McMullin Area Groundwater Sustainability Agency

Aquaterra Water Bank Project
Draft Initial Study/Mitigated Negative Declaration

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MARCH 2024

1 INTRODUCTION 1
1.1 PROJECT OBJECTIVES 1
1.2 PROJECT BACKGROUND 1
1.2.1 OVERVIEW OF CALIFORNIA WATER PROJECTS AND CONTRACTORS 1
1.3 PURPOSE AND NEED 8
1.4 PROJECT DESCRIPTION 9
1.4.1 CONTRACT WATER SOURCES 10
1.4.2 GROUNDWATER BANKING PROGRAM 10
1.4.3 INFRASTRUCTURE AND EASEMENTS 10
1.4.4 CONSTRUCTION 28
1.4.5 OPERATIONS AND MAINTENANCE 31
1.4.6 MONITORING 34
1.4.7 GOVERNANCE, OWNERSHIP, AND PARTNER RELATIONSHIPS 34
2 MITIGATION MEASURES 35
2.1 AIR-1) PREPARE AND IMPLEMENT A FUGITIVE DUST CONTROL PLAN 35
2.2 AIR-2) MINIMIZE PERSONNEL AND PUBLIC EXPOSURE 35
2.3 AIR-3) IMPLEMENT VEHICLE EMISSIONS CONTROLS 36
2.4 BIO-1) GENERAL MEASURES 36
2.5 BIO-2) PROTECT AND PRESERVE GIANT GARTER SNAKE 36
2.6 BIO-3) PROTECT AND PRESERVE TRICOLORED BLACKBIRD 37
2.7 BIO-4) PROTECT AND PRESERVE WATERS OF THE U.S. AND WATERS OF THE STATE 38
2.8 BIO-5) PROTECT AND PRESERVE THE BURROWING OWL 38
2.9 BIO-6) PROTECT AND PRESERVE SWAINSON'S HAWK 39
2.10 BIO-7) PROTECT AND PRESERVE NESTING BIRDS 39
2.11 BIO-8) PROTECT AND PRESERVE SAN JOAQUIN KIT FOX 40
2.12 CUL-1: WORKER ENVIRONMENTAL TRAINING 40
2.13 CUL-2: CULTURAL RESOURCE MONITORING AND INADVERTENT DISCOVERY PLAN 41
2.14 GEO-1: CERTIFIED PALEONTOLOGIST 41
2.15 HAZ-1: PREPARE AND IMPLEMENT A SPILL PREVENTION AND RESPONSE PLAN (SPRP) 41
2.16 TRA-1: PREPARE AND IMPLEMENT A TRAFFIC SAFETY PLAN. 42
2.17 WAT-1: RECHARGE BASIN SCREENING 42
2.18 WAT-2: MANAGE IMPORT WATER TO THE BANK 43
2.19 WAT-3: RECHARGE BASIN EMPLOYMENT AND OPERATIONS 43
2.20 WAT-4: RECOVERY WELL DISTRIBUTION AND DESIGN 43
2.21 WAT-5: GROUNDWATER MONITORING AND EXPORT WATER STANDARDS 43
2.22 WAT-6. COMPLIANCE WITH IRRIGATED LANDS REGULATORY PROGRAM (ILRP) 44
2.23 WAT-7. STORMWATER POLLUTION PREVENTION PLAN (SWPPP) 44
2.24 WAT-8. INSPECT WATER CONTROL STRUCTURES AND CANALS. 44
2.25 WAT-9. DEVELOP AND IMPLEMENT SURFACE WATER MONITORING PLAN 44
2.26 WAT-10. DEVELOP AND IMPLEMENT FACILITIES OPERATION, MAINTENANCE AND MONITORING MANUAL 44
2.27 WAT-11. MANAGE DIVERSIONS AND RECOVERY TIMING 45
2.28 WAT-12. DEVELOP AND IMPLEMENT OPERATION MODEL 45
3 ENVIRONMENTAL FACTORS POTENTIALLY AFFECTED 46
3.1 PROPOSED DECLARATION 46
4 EVALUATION OF ENVIRONMENTAL IMPACTS 47
4.1 AESTHETICS (AES) 49
4.1.1 ENVIRONMENTAL SETTING 49
4.1.2 REGULATORY SETTING 50
4.1.2.1 FEDERAL 50
4.1.2.2 STATE 50
4.1.2.3 COUNTY AND REGIONAL 51
4.1.3 POTENTIAL IMPACTS 51
4.2 AGRICULTURAL AND FOREST RESOURCES (AFR) 53
4.2.1 ENVIRONMENTAL SETTING 53
4.2.2 REGULATORY SETTING 54

4.2.2.1 Federal....54
4.2.2.2 State....57
4.2.2.3 County and Regional....57
4.2.3 Potential Impacts....59
4.3 Air Quality (AIR)....61
4.3.1 Environmental Setting....61
4.3.2 Regulatory Setting....62
4.3.2.1 Federal....62
4.3.2.2 State....62
4.3.2.3 County and Regional....63
4.3.3 Potential Impacts....65
4.4 Biological Resources (BIO)....69
4.4.1 Environmental Setting....70
4.4.2 Regulatory Setting....76
4.4.2.1 Federal....76
4.4.2.2 State....77
4.4.2.3 County and Regional....78
4.4.3 Potential Impacts....78
4.5 Cultural Resources (CUL)....83
4.5.1 Environmental Setting....84
4.5.2 Regulatory Setting....86
4.5.2.1 Federal....86
4.5.2.2 State....86
4.5.2.3 County and Regional....87
4.5.3 Potential Impacts....88
4.6 Energy (ENE)....90
4.6.1 Environmental Setting....90
4.6.2 Regulatory Setting....90
4.6.2.1 Federal....90
4.6.2.2 State....90
4.6.2.3 County and Regional....90
4.6.3 Potential Impacts....91
4.7 Geology and Soils (GEO)....94
4.7.1 Environmental Setting....95
4.7.2 Regulatory Setting....100
4.7.2.1 Federal....100
4.7.2.2 State....101
4.7.2.3 County and Regional....101
4.7.3 Potential Impacts....102
4.8 Greenhouse Gas Emissions (GHG)....105
4.8.1 Environmental Setting....105
4.8.2 Regulatory Setting....105
4.8.3 Regional and County....106
4.8.4 Potential Impacts....107
4.9 Hazardous Materials (HAZ)....109
4.9.1 Environmental Setting....109
4.9.2 Regulatory Setting....110
4.9.2.1 Federal....110
4.9.2.2 State....112
4.9.2.3 County and Regional....112
4.9.3 Potential Impacts....113
4.10 Hydrology and Water Quality (WAT)....116
4.10.1 Environmental Setting....117
4.10.2 Regulatory Setting....123
4.10.2.1 Federal....123
4.10.2.2 State....124

4.10.2.3 County and Regional 125
4.10.3 Potential Impacts 125
4.11 Land Use and Planning (USE) 131
4.11.1 Environmental Setting 131
4.11.2 Regulatory Setting 132
4.11.2.1 Federal 132
4.11.2.2 State 132
4.11.2.3 County and Regional 132
4.11.3 Potential Impacts 133
4.12 Mineral Resources (MIN) 135
4.12.1 Environmental Setting 135
4.12.2 Regulatory Setting 136
4.12.2.1 Federal 136
4.12.2.2 State 136
4.12.2.3 County and Regional 136
4.12.3 Potential Impacts 137
4.13 Noise (DBA) 138
4.13.1 Environmental Setting 138
4.13.2 Regulatory Setting 139
4.13.2.1 Federal 139
4.13.2.2 State 139
4.13.2.3 County and Regional 139
4.13.3 Potential Impacts 140
4.14 Population and Housing (POP) 143
4.14.1 Environmental Setting 143
4.14.2 Regulatory Setting 143
4.14.2.1 Federal 143
4.14.2.2 State 145
4.14.2.3 County and Regional 145
4.14.3 Potential Impacts 145
4.15 Public Services (PUB) 146
4.15.1 Environmental Setting 146
4.15.2 Regulatory Setting 147
4.15.2.1 Federal 147
4.15.2.2 State 147
4.15.2.3 County and Regional 147
4.15.3 Potential Impacts 148
4.16 Recreation (REC) 150
4.16.1 Environmental Setting 150
4.16.2 Regulatory Setting 150
4.16.2.1 Federal 150
4.16.2.2 State 151
4.16.2.3 County and Regional 151
4.16.3 Potential Impacts 151
4.17 Transportation and Circulation (TRA) 152
4.17.1 Environmental Setting 152
4.17.2 Regulatory Setting 154
4.17.2.1 Federal 154
4.17.2.2 State 155
4.17.2.3 County and Regional 155
4.17.3 Potential Impacts 155
4.18 Tribal Cultural Resources (TCR) 157
4.18.1 Environmental Setting 157
4.18.2 Regulatory Setting 158
4.18.3 Potential Impacts 159
4.19 Utilities and Service Systems (USS) 160

4.19.1 ENVIRONMENTAL SETTING 160
4.19.2 REGULATORY SETTING 161
4.19.2.1 FEDERAL 161
4.19.2.2 STATE 161
4.19.2.3 COUNTY AND REGIONAL 162
4.19.3 POTENTIAL IMPACTS 164
4.20 WILDFIRE (WDF) 166
4.20.1 ENVIRONMENTAL SETTING 166
4.20.2 REGULATORY SETTING 167
4.20.2.1 FEDERAL 167
4.20.2.2 STATE 167
4.20.2.3 COUNTY AND REGIONAL 167
4.20.3 POTENTIAL IMPACTS 167
5 MANDATORY FINDINGS OF SIGNIFICANCE (MFS) 169
6 REFERENCES 170
7 ACRONYMS 177
8 REPORT PREPARERS AND CONTRIBUTORS 182

TABLES

TABLE 1-1. AQUATERRA WATER BANK SPECIFICATIONS 9
TABLE 1-2. CONVEYANCE FACILITIES PRELIMINARY DESIGN CRITERIA 11
TABLE 1-3. CANAL DIMENSIONS 13
TABLE 1-4. CHANNEL CUT AND FILL VOLUMES 13
TABLE 1-5. PUMP STATIONS 15
TABLE 1-6. ROAD CROSSINGS 16
TABLE 1-7. DESIGN AND FILL SUMMARY FOR RECHARGE BASINS, ESTIMATED AT 30 PERCENT DESIGN 21
TABLE 1-8. ESTIMATED HEAVY EQUIPMENT REQUIREMENTS 29
TABLE 4-1: ATTAINMENT STATUS FOR SAN JOAQUIN VALLEY 64
TABLE 4-2: ESTIMATED EMISSIONS AND COMPLIANCE OF CRITERIAL POLLUTANTS (SHORT TONS PER YEAR; TPY) AND GHG (METRIC TONS PER YEAR; MT/YEAR) DURING CONSTRUCTION OF THE PROPOSED PROJECT (SEP-2024 TO FEB-2028) 66
TABLE 4-3: ESTIMATED EMISSIONS (TONS PER YEAR) AND COMPLIANCE OF CRITERIAL POLLUTANTS (SHORT TONS PER YEAR; TPY) AND GHG (METRIC TONS PER YEAR; MT/YEAR) DURING ANNUAL OPERATION AFTER PROJECT COMPLETION 66
TABLE 4-4: ECOLOGICALLY IMPORTANT CONSERVATION AREAS ADJACENT TO OR WITHIN THE PROJECT AREA 70
TABLE 4-5. SPECIAL STATUS SPECIES THAT MAY OCCUR WITHIN THE PROJECT AREA AND VICINITY 71
TABLE 4-6. SENSITIVE RARE NATURAL COMMUNITIES THAT OCCUR IN THE PROJECT AREA OR VICINITY 74
TABLE 4-7: SUMMARY OF IDENTIFIED CULTURAL RESOURCES 85
TABLE 4-8: PUMP AND WELL SPECIFICATIONS 92
TABLE 4-9. GEOLOGIC UNITS IN THE PROJECT AREA (ADAPTED FROM BROWN AND CALDWELL 2006, TABLE 4-1) 95
TABLE 4-10: SOIL DATA AND PERCENT AREA, FROM SSURGO DATABASE 99
TABLE 4-11: SCHOOLS NEAR THE PROJECT AREA 139
TABLE 4-12: CONSTRUCTION EQUIPMENT NOISE EMISSION LEVELS 140
TABLE 4-13: TYPICAL CONSTRUCTION EQUIPMENT VIBRATION LEVELS 141

TABLE 4-14: AVERAGE ANNUAL TRAFFIC COUNTS FOR 2019 154

FIGURES

FIGURE 1-1: MAGSA REGIONAL LOCATION 2

FIGURE 1-2: KINGS GROUNDWATER SUBBASINS AND GROUNDWATER SUSTAINABILITY AGENCIES 3

FIGURE 1-3. SAN LUIS RESERVOIR AND ASSOCIATED SWP AND CVP FACILITIES (MODIFIED FROM USBR 2013) 4

FIGURE 1-4. MAGSA HYDROLOGIC FEATURES 6

FIGURE 1-5: PROJECT FEATURES 7

FIGURE 1-6. PROJECT DESIGN DETAILS 17

FIGURE 1-7. CONCEPTUAL RECHARGE BASIN DESIGN ON 80-ACRE FIELD WITH 20-ACRE CHECKS. 19

FIGURE 1-8. CROSS-SECTION AND ASSUMPTIONS FOR EXTERNAL BERMS 20

FIGURE 1-9. RECHARGE BASINS AND LOCAL AND REGIONAL RECOVERY WELLS 23

FIGURE 1-10. HYDROLOGIC SOILS GROUPS A (20,000 ACRES) AND B (24,000 ACRES) 24

FIGURE 1-11. AVOIDANCE AREAS 26

FIGURE 1-12: MAGSA HYDROLOGY UNDER RECHARGE FLOW CONDITIONS 32

FIGURE 1-13: MAGSA HYDROLOGY UNDER EXTRACTION FLOW CONDITIONS 33

FIGURE 4-1: AGRICULTURAL LAND USE 55

FIGURE 4-2: FARMLAND DESIGNATIONS 56

FIGURE 4-3: WILLIAMSON ACT 58

FIGURE 4-4: POTENTIAL HAZARDOUS MATERIALS 111

FIGURE 4-5: GROUNDWATER ELEVATION CONTOURS 119

FIGURE 4-6: REPORTED HOUSEHOLD DRY WELLS 121

FIGURE 4-7: POPULATION AND HOUSING 144

FIGURE 4-8: TRANSPORTATION 153

FIGURE 4-9: UTILITIES IN THE MAGSA VICINITY 163

APPENDICES

APPENDIX 1: MCMULLIN PHASE 1 FLOOD FLOW RECAPTURE PLAN

APPENDIX 2: THE AQUATERRA WATER BANK: PREDICTING GROUNDWATER RESPONSES AND ANTICIPATING HYDROLOGIC MANAGEMENT

APPENDIX 3: THE AQUATERRA WATER BANK: WATER QUALITY CONSIDERATIONS, BENEFITS, CONSTRAINTS, AND MANAGEMENT REPORT

APPENDIX 4: AIR QUALITY TECHNICAL MEMORANDUM AND CALEEMOD REPORT

APPENDIX 5: AQUATERRA WATER BANK PROJECT: RECONNAISSANCE LEVEL BIOLOGICAL SURVEY REPORT

APPENDIX 6: LETTER FROM USFWS REGARDING LISTED SPECIES THAT MAY OCCUR IN THE PROJECT AREA

APPENDIX 7: EXAMPLE TRIBAL COORDINATION LETTER

APPENDIX 8: MITIGATION MONITORING AND REPORTING PLAN (MMRP)

1 INTRODUCTION

The McMullin Area Groundwater Sustainability Agency (MAGSA) is proposing to develop and operate the Aquaterra Groundwater Bank Project (Project) within its jurisdictional boundaries, located approximately 20 miles southwest of Fresno (Figure 1-1). MAGSA was formed on January 31, 2017, when Fresno County, Raisin City Water District, and Mid-Valley Water District executed the McMullin Area Groundwater Sustainability Agency Joint Powers Agreement. This agreement formed a Groundwater Sustainability Agency (GSA) under the Sustainable Groundwater Management Act (SGMA) for the McMullin Area.

Signed into law in September 2014, SGMA provides a framework for local governments and water agencies to manage groundwater resources through the formation of GSAs. MAGSA is authorized under SGMA to develop, adopt, and implement a Groundwater Sustainability Plan (GSP) for the sustainable management of groundwater in a portion of the Kings Subbasin. MAGSA is one of seven GSAs within the Kings Subbasin (Figure 1-2). It is located west of SR-99 and east of the James Bypass within an agricultural region of the mid-northern portion of Fresno County, CA.

1.1 PROJECT OBJECTIVES

The Project is intended to meet two primary objectives:

1. Establish the Aquaterra Water Bank (Bank) for use by local, regional, and statewide entities to improve their use of available surface water supplies; and,
2. Help MAGSA in achieving sustainable groundwater management for local water and agricultural sustainability, in compliance with SGMA.

1.2 PROJECT BACKGROUND

This section provides background information considered relevant to this Project, including:

- The Central Valley Project (CVP) and the State Water Project (SWP); and
- Groundwater conditions and the SGMA.

1.2.1 Overview of California Water Projects and Contractors

The SWP and the CVP form the backbone of California’s engineered water system. The CVP, a federal water project owned and operated by the U.S. Bureau of Reclamation (Reclamation) extends from Redding to Bakersfield, covering about 400 linear miles and including 20 dams and reservoirs (CRS 2021). The CVP can deliver more than 9.5 million acre-feet (AF) of water and provides about 75 percent of its total deliveries for agricultural irrigation, including seven of California’s top 10 agricultural counties. The SWP extends more than 700 linear miles and includes canals, pipelines, reservoirs, and hydroelectric facilities (CDWR 2022a). Operated and maintained by California’s Department of Water Resources (DWR), the SWP has, on average, provided 34 percent of its water to agriculture and 66 percent to residential, municipal, and industrial users. The CVP and SWP are operated jointly by DWR and Reclamation (CRS 2021).

Several elements of the CVP and SWP are particularly relevant to this Project. These include state and federal water contractors, the San Luis Reservoir and its associated facilities (Figure 1-3), and the Mendota Pool and the Fresno Slough/James Bypass (Figures 1-4 and 1-5).

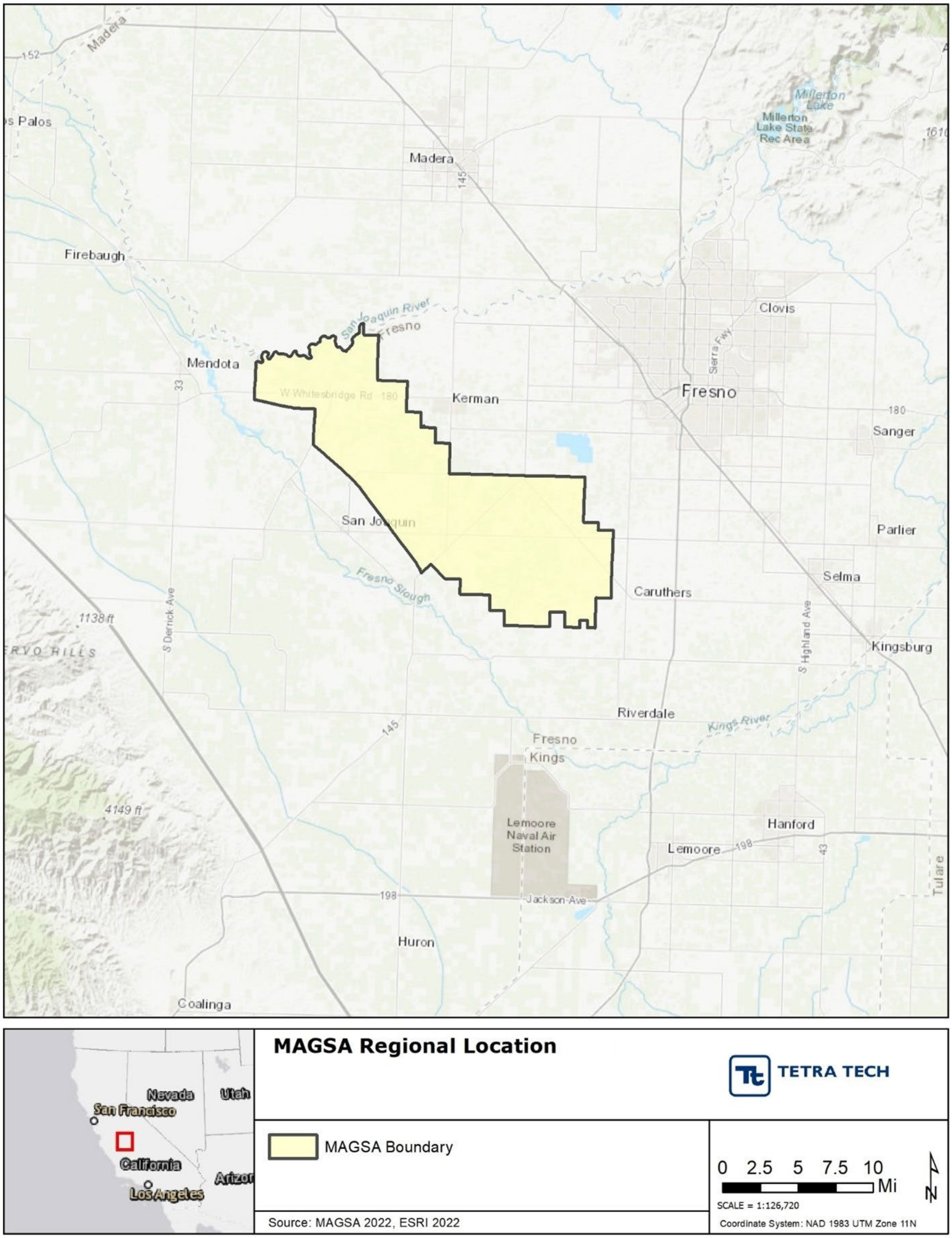


Figure 1-1: MAGSA Regional Location

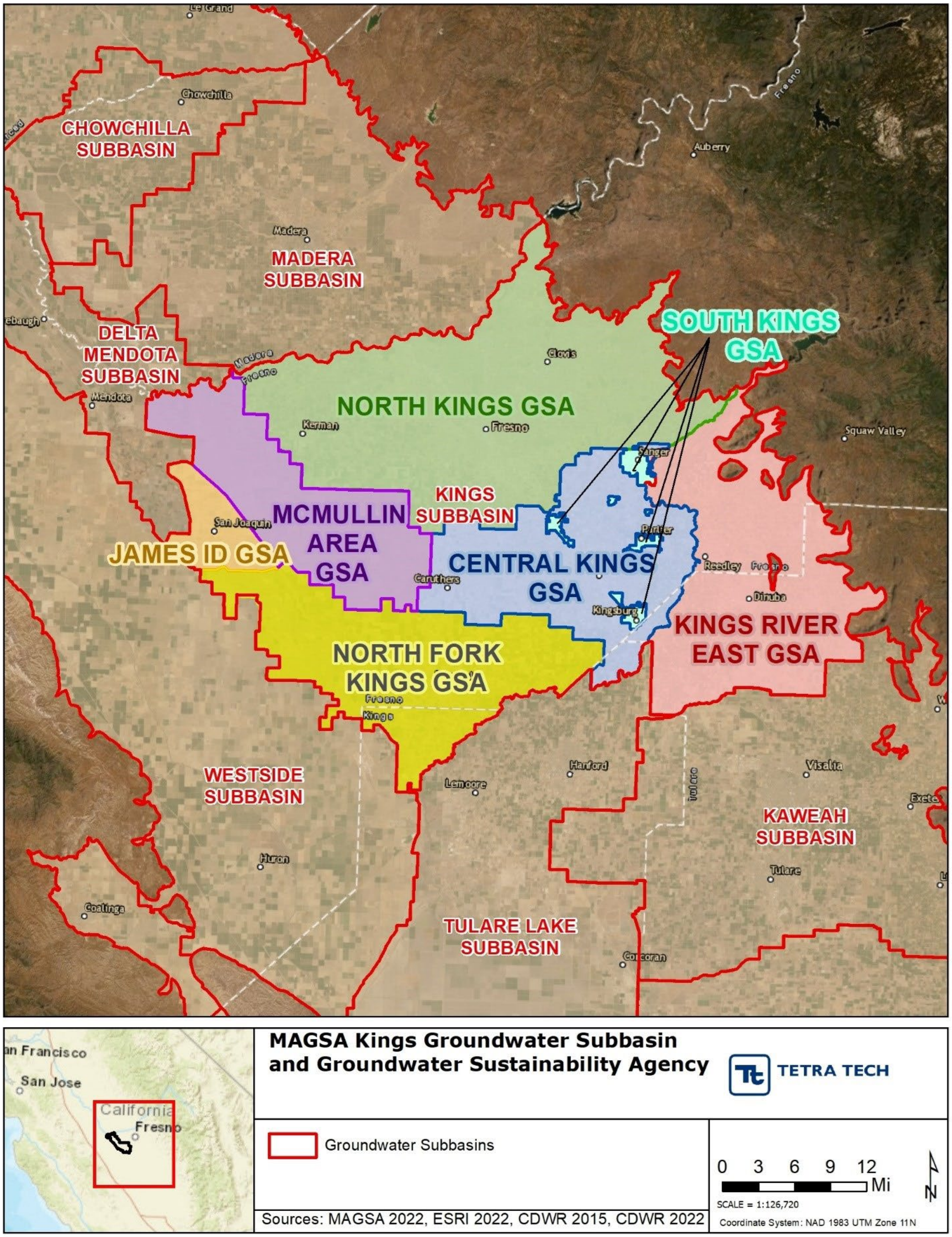


Figure 1-2: Kings Groundwater Subbasins and Groundwater Sustainability Agencies

Water Contractors

Water contractors are public agencies and local water districts who signed long-term water supply contracts that set the maximum amount each can request annually, with actual deliveries based upon regional and statewide hydrologic conditions, current reservoir storage, and the combined requests from all water contractors. These water contractors have financially supported the SWP and CVP by repaying principal and interest on bonds for initial construction and subsequent improvements. The water contractors also pay all associated costs, including labor and power, for facility maintenance and operation (CDWR 2022b).

