5	133.7	90.5	43.2	0.75	5959	614601	688
James ID	Central Delta Mendota Regional Mulit Agency GSA	133	***171,000***	N/A	171,000	5559.6	0.0008	4.0	212.7	200.4	32.7	20.4	12.4	0.22	1189	155553	174
James ID	Westlands WD	134	***171,000***	N/A	171,000	5435.6	0.0006	3.2	248.5	180.8	68.5	0.8	67.8	1.18	5031	518444	581
James ID	Westlands WD	135	***87,000***	N/A	87,000	6701.1	0.0007	3.5	214.8	90.6	34.8	90.6	55.8	0.97	5546	317975	356
James ID	Westlands WD	136	***87,000***	N/A	87,000	10529.2	0.0014	7.1	147.3	118.7	147.3	118.7	28.6	0.50	5041	593466	665
Westlands WD	North Fork Kings	137	***87,000***	N/A	87,000	23573.7	0.0018	9.5	140.2	153.4	140.2	153.4	13.1	0.23	5345	834330	935
Westlands WD	North Fork Kings	138	***90,000***	N/A	90,000	5362.7	N/A	N/A	N/A	91.6	N/A	91.6	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	139	***90,000***	N/A	90,000	9680.0	0.0017	9.0	140.7	0.9	140.7	0.9	40.2	0.70	6250	956768	1072
North Fork Kings	Westlands WD	140	***90,000***	N/A	90,000	8413.5	0.0019	9.8	116.9	90.5	116.9	90.5	26.4	0.46	3738	623450	698
Westlands WD	North Fork Kings	141	***90,000***	N/A	90,000	14877.4	0.0010	5.2	33.4	178.8	33.4	178.8	34.6	0.60	8438	753278	844
North Fork Kings	Westlands WD	142	***90,000***	N/A	90,000	7984.0	0.0011	6.0	298.8	178.9	118.8	178.9	60.1	1.05	6923	709456	795
North Fork Kings	Westlands WD	143	***90,000***	N/A	90,000	10906.7	0.0016	8.4	103.6	104.2	103.6	104.2	0.7	0.01	127	18236	20
North Fork Kings	Westlands WD	144	***90,000***	N/A	90,000	5362.7	0.0012	6.2	347.1	181.6	167.1	1.6	14.5	0.25	1345	143121	160
North Fork Kings	Westlands WD	145	***90,000***	N/A	90,000	5361.1	0.0007	3.7	329.8	269.2	149.8	89.2	60.6	1.06	4670	291181	326
Westlands WD	North Fork Kings	146	***90,000***	N/A	90,000	5063.3	0.0007	3.8	12.2	180.8	12.2	0.8	11.3	0.20	993	63781	71
Westlands WD	North Fork Kings	147	***60,000***	N/A	60,000	10639.8	0.0007	3.5	287.0	90.8	107.0	90.8	16.2	0.28	2965	118838	133
Westlands WD	North Fork Kings	148	***60,000***	N/A	60,000	10581.3	0.0007	3.5	79.4	90.8	79.4	90.8	11.4	0.20	2098	83538	94
Westlands WD	North Fork Kings	149	***60,000***	N/A	60,000	14856.4	0.0017	8.9	344.8	135.4	164.8	135.4	29.4	0.51	7288	741073	830
Westlands WD	North Fork Kings	150	***60,000***	N/A	60,000	15047.2	0.0013	7.0	103.0	135.4	103.0	135.4	32.4	0.57	8068	645488	723
North Fork Kings	Westlands WD	151	***60,000***	N/A	60,000	8452.6	0.0013	6.9	222.9	72.0	42.9	72.0	29.1	0.51	4115	321895	361
Westlands WD	North Fork Kings	152	***60,000***	N/A	60,000	11535.4	0.0012	6.3	120.5	136.8	120.5	136.8	16.3	0.28	3243	231888	260
Westlands WD	North Fork Kings	153	***60,000***	N/A	60,000	15489.2	0.0005	2.6	13.7	180.8	13.7	0.8	12.9	0.22	3447	100007	112
North Fork Kings	Westlands WD	154	***60,000***	N/A	60,000	5285.2	0.0007	3.7	297.2	180.8	117.2	0.8	63.6	1.11	4736	200319	224
Westlands WD	North Fork Kings	155	***90,000***	N/A	90,000	5361.1	0.0013	6.7	299.6	90.8	119.6	90.8	28.8	0.50	2581	296054	332
South Fork Kings GSA	North Fork Kings	156	***90,000***	N/A	90,000	5346.1	0.0016	8.5	305.5	77.1	125.5	77.1	48.4	0.84	3998	579014	649
South Fork Kings GSA	North Fork Kings	157	***90,000***	N/A	90,000	4074.8	0.0017	9.0	284.6	0.7	104.6	0.7	76.1	1.33	3955	604801	0
South Fork Kings GSA	North Fork Kings	158	***90,000***	N/A	90,000	2477.5	0.0026	13.5	260.6	0.7	80.6	0.7	79.9	1.40	2439	563021	0
South Fork Kings GSA	North Fork Kings	159	***90,000***	20%	90,000	6526.5	0.0045	23.7	243.0	54.4	63.0	54.4	8.6	0.15	974	394265	0
South Fork Kings GSA	North Fork Kings	160	***90,000***	19%	90,000	37726.0	0.0022	11.7	262.8	48.0	82.8	48.0	34.8	0.61	21533	4298109	0
North Fork Kings	Mid Kings River GSA	161	***90,000***	18%	90,000	4940.9	0.0027	14.1	210.2	47.3	30.2	47.3	17.2	0.30	1461	350285	0
North Fork Kings	Mid Kings River GSA	162	***90,000***	17%	90,000	5730.5	0.0040	21.4	216.7	47.3	36.7	47.3	10.7	0.19	1063	387332	0
North Fork Kings	Mid Kings River GSA	163	***90,000***	8%	90,000	19953.9	0.0040	21.0	216.8	90.4	36.8	90.4	53.7	0.94	16075	5746847	0
North Fork Kings	Mid Kings River GSA	164	***90,000***	7%	90,000	10560.8	0.0021	11.2	195.0	46.9	15.0	46.9	32.0	0.56	5589	1070269	1199
Mid Kings River GSA	North Fork Kings	165	***90,000***	11%	90,000	6769.4	0.0020	10.4	36.5	46.9	36.5	46.9	10.4	0.18	1223	217105	243
Mid Kings River GSA	Central Kings	166	***90,000***	9%	90,000	8937.1	0.0026	13.6	84.8	178.6	84.8	178.6	86.2	1.50	8918	2072910	2322
Central Kings	Mid Kings River GSA	167	***84,000***	4%	84,000	18901.3	0.0051	26.7	170.1	69.0	170.1	69.0	78.9	1.38	18550	7884064	0
Central Kings	Mid Kings River GSA	168	***84,000***	4%	84,000	16749.2	0.0026	13.5	137.6	27.2	137.6	27.2	69.7	1.22	15707	3377352	0
Kings River East	Mid Kings River GSA	169	***84,000***	8%	84,000	1489.1	0.0020	10.6	106.0	90.0	106.0	90.0	16.0	0.28	410	69522	78
Mid Kings River GSA	Kings River East	170	***84,000***	15%	84,000	31942.3	0.0035	18.7	163.5	180.7	163.5	0.7	17.1	0.30	9409	2795219	3131
Kings River East	Mid Kings River GSA	171	***99,000***	22%	99,000	10649.1	0.0017	9.1	203.9	91.2	23.9	91.2	67.3	1.18	9828	1683644	1886
Kings River East	Greater Kaweah GSA	172	***99,000***	19%	99,000	23363.7	0.0024	12.5	243.9	64.0	63.9	64.0	0.0	0.00	17	4068	5
Greater Kaweah GSA	Kings River East	173	***99,000***	7%	99,000	5805.0	0.0038	20.2	287.9	64.0	107.9	64.0	43.9	0.77	4027	1527193	1711
Kings River East	Greater Kaweah GSA	174	***50,000***	-2%	50,000	15892.6	0.0021	10.9	265.8	93.8	85.8	93.8	8.0	0.14	2199	227543	255
Greater Kaweah GSA	Kings River East	175	***40,000***	-2%	40,000	1714.0	0.0023	12.1	116.3	182.5	116.3	2.5	66.2	1.15	1568	144060	161
Kings River East	Greater Kaweah GSA	176	***40,000***	N/A	40,000	10626.4	0.0025	13.3	107.0	90.5	107.0	90.5	16.5	0.29	3012	303958	340
Kings River East	Greater Kaweah GSA	177	***40,000***	N/A	40,000	13273.9	0.0049	26.1	167.3	90.5	167.3	90.5	76.8	1.34	12922	2557875	2865
East Kaweah GSA	Kings River East	178	***20,000***	N/A	20,000	15785.5	0.0051	26.9	191.8	0.8	11.8	0.8	11.0	0.19	3008	306908	344
Kings River East	East Kaweah GSA	179	***20,000***	N/A	20,000	16008.0	0.0033	17.5	197.1	90.5	17.1	90.5	73.5	1.28	15346	1019747	1142
East Kaweah GSA	Kings River East	180	***20,000***	N/A	20,000	4996.5	0.0047	24.8	239.9	359.0	59.9	179.0	60.9	1.06	4368	409634	459

Attachment 3 - 2012 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^{o})	Flow Direction converted to between 0 & 180^{o}	Segement Azimuth converted to between 0 & 180^{o}	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
East Kaweah GSA	Kings River East	181	***20,000***	N/A	20,000	3194.6	0.0057	30.2	225.0	359.0	45.0	179.0	46.0	0.80	2300	262788	294
East Kaweah GSA	Kings River East	182	***20,000***	N/A	20,000	5861.0	0.0051	27.0	212.5	295.6	32.5	115.6	83.1	1.45	5819	595778	667

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 4

Estimated Flows
Grouped by Shared Boundaries

Internal

Kings Subbasin Groundwater Flow (Unconfined) Estimation

10-24-18 Boundary Flow Estimations.
Values will change if contours are revised.

		1925		1997		1998		1999		2000		2001		2002		2003		2004		2005		2006		2007		2008		2009		2011		2012		Average 97-12	
GSA	Neighboring GSA	Internal	External	Internal	External	Internal	External	Internal	External	Internal	External	Internal	External	Internal	External	Internal	External	Internal	External	Internal	External	Internal	External	Internal	External	Internal	External	Internal	External	Internal	External	Internal	External	Internal	External
Central/South Kings		-10,500	-600	-26,900	-500	-20,100	-1,100	-24,200	-1,100	-21,000	800	-19,000	1,200	-17,300	-300	-13,900	2,700	-7,500	700	-20,000	2,200	-21,400	2,500	-23,500	-1,100	-17,900	-400	-15,900	-1,000	-21,900	-400	-34,800	2,300	-20,400	400
	McMullin	-4,400		-8,000		-7,400		-8,500		-8,500		-8,300		-8,000		-5,200		-4,800		-7,300		-7,000		-9,000		-8,700		-5,700		-8,100		-10,300		-7,700	
	North Fork	-9,500		-15,800		-15,400		-15,600		-15,200		-14,200		-13,200		-8,700		-6,100		-11,300		-17,400		-19,500		-15,100		-15,500		-19,700		-24,100		-15,100	
	Kings River East	0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0	
	North Kings	3,400		-3,100		2,700		-100		2,700		3,500		3,900		0		3,400		-1,400		3,000		5,000		5,900		5,300		5,900		-400		2,400	
	Mid Kings River GSA		-600		-500		-1,100		-1,100		800		1,200		-300		2,700		700		2,200		2,500		-1,100		-400		-1,000		-400		2,300		400
James		2,500	0	-16,400	4,500	-14,800	200	-45,300	-500	-9,800	11,300	-27,400	16,400	-2,900	0	-13,600	11,400	-20,000	13,200	-30,400	6,100	-4,700	1,300	-39,800	600	-24,100	21,500	-20,600	12,000	-13,700	8,100	-4,300	8,600	-19,200	7,700
	McMullin	2,400		-10,100		-13,000		-42,200		-7,800		-24,400		-5,500		-9,600		-17,800		-23,400		-4,300		-32,400		-19,600		-15,100		-13,700		-3,600		-16,200	
	North Fork	100		-6,300		-1,800		-3,100		-2,000		-3,000		2,600		-4,000		-2,200		-7,000		-400		-7,400		-4,500		-5,500		0		-700		-3,000	
	Fresno County		0		1,400		1,300		100		2,100		2,200		0		3,100		2,000		300		1,300		-4,700		-200		4,100		3,300		3,400		1,300
	CDMRMA		0		4,200		500		500		10,900		16,600		0		11,100		12,600		5,800		0		3,900		22,800		9,900		5,000		6,800		7,400
	Westlands WD		0		-1,100		-1,600		-1,100		-1,700		-2,400		0		-2,800		-1,400		0		0		1,400		-1,100		-2,000		-200		-1,600		-1,000
Kings River East		0	0	0	5,400	0	-1,600	0	-2,000	0	-2,300	0	-5,200	0	-2,400	0	-2,900	0	1,800	0	-7,500	0	-3,000	0	-1,700	0	-5,900	0	-2,600	0	-1,600	0	200	0	-2,100
	Central/South Kings	0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0	
	North Kings	0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0	
	Mid Kings River GSA		0		7,800		1,200		4,900		2,800		1,200		700		1,800		2,200		100		3,700		3,900		-600		6,800		1,700		1,200		2,600
	Greater Kaweah GSA		0		-700		-1,600		-4,600		-4,900		-5,300		-2,400		-4,700		-1,000		-6,900		-6,500		-5,800		-5,300		-9,300		-3,400		-1,600		-4,300
	East Kaweah GSA		0		-1,700		-1,200		-2,300		-200		-1,100		-700		0		600		-700		-200		200		0		-100		100		600		-400
McMullin		16,600	-300	92,000	5,300	89,600	6,400	113,000	6,400	79,100	8,700	103,300	10,100	81,700	-2,500	83,600	1,800	89,100	200	95,300	33,700	79,700	-7,600	110,400	2,400	95,000	1,200	88,900	5,800	93,000	2,400	80,700	20,300	91,700	6,300
	North Kings	18,800		69,000		54,300		53,600		56,000		61,100		57,600		65,400		67,600		66,300		66,700		72,100		71,600		68,200		72,000		67,200		64,600	
	Central/South Kings	4,400		8,000		7,400		8,500		8,500		8,300		8,000		5,200		4,800		7,300		7,000		9,000		8,700		5,700		8,100		10,300		7,700	
	North Fork	-4,200		4,900		14,900		8,700		6,800		9,500		10,600		3,400		-1,100		-1,700		1,700		-3,100		-4,900		-100		-800		-400		3,200	
	James	-2,400		10,100		13,000		42,200		7,800		24,400		5,500		9,600		17,800		23,400		4,300		32,400		19,600		15,100		13,700		3,600		16,200	
	Aliso WD		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
	Farmers WD		0		1,400		1,100		0		-500		1,400		0		0		1,700		2,000		-900		0		-600		100		-600		2,300		500
	Frenso County		-300		3,900		5,300		6,400		9,200		8,700		-2,500		1,800		-1,500		31,700		-6,700		2,400		1,800		5,700		3,000		18,000		5,800
North Fork Kings		13,600	500	17,200	1,200	2,300	-2,100	10,000	2,900	10,400	-9,400	7,700	-11,000	0	-4,300	9,300	-6,000	9,400	-2,800	20,000	800	16,100	-3,100	30,000	18,900	24,500	19,700	21,100	13,300	20,500	-800	25,200	3,700	14,900	1,400
	Central/South Kings	9,500		15,800		15,400		15,600		15,200		14,200		13,200		8,700		6,100		11,300		17,400		19,500		15,100		15,500		19,700		24,100		15,100	
	McMullin	4,200		-4,900		-14,900		-8,700		-6,800		-9,500		-10,600		-3,400		1,100		1,700		-1,700		3,100		4,900		100		800		400		-3,200	
	James	-100		6,300		1,800		3,100		2,000		3,000		-2,600		4,000		2,200		7,000		400		7,400		4,500		5,500		0		700		3,000	
	Westlands WD		0		-1,600		-2,700		1,900		-11,600		-11,100		-9,000		-4,100		-1,300		2,300		-3,000		17,100		16,600		12,800		1,600		4,300		800
	South Fork Kings GSA		0		300		0		0		-400		0		-700		-500		0		100		-100		300		1,300		0		-400		600		0
	Mid Kings River GSA		500		2,500		600		1,000		2,600		100		5,400		-1,400		-1,500		-1,600		0		1,500		1,800		500		-2,000		-1,200		600
North Kings		-22,200	0	-65,900	0	-57,000	0	-53,500	0	-58,700	0	-64,600	0	-61,500	0	-65,400	0	-71,000	0	-64,900	0	-69,700	0	-77,100	0	-77,500	0	-73,500	0	-77,900	0	-66,800	0	-67,000	0
	Kings River East	0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0	
	McMullin	-18,800		-69,000		-54,300		-53,600		-56,000		-61,100		-57,600		-65,400		-67,600		-66,300		-66,700		-72,100		-71,600		-68,200		-72,000		-67,200		-64,600	
	Central/South Kings	-3,400		3,100		-2,700		100		-2,700		-3,500		-3,900		0		-3,400		1,400		-3,000		-5,000		-5,900		-5,300		-5,900		400		-2,400	
	Madera County		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
	Root Creek WD		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
	Madera ID		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0

Notes: 1) Values are acre-feet. Positive means inflow from neighboring GSA. Negative value means outflow to neighboring GSA.
2) CDMRMA = Central Delta Mendota Regional Multi Agency GSA
3) External flows are draft as of 10/24/2018

1925 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Kings	→	McMullin	0	0
			2	415
			3	1,390
			4	1,317
			5	1,067
			6	4,194
			7	2,318
			8	1,374
			9	1,465
			10	1,346
			11	1,557
			12	1,871
			13	1,089
		Total		**19,404**
McMullin	→	North Kings	1	638
		Total		**638**
North Kings	→	Central Kings	14	568
			16	1,399
			17	599
			18	697
			20	808
			24	1,265
			25	3,165
			26	593
			27	373
		Total		**9,468**
Central Kings	→	North Kings	15	918
			19	1,142
			21	483
			22	1,515
			23	1,970
		Total		**6,029**
North Kings	→	Kings River East	28	0
			29	0
			30	0
			31	0
			32	0
		Total		**0**

1925 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
Central Kings	→	Kings River East	33	0
			37	0
			38	0
			40	0
			44	0
			45	0
			46	0
		Total		**0**
Kings River East	→	Central Kings	34	0
			35	0
			36	0
			39	0
			41	0
			42	0
			43	0
			47	0
		Total		**0**
Central Kings	→	McMullin	48	2,007
			49	861
			50	189
			51	1,326
		Total		**4,383**
McMullin	→	James	52	407
			53	431
			54	271
			55	390
			56	308
			57	237
			58	153
			59	170
		Total		**2,367**
North Fork Kings	→	McMullin	60	269
			64	5
			66	300
		Total		**574**
McMullin	→	North Fork Kings	61	759
			62	1,404
			63	1,538
			65	47
			67	99
			68	504
			69	381
		Total		**4,733**

1925 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
Central Kings	→	North Fork Kings	70	429
			71	627
			72	360
			73	951
			75	805
			76	2,300
			77	137
			78	1,827
			79	525
			80	701
			81	1,011
			82	85
		Total		**9,758**
North Fork Kings	→	Central Kings	74	223
		Total		**223**
North Fork Kings	→	James	83	N/A
			84	14
			85	48
		Total		**61**

1997 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Kings	→	McMullin	0	1,408
			1	2,413
			3	2,244
			4	5,279
			5	1,261
			6	10,923
			7	5,065
			8	5,469
			9	7,075
			10	5,921
			11	11,302
			12	7,255
			13	3,973
		Total		**69,587**
McMullin	→	North Kings	2	622
		Total		**622**
North Kings	→	Central Kings	14	1,604
			16	1,542
			17	369
			18	614
			24	1,282
			25	2,635
			26	670
			27	576
		Total		**9,292**
Central Kings	→	North Kings	15	4,215
			19	2,642
			20	287
			21	805
			22	2,099
			23	2,312
		Total		**12,360**
North Kings	→	Kings River East	28	0
			29	0
			30	0
			31	0
		Total		**0**
Kings River East	→	North Kings	32	0
		Total		**0**

1997 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
Central Kings	→	Kings River East	33	0
			36	0
			37	0
			38	0
			41	0
			46	0
			47	0
		Total		**0**
Kings River East	→	Central Kings	34	0
			35	0
			39	0
			40	0
			41	0
			42	0
			43	0
			44	0
			45	0
		Total		**0**
Central Kings	→	McMullin	48	4,000
			49	2,212
			51	1,915
		Total		**8,126**
McMullin	→	Central Kings	50	92
		Total		**92**
McMullin	→	James	52	218
			53	709
			54	214
		Total		**1,141**
James	→	McMullin	55	1,396
			56	3,195
			57	3,175
			58	2,048
			59	1,388
		Total		**11,202**
North Fork Kings	→	McMullin	61	2,154
			62	3,295
			63	490
			64	969
			65	112
			66	457
		Total		**7,478**

1997 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
McMullin	→	North Fork Kings	60	1,093
			67	46
			68	631
			69	831
		Total		**2,602**
North Fork Kings	→	Central Kings	74	474
			79	18
		Total		**493**
Central Kings	→	North Fork Kings	70	976
			71	702
			72	894
			73	1,354
			75	708
			76	3,502
			77	400
			78	3,054
			80	217
			81	2,847
			82	1,667
		Total		**16,321**
James	→	North Fork Kings	83	1,417
			84	731
			85	4,119
		Total		**6,267**

1998 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Kings	→	McMullin	0	970
			1	659
			3	880
			4	6,896
			5	2,777
			6	7,871
			7	1,822
			8	3,046
			9	4,270
			10	7,767
			11	9,270
			12	6,215
			13	2,569
		Total		**55,012**
McMullin	→	North Kings	2	694
		Total		**694**
North Kings	→	Central Kings	14	1,642
			16	1,629
			17	953
			18	2,158
			24	1,611
			25	2,429
			26	766
			27	682
		Total		**11,869**
Central Kings	→	North Kings	15	1,564
			19	2,010
			20	2
			21	790
			22	2,002
			23	2,821
		Total		**9,189**
North Kings	→	Kings River East	28	0
			29	0
			30	0
		Total		**0**
Kings River East	→	North Kings	31	0
			32	0
		Total		**0**

1998 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
Central Kings	→	Kings River East	33	0
			35	0
			36	0
			37	0
			38	0
			40	0
			41	0
			46	0
		Total		**0**
Kings River East	→	Central Kings	34	0
			39	0
			42	0
			43	0
			44	0
			45	0
			47	0
		Total		**0**
Central Kings	→	McMullin	48	4,147
			49	2,440
			51	1,241
		Total		**7,828**
McMullin	→	Central Kings	50	414
		Total		**414**
James	→	McMullin	52	131
			53	107
			54	719
			55	2,105
			56	2,257
			57	2,893
			58	3,222
			59	1,538
		Total		**12,973**
North Fork Kings	→	McMullin	60	195
			61	2,497
			62	6,822
			63	5,141
			64	1,240
			65	182
			66	197
			67	106
		Total		**16,379**
McMullin	→	North Fork Kings	68	675
			69	808
		Total		**1,483**

1998 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Fork Kings	→	Central Kings	70	733
			74	158
		Total		**891**
Central Kings	→	North Fork Kings	71	663
			72	1,309
			73	1,277
			75	817
			76	3,864
			77	429
			78	4,100
			79	101
			80	575
			81	2,226
			82	971
		Total		**16,333**
James	→	North Fork Kings	83	1,411
			84	509
		Total		**1,920**
North Fork Kings	→	James	85	121
		Total		**121**

1999 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Kings	→	McMullin	0	1,221
			1	1,837
			3	52
			4	5,931
			5	2,038
			6	9,217
			7	2,310
			8	4,015
			9	4,064
			10	6,381
			11	12,782
			12	1,012
			13	3,077
		Total		**53,935**
McMullin	→	North Kings	2	313
		Total		**313**
North Kings	→	Central	14	1,600
			16	2,734
			17	648
			18	1,785
			20	1,032
			24	283
			25	1,949
			26	516
			27	510
		Total		**11,058**
Central	→	North Kings	15	1,766
			19	2,429
			21	868
			22	2,104
			23	3,950
		Total		**11,118**
North Kings	→	Kings River East	28	0
			29	0
			30	0
			31	0
		Total		**0**
Kings River East	→	North Kings	32	0
		Total		**0**

1999 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
Kings River East		Central	35	0
			39	0
			40	0
			41	0
			44	0
			45	0
		Total		**0**
Central	→	Kings River East	33	0
			34	0
			37	0
			36	0
			38	0
			42	0
			43	0
			46	0
			47	0
		Total		**0**
North Fork Kings	→	Central	70	1,245
			74	504
		Total		**1,748**
Central	→	North Fork Kings	71	1,083
			72	747
			73	1,535
			75	560
			76	3,432
			77	377
			78	3,505
			79	489
			80	1,338
			81	2,823
			82	1,437
		Total		**17,325**
North Fork Kings	→	McMullin	61	1,951
			62	2,576
			63	399
			64	3,043
			65	357
			66	278
			67	260
			69	1,144
		Total		**10,007**
McMullin	→	North Fork Kings	60	539
			68	785
		Total		**1,324**

1999 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
James	→	North Fork Kings	83	1,442
			84	539
			85	1,157
		Total		**3,138**
James	→	McMullin	52	4,327
			53	7,139
			54	5,195
			55	9,454
			56	8,310
			57	4,731
			58	1,778
			59	1,218
		Total		**42,152**
McMullin	→	Central	50	261
		Total		**261**
Central	→	McMullin	48	4,814
			49	2,452
			51	1,445
		Total		**8,711**

2000 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Kings	→	McMullin	0	1,474
			1	2,911
			4	3,590
			5	1,432
			6	9,828
			7	5,305
			8	3,383
			9	6,247
			10	5,749
			11	10,433
			12	3,280
			13	3,380
		Total		**57,014**
McMullin	→	North Kings	3	814
			3	198
		Total		**1,012**
North Kings	→	Central	14	1,324
			16	1,046
			17	877
			18	1,258
			20	2,049
			24	2,279
			25	2,524
			26	567
			27	500
		Total		**12,423**
Central	→	North Kings	15	1,116
			19	2,866
			21	538
			22	1,915
			23	3,251
		Total		**9,687**
North Kings	→	Kings River East	28	0
			29	0
			30	0
			31	0
		Total		**0**
Kings River East	→	North Kings	32	0
		Total		**0**

2000 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
Kings River East		Central	35	0
			39	0
			40	0
			41	0
			42	0
			43	0
			44	0
			45	0
			47	0
		Total		**0**
Central	→	Kings River East	33	0
			34	0
			36	0
			37	0
			38	0
			46	0
		Total		**0**
North Fork Kings	→	Central	70	1,000
			71	1,401
			74	687
		Total		**3,087**
Central	→	North Fork Kings	72	1,791
			73	2,272
			75	557
			76	3,033
			77	412
			78	3,353
			79	705
			80	1,998
			81	2,594
			82	1,527
		Total		**18,243**
North Fork Kings	→	McMullin	60	954
			61	2,012
			62	2,725
			63	255
			64	625
			66	481
			69	458
		Total		**7,509**
McMullin		North Fork Kings	65	37
			67	210
			68	436
		Total		**684**

2000 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
James	→	North Fork Kings	83	1,740
			84	1,001
		Total		**2,741**
North Fork Kings	→	James	85	751
				751
James	→	McMullin	52	1,822
			53	924
			54	285
			56	273
			57	3,232
			58	1,373
			59	415
		Total		**8,324**
McMullin	→	James	55	569
		Total		**569**
McMullin	→	Central	50	228
		Total		**228**
Central	→	McMullin	48	5,205
			49	2,592
			51	933
		Total		**8,731**

2001 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Kings	→	McMullin	0	1,689
			1	3,506
			3	2,203
			4	2,816
			5	686
			6	9,104
			7	2,076
			8	5,442
			9	4,550
			10	7,135
			11	15,088
			12	3,648
			13	3,364
		Total		**61,307**
McMullin	→	North Kings	2	167
		Total		**167**
North Kings	→	Central	14	1,320
			16	1,975
			17	907
			18	2,224
			24	1,004
			25	1,786
			26	486
			27	447
		Total		**10,148**
Central	→	North Kings	15	1,190
			19	1,252
			20	1,686
			21	825
			22	1,145
			23	562
		Total		**6,661**
North Kings	→	Kings River East	28	0
			29	0
			30	0
			31	0
		Total		**0**
Kings River East	→	North Kings	32	0
		Total		**0**

2001 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
			39	0
			40	0
			41	0
			42	0
			43	0
			44	0
			45	0
			47	0
		Total		**0**
Central	→	Kings River East	33	0
			34	0
			35	0
			36	0
			37	0
			38	0
			46	0
		Total		**0**
North Fork Kings	→	Central	70	905
			74	678
		Total		**1,583**
Central	→	North Fork Kings	71	92
			72	1,494
			73	738
			75	1,032
			76	3,468
			77	431
			78	3,907
			79	751
			80	2,057
			81	1,477
			82	354
		Total		**15,801**
North Fork Kings	→	McMullin	60	872
			61	2,456
			62	2,381
			63	1,853
			64	1,889
			65	193
			66	330
			67	422
		Total		**10,397**
McMullin	→	North Fork Kings	68	801
			69	70
		Total		**871**