San Luis Reservoir and Associated Facilities

San Luis Reservoir (SLR) is an offline reservoir serving both the CVP and SWP. It receives state and federal contract water (Figure 1-3). The water stored in the reservoir is managed as approximately 45 percent federal water and 55 percent state water (USBR 2013) and is jointly managed by both the federal and state governments.

Figure 1-3. San Luis Reservoir and Associated SWP and CVP Facilities (Modified from USBR 2013)

Federal contract water is pumped from the southern end of the Sacramento – San Joaquin Delta (Delta) into the Delta Mendota Canal (DMC) using the Tracy Pumping Plant, typically at 2,500 – 3,000 cubic feet per second (CFS) (USBR 2020). Downstream of the pumping plant, federal water gravity flows in the DMC to the O'Neill Pumping Plant, which lifts the water into the O'Neill Forebay (Figure 1-3). State contract water is similarly pumped at the southern end of the Delta, from the Clifton Court Forebay. State contract water is pumped into the California Aqueduct which gravity flows to the O'Neill Forebay.

The Mendota Pool

The Mendota Pool is a 2,000-acre reservoir created by Mendota Dam with a San Joaquin River (SJR) arm and a Fresno Slough arm (Figure 1-4). DMC contract water delivered to the pool is delivered to the SJR Exchange Contractors Water Authority, other CVP contractors, the Mendota Wildlife Area, and State water contractors through seven withdrawal points in the pool, canals, or pump locations. About 500 CFS remains for discharge past the Mendota Dam into the SJR.

Fresno Slough/James Bypass

The North Fork of the Kings River becomes the Fresno Slough, flowing northward and carrying floodwaters to the Mendota Pool and the SJR (Figure 1-4, Figure 1-5). The James Bypass is a constructed channel bypassing a portion of Fresno Slough, which was originally designed to contain excessive high flows, particularly for flood management. Flows in Fresno Slough and the James Bypass primarily result from Pine Flat Dam flood releases, 55 miles east (Figure 1-4).

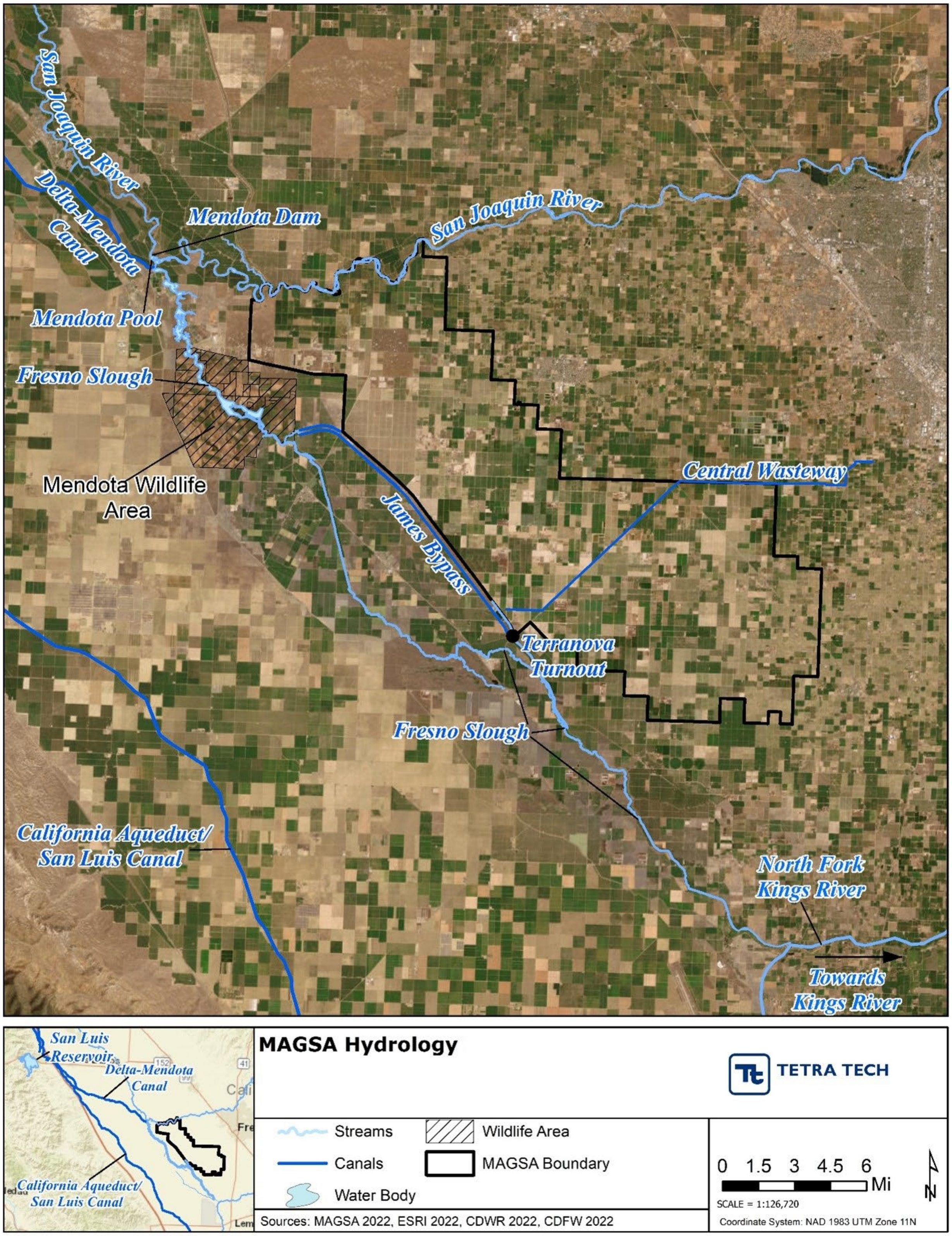


Figure 1-4. MAGSA Hydrologic Features

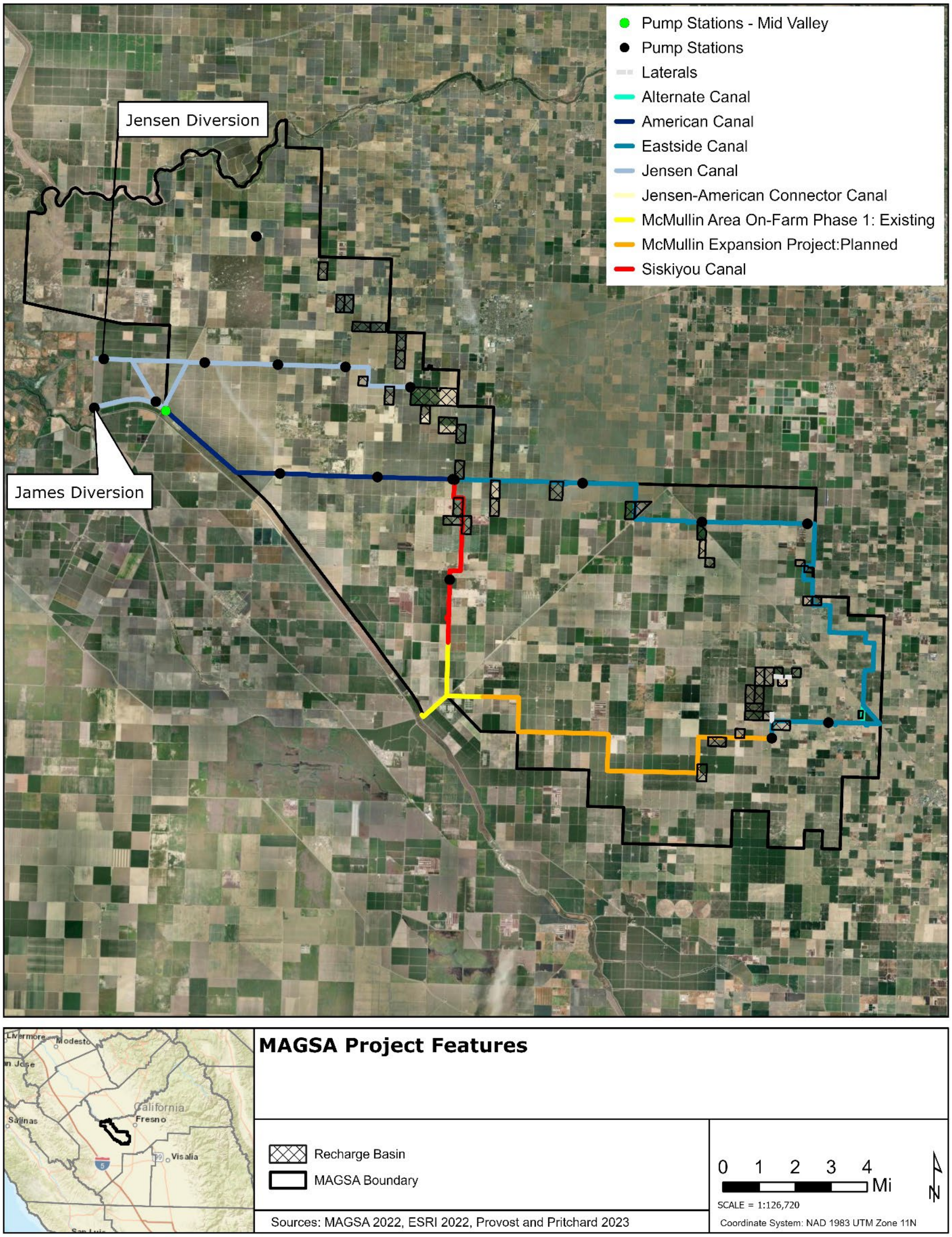


Figure 1-5: Project Features

1.3 PURPOSE AND NEED

The sustainability goal of the MAGSA GSP 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. The purpose of the Project is to contribute to this sustainability goal by constructing and operating a groundwater bank that provide flexibility to water contractors and contribute to aquifer recharge. The Project will provide additional storage to maximize the capture and use of allocated waters, by allowing contractors to store excess contract water and flood water in wetter years and recover this water in normal or dry years.

The Project is needed is to improve groundwater sustainability in the region by improving water supply reliability and providing flexibility to local agencies complying with the SGMA. Agricultural land uses in the MAGSA area are exclusively dependent on groundwater for irrigation. Groundwater extraction has created a pumping cone of depression, resulting in large amounts of available aquifer storage space. The Project will provide a dry-year water supply to prevent agricultural field fallowing or loss of crops.

The Project will establish the 800k AF-capacity Bank underlying the MAGSA area, which is adjacent to, and will accept water from, the Fresno Slough and the Mendota Pool (Figure 1-4, Figure 1-5). The Project will be designed to divert and recharge up to 208,000 acre-feet per year (AFY) of contract water into the Bank over a 5-month period, and subsequently recover up to 148,000 AFY of contract water from the Bank over a 5-month period for use by SWP and CVP contractors (MAGSA 2022) (Table 1-1).

The Bank's proximity to existing water system infrastructure makes it well-suited to accept water deposits from SWP and CVP contractors, local MAGSA partners and consortiums, and others. It is anticipated that the Bank will be recognized as a water bank by the Bureau of Reclamation.

Table 1-1. Aquaterra Water Bank Specifications

Specification	Value	Unit
Recharge		
Maximum Recharge [1]	208,000	AF/Y
Period	Nov - Mar	Months
Days	151	Days
Recharge Rate per Day	1,377	AF/D
Recharge Basin Acres	3,480	Acres
% of land available for recharge basins [2]	8000	n/a
Available Recharge Acres	278,400	Acres
Design Recharge Basin Infiltration Rate	6	in/d
Recovery [2]		
Maximum Recovery	148,000	AF/Y
Period	May - Sept	Months
Days	153	Days
Recovery Rate per Day	972	AF/D
Number of Pumps [3]	88	n/a
Design Recovery Pump Capacity	2,500	GPM

Notes

[1] Based upon available capacity within the SWP and CVP

[2] Land is required for associated infrastructure

[3] Number of extraction/recovery pumps operational simultaneously

1.4 PROJECT DESCRIPTION

MAGSA proposes to construct and operate a groundwater banking program, described in the following paragraphs. This project description includes the following sections:

- Sources of water;
- Banking program description and operations;
- Infrastructure and easements;
- Construction actions;
- Operations and maintenance;
- Monitoring;
- Governance, ownership, and partner relationships.

This document addresses the construction of the Bank and the first offering of 800,000 AF of bank storage operations. Previous studies estimate the MAGSA aquifer has approximately 1.8 million AF of storage capacity due to aquifer overdraft, therefore up to 1 million AF of storage capacity will remain available after the initial 800,000 AF are deposited (MAGSA 2022). While future offerings are anticipated to use this additional storage capacity once the bank is constructed and initial storage capacity has been met, such offerings are conceptual and not planned to a degree to be assessed in this document. Future offerings would result only in operational changes and would be addressed in future environmental documentation.

1.4.1 Contract Water Sources

State and federal contract water described in Section 1.2.1 will be the source water for the Bank. Diversions to the Bank will be spilled contractor carryover water from San Luis Reservoir that is routed to the Fresno Slough and the Mendota Pool. Carryover water is contractor water saved for the following year's annual allocation through storage in San Luis Reservoir. These waters can be lost to enable reservoir accommodation of the following year's water. Thus, spilled water would be carryover water lost by the contractor. The Project will allow additional, temporary storage in years where carryover water is at risk, allowing contractors to retain the current year's allocation from reservoir accommodations for the following year's water.

1.4.2 Groundwater Banking Program

Establishment of the Bank will require construction of conveyance, recharge, and recovery facilities. Construction costs will be recovered through subscription fees collected from bank users, referred to as banking partners. Initial banking partners will have priority options within the water bank, through the purchase of a *subscription stock* that will provide them with a permanent and perpetual right to a set amount of storage capacity. Banking partners with subscription stocks will be able to deposit and withdraw contract water within that account. These subscription stocks will be purchased per AF of storage capacity and will be available for the entire planned storage capacity of the bank's first offering of 800,000 AF. Should later offerings become available, they would provide a different type of bank stock without priority options. MAGSA will own all associated facilities and space of the Bank.

Ten percent of each deposit will be left behind in the water bank to offset operational and evaporative losses and improve subsurface conditions through *in lieu recharge* (i.e., improving unsaturated zone water content to benefit crops and plants) or direct recharge (i.e., replenishing the underlying aquifer). Losses will be accounted for within the Project area as the volume of water for deposit will be metered when it enters the Mendota Pool and will move directly into the water bank conveyance system for distribution through MAGSA and recharge within the identified recharge zones.

Banking partners are likely to be charged an *annual fee* to cover operations and maintenance (O&M), monitoring, and other regular annual costs. Banking partners will not be charged any *transaction fees* for depositing into or withdrawing from the water bank. Future offerings, not evaluated in this document, may involve the potential for transaction fees. All fees will be charged with zero-base budgeting, with no profits for MAGSA, since it operates as a local agency without profit.

Operational Schedule

Recharge deposits to the Bank are expected to occur primarily from November through March of any given year, a five-month period during which the State and Federal Water Projects have historically had excess capacity. Contract water recovery withdrawals from the Bank are expected to occur from May through September (Table 1-1, MAGSA 2022). This period coincides with both the regional growing season when irrigation drives higher water demand, and California's dry season when other demands such as streamflows for fisheries, recreational use, urban and suburban irrigation increase.

1.4.3 Infrastructure and Easements

The project infrastructure elements include conveyance, recharge, and recovery facilities. 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. Each facility type is discussed in the following sections.

Conveyance Infrastructure and Easements

The conveyance system (Figure 1-6) will include the construction of a main canal, lateral canals, pump stations with pumps, and road crossings. Table 1-2 summarizes the general design criteria for canals, pumps, and pump stations. Table 1-3 shows the design criteria for each canal.

Table 1-2. Conveyance Facilities Preliminary Design Criteria

System Component	Design Criteria	Unit
Levee and Channel		
Main Canal Design Capacities	300, 400, 500	CFS
Lateral Canal Design Capacities	120	CFS
Side Slopes, Inside and Outside	1.5:1	ratio
Design Velocity	1	FPS
Consolidation Factor	25 [1]	%
Freeboard at Maximum Capacity	1	ft
Direction of Flow	bi-directional [2]	n/a
Levee Easements		
Conveyance Easements	160	ft
Temporary Construction Easements	40	ft
Pump Stations		
Design Capacities	300, 400, 500	CFS
Construction and Materials	Concrete and Steel	n/a
Water Lift Distance per Pump Station	13, 15, 11.25	ft
Pump Bays and Pump Types at Full Capacity	6	each
Number of Pump Stations	19	each
Pumps, Electric [4]		
Individual Pump Capacity: 20% of Pump Station Capacity [3]		
300 CFS Canal	60	CFS
400 CFS Canal	80	CFS
500 CFS Canal	100	CFS
Design Lift	16	ft
Design HP (Based upon CFS)		
300 CFS Canal	145	HP
400 CFS Canal	195	HP
500 CFS Canal	240	HP
Total Number of Electric Pumps	84	n/a
Pumps, Natural Gas [3, 4, 5]		
Individual Pump Capacity: 400 CFS Canal		
Design Lift	16	ft
Horsepower: 400 CFS Canal	195	HP
Total Number of Natural Gas Pumps	18	n/a
Pumps, Propane [3, 4, 5]		
Individual Pump Capacity: 300 CFS Canal		
Design Lift	16	ft
Horsepower: 300 CFS Canal	145	HP
Total Number of Propane Pumps	12	n/a
Notes		

System Component	Design Criteria	Unit
[1] Compaction factor is the amount excavated fill will decrease after compaction.		
[2] Main canals have 0% slope to allow flow into and from MAGSA.		
[3] Each canal is designed to function on five pumps, with one to serve as a backup.		
[4] All pumps will have variable frequency drive controls to minimize energy use during low flow.		
[5] Natural gas pumps will only be on 400 CFS canals, and propane pumps will only be on 300 CFS canals.		

Channels and Levees. The bi-directional main canal will convey water from the Mendota Pool to recharge basins to deposit water into the water bank and will withdraw water back to the Mendota Pool from recovery wells. Table 1-3 summarizes the current design criteria of the canal network. The water bank will include 63.5 miles of new or upgraded canals. A lateral canal system will be constructed to distribute water from the main canal system to non-adjacent recharge basins where necessary. Table 1-4 summarizes the cut and fill volumes of canals. Cut has been calculated at 3.3M cubic yards and fill calculated at 2.3M cubic yards.

Table 1-3. Canal Dimensions

Canal / Channel	Length [5] Miles	Bottom Width [5] (interior) ft	Levee Top Width (each side) ft	Canal Top Width (interior) [3] ft	Canal Exterior Width [1,3,5] ft	Water Depth ft	Total Canal Depth [5] ft	Average Excavation below Grade ft	Design Capacity CFS	Total Acres [(4)] acres
Main										
Eastside	37	16	14	52	116	10	12	7	500	897
Jensen	9.5	16	14	49	110	9	11	7	500	230
American	10.75	16	14	49	110	9	11	7	400	261
Siskiyou	4.5	13	14	44.5	104	8.5	10.5	6	300	109
Connecting Canals	1.75	13	14	44.5	104	8.5	10.5	6	300	42
Subtotal	*63.5*	--	--	--	--	--	--	--	--	*1539*
Laterals [2]										
120 CFS	0.75	8	14	28.25	76.5	4.75	6.75	4.5	120	18

Notes:

[1] Measured as slope toe to slope toe on the exterior of levee, and calculated assuming canal invert at surface grade, thus representing a maximum width; if canal invert is situated below grade, this width will be smaller.

[2] Laterals fall mostly within the recharge basin footprints.

[3] Slope of 1.5.

[4] Total easement widths = 200 ft.

[5] Represents maximum potential value for earthmoving activities (length, bottom width, top width, depth).

Table 1-4. Channel Cut and Fill Volumes

Main Canal / Channel	Cut (cubic yards)	Fill (cubic yards)
Eastside	1,946,141	1,390,229
Jensen	416,031	326,403
American	556,601	355,015
Connecting Canals	203,923	15,904
Siskiyou	196,927	162,846
Main Canal Subtotal	3,319,623	2,250,397
Laterals	12,734	9,551
Total	3,332,357	2,259,948

Diversion and Lift Pumps and Pump Stations. The conveyance system includes diversion pump stations and lift pumps that will enable operation of the water bank program (Figure 1-6). Pump station capacities will range from 300 to 500 cubic feet per second (CFS), depending upon the canal they are servicing, and the pump capacities and power requirements will be specified accordingly (Table 1-2, Table 1-5).

Diversion pump stations are located to divert water from the Mendota Pool (Jensen Diversion; James Diversion) as part of the water banking program. General design criteria for pump stations are provided in Table 1-2. Lift pump stations will be installed along the canal system. Lift pump stations will lift water up to 16 feet (ft), with differences depending upon grade and location. For the bi-directional canal system, lift pumps will be designed for bi-directional flow, able to pump up-gradient and gravity flow down. Up-gradient flow will be used to move diverted waters to recharge basins. Down-gradient flow will be used to gravity flow recovery water back to the Mendota Pool. Descriptive information for the specific diversion stations and summaries of the number of 300, 400 and 500 CFS pumps are presented in Table 1-5.

All pump stations will include discharge manifolds, canal gates, bypass functionality to allow bi-directional flow in the canals, electrical and transmission equipment, and accessories. All pump stations will be designed for six bays. Electric, propane and natural gas-powered pumps will be used at the pump stations:

- 500 CFS pump stations will be comprised of 6 electric-powered pumps;
- 400 CFS pump stations will be comprised of 3 electric pumps and 3 natural gas-powered pumps; and
- 300 CFS pump stations will be comprised of 3 electric pumps and 3 propane powered pumps.

The system will include a total of 84 electric pumps, 18 natural gas and 12 propane powered pumps across 19 pump stations (Table 1-5).

The primary reliance upon electric pumps is intended to reduce greenhouse gas emissions from pumping in compliance with California SB 32. These pumping plants will require new associated natural gas, electrical, and control facilities to enable their operation.

Easements. MAGSA will obtain easements for the construction and operation of the conveyance system. Permanent conveyance easements will be obtained from individual landowners to build canals across their properties. Permanent conveyance easements will be up to 160 ft wide (80 ft to either side of the canal center line). All canals and channels, associated levees, pump stations and road crossings will be located within the permanent conveyance easement. Temporary construction easements, up to 40 feet wide, will be obtained for the Project along the canal system.

Based upon the specifications for the temporary and construction easements, the total maximum easement width will be 200 ft (Table 1-2) along the 63.5-mile main conveyance system (Table 1-3), corresponding to about 1,540 acres.

Table 1-5. Pump Stations

Station Name	No. of Stations	Type	Capacity (CFS)	Location From	Location To
Diversion					
Jensen Diversion	1	New	300	Mendota Pool	Fresno Slough Access
James Diversion	1	Replacement [1]	300	Mendota Pool	Fresno Slough Access
American Diversion	1	New	400	James Bypass	American
Subtotal	***3***				
Lift					
Jensen Canal Lift Stations	4	New	500	Jensen Canal	
American Canal Lift Stations	4	New	400	American Canal	
Siskiyou Canal Lift Station	3	New	300	Siskiyou Canal	
Eastside Canal Lift Stations	5	New	500	Eastside Canal	
Subtotal	***16***				
Pump Distribution		***Pump Types per Station***			
500 CFS	*9*	*6 Electric Pumps per 500 CFS Station*			
400 CFS	*6*	*4 Electric and 2 Natural Gas Pumps per 400 CFS Station*			
300 CFS	*4*	*4 Electric and 2 Propane Pumps per 300 CFS Station*			
Total Stations	***19***				

Notes:

1. Replacement of Mid-Valley Water District Pump Station

McMullin Projects (Phase 1 and Expansion) Integration. The McMullin Projects include a 5,000-acre pilot recharge project in the southwest corner of MAGSA that was constructed in 2021, and the McMullin Expansion Project, found in the south of the MAGSA area and which is in the final stages of planning and design. Conveyance infrastructure constructed for these projects will be integrated with this project to increase capacity and functionality. In particular, the McMullin Project conveyance infrastructure will enable transport of surface waters across the MAGSA area for water banking recharge through recharge basins.

Road Crossings. Box culverts will be installed for County roads when appropriate. Crossings at State highways and busy roads will be jack and bore pipelines. Box culverts will have a design capacity consistent with the adjacent canals and will be designed to meet County and Caltrans requirements as appropriate. For paved road crossings, pavement will be replaced in the impacted area. During construction, traffic at County and State road crossings will be managed through either closing half the road for traffic or having detours. Design details for road crossings are shown in Table 1-6.

Box culverts or standard pipe crossings will be installed at farm road crossings. Selections will depend upon design flows, costs and other site considerations. Culverts will be designed for road crossing lengths ranging from 30 to 120 ft, depending on whether the crossing is perpendicular or diagonal to the road. Culvert piping will either be steel or concrete.

The details and locations of the crossings will be finalized during design with the goal of maintaining the functionality and capacity of the road system during construction and operations. Traffic management requirements will be determined by the County based upon traffic load of the crossing (e.g., vehicles/day) and other factors that affect the road system functionality, such as the detour length.

Table 1-6. Road Crossings

State Highway and County Road Crossings		**Units**
Design	Jack and Bore pipeline [1]	
Construction and Materials	Concrete	
Length	Based on Road Width [1]	ft
Design Head Loss through Culvert	<0.1	ft
Traffic Management	Not required	
County Roads as possible		
Design	Box [1]	
Construction and Materials	Pre-Cast Box Culverts	
Length	Based on Road Width [2]	ft
Design Head Loss through Culvert	<0.1	ft
Traffic Management	Detour or traffic control [3]	
Farm Road Crossings, Option 1		
Design	Box	
Construction and Materials	Pre-Cast Box Culverts	
Length	Based on Road Width [2]	ft
Design Head Loss through Culvert	<0.1	ft
Traffic Management	Detours or traffic control as needed [3]	
Farm Road Crossings, Option 2		
Design	Pipe [7], with end section	
Construction and Materials	Corrugated Steel or Concrete (H25 Live Load)	
Length	Based on Road Width [2]	ft
Design Head Loss through Culvert	<0.1	ft
Traffic Management	Detours or traffic control as needed [3]	

Notes

[1] Designed in accordance with County and State standards, as appropriate.

[2] Will depend upon layout. Will extend beyond the road in accordance with local and county standards as appropriate.

[3] Determined by the County based upon local traffic conditions and need to maintain road system functionality during construction

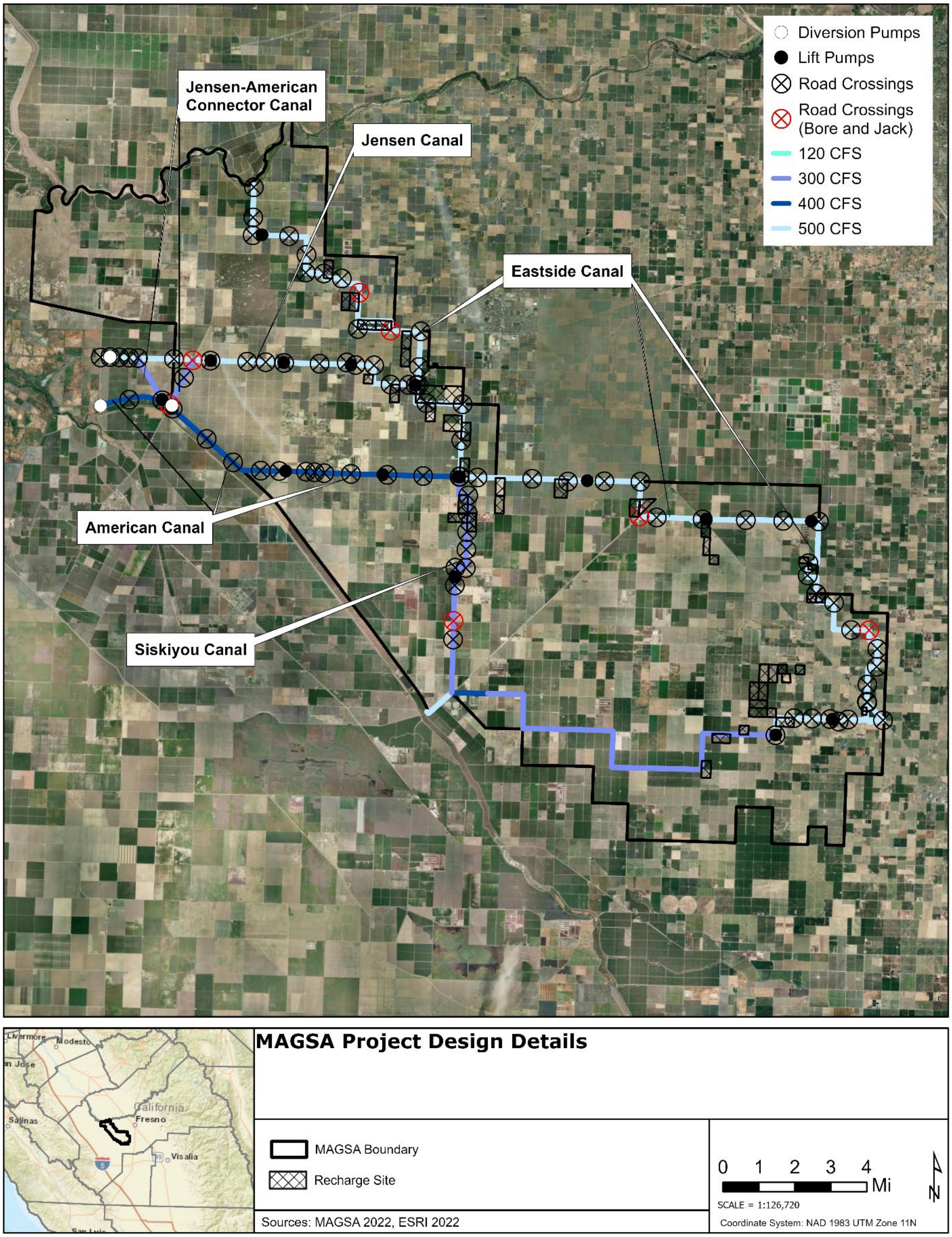


Figure 1-6. Project Design Details

Recharge Basins and Infrastructure

The water banking program will rely on recharge basins for depositing banked water into the underlying aquifer through surface to groundwater infiltration. Approximately 3,480 acres of farmland will be used as recharge basins on a seasonal basis, providing a recharge capacity of approximately 1,377 AF per day (AFD) (Table 1-1). This estimate is based on the following assumptions:

- 80 percent of the land is in operation as recharge area, while the remaining 20 percent is required for associated infrastructure (e.g., levees and drive roads), and
- An estimated recharge rate of 6 inches per day.

Design. The exterior berms are designed to be drivable by truck or tractor at 14-ft top widths. The perimeter levee around the recharge basins will have a design exterior slope of 2:1 and interior slope of 5:1 and will have a bottom width of up to 54 ft, depending on the topography of each site and the height of each berm (between 3.5 ft to 4 ft). The perimeter levees will be constructed by pushing up soils within the recharge basin adjacent to the levee, creating a shallow, 1-foot deep borrow area whose length will depend upon the perimeter berm design. The borrow areas will be up to 140 ft wide. Gathering soils from the recharge basins for levee construction simplifies heavy equipment selection and duration of earthwork construction and minimizes the travel distance of fill material used for berm construction. Scrapers are expected to be used to create the berms. Interior levees will serve as checks to accommodate changes in grade and will have a top width of 8 ft, and a bottom width of up to 30 ft depending on the topography of each site and the height of each berm. Figure 1-7 provides the design for a typical recharge basin and Figure 1-8 provides a cross-section of the external berms. To minimize earthwork in constructing the recharge basins, two primary design configurations have been identified:

1. 3.5-ft tall perimeter and interior berms with 20-acre checks
2. 4-ft tall perimeter and interior berms with 40-acre checks

These designs enable a minimum water depth during operation of about 1 ft, equivalent to two days of supplied water for the design infiltration rate of 6 inches per day. A summary of design and fill specifications for the recharge basins is shown in Table 1-7.

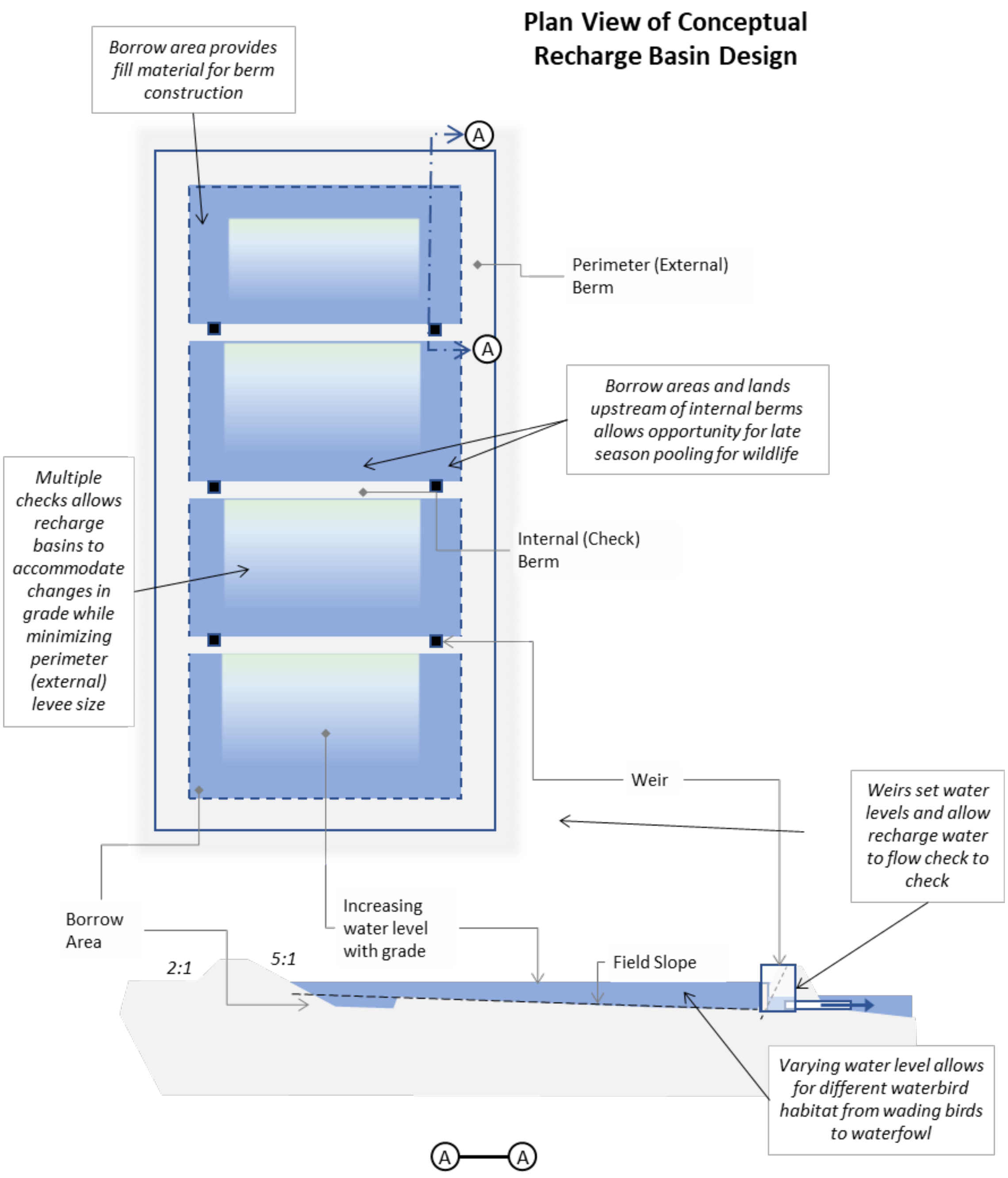
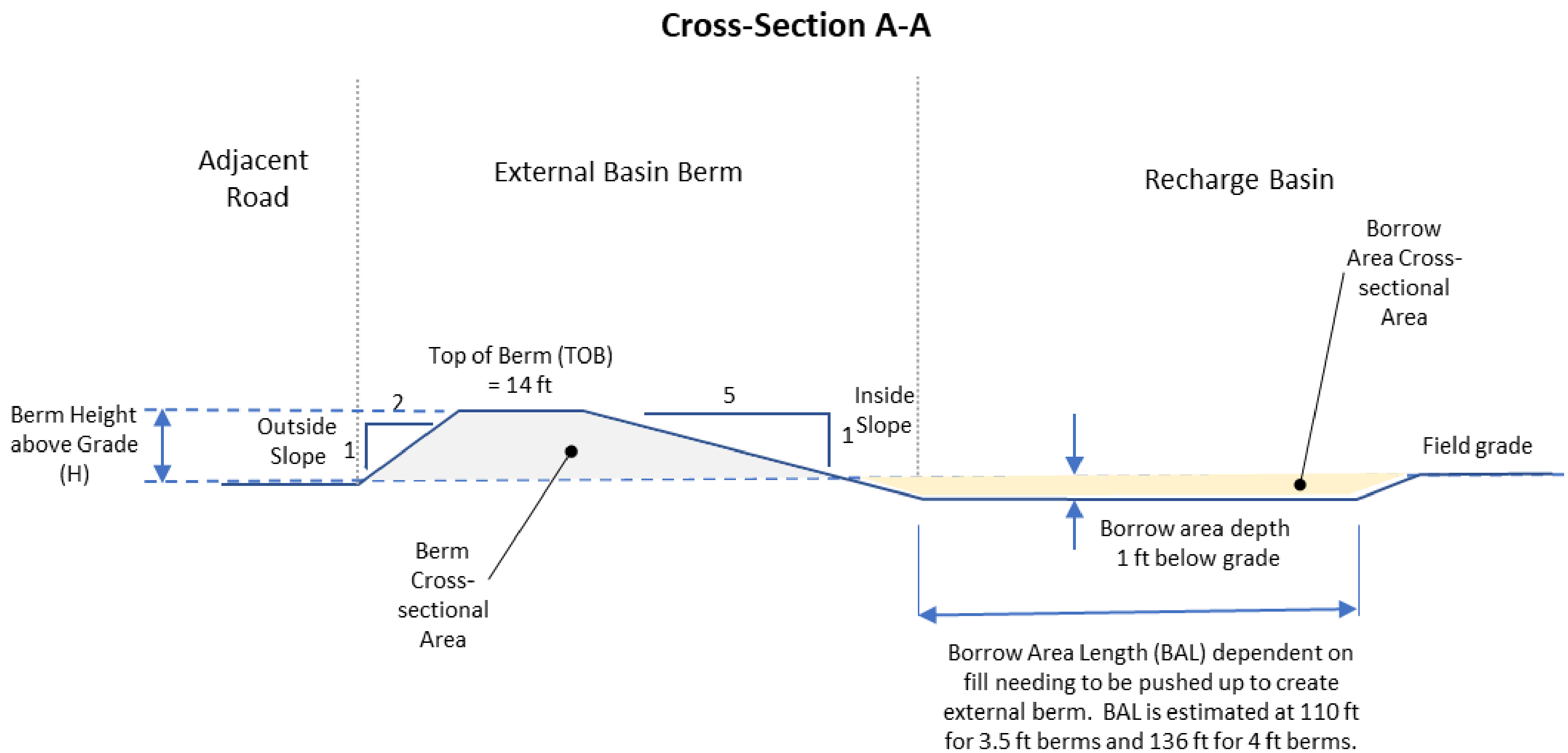


Figure 1-7. Conceptual Recharge Basin Design on 80-acre field with 20-acre checks.

Design shows an overall conceptual approach with berm height, field size and number of checks varying by location.



Notes
1. Not to scale
2. Berm X-sectional Area =Borrow Area X-sectional Area. Does not consider limits on compaction of scraped soils during berm construction. BDL will depend upon compaction efficiencies.
3. Height of berm above grade specified in design and is important for determining fill volumes
4. Fill calculated as Cross-section berm volume for an average berm height above grade times the length of the external levee around the field perimeter. A rectangular 80-acre field has a 1.5-mile perimeter. A square 40-acre field has a 1-mile perimeter. Berms are assumed to surround the perimeter of the field with at the specified average height.

Figure 1-8. Cross-section and assumptions for external berms

Table 1-7. Design and Fill Summary for Recharge Basins, Estimated at 30 Percent Design

Characteristic	Option			Total Fields	Unit
	1	2			
		a	b		
Description	3.5 ft berms. 20 ac checks[5]. 80 ac field	4 ft berms. 40 ac checks. 80 ac fields.	4 ft berms. 40 ac checks. 40 ac fields.		
Acres and Distribution					
Total Planned Acres	***2,160.0***	***720***	***600***	***3,480***	***acres***
% of Total Area	62	21	17		percent
Field Size [4]	80	80	40		acres
Recharge Field Configurations and Requirements					
Berm Height Above Grade	3.5	4.0	4.0		ft
Check Size [5]	20	40	40		acres
Perimeter Levee Length	1.50	1.50	1.00		miles
Interior Levee Length	0.75	0.25	0.00		miles
Total Levee Length	2.25	1.75	1.00		miles
Perimeter Berm Fill [3]	32,340	39,893	26,596		CY
Interior Berm Fill [3]	6,673	2,738	0		CY
Field Construction					
Total Fill for Given Field [3]	39,013	42,631	26,596		CY
Borrow Area Length (BAL)[1]	*110*	*136*	*136*		*ft*
Days to Create Perimeter Berms [2]	56	61	38		days
Construction of All Recharge Fields					
Number of Fields	***27***	***9***	***15***	***51***	***ea***
Total Fill for Planned Area	1,053,360	383,680	398,933	1,835,973	CY
Total Scraper Days for Construction[10]	1,512	549	570	2,631	Scraper-days
Operational Hydrology					
Freeboard[6]	1	1	1		ft
Typical Diagonal Design Slope [9]	0.1	0.1	0.1		percent
Estimated Fall Across Check Diagonal	1.5	1.9	1.9		ft
Maximum Operational Water Level [8]	3	3	3		ft
Minimum Operation Water Level [7]	1.0	1.1	1.1		ft

Notes
[1] Adjacent to perimeter berm. Assumes 1-ft depth
[2] Based upon assumed rate for each scraper day of 700 CY/d
[3] Soil is compacted to about 80 percent of the original volume
[4] For planning and calculation purposes
[5] Check sizes selected to reduce effect of fall on the required perimeter berm size
[6] Based on slope applied to diagonal across check
[7] Minimum water depth measured across check at locations with maximum standing water levels
[8] Water level in check where deepest (lowest bed elevation in check)
[9] Diagonal slope maximum of 0.1 percent considered design constraint to minimize fill volumes
[10] Represents maximum potential value for earthmoving activities.

Recharge Field Selection Process and Operations. The recharge basins are concentrated in five general zones suitable for recharge totaling approximately 37,500 acres (Figure 1-9) (MAGSA 2022). Considerations regarding their placement include land use, location relative to conveyance, soils, underlying lithology, landowner interest in participation, and avoidance of areas that might affect water quality.

Agriculture is the primary land use throughout the recharge zones. Approximately 10 percent of active agricultural land within the recharge zones will be converted to recharge basins, although the basins may still be used for seasonal agricultural practices. The recharge basins are generally located along conveyance alignments. Lateral canals needed for the Project generally lay within the areas designated as recharge basins, and less than one mile of additional laterals to move water from the main conveyance canals to recharge basin complexes has been identified (Figure **1-9**).

The selected zones have large areas of soil types suitable for infiltration and aquifer recharge. Within the entire MAGSA boundary, approximately 20,000 acres of Hydrologic Soils Group (HSG) A soils and approximately 24,000 acres of HSG B soils are found (Figure 1-10). These soil types are predominantly sand, and HSG A soils have no underlying restrictive layers. Soil cores have been collected within the recharge zones and the lithology was determined as suitable for recharge (MAGSA 2022).