2001 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
James	→	North Fork Kings	83	1,801
			84	1,045
			85	179
		Total		**3,025**
James	→	McMullin	52	2,178
			53	1,866
			54	1,738
			55	4,729
			56	4,369
			57	4,375
			58	3,332
			59	1,786
		Total		**24,373**
McMullin	→	Central	50	387
		Total		**387**
Central	→	McMullin	48	5,674
			49	1,991
			51	1,026
		Total		**8,691**

2002 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Kings	→	McMullin	0	703
			1	1,396
			2	224
			4	3,159
			5	1,630
			6	7,542
			7	4,850
			8	4,615
			9	7,107
			10	6,072
			11	11,700
			12	5,493
			13	3,949
		Total		**58,440**
McMullin	→	North Kings	3	818
		Total		**818**
North Kings	→	Central	14	1,642
			16	2,137
			17	1,096
			18	2,482
			20	483
			24	2,956
			25	408
			26	528
			27	543
		Total		**12,275**
Central	→	North Kings	15	1,564
			19	1,822
			21	722
			22	2,480
			23	1,758
		Total		**8,347**
North Kings	→	Kings River East	28	0
			29	0
			30	0
			31	0
		Total		**0**
Kings River East	→	North Kings	32	0
		Total		**0**

2002 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
Kings River East	→	Central	35	0
			36	0
			39	0
			40	0
			41	0
			42	0
			44	0
			45	0
		Total		**0**
Central	→	Kings River East	33	0
			34	0
			37	0
			38	0
			43	0
			46	0
			47	0
		Total		**0**
North Fork Kings	→	Central	70	1,594
			74	712
		Total		**2,306**
Central	→	North Fork Kings	71	538
			72	1,388
			73	1,562
			75	533
			76	3,804
			77	458
			78	4,071
			79	578
			80	886
			81	1,427
			82	275
		Total		**15,520**
North Fork Kings	→	McMullin	60	1,301
			61	1,332
			62	3,094
			63	1,470
			64	1,548
			65	171
			66	614
			67	395
			69	1,323
		Total		**11,247**
McMullin	→	North Fork Kings	68	667
		Total		**667**

2002 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Fork Kings	→	James	83	N/A
			85	2,557
		Total		**2,557**
James	→	North Fork Kings	84	N/A
		Total		**0**
McMullin	→	James	52	373
			53	524
			54	296
			55	449
		Total		**1,641**
James	→	McMullin	56	665
			57	2,047
			58	3,035
			59	1,430
		Total		**7,177**
McMullin	→	Central	50	279
		Total		**279**
Central	→	McMullin	48	5,129
			49	2,185
			51	976
		Total		**8,290**

2003 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Kings	→	McMullin	0	1,068
			1	1,388
			4	5,877
			5	1,522
			6	10,093
			7	4,007
			8	5,868
			9	6,980
			10	9,492
			11	10,948
			12	5,272
			13	3,145
		Total		**65,662**
McMullin	→	North Kings	2	208
			3	51
		Total		**259**
North Kings	→	Central	14	1,496
			16	1,938
			17	1,138
			18	3,282
			24	702
			25	1,883
			26	583
			27	596
		Total		**11,617**
Central	→	North Kings	15	1,632
			19	1,872
			20	926
			21	1,155
			22	2,423
			23	3,629
		Total		**11,637**
North Kings	→	Kings River East	28	0
			29	0
			30	0
			31	0
		Total		**0**
Kings River East	→	North Kings	32	0
		Total		**0**

2003 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
Kings River East	→	Central	35	0
			36	0
			39	0
			40	0
			41	0
			43	0
			44	0
			45	0
			47	0
		Total		**0**
Central	→	Kings River East	33	0
			34	0
			37	0
			38	0
			42	0
			46	0
		Total		**0**
North Fork Kings	→	Central	70	1,610
			74	1,012
			82	602
		Total		**3,223**
Central	→	North Fork Kings	71	529
			72	1,019
			73	1,479
			75	356
			76	1,872
			77	247
			78	3,101
			79	725
			80	1,675
			81	898
		Total		**11,901**
North Fork Kings	→	McMullin	61	724
			62	2,390
			64	903
			65	140
			66	688
			67	262
			69	896
		Total		**6,003**
McMullin	→	North Fork Kings	60	685
			63	984
			68	933
		Total		**2,603**

2003 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
James	→	North Fork Kings	83	2,247
			84	511
			85	1,221
		Total		**3,979**
James	→	McMullin	52	1,464
			53	1,154
			54	1,070
			55	1,802
			56	1,356
			57	1,413
			58	971
			59	409
		Total		**9,637**
McMullin	→	Central	50	317
			51	225
		Total		**542**
Central	→	McMullin	48	3,842
			49	1,855
		Total		**5,697**

2004 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Kings	→	McMullin	0	1,995
			1	921
			2	1,783
			3	2,994
			4	6,062
			5	1,862
			6	10,608
			7	3,987
			8	5,594
			9	7,211
			10	6,287
			11	9,408
			12	5,777
			13	3,132
		Total		**67,621**
North Kings	→	Central	14	1,940
			16	2,247
			17	1,208
			18	2,255
			20	685
			24	3,646
			25	2,726
			26	582
			27	547
		Total		**15,838**
Central	→	North Kings	15	1,849
			19	2,528
			21	1,064
			22	3,220
			23	3,727
		Total		**12,388**
North Kings	→	Kings River East	28	0
			29	0
			30	0
			31	0
		Total		**0**
Kings River East	→	North Kings	32	0
		Total		**0**

2004 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
Kings River East	→	Central	35	0
			36	0
			39	0
			40	0
			41	0
			43	0
			44	0
			45	0
			47	0
		Total		**0**
Central	→	Kings River East	33	0
			34	0
			37	0
			38	0
			42	0
			46	0
		Total		**0**
North Fork Kings	→	Central	70	1,422
			71	319
			73	1,444
			74	1,130
			75	53
			82	983
		Total		**5,351**
Central	→	North Fork Kings	72	992
			76	1,951
			77	299
			78	3,546
			79	915
			80	2,078
			81	1,636
		Total		**11,415**
North Fork Kings	→	McMullin	61	1,700
			65	219
			66	545
			69	102
		Total		**2,566**
McMullin	→	North Fork Kings	60	191
			62	929
			63	1,004
			64	806
			67	201
			68	530
		Total		**3,661**

2004 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
James	→	North Fork Kings	83	936
			84	241
			85	997
		Total		**2,174**
James	→	McMullin	52	1,648
			53	2,217
			54	719
			55	934
			56	2,128
			57	3,238
			58	4,747
			59	2,160
		Total		**17,792**
McMullin	→	Central	50	499
		Total		**499**
Central	→	McMullin	48	2,747
			49	1,497
			51	1,036
		Total		**5,280**

2005 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Kings	→	McMullin	0	2,185
			1	1,343
			2	1,279
			3	3,262
			4	7,075
			5	1,926
			6	10,631
			7	4,050
			8	3,107
			9	6,033
			10	6,841
			11	11,323
			12	4,799
			13	2,470
		Total		**66,323**
North Kings	→	Central	14	1,631
			16	1,940
			17	1,129
			18	2,806
			24	1,179
			25	1,201
			26	547
			27	531
		Total		**10,965**
Central	→	North Kings	15	1,526
			19	1,869
			20	947
			21	1,070
			22	3,431
			23	3,504
		Total		**12,347**
North Kings	→	Kings River East	28	0
			29	0
			30	0
			31	0
		Total		**0**
Kings River East	→	North Kings	32	0
		Total		**0**

2005 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
Kings River East	→	Central	39	0
			40	0
			41	0
			42	0
			43	0
			44	0
			45	0
			47	0
		Total		**0**
Central	→	Kings River East	33	0
			34	0
			35	0
			36	0
			37	0
			38	0
			46	0
		Total		**0**
North Fork Kings	→	Central	70	1,869
			74	771
		Total		**2,640**
Central	→	North Fork Kings	71	25
			72	988
			73	948
			75	661
			76	2,655
			77	370
			78	3,049
			79	606
			80	1,942
			81	2,223
			82	506
		Total		**13,975**
North Fork Kings	→	McMullin	61	1,504
			64	359
			65	116
			66	608
			67	240
			69	1,962
		Total		**4,791**
McMullin	→	North Fork Kings	60	522
			62	2,813
			63	2,567
			68	624
		Total		**6,525**

2005 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
James	→	North Fork Kings	83	2,474
			84	1,565
			85	2,942
		Total		**6,981**
James	→	McMullin	52	3,917
			53	4,222
			54	2,904
			55	3,509
			56	1,763
			57	4,362
			58	1,828
			59	923
		Total		**23,429**
McMullin	→	Central	50	183
		Total		**183**
Central	→	McMullin	48	4,077
			49	2,233
			51	1,143
		Total		**7,454**

2006 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Kings	→	McMullin	0	742
			1	1,710
			3	1,056
			4	5,558
			5	1,452
			6	8,673
			8	10,050
			9	7,364
			10	8,612
			11	14,739
			12	4,426
			13	3,624
		Total		**68,005**
McMullin	→	North Kings	2	1,072
			7	199
		Total		**1,272**
North Kings	→	Central	14	2,166
			16	2,801
			17	1,017
			18	2,900
			20	1,004
			24	169
			25	1,469
			26	484
			27	458
		Total		**12,469**
Central	→	North Kings	15	2,106
			19	1,866
			21	772
			22	2,058
			23	2,663
		Total		**9,466**
North Kings	→	Kings River East	28	0
			29	0
			30	0
			31	0
		Total		**0**
Kings River East	→	North Kings	32	0
		Total		**0**

2006 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
Kings River East	→	Central	34	0
			35	0
			36	0
			39	0
			40	0
			41	0
			42	0
			43	0
			44	0
			45	0
			47	0
		Total		**0**
Central	→	Kings River East	33	0
			37	0
			38	0
			46	0
		Total		**0**
North Fork Kings	→	Central	70	364
			74	734
		Total		**1,098**
Central	→	North Fork Kings	71	611
			72	949
			73	1,560
			75	217
			76	2,986
			77	353
			78	3,827
			79	1,035
			80	2,195
			81	3,650
			82	1,079
		Total		**18,463**
North Fork Kings	→	McMullin	61	1,579
			63	278
			64	1,256
			65	186
			66	611
		Total		**3,910**
McMullin	→	North Fork Kings	60	481
			62	548
			67	93
			68	938
			69	118
		Total		**2,179**

2006 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
James	→	North Fork Kings	83	N/A
			85	554
		Total		**554**
North Fork Kings	→	James	84	171
		Total		**171**
McMullin	→	James	52	625
			53	412
		Total		**1,038**
James	→	McMullin	54	133
			55	1,184
			56	1,205
			57	1,043
			58	1,071
			59	677
		Total		**5,313**
McMullin	→	Central	50	225
		Total		**225**
Central	→	McMullin	48	2,987
			49	3,610
			51	623
		Total		**7,220**

2007 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Kings	→	McMullin	0	1,229
			1	4,161
			2	1,098
			3	1,461
			4	4,310
			5	2,392
			6	10,450
			7	2,675
			8	5,640
			9	7,760
			10	8,082
			11	14,370
			12	4,614
			13	3,872
		Total		**72,114**
North Kings	→	Central	14	1,542
			16	3,809
			17	707
			18	3,436
			20	1,436
			24	385
			25	1,765
			26	539
			27	477
		Total		**14,094**
Central	→	North Kings	15	1,258
			19	2,956
			21	1,130
			22	2,144
			23	1,601
		Total		**9,089**
North Kings	→	Kings River East	28	0
			29	0
			30	0
			31	0
		Total		**0**
Kings River East	→	North Kings	32	0
		Total		**0**

2007 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
Kings River East	→	Central	34	0
			35	0
			36	0
			39	0
			40	0
			41	0
			43	0
			44	0
			45	0
			47	0
		Total		**0**
Central	→	Kings River East	33	0
			37	0
			38	0
			42	0
			46	0
		Total		**0**
North Fork Kings	→	Central	74	466
		Total		**466**
Central	→	North Fork Kings	70	709
			71	351
			72	1,393
			73	824
			75	401
			76	3,486
			77	405
			78	4,060
			79	540
			80	2,128
			81	4,220
			82	1,408
		Total		**19,925**
North Fork Kings	→	McMullin	61	1,185
			64	526
			65	119
			66	984
			69	796
		Total		**3,610**
McMullin	→	North Fork Kings	60	1,518
			62	1,293
			63	2,265
			67	868
			68	742
		Total		**6,686**

2007 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
James	→	North Fork Kings	83	2,180
			84	1,256
			85	3,931
		Total		**7,366**
James	→	McMullin	52	3,944
			53	5,327
			54	4,215
			55	5,764
			56	6,078
			57	4,116
			58	1,866
			59	1,067
		Total		**32,378**
McMullin	→	Central	50	10
		Total		**10**
Central	→	McMullin	48	4,818
			49	2,395
			51	1,792
		Total		**9,005**

2008 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Kings	→	McMullin	0	367
			1	990
			2	1,259
			3	1,851
			4	6,744
			5	2,090
			6	8,919
			7	3,112
			8	6,647
			9	7,849
			10	7,949
			11	14,284
			12	5,857
			13	3,678
		Total		**71,596**
North Kings	→	Central	14	1,598
			16	2,768
			17	1,055
			18	2,975
			20	1,360
			24	472
			25	2,175
			26	694
			27	588
		Total		**13,685**
Central	→	North Kings	15	1,485
			19	1,768
			21	877
			22	1,930
			23	1,768
		Total		**7,827**
North Kings	→	Kings River East	28	0
			29	0
			30	0
			31	0
		Total		**0**
Kings River East	→	North Kings	32	0
		Total		**0**

2008 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
Kings River East	→	Central	35	0
			36	0
			37	0
			39	0
			40	0
			43	0
			44	0
			45	0
		Total		**0**
Central	→	Kings River East	33	0
			34	0
			38	0
			41	0
			42	0
			46	0
			47	0
		Total		**0**
North Fork Kings	→	Central	70	1,656
			71	147
			74	576
		Total		**2,379**
Central	→	North Fork Kings	72	883
			73	1,067
			75	748
			76	2,876
			77	347
			78	4,332
			79	549
			80	2,024
			81	3,999
			82	691
		Total		**17,517**
North Fork Kings	→	McMullin	60	147
			61	677
			64	601
			65	349
			66	507
			69	820
		Total		**3,101**
McMullin	→	North Fork Kings	62	3,223
			63	3,793
			67	34
			68	987
		Total		**8,037**

2008 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
James	→	North Fork Kings	83	2,191
			84	1,272
			85	1,069
		Total		**4,532**
James	→	McMullin	52	1,062
			53	969
			54	1,180
			55	3,479
			56	3,951
			57	4,597
			58	2,842
			59	1,558
		Total		**19,637**
McMullin	→	Central	50	137
		Total		**137**
Central	→	McMullin	48	5,004
			49	2,873
			51	915
		Total		**8,793**

2009 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Kings	→	McMullin	0	1,098
			1	259
			2	347
			3	664
			4	4,658
			5	1,590
			6	7,578
			7	1,820
			8	9,142
			9	8,422
			10	7,484
			11	16,119
			12	5,188
			13	3,822
		Total		**68,193**
North Kings	→	Central	14	1,568
			16	2,641
			17	995
			18	3,165
			20	1,588
			24	721
			25	1,659
			26	563
			27	500
		Total		**13,400**
Central	→	North Kings	15	1,833
			19	1,301
			21	1,280
			22	2,380
			23	1,263
		Total		**8,057**
North Kings	→	Kings River East	28	0
			29	0
			30	0
			31	0
		Total		**0**
Kings River East	→	North Kings	32	0
		Total		**0**

2009 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
Kings River East	→	Central	34	0
			35	0
			36	0
			37	0
			39	0
			40	0
			41	0
			44	0
			45	0
		Total		**0**
Central	→	Kings River East	33	0
			38	0
			42	0
			43	0
			46	0
			47	0
		Total		**0**
North Fork Kings	→	Central	70	959
			73	784
			74	1,283
		Total		**3,026**
Central	→	North Fork Kings	71	364
			72	1,274
			75	322
			76	3,645
			77	546
			78	4,781
			79	550
			80	2,363
			81	3,963
			82	764
		Total		**18,573**
North Fork Kings	→	McMullin	61	2,688
			64	1,285
			65	215
			66	780
			69	1,927
		Total		**6,895**
McMullin	→	North Fork Kings	60	1,414
			62	1,274
			63	967
			67	899
			68	2,399
		Total		**6,953**

2009 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
James	→	North Fork Kings	83	1,955
			84	1,127
			85	2,415
		Total		**5,497**
James	→	McMullin	52	1,216
			53	275
			54	61
			55	2,175
			56	3,898
			57	4,306
			58	1,833
			59	1,380
		Total		**15,145**
McMullin	→	Central	50	434
		Total		**434**
Central	→	McMullin	48	2,850
			49	2,347
			51	907
		Total		**6,103**

2011 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Kings	→	McMullin	0	858
			1	960
			3	1,111
			4	6,786
			5	2,479
			6	8,936
			7	2,610
			8	6,095
			9	7,021
			10	8,472
			11	15,652
			12	6,563
			13	4,475
		Total		**72,019**
McMullin	→	North Kings	2	38
		Total		**38**
North Kings	→	Central	14	1,723
			16	2,788
			17	898
			18	2,104
			20	2,806
			24	387
			25	1,543
			26	449
			27	480
		Total		**13,178**
Central	→	North Kings	15	1,335
			19	1,471
			21	974
			22	1,115
			23	2,413
		Total		**7,308**
North Kings	→	Kings River East	28	0
			29	0
			30	0
			31	0
			32	0
		Total		**0**

2011 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
Kings River East	→	Central	35	0
			36	0
			37	0
			39	0
			40	0
			45	0
			47	0
		Total		**0**
Central	→	Kings River East	33	0
			34	0
			38	0
			41	0
			42	0
			43	0
			44	0
			46	0
		Total		**0**
North Fork Kings	→	Central	74	534
		Total		**534**
Central	→	North Fork Kings	70	673
			71	834
			72	811
			73	1,625
			75	765
			76	3,995
			77	483
			78	4,308
			79	699
			80	2,120
			81	3,703
			82	170
		Total		**20,185**
North Fork Kings	→	McMullin	60	31
			61	1,458
			64	816
			66	518
		Total		**2,824**
McMullin	→	North Fork Kings	62	608
			63	1,585
			65	63
			67	35
			68	1,230
			69	131
		Total		**3,652**

2011 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Fork Kings	→	James	85	1,111
		Total		**1,111**
James	→	North Fork Kings	83	973
			84	115
		Total		**1,088**
McMullin	→	James	52	419
		Total		**419**
James	→	McMullin	53	1,171
			54	1,867
			55	4,118
			56	2,850
			57	1,943
			58	1,357
			59	765
		Total		**14,072**
McMullin	→	Central	50	86
		Total		**86**
Central	→	McMullin	48	3,726
			49	2,669
			51	1,760
		Total		**8,156**

2012 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Kings	→	McMullin	0	1,337
			1	577
			2	1,116
			3	1,999
			4	5,526
			5	2,184
			6	5,608
			7	2,593
			8	5,903
			9	8,228
			10	8,399
			11	14,202
			12	5,670
			13	3,841
		Total		**67,184**
North Kings	→	Central	14	1,061
			16	2,599
			17	1,062
			20	1,248
			24	530
			25	1,594
			26	584
			27	558
		Total		**9,237**
Central	→	North Kings	15	2,017
			18	874
			19	1,260
			21	1,092
			22	2,325
			23	2,030
		Total		**9,599**
North Kings	→	Kings River East	28	0
			29	0
			30	0
			31	0
		Total		**0**
Kings River East	→	North Kings	32	0
		Total		**0**

2012 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
Kings River East	→	Central	34	0
			35	0
			36	0
			39	0
			40	0
			41	0
			45	0
		Total		**0**
Central	→	Kings River East	33	0
			37	0
			38	0
			42	0
			43	0
			44	0
			46	0
			47	0
		Total		**0**
North Fork Kings	→	Central	70	579
			74	560
		Total		**1,139**
Central	→	North Fork Kings	71	1,288
			72	1,127
			73	1,762
			75	687
			76	4,640
			77	431
			78	4,565
			79	1,035
			80	2,469
			81	4,793
			82	2,479
		Total		**25,275**
North Fork Kings	→	McMullin	61	789
			62	2,036
			64	2,276
			65	581
			66	819
		Total		**6,501**
McMullin	→	North Fork Kings	60	136
			63	3,394
			67	933
			68	2,217
			69	220
		Total		**6,900**

2012 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
James	→	North Fork Kings	83	N/A
			84	242
			85	444
		Total		**686**
McMullin	→	James	52	17
			54	284
			55	732
		Total		**1,033**
James	→	McMullin	53	26
			56	604
			57	1,661
			58	1,539
			59	795
		Total		**4,625**
McMullin	→	Central	50	419
		Total		**419**
Central	→	McMullin	48	6,399
			49	2,998
			51	1,289
		Total		**10,686**

External

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1925 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Kings	→	Madera County	100	0
			101	0
			102	0
			103	0
			104	0
			105	0
			106	0
			108	0
		Total		**0**
North Kings	→	Root Creek WD	107	0
		Total		**0**
North Kings	→	Madera ID	109	0
			110	0
			111	0
			112	0
			113	0
		Total		**0**
McMullin	→	Aliso WD	114	0
			115	0
			116	0
			117	0
			118	0
			119	0
		Total		**0**
McMullin	→	Farmer WD	120	0
			121	N/A
		Total		**0**
McMullin	→	Fresno County	122	N/A
			123	N/A
			125	320
			126	N/A
		Total		**320**
Fresno County	→	McMullin	124	N/A
		Total		**0**
James ID	→	Fresno County	127	N/A
			128	N/A
		Total		**0**
James ID	→	Central Delta Mendota Regional Mulit Agency GSA	129	N/A
			130	N/A
			131	N/A
			132	N/A
			133	N/A
			134	N/A
		Total		**0**

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1925 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
James ID	→	Westlands WD	135	N/A
			135	N/A
			136	N/A
		Total		**0**
North Fork Kings	→	Westlands WD	137	N/A
			138	N/A
			139	N/A
			141	N/A
			142	N/A
			143	N/A
			144	N/A
			145	N/A
			146	N/A
			147	N/A
			148	N/A
			153	N/A
			154	N/A
			155	N/A
		Total		**0**
Westlands WD	→	North Fork Kings	140	N/A
			149	N/A
			150	N/A
			151	N/A
			152	N/A
		Total		**0**
South Fork Kings GSA	→	North Fork Kings	156	N/A
			157	0
			158	0
		Total		**0**
North Fork Kings	→	South Fork Kings GSA	159	0
			160	0
			161	0
		Total		**0**
North Fork Kings	→	Mid Kings River GSA	163	0
		Total		**0**
Mid Kings River GSA	→	North Fork Kings	162	0
			164	263
			165	201
		Total		**465**
Central Kings	→	Mid Kings River GSA	166	623
			167	0
		Total		**623**

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1925 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Mid Kings River GSA	→	Central Kings	168	0
		Total		**0**
Kings River East	→	Mid Kings River GSA	169	N/A
			170	N/A
			171	N/A
		Total		**0**
Kings River East	→	Greater Kaweah GSA	172	N/A
			175	N/A
		Total		**0**
Greater Kaweah GSA	→	Kings River East	173	N/A
			174	N/A
			176	N/A
			177	N/A
		Total		**0**
East Kaweah GSA	→	Kings River East	178	N/A
			179	N/A
		Total		**0**
Kings River East	→	East Kaweah GSA	180	N/A
			181	N/A
			182	N/A
		Total		**0**

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1997 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Kings	→	Madera County	100	0
			101	0
			103	0
			104	0
			105	0
			108	0
		Total		**0**
Madera County	→	North Kings	102	0
			106	0
		Total		**0**
North Kings	→	Root Creek WD	107	0
		Total		**0**
Madera ID	→	North Kings	111	0
		Total		**0**
North Kings	→	Madera ID	109	0
			110	0
			112	0
			113	0
		Total		**0**
McMullin	→	Aliso WD	114	0
			116	0
			117	0
			119	0
		Total		**0**
Aliso WD	→	McMullin	115	0
			118	0
		Total		**0**
Farmer WD	→	McMullin	120	0
			121	1,389
		Total		**1,389**
Fresno County	→	McMullin	122	2,359
			124	75
			125	45
			126	1,717
		Total		**4,197**
McMullin	→	Fresno County	123	271
		Total		**271**
Fresno County	→	James ID	127	971
			128	439
		Total		**1,410**

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1997 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Central Delta Mendota Regional Mulit Agency GSA	→	James ID	129	164
			130	1,601
			131	710
			132	1,241
			133	459
		Total		**4,175**
James ID		Westlands WD	135	759
			136	676
		Total		**1,435**
Westlands WD		James ID	134	319
		Total		**319**
Westlands WD	→	North Fork Kings	137	1,768
			138	149
			141	1,492
			142	73
			143	1,281
			147	361
			148	355
			151	1,231
			155	198
		Total		**6,908**
North Fork Kings	→	Westlands WD	139	2,739
			140	985
			144	297
			145	394
			146	140
			149	890
			150	1,392
			152	811
			153	539
			154	273
		Total		**8,459**
South Fork Kings GSA	→	North Fork Kings	156	348
			157	0
			158	0
			159	0
			160	0
		Total		**348**
Mid Kings River GSA	→	North Fork Kings	161	0
			162	0
			164	714
			165	1,807
		Total		**2,521**

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1997 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Fork Kings	→	Mid Kings River GSA	163	0
		Total		**0**
Central Kings	→	Mid Kings River GSA	166	524
			167	0
			168	0
		Total		**524**
Kings River East	→	Mid Kings River GSA	169	309
			171	1,428
		Total		**1,737**
Mid Kings River GSA	→	Kings River East	170	9,523
		Total		**9,523**
Greater Kaweah GSA	→	Kings River East	172	1,751
			173	842
			175	15
		Total		**2,608**
Kings River East	→	Greater Kaweah GSA	174	852
			176	1,142
			177	1,357
		Total		**3,352**
Kings River East	→	East Kaweah GSA	178	1,308
			179	2,253
		Total		**3,561**
East Kaweah GSA	→	Kings River East	180	633
			181	434
			182	791
		Total		**1,858**

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1998 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Kings	→	Madera County	100	0
			101	0
			102	0
			103	0
			104	0
			105	0
			108	0
		Total		**0**
Madera County	→	North Kings	106	0
		Total		**0**
Root Creek WD	→	North Kings	107	0
		Total		**0**
North Kings	→	Madera ID	109	0
			110	0
			111	0
			112	0
			113	0
		Total		**0**
McMullin	→	Aliso WD	114	0
			116	0
			117	0
		Total		**0**
Aliso WD	→	McMullin	115	0
			118	0
			119	0
		Total		**0**
Farmer WD	→	McMullin	120	0
			121	1,100
		Total		**1,100**
Fresno County	→	McMullin	122	1,367
			126	4,425
		Total		**5,792**
McMullin	→	Fresno County	123	397
			124	15
			125	105
		Total		**518**
Fresno County	→	James ID	127	869
			128	477
		Total		**1,346**
James ID	→	Central Delta	129	330
		Mendota Regional	130	25
		Mulit Agency GSA	133	89
		Total		**443**

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1998 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Central Delta Mendota Regional Mulit Agency GSA	→	James ID	131	70
			132	798
			134	108
		Total		**975**
James ID	→	Westlands WD	135	723
			136	841
		Total		**1,564**
Westlands WD	→	North Fork Kings	137	1,710
			141	102
			142	115
			143	645
			147	534
			148	503
			151	68
		Total		**3,677**
North Fork Kings	→	Westlands WD	138	226
			139	1,055
			140	989
			144	250
			145	440
			146	89
			149	172
			150	947
			152	920
			153	1,146
			154	105
			155	48
		Total		**6,387**
South Fork Kings GSA	→	North Fork Kings	156	10
			157	0
			158	0
			159	0
			160	0
		Total		**10**
Mid Kings River GSA	→	North Fork Kings	161	0
			162	0
			165	1,049
		Total		**1,049**
North Fork Kings	→	Mid Kings River GSA	163	0
			164	450
		Total		**450**

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1998 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Central Kings	→	Mid Kings River GSA	166	1,105
			167	0
			168	0
		Total		**1,105**
Kings River East	→	Mid Kings River GSA	169	127
			171	525
		Total		**653**
Mid Kings River GSA	→	Kings River East	170	1,805
		Total		**1,805**
Greater Kaweah GSA	→	Kings River East	172	2,150
			173	442
		Total		**2,592**
Kings River East	→	Greater Kaweah GSA	174	1,022
			175	47
			176	1,314
			177	1,802
		Total		**4,184**
Kings River East	→	East Kaweah GSA	178	308
			179	1,836
		Total		**2,144**
East Kaweah GSA	→	Kings River East	180	263
			181	132
			182	530
		Total		**924**

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1999 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Kings	→	Madera County	100	0
			101	0
			102	0
			103	0
			104	0
			108	0
		Total		**0**
Madera County	→	North Kings	105	0
			106	0
		Total		**0**
Root Creek WD	→	North Kings	107	0
		Total		**0**
Madera ID	→	North Kings	111	0
		Total		**0**
North Kings	→	Madera ID	109	0
			110	0
			112	0
			113	0
		Total		**0**
McMullin	→	Aliso WD	114	0
			116	0
			117	0
		Total		**0**
Aliso WD	→	McMullin	115	0
			118	0
			119	0
		Total		**0**
McMullin	→	Farmers WD	120	0
			121	N/A
		Total		**0**
McMullin	→	Fresno County	122	N/A
			124	2,428
		Total		**2,428**
Fresno County	→	McMullin	123	894
			125	723
			126	7,169
		Total		**8,786**
James ID	→	Fresno County	127	1,279
		Total		**1,279**
Fresno County	→	James ID	128	1,405
		Total		**1,405**