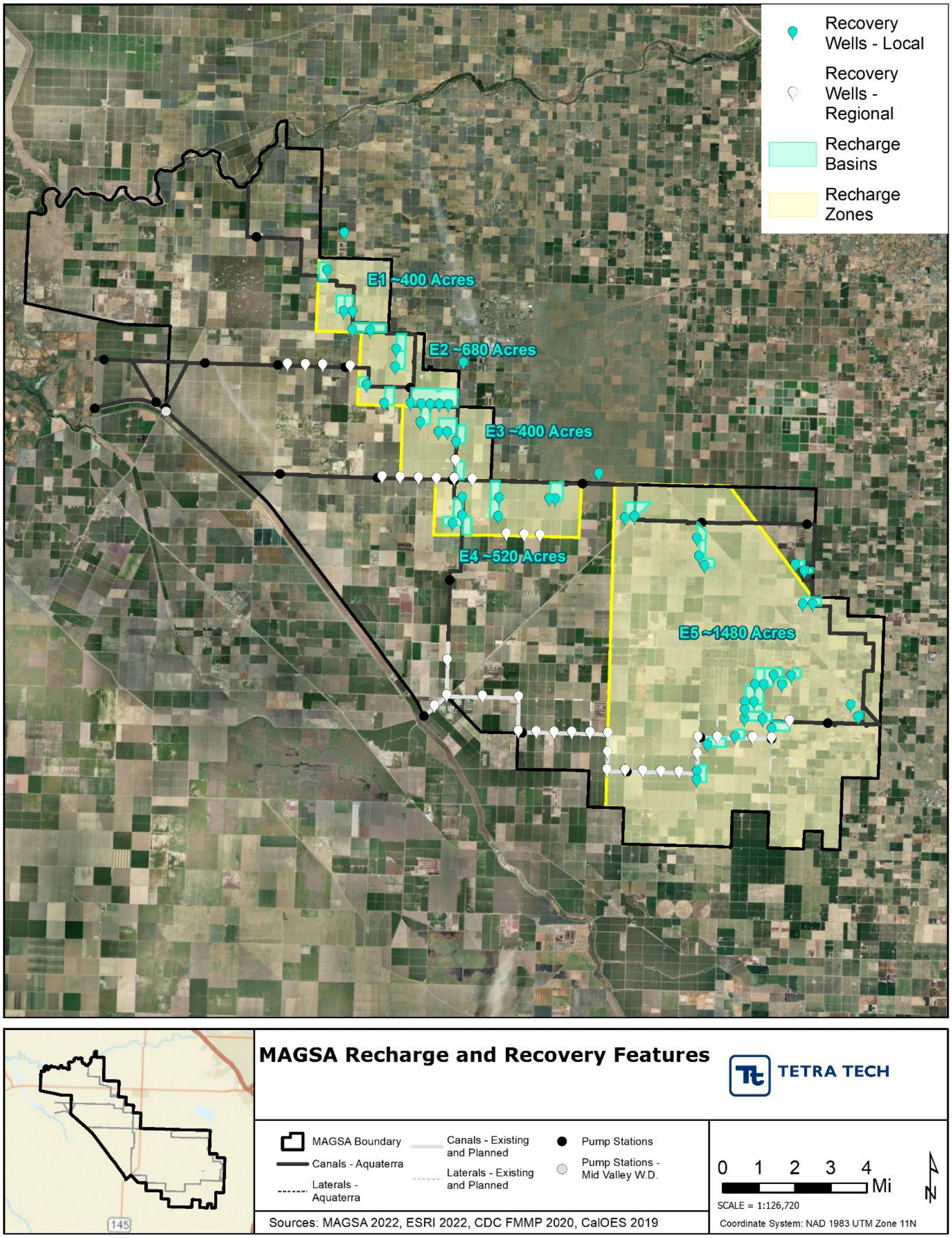


Figure 1-9. Recharge Basins and Local and Regional Recovery Wells

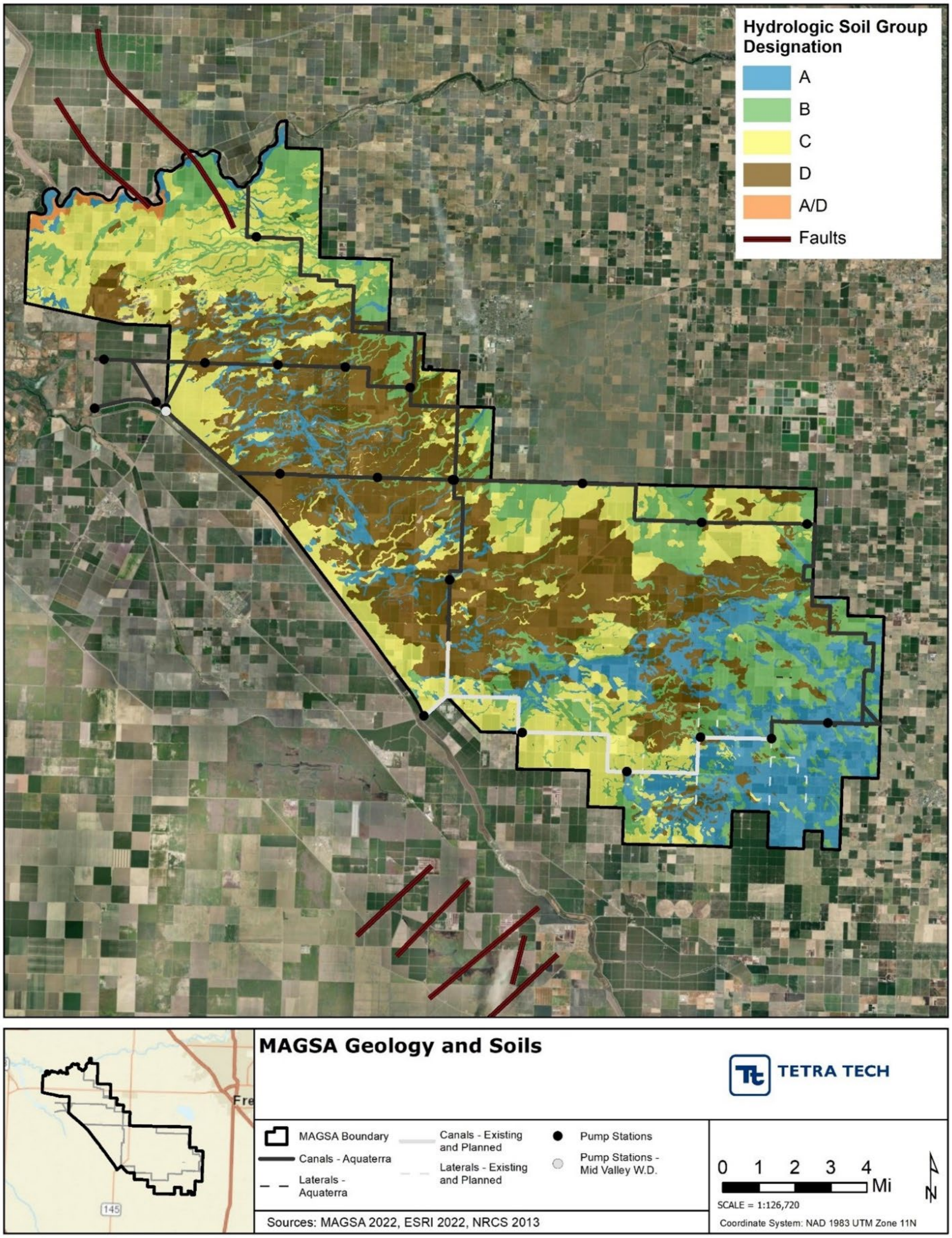


Figure 1-10. Hydrologic Soils Groups A (20,000 acres) and B (24,000 acres)

To protect groundwater quality and to minimize other disturbances to the region, recharge land locations were reviewed for areas with a potential to affect water quality. These areas include ecological preserves, future planned housing developments, townships (e.g., Raisin City), areas with potential soil or groundwater contamination (e.g., the regional landfill, Raisin City oil field, and current or past concentrated animal feed operations). Current or former industrial or maintenance sites are more likely to have broader and more concentrated soil contaminants such as pesticides, fertilizers, heavy metals, hydrocarbons, and animal wastes. Recharge basins will be situated to minimize the potential to transport these constituents to groundwater or mobilize these constituents in existing groundwater.

The Aquaterra Groundwater Bank Feasibility Study (MAGSA 2022) and the McMullin Phase 1 Flood Flow Capture Plan (FFCP, Bachand et al. 2022b, Appendix 1) provide information and guidance regarding locating, managing, and operating recharge basins, including on active farmlands.

Ownership and Agreements. Recharge will primarily be implemented on private farmlands, ensuring groundwater allocations associated with those lands remain with the landowner. Recharge basins will be under easements and agreements that will require the acceptance of banking water when that water is available.

Multi-Benefit and Associated Design and Operations Requirements. Recharge will be the primary use for the recharge basins and that primary use will be reflected in the design and operations of the recharge basins. Recharge basin operations are expected to allow farming opportunities outside the anticipated recharge schedule, primarily during the normal irrigation season. Compatible farming could include annual crops, such as tomatoes, carrots, alfalfa, and grasses. Farming operations will depend upon farmer needs and decisions. Management practices will be developed to ensure farming operations, if conducted, do not compromise recharge operations and performance.

Decisions regarding using the recharge basins for other uses to provide multiple benefits will be made in discussions with landowners and incorporated into design and operations as appropriate. Outcomes will be consistent with the goals and efforts of MAGSA and its partners.

Mosquito Control. The recharge basins may require measures for mosquito control. These measures could include varying water levels and having periods of draw down to interfere with mosquito breeding patterns, and seasonal introduction of fish to prey on mosquitos. Several Fresno County Mosquito Abatement Districts cover area within MAGSA (Consolidated Mosquito Abatement District, Fresno Mosquito and Vector Control District, Fresno Westside Mosquito Abatement District). Recharge basins will be operated in accordance with their recommendations to manage mosquitos.

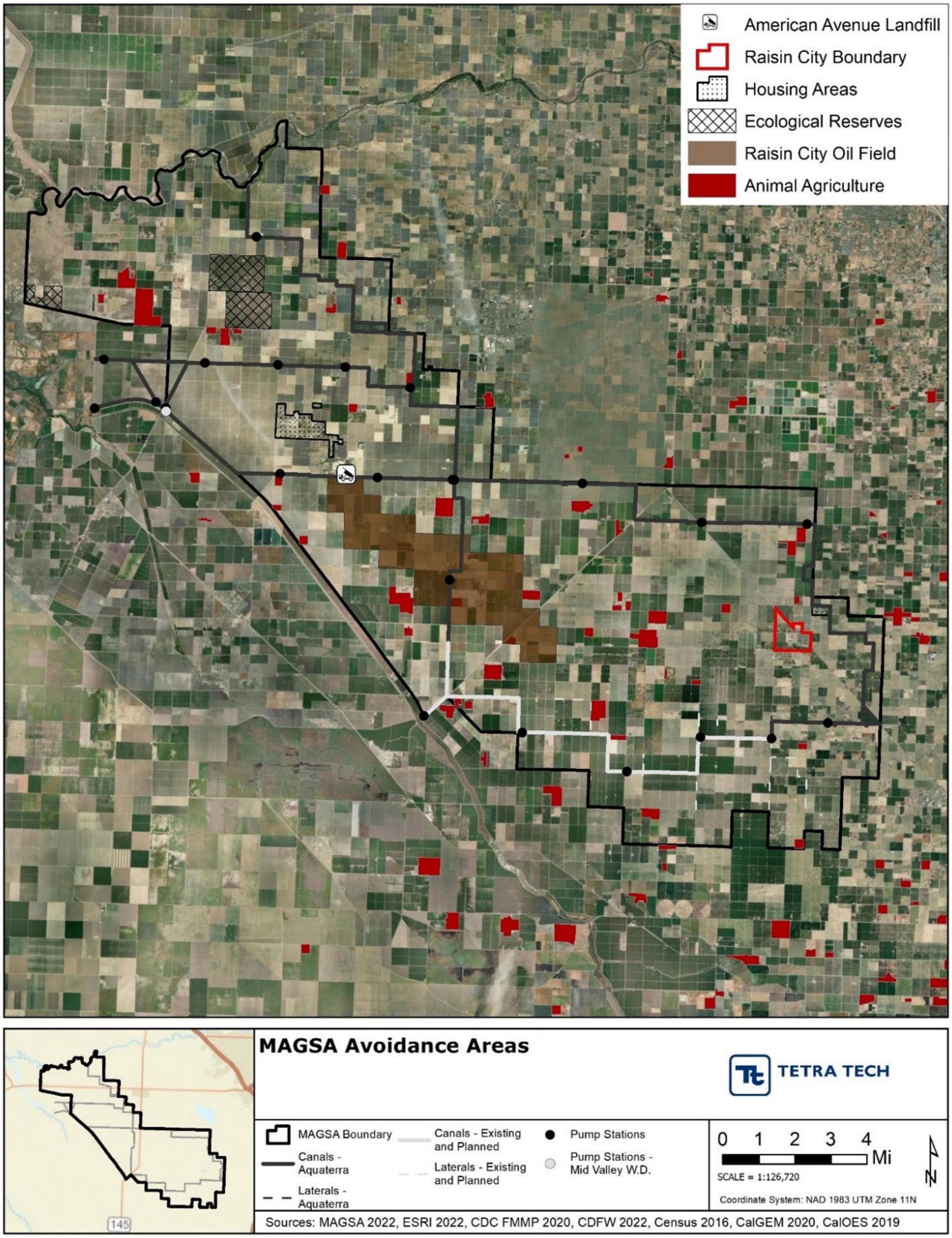


Figure 1-11. Avoidance Areas

Recovery Wells, Infrastructure and Easements

Nearly 90 electric recovery wells with a design capacity of 2,500 GPM will be installed to enable an extraction rate of 148,000 AFY (Table 1-1). These wells will return contract water back into the CVP/SWP system for banking partners (MAGSA 2022). Recovery wells have been distributed within MAGSA into two groups, which include local recovery wells and regional recovery wells. Figure **1-9** shows the well distribution.

Local recovery well placement. Local recovery wells will be installed to capture water at or near recharge basins to extract locally recharged water. These wells will be installed at the downstream groundwater gradient within the recharge basin footprint and included in any easements and agreements on that property.

Regional recovery well placement. Regional recovery wells will be installed to capture recharged contract water that has extended beyond the footprint of the recharge basin and beyond the zone of influence for the local recovery wells. The goals of the regional recovery well systems will be to capture groundwater that has moved beyond the local footprints of recharge basins and to control groundwater flows to manage potential effects, such as water quality impacts associated with past and current land uses and regional hydrology impacts. The groundwater hydrology report (Appendix 2) describes expected mounding during recharge periods that will raise local groundwater elevations up to 100 feet under recharge basins. During the spreading process and in consideration of the groundwater gradient, some portion of the recharged water may extend outside the influence of local recovery wells and travel along groundwater gradients. The regional recovery wells will generally be located about ½ mile apart along the main conveyance corridors to capture groundwater flowing along the groundwater gradient.

Well depths. The typical depths of recovery wells will range from approximately 300 to 600 feet below ground surface (bgs), with an expected average depth of 450 ft. All wells will be screened in the unconfined layer above the Corcoran Clay. The Corcoran Clay layer ranges from 300 to 700 ft deep throughout MAGSA, with shallower depths on the eastern side than the western side.

Monitoring Wells

A groundwater monitoring well network consisting of 80-90 percent 100 to 200 ft deep shallow monitoring wells and 10-20 percent as 400 to 600 ft deep monitoring wells will be installed. All wells will draw from the unconfined layer above the Corcoran Clay. Groundwater monitoring wells will be placed to fulfill the following Project requirements and needs:

- Deep and shallow nested wells will enable MAGSA to monitor water quality groundwater gradients, transport, and mixing across groundwater depths;
- Placement along the main conveyance corridors will enable tracking of groundwater transport, elevation changes, and water quality effects in response to basin recharge and well recovery actions, and inform measures needed to mitigate potential impacts and maximize operations;
- Provide operations decisions as related to managing groundwater levels and energy needs associated with groundwater pumping;
- Allow monitoring of groundwater elevations, groundwater gradients and groundwater flow response towards or away from areas of interests (e.g., MAGSA jurisdictional boundaries, recharge zones boundaries, San Joaquin River, oil field, Raisin City Water District); and,
- Provide information and data to calibrate the Operational Model and help in its development as a planning and validation tool.

Approximately 60 private monitoring wells are estimated for the Project with the final number to be determined based upon operational needs.

1.4.4 Construction

Construction will require obtaining permits and approvals, establishing a schedule, and managing construction logistics including heavy equipment usage, staging areas, soil management, and building materials.

Construction Permitting and Approvals

Project construction and operation will require coordination, consultation and permits from multiple agencies with jurisdiction for various aspects of the Project. An important element of this process is federal recognition and acknowledgment of the Bank by Reclamation as a groundwater bank, which will allow CVP contractors to take delivery of their water at the bank. Water banking and returning practices will be consistent with California and Federal law, including State of California authorized places-of-use as permitted or licensed. Reclamation is performing a separate NEPA analysis for this project.

Project and Construction Schedule

Construction is planned to begin in 2024 and be completed in 2027. Recharge facilities for banking partners are planned to become available in 2024 and recovery planned to become available in 2025.

Construction Logistics

Preliminary planning identifies typical heavy equipment required for installation of the various facilities to include various heavy equipment (e.g., cranes, drill rigs, excavators, backhoes, graders, concrete trucks, dump trucks, loaders and bulldozers). Table 1-8 shows an estimate of heavy equipment required for conveyance, recharge and recovery construction duration. The calculations estimate approximately 4,700 heavy equipment weeks over a 3-year construction period, equivalent to 1,560 heavy equipment weeks each year and 30 pieces of heavy equipment typically being used simultaneously. Most construction machinery would be used on site.

Five-acre construction staging areas will be identified along the canal system with collaboration and written permission from landowners. One-acre staging areas are anticipated to be required near each pump station. Staging areas would be situated a sufficient distance from Raisin City and other populated areas to avoid nuisances to residents.

All soil excavation will be balanced such that excavated soils equal needed fill. A balanced design will ensure no soil will be imported or exported. Any excess soil will be moved from the excavation areas to on-site disposal areas, such as adjacent farmlands, with scrapers or 16-yard dump trucks.

Building and construction materials are assumed to be locally available from Fresno or neighboring areas with assumed one-way mileage of 20 miles. Building and construction materials will include concrete, steel, and wood, as well as PVC and electrical items. Riprap may be needed for canal slope protection.

Table 1-8. Estimated Heavy Equipment Requirements

Project Element	Duration				Expected Equipment Utilized [2]											Pieces of heavy equipment in operation in parallel	Heavy Equipment Weeks
	Estimated weeks per project element [(1)]	per unit of	# of units within element [(2)]	Total calculated duration (weeks)	Crane	Drill Rig	Backhoe	Excavator	Grader	Concrete Truck	Scraper	Compactor	Dump truck	Loader	Bulldozer		
Pump Stations																	
Pump Stations	14	location	18	252	x		x	x		x		x				3	756
Road Crossings																	
Paved Road Crossings (Box Culverts)	14	location	17	238	x			x				x	x	x	x	2	476
Railroad Crossings	14	location	2	28	x			x				x	x	x	x	2	56
Paved Road Crossings (Jack and Bore)	14	location	8	112	x			x				x	x	x	x	2	224
Farm Road Pipe Culverts	4	location	56	224	x			x				x	x	x	x	2	448
Subtotal				602													1,204
Main Conveyance Canal																	
Main Conveyance Canals	3	mile	63.5	191				x	x		x	x				4	762
Subtotal																	762
Recharge Elements																	
Recharge Basins	14	basin	51	714			x		x		x	x	x	x	x	2	1,428
Subtotal																	1,428

Recovery Well Elements																	
Recovery Wells	3	well	88	264	x	x			x	x			x	x	x	2	528
Summary																	
Total Heavy Equipment Weeks																	4,678
Years of Construction																	3
Estimated Heavy Equipment Weeks per Year																	1,559
Estimated Heavy Equipment in Operation in parallel																	30

Notes:

[1] Based upon best engineering estimate.

[2] Numbers based upon current design. Some changes may occur during final design and construction

1.4.5 Operations and Maintenance

This section describes how the Bank will be operated and maintained. The Bank will be managed by monitoring hydrologic and water quality data and by planning, tracking, and projecting through an Operational Model. These efforts are described in detail in Appendix 3.

The Bank will receive surface water from, and deliver water to, the Fresno Slough and the hydraulically connected Mendota Pool. Diversions from the Mendota Pool are planned for November through March. The maximum diversion rate is 770 CFS (MAGSA 2022). The James Bypass has a design capacity of 4,750 CFS. Historical data from the James Bypass upstream of the Mendota Pool and during periods of flood releases show 75 percent of the bypass flows in March are below 4,000 CFS with over 80 percent of flows below 4,000 CFS between November and March. The Bank operators will limit diversions from, and discharge to, the Mendota Pool in consideration of upstream flood flow releases and Mendota Pool operational requirements. For instance, limiting Bank operations to occur when flood releases are at or below 4,000 CFS will enable the Bank to operate within the design capacity of the James Bypass.

During recharge opportunity years, the diverted water will be infiltrated to the underlying aquifer through 3,500 acres of farmland used as recharge basins. The historical data suggests recharge opportunities will occur in about 46 percent of years and recovery opportunities in 42 percent of years, typically below the maximum design capacities. Surface water hydrology under recharge conditions is shown in Figure 1-12.

During recovery opportunity years, approximately ninety recovery wells within MAGSA will be used to withdraw water from the Bank for return to partners. Annual recovery will occur from May through September up to a maximum annual recovery of 148,000 AF. Contractors will receive water either directly from the Mendota Pool through the DMC or through direct connections to their distribution facilities (MAGSA 2022). Surface water hydrology under recovery conditions is shown in Figure 1-13.

Table 1-1 summarizes the maximum recharge and recovery water volumes that can be served by the Bank and the CVP/SWP infrastructure capacity (MAGSA 2022) and the periods those actions can occur. As part of Bank operations, 10 percent of contract water deposited for storage in the Bank will be left behind. Locally, this water will help to replenish the over-drafted aquifer and raise the water table.

Recovered groundwater will be returned to the Mendota Pool, where it will be returned to banking partners through exchange with other existing water users, either within Mendota Pool or by making an equivalent amount available at San Luis Reservoir. Recovery would be limited by the ability to perform exchanges with Mendota Pool water users, which would be feasible from May through September. Participants will generally have priority access to banking recharge and recovery facilities, with MAGSA having secondary access to those facilities for its own uses on an as-available basis.

All elements of the bank will need routine maintenance. General maintenance practices throughout the project will include weed abatement, trash removal, periodic sediment removal, levee and berm upkeep, pump and equipment maintenance and repairs, and water control structure adjustments. Occasionally, service employees may be on-site for scheduled, preventative maintenance as well as unscheduled service, especially at key monitoring and control locations. Maintenance actions will be logged as part of an Operations and Maintenance Plan.

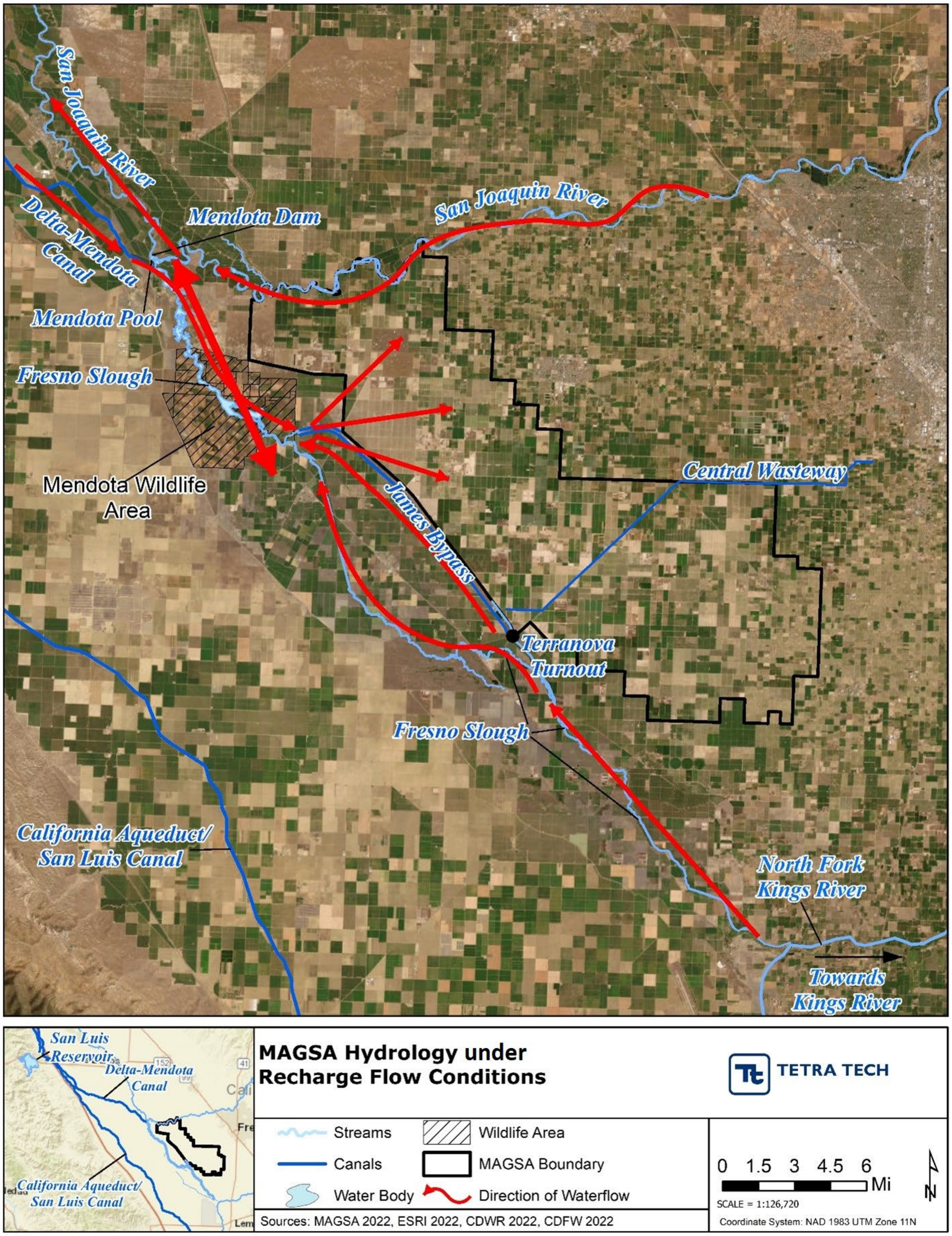


Figure 1-12: MAGSA Hydrology under Recharge Flow Conditions

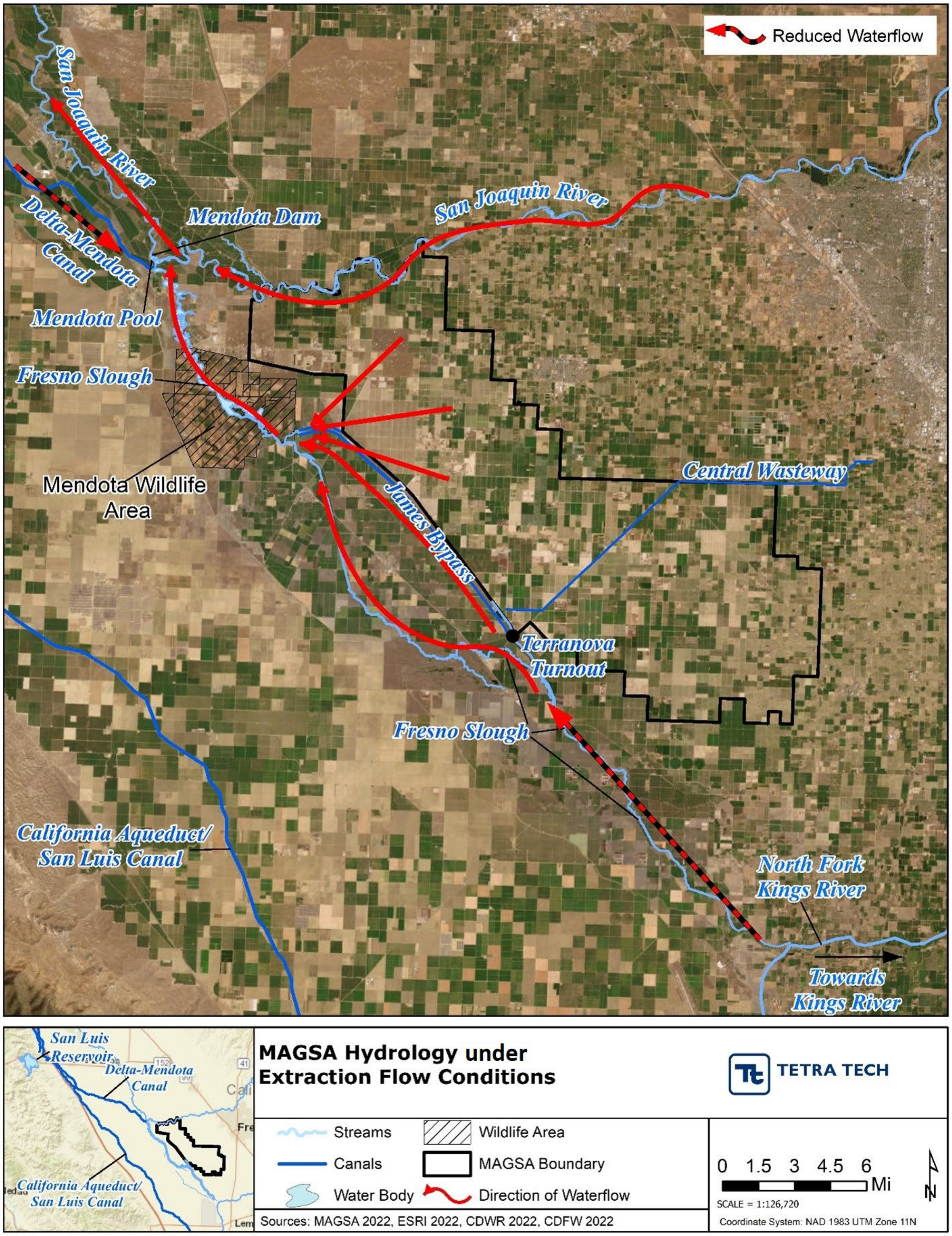


Figure 1-13: MAGSA Hydrology under Extraction Flow Conditions

1.4.6 Monitoring

MAGSA has developed a robust program to monitor and manage groundwater quality, groundwater, and surface water movement, import and export of drinking water constituents to and from the Mendota Pool, and movement of legacy groundwater constituents. Monitoring considerations, processes, and mitigation options are addressed in detail in the project water quality report (Appendix 3).

1.4.7 Governance, Ownership, and Partner Relationships

MAGSA will develop agreements with water banking partners. MAGSA will retain complete ownership of any project facilities and hold the water that is stored in the aquifer in trust for the banking partners. As such, MAGSA will be responsible for the project execution, meaning all permits, environmental documentation, design, construction, land acquisition, and other responsibilities to develop a functioning project. The banking partners will review and agree to contracts and costs as they are developed and prior to MAGSA entering into any agreements.

MAGSA will form a Management Committee to advise on the development, operation, monitoring, and management of the Project. The Management Committee will report to MAGSA and will include membership by water banking partners, local agencies, and area landowners.

The Management Committee will help in planning, development and implementation (e.g. bank Standard Operating Procedures, fee structures, integrating operations with local, regional, and statewide operations; groundwater monitoring and management strategies).The Management Committee will also provide regular reviews and recommendations (e.g., annual operations review, recommendations regarding bank operations, identification and discussion of regional effects or consideration) to ensure the water bank operation is minimizing and mitigating potential hydrologic, water quality or other potential impacts.

2 MITIGATION MEASURES

The following mitigation measures will be incorporated into the program to reduce any potential impacts to a less-than significant level.

2.1 AIR-1) PREPARE AND IMPLEMENT A FUGITIVE DUST CONTROL PLAN

MAGSA will prepare and implement a Fugitive Dust Control Plan (DCP) consistent with SJVAPCD's *Regulation VIII Fugitive Dust Prohibitions*. The DCP shall be submitted to and approved by the SJVAPCD prior to issuance of construction/grading permits. Fugitive dust control measures to be included in the DCP shall include, but are not limited to, the following:

a. All disturbed areas, including storage piles, which are not being actively utilized for construction purposes, shall be effectively stabilized of dust emissions using water, chemical stabilizer/suppressant, covered with a tarp or other suitable cover or vegetative ground cover.
b. All on-site unpaved roads and off-site unpaved access roads shall be effectively stabilized of dust emissions using water or chemical stabilizer/suppressant.
c. All land clearing, grubbing, scraping, excavation, land leveling, grading, cut & fill, and demolition activities shall be effectively controlled of fugitive dust emissions utilizing application of water or by presoaking.
d. When materials are transported off-site, all material shall be covered, or effectively wetted to limit visible dust emissions, and at least six inches of freeboard space from the top of the container shall be maintained.
e. All operations shall limit or expeditiously remove the accumulation of mud or dirt from adjacent public streets at the end of each workday. (The use of dry rotary brushes is expressly prohibited except where preceded or accompanied by sufficient wetting to limit the visible dust emissions.) (Use of blower devices is expressly forbidden.)
f. Following the addition of materials to, or the removal of materials from, the surface of outdoor storage piles, said piles shall be effectively stabilized of fugitive dust emissions
g. Utilizing sufficient water or chemical stabilizer/suppressant.
h. An owner/operator of any site with 150 or more vehicle trips per day, or 20 or more vehicle trips per day by vehicles with three or more axles shall implement measures to prevent carryout and trackout.

2.2 AIR-2) MINIMIZE PERSONNEL AND PUBLIC EXPOSURE

To minimize personnel and public exposure to potential Valley Fever–containing dust both on- and off-site, the following additional control measures shall be included in the DCP to be prepared for this project as required by Mitigation Measure AQ-1:

a. Equipment, vehicles, and other items shall be thoroughly cleaned of dust before they are moved offsite to other work locations.
b. Wherever possible, grading and trenching work shall be phased so that earth-moving equipment is working well ahead or down-wind of workers on the ground.
c. The area immediately behind grading or trenching equipment shall be sprayed with water before ground workers move into the area.
d. In the event that a water truck runs out of water before dust is sufficiently dampened, ground workers being exposed to dust are to leave the area until a full truck resumes water spraying.

e. All heavy-duty earth-moving vehicles shall be closed-cab and equipped with a HEP-filtered air system.
f. Workers shall receive training to recognize the symptoms of Valley Fever, and shall be instructed to promptly report suspected symptoms of work-related Valley Fever to a supervisor.
g. A Valley Fever informational handout shall be provided to all on-site construction personnel. The handout shall, at a minimum, provide information regarding the symptoms, health effects, preventative measures, and treatment.
h. Onsite personnel shall be trained on the proper use of personnel protective equipment, including respiratory equipment. National Institute for Occupational Safety and Health (NIOSH)-approved respirators shall be provided to onsite personal, upon request.

2.3 AIR-3) Implement Vehicle Emissions Controls

1. To the extent locally available, alternative fueled, electric, hybrid, or catalyst construction equipment will be used during construction.
2. On-site mobile equipment will be equipped with PM_{10} pollution control devices and/or newer, less polluting equipment will be required (either lower emissions diesel or alternative fuels engines).
3. Heavy-duty (50 hp, or greater) off-road construction equipment shall, at a minimum, meet U.S. EPA Tier 3 emission standards.
4. On-site equipment will utilize aqueous diesel fuel.
5. The construction contractor will comply with all current and future Regulation VIII rules.
6. Diesel engines will be shut off when not in use for more than 5 minutes to reduce emissions from idling.

2.4 BIO-1) General Measures

GM #1. A Worker Environmental Awareness Program (WEAP) will be incorporated into the Project to ensure that all construction personnel are informed about the special status and sensitive biological resources known to occur in and/or adjacent to the Project area. A qualified biologist shall conduct a WEAP training session for construction workers prior to any Project construction activities. Trainings will be documented and kept on file.

GM #2 Environmentally sensitive areas will be protected from encroachment by construction workers and heavy equipment by orange construction fencing and will be designated as such on the construction plans.

GM #3. Working hours will be confined to daylight hours (sunrise to sunset) unless otherwise necessary to assess or protect biological resources or remain in compliance with local ordinances.

GM #4. Construction workers must limit personal vehicle and construction heavy equipment speeds to 20 miles per hour in the Project area and immediate vicinity.

GM #5. No pets will be allowed in the Project area or immediate vicinity.

2.5 BIO-2) Protect and Preserve Giant Garter Snake

Habitats that are permanently or seasonally flooded and contain herbaceous wetland vegetation such as cattails and bulrushes occur within and adjacent to the Project area. Even unmaintained irrigation canals can substitute as marginally suitable habitat for giant garter snake (GGS) and may occur within the Project area. Areas with excessive shade, lack of basking sites, and absence of GGS prey are not considered suitable habitat.

To protect and preserve the GGS, to avoid any impacts to it or its habitat, and to meet CDFW and USFWS requirements, the following preventative measures shall be incorporated into the Project.

GGS #1. A qualified biologist will flag and designate avoided GGS habitat within or immediately adjacent to the project area as Environmentally Sensitive Areas to be avoided by all construction personnel and equipment.

Escape routes for GGS should be determined in advance of construction and snakes will be allowed to leave on their own.

Construction activities within 200 feet from the banks of GGS aquatic habitat will be avoided to the greatest extent possible.

GGS #2. Clearing will be confined to the minimal area necessary to facilitate construction activities.

Movement of heavy equipment will be confined to existing roadways to minimize habitat disturbance.

Construction-related holes will be covered to prevent entrapment of individuals.

GGS #3. If temporary giant garter snake habitat disturbance is necessary, then 24-hours prior to construction activities, the project area will be surveyed for GGS by a qualified biologist. Survey of the project area will be repeated if a lapse in construction activity of two weeks or greater has occurred.

Construction activity within habitat will be conducted between May 1 and October 1. This is the active period for giant garter snakes and direct mortality is lessened, because snakes are expected to actively move and avoid danger.

Any dewatered habitat will be required to remain dry for at least 15 consecutive days after April 15 and prior to excavating or filling of the dewatered habitat. Sightings or incidental take will be reported to the USFWS and CDFW immediately.

GGS #4. During post-construction restoration, the MAGSA contractor will remove any temporary fill and construction debris and restore temporarily disturbed areas to pre-project conditions. If erosion control materials are installed in suitable habitat for GGS, then only non-entangling erosion control materials (no monofilament) will be used to reduce the potential for entrapment. This limitation will be communicated to the contractor through use of special provisions included in the bid solicitation package.

2.6 BIO-3) Protect and Preserve Tricolored Blackbird

Within the Project area, potential tricolored blackbird (TCB) nest sites are often associated with freshwater marsh or thistle thickets and other thorny vegetation, and TCBs may forage in agricultural fields (such as large tracts of alfalfa or dairies). To protect and preserve the TCB, to avoid any impacts to it or its habitat, and to meet CDFW requirements, the following preventive measures shall be incorporated into the Project during construction activities.

TCB #1. If a Project activity is anticipated to occur in potential TCB habitat or habitat is present within 500 feet of the Project footprint, then an approved biologist will conduct a field investigation to determine if existing or potential nesting or foraging sites are present within the project footprint and adjacent areas within 500 feet. Nesting sites shall be noted on plans.

TCB #2. Pre-construction surveys will be required to determine if active nests are present within a project footprint or within 500 feet of a project footprint if existing or potential nest sites were found during design surveys and construction activities will occur during the breeding season (March 1 through September 15). An approved biologist will conduct pre-construction surveys within 30 days and within 3 days of ground-disturbing activities, and within the proposed Project footprint and 500 feet of the proposed Project footprint to determine the presence of nesting tricolored blackbird. Pre-construction surveys will be conducted during the breeding season (March 1 through August 31).

TCB #3. a. If active nests are found within the Project construction footprint, the MAGSA contractor will establish a 500-foot temporary buffer around the active nest until the young have fledged.

b. An approved biologist experienced with TCB behavior will be retained by the MAGSA contractor to monitor the nest throughout the nesting season and to determine when the young have fledged. The approved biologist will be on site daily while construction-related activities are taking place near the disturbance buffer. Work within the nest disturbance buffer will not be permitted. If the approved biologist determines that tricolored blackbirds are exhibiting agitated behavior, construction will cease until the buffer size is increased to a distance necessary to result in no harm or harassment to the nesting tricolored blackbirds.

2.7 BIO-4) Protect and Preserve Waters of the U.S. and Waters of the State

To protect and preserve waters of the U.S. habitats, to avoid and lessen any potential impacts, and to meet CDFW, USACE, and RWQCB regulatory requirements, the following preventive measures shall be incorporated into the project.

WUS #1. As the design for conveyance system alignments and associated Project infrastructure continues to be developed, the project team including wetland and permitting specialists, will avoid direct impacts to wetlands to the extent possible. Where avoidance is not possible, impacts will be minimal and concentrated to previously impacted areas.

WUS #2. If additional construction is required in areas not within the 2022 ARD review area, then an additional ARD shall be conducted if necessary to evaluate and quantify wetlands and/or other waters of the State of California and/or U.S. which may be impacted by the additional construction. A resulting ARD report will quantify the acreage of wetlands or other waters which will be impacted and thus, the acreage to be permitted by the resource and regulatory agencies. The evaluation will also aid the consultants and USACE in determining the type of permit and the permitting process to follow if needed.

2.8 BIO-5) Protect and Preserve the Burrowing Owl

California ground squirrel burrows are dispersed throughout the Project area and may offer some suitable nesting/denning habitat for burrowing owls. Earthwork performed with heavy equipment during project construction has the potential to destroy this habitat type and/or harm retreating owls.

To protect and preserve the burrowing owl, to avoid any impacts to it or its habitat, and to meet CDFW requirements, the following preventive measures shall be incorporated into the Project.

BO #1. A protocol burrowing owl survey shall be conducted to ensure that no owls nest on or adjacent to the Main Canal alignment. The surveys shall be conducted four times in the winter and five times during the February through July period as per the guidelines (CBOC 1997).

BO #2. If an owl is found, the CDFW shall be consulted and MAGSA shall select one or more of the following possible measures for implementation by a qualified biologist.

- Redesign the Project temporarily or permanently to avoid occupied burrows or nest sites until after the nesting/fledgling season (February 1 through August 31).
- Delay the Project until after the nesting/fledgling season (March 1 through August 31).
- Install artificial burrows in open-space areas of or near the Project area and wait for passive relocation of the burrowing owl.
- Active relocation of burrowing owl with conditions. MAGSA shall fund the relocation of burrowing owls to unoccupied, suitable habitat which is permanently preserved (up to 6.5 acres per nesting pair). Details and requirements are specified in CDFW (2012).
- Though not endorsed by the CDFW, if other measures are possible and can be successful, ensure that potential burrows are vacant, and destroy vacant burrows prior to February 1 and/or after August 31.

2.9 BIO-6) Protect and Preserve Swainson's Hawk

To protect and preserve the Swainson's hawk, to avoid any impacts to it and its habitats, and to meet CDFW and USFWS requirements, the following measures shall be incorporated into the Project.

SH #1. a. Swainson's hawk nest trees should not be removed.

b. To the extent feasible, construction activities shall be started during the non-nesting season of September 1 through January 31 when Swainson's hawks are gone from California and have migrated to their wintering grounds in Mexico and South America. Thus, Swainson's hawk will not be in the project vicinity and thus will not be disturbed by the project.

SH #2. If construction must occur during the nesting season, a preconstruction survey shall be conducted by a qualified biologist for hawks and their nests within a one-half mile radius of the construction area prior to construction. Surveys should be performed within 30 days prior to the onset of construction.

SH #3. If an active Swainson's hawk nest is found within a one-half mile radius of the Project area, the biologist will establish a half-mile buffer around the nest, or as needed to adequately protect the nest in the context of the actions planned at that location. The buffer will be identified by placing flags and stakes around the perimeter and will remain in place until the biologist has determined that all young have fledged.

2.10 BIO-7) Protect and Preserve Nesting Birds

Although no trees will be removed by the Project, potential nesting trees associated with the settlement areas occur scattered throughout the project area. Swallow nesting habitats and ground nesting shall also be considered.

To protect and preserve nesting birds and their nests, to avoid any impacts to them and their nests, and to meet CDFW and USFWS requirements, the following preventive measures shall be incorporated into the project.

NB #1. Prior to any construction activities on the project area during the nesting season (February 1 through August 31), a preconstruction (one-day) survey shall be conducted by a qualified biologist for nesting birds within a minimum of a 250-foot radius around project activities. Results of the preconstruction survey shall be prepared in a letter and given to MAGSA prior to any construction activities. If no nests are observed, project construction activities can proceed without additional nesting bird measures.

NB #2. If any active nests are observed, the nests shall be designated as an Environmentally Sensitive Area with buffer zones determined by a qualified biologist to be protected and avoided (while occupied) during the construction activities. CDFW shall be contacted, consulted, and avoidance measures, specific to each incident, shall be developed in cooperation with the project biologist.

2.11 BIO-8) Protect and Preserve San Joaquin Kit Fox

To protect and preserve the SJKF, to avoid any impacts to it or its habitat, and to meet CDFW and USFWS requirements, the following preventive measures shall be incorporated into the Project during construction activities.

KF #1. The USFWS's Standardized Recommendations for the Protection of the San Joaquin Kit Fox Prior to or During Ground Disturbance (USFWS 2011) will be incorporated into the Project and shall be implemented to avoid potential impacts to SJKF.

KF #2. A check for and monitoring of potential kit fox dens (squirrel burrows) along the Main Canal alignment shall be conducted for three consecutive nights to evaluate SJKF use as per the USFWS 2011 guidelines (USFWS 2011). A report on the findings will be prepared. Vacant squirrel holes will be filled by hand after the survey by a qualified biologist to prevent future use by and future impacts to the SJKF.

KF #3. A preconstruction (one-day) survey shall be conducted by a qualified biologist to examine potential dens (squirrel burrows) on and immediately adjacent to the Project area for the existence of SJKF. The survey shall be conducted within 30 days prior to any construction activities. Results of the preconstruction survey shall be prepared in a letter and given to MAGSA prior to any construction activities.

KF #4. If a SJKF den is found, the CDFW and USFWS shall be immediately consulted, and appropriate avoidance measures shall be developed in cooperation with the qualified Project biologist and MAGSA.