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1999 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Central Delta Mendota Regional Mulit Agency GSA	→	James ID	129	2,670
			132	2,402
			133	346
			134	13
		Total		**5,431**
James ID	→	Central Delta Mendota Regional	130	4,644
			131	277
		Total		**4,921**
James ID	→	Westlands WD	135	387
			136	707
		Total		**1,093**
Westlands WD	→	North Fork Kings	137	1,982
			141	2,772
			142	694
			143	869
			144	212
			146	348
			147	753
			148	538
			149	187
		Total		**8,356**
North Fork Kings	→	Westlands WD	138	235
			139	1,137
			140	603
			145	49
			150	528
			151	554
			152	1,430
			153	1,968
			154	N/A
			155	N/A
		Total		**6,504**
North Fork Kings	→	South Fork Kings GSA	156	N/A
			157	0
			160	0
		Total		**0**
South Fork Kings GSA	→	North Fork Kings	158	0
			159	0
		Total		**0**
North Fork Kings	→	Mid Kings River GSA	161	0
			162	0
			163	0
		Total		**0**

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1999 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Mid Kings River GSA	→	North Fork Kings	164	53
			165	963
		Total		**1,016**
Central Kings	→	Mid Kings River GSA	166	1,122
			167	0
			168	0
		Total		**1,122**
Kings River East	→	Mid Kings River GSA	169	295
			171	1,524
		Total		**1,819**
Mid Kings River GSA	→	Kings River East	170	6,714
		Total		**6,714**
Kings River East	→	Greater Kaweah GSA	172	1,909
			174	546
			175	33
			176	762
			177	2,176
		Total		**5,426**
Greater Kaweah GSA	→	Kings River East	173	788
		Total		**788**
Kings River East	→	East Kaweah GSA	178	831
			179	2,085
			180	N/A
			181	N/A
		Total		**2,915**
East Kaweah GSA	→	Kings River East	182	609
		Total		**609**

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2000 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Kings	→	Madera County	100	0
			101	0
			108	0
		Total		**0**
Madera County	→	North Kings	102	0
			103	0
			104	0
			105	0
			106	0
		Total		**0**
Root Creek WD	→	North Kings	107	0
		Total		**0**
North Kings	→	Madera ID	109	0
			110	0
			111	0
			112	0
			113	0
		Total		**0**
McMullin	→	Aliso WD	114	0
			115	0
			116	0
			117	0
			119	0
		Total		**0**
Aliso WD	→	McMullin	118	0
		Total		**0**
McMullin	→	Farmers WD	120	0
			121	521
		Total		**521**
McMullin	→	Fresno County	123	28
			125	875
		Total		**903**
Fresno County	→	McMullin	122	271
			124	700
			126	9,103
		Total		**10,074**
Fresno County	→	James ID	127	974
			128	1,132
		Total		**2,106**

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2000 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Central Delta Mendota Regional Mulit Agency GSA	→	James ID	129	809
			130	4,925
			132	2,693
			133	1,582
			134	904
		Total		**10,914**
James ID	→	Central Delta Mendota Regional Mulit Agency GSA	131	27
		Total		**27**
James ID	→	Westlands WD	135	777
			136	965
		Total		**1,743**
Westlands WD	→	North Fork Kings	137	733
			141	450
			142	104
			147	325
			148	350
		Total		**1,963**
North Fork Kings	→	Westlands WD	138	243
			139	723
			140	1,121
			143	46
			144	228
			145	231
			146	4
			149	806
			150	3,068
			151	809
			152	1,892
			153	3,015
			154	762
			155	587
		Total		**13,534**
North Fork Kings	→	South Fork Kings GSA	156	393
			159	0
		Total		**393**
South Fork Kings GSA	→	North Fork Kings	157	0
			158	0
			160	0
		Total		**0**

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2000 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Fork Kings	→	Mid Kings River GSA	163	0
		Total		**0**
Mid Kings River GSA	→	North Fork Kings	161	0
			162	0
			164	945
			165	1,606
		Total		**2,551**
Mid Kings River GSA	→	Central Kings	166	830
		Total		**830**
Central Kings	→	Mid Kings River GSA	167	0
			168	0
		Total		**0**
Kings River East	→	Mid Kings River GSA	169	180
			171	1,163
		Total		**1,343**
Mid Kings River GSA	→	Kings River East	170	4,109
		Total		**4,109**
Kings River East	→	Greater Kaweah GSA	174	578
			175	23
			176	1,097
			177	3,482
		Total		**5,180**
Greater Kaweah GSA	→	Kings River East	172	271
			173	54
		Total		**326**
Kings River East	→	East Kaweah GSA	179	1,389
		Total		**1,389**
East Kaweah GSA	→	Kings River East	178	70
			180	344
			181	200
			182	574
		Total		**1,188**

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2001 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Kings	→	Madera County	100	0
			101	0
			103	0
			104	0
			105	0
			108	0
		Total		**0**
Madera County	→	North Kings	102	0
			106	0
		Total		**0**
Root Creek WD	→	North Kings	107	0
		Total		**0**
North Kings	→	Madera ID	109	0
			110	0
			111	0
			112	0
			113	0
		Total		**0**
McMullin	→	Aliso WD	116	0
			117	0
			118	0
			119	0
		Total		**0**
Aliso WD	→	McMullin	114	0
			115	0
		Total		**0**
Farmers WD	→	McMullin	120	0
			121	1,396
		Total		**1,396**
Fresno County	→	McMullin	122	341
			124	386
			126	9,525
		Total		**10,252**
McMullin	→	Fresno County	123	261
			125	1,326
		Total		**1,587**
Fresno County	→	James ID	127	1,061
			128	1,137
		Total		**2,198**

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2001 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Central Delta Mendota Regional Mulit Agency GSA	→	James ID	129	2,231
			130	7,183
			131	1,736
			132	2,263
			133	1,953
			134	1,249
		Total		**16,616**
James ID	→	Westlands WD	135	1,398
			136	1,015
		Total		**2,414**
Westlands WD	→	North Fork Kings	140	926
			141	1,917
			144	N/A
			145	N/A
			146	N/A
			152	315
			155	81
		Total		**3,240**
North Fork Kings	→	Westlands WD	137	1,391
			138	1,100
			139	1,254
			140	926
			142	194
			143	544
			147	N/A
			148	N/A
			149	3,601
			150	1,495
			151	450
			153	2,677
			154	676
		Total		**14,309**
North Fork Kings	→	South Fork Kings GSA	156	10
		Total		**10**
South Fork Kings GSA	→	North Fork Kings	157	0
			158	0
			159	0
			160	0
		Total		**0**

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2001 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Mid Kings River GSA	→	North Fork Kings	161	0
			162	0
			165	164
		Total		**164**
North Fork Kings	→	Mid Kings River GSA	163	0
			164	102
		Total		**102**
Mid Kings River GSA	→	Central Kings	166	1,184
		Total		**1,184**
Central Kings	→	Mid Kings River GSA	167	0
			168	0
		Total		**0**
Kings River East	→	Mid Kings River GSA	169	192
			171	2,295
		Total		**2,488**
Mid Kings River GSA	→	Kings River East	170	3,711
		Total		**3,711**
Kings River East	→	Greater Kaweah GSA	172	3,259
			174	883
			175	10
			176	880
			177	340
		Total		**5,373**
Greater Kaweah GSA	→	Kings River East	173	36
		Total		**36**
Kings River East	→	East Kaweah GSA	178	605
			179	1,933
		Total		**2,538**
East Kaweah GSA	→	Kings River East	180	474
			181	276
			182	640
		Total		**1,389**

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2002 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Kings	→	Madera County	100	0
			101	0
			103	0
			108	0
		Total		**0**
Madera County	→	North Kings	102	0
			104	0
			105	0
			106	0
		Total		**0**
Root Creek WD	→	North Kings	107	0
		Total		**0**
Madera ID	→	North Kings	111	0
		Total		**0**
North Kings	→	Madera ID	109	0
			110	0
			112	0
			113	0
		Total		**0**
McMullin	→	Aliso WD	114	0
			119	0
		Total		**0**
Aliso WD	→	McMullin	115	0
			116	0
			117	0
			118	0
		Total		**0**
McMullin	→	Farmers WD	120	0
			121	N/A
		Total		**0**
Fresno County	→	McMullin	123	N/A
			126	46
		Total		**46**
McMullin	→	Fresno County	122	N/A
			124	N/A
			125	2,535
		Total		**2,535**
Fresno County	→	James ID	127	N/A
			128	N/A
		Total		**0**

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2002 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Central Delta Mendota Regional Mulit Agency GSA	→	James ID	130	N/A
			131	N/A
			134	N/A
		Total		**0**
James ID	→	Central Delta Mendota Regional Mulit Agency GSA	129	N/A
			132	N/A
			133	N/A
		Total		**0**
Westlands WD	→	James ID	135	N/A
			136	N/A
		Total		**0**
Westlands WD	→	North Fork Kings	137	1,444
			141	1,119
			142	628
			144	601
			145	370
			146	686
			147	753
			151	39
		Total		**5,640**
North Fork Kings	→	Westlands WD	138	527
			139	841
			140	863
			143	1,180
			148	392
			149	1,579
			150	2,203
			152	1,815
			153	3,034
			154	958
			155	1,253
		Total		**14,645**
North Fork Kings	→	South Fork Kings GSA	156	744
			159	0
			160	0
		Total		**744**
South Fork Kings GSA	→	North Fork Kings	157	0
			158	0
		Total		**0**
Mid Kings River GSA	→	North Fork Kings	162	0
			164	3,022
			165	2,395
		Total		**5,417**

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2002 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Fork Kings	→	Mid Kings River GSA	161	0
			163	0
		Total		**0**
Central Kings	→	Mid Kings River GSA	166	285
			167	0
			168	0
		Total		**285**
Kings River East	→	Mid Kings River GSA	169	71
			171	2,157
		Total		**2,228**
Mid Kings River GSA	→	Kings River East	170	2,962
		Total		**2,962**
Kings River East	→	Greater Kaweah GSA	172	517
			174	594
			175	27
			176	781
			177	1,027
		Total		**2,946**
Greater Kaweah GSA	→	Kings River East	173	528
		Total		**528**
Kings River East	→	East Kaweah GSA	178	294
			179	1,110
		Total		**1,404**
East Kaweah GSA	→	Kings River East	180	192
			181	104
			182	370
		Total		**667**

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2003 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Kings	→	Madera County	100	0
			101	0
			103	0
			104	0
			105	0
			106	0
			108	0
		Total		**0**
Madera County	→	North Kings	102	0
		Total		**0**
North Kings	→	Root Creek WD	107	0
		Total		**0**
Madera ID	→	North Kings	109	0
			112	0
		Total		**0**
North Kings	→	Madera ID	110	0
			111	0
			113	0
		Total		**0**
McMullin	→	Aliso WD	114	0
			116	0
			117	0
			119	0
		Total		**0**
Aliso WD	→	McMullin	115	0
			118	0
		Total		**0**
Farmers WD	→	McMullin	120	0
			121	22
		Total		**22**
McMullin	→	Fresno County	122	824
			124	1,772
			123	184
			125	5,554
		Total		**8,333**
Fresno County	→	McMullin	126	10,119
		Total		**10,119**
Fresno County	→	James ID	127	1,404
			128	1,730
		Total		**3,134**

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2003 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Central Delta Mendota Regional Mulit Agency GSA	→	James ID	129	1,590
			130	6,948
			131	1,444
			132	995
			133	289
		Total		**11,266**
James ID	→	Central Delta Mendota Regional Mulit Agency GSA	134	212
		Total		**212**
James ID	→	Westlands WD	135	1,134
			136	1,657
		Total		**2,791**
Westlands WD	→	North Fork Kings	141	1,608
			142	578
			143	831
			144	223
			146	427
			147	637
			148	905
			149	1,874
		Total		**7,083**
North Fork Kings	→	Westlands WD	137	607
			138	370
			139	693
			140	842
			145	593
			150	1,687
			151	638
			152	1,870
			153	2,726
			154	620
			155	509
		Total		**11,157**
North Fork Kings	→	South Fork Kings GSA	156	518
			159	0
			160	0
		Total		**518**
South Fork Kings GSA	→	North Fork Kings	157	0
			158	0
		Total		**0**

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2003 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Mid Kings River GSA	→	North Fork Kings	161	0
			162	0
		Total		**0**
North Fork Kings	→	Mid Kings River GSA	163	0
			164	836
			165	532
		Total		**1,368**
Mid Kings River GSA	→	Central Kings	166	2,747
		Total		**2,747**
Central Kings	→	Mid Kings River GSA	167	0
			168	0
		Total		**0**
Kings River East	→	Mid Kings River GSA	169	335
			171	2,418
		Total		**2,752**
Mid Kings River GSA	→	Kings River East	170	4,561
		Total		**4,561**
Kings River East	→	Greater Kaweah GSA	172	3,518
			174	49
			175	64
			176	872
			177	228
		Total		**4,731**
Greater Kaweah GSA	→	Kings River East	173	28
		Total		**28**
Kings River East	→	East Kaweah GSA	179	1,989
		Total		**1,989**
East Kaweah GSA	→	Kings River East	178	794
			180	415
			181	219
			182	522
		Total		**1,950**

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2004 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Kings	→	Madera County	100	0
			101	0
			103	0
			104	0
			108	0
		Total		**0**
Madera County	→	North Kings	102	0
			105	0
			106	0
		Total		**0**
North Kings	→	Root Creek WD	107	0
		Total		**0**
North Kings	→	Madera ID	109	0
			110	0
			111	0
			112	0
			113	0
		Total		**0**
McMullin	→	Aliso WD	114	0
			116	0
			119	0
		Total		**0**
Aliso WD	→	McMullin	115	0
			117	0
			118	0
		Total		**0**
Farmers WD	→	McMullin	120	0
			121	1,680
		Total		**1,680**
Fresno County	→	McMullin	122	1,901
			126	4,805
		Total		**6,706**
McMullin	→	Fresno County	123	1,787
			124	2,629
			125	3,744
		Total		**8,160**
Fresno County	→	James ID	127	763
			128	1,279
		Total		**2,042**

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2004 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Central Delta Mendota Regional Mulit Agency GSA	→	James ID	129	4,062
			130	6,158
			131	1,264
			132	374
			133	392
			134	336
		Total		**12,585**
James ID	→	Westlands WD	135	899
			136	548
		Total		**1,447**
Westlands WD	→	North Fork Kings	137	1,770
			141	2,390
			142	980
			143	2,210
			147	432
			151	36
			155	N/A
		Total		**7,817**
North Fork Kings	→	Westlands WD	138	79
			139	1,682
			140	479
			144	150
			145	1,209
			146	161
			148	660
			149	857
			150	594
			152	866
			153	2,365
			154	N/A
		Total		**9,104**
North Fork Kings	→	South Fork Kings GSA	156	N/A
			157	0
			158	0
			159	0
			160	0
		Total		**0**
Mid Kings River GSA	→	North Fork Kings	161	0
			162	0
		Total		**0**

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2004 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Fork Kings	→	Mid Kings River GSA	163	0
			164	765
			165	714
		Total		**1,479**
Mid Kings River GSA	→	Central Kings	166	748
		Total		**748**
Central Kings	→	Mid Kings River GSA	167	0
			168	0
		Total		**0**
Kings River East	→	Mid Kings River GSA	169	279
			171	1,723
		Total		**2,002**
Mid Kings River GSA	→	Kings River East	170	4,187
		Total		**4,187**
Kings River East	→	Greater Kaweah GSA	172	1,945
			174	18
			175	49
		Total		**2,011**
Greater Kaweah GSA	→	Kings River East	173	543
			176	200
			177	230
		Total		**973**
Kings River East	→	East Kaweah GSA	179	426
			180	N/A
			181	N/A
		Total		**426**
East Kaweah GSA	→	Kings River East	178	626
			182	359
		Total		**985**

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2005 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Kings	→	Madera County	100	0
			101	0
			103	0
			108	0
		Total		**0**
Madera County	→	North Kings	102	0
			104	0
			105	0
			106	0
		Total		**0**
Root Creek WD	→	North Kings	107	0
		Total		**0**
North Kings	→	Madera ID	109	0
			110	0
			111	0
			112	0
			113	0
		Total		**0**
McMullin	→	Aliso WD	114	0
			116	0
			117	0
			119	0
		Total		**0**
Aliso WD	→	McMullin	115	0
			118	0
		Total		**0**
Farmers WD	→	McMullin	120	0
			121	2,034
		Total		**2,034**
Fresno County	→	McMullin	122	2,621
			123	3,482
			124	8,772
			125	7,060
			126	9,756
		Total		**31,690**
James ID	→	Fresno County	127	1,560
		Total		**1,560**
Fresno County	→	James ID	128	1,898
		Total		**1,898**

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2005 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Central Delta Mendota Regional Mulit Agency GSA	→	James ID	129	2,254
			130	3,156
			131	395
			132	N/A
			133	N/A
			134	N/A
		Total		**5,805**
James ID	→	Westlands WD	135	N/A
			136	N/A
		Total		**0**
Westlands WD	→	North Fork Kings	137	1,490
			138	59
			141	2,401
			142	990
			143	2,005
			144	731
			146	N/A
			151	310
			153	358
			154	72
		Total		**8,414**
North Fork Kings	→	Westlands WD	139	1,296
			140	789
			145	N/A
			147	N/A
			148	407
			149	867
			150	1,339
			152	1,017
			155	399
		Total		**6,114**
South Fork Kings GSA	→	North Fork Kings	156	84
			157	0
			158	0
			159	0
			160	0
		Total		**84**
Mid Kings River GSA	→	North Fork Kings	162	0
		Total		**0**

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2005 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Fork Kings	→	Mid Kings River GSA	161	0
			163	0
			164	1,190
			165	366
		Total		**1,556**
Mid Kings River GSA	→	Central Kings	166	2,203
		Total		**2,203**
Central Kings	→	Mid Kings River GSA	167	0
			168	0
		Total		**0**
Kings River East	→	Mid Kings River GSA	169	236
			171	2,299
		Total		**2,535**
Mid Kings River GSA	→	Kings River East	170	2,595
		Total		**2,595**
Kings River East	→	Greater Kaweah GSA	172	2,642
			173	384
			174	1,262
			175	18
			176	1,494
			177	1,063
		Total		**6,864**
Kings River East	→	East Kaweah GSA	179	1,406
		Total		**1,406**
East Kaweah GSA	→	Kings River East	178	128
			180	178
			181	86
			182	295
		Total		**687**

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2006 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Kings	→	Madera County	100	0
			101	0
			103	0
			108	0
		Total		**0**
Madera County	→	North Kings	102	0
			104	0
			105	0
			106	0
		Total		**0**
North Kings	→	Root Creek WD	107	0
		Total		**0**
North Kings	→	Madera ID	109	0
			110	0
			111	0
			112	0
			113	0
		Total		**0**
McMullin	→	Aliso WD	114	0
			119	0
		Total		**0**
Aliso WD	→	McMullin	115	0
			116	0
			117	0
			118	0
		Total		**0**
Farmers WD	→	McMullin	120	0
		Total		**0**
McMullin	→	Farmers WD	121	904
		Total		**904**
Fresno County	→	McMullin	126	828
		Total		**828**
McMullin	→	Fresno County	122	1,076
			123	1,177
			124	2,952
			125	2,299
		Total		**7,504**
Fresno County	→	James ID	127	1,443
		Total		**1,443**
James ID	→	Fresno County	128	163
		Total		**163**

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2006 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
James ID	→	Central Delta Mendota Regional Mulit Agency GSA	129	N/A
		Total		**0**
Central Delta Mendota Regional Mulit Agency GSA	→	James ID	130	N/A
			131	N/A
			132	N/A
			133	N/A
			134	N/A
		Total		**0**
James ID	→	Westlands WD	135	N/A
			136	N/A
		Total		**0**
Westlands WD	→	North Fork Kings	137	N/A
			141	1,084
			142	340
			143	544
			146	92
			147	363
			152	646
		Total		**3,069**
North Fork Kings	→	Westlands WD	138	N/A
			139	N/A
			140	679
			144	139
			145	309
			148	464
			149	253
			150	561
			151	792
			153	1,862
			154	405
			155	581
		Total		**6,046**
North Fork Kings	→	South Fork Kings GSA	156	64
			159	0
		Total		**64**
South Fork Kings GSA	→	North Fork Kings	157	0
			158	0
			160	0
		Total		**0**

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2006 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Mid Kings River GSA	→	North Fork Kings	161	0
			162	0
			164	335
		Total		**335**
North Fork Kings	→	Mid Kings River GSA	163	0
			165	380
		Total		**380**
Mid Kings River GSA	→	Central Kings	166	2,505
		Total		**2,505**
Central Kings	→	Mid Kings River GSA	167	0
			168	0
		Total		**0**
Kings River East	→	Mid Kings River GSA	169	134
			171	2,712
		Total		**2,846**
Mid Kings River GSA	→	Kings River East	170	6,500
		Total		**6,500**
Kings River East	→	Greater Kaweah GSA	172	1,850
			174	1,074
			175	69
			176	1,030
			177	2,480
		Total		**6,504**
Greater Kaweah GSA	→	Kings River East	173	7
		Total		**7**
Kings River East	→	East Kaweah GSA	179	1,284
		Total		**1,284**
East Kaweah GSA	→	Kings River East	178	371
			180	279
			181	131
			182	329
		Total		**1,110**

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2007 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Kings	→	Madera County	100	0
			101	0
			103	0
			104	0
			105	0
			108	0
		Total		**0**
Madera County	→	North Kings	102	0
			106	0
		Total		**0**
Root Creek WD	→	North Kings	107	0
		Total		**0**
North Kings	→	Madera ID	109	0
			110	0
			111	0
			112	0
			113	0
		Total		**0**
McMullin	→	Aliso WD	114	0
			116	0
			117	0
			119	0
		Total		**0**
Aliso WD	→	McMullin	115	0
			118	0
		Total		**0**
Farmers WD	→	McMullin	120	0
			121	21
		Total		**21**
Fresno County	→	McMullin	122	1,446
			126	4,502
		Total		**5,948**
McMullin	→	Fresno County	123	850
			124	1,506
			125	1,146
		Total		**3,502**
James ID	→	Fresno County	127	5,108
		Total		**5,108**
Fresno County	→	James ID	128	434
		Total		**434**
James ID	→	Central Delta	129	2,412
		Mendota Regional	130	3,608
		Total		**6,019**

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2007 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Central Delta Mendota Regional Mulit Agency GSA	→	James ID	131	991
			132	1,259
			133	3,320
			134	4,344
		Total		**9,914**
Westlands WD	→	James ID	135	633
			136	779
		Total		**1,411**
Westlands WD	→	North Fork Kings	137	3,232
			138	348
			141	2,971
			142	1,578
			143	825
			144	1,331
			146	573
			147	2,426
			148	3,825
			149	2,064
			150	2,196
			151	1,336
			155	286
		Total		**22,990**
North Fork Kings	→	Westlands WD	139	1,944
			140	877
			145	661
			152	235
			153	1,488
			154	690
		Total		**5,895**
South Fork Kings GSA	→	North Fork Kings	156	276
			157	0
			158	0
			159	0
			160	0
		Total		**276**
Mid Kings River GSA	→	North Fork Kings	161	0
			162	0
			164	459
			165	1,049
		Total		**1,508**
North Fork Kings	→	Mid Kings River GSA	163	0
		Total		**0**

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2007 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Central Kings	→	Mid Kings River GSA	166	1,105
			167	0
			168	0
		Total		**1,105**
Kings River East	→	Mid Kings River GSA	169	157
			171	2,313
		Total		**2,470**
Mid Kings River GSA	→	Kings River East	170	6,344
		Total		**6,344**
Kings River East	→	Greater Kaweah GSA	172	4,143
			174	359
			175	4
			176	222
			177	1,187
		Total		**5,916**
Greater Kaweah GSA	→	Kings River East	173	140
		Total		**140**
Kings River East	→	East Kaweah GSA	179	657
		Total		**657**
East Kaweah GSA	→	Kings River East	178	252
			180	173
			181	100
			182	316
		Total		**841**

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2008 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Kings	→	Madera County	100	0
			101	0
			103	0
			108	0
		Total		**0**
Madera County	→	North Kings	102	0
			104	0
			105	0
			106	0
		Total		**0**
Root Creek WD	→	North Kings	107	0
		Total		**0**
North Kings	→	Madera ID	109	0
			110	0
			111	0
			112	0
			113	0
		Total		**0**
McMullin	→	Aliso WD	117	0
			119	0
		Total		**0**
Aliso WD	→	McMullin	114	0
			115	0
			116	0
			118	0
		Total		**0**
Farmers WD	→	McMullin	120	0
		Total		**0**
McMullin	→	Farmers WD	121	609
		Total		**609**
Fresno County	→	McMullin	122	1,245
			123	144
			126	2,946
		Total		**4,335**
McMullin	→	Fresno County	124	1,501
			125	1,064
		Total		**2,564**
James ID	→	Fresno County	127	1,446
		Total		**1,446**
Fresno County	→	James ID	128	1,201
		Total		**1,201**

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2008 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Central Delta Mendota Regional Mulit Agency GSA	→	James ID	129	2,364
			130	9,075
			131	2,486
			132	765
			133	4,063
			134	3,997
		Total		**22,750**
James ID	→	Westlands WD	135	687
			136	381
		Total		**1,068**
Westlands WD	→	North Fork Kings	137	N/A
			141	3,927
			142	1,645
			143	3,363
			144	2,252
			146	1,146
			148	1,147
			150	913
			153	2,987
			154	1,656
			155	1,827
		Total		**20,863**
North Fork Kings	→	Westlands WD	138	N/A
			139	N/A
			140	2,474
			145	54
			147	64
			149	617
			151	510
			152	550
		Total		**4,269**
North Fork Kings	→	South Fork Kings GSA	159	0
		Total		**0**
South Fork Kings GSA	→	North Fork Kings	156	1,307
			157	0
			158	0
			160	0
		Total		**1,307**
Mid Kings River GSA	→	North Fork Kings	162	0
			164	1,547
			165	250
		Total		**1,797**

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2008 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Fork Kings	→	Mid Kings River GSA	161	0
			163	0
		Total		**0**
Central Kings	→	Mid Kings River GSA	166	410
			167	0
			168	0
		Total		**410**
Kings River East	→	Mid Kings River GSA	169	205
			171	1,909
		Total		**2,114**
Mid Kings River GSA	→	Kings River East	170	1,551
		Total		**1,551**
Kings River East	→	Greater Kaweah GSA	172	2,027
			174	2,181
			175	9
			176	394
			177	945
		Total		**5,557**
Greater Kaweah GSA	→	Kings River East	173	213
		Total		**213**
Kings River East	→	East Kaweah GSA	179	1,188
		Total		**1,188**
East Kaweah GSA	→	Kings River East	178	8
			180	413
			181	223
			182	582
		Total		**1,226**

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2009 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Kings	→	Madera County	100	0
			101	0
			103	0
			104	0
			105	0
			106	0
			108	0
		Total		**0**
Madera County	→	North Kings	102	0
		Total		**0**
North Kings	→	Root Creek WD	107	0
		Total		**0**
North Kings	→	Madera ID	109	0
			110	0
			111	0
			112	0
			113	0
		Total		**0**
McMullin	→	Aliso WD	114	0
			116	0
			117	0
			118	0
			119	0
		Total		**0**
Aliso WD	→	McMullin	115	0
		Total		**0**
Farmers WD	→	McMullin	120	0
			121	134
		Total		**134**
Fresno County	→	McMullin	122	268
			126	6,693
		Total		**6,961**
McMullin	→	Fresno County	123	365
			124	312
			125	574
		Total		**1,250**
Fresno County	→	James ID	127	3,120
			128	945
		Total		**4,065**

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2009 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Central Delta Mendota Regional Mulit Agency GSA	→	James ID	129	985
			130	5,811
			131	1,401
			132	1,609
			133	45
			134	54
		Total		**9,906**
James ID	→	Westlands WD	135	997
			136	1,018
		Total		**2,015**
Westlands WD	→	North Fork Kings	137	2,387
			138	N/A
			140	1,242
			141	5,497
			142	2,526
			143	2,508
			144	2,032
			145	51
			146	1,218
			147	893
			148	1,802
			151	954
			155	N/A
		Total		**21,109**
North Fork Kings	→	Westlands WD	139	1,693
			149	1,209
			150	1,696
			152	240
			153	2,614
			154	815
		Total		**8,267**
South Fork Kings GSA	→	North Fork Kings	156	N/A
			157	0
			158	0
			159	0
			160	0
		Total		**0**
Mid Kings River GSA	→	North Fork Kings	161	0
			162	0
			165	675
		Total		**675**

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2009 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Fork Kings	→	Mid Kings River GSA	163	0
			164	195
		Total		**195**
Central Kings	→	Mid Kings River GSA	166	970
			167	0
			168	0
		Total		**970**
Kings River East	→	Mid Kings River GSA	169	81
			171	2,178
		Total		**2,259**
Mid Kings River GSA	→	Kings River East	170	9,009
		Total		**9,009**
Kings River East	→	Greater Kaweah GSA	172	1,759
			173	601
			174	2,312
			175	61
			176	2,022
			177	2,526
		Total		**9,281**
Kings River East	→	East Kaweah GSA	179	1,167
			180	N/A
			181	N/A
		Total		**1,167**
East Kaweah GSA	→	Kings River East	178	642
			182	437
		Total		**1,079**

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2011 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Kings	→	Madera County	100	0
			101	0
			102	0
			103	0
			108	0
		Total		**0**
Madera County	→	North Kings	104	0
			105	0
			106	0
		Total		**0**
Root Creek WD	→	North Kings	107	0
		Total		**0**
North Kings	→	Madera ID	109	0
			110	0
			111	0
			112	0
			113	0
		Total		**0**
McMullin	→	Aliso WD	114	0
			116	0
			117	0
			118	0
			119	0
		Total		**0**
Aliso WD	→	McMullin	115	0
		Total		**0**
McMullin	→	Farmers WD	120	0
			121	577
		Total		**577**
McMullin	→	Fresno County	122	846
			123	487
		Total		**1,333**
Fresno County	→	McMullin	124	237
			125	1,444
			126	2,666
		Total		**4,347**
Fresno County	→	James ID	127	2,899
			128	418
		Total		**3,317**

Draft

2011 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Central Delta Mendota Regional Mulit Agency GSA	→	James ID	129	198
			130	1,434
			131	743
			132	1,835
			133	787
			Total	**4,996**
Westlands WD	→	James ID	134	514
			Total	**514**
James ID	→	Westlands WD	135	567
			136	187
			Total	**755**
Westlands WD	→	North Fork Kings	137	2,515
			141	1,737
			142	691
			143	791
			144	5
			148	188
			Total	**5,926**
North Fork Kings	→	Westlands WD	138	115
			139	960
			140	313
			145	246
			146	37
			147	7
			149	681
			150	705
			151	304
			152	259
			153	203
			154	183
			155	331
			Total	**4,343**
North Fork Kings	→	South Fork Kings GSA	156	359
			158	0
			159	0
			160	0
			Total	**359**
South Fork Kings GSA	→	North Fork Kings	157	0
			Total	**0**
Mid Kings River GSA	→	North Fork Kings	161	0
			162	0
			Total	**0**

Draft

2011 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Fork Kings	→	Mid Kings River GSA	163	0
			164	1,457
			165	542
		Total		**1,999**
Central Kings	→	Mid Kings River GSA	166	365
			167	0
			168	0
		Total		**365**
Kings River East	→	Mid Kings River GSA	169	106
			171	1,612
		Total		**1,717**
Mid Kings River GSA	→	Kings River East	170	3,421
		Total		**3,421**
Kings River East	→	Greater Kaweah GSA	172	830
			174	1,277
			176	835
			177	961
		Total		**3,903**
Greater Kaweah GSA	→	Kings River East	173	392
			175	139
		Total		**531**
East Kaweah GSA	→	Kings River East	178	520
			182	1,272
		Total		**1,792**
Kings River East	→	East Kaweah GSA	179	1,647
			180	N/A
			181	N/A
		Total		**1,647**

Draft

2012 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Kings	→	Madera County	100	0
			101	0
			103	0
			105	0
			108	0
		Total		**0**
Madera County	→	North Kings	102	0
			104	0
			106	0
		Total		**0**
Root Creek WD	→	North Kings	107	0
		Total		**0**
North Kings	→	Madera ID	109	0
			110	0
			111	0
			112	0
			113	0
		Total		**0**
McMullin	→	Aliso WD	114	0
			116	0
			117	0
			118	0
		Total		**0**
Aliso WD	→	McMullin	115	0
			119	0
		Total		**0**
Farmers WD	→	McMullin	120	0
			121	2,270
		Total		**2,270**
Fresno County	→	McMullin	122	2,853
			123	2,122
			124	5,194
			125	3,468
			126	4,346
		Total		**17,982**
Fresno County	→	James ID	127	3,116
			128	298
		Total		**3,414**
Central Delta Mendota Regional Mulit Agency GSA	→	James ID	129	205
			130	4,683
			131	1,370
			132	688
		Total		**6,946**

Draft

2012 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
James ID	→	Central Delta Mendota Regional Mulit Agency GSA	133	174
		Total		**174**
James ID	→	Westlands WD	134	581
			135	356
			136	665
		Total		**1,602**
Westlands WD	→	North Fork Kings	137	935
			138	N/A
			141	844
			146	71
			147	133
			148	94
			149	830
			150	723
			152	260
			153	112
			155	332
		Total		**4,333**
North Fork Kings	→	Westlands WD	139	1,072
			140	698
			142	795
			143	20
			144	160
			145	326
			151	361
			154	224
		Total		**3,657**

Draft

2012 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
South Fork Kings GSA	→	North Fork Kings	156	649
			157	0
			158	0
			159	0
			160	0
		Total		**649**
North Fork Kings	→	Mid Kings River GSA	161	0
			162	0
			163	0
			164	1,199
		Total		**1,199**
Mid Kings River GSA	→	North Fork Kings	165	243
		Total		**243**
Mid Kings River GSA	→	Central Kings	166	2,322
		Total		**2,322**
Central Kings	→	Mid Kings River GSA	167	0
			168	0
		Total		**0**
Kings River East	→	Mid Kings River GSA	169	78
			171	1,886
		Total		**1,964**
Mid Kings River GSA	→	Kings River East	170	3,131
		Total		**3,131**
Kings River East	→	Greater Kaweah GSA	172	5
			174	255
			176	340
			177	2,865
		Total		**3,465**
Greater Kaweah GSA	→	Kings River East	173	1,711
			175	161
		Total		**1,872**

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2012 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
East Kaweah GSA	→	Kings River East	178	344
			180	459
			181	294
			182	667
		Total		**1,764**
Kings River East	→	East Kaweah GSA	179	1,142
		Total		**1,142**

Technical Memorandum 6
Summary of Alternatives for Initial Estimation

This Technical Memorandum (TM) summarizes the alternatives considered for determining the estimated overdraft volume that each GSA in the Kings Subbasin should initially include in their respective GSPs related to the unconfined aquifer. This TM utilizes the information presented in TMs 1, 2, 3, 4 and 5 from the Kings Basin Coordination Effort.

Alternatives

The following is a description of the alternatives developed for initial consideration. Attachment 1 to this memo includes a table showing the values for each Alternative.

Alternative 1 – Equal Distribution

Alternative 1 includes equal distribution of the total estimated overdraft in the basin. The estimated total storage change from TM4 (122,000AF for the Spring 1997 to Spring 2012 base period) was divided by the total acreage within the Kings Subbasin (981,541 acres) to determine a per acre responsibility. That per acre responsibility was multiplied by the total acreage within each GSA to determine that GSA's responsibility. This alternative was primarily prepared for reference as it does not factor in location or water supply and was not agreeable to GSAs that have an adequate surface water supply.

Alternative 2 – Storage Change Only

Alternative 2 uses the storage change values per GSA that were estimated in TM4. This alternative does not consider boundary flows, which historically occurred but over time have changed significantly within the basin as a depression has formed in the McMullin GSA, as well as the impact from neighboring basins.

Alternative 3 – Storage Change less Recent Boundary Flows

Alternative 3 uses the Storage Change values per GSA estimated in TM4 and also factors in the recent internal boundary flows during the base period estimated in TM5. The average annual boundary flow across internal Kings basin GSA boundaries for the base period of years were determined in TM5 and included in this alternative. The entire boundary flow across a GSA boundary as estimated in TM5 was credited back to the upgradient GSA. Crediting back the entire amount of boundary flow to the upgradient GSA was considered excessive as this assumption ignored the historic boundary flow in the region. It is important to note that the totals shown in this alternative are not adjusted for external boundary flows. External boundary flows in the unconfined aquifer were estimated in TM5, and groundwater flow across the external Kings Basin boundary is predominantly away from the Kings Basin. An adjustment for external basin boundary flows was not included in this alternative as discussions with neighboring basin GSAs is necessary for consideration.

Alternative 4 – Storage Change less the difference between Recent and Historic Boundary Flows

Alternative 4 was developed as a variation of Alternative 3 with the additional consideration of historic boundary flows within the subbasin. The boundary flows from 1925 were determined in TM5 using the same method that was used to estimate recent boundary flows during the base period. This alternative utilized the Storage Change values per GSA from TM4 as a starting point,

but then adjusted these values based on the difference between recent (average of all base period years) boundary flows and the historic (1925) boundary flows. This alternative includes as much recent data as possible in estimating current boundary flow conditions and recognizes that some groundwater historically flowed from higher elevations to lower elevations and that the downgradient GSAs should only be responsible for the increased groundwater flow caused by pumping. Similar to Alternative 3, external basin boundary flows are not factored into the totals included in this alternative.

Recommendation

From discussion with GSA representatives in the Kings Basin coordination effort, Alternative 4 is the preferred alternative for GSAs to use in setting an initial target overdraft volume for each GSA to include in their respective GSPs. A table showing the total for each GSA is included below.

GSA	Proposed Initial Responsibility (AF)
Central/South	-7,100
James	16,700
Kings River East	-11,000
McMullin	-91,100
North Fork	-50,300
North Kings	20,800
Total	-122,000

Although specific values are identified, it is critical to understand there is significant margin of error in calculating both storage change and boundary flows. It is recommended for GSAs to consider at least a 20% contingency range when considering projects and programs for implementation to correct the overdraft in the basin. These values do not consider James pumping in McMullin GSA. These initial values will also be compared to estimates developed from the basin water budget development. It is important to remember that these overdraft estimates are only for the unconfined aquifer and do not include any external boundary flow estimates, from either the unconfined or confined aquifer, as the GSAs will need to discuss how these external boundary flows are going to be addressed with the neighboring basin GSAs. The GSAs will need to evaluate and adjust these values regularly in future years as additional information is collected and estimates of storage change are updated.

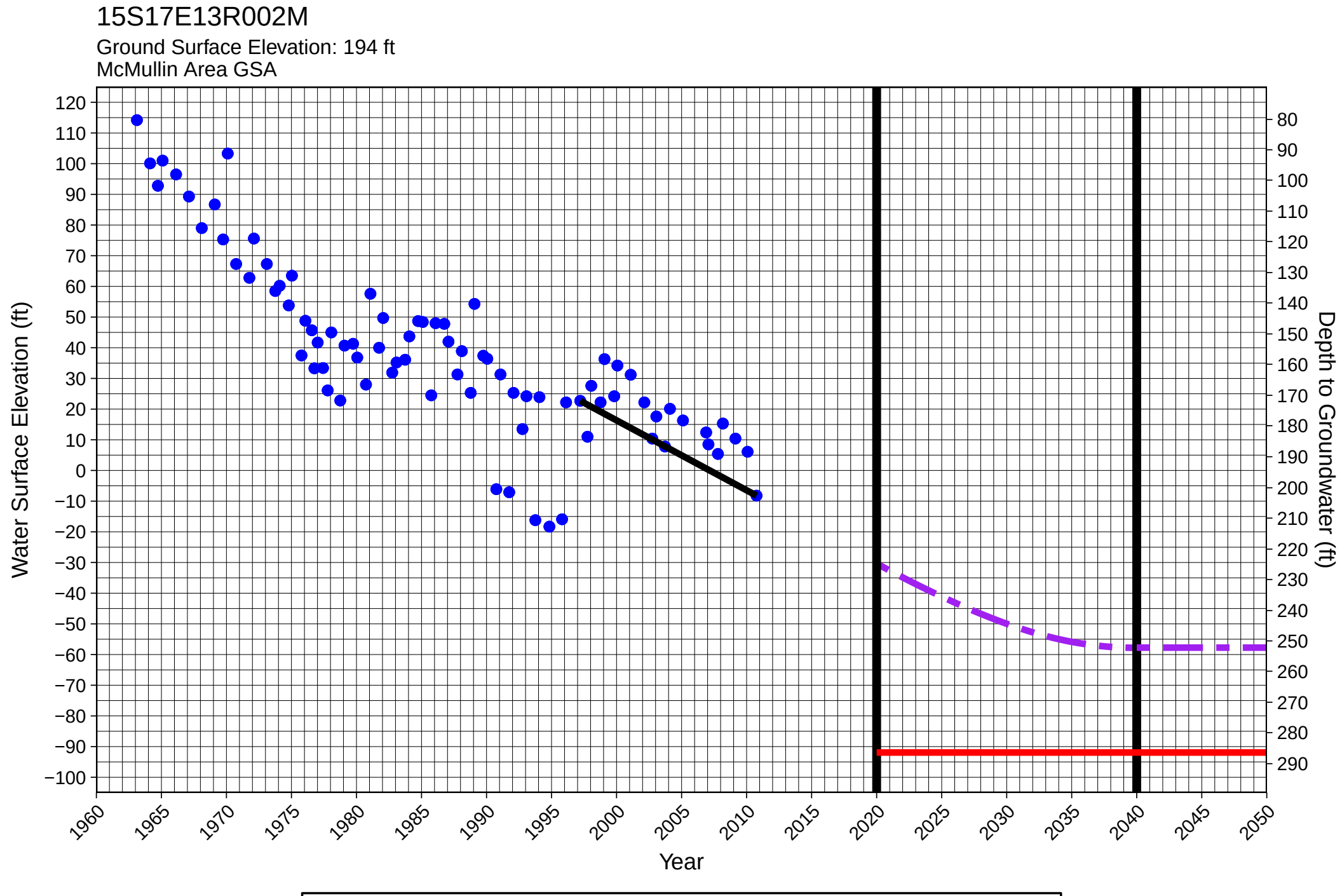
Attachment 1
Alternatives Table

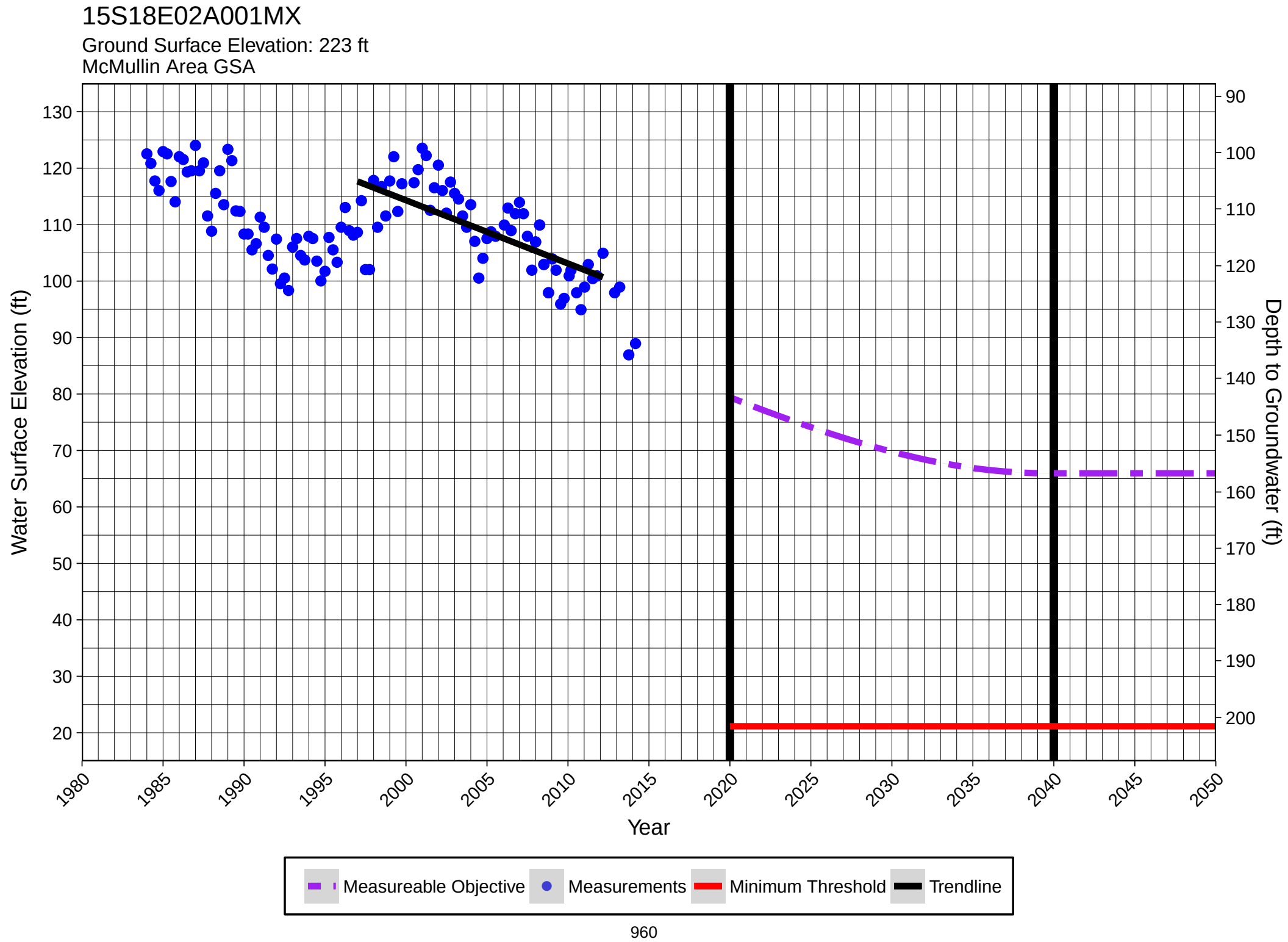
Kings Basin Methodology Alternatives for Proportionment of Storage Change
10/24/2018

Column #	1	2	3	4	5	6	7
Methodology	**Alt 1** **Equal Distribution**		**Alt 2** **Storage Change Only**	**Alt 3** **Storage Change +/- Recent Boundary Flows**		**Alt 4** **Storage Change +/- Difference between Historic and Recent Boundary Flows**	
Column Calculation					3 - 4		3 - (4 - 6)
GSA	Acreage	Total Basin Storage Change 97-12 divided by Total Basin Acreage multiplied by GSA Acreage (AF)	Storage Change Estimation (Spring 97-12) from TM4 (AF)	Average of Base Period (97-12) Internal Boundary Flows [1] (AF)	Total w/Recent (Base Period) Average Internal Boundary Flows (AF)	1925 Internal Boundary Flows from TM4 [1] (AF)	Storage Change less difference between Int Flows only (AF)
Central/South	160,870	-19,995	-17,000	-20,400	3,400	-10,500	-7,100
James	29,051	-3,611	-5,000	-19,200	14,200	2,500	16,700
Kings River East	191,126	-23,756	-11,000	0	-11,000	0	-11,000
McMullin	120,580	-14,987	-16,000	91,700	-107,700	16,600	-91,100
North Fork	168,187	-20,905	-49,000	14,900	-63,900	13,600	-50,300
North Kings	311,728	-38,746	-24,000	-67,000	43,000	-22,200	20,800
Total	981,542	-122,000	-122,000		-122,000		-122,000

Notes: 1) A negative boundary flow value means the total sum of flow is out of or away from the GSA. A positive value means flow into the GSA.

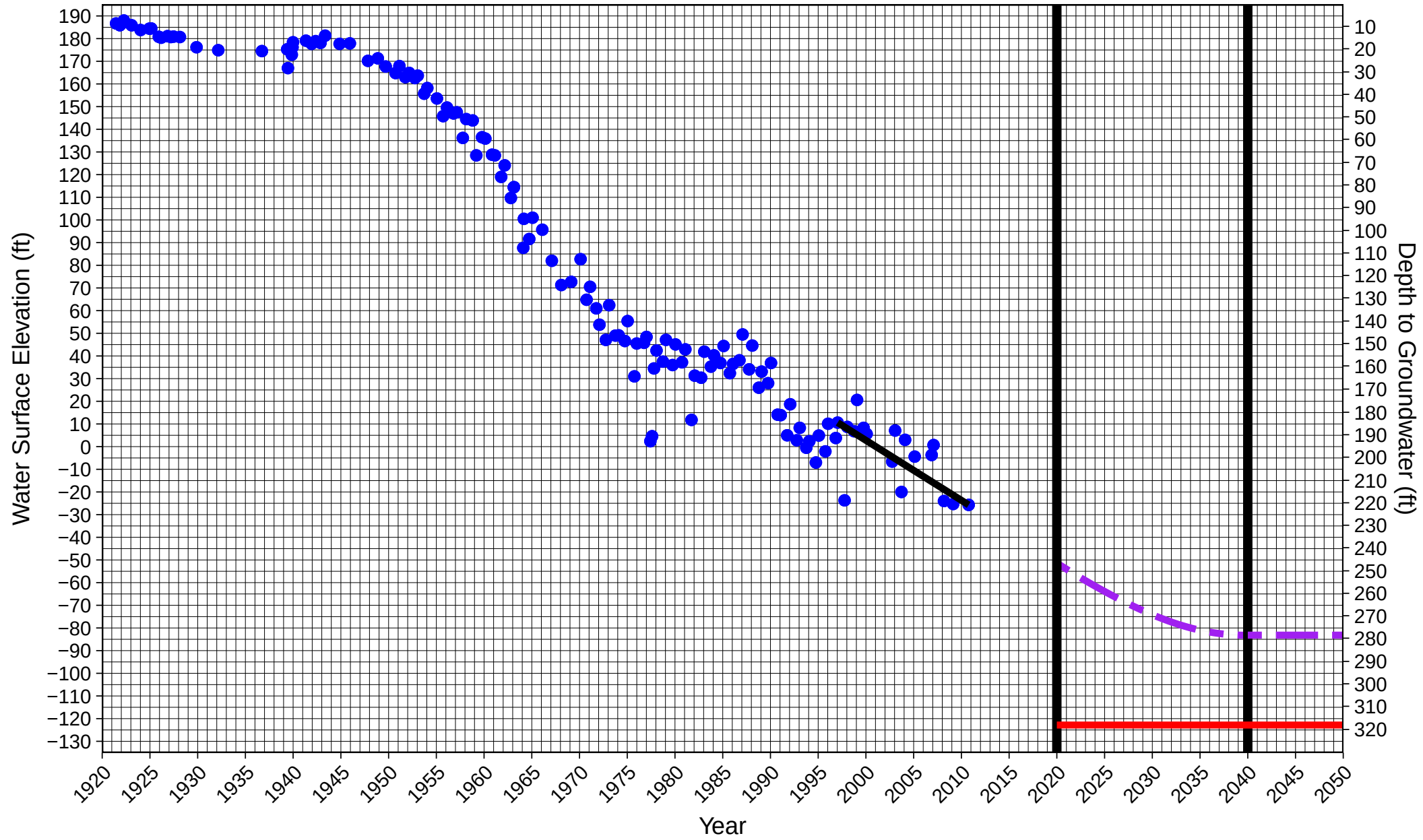
Appendix 4 A
Hydrographs


15S17E13R002M
Ground Surface Elevation: 194 ft
McMullin Area GSA
Water Surface Elevation (ft)
Depth to Groundwater (ft)
Year
Measureable Objective
Measurements
Minimum Threshold
Trendline


15S18E02A001MX
Ground Surface Elevation: 223 ft
McMullin Area GSA
Water Surface Elevation (ft)
Depth to Groundwater (ft)
Year
130
120
110
100
90
80
70
60
50
40
30
20
90
100
110
120
130
140
150
160
170
180
190
200
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050
Measureable Objective
Measurements
Minimum Threshold
Trendline