2.12 CUL-1: Worker Environmental Training

Prior to the initiation of construction of the project, a Secretary of Interior qualified archaeologist will be retained and will provide a cultural resource briefing to all construction workers. The briefing will include discussion of all applicable laws and penalties pertaining to disturbing cultural resources, a brief discussion of the prehistoric and historic regional context and archaeological sensitivity of the area, types of cultural resources found in the area, and instruction that project workers will halt construction if a cultural resource is inadvertently discovered during construction. The archaeologist will discuss procedures to follow in the event an inadvertent discovery is encountered, including appropriate treatment and respectful behavior of a discovery (e.g., no posting to social media or photographs). The consulting tribes will provide a representative to participate in the environmental training to discuss or provide input from a tribal cultural perspective regarding the potential cultural resources within the region (as applicable). After the training, all personnel will be given a worker education/training brochure regarding identification of cultural resources and protocols for reporting finds. Any employee beginning work following the initial worker education/training secession must also receive commensurate cultural, tribal, and archaeological resources sensitivity training (via a power point presentation or handout) and will be provided the brochure.

2.13 CUL-2: Cultural Resource Monitoring and Inadvertent Discovery Plan

A Secretary of Interior qualified archaeologist shall be retained on-call and shall prepare a Monitoring and Inadvertent Discovery Plan for the project which includes appropriate Monitoring and Inadvertent Discovery Procedures. The Plan shall be prepared and approved prior to the initiation of construction. The Plan shall include (but not limited to): monitoring schedule, project ground disturbing activities and areas that require a cultural resource monitor, monitoring procedures, stop work and notification procedures in the event of an inadvertent discovery, treatment for an inadvertent discovery, reporting, and final monitor reporting. During project-level construction, should subsurface archaeological resources be discovered, all activity in the vicinity of the find (and 100-foot buffer) shall stop. The qualified archaeologist shall be contacted to assess the significance of the find according to CEQA Guidelines Section 15064.5 and/or NRHP criteria (as applicable). In addition, the lead representative for the consulting tribes will be notified (as applicable). If any find is determined to be significant, the archaeologist shall determine, in consultation with the implementing agencies and consulting Native American group(s) expressing interest, appropriate avoidance measures or other appropriate mitigation. Under CEQA Guidelines Section 15126.4(b)(3), preservation in place shall be the preferred means to avoid impacts to significant tribal cultural resources (as defined by PRC 21074), and archaeological resources qualifying as historical resources. Methods of avoidance may include, but shall not be limited to, project reroute or re-design, project cancellation, or identification of protection measures such as capping or fencing, PRC 20184.3(b)(2) provides examples of mitigation measures that lead agencies may considered to avoid or minimize impacts to tribal cultural resources. Consistent with CEQA Guidelines Section 15126.4(b)(3)(C), if it is demonstrated that resources cannot be avoided, the qualified archaeologist shall develop additional treatment measures, such as data recovery or other appropriate measures, in consultation with the implementing agency and any local Native American representatives expressing interest in prehistoric or tribal resources. If an archaeological site does not qualify as an historical resource but meets the criteria for a unique archaeological resource as defined in Section 21083.2, then the site shall be treated in accordance with the provisions of Section 21083.2. Federal law and California state law requires that all project excavation activities halt if human remains are encountered and the County Coroner must be notified. Any discovery of human remains during project-related activities would be treated in accordance with federal laws and PRC Section 5097.98 and Section 7050.5 of the State Health and Safety Code.

2.14 GEO-1: Certified Paleontologist

The project shall have a certified paleontologist, who meets the standards of SVP, on call to evaluate excavated material for paleontological significance. If the paleontologist makes a paleontologically significant discovery, all construction will stop within 50 feet of the find. The paleontologist will evaluate the significance and recommend any appropriate treatment of the site. At each location where a fossil was found, the paleontologist will maintain all appropriate data forms; record pertinent geologic and stratigraphic data; take notes and photographs and map the location; collect and submit for analysis any necessary sediment samples; and ensure all records and data of the find are curated at an accredited institution. The paleontologist will prepare a report for any significant finds and submit to the appropriate entities, including Fresno County records.

2.15 HAZ-1: Prepare and Implement a Spill Prevention and Response Plan (SPRP).

To help avoid and minimize potential accidental spills during construction, a project specific SPRP would be prepared by the construction contractor prior to construction that conforms to applicable local, state, and federal requirements. The SPRP would be on site during construction and distributed to all workers and managers prior to construction. The SPRP shall include measures that ensure the safe transport, storage, use, and disposal of hazardous materials used or encountered during construction. The construction contractors shall be required to comply with the SPRP and applicable federal, state, and local laws. The project sponsor would provide compliance oversight. The plan shall outline measures for specific handling and reporting procedures for hazardous materials and disposal of hazardous materials removed from the site at an appropriate offsite disposal facility.

The federal reportable spill quantity for petroleum products, as defined in EPA's CFR (40 CFR 110), is any oil spill that 1) violates applicable water quality standards, 2) causes a film or sheen upon or discoloration of the water surface or adjoining shoreline, or 3) causes a sludge or emulsion to be deposited beneath the surface of the water or adjoining shorelines. If a spill is reportable, the construction contractor shall notify the project proponent who shall inform the applicable county agency and arrange for the appropriate safety and cleanup crews to ensure the spill prevention plan is followed. A written description of reportable releases must be submitted to the RWQCB and the applicable county agencies. This submittal must include a description of the release, including the type of material and an estimate of the amount spilled, the date of the release, an explanation of why the spill occurred, and a description of the steps taken to prevent and control future releases. The releases would be documented on a spill report form. If a spill has occurred, the applicant shall coordinate with responsible regulatory agencies to implement measures to control and abate contamination.

2.16 TRA-1: Prepare and Implement a Traffic Safety Plan.

The project proponent will require the construction contractor to prepare and implement a traffic safety plan before the onset of the construction phase. The traffic safety plan shall be reviewed and approved by the Fresno County Department of Public Works and Planning, Transportation Planning Division. The plan shall address:

- Appropriate vehicle size and speed,
- Travel routes,
- Detour or lane-closure plans,
- Flag person requirements,
- Locations of turnouts to be constructed,
- Coordination with law enforcement and fire control agencies,
- Coordination with California Department of Transportation personnel (for work affecting state road rights-of-way),
- Emergency access to ensure public safety, and
- Traffic and speed limit signs.

It shall also be specific in this plan that before beginning construction activities, the project proponent or the construction contractor shall contact local emergency-response agencies (Fresno County Sheriff and Fire Departments) to provide information on the timing and location of any traffic control measures required to complete the proposed project. Emergency response agencies will be notified of any change to traffic control measures as the construction phases proceed so that emergency-response providers can modify their response routes to ensure that response time would not be affected.

2.17 WAT-1: Recharge Basin Screening

The first flush of nitrate, salts and other constituents from the vadose zone could create local water quality challenges for the Bank and limit its flexibility. Selecting basins with lower expected legacy loading will help mitigate those challenges. A three-step program will be used to screen sites through 1) avoiding areas of particular concern, such as the Raisin City Oil Field; 2) selecting preliminary locations with low loading based on public crop and nutrient datasets and; 3) validating preliminary locations with 30 foot deep field cores. Samples from these cores will be tested for nitrogen species and TDS. Results will be used to select basin locations with lowest legacy loads.

2.18 WAT-2: Manage Import Water to the bank

Aquaterra will manage imported water quality by setting a water quality standard for imported water and monitoring imported water to assure it is meeting the standard. Use of a standard will result in higher quality import water diluting and improving the resident groundwater underlying MAGSA.

A default standard for Pump-in water will be equivalent to the Mendota Pool Group standard (Reclamation 2019). A more stringent water quality standard may be developed based on the current water quality at the O'Neil Forebay. Both standards will result in imported water with higher quality than existing groundwater. The more stringent standard will increase groundwater conditions more rapidly in MAGSA and allow more flexibility under future recovery pumping (Appendix 3, section 9.1.1) (Bachand et al., 2023b).

2.19 WAT-3: Recharge basin Employment and operations

Incremental introduction of recharge basins will reduce vadose zone first flush impacts by spreading it over time. A stepwise approach will avoid that issue with the incremental introduction of recharge basins, so that as a first flush completes and flush water becomes clean, another basin starts infiltrating. Continued use of recharge basins that have infiltrated more than 15-30 feet of water will be prioritized because it will result in improved groundwater quality. First flush will be tracked by measuring flow into the basins, and the groundwater quality underlying the basin or adjacent areas will be monitored to document completion of the first flush of constituents from the vadose zone.

2.20 WAT-4: Recovery Well Distribution and Design

The locations of recharge basins and extraction wells are designed to optimize the water quality of groundwater reaching potential users. Extraction wells will be located to limit groundwater flow into areas such as the oil fields, where it could hasten movement of existing plumes of degraded groundwater, potentially impacting other users. Extraction wells will be located a minimum of 500 meters downstream of basins to avoid first-flush impacts. The extraction wells will initially be situated in regions with higher quality groundwater, such as the eastern quarter of MAGSA, where groundwater meets Pump-in standards. This will allow high quality groundwater to be returned to contractors, even during the early first flush period.

2.21 WAT-5: Groundwater Monitoring And Export Water Standards

MAGSA will implement a groundwater monitoring program that **will** include a grid of monitoring wells spaced approximately 1 – 2 miles apart to accurately map groundwater quality and levels and track lateral groundwater movement. A subset of nested wells will be used to track water quality constituent concentrations with depth to avoid any negative impacts to domestic wells and to ensure recovery wells can access higher quality groundwater. Wells underlying and downstream of recharge basins will be used to monitor first flush of constituents, characterize flow paths, and plan for future groundwater recovery.

Real-time groundwater monitoring at recovery wells will be used to ensure water returned to the contractors and partners meets DWR Non-Project pump-in standards (DWR 2012). MAGSA will develop and comply with export water quality standards equivalent to standards developed by the Mendota Pool Group (Reclamation 2019). These standards will drive recovery operations such as temporary recovery well shutdown, permanent recovery well abandonment, adjusted recharge strategies, and mixing of recovered waters.

2.22 WAT-6. Compliance with Irrigated Lands Regulatory Program (ILRP)

Some recharge basins may be used for multiple uses, specifically farming and recharge. All farms in the Central Valley are regulated through the Central Valley IRLP, limiting their use of pesticides, fertilizers and salts. Farms participating in the banking program will implement practices that have been designed to integrate farming and recharge programs together as possible.

2.23 WAT-7. Stormwater Pollution Prevention Plan (SWPPP)

Because soil surface disturbance for the proposed project would be greater than one acre, specific erosion control measures will be identified as part of the CGP and SWPPP required for construction. The construction contractor will prepare an SWPPP that details measures to control erosion, contain sediments, and prevent turbidity and leakage of vehicle and equipment fluids during construction. The SWPPP will be approved by the Bank sponsors and ensure compliance with the plan throughout the construction process. Measures from the SWPPP will be incorporated into the contractor's work plan and will be implemented prior to groundbreaking. The Bank sponsors will comply with requirements, including preparation and implementation of the SWPPP and the NPDES General Permit for Stormwater Discharges from Construction and Land Disturbing Activities issued by the SWRCB.

2.24 WAT-8. Inspect Water Control Structures and Canals.

During initial operations each season, MAGSA will visually inspect all levees that protect infrastructure or surrounding buildings to ensure that there are no structural deficiencies that may lead to levee failure under normal operating conditions. The levees will be reinspected each year before flooding or after events which may damage levees, such as earthquakes. The inspectors will record the dates and locations of all levees inspected, any deficiencies identified, and remedial measures used to correct problems.

2.25 WAT-9. Develop and Implement Surface water Monitoring Plan

Surface water hydrology and water quality monitoring will be critical in real-time operational decisions and for regulatory requirements. Surface water monitoring will occur at key conveyance locations (e.g., import, export, operational nodes) and recharge basin locations. Monitoring will include real-time, telemetric monitoring of surface flows and levels to provide data for managing the distribution of surface waters through the Bank and alert water managers of potential levee or operational failures. The Water Quality Report, Section 10, provides an initial plan for monitoring during periods of recharge and recovery (Appendix 3).

2.26 WAT-10. Develop and implement Facilities operation, Maintenance and Monitoring manual

MAGSA will develop a comprehensive Facilities Operation, Maintenance and Monitoring Manual for the Bank. This manual will develop O&M protocols for conveyance canals, recovery wells and recharge basins and their associated turnouts, valves, pumping stations, security fencing and other equipment and instrumentation. Mechanical and electrical equipment such as pump stations, valves instrumentation, and telemetry systems will utilize manufacturer and installer recommendations, manuals, and standard practices for their O&M. The conveyance and distributions system will include protocols for routine maintenance and emergency actions including the following:

- Regular scheduled inspections, vegetation management, channel repair and stabilization of canals,
- Regular scheduled inspections, vegetation management, and repair of recharge basins,
- Implementation of real-time flow and level monitoring of the canal system at key nodes to

track flows and deliveries, manage freeboard in the canal system, and to alert operators to canal levee failures,

- Emergency protocols for canal operations in case of levee failures (e.g., stopping pumping to canal sections, diverting from or draining canal sections, emergency repairs such as sandbags and earthwork), and
- Access road repairs and maintenance.

2.27 WAT-11. Manage diversions and recovery Timing

Bank management and scheduling of diversions to and recovery from will be developed in coordination with Bank partners and other local and potentially affected agencies and contractors to ensure Bank operations are not interfering with flow management and diversions from the Mendota Pool. Scheduling guidelines will be developed from this effort and updated on a regular schedule to accommodate changing conditions and needs in the region (e.g., 5 years).

2.28 WAT-12. Develop and Implement Operation Model

MAGSA will develop an Operational Model (OM) to guide planning and design, and for developing initial operations and management plans. The OM will use currently available information and data and will be subsequently refined and evolve as water quality, hydrology and other needed data is collected. As the OM is refined, it will become a more precise predictive model that will further support decision making.

Key goals and objectives of the OM include;

- Developing recharge and recovery strategies to ensure water quality requirements are being met for exported water returned to contractors,
- Supporting design and distribution of recharge basins and recovery wells to protect or enhance groundwater recovery and its quality,
- Recharge and recovery actions are not adversely affecting groundwater levels or quality outside of MAGSA,
- Recharge and recovery actions are not impeding use of groundwater within MAGSA for irrigation, drinking water or other uses,
- Recharge and recovery actions are enhancing groundwater sustainability throughout MAGSA with regard to groundwater supplies and quality.

These goals and objectives are discussed by Bachand et al. in the water quality and hydrologic analysis (2023a; 2023b). The model development will utilize collected groundwater data (*WAT-5*) and surface water data (*WAT-9*) for initial calibration and for subsequent refinement.

3 ENVIRONMENTAL FACTORS POTENTIALLY AFFECTED

The environmental factors checked below would be potentially affected by this project, involving at least one impact that is a "Potentially Significant Impact" as indicated by the checklists on the following pages.

☐	Aesthetics	☐	Agriculture and Forest Resources	☒	Air Quality
☒	Biological Resources	☒	Cultural/Paleo Resources	☐	Energy
☒	Geology /Soils	☐	Greenhouse Gas Emissions	☒	Hazards & Hazardous Materials
☒	Hydrology / Water Quality	☐	Land Use / Land use Planning	☐	Mineral Resources
☐	Noise	☐	Population / Housing	☐	Public Services
☐	Recreation	☒	Tribal Cultural Resources	☒	Transportation/Circulation
☐	Utilities / Service Systems	☐	Wildfire	☐	Mandatory Findings of Significance

3.1 PROPOSED DECLARATION

DETERMINATION: On the basis of this initial evaluation:

☐	I find that the proposed project COULD NOT have a significant effect on the environment, and a NEGATIVE DECLARATION will be prepared.
☒	I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because revisions in the project have been made by or agreed to by the project proponent. A MITIGATED NEGATIVE DECLARATION will be prepared.
☐	I find that the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required.
☐	I find that the proposed project MAY have a "potentially significant impact" or "potentially significant unless mitigated" impact on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier analysis as described on attached sheets. An ENVIRONMENTAL IMPACT REPORT is required, but it must analyze only the effects that remain to be addressed.
☐	I find that although the proposed project could have a significant effect on the environment, because all potentially significant effects (a) have been analyzed adequately in an earlier EIR or NEGATIVE DECLARATION pursuant to applicable standards, and (b) have been avoided or mitigated pursuant to that earlier EIR or NEGATIVE DECLARATION, including revisions or mitigation measures that are imposed upon the proposed project, nothing further is required.

Signature

Signature

3 /10 /2024

Date

4 EVALUATION OF ENVIRONMENTAL IMPACTS

This chapter describes resources that are found in the study area and describes the effects that implementation of the proposed project may have on those resources. Impacts to resources may typically result from the construction of the proposed project, or the operation and maintenance of the project. For each resource area, the potential impacts resulting from implementation of the proposed project are evaluated for their level of significance.

The categories used to designate impact significance are described below:

- *No Impact* A project is considered to have no impact if there is no potential for impacts, or if the environmental resource does not exist within the project area or the area of potential effect. For example, there would be no impacts related to wastewater disposal if the project would not involve the production of wastewater.
- *Less than Significant* This determination applies if there is some impact, but not one that qualifies under the significance criteria as a significant impact.
- *Less than Significant with Mitigation* This determination applies to impacts that exceed significance criteria, but for which feasible mitigation is available to reduce the impacts to a less than significant level.
- *Potentially Significant* This determination applies to impacts that are significant but for which: (1) no feasible mitigation has been identified to reduce the impact to a less than significant level, or (2) feasible mitigation has been identified but the residual impact remains significant after mitigation is applied. Therefore, the impact is considered significant and unavoidable.

Determination of impact is driven by the application of significance criteria. These are the thresholds which trigger a determination of impact significance. In turn, significance criteria are determined through evaluation of the regulatory setting of the area from a Federal, State, and local standpoint. When no regulatory guidelines are available, generalized criteria can be substituted.

In cases where impacts are expected, but which can be reduced with adequate mitigation, those mitigation measures are described. A revised level of significance may result from mitigation. In some cases, less than significant determinations are made, but application of mitigation may still be warranted to further reduce potential impacts (CEQA Section 15021).

Impact assessment takes into consideration construction and operational impacts. Construction impacts are those that may occur during implementation of construction actions and are compared to baseline conditions under which no project would occur. Operational impacts are those that may occur after the project has been completed.

The analysis of potential impacts and mitigation measures is based on pre-determined significance criteria. The significance criteria used in this IS are taken from the Appendix: Environmental Checklist Form included in the CEQA Guidelines (CEQA Guidelines, Appendix G).

(1) A brief explanation is required for all answers except "No Impact" answers that are adequately supported by the information sources a lead agency cites in the parentheses following each question. A "No Impact" answer is adequately supported if the referenced information sources show that the impact simply does not apply to projects like the one involved (for example, the project falls outside a fault rupture zone). A "No Impact" answer should be explained where it is based on project-specific factors as well as general standards (for example, the project will not expose sensitive receptors to pollutants, based on a project-specific screening analysis).

(2) All answers must take account of the whole action involved, including off-site as well as on-site, cumulative as well as project-level, indirect as well as direct, and construction as well as operational impacts.

(3) Once the lead agency has determined that a particular physical impact may occur, the checklist answers must indicate whether the impact is potentially significant, less than significant with mitigation, or less than significant. "Potentially Significant Impact" is appropriate if there is substantial evidence that an effect may be significant. If there are one or more "Potentially Significant Impact" entries when the determination is made, an EIR is required.

(4) "Negative Declaration: Less Than Significant with Mitigation Incorporated" applies where the incorporation of mitigation measures has reduced an effect from "Potentially Significant Impact" to a "Less Than Significant Impact." The lead agency must describe the mitigation measures, and briefly explain how they reduce the effect to a less than significant level [mitigation measures from "Earlier Analyses," as described in (5) below, may be cross-referenced].

(5) Earlier analyses may be used where, pursuant to tiering, programmatic environmental impact report (EIR), or other CEQA process, an effect has been adequately analyzed in an earlier EIR or negative declaration. Section 15063(c)(3)(D). In this case, a brief discussion should identify the following:

   a. Earlier Analysis Used. Identify and state where they are available for review.
   b. Impacts Adequately Addressed. Identify which effects from the checklist were within the scope of and adequately analyzed in an earlier document pursuant to applicable legal standards, and state whether such effects were addressed by mitigation measures based on the earlier analysis.
   c. Mitigation Measures. For effects that are "Less than Significant with Mitigation Measures Incorporated," describe the mitigation measures which were incorporated or refined from the earlier document and the extent to which they address site-specific conditions for the project.

(6) Lead agencies are encouraged to incorporate into the checklist references to information sources for potential impacts. Reference to a previously prepared or outside document should, where appropriate, include a reference to the page or pages where the statement is substantiated.

(7) Supporting Information Sources: A source list should be attached, and other sources used or individuals contacted should be cited in the discussion.

(8) This form is only suggested, and lead agencies are free to use different formats; however, lead agencies should normally address the questions from this checklist that are relevant to a project's environmental effects in whatever format is selected.

(9) The explanation of each issue should identify:

   a. The significance criteria or threshold, if any, used to evaluate each question; and
   b. The mitigation measure identified, if any, to reduce the impact to less than significance.

4.1 AESTHETICS (AES)

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
Would the Project:				
a) Have a substantial adverse effect on a scenic vista?	☐	☐	☒	☐
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?	☐	☐	☐	☒
c) In non-urbanized areas, substantially degrade the existing visual character or quality of public views of the site and its surroundings? If the project is in an urbanized area, would the project conflict with applicable zoning and other regulations governing scenic quality?	☐	☐	☒	☐
d) Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area?	☐	☐	☒	☐

4.1.1 Environmental Setting

Aesthetic resources include the visual characteristics of the existing natural and human made landscape. Analysis of aesthetic impacts requires the subjective assessment of the changes to visual characteristics resulting from the construction and operation of the proposed project. Aesthetics impact analysis considers project design in relation to the surrounding visual character, including natural landscape features, scenic designations, and existing structure types, as well as the potential for the project to obstruct scenic views or vistas and create new sources of light or glare.

Local visual conditions within the project area are dominated by agricultural production, paved and unpaved roadways, irrigation facilities, overhead utilities, and limited structures that include homes and agricultural facilities. Agricultural production primarily includes perennial crops such as fruit trees, nut trees, and vineyards, with some annual crops. Fallow, or uncultivated lands, are also present on a rotational basis throughout the project area.

Human development in the area includes roads, bridges, buildings, canals, and irrigation facilities. Major road arterials are two-lane paved roads with an extensive network of two-lane dirt roads radiating through farm fields. Along roadways are irrigation ditches, turnouts, reservoirs, culverts, bridges, utility boxes, and pole utility lines. Farming operations include warehouses and barns for dairy farms and the associated storage and maintenance buildings, silos and other storge facilities. The area has few private homes and commercial retail space is limited to Raisin City. The American Avenue landfill is in the central portion of the project area. The San Joaquin Valley has been highly altered from its native grassland condition into intensely farmed agricultural land.

Those experiencing views in the project area include farm owners, operators, and workers, as well as the few homeowners in the area, and those passing through on their way to the cities in the region. Long-range views from the project area may include the Sierra Nevada Mountain Range to the east and the Diablo Range to the west on clear days. Long-range views into the project area from the Sierra Nevada and Diablo ranges are too distant (at approximately 25 miles and 20 miles, respectively) to observe detailed visual characteristics of the project area.

The California Scenic Highway Program, governed by the Streets and Highways Code, §260 et seq., is intended to preserve and protect highway corridors in areas of outstanding natural beauty from changes that would diminish the aesthetic value of the adjacent lands. There are no Caltrans-designated scenic highways in the project area or vicinity (Caltrans 2022). The Fresno County General Plan does not specify any scenic vistas or roadways in the project area; the nearest roadway eligible for scenic designation is SR-198 in the southwestern portion of the county, approximately 18 miles from the project area (Fresno County 2000, Fresno County 2021a).

4.1.2 Regulatory Setting

4.1.2.1 Federal

There are no Federal regulations relating to aesthetics that are applicable to the Project or the Project site.

4.1.2.2 State

California Environmental Quality Act. State regulations relating to aesthetics include the California Scenic Highway Program, California Landscape Province Preservation, California State Park Program. The Project is not subject to any of these regulations since there are no state-designated lands or scenic highways in the vicinity.

California Building Code Title 24 Outdoor Lighting Standards. The requirements vary according to which "Lighting Zone" the equipment is in. The Standards contain lighting power allowances for newly installed equipment and specific alterations that are dependent on which Lighting Zone the project is located in. Existing outdoor lighting systems are not required to meet these lighting power allowances. However, alterations that increase the connected load, or replace more than 50 percent of the existing luminaries, for each outdoor lighting application that is regulated by the Standards, must meet the lighting power allowances for newly installed equipment.

An important part of the Standards is to base the lighting power that is allowed on how bright the surrounding conditions are. The eyes adapt to darker surrounding conditions, and less light is needed to properly see; when the surrounding conditions get brighter, more light is needed to see. The least power is allowed in Lighting Zone 1 and increasingly more power is allowed in Lighting Zones 2, 3, and 4.

By default, government designated parks, recreation areas and wildlife preserves are Lighting Zone 1; rural areas are Lighting Zone 2; and urban areas are Lighting Zone 3. Lighting Zone 4 is a special use district that may be adopted by a local government. The Project is in a rural area, as defined by the 2020 Census, so it is in Lighting Zone 2.

California Scenic Highway Program. The California Scenic Highway Program, governed by the Streets and Highways Code, §260 et seq., is intended to preserve and protect highway corridors in areas of outstanding natural beauty from changes that would diminish the aesthetic value of the adjacent lands. There are no Caltrans-designated scenic highways in the project area or vicinity (Caltrans 2022).

4.1.2.3 County and Regional

Fresno County General Plan. The Fresno County General Plan provides the following policies and goals that apply to scenic and visual character within agricultural areas or along transportation corridors (Fresno County 2000). Although several policies apply to visual resources, they are not specific to the conditions within the project area.

> ***Policy LU-B.11.*** The County shall require that new development requiring a County discretionary permit be planned and designed to maintain the scenic open space character of rangelands including view corridors of highways. New development shall utilize natural landforms and vegetation in the least visually disruptive way possible, and use design, construction and maintenance techniques that minimize the visibility of structures on hillsides, ridgelines, steep slopes, and canyons.
>
> ***Policy PF-J.2.*** The County shall work with local gas and electric utility companies to design and locate appropriate expansion of gas and electric systems, while minimizing impacts to agriculture and minimizing noise, electromagnetic, visual, and other impacts on existing and future residents.
>
> ***Policy OS-A.18.*** The County shall require that natural watercourses are integrated into new development in such a way that they are accessible to the public and provide a positive visual element and a buffer area between waterways and urban development in an effort to protect water quality and riparian areas.
>
> ***Goal OS-L.*** This goal and its associated policies are intended to conserve, protect, and maintain the scenic quality of land and landscape adjacent to scenic roads in Fresno County. There are no designated scenic highways, roads, or vistas in the project area under the General Plan.

4.1.3 Potential Impacts

AES a): Would the proposed project have a substantial adverse effect on a scenic vista?

(Less than Significant Impact) The proposed project would result in a temporary adverse effect on the immediate viewshed during the construction period. Visual impacts would result from the presence of construction equipment and may include equipment that rises near or above surrounding vegetation and the horizon line. Construction equipment would be visible to residents in the immediate area of construction and those passing on nearby roadways. These impacts would be temporary, occurring during the construction period only, and would cease once construction ends. There would be no impacts to scenic vistas. Construction and operation of the project would not be subject to the requirements of the Scenic Highway Program.

AES b): Would the proposed project substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?

(No Impact) Proposed construction activities and operational conditions would not affect rocky outcrops, as these types of resources do not occur in the impact area. There are no state scenic highways in the project area or vicinity (Caltrans 2022). Similarly, the Fresno County General Plan does not list scenic resources as being present in the project area (Fresno County 2000). Therefore, there would be no impact to scenic resources.

AES c): Would the proposed project, in non-urbanized areas, substantially degrade the existing visual character or quality of the site and its surroundings? If the project is in an urbanized area, would the project conflict with applicable zoning and other regulations governing scenic quality?

(Less Than Significant Impact) Temporary impacts could result to visual resources during the construction of the project. The presence of construction equipment, land clearing and earth moving, and increased generation of dust from exposed soils could all contribute to diminished aesthetic appeal of the project area. However, ongoing visual conditions of the project area are already similar to the visual components of construction since heavy trucks and machinery are regularly present in project area agricultural lands. Because visual impacts due to construction would be temporary and would only be incrementally more observable than ongoing practices at the site, impacts to visual character or quality due to construction would be less than significant.

Operations of the newly constructed canals or recharge basins would require minimal increases in truck and car traffic within the project area, and new infrastructure, such as weirs, canals, and water pumps, would be consistent with the existing farming landscape. Visual changes resulting from operation of the project would not generate any substantial change in visual character or quality. Therefore, operations impact to visual resources are less than significant.

AES d): Would the proposed project create a new source of substantial light or glare which would adversely affect day or nighttime views in the area?

(Less Than Significant Impact) Increased water surface during times when recharge basins are flooded would create a minor source of glare into the environment, but the basins would be surrounded by berms and the water surfaces would not be visible from highways, roads, or residences. During construction, temporary security lighting will likely be installed and used at staging areas. Such lights would be hooded and have shields installed to contain glare and reduce potential for light-related impacts to nearby dwellings and would be removed at the end of the construction period. There would be no new permanent sources of light associated with the proposed project area. This impact would be less than significant.

4.2 Agricultural and Forest Resources (AFR)

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
Would the Project:				
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to nonagricultural use?	☐	☐	☒	☐
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?	☐	☐	☐	☒
c) Conflict with existing zoning for, or cause rezoning of, forest land (as defined in Public Resources Code section 12220(g)), timberland (as defined by Public Resources Code section 4526), or timberland zoned Timberland Production (as defined by Government Code section 51104(g))?	☐	☐	☐	☒
d) Result in the loss of forest land or conversion of forest land to non-forest use?	☐	☐	☐	☒
e) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use or conversion of forest land to non-forest use?	☐	☐	☒	☐

4.2.1 Environmental Setting

The proposed project is in Fresno County within the San Joaquin Valley, one of the most productive agricultural areas in the United States. Fresno County is the leading agricultural county in California, producing over $7.7 billion in 2019 (CDFA 2020) and supporting 9 percent of jobs in Fresno County (U.S. Census Bureau 2020). Twenty-one percent of the jobs in Raisin City, within the proposed project area, are related to agriculture (U.S. Census Bureau 2020). Fresno County's top commodities include almonds, pistachios, livestock, and table grapes (CDFA 2020). Crops observed within the proposed project area include perennial crops (pistachios, almonds, walnuts, grapes, and cherries) and annual crops (tomatoes, peppers, onions, corn, wheat, and alfalfa), as well as pasture and dairy use (Figure 4-1). The Natural Resources Conservation Service (NRCS) Soil Service Geographic Database has classified soils in the study footprint area as sandy and loamy soil types (NRCS 2013). There are no forested lands within the project area.

The project area is comprised of lands classified by the California Resources Agency (CRA) as being prime farmlands, unique farmlands, farmlands of statewide importance, or farmlands of local importance (Figure 4-2). These lands are defined as follows:

- Prime Farmland, as defined by the U.S. Department of Agriculture, is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and as available for these uses. The soil quality, growing season, and moisture supply are those needed for the soil to economically produce sustained high yields of crops when proper management, including water management, and acceptable farming methods are applied.
- Unique Farmland is land other than prime farmland that is used for production of specific high-value food and fiber crops. It has the special combination of soil quality, growing season, moisture supply, temperature, humidity, drainage, elevation, and aspect needed for the soil to economically produce sustainable high yields of crops when properly managed.
- Farmland of Statewide Importance is farmland similar to prime farmland but with minor shortcomings, such as greater slopes or less ability to store moisture.
- Farmland of Local Importance is farmland that is important to the local agricultural economy as determined by each county's board of supervisors and a local advisory committee.

4.2.2 Regulatory Setting

4.2.2.1 Federal

Farmland Protection Policy Act. The Farmland Protection Policy Act (FPPA) was passed in 1981, after studies found that urban sprawl was accelerating the conversion of farmland to buildings and roads. The goal of the FPPA is to minimize the impact of federal programs on the unnecessary and irreversible conversion of farmland to nonagricultural uses. It ensures that federal programs are compatible with state, local, and private programs and policies that protect farmland. Under the FPPA, farmland includes prime farmland, unique farmland, and land of statewide or local importance. Farmland subject to FPPA requirements does not have to be in current agricultural use. It can include forest land, pastureland, cropland, or other land uses, but not water or urban built-up land (NRCS 2022).

The FPPA does not authorize the federal government to regulate the use of private or nonfederal land and does not affect the property rights of owners. Funding agencies have the latitude to determine if a use is irreversible. Lands committed to water storage are exempt from FPPA. Also, construction of non-farm structures necessary to support on-going farm operations, are not subject to FPPA. The conveyance canals will remove land from productive agriculture, but such removal is reversible; meaning said lands could be put back into production at any time should the project be abandoned for whatever reason in the future. The ancillary facilities necessary for the project pipelines and recharge basins to function (i.e., wells, pumps, and turn-outs,) are collectively necessary to support on-going farm operations.

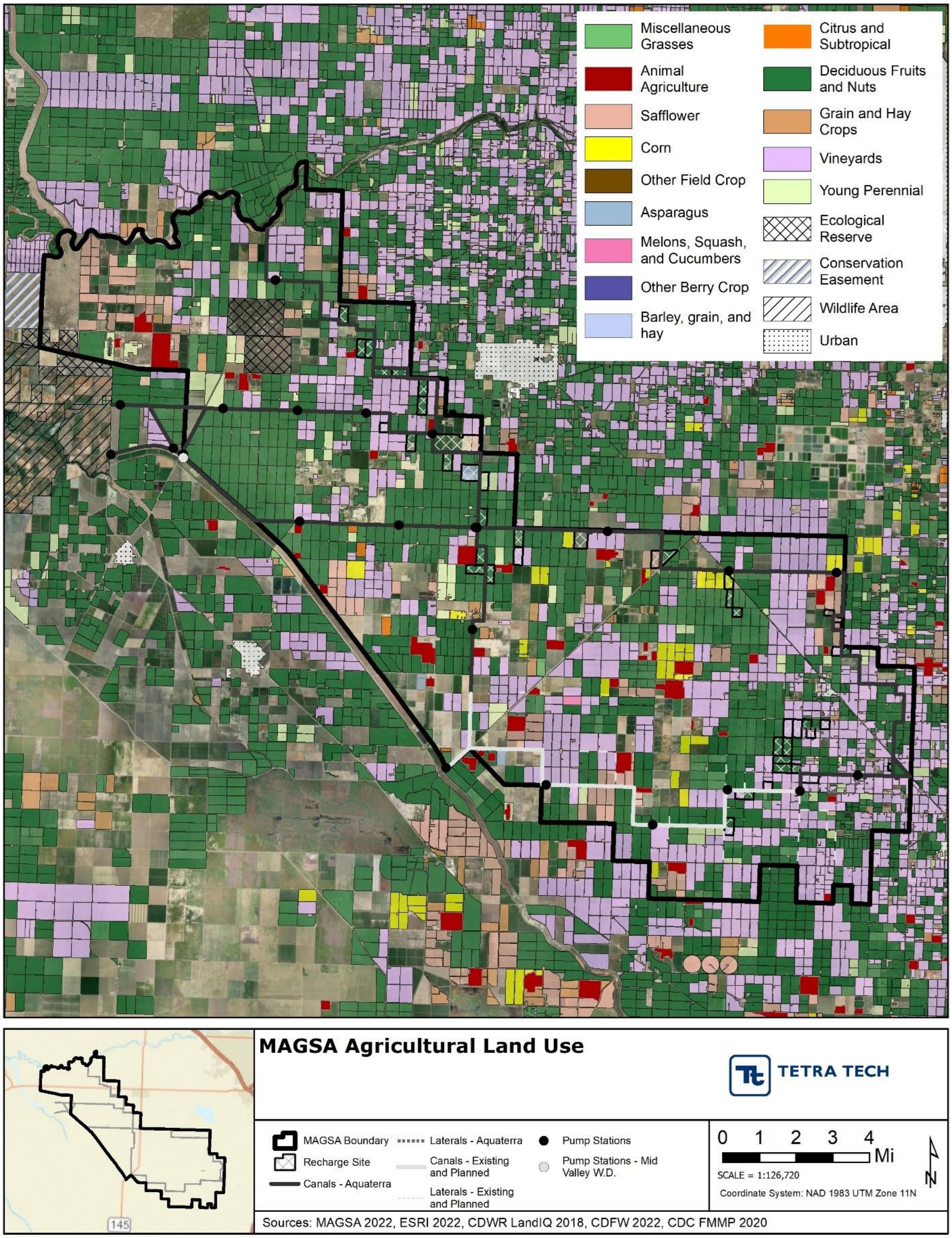


Figure 4-1: Agricultural Land Use

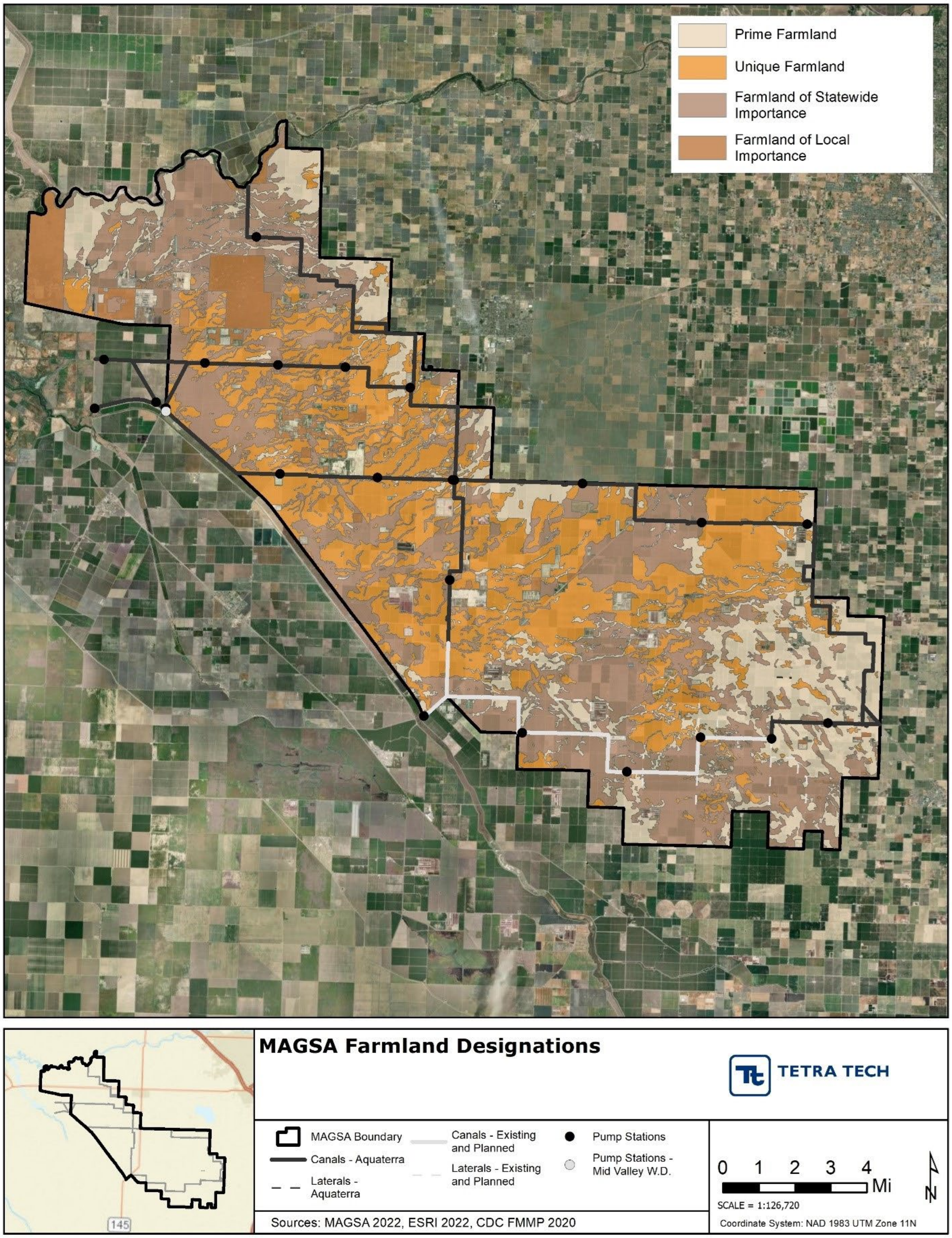


Figure 4-2: Farmland Designations

4.2.2.2 State

California Land Conservation Act (Williamson Act). The California Land Conservation Act, commonly known as the Williamson Act, was the result of a study by the Assembly Agriculture Committee in cooperation with the California Department of Food and Agriculture (CDFA) and others. The study eventually led to the passage of legislation in 1965. Under the Williamson Act, an owner of agricultural land may enter a contract with the County if the landowner agrees to restrict use of the land to the production of commercial crops for a term of not less than 10 years. The term of the contract is automatically extended each year unless notice of cancellation or nonrenewal is given. Certain compatible uses are also allowed on the property. In return, the landowner is taxed on the capitalization of the income from the land and not on the Proposition 13 value. As of 2021, there are more than 12 million acres enrolled in the Williamson Act in 52 counties in the state (CDC 2022). Within the proposed project area, 95,136 acres are enrolled (Figure 4-3).

California Department of Conservation (CDC), Farmland Mapping and Monitoring Program (FMMP). The FMMP produces maps and statistical data used for analyzing impacts to California's agricultural resources. Agricultural land is rated according to soil quality and irrigation status; the best quality land is called Prime Farmland. The maps are updated every two years with the use of a computer mapping system, aerial imagery, public review, and field reconnaissance.

Sustainable Groundwater Management Act of 2014. The California Legislature enacted the Sustainable Groundwater Management Act of 2014 ("Act") a decade ago. The Act provides authority for local agency management of groundwater and requires implementation of plans to meet the goal of groundwater sustainability established by the Act within basins of high- and medium-priority which includes the basin underlying MAGSA (Kings' Basin). The Act's goal of sustainability is met by implementation of sustainability plans that identify and cause implementation of measures targeted to ensure that the applicable basin is operated within its safe yield. (Water Code § 10721(t)). Safe yield is defined as the maximum quantity of water that can be withdrawn annually from the groundwater supply without causing an undesirable result and includes within the definition of "undesirable result" chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply and significant and unreasonable reduction in groundwater storage. (Water Code § 10721(w)). The Act recognizes that fallowing of agricultural lands and reduction of pumping may be required to achieve groundwater sustainability. (Water Code §§ 10726.2(c), 10726.4(a)).

4.2.2.3 County and Regional

Fresno County General Plan. The proposed project area is addressed in the existing Fresno County General Plan and the ongoing update to the General Plan (Fresno County 2000, 2021b). More detailed information, including goals and policies, can be found in the Agriculture and Land Use Element of each document. Most of the proposed project area is zoned AE-20, Exclusive Agriculture, which requires a 20-acre minimum lot size. Raisin City is zoned A-1, Agricultural District.

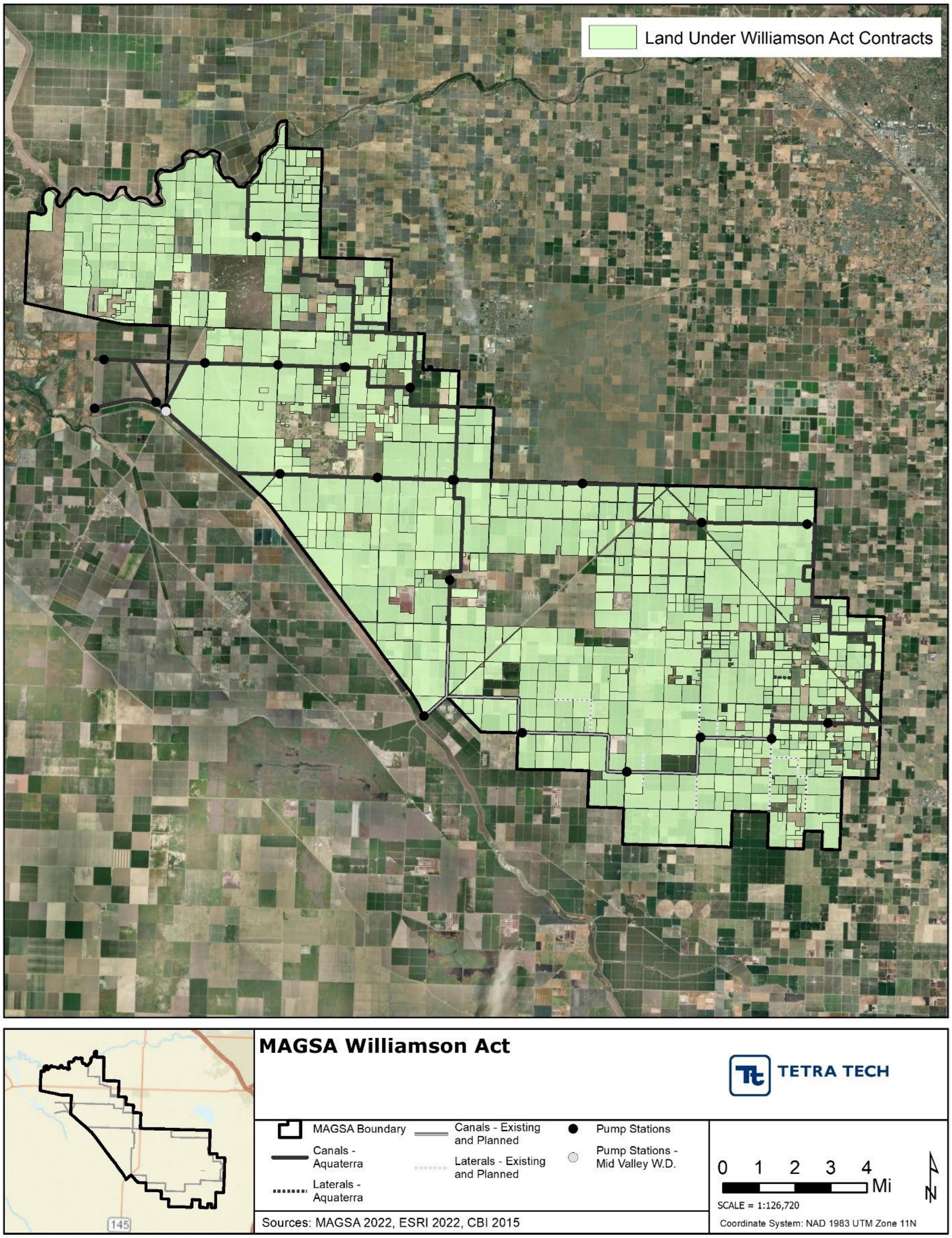


Figure 4-3: Williamson Act

4.2.3 Potential Impacts

AFR a): Would the proposed project convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to nonagricultural use?