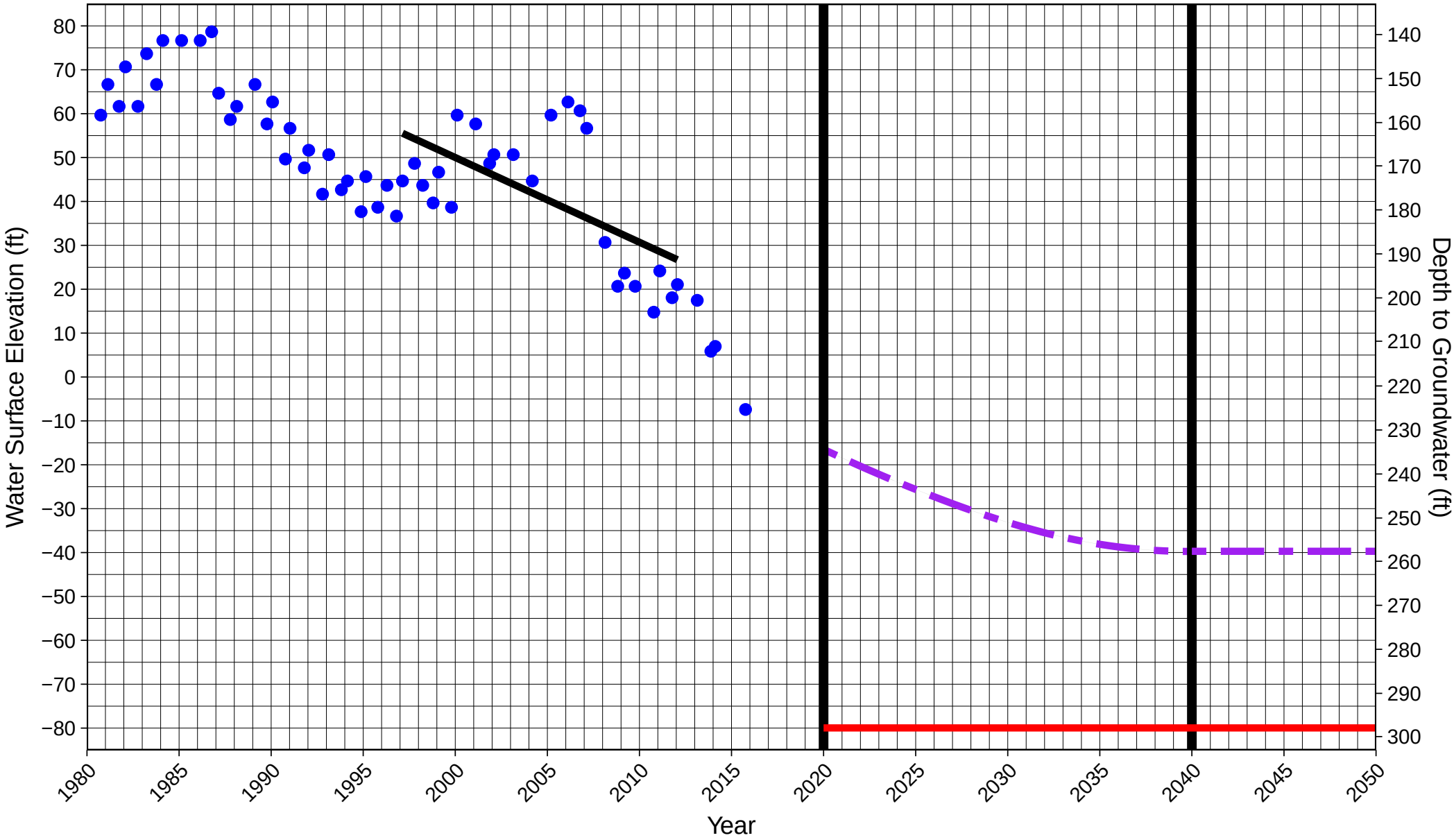
15S18E30L001M

Ground Surface Elevation: 195 ft
McMullin Area GSA



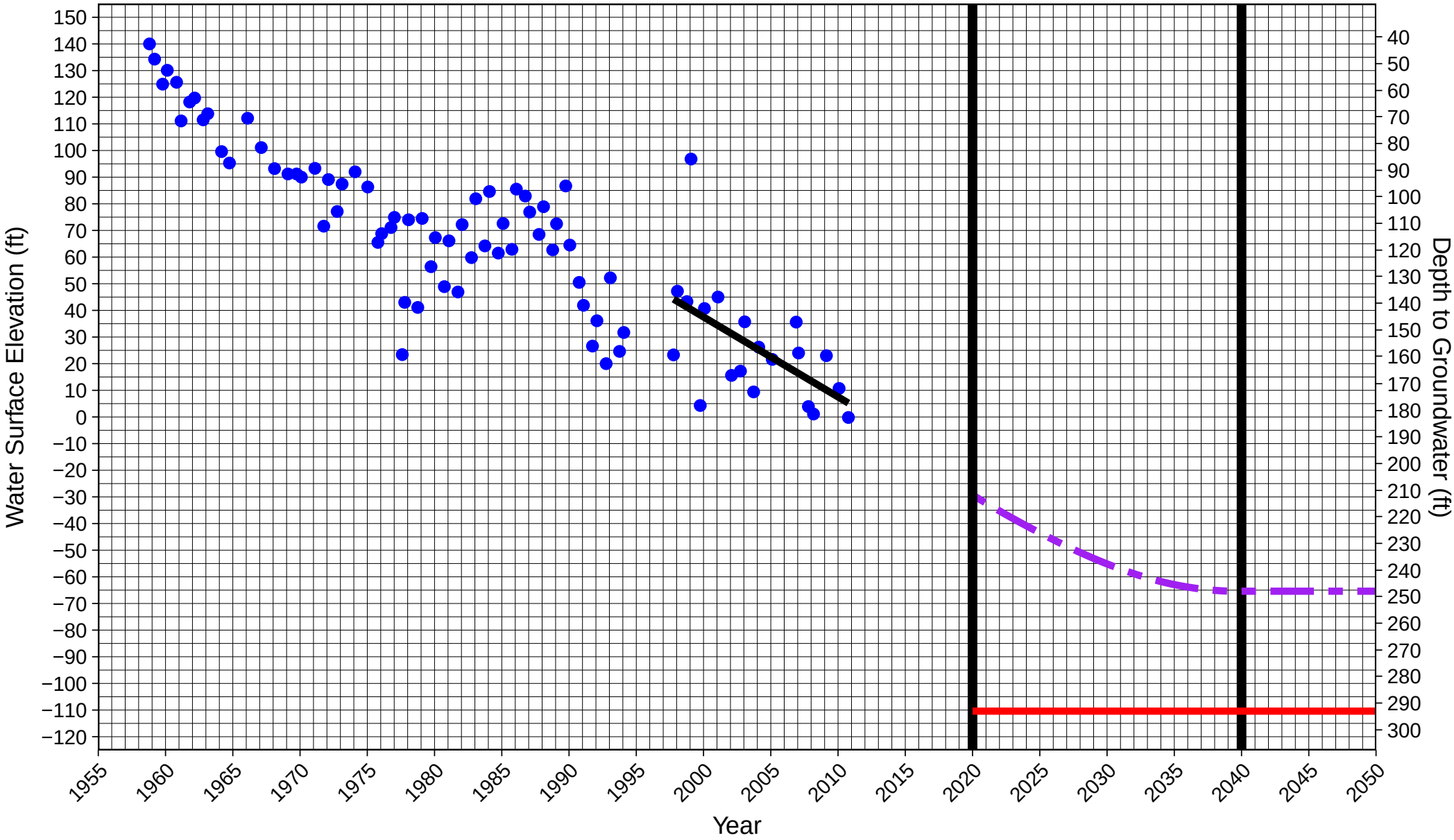
365463N1199268W001

State Well ID: 16S19E17C001M
Ground Surface Elevation: 218 ft
McMullin Area GSA



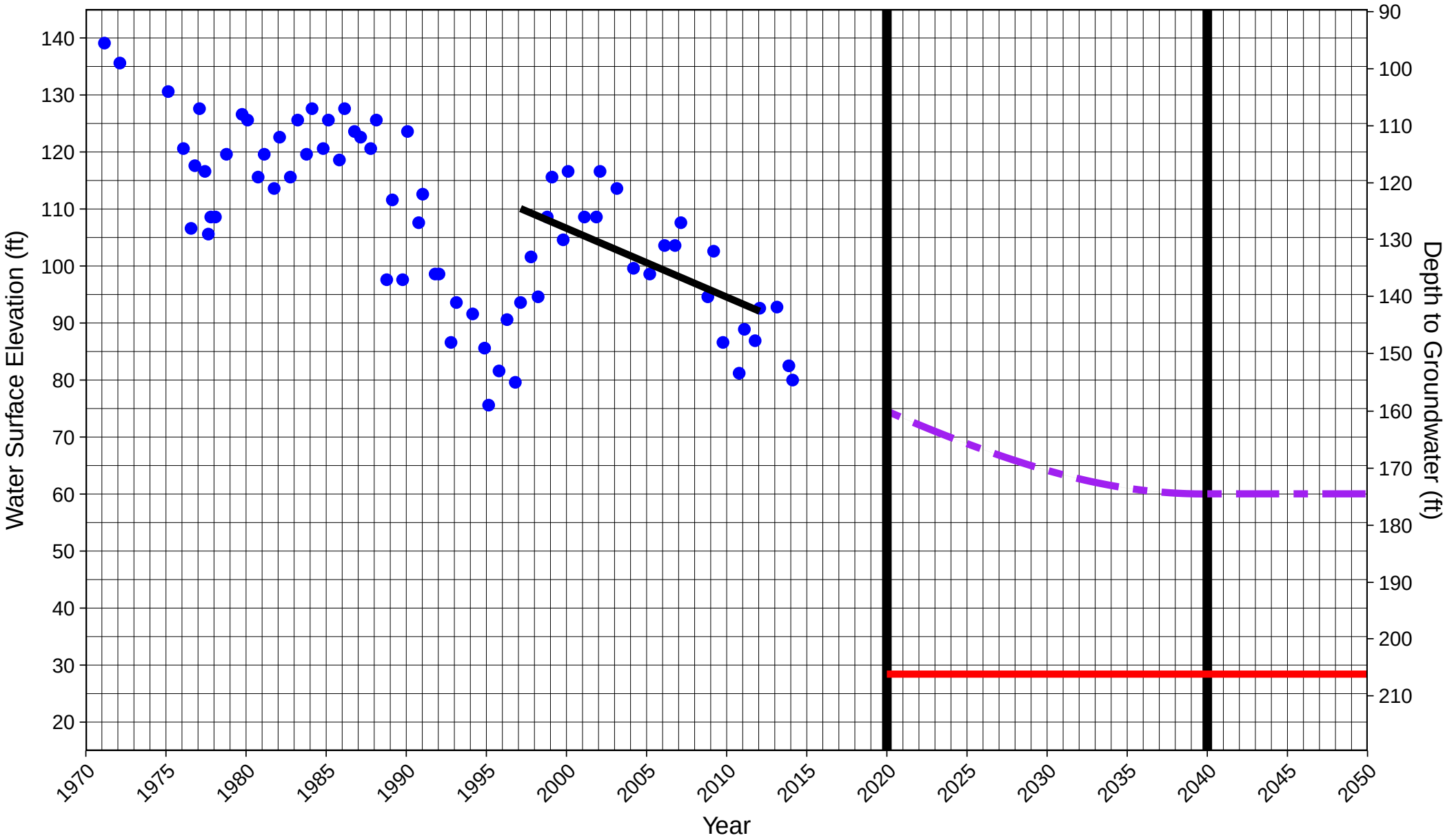
366082N1201199W001

State Well ID: 15S17E21J001M
Ground Surface Elevation: 183 ft
McMullin Area GSA



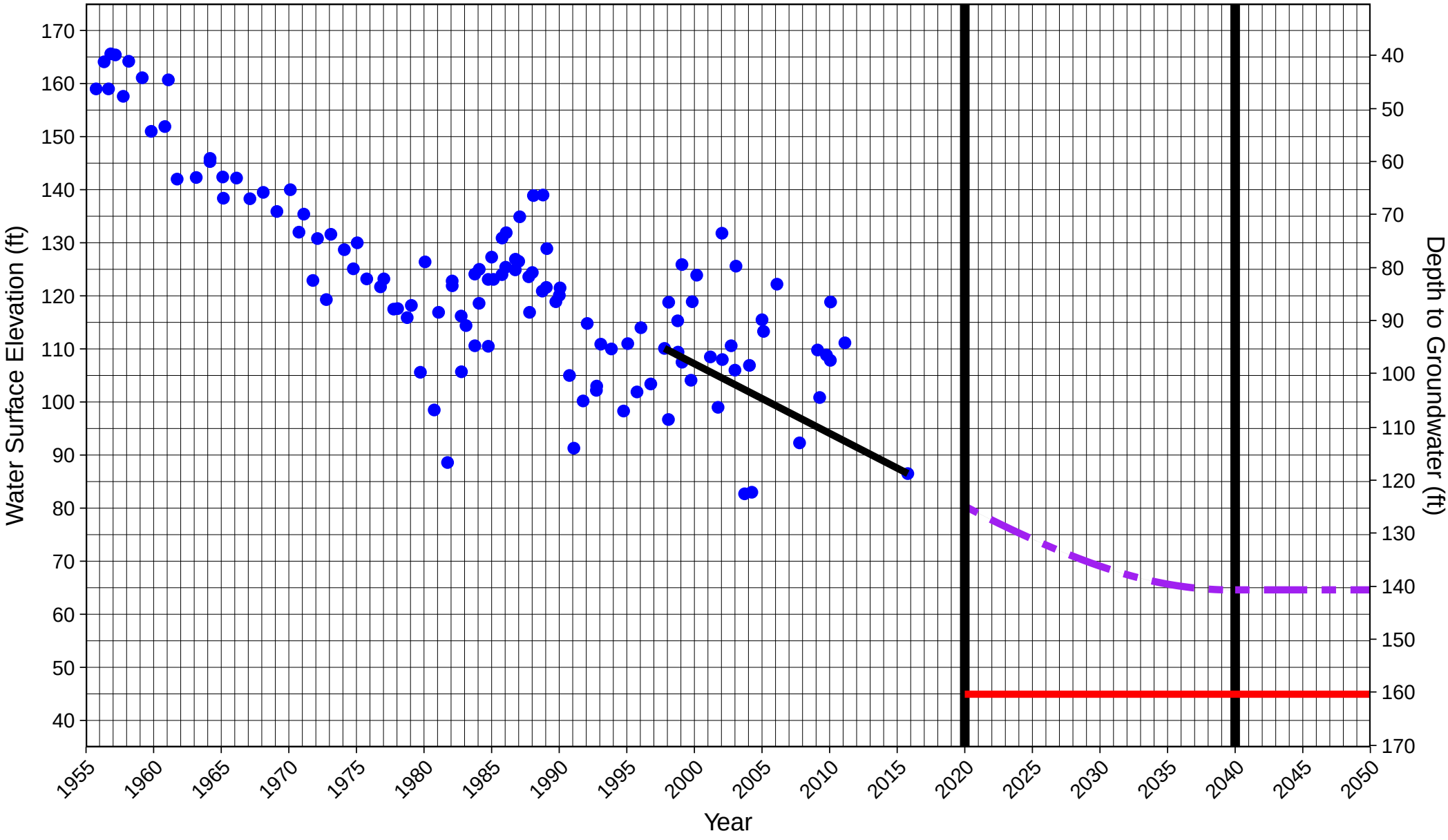
366188N1199104W001

State Well ID: 15S19E21C003M
Ground Surface Elevation: 235 ft
McMullin Area GSA



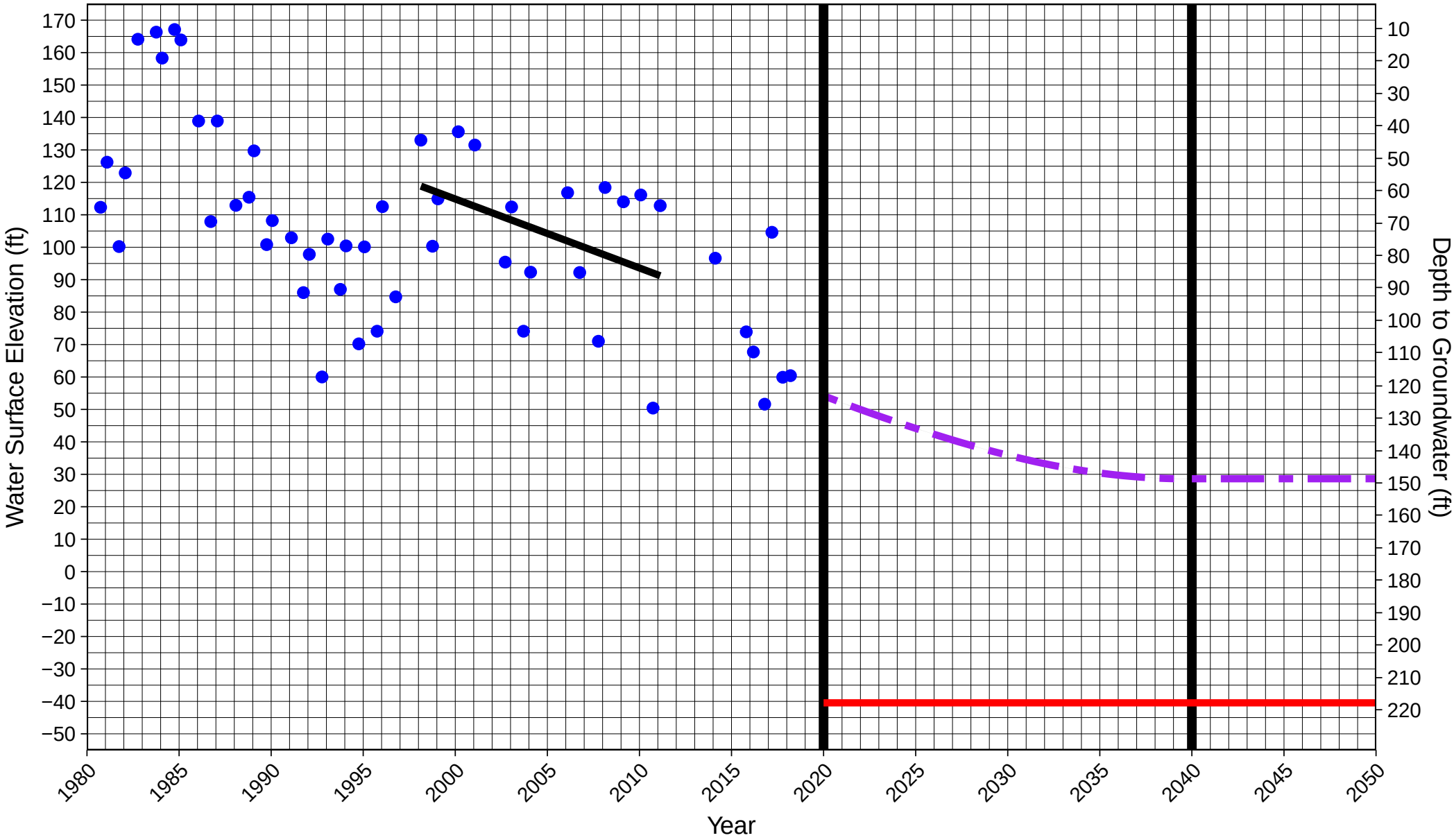
367477N1201460W001

State Well ID: 14S17E05D001M
Ground Surface Elevation: 205 ft
McMullin Area GSA



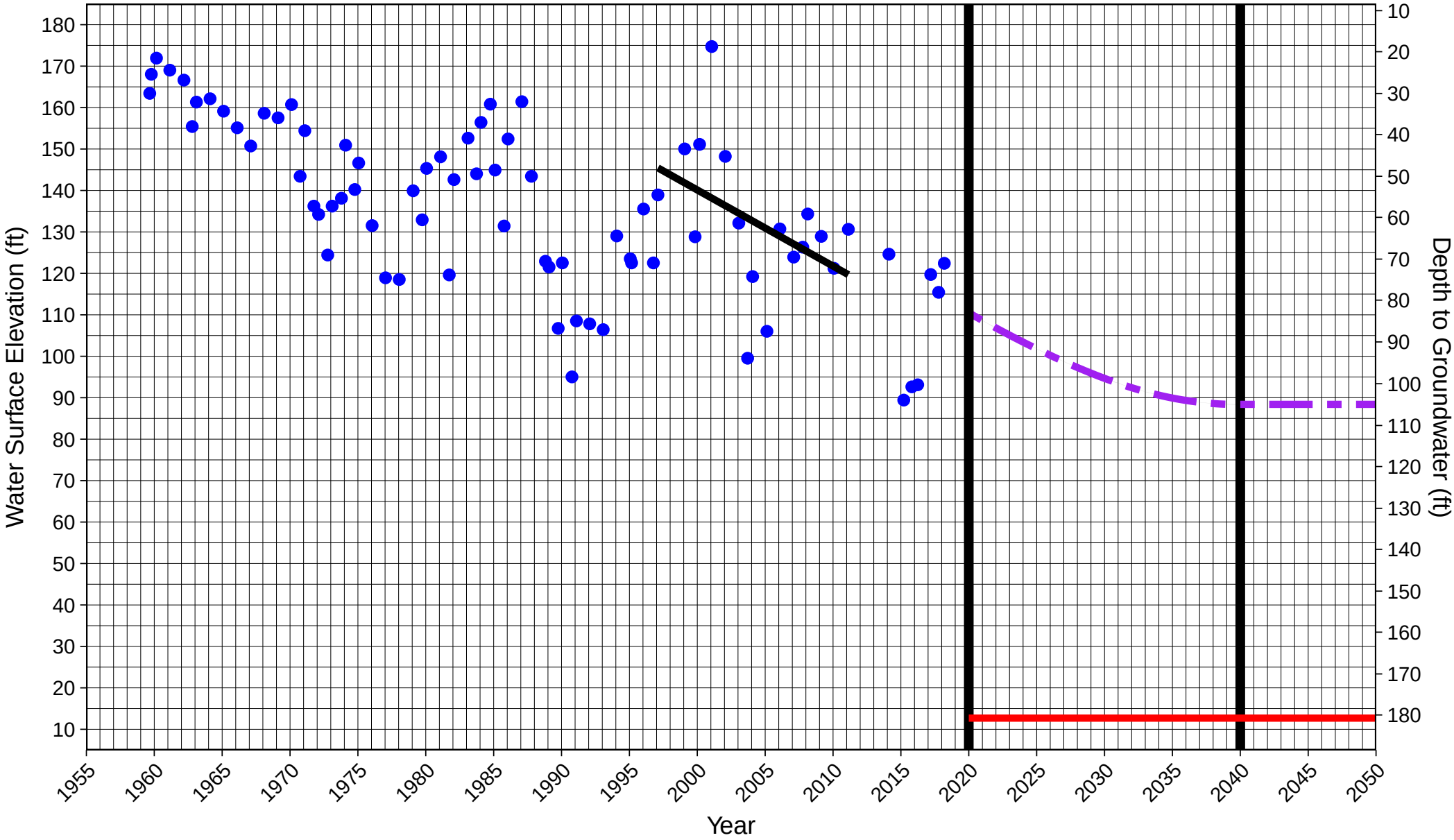
367705N1202691W001

State Well ID: 13S16E30L003M
Ground Surface Elevation: 177 ft
McMullin Area GSA



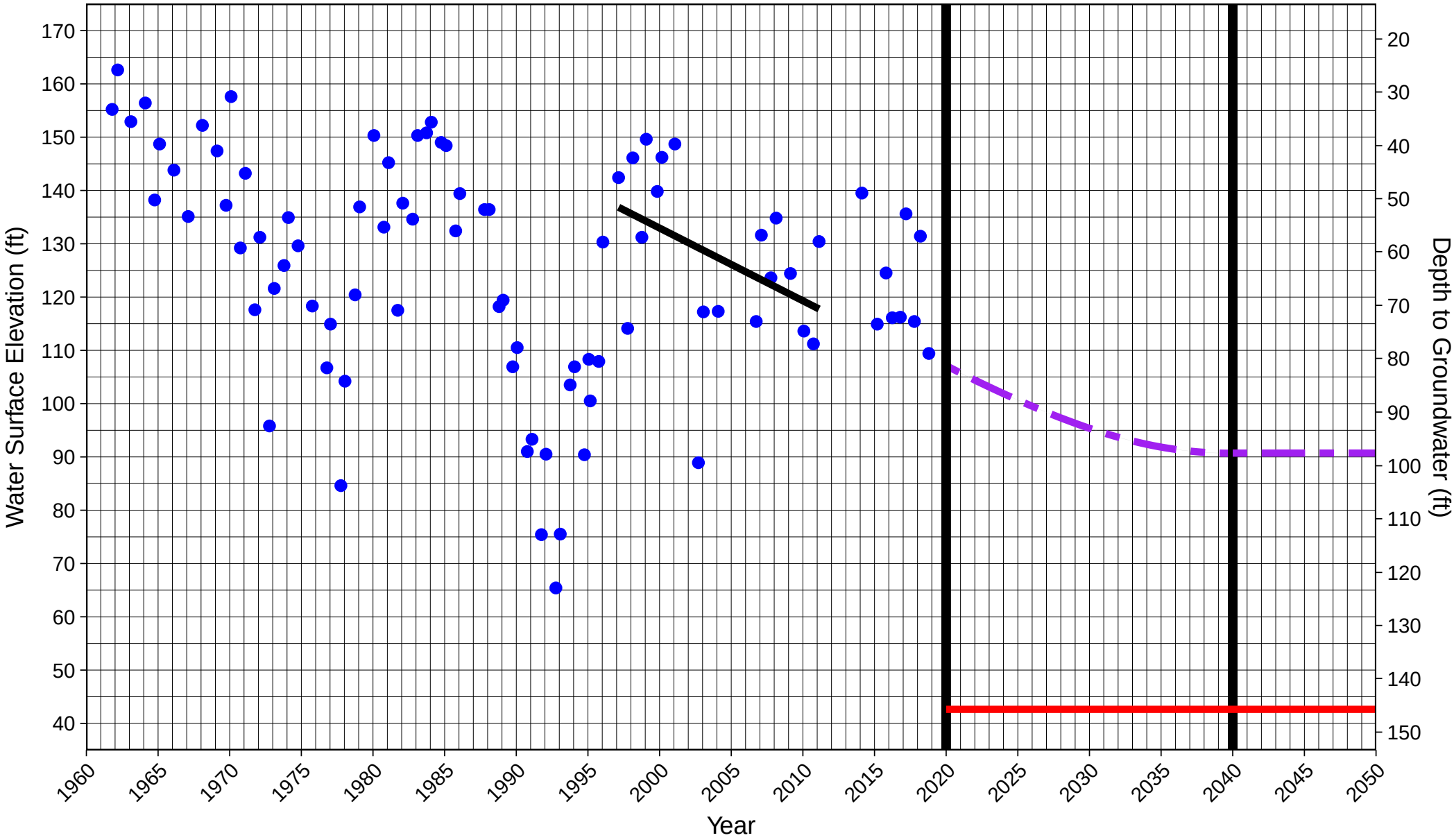
367757N1201874W001

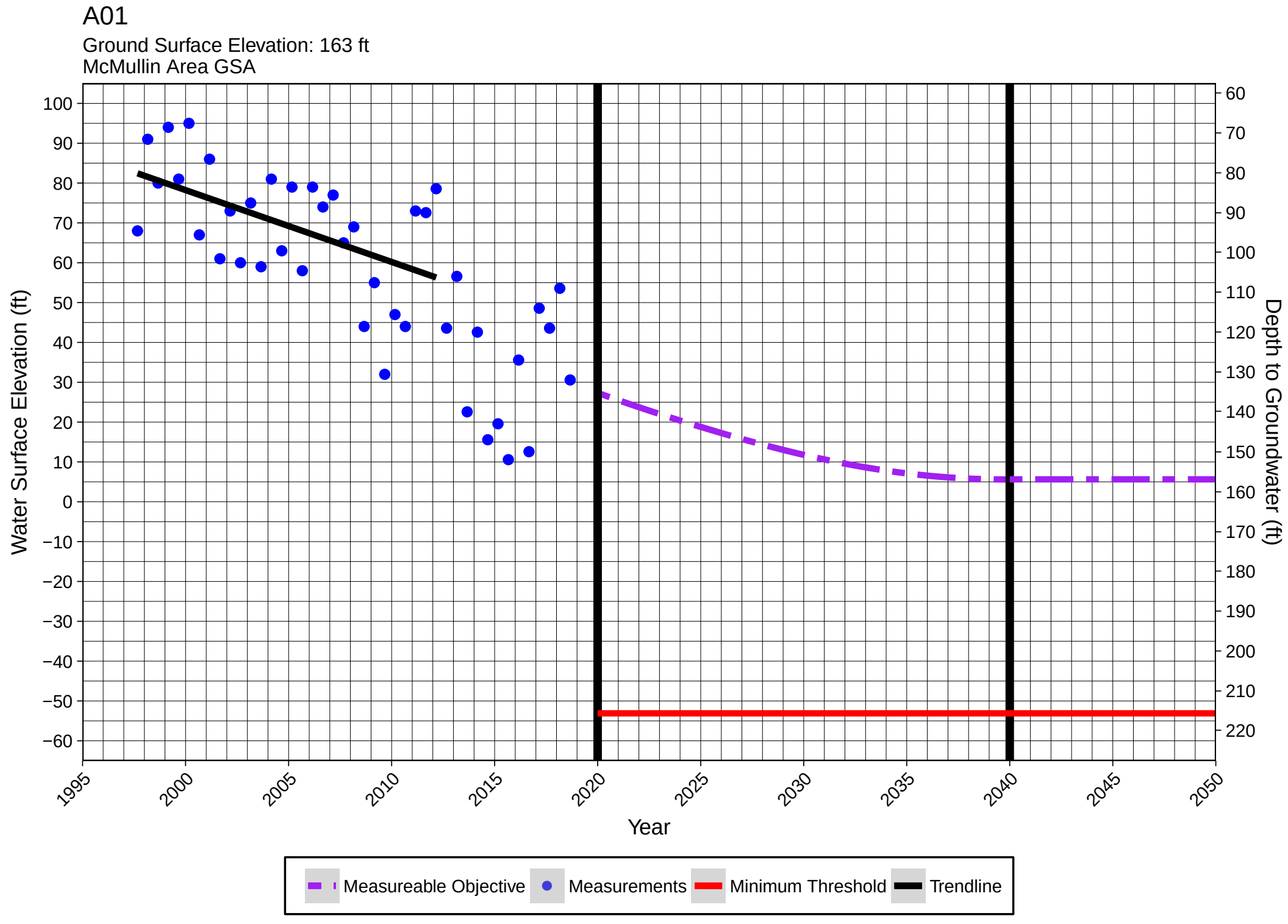
State Well ID: 13S16E26A001M
Ground Surface Elevation: 193 ft
McMullin Area GSA



367782N1202141W001

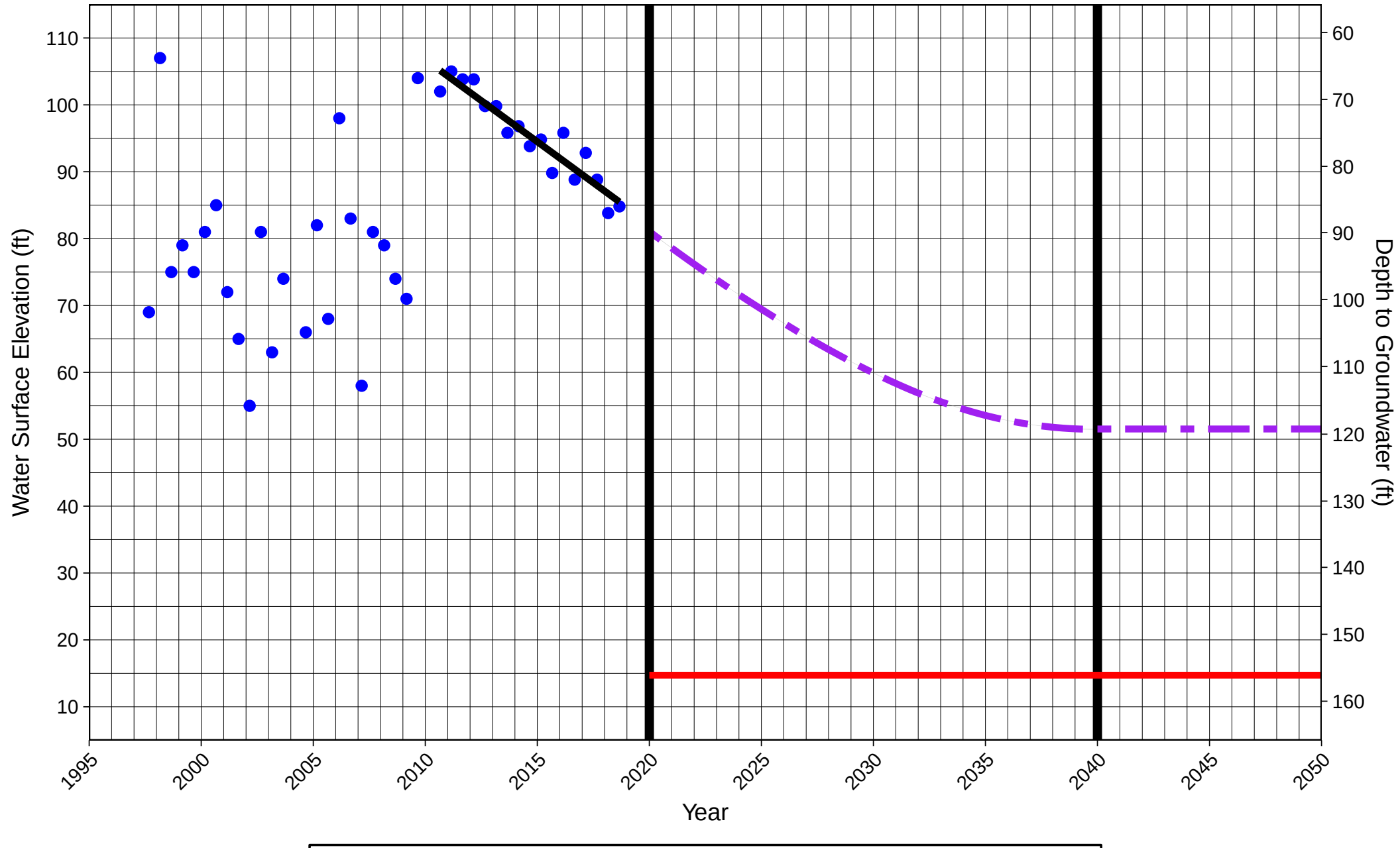
State Well ID: 13S16E27C001M
Ground Surface Elevation: 188 ft
McMullin Area GSA




A01
Ground Surface Elevation: 163 ft
McMullin Area GSA
Water Surface Elevation (ft)
Depth to Groundwater (ft)
Year
100
90
80
70
60
50
40
30
20
10
0
−10
−20
−30
−40
−50
−60
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
1995
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050
Measureable Objective
Measurements
Minimum Threshold
Trendline