(Less than Significant Impact) Proposed use of existing prime and unique farmlands or farmlands of statewide or local importance for groundwater banking is not considered a conversion from agricultural use to nonagricultural use. According to the California Code, Public Resources Code, §65570, "amount of land converted from agricultural use" means those lands which were permanently converted or committed to urban or other nonagricultural uses and were shown as agricultural land on Important Farmland Series maps maintained by the CDC and in the most recent biennial report.

Approximately 1,543 acres of agricultural lands will be taken out of direct agricultural production for the permanent easement and conveyance system, and an additional 3,480 acres will be used as recharge basins on a seasonal basis. This is considered a less than significant impact for the following reasons:

- Construction and use of recharge basins would not constitute a permanent change because the lands within the recharge basins can still be used for seasonal agriculture and will support agricultural uses by facilitating groundwater recharge. This is an important distinction from projects that would convert agricultural lands to housing developments, industrial sites, or businesses.
- Lands within the conveyance canals and permanent easements are situated directly along roads in areas of low productivity and could be converted back to agricultural land in the future.
- The proposed project will benefit agricultural uses in the surrounding area by raising the groundwater table, increasing water conveyance to farmlands throughout the southern and eastern sides of the MAGSA area, and improving irrigation infrastructure. Furthermore, the conveyance system is designed to be situated directly alongside roads, in lands typically not in active agricultural production.
- The proposed project is consistent with Fresno County's zoning as Exclusive Agriculture (AE-20) and with its rules implementing the Williamson Act. Recharge facilities, such as the proposed recharge basins and associated wells, pumps, pipelines and regulating basin, are permitted uses in agricultural zoning districts and agricultural preserves as accessory or supporting uses to agriculture. Local land use authorities do not recognize the proposed project as a conversion of farmland to non-agricultural use, but rather see the project as an agricultural or agricultural-support operation. The proposed project would not directly induce loss of farmland in the project area, as is typical of projects that convert agricultural lands to residential or commercial uses.
- The proposed project would be compatible with the goals and policies of Fresno County's General Plan for protecting and enhancing surface and groundwater resources critical to agriculture (LU-A.20), importing flood, surplus, and other available water for use in Fresno County (PF-C.2), and supporting water banking when the program has local sponsorship and involvement and provides new benefits to the County (PF-C.5).

AFR b): Would the proposed project conflict with existing zoning for agricultural use, or a Williamson Act contract?

(No Impact) The proposed project area is zoned as AE-20 and A-1. There will be no changes in zoning designations from the resulting proposed action. The 95,136 acres of land within the project area currently under Williamson Act contracts will remain enrolled and eligible for this program. The proposed project is consistent with Fresno County's General Plan policy for Williamson Act contracts (LU-A.1), and changes made to agricultural lands from the construction of the conveyance system, pump stations, and recharge sites will remain consistent with Williamson Act guidelines. There will be no impact to existing zoning or Williamson Act contracts under the proposed project.

AFR c): Would the proposed project conflict with existing zoning for, or cause rezoning of, forest land (as defined in Public Resources Code section 12220(g)), timberland (as defined by Public Resources Code section 4526), or timberland zoned Timberland Production (as defined by Government Code section 51104(g))?

(No Impact) No portion of the project area is categorized as timber, timberland, or timberland production zone and there would be no impact to forest resources.

AFR d): Would the proposed project result in the loss of forest land or conversion of forest land to non-forest use?

(No Impact) There are no forested lands within the proposed project area so there will be no impact to forest land under the proposed project.

AFR e): Would the proposed project involve other changes in the existing environment which, due to their location or nature, could result in conversion of farmland to nonagricultural use or conversion of forest land to non-forest use?

(Less than Significant Impact) The proposed project is an agricultural-related water storage and groundwater recharge project that would not result in other changes in the existing environment, such as growth inducement, which would cause additional land to be converted to non-agricultural or non-forest use. While the project would remove up to 1,534 acres of agricultural lands from production, the adverse effect of this is offset by the beneficial effect of increasing ability for groundwater storage, and ability to make beneficial use of excess surface water flows during wet periods that might otherwise flow downstream and out of the area. The proposed project will provide a "greater good" to existing agricultural operations by conserving excess surface water as groundwater recharge for banking purposes. This concept is consistent with Part III, as well as Drought and Water Conservation Declarations and Executive Orders issued in recent years by the Governor, and with the more contemporary California Water and Water Action Plans and legislative directives to conserve water state-wide. The conversion of part of the project area from orchard to seasonal farming activities in the recharge basins is consistent with the Fresno County General Plan land use designation for "Agriculture" and a compatible use within "Exclusive Agriculture" zoning. The establishment of recharge basins where soils are conducive to recharge in place of active orchard and row crop farming is considered a compatible use because the basins are integral to supporting agriculture and preventing other lands from being fallowed. Therefore, impacts would be less than significant.

4.3 AIR QUALITY (AIR)

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
Would the Project:				
a) Conflict with or obstruct implementation of the applicable air quality plan?	☐	☒	☐	☐
b) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is in non-attainment under an applicable federal, state, or regional ambient air quality standard?	☐	☒	☐	☐
c) Expose sensitive receptors to substantial pollutant concentrations?	☐	☒	☐	☐
d) Result in other emissions (such as those leading to odors) adversely affecting a substantial number of people?	☐	☐	☒	☐

4.3.1 Environmental Setting

The Project is located within the San Joaquin Valley Air Basin (SJVAB), which is under the jurisdiction of the San Joaquin Valley Air Pollution Control District (SJVAPCD). The topology and meteorology of the San Joaquin Valley (SJV) are conducive to trapping air pollutants for extended periods and the formation of photochemical smog. The SJV is bordered by the Sierra Nevada Mountains in the east (8,000 to 14,491 feet in elevation), the Coast Ranges in the west (averaging 3,000 feet in elevation), and the Tehachapi mountains in the south (6,000 to 7,981 feet in elevation) and open to the Sacramento Valley and the San Francisco Bay Area to the north. The bowl-shaped topography inhibits movement of pollutants out of the valley. Low precipitation levels, cloudless days, high temperatures, and light winds during the summer in the SJV are conducive to ozone formation. Inversion layers in the atmosphere during the winter can trap emissions of directly emitted $PM_{2.5}$ and $PM_{2.5}$ precursors within the SJV for several days, accumulating to unhealthy levels.

Appendix 4 of this document includes an Air Quality and Greenhouse Gas Impact Analysis study completed for this project. That study provides a detailed description of the existing environment in the project area and identifies potential impacts associated with the proposed project in relation to regional and local air quality, as well as increased emissions of greenhouse gases (GHGs). The study also addressed odors and other potential issues of concern related to air quality for sensitive receptors. The study was prepared in accordance with the SJVAPCD's Guidance for Assessing and Mitigating Air Quality Impacts (2015).

4.3.2 Regulatory Setting

Air quality within the SJVAB is regulated by several jurisdictions including the U.S. EPA, California Air Resources Board (CARB), and the SJVAPCD. Each of these jurisdictions develops rules, regulations, and policies to attain the goals or directives imposed upon them through legislation. Although U.S. EPA regulations may not be superseded, both state and local regulations may be more stringent.

4.3.2.1 Federal

Clean Air Act (CAA). The Clean Air Act (42 U.S.C. 7401, et seq.) delegates primary enforcement to the states, with direct oversight by the U.S. Environmental Protection Agency (EPA). The CAA, , last amended in 1990, requires EPA to set National Ambient Air Quality Standards (NAAQSs) (40 CFR part 50) for pollutants considered harmful to public health and the environment. The CAA established two types of standards. Primary standards were established to promote human health with an adequate margin of safety to protect those most vulnerable such as asthmatics, infants, and elderly persons. Secondary standards were established to promote human welfare to prevent impaired visibility, building and crop damage, etc.

The Federal CAA requires areas with air quality violating the NAAQS to prepare an air quality control plan referred to as the State Implementation Plan (SIP). The SIP contains the strategies and control measures that states will use to attain the NAAQS. The Federal CAA amendments of 1990 require states containing areas that violate the NAAQS to revise their SIPs to incorporate additional control measures to reduce air pollution.

Toxic Substances Control Act

The Toxic Substances Control Act (TSCA) first authorized the U.S.E.P.A. to regulate asbestos in schools and Public and Commercial buildings under Title II of the law, which is also known as the Asbestos Hazard Emergency Response Act (AHERA). AHERA requires Local Education Agencies (LEAs) to inspect their schools for ACBM and prepare management plans to reduce the asbestos hazard. The Act also established a program for the training and accreditation of individuals performing certain types of asbestos work.

National Emission Standards for Hazardous Air Pollutants

Pursuant to the FCAA of 1970, the U.S. EPA established the National Emission Standards for Hazardous Air Pollutants (NESHAP). These are technology-based source-specific regulations that limit allowable emissions of HAPs.

4.3.2.2 State

California Clean Air Act. CARB is the agency responsible for coordination and oversight of state and local air pollution control programs in California and for implementing the California Clean Air Act (CCAA). The CCAA, which was adopted in 1988, requires CARB to establish California Ambient Air Quality Standards (CAAQS) (California Air Resources Board, 2010). The standards for criteria pollutants established by CARB are generally more restrictive than the NAAQS. CARB has also established CAAQS for sulfates, hydrogen sulfide, vinyl chloride, visibility-reducing particulate matter, and the criteria air pollutants described below.

The CCAA requires that all local air districts in the State endeavor to achieve and maintain the CAAQS by the earliest practical date. The act specifies that local air districts should focus particular attention on reducing the emissions from transportation and area wide emission sources and provides districts with the authority to regulate indirect sources (i.e., sources that are not stationary or regulated as a stationary source, such as construction sources).

Federal and state regulations designate areas with levels above the standards as nonattainment areas, and areas with levels below as attainment areas. Attainment status of Fresno County for both the NAAQS and CAAQS is outlined in Table 4-1.

State Implementation Plan. Federal clean air laws require areas with unhealthy levels of ozone, particulates (PM_{10}) inhalable particulate matter ($PM_{2.5}$), carbon monoxide (CO), nitrogen dioxide (NO_2), and sulfur dioxide (SO2) to develop plans, known as State Implementation Plans (SIPs). The purpose of the SIPs is to establish what air districts must do to demonstrate how they will achieve attainment with NAAQS and CAAQS. The State of California has adopted a statewide SIP. Individual air districts have, in turn, either adopted their own comprehensive regional air quality management plans and/or SIPs that describe how an air district will attain NAAQS and CAAQS. The 1990 amendments to the Federal Clean Air Act set deadlines for attainment based on the severity of an area's air pollution problem.

SIPs in place for the SJV include the SJVAPCD 2015 $PM_{2.5}$ Plan, the SJVAPCD 2007 8-hour Ozone Plan, the SJVAPCD 2013 Plan for the Revoked 1-Hour Ozone Standard, and the SJVAPCD 2006 PM_{10} Plan.

California Assembly Bill 170

Assembly Bill 170, Reyes (AB 170), was adopted by state lawmakers in 2003 creating Government Code Section 65302.1 which requires cities and counties in the San Joaquin Valley to amend their general plans to include data and analysis, comprehensive goals, policies and feasible implementation strategies designed to improve air quality.

Assembly Bills 1807 & 2588

Toxic Air Contaminants: Within California, TACs are regulated primarily through AB 1807 (Tanner Air Toxics Act) and AB 2588 (Air Toxics Hot Spots Information and Assessment Act of 1987). The Tanner Air Toxics Act sets forth a formal procedure for ARB to designate substances as TACs. This includes research, public participation, and scientific peer review before ARB designates a substance as a TAC. Existing sources of TACs that are subject to the Air Toxics Hot Spots Information and Assessment Act are required to: (1) prepare a toxic emissions inventory; (2) prepare a risk assessment if emissions are significant; (3) notify the public of significant risk levels; and (4) prepare and implement risk reduction measures.

4.3.2.3 County and Regional

San Joaquin Valley Air Pollution Control District. The SJVAPCD is a public health agency whose mission is to improve the health and quality of life for all San Joaquin Valley residents through efficient, effective, and entrepreneurial air quality-management strategies. Eight counties, including Fresno County, are within the District. The SJVAPCD is responsible for the implementation of programs and regulations required by the federal Clean Air Act and the California Clean Air Act. To meet that responsibility, the District has adopted several air quality attainment plans over the years that identify measures needed in the Valley to attain federal and State air quality standards. The District has implemented these plans and adopted nearly 650 rules that have resulted in significant emissions reductions. The District's plans include emissions inventories that identify sources of air pollutants, evaluations for feasibility of implementing potential opportunities to reduce emissions, sophisticated computer modeling to estimate future levels of pollution, and a strategy for how air pollution will be further reduced. As a result, PM 2.5 and ozone levels are now at historically low levels.

As seen in Table 4-1, the San Joaquin Valley is designated as being in nonattainment for the federal 8-hour ozone standard as well as both the annual and 24-hour $PM_{2.5}$ standard. In response, the District has adopted the 2020 RACT Demonstration for the 2015 8-Hour Ozone Standard of 70 parts per billion and the 2016 Plan for the 2008 8-Hour Ozone Standard of 75 parts per billion 8-hour ozone standard. These plans demonstrate attainment of the national ozone standard. The District adopted the 2018 Plan for the 1997, 2006, and 2012 $PM_{2.5}$ Standards on November 15, 2018. This plan addresses the EPA federal 1997 annual $PM_{2.5}$ standard of 15 µg/m³ and 24-hour $PM_{2.5}$ standard of 65 µg/m³; the 2006 24-hour $PM_{2.5}$ standard of 35 µg/m³; and the 2012 annual $PM_{2.5}$ standard of 12 µg/m³.

The District's Indirect Source Review (Rule 9510), applicable to construction and operation of new development projects, including transportation and transit development projects, is applicable to this project. Rule 9510 requires certain on-site emission reductions of PM_{10} and NOx emissions relative to baseline, or a fee for off-site emissions reductions, for projects which exceed two tons per year of NOx or PM_{10}.

Table 4-1: Attainment Status for San Joaquin Valley

<table>
<tr><th rowspan="2">Pollutant</th><th rowspan="2">Averaging</th><th colspan="2">CAAQS</th><th colspan="2">NAAQS</th></tr>
<tr><th>Conc.</th><th>Attainment Status</th><th>Conc.</th><th>Attainment Status</th></tr>
<tr><td rowspan="2">Ozone</td><td>8 Hour</td><td>0.070 ppm</td><td>Nonattainment</td><td>0.070 ppm</td><td>Nonattainment/ Extreme</td></tr>
<tr><td>1 Hour</td><td>0.090 ppm</td><td>Nonattainment/ Severe</td><td>Revoked</td><td>n/a</td></tr>
<tr><td rowspan="2">Carbon Monoxide</td><td>8 Hour</td><td>9.0 ppm</td><td rowspan="2">Attainment/ Unclassified</td><td>9.0 ppm</td><td rowspan="2">Attainment/Maintenance</td></tr>
<tr><td>1 Hour</td><td>20 ppm</td><td>35 ppm</td></tr>
<tr><td rowspan="2">Nitrogen Dioxide</td><td>1 Hour</td><td>0.18 ppm</td><td rowspan="2">Attainment</td><td>100 ppb</td><td rowspan="2">Attainment/Unclassified</td></tr>
<tr><td>AAM</td><td>0.030 ppm</td><td>53 ppb</td></tr>
<tr><td rowspan="3">Sulfur Dioxide</td><td>24 Hour</td><td>0.04 ppm</td><td rowspan="3">Attainment</td><td>n/a</td><td rowspan="3">Attainment/Unclassified</td></tr>
<tr><td>3 Hour</td><td>n/a</td><td>0.5 ppb</td></tr>
<tr><td>1 hour</td><td>0.25 ppm</td><td>75 ppm</td></tr>
<tr><td rowspan="2">Particulate Matter (PM_{10})</td><td>AAM</td><td>20 µg/m³</td><td rowspan="2">Nonattainment</td><td>n/a</td><td rowspan="2">Attainment</td></tr>
<tr><td>24 Hour</td><td>50 µg/m³</td><td>150 µg/m³</td></tr>
<tr><td rowspan="2">Fine Particulate Matter ($PM_{2.5}$)</td><td>AAM</td><td>12 µg/m³</td><td rowspan="2">Nonattainment</td><td>12 µg/m³</td><td rowspan="2">Non-attainment</td></tr>
<tr><td>24 Hour</td><td>n/a</td><td>35 µg/m³</td></tr>
<tr><td>Lead (Particulate)</td><td>Rolling three-month period,</td><td>n/a</td><td>n/a</td><td>0.15 µg/m³</td><td>No Designation/Classification</td></tr>
</table>

Pollutant	Averaging	CAAQS		NAAQS	
		Conc.	**Attainment Status**	**Conc.**	**Attainment Status**
Lead (Particulate)	30 Day Average	1.5 µg/m^3	Attainment	n/a	n/a
Hydrogen Sulfide	1 Hour	0.03 ppm	Unclassified	n/a	n/a
Sulfates	24 Hour	25 µg/m^3	Attainment	n/a	n/a
Visibility Reducing Particles	8 Hour	*	Unclassified	n/a	n/a
Vinyl Chloride	24 Hour	0.010 ppm (26 µg/m^3)	Attainment	n/a	n/a

Source: San Joaquin Valley Air Pollution Control District. 2015.
Micrograms per cubic meter (µg/m3), parts per million (ppm), annual arithmetic mean (AAM).
* Statewide Visibility Reducing Particle Standard (except Lake Tahoe Air Basin): Particles in sufficient amount to produce an extinction coefficient of 0.23 per kilometer when the relative humidity is less than 70 percent. This standard is intended to limit the frequency and severity of visibility impairment due to regional haze and is equivalent to a 10-mile nominal visual range.

4.3.3 Potential Impacts

The potential for the proposed project to affect air quality was assessed and documented in the air quality technical document prepared for the project (Appendix 4) (Tetra Tech 2024). The assessment considered potential impacts resulting from both the construction and operation of the project. Emissions of key air pollutants and greenhouse gases (GHGs) were estimated for the Aquaterra Project based on the use of California Emissions Estimator Model (CalEEMod version 2022.1; California Air Pollution Control Officers Association 2023). The modeling of air pollutant and GHG emissions using the CalEEMod includes two components: (1) a construction phase to develop the main conveyance and recharge basin elements; and (2) an operation phase mainly involving the use of various pump stations and recovery wells to carry out seasonal groundwater recharge and pumping to and from the Mendota Pool. Emissions from construction generally result from the equipment used for grading, excavation, and hauling, and from daily trips of workforce and equipment. Emissions from the operation phase result from the use of pumps used for groundwater recharge and occasional trips for inspection and maintenance.

AIR (a): Would the project conflict with or obstruct implementation of an applicable air quality plan?

(Less than Significant Impact with Mitigation Incorporation) Construction of the proposed project would generate temporary emissions during construction and long-term emissions during operations, both of which could conflict with or obstruct air quality attainment and maintenance planning efforts. Consistency with air quality plans is evaluated based on a comparison of project-generated growth in employment, population, and vehicle miles traveled (VMT) within the region, which is used for development of the emissions inventories contained in the air quality plans. The proposed project is consistent with current zoning and general plan land use designations, and would not result in growth in employment, population, or VMTs. Therefore, it would be considered consistent with employment and VMT growth projections identified in local plans.

Projects that exceed applicable project-level CEQA significance thresholds would be considered to have a potentially significant cumulative impact to regional air quality, which could interfere with regional air quality attainment and maintenance planning efforts. As shown in Tables 4-2 and 4-3, below, construction and operations emissions would not exceed SJVAPCD's localized significance thresholds.

Although emissions of PM would not exceed SJVAPCD's significance thresholds, uncontrolled PM emissions could result in localized increases in pollutant concentrations at nearby residential dwellings. Ground disturbing activities may also result in increased potential for exposure of nearby individuals to Coccidioides spores and contraction of Valley Fever. Therefore, this impact is considered potentially significant. However, with implementation of Mitigation Measures AIR-1 and AIR-2, the proposed project will be consistent with SJVAPCD's Regulation VIII for controlling fugitive dust. Impacts will be less than significant after mitigation incorporation.

Table 4-2: Estimated emissions and compliance of criterial pollutants (short tons per year; tpy) and GHG (metric tons per year; MT/year) during construction of the proposed project (Sep-2024 to Feb-2028)

Year	TOG (tpy)	ROG (tpy)	NOx (tpy)	CO (tpy)	SO_x (tpy)	PM_{10} (tpy)	$PM_{2.5}$ (tpy)	CO_2e (MT per year)
2024	0.072	0.071	1.85	2.147	0.004	2.694	0.387	411.4
2025	0.214	0.21	5.528	6.421	0.012	8.059	1.159	1228
2026	0.214	0.21	5.522	6.418	0.012	8.059	1.159	1226
2027	0.213	0.21	5.517	6.416	0.012	8.059	1.159	1222
2028	0.035	0.035	0.906	1.055	0.002	1.325	0.191	200.4
Annual threshold	-	10	10	100	27	15	15	-
Above threshold	-	No	No	No	No	No	No	-
Construction total	0.748	0.736	19.323	22.457	0.042	28.196	4.055	4287.8

Table 4-3: Estimated emissions (tons per year) and compliance of criterial pollutants (short tons per year; tpy) and GHG (metric tons per year; MT/year) during annual operation after project completion

	TOG (tpy)	ROG (tpy)	NOx (tpy)	CO (tpy)	SO_x (tpy)	PM_{10} (tpy)	$PM_{2.5}$ (tpy)	CO_2e (MT per year)
Annual emissions	0.606	0.467	4.812	5.997	0.016	0.933	0.854	9311
Annual threshold	-	10	10	100	27	15	15	-
Above threshold	-	No	No	No	No	No	No	-

AIR (b): Would the project result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal, state, or regional ambient air quality standard?

(*Less than Significant Impact with Mitigation Incorporation)*

Short-Term Construction

Short-term increases in emissions would occur during the construction process. Construction-generated emissions would be temporary, lasting only as long as construction activities occur, but have the potential to result in a significant air quality impact. Construction would result in the temporary generation of emissions associated with various activities, including site preparation, grading, and installation of project infrastructure. Emissions of ozone-precursor pollutants (ROG and NOx) would be largely associated with off-road equipment use and on-road vehicle operations associated with workers commuting to and from the project site and haul truck trips. The estimated annual and total project construction emissions, shown in Tables 4-2 and 4-3, are all less than the thresholds of significance.

Annual Construction Emissions

Estimated annual construction emissions would total approximately 0.21 tons per year (tpy) of ROG, 5.53 tpy of NO_X, 6.42 tpy of CO, 0.01 tpy of SO_X, 8.06 tpy of PM_{10}, and1.16 tpy of $PM_{2.5}$. Estimated annual construction-generated emissions would not exceed the SJVAPCD'S significance thresholds.

Long-Term Operations

Emissions of criteria pollutants associated with the operation of the proposed project, shown in Table 4-3, are estimated to be a very small fraction of the thresholds of significance and are not expected to contribute cumulatively to the net increase of any pollutants.

AIR (c):) Would the project expose sensitive receptors to substantial pollutant concentrations? ***(Less than Significant Impact with Mitigation Incorporation