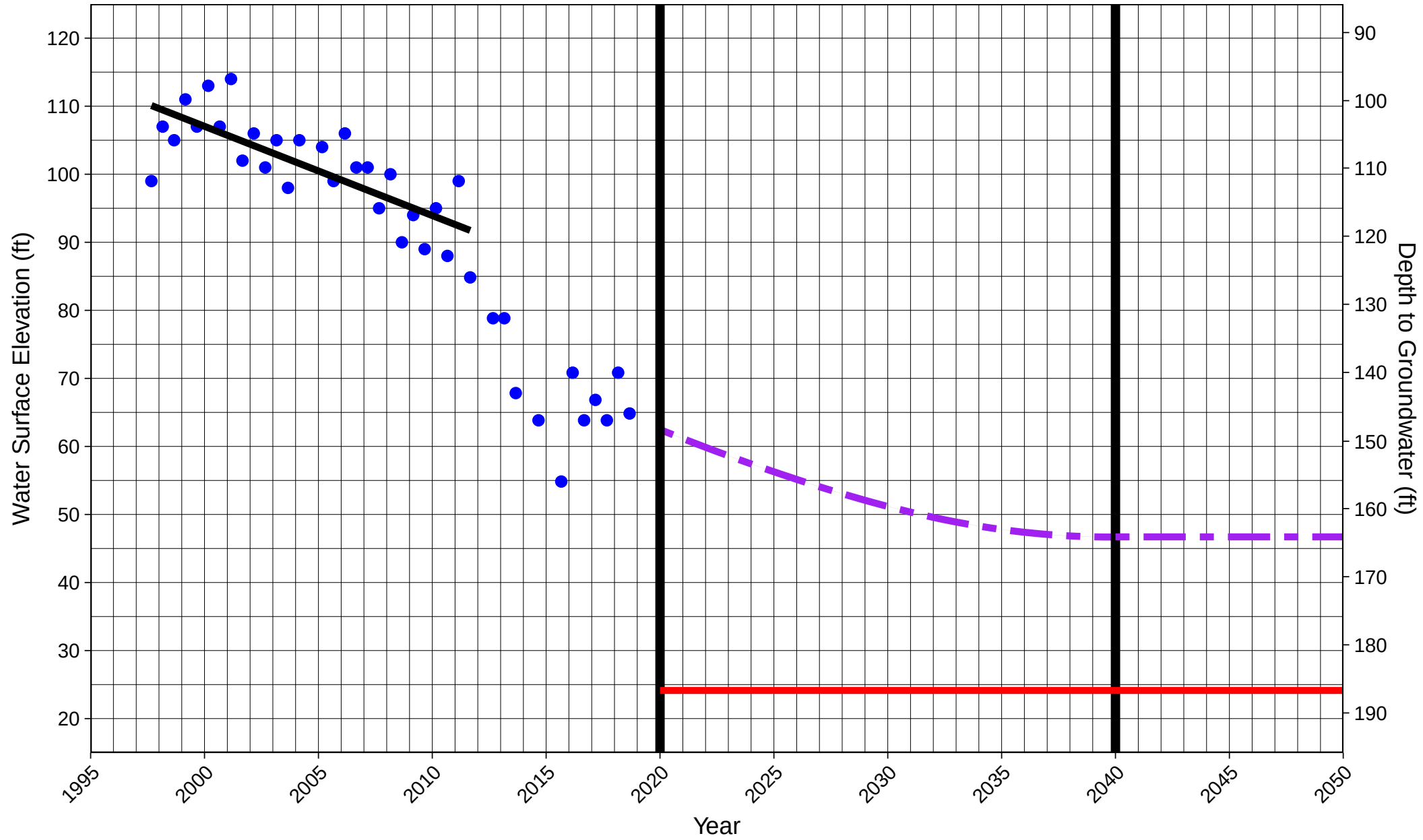
A07

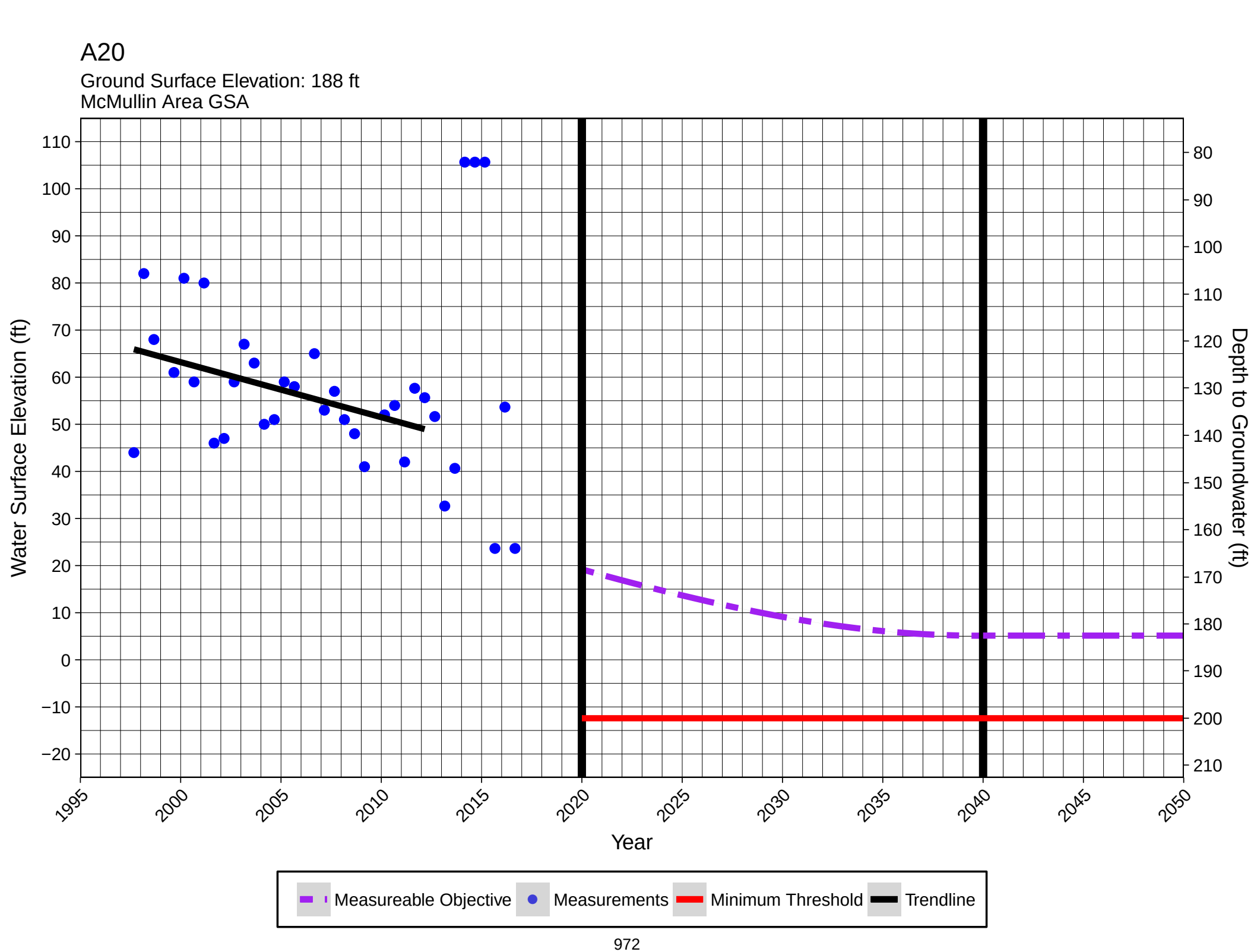
Ground Surface Elevation: 171 ft
McMullin Area GSA



A17

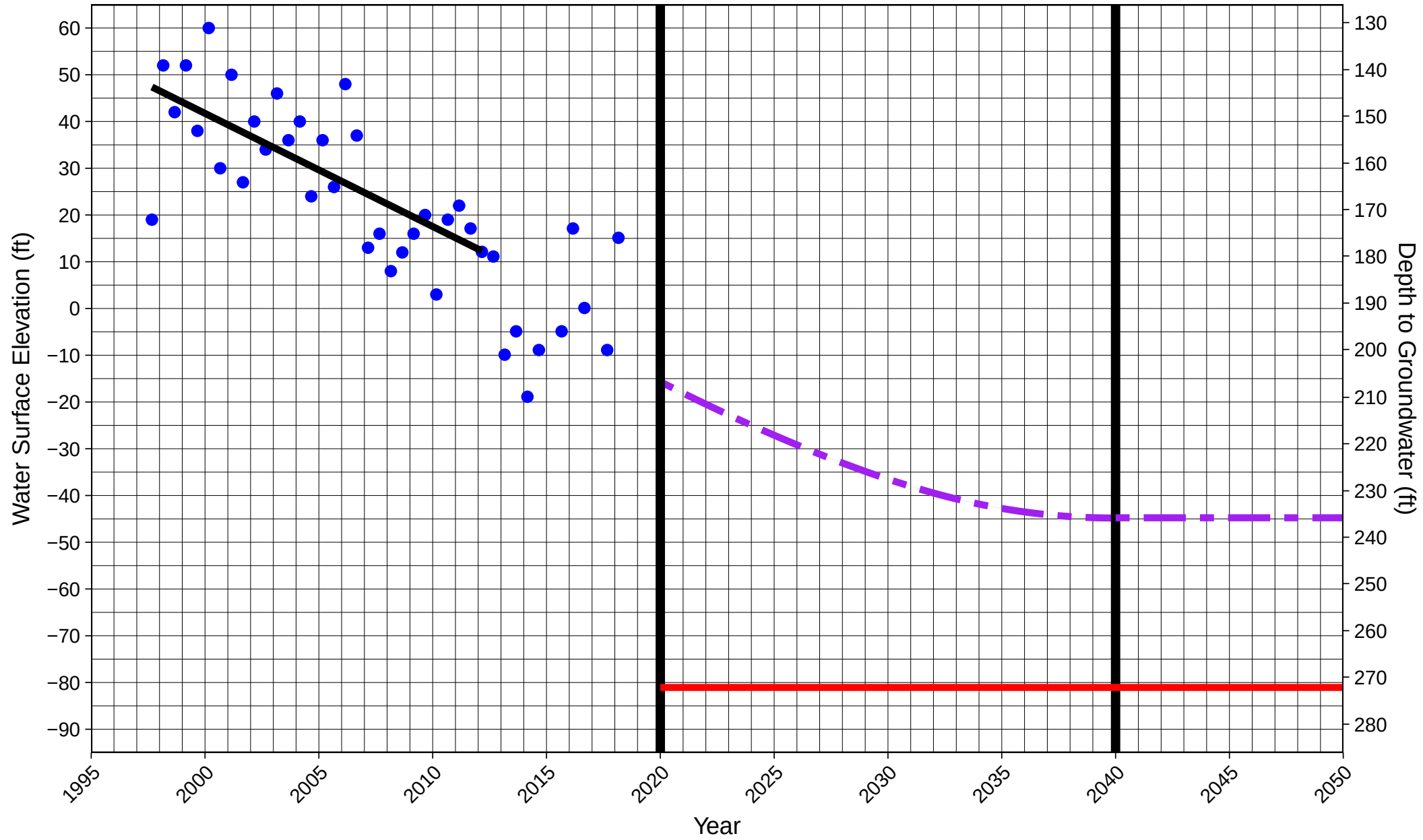
Ground Surface Elevation: 211 ft
McMullin Area GSA

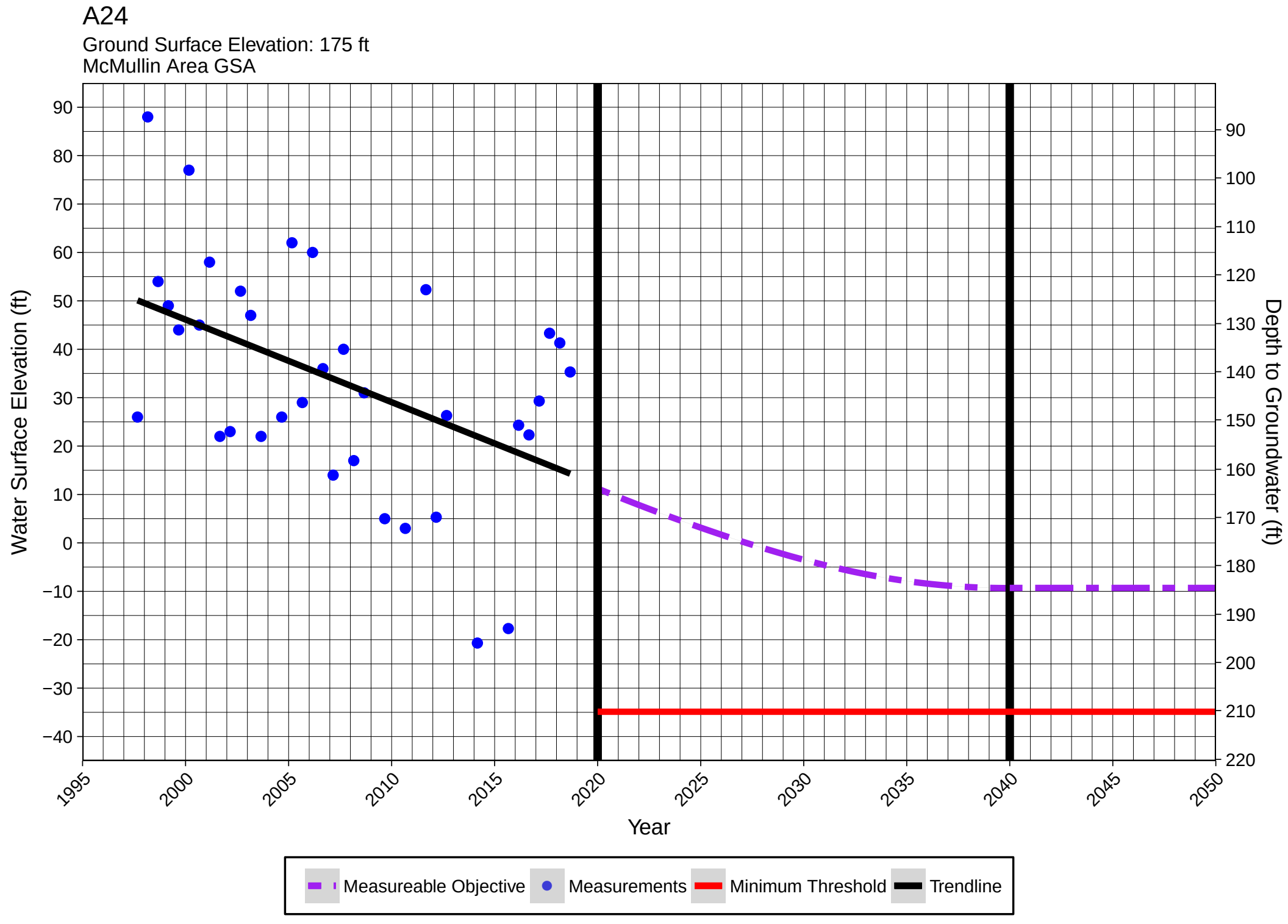


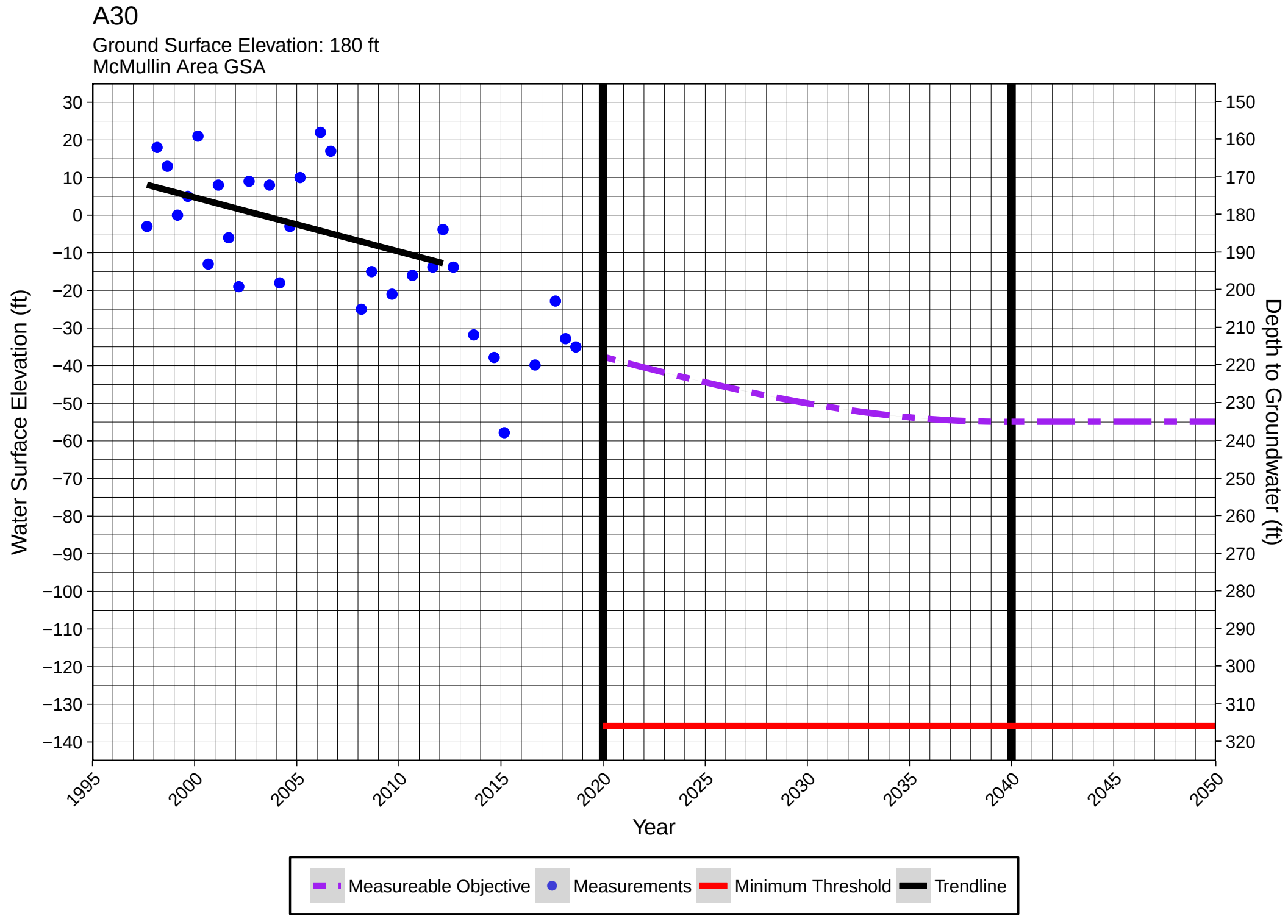

A20
Ground Surface Elevation: 188 ft
McMullin Area GSA
Water Surface Elevation (ft)
Depth to Groundwater (ft)
Year
110
100
90
80
70
60
50
40
30
20
10
0
−10
−20
80
90
100
110
120
130
140
150
160
170
180
190
200
210
1995
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050
Measureable Objective
Measurements
Minimum Threshold
Trendline

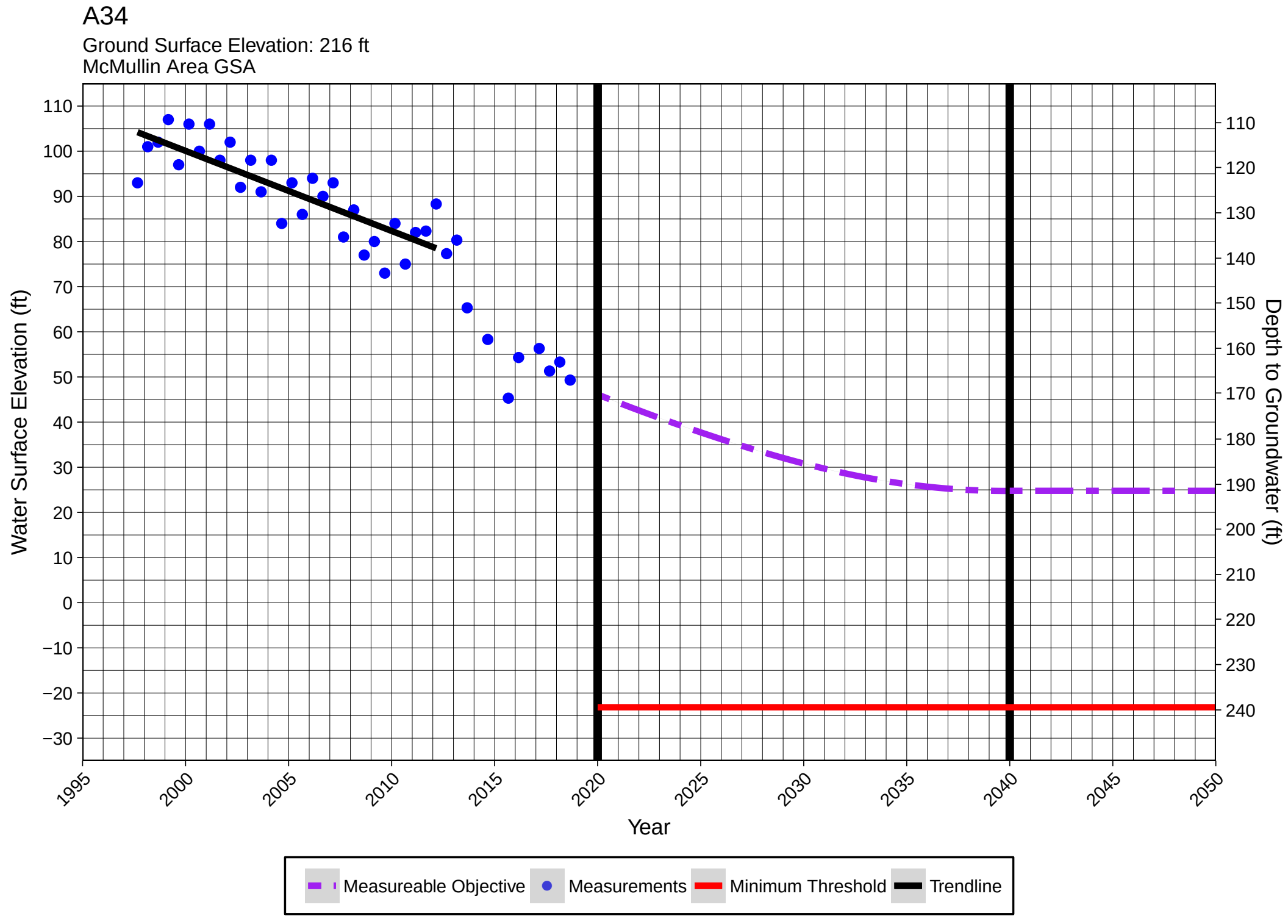
A23

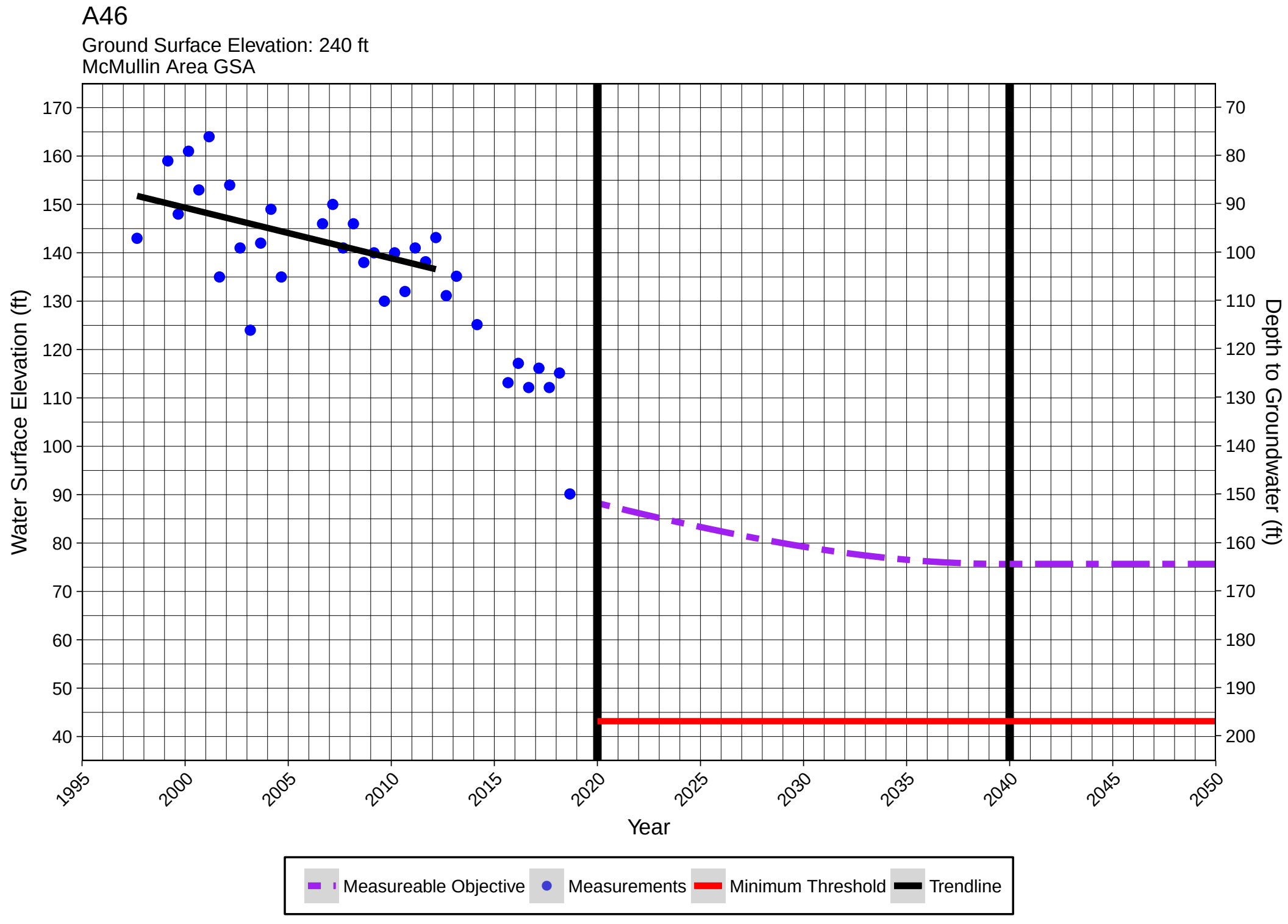
Ground Surface Elevation: 191 ft
McMullin Area GSA




A24
Ground Surface Elevation: 175 ft
McMullin Area GSA
Water Surface Elevation (ft)
Depth to Groundwater (ft)
Year
90
80
70
60
50
40
30
20
10
0
−10
−20
−30
−40
90
100
110
120
130
140
150
160
170
180
190
200
210
220
1995
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050
Measureable Objective
Measurements
Minimum Threshold
Trendline

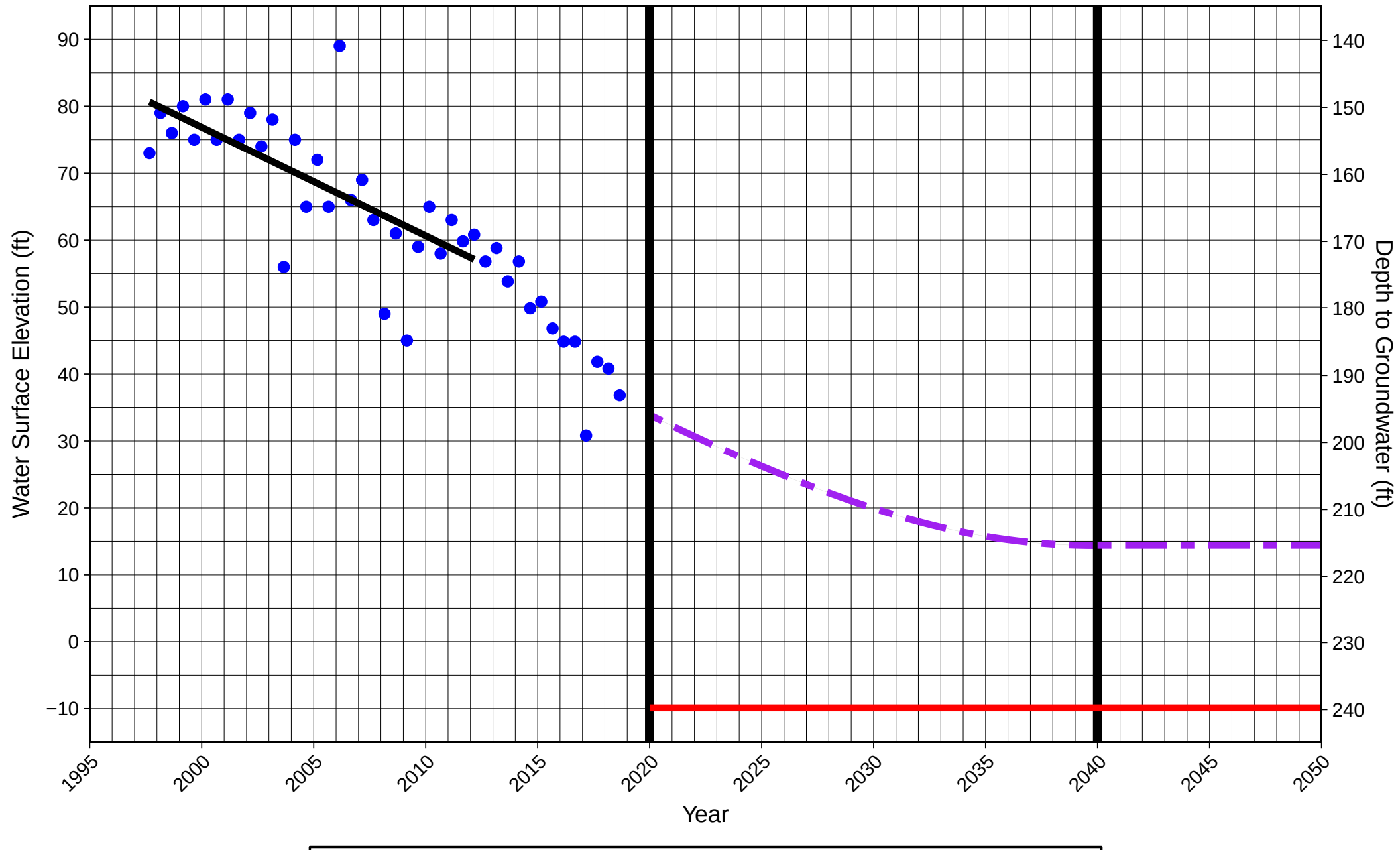

A30
Ground Surface Elevation: 180 ft
McMullin Area GSA
Water Surface Elevation (ft)
Depth to Groundwater (ft)
Year
30
20
10
0
−10
−20
−30
−40
−50
−60
−70
−80
−90
−100
−110
−120
−130
−140
150
160
170
180
190
200
210
220
230
240
250
260
270
280
290
300
310
320
1995
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050
Measureable Objective
Measurements
Minimum Threshold
Trendline

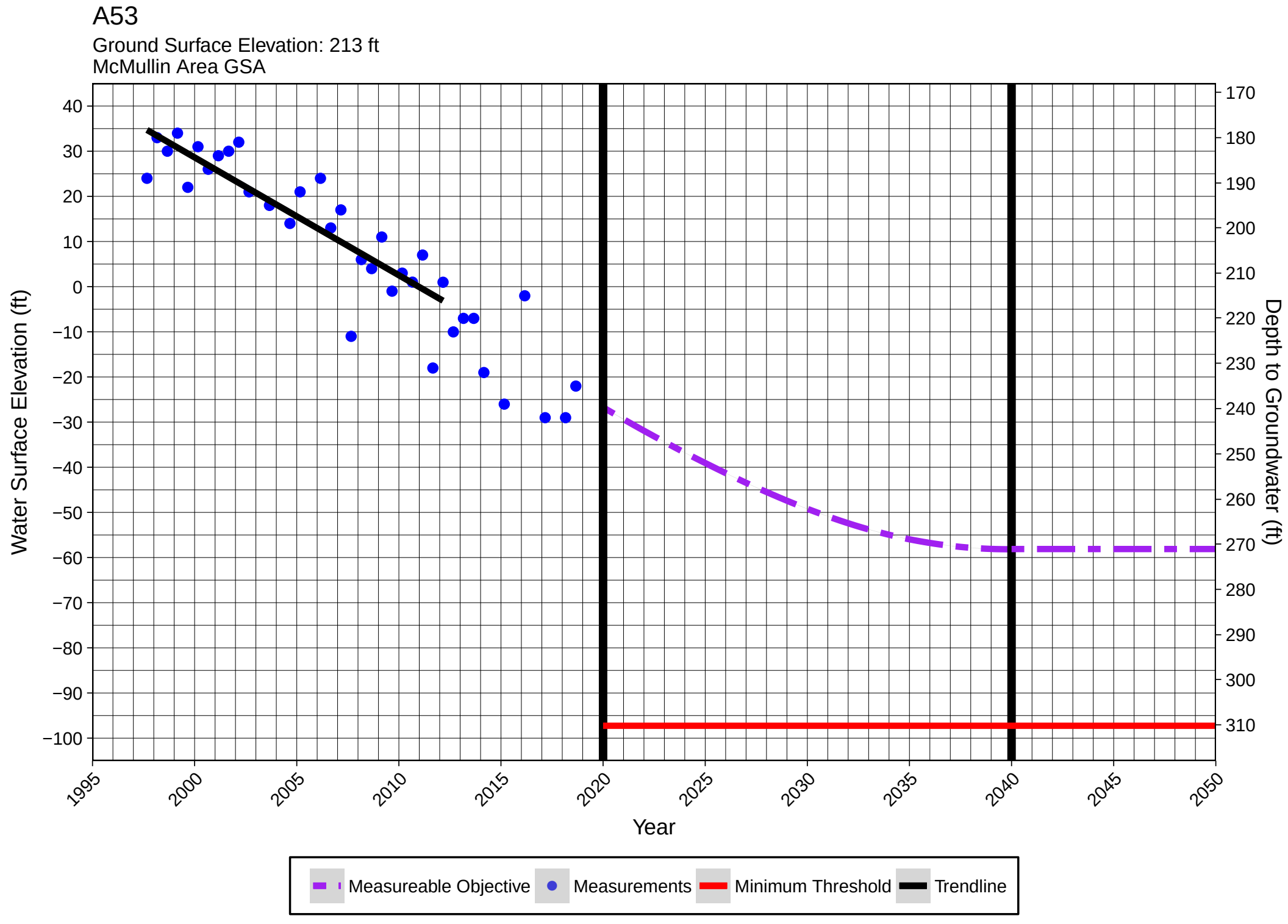

A34
Ground Surface Elevation: 216 ft
McMullin Area GSA
Water Surface Elevation (ft)
Depth to Groundwater (ft)
Year
110
100
90
80
70
60
50
40
30
20
10
0
−10
−20
−30
120
130
140
150
160
170
180
190
200
210
220
230
240
1995
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050
Measureable Objective
Measurements
Minimum Threshold
Trendline


A46
Ground Surface Elevation: 240 ft
McMullin Area GSA
Water Surface Elevation (ft)
Depth to Groundwater (ft)
Year
170
160
150
140
130
120
110
100
90
80
70
60
50
40
70
80
90
100
110
120
130
140
150
160
170
180
190
200
1995
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050
Measureable Objective
Measurements
Minimum Threshold
Trendline

A51

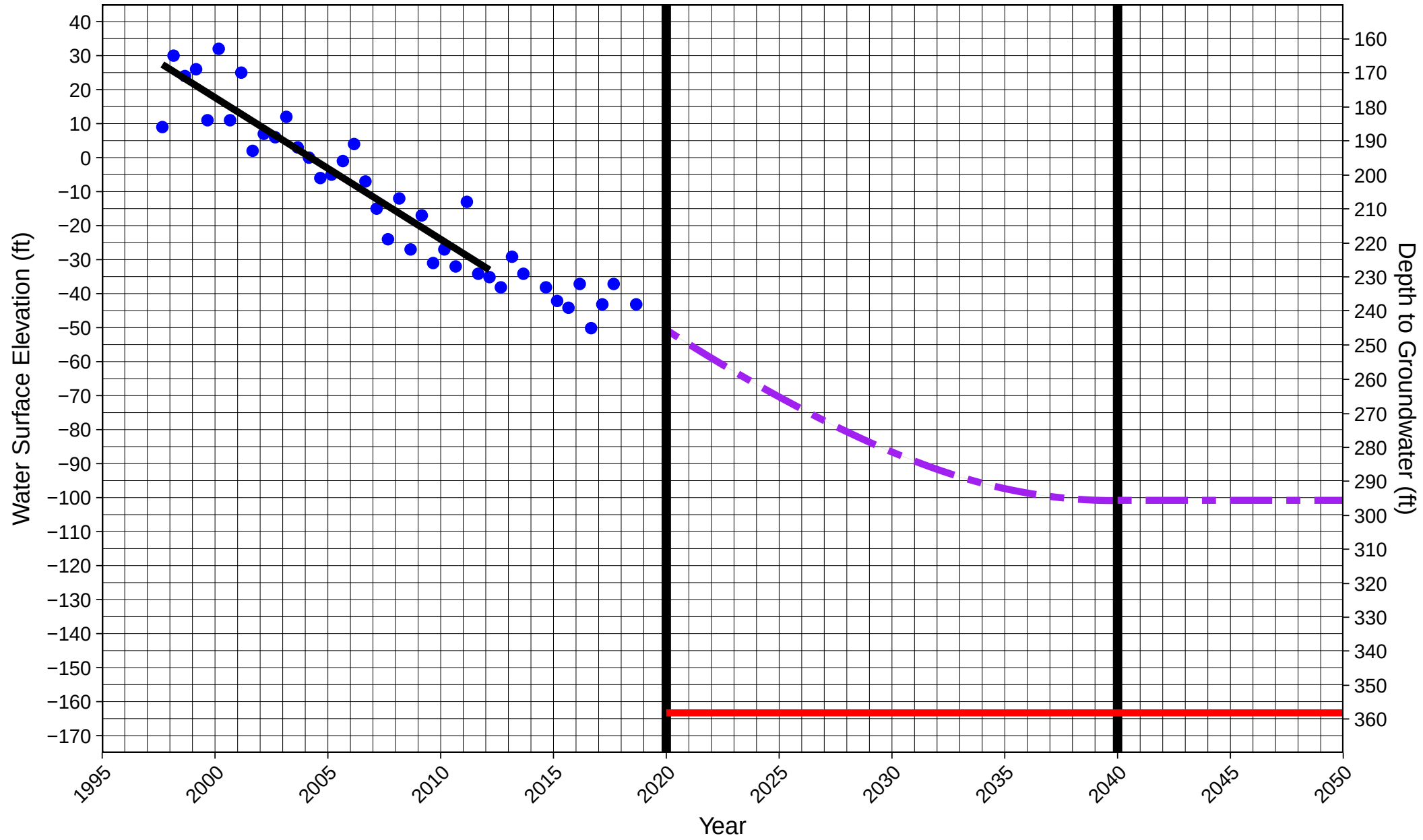
Ground Surface Elevation: 230 ft
McMullin Area GSA




A53
Ground Surface Elevation: 213 ft
McMullin Area GSA
Water Surface Elevation (ft)
Depth to Groundwater (ft)
Year
40
30
20
10
0
−10
−20
−30
−40
−50
−60
−70
−80
−90
−100
170
180
190
200
210
220
230
240
250
260
270
280
290
300
310
1995
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050
Measureable Objective
Measurements
Minimum Threshold
Trendline

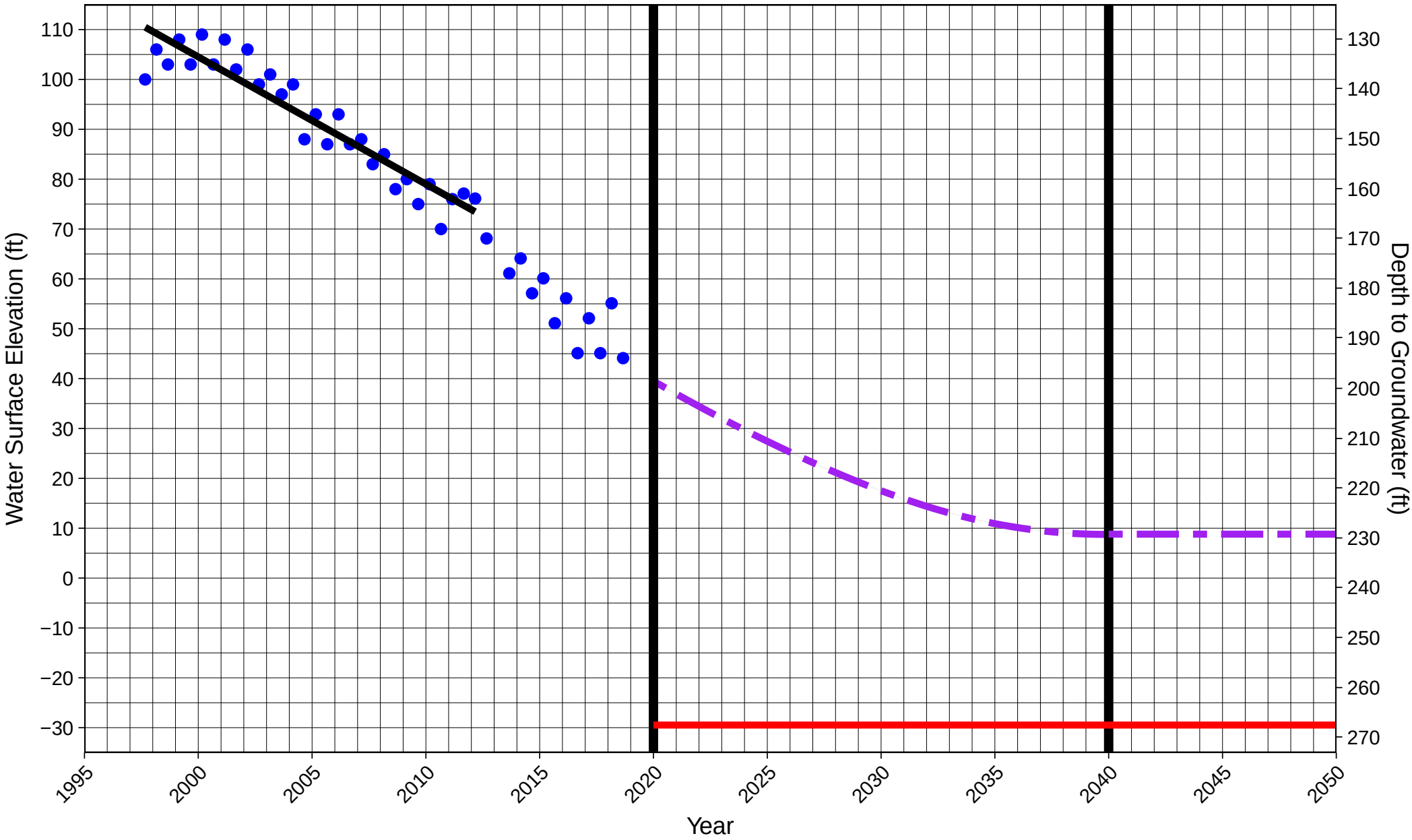
A58

Ground Surface Elevation: 195 ft, Perforated Depth: 240− 570 ft
McMullin Area GSA



A62

Ground Surface Elevation: 238 ft
McMullin Area GSA



Appendix 4 B
Groundwater Storage Calculations

Appendix 5 A
Table of Monitoring Site Attributes

Appendix 5-A Monitoring Network Attricutes Tables

Site ID	Monitoring purpose	Master Site Code	Well Type	Perforations (feet bgs)	Total Depth (feet bgs)
15S18E02A001MX	Water Level	NA	Irrigation		
365463N1199268W001	Water Level	365463N1199268W001	Unknown		
366082N1201199W001	Water Level	366082N1201199W001	Unknown		
366188N1199104W001	Water Level	366188N1199104W001	Irrigation	270-522	555
367477N1201460W001	Water Level	367477N1201460W001	Irrigation		
367705N1202691W001	Water Level	367705N1202691W001	Unknown		
367757N1201874W001	Water Level	367757N1201874W001	Unknown		
367782N1202141W001	Water Level	367782N1202141W001	Unknown		
A01	Water Level	NA	Unknown		
A07	Water Level	NA	Monitoring		
A17	Water Level	NA	Unknown		
A20	Water Level	NA	Unknown		
A23	Water Level	366500N1201000W001	Irrigation	111-214	306
A24	Water Level	NA	Unknown		
A30	Water Level	365800N1200900W001	Irrigation	280-560	580
A34	Water Level	366600N1200200W001	Irrigation		
A46	Water Level	NA	Unknown		
A51	Water Level	NA	Unknown		
A53	Water Level	365700N1199500W001	Irrigation	303-393	460
A58	Water Level	365400N1200000W001	Irrigation	240-570	585
A62	Water Level	NA	Unknown		
15S17E13R002M	Water Level	366196N1200632W001	Unknown		
15S18E30L001M	Water Level	365963N1200529W001	Unknown		
1000317-001	Water Quality				
1000465-001	Water Quality				
1000551-001	Water Quality				
1000560-001	Water Quality				
1005602-003	Water Quality				
1000604-002	Water Quality				
1000641-001	Water Quality				
1009120-001	Water Quality				
L10006109169-DMW-21	Water Quality				
L10006109169-DMW-25	Water Quality				
L10006109169-DMW-17	Water Quality				
L10006109169-BMW-1	Water Quality				
SUB052	Land Subsidence				
SUB041	Land Subsidence				
SUB085	Land Subsidence				
SUB019	Land Subsidence				
SUB060	Land Subsidence				

Appendix 5 B
Data Management Standards

ARTICLE 3. Technical and Reporting Standards

§ 352. Introduction to Technical and Reporting Standards

This Article describes the monitoring protocols, standards for monitoring sites, and other technical elements related to the development or implementation of a Plan.

Note: Authority cited: Section 10733.2, Water Code.

Reference: Section 10733.2, Water Code.

§ 352.2. Monitoring Protocols

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.

Note: Authority cited: Section 10733.2, Water Code.

Reference: Sections 10727.2, 10728.2, 10729, and 10733.2, Water Code.

§ 352.4. Data and Reporting Standards

(a) The following reporting standards apply to all categories of information required of a Plan, unless otherwise indicated:

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

(2) Surface water flow shall be reported in cubic feet per second and groundwater flow shall be reported in acre-feet per year.

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

(4) Reference point elevations shall be measured and reported in feet to an accuracy of at least 0.5 feet, or the best available information, relative to NAVD88, or another national standard that is convertible to NAVD88, and the method of measurement described.

(5) 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.

(b) Monitoring sites shall include the following information:

(1) A unique site identification number and narrative description of the site location.

(2) A description of the type of monitoring, type of measurement taken, and monitoring frequency.

(3) Location, elevation of the ground surface, and identification and description of the reference point.

(4) 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.

(c) The following standards apply to wells:

(1) Wells used to monitor groundwater conditions shall be constructed according to applicable construction standards, and shall provide the following information in both tabular and geodatabase-compatible shapefile form:

(A) 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.

(B) Well location, elevation of the ground surface and reference point, including a description of the reference point.

(C) A description of the well use, such as public supply, irrigation, domestic, monitoring, or other type of well, whether the well is active or inactive, and whether the well is a single, clustered, nested, or other type of well.

(D) Casing perforations, borehole depth, and total well depth.

(E) Well completion reports, if available, from which the names of private owners have been redacted.

(F) Geophysical logs, well construction diagrams, or other relevant information, if available.

(G) Identification of principal aquifers monitored.

(H) Other relevant well construction information, such as well capacity, casing diameter, or casing modifications, as available.

(2) If an Agency relies on wells that lack casing perforations, borehole depth, or total well depth information to monitor groundwater conditions as part of a Plan, the Agency shall describe a schedule for acquiring monitoring wells with the necessary information, or demonstrate to the Department that such information is not necessary to understand and manage groundwater in the basin.

(3) Well information used to develop the basin setting shall be maintained in the Agency's data management system.

(d) Maps submitted to the Department shall meet the following requirements:

(1) Data layers, shapefiles, geodatabases, and other information provided with each map, shall be submitted electronically to the Department in accordance with the procedures described in Article 4.

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

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

(e) Hydrographs submitted to the Department shall meet the following requirements:

(1) Hydrographs shall be submitted electronically to the Department in accordance with the procedures described in Article 4.

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

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

(f) Groundwater and surface water models used for a Plan shall meet the following standards:

(1) The model shall include publicly available supporting documentation.

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

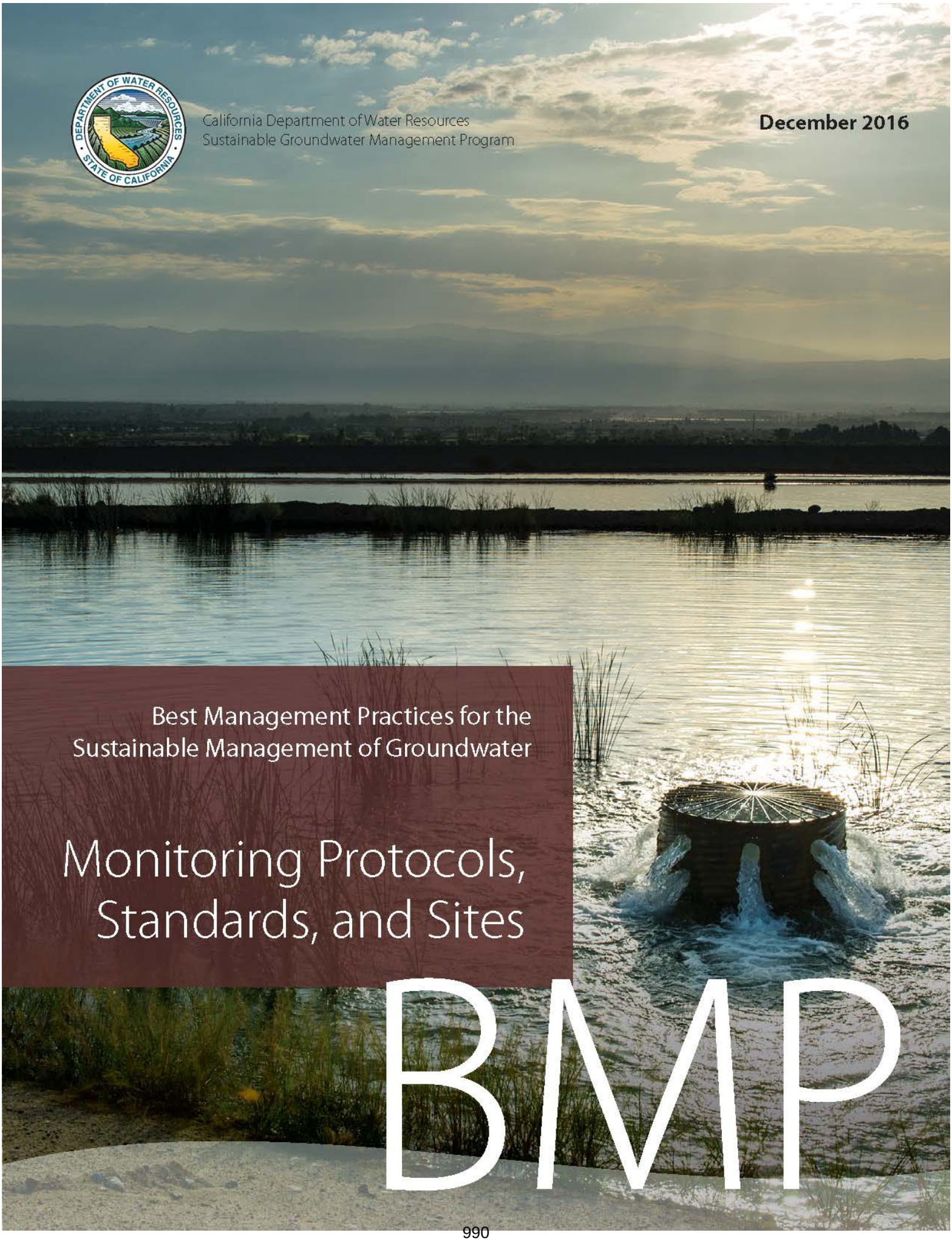
(3) Groundwater and surface water models developed in support of a Plan after the effective date of these regulations shall consist of public domain open-source software.

(g) The Department may request data input and output files used by the Agency, as necessary. The Department may independently evaluate the appropriateness of model results relied upon by the Agency, and use that evaluation in the Department's assessment of the Plan.

Note: Authority cited: Section 10733.2, Water Code.

Reference: Sections 10727.2, 10727.6, and 10733.2, Water Code.

Appendix 5 C
Best Management Practices for Monitoring Protocols, Standards, and Sites



California Department of Water Resources
Sustainable Groundwater Management Program

December 2016

Best Management Practices for the Sustainable Management of Groundwater

Monitoring Protocols, Standards, and Sites

BMP

State of California
Edmund G. Brown Jr., Governor

California Natural Resources Agency
John Laird, Secretary for Natural Resources

Department of Water Resources
Mark W. Cowin, Director

Carl A. Torgersen, Chief Deputy Director

Office of the Chief Counsel Spencer Kenner	Public Affairs Office Ed Wilson	Government and Community Liaison Anecita S. Agustinez
Office of Workforce Equality Stephanie Varrelman	Policy Advisor Waiman Yip	Legislative Affairs Office Kasey Schimke, Ass't Dir.

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William Croyle	**Statewide Emergency Preparedness and Security**
Mark Anderson	**State Water Project**
John Pacheco (Acting)	**California Energy Resources Scheduling**
Kathie Kishaba	**Business Operations**
Taryn Ravazzini	**Special Initiatives**

Division of Integrated Regional Water Management

Arthur Hinojosa Jr., Chief

Prepared under the direction of:

David Gutierrez, Sustainable Groundwater Management Program Manager
Rich Juricich, Sustainable Groundwater Management Branch

Prepared by:

Trevor Joseph, BMP Project Manager

Timothy Godwin
Dan McManus
Mark Nordberg
Heather Shannon
Steven Springhorn

With assistance from:

DWR Region Office Staff

Groundwater Monitoring Protocols, Standards, and Sites Best Management Practice

1. OBJECTIVE

The objective of this *Best Management Practice* (BMP) is to assist in the development of Monitoring Protocols. The California Department of Water Resources (the Department or DWR) has developed this document as part of the obligation in the Technical Assistance chapter (Chapter 7) of the Sustainable Groundwater Management Act (SGMA) to support the long-term sustainability of California's groundwater *basins*. Information provided in this BMP provides technical assistance to Groundwater Sustainability Agencies (GSAs) and other stakeholders to aid in the establishment of consistent data collection processes and procedures. In addition, this BMP can be used by GSAs to adopt a set of sampling and measuring procedures that will yield similar data regardless of the monitoring personnel. Finally, this BMP identifies available resources to support the development of monitoring protocols.

This BMP includes the following sections:

1. Objective. A brief description of how and where monitoring protocols are required under SGMA and the overall objective of this BMP.
2. Use and Limitations. A brief description of the use and limitations of this BMP.
3. Monitoring Protocol Fundamentals. A description of the general approach and background of groundwater monitoring protocols.
4. Relationship of Monitoring Protocols to other BMPs. A description of how this BMP is connected with other BMPS.
5. Technical Assistance. Technical content providing guidance for regulatory sections.
6. Key Definitions. Descriptions of definitions identified in the GSP Regulations or SGMA.
7. Related Materials. References and other materials that provide supporting information related to the development of Groundwater Monitoring Protocols.

2. USE AND LIMITATIONS

BMPs developed by the Department provide technical guidance to GSAs and other stakeholders. Practices described in these BMPs do not replace the GSP Regulations, nor do they create new requirements or obligations for GSAs or other stakeholders. In addition, using this BMP to develop a GSP does not equate to an approval determination by the Department. All references to GSP Regulations relate to Title 23 of the California Code of Regulations (CCR), Division 2, Chapter 1.5, and Subchapter 2. All references to SGMA relate to California Water Code sections in Division 6, Part 2.74.

3. MONITORING PROTOCOL FUNDAMENTALS

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.

4. RELATIONSHIP OF MONITORING PROTOCOL TO OTHER BMPS

Groundwater monitoring is a fundamental component of SGMA, as each GSP must include a sufficient network of data that demonstrates measured progress toward the achievement of the sustainability goal for each basin. For this reason, a standard set of protocols need to be developed and utilized.

It is important that data is developed in a manner consistent with the basin setting, planning, and projects/management actions steps identified on **Figure 1** and the GSP Regulations. The inclusion of monitoring protocols in the GSP Regulations also emphasizes the importance of quality empirical data to support GSPs and provide comparable information from basin to basin.

Figure 1 provides a logical progression for the development of a GSP and illustrates how monitoring protocols are linked to other related BMPs. This figure also shows the context of the BMPs as they relate to various steps to sustainability as outlined in the GSP Regulations. The monitoring protocol BMP is part of the Monitoring step identified in **Figure 1**.

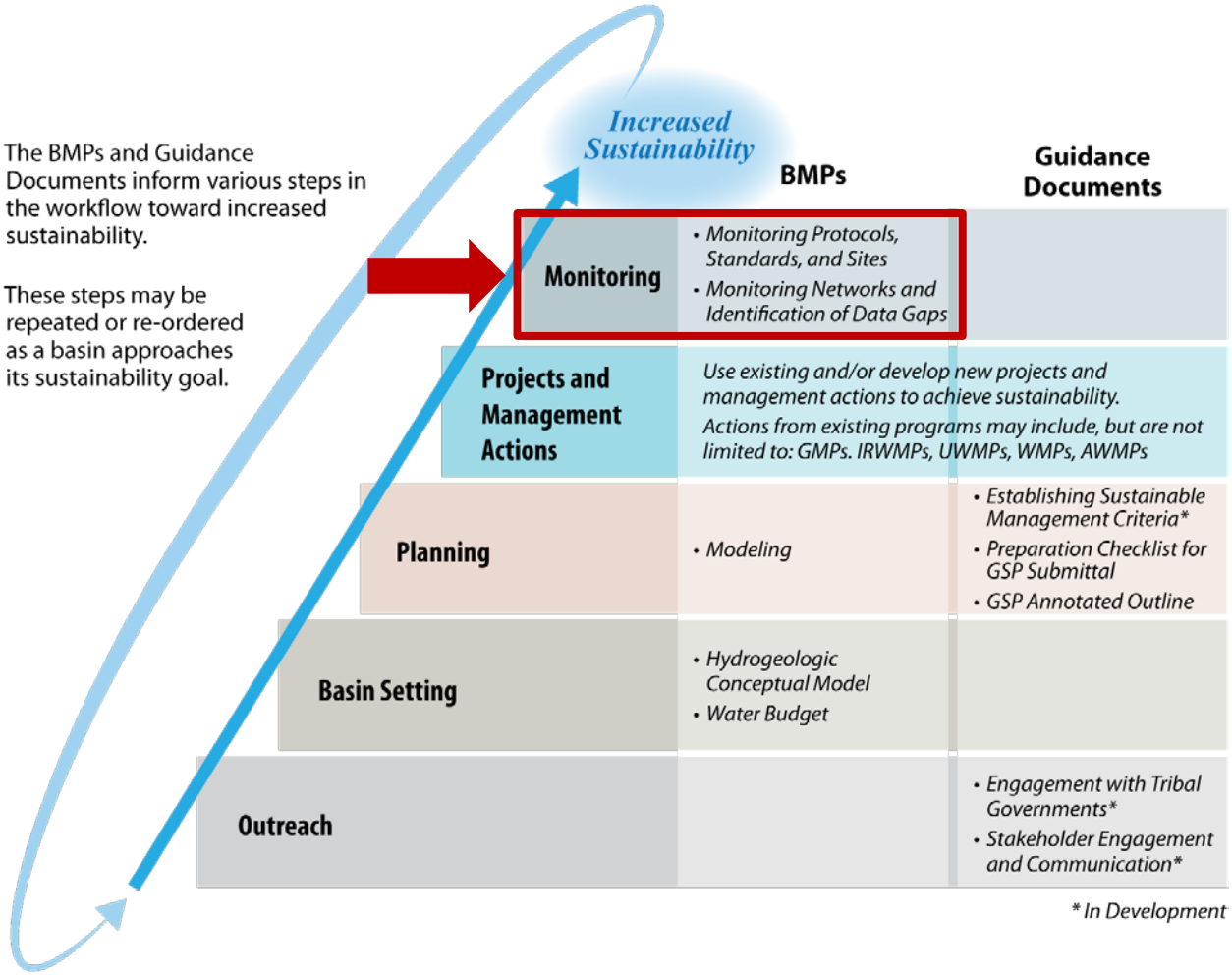

Figure 1 – Logical Progression of Basin Activities Needed to Increase Basin Sustainability

5. TECHNICAL ASSISTANCE

23 CCR §352.2. Monitoring Protocols. 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.

The GSP Regulations specifically call out the need to utilize protocols identified in this BMP, or develop similar protocols. The following technical protocols provide guidance based upon existing professional standards and are commonly adopted in various groundwater-related programs. They provide clear techniques that yield quality data for use in the various components of the GSP. They can be further elaborated on by individual GSAs in the form of standard operating procedures which reflect specific local requirements and conditions. While many methodologies are suggested in this BMP, it should be understood that qualified professional judgment should be used to meet the specific monitoring needs.

The following BMPs may be incorporated into a GSP's monitoring protocols section for collecting groundwater elevation data. A GSP that adopts protocols that deviate from these BMPs must demonstrate that they will yield comparable data.

PROTOCOLS FOR ESTABLISHING A MONITORING PROGRAM

The protocol for establishment of a monitoring program should be evaluated in conjunction with the *Monitoring Network and Identification of Data Gaps* BMP and other BMPs. Monitoring protocols must take into consideration the *Hydrogeologic Conceptual Model, Water Budget, and Modeling* BMPs when considering the data needs to meet GSP objectives and the sustainability goal.

It is suggested that each GSP incorporate the Data Quality Objective (DQO) process following the U.S. 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.

The DQO process presents a method that can be applied directly to the sustainability criteria quantitative requirements through the following steps.

1. State the problem – Define sustainability indicators and planning considerations of the GSP and sustainability goal.
2. Identify the goal – Describe the quantitative measurable objectives and minimum thresholds for each of the sustainability indicators.
3. Identify the inputs – Describe the data necessary to evaluate the sustainability indicators and other GSP requirements (i.e. water budget).
4. Define the boundaries of the study – This is commonly the extent of the Bulletin 118 groundwater basin or subbasin, unless multiple GSPs are prepared for a given basin. In that case, evaluation of the coordination plan and specifically how the monitoring will be comparable and meet the sustainability goals for the entire basin.
5. Develop an analytical approach – Determine how the quantitative sustainability indicators will be evaluated (i.e. are special analytical methods required that have specific data needs).
6. Specify performance or acceptance criteria – Determine what quality the data must have to achieve the objective and provide some assurance that the analysis is accurate and reliable.
7. Develop a plan for obtaining data – Once the objectives are known determine how these data should be collected. Existing data sources should be used to the greatest extent possible.

These steps of the DQO process should be used to guide GSAs to develop the most efficient monitoring process to meet the measurable objectives of the GSP and the sustainability goal. The DQO process is an iterative process and should be evaluated regularly to improve monitoring efficiencies and meet changing planning and project needs. Following the DQO process, GSAs should also include a data quality control and quality assurance plan to guide the collection of data.

Many monitoring programs already exist as part of ongoing groundwater management or other programs. To the extent possible, the use of existing monitoring data and programs should be utilized to meet the needs for characterization, historical record documentation, and continued monitoring for the SGMA program. However, an evaluation of the existing monitoring data should be performed to assure the data being collected meets the DQOs, regulatory requirements, and data collection protocol described in this BMP. While this BMP provides guidance for collection of various

regulatory based requirements, there is flexibility among the various methodologies available to meet the DQOs based upon professional judgment (local conditions or project needs).

At a minimum, for each monitoring site, the following information or procedure should be collected and documented:

- Long-term access agreements. Access agreements should include year-round site access to allow for increased monitoring frequency.
- A unique identifier that includes a general written description of the site location, date established, access instructions and point of contact (if necessary), type of information to be collected, latitude, longitude, and elevation. Each monitoring location should also track all modifications to the site in a modification log.

PROTOCOLS FOR MEASURING GROUNDWATER LEVELS

This section presents considerations for the methodology of collection of groundwater level data such that it meets the requirements of the GSP Regulations and the DQOs of the specific GSP. Groundwater levels are a fundamental measure of the status of groundwater conditions within a basin. In many cases, relationships of the sustainability indicators may be able to be correlated with groundwater levels. The quality of this data must consider the specific aquifer being monitored and the methodology for collecting these levels.

The following considerations for groundwater level measuring protocols should ensure the following:

- 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

General Well Monitoring Information

The following presents considerations for collection of water level data that include regulatory required components as well as those which are recommended.

- Groundwater elevation data will form the basis of basin-wide water-table and piezometric maps, and should approximate conditions at a discrete period in time. 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.
- 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.
- The elevation of the RP of each well must be surveyed to the North American Vertical Datum of 1988 (NAVD88), or a local datum that can be converted to NAVD88. The elevation of the RP must be accurate to within 0.5 foot. It is preferable for the RP elevation to be accurate to 0.1 foot or less. 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.
- 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 of time to allow the water level to equilibrate.
- Depth to groundwater must be measured to an accuracy of 0.1 foot below the RP. It is preferable to measure depth to groundwater to an accuracy of 0.01 foot. Air lines and acoustic sounders may not provide the required accuracy of 0.1 foot.
- The water level meter should be decontaminated after measuring each well.

Where existing wells do not meet the base standard as described in the GSP Regulations or the considerations provided above, new monitoring wells may need to be constructed to meet the DQOs of the GSP. The design, installation, and documentation of new monitoring wells must consider the following:

- Construction consistent with California Well Standards as described in Bulletins 74-81 and 74-90, and local permitting agency standards of practice.
- Logging of borehole cuttings under the supervision of a California Professional Geologist and described consistent with the Unified Soil Classification System methods according to ASTM standard D2487-11.
- Written criteria for logging of borehole cuttings for comparison to known geologic formations, principal aquifers and aquitards/aquicludes, or specific marker beds to aid in consistent stratigraphic correlation within and across basins.
- Geophysical surveys of boreholes to aid in consistency of logging practices. Methodologies should include resistivity, spontaneous potential, spectral gamma, or other methods as appropriate for the conditions. Selection of geophysical methods should be based upon the opinion of a professional geologist or professional engineer, and address the DQOs for the specific borehole and characterization needs.
- Prepare and submit State well completion reports according to the requirements of §13752. Well completion report documentation should include geophysical logs, detailed geologic log, and formation identification as attachments. An example well completion as-built log is illustrated in **Figure 2.** DWR well completion reports can be filed directly at the Online System for Well Completion Reports (OSWCR) http://water.ca.gov/oswcr/index.cfm.

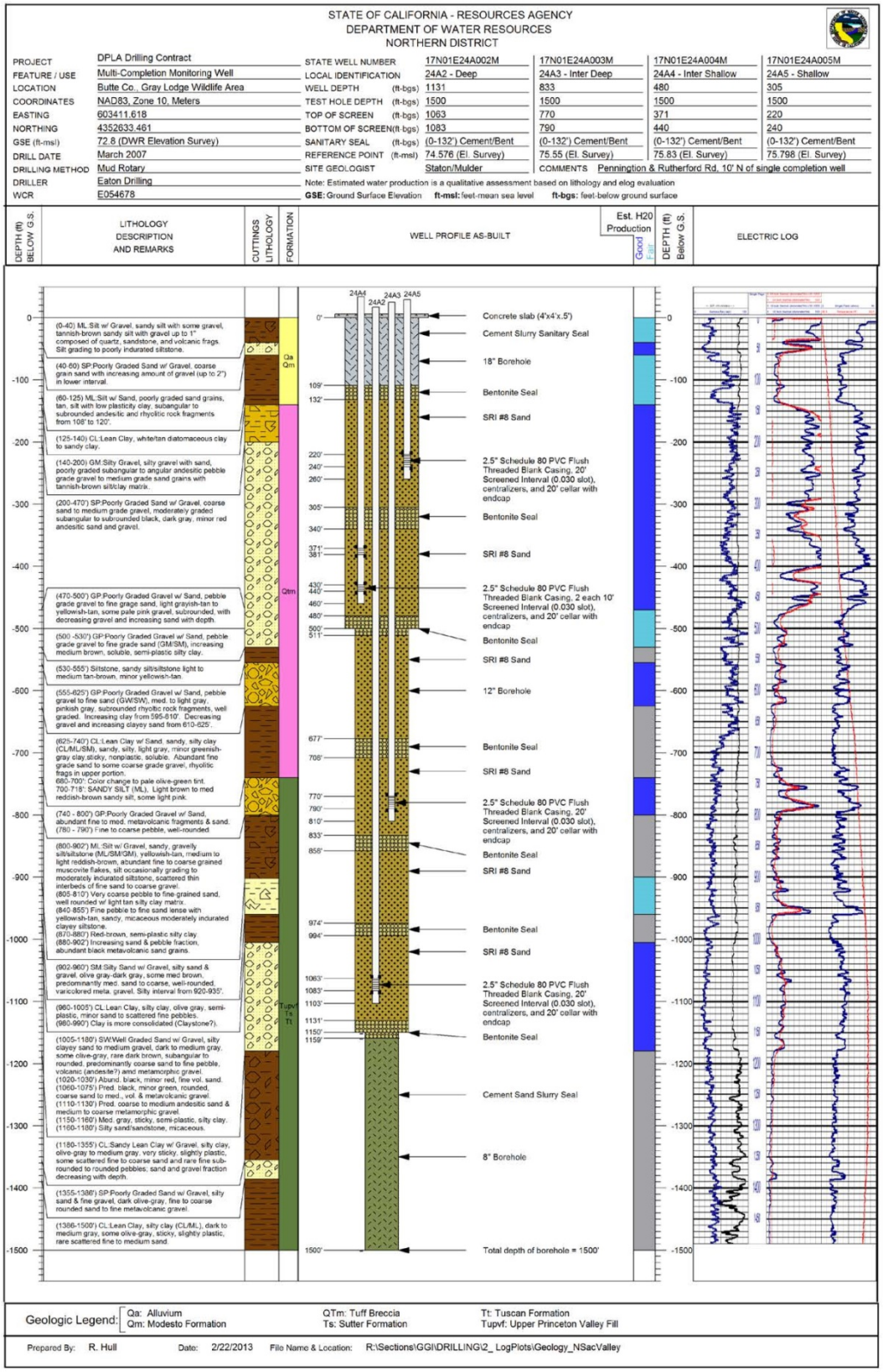

Figure 2 – Example As-Built Multi-Completion Monitoring Well Log

Measuring Groundwater Levels

Well construction, anticipated groundwater level, groundwater level measuring equipment, field conditions, and well operations should be considered prior collection of the groundwater level measurement. The USGS *Groundwater Technical Procedures* (Cunningham and Schalk, 2011) provide a thorough set of procedures which can be used to establish specific Standard Operating Procedures (SOPs) for a local agency. **Figure 3** illustrates a typical groundwater level measuring event and simultaneous pressure transducer download.

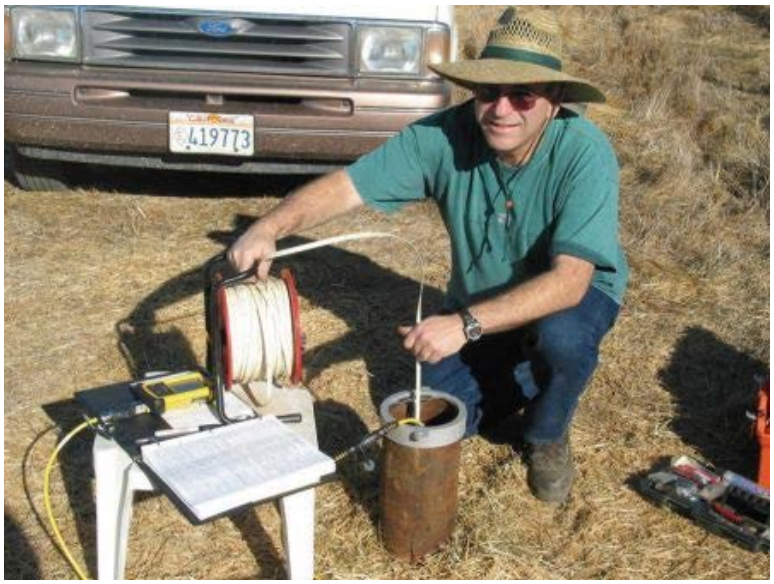

Figure 3 – Collection of Water Level Measurement and Pressure Transducer Download

The following points provide a general approach for collecting groundwater level measurements:

- 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. Groundwater levels should be measured to the nearest 0.01 foot relative to the RP.
- 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. In the event that a well is artesian, 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.

- The sampler should calculate the groundwater elevation as:

$$GWE = RPE - DTW$$

Where:

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

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

Recording Groundwater Levels

- The sampler should record the well identifier, date, time (24-hour format), RPE, height of RP above or below ground surface, DTW, GWE, and comments regarding any factors that may influence the depth to water readings such as weather, nearby irrigation, flooding, potential for tidal influence, or well condition. If there is a questionable measurement or the measurement cannot be obtained, it should be noted. An example of a field sheet with the required information is shown in **Figure 4**. It includes questionable measurement and no measurement codes that should be noted. This field sheet is provided as an example. Standardized field forms should be used for all data collection. The aforementioned USGS *Groundwater Technical Procedures* offers a number of example forms.
- The sampler should replace any well caps or plugs, and lock any well buildings or covers.
- All data should be entered into the GSA data management system (DMS) as soon as possible. Care should be taken to avoid data entry mistakes and the entries should be checked by a second person for compliance with the DQOs.

STATE OF CALIFORNA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WELL DATA

STATE WELL NUMBER	COUNTY	REFERENCE POINT ELEV.	MEASURING AGENCY
			DWR

NO MEASUREMENT
0. Measurement discontinued
1. Pumping
2. Pump house locked
3. Tape hung up
4. Can't get tape in casing
5. Unable to locate well
6. Well has been destroyed
7. Special
8. Casing leaky or wet
9. Temporarily inaccessible

QUESTIONABLE MEASUREMENT
0. Caved or deepened
1. Pumping
2. Nearby pump operating
3. Casing leaky or wet
4. Pumped recently
5. Air or pressure gauge measurement
6. Other
7. Recharge operation at or nearby well
8. Oil in casing

DATE	NM	QM	TAPE AT RP	TAPE AT WS	RP to WS	OBSR VR	COMMENTS

Pressure Transducers

Groundwater levels and/or calculated groundwater elevations may be recorded using pressure transducers equipped with data loggers installed in monitoring wells. 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.

PROTOCOLS FOR SAMPLING GROUNDWATER QUALITY

The following protocols can be incorporated into a GSP's monitoring protocols for collecting groundwater quality data. More detailed sampling procedures and protocols are included in the standards and guidance documents listed at the end of this BMP. A GSP that adopts protocols that deviate from these BMPs must demonstrate that the adopted protocols will yield comparable data.

In general, the use of existing water quality data within the basin should be done to the greatest extent possible if it achieves the DQOs for the GSP. In some cases it may be necessary to collect additional water quality data to support monitoring programs or evaluate specific projects. The USGS *National Field Manual for the Collection of Water Quality Data* (Wilde, 2005) should be used to guide the collection of reliable data. **Figure 5** illustrates a typical groundwater quality sampling setup.

Figure 5 – Typical Groundwater Quality Sampling Event

All analyses should be performed by a laboratory certified under the State Environmental Laboratory Accreditation Program. The specific analytical methods are beyond the scope of this BMP, but should be commiserate with other programs evaluating water quality within the basin for comparative purposes.

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 DQOs
- All salient information is recorded to normalize, if necessary, and compare data
- Data are handled in a way that ensures data integrity

The following points are general guidance in addition to the techniques presented in the previously mentioned USGS *National Field Manual for the Collection of Water Quality Data.*

Standardized protocols include the following:

- 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.
- In the case of wells with dedicated pumps, samples should be collected at or near the wellhead. Samples should not be collected from storage tanks, at the end of long pipe runs, or after any water treatment.
- The sampler should clean the sampling port and/or sampling equipment and the sampling port and/or sampling equipment must be free of any contaminants. The sampler must decontaminate sampling equipment between sampling locations or wells to avoid cross-contamination between samples.
- The groundwater elevation in the well should be measured following appropriate protocols described above in the groundwater level measuring protocols.
- For any well not equipped with low-flow or passive sampling equipment, an adequate volume of water should be purged from the well to ensure that the groundwater sample is representative of ambient groundwater and not stagnant water in the well casing. Purging three well casing volumes is generally

considered adequate. Professional judgment 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. If pumping causes a well to be evacuated (go dry), document the condition and allow well to recover to within 90% of original level prior to sampling. Professional judgment should be exercised as to whether the sample will meet the DQOs and adjusted as necessary.

- Field parameters of pH, electrical conductivity, and temperature should be collected for each sample. Field parameters should be evaluated during the purging of the well and should stabilize prior to sampling. Measurements of pH should only be measured in the field, lab pH analysis are typically unachievable due to short hold times. Other parameters, such as oxidation-reduction potential (ORP), dissolved oxygen (DO) (in situ measurements preferable), or turbidity, 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.
- 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 collected under laminar flow conditions. This may require reducing pumping rates prior to sample collection.
- Samples should be collected according to appropriate standards such as those listed in the *Standard Methods for the Examination of Water and Wastewater*, USGS *National Field Manual for the Collection of Water Quality Data*, or other appropriate guidance. The specific sample collection procedure should reflect the type of analysis to be performed and DQOs.
- All samples requiring preservation must be preserved as soon as practically possible, ideally at the time of sample collection. Ensure that samples are appropriately filtered as recommended for the specific analyte. Entrained solids can be dissolved by preservative leading to inconsistent results of dissolve analytes. Specifically, samples to be analyzed for metals should be field-filtered prior to preservation; do not collect an unfiltered sample in a preserved container.
- 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.

Special protocols for low-flow sampling equipment

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. These protocols are not intended for bailers.

Special protocols for passive sampling equipment

In addition to the protocols listed above, passive diffusion samplers should follow protocols set forth in USGS Fact Sheet 088-00.

PROTOCOLS FOR MONITORING SEAWATER INTRUSION

Monitoring seawater intrusion requires analysis of the chloride concentrations within groundwater of each principal aquifer subject to seawater intrusion. While no significant standardized approach exists, the methodologies described above for degraded water quality can be applied for the collection of groundwater samples. In addition to the protocol described above, the following protocols should be followed:

- Water quality samples should be collected and analyzed at least semi-annually. Samples will be analyzed for dissolved chloride at a minimum. It may be beneficial to include analyses of iodide and bromide to aid in determination of salinity source. More frequent sampling may be necessary to meet DQOs of GSP. The development of surrogate measures of chloride concentration may facilitate cost-effective means to monitor more frequently to observe the range of conditions and variability of the flow dynamics controlling seawater intrusion.
- Groundwater levels will be collected at a frequency adequate to characterize changes in head in the vicinity of the leading edge of degraded water quality in each principal aquifer. Frequency may need to be increased in areas of known preferential pathways, groundwater pumping, or efficacy evaluation of mitigation projects.
- The use of geophysical surveys, electrical resistivity, or other methods may provide for identification of preferential pathways and optimize monitoring well placement and evaluation of the seawater intrusion front. Professional judgment

should be exercised to determine the appropriate methodology and whether the DQOs for the GSP would be met.

PROTOCOLS FOR MEASURING STREAMFLOW

Monitoring of streamflow is necessary for incorporation into water budget analysis and for use in evaluation of stream depletions associated with groundwater extractions. The use of existing monitoring locations should be incorporated to the greatest extent possible. Many of these streamflow monitoring locations currently follow the protocol described below.

Establishment of new streamflow discharge sites should consider the existing network and the objectives of the new location. Professional judgment should be used to determine the appropriate permitting that may be necessary for the installation of any monitoring locations along surface water bodies. Regular frequent access will be necessary to these sites for the development of ratings curves and maintenance of equipment.

To establish a new streamflow monitoring station special consideration must be made in the field to select an appropriate location for measuring discharge. Once a site is selected, development of a relationship of stream stage to discharge will be necessary to provide continuous estimates of streamflow. Several measurements of discharge at a variety of stream stages will be necessary to develop the ratings curve correlating stage to discharge. The use of Acoustic Doppler Current Profilers (ADCPs) can provide accurate estimates of discharge in the correct settings. Professional judgment must be exercised to determine the appropriate methodology. Following development of the ratings curve a simple stilling well and pressure transducer with data logger can be used to evaluate stage on a frequent basis. A simple stilling well and staff gage is illustrated in **Figure 6**.

Streamflow measurements should be collected, analyzed, and reported in accordance with the procedures outlined in USGS Water Supply Paper 2175, *Volume 1. – Measurement of Stage Discharge* and *Volume 2. – Computation of Discharge.* This methodology is currently being used by both the USGS and DWR for existing streamflow monitoring throughout the State.

Figure 6 – Simple Stilling Well and Staff Gage Setup

PROTOCOLS FOR MEASURING SUBSIDENCE

Evaluating and monitoring inelastic land subsidence can utilize multiple data sources to evaluate the specific conditions and associated causes. To the extent possible, the use of existing data should be utilized. Subsidence can be estimated from numerous techniques, they include: level surveying tied to known stable benchmarks or benchmarks located outside the area being studied for possible subsidence; installing and tracking changes in borehole extensometers; obtaining data from continuous GPS (CGPS) locations, static GPS surveys or Real-Time-Kinematic (RTK) surveys; or analyzing Interferometric Synthetic Aperture Radar (InSAR) data. No standard procedures exist for collecting data from the potential subsidence monitoring approaches. However, an approach may include:

- Identification of land subsidence conditions.
    - Evaluate existing regional long-term leveling surveys of regional infrastructure, i.e. roadways, railroads, canals, and levees.
    - Inspect existing county and State well records where collapse has been noted for well repairs or replacement.
    - Determine if significant fine-grained layers are present such that the potential for collapse of the units could occur should there be significant depressurization of the aquifer system.

  - Inspect geologic logs and the hydrogeologic conceptual model to aid in identification of specific units of concern.
  - Collect regional remote-sensing information such as InSAR, commonly provided by USGS and NASA. Data availability is currently limited, but future resources are being developed.
- Monitor regions of suspected subsidence where potential exists.
  - Establish CGPS network to evaluate changes in land surface elevation.
  - Establish leveling surveys transects to observe changes in land surface elevation.
  - Establish extensometer network to observe land subsidence. An example of a typical extensometer design is illustrated in **Figure 7**. There are a variety of extensometer designs and they should be selected based on the specific DQOs.

Various standards and guidance documents for collecting data include:

- Leveling surveys must follow surveying standards set out in the California Department of Transportation's Caltrans Surveys Manual.
- GPS surveys must follow surveying standards set out in the California Department of Transportation's Caltrans Surveys Manual.
- USGS has been performing subsidence surveys within several areas of California. These studies are sound examples for appropriate methods and should be utilized to the extent possible and where available:
  - http://ca.water.usgs.gov/land_subsidence/california-subsidence-measuring.html
- Instruments installed in borehole extensometers must follow the manufacturer's instructions for installation, care, and calibration.
- Availability of InSAR data is improving and will increase as programs are developed. This method requires expertise in analysis of the raw data and will likely be made available as an interpretative report for specific regions.

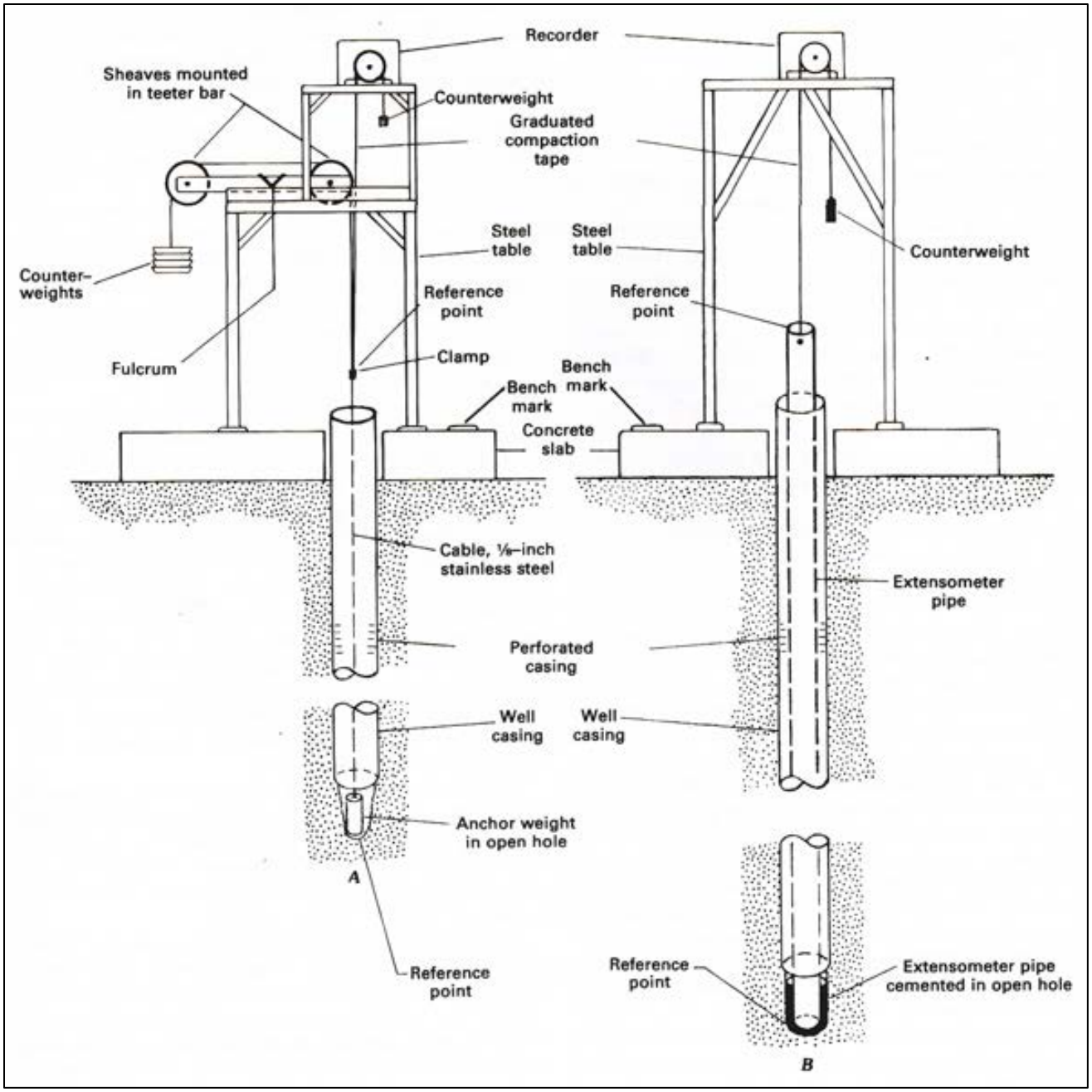

Figure 7 – Simplified Extensometer Diagram

6. KEY DEFINITIONS

The key definitions and sections related to Groundwater Monitoring Protocols, Standards, and Sites outlined in applicable SGMA code and regulations are provided below for reference.

Groundwater Sustainability Plan Regulations (California Code of Regulations §351)

- §351(h) "Best available science" refers to the use of sufficient and credible information and data, specific to the decision being made and the time frame available for making that decision, that is consistent with scientific and engineering professional standards of practice.
- §351(i) "Best management practice" refers to a practice, or combination of practices, that are designed to achieve sustainable groundwater management and have been determined to be technologically and economically effective, practicable, and based on best available science.

Monitoring Protocols Reference

§352.2. Monitoring Protocols

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.

SGMA Reference

§10727.2. Required Plan Elements

(f) Monitoring protocols that are designed to detect changes in groundwater levels, groundwater quality, inelastic surface subsidence for basins for which subsidence has been identified as a potential problem, and flow and quality of surface water that directly affect groundwater levels or quality or are caused by groundwater extraction in the basin. The monitoring protocols shall be designed to generate information that promotes efficient and effective groundwater management.

7. Related Materials

CASE STUDIES

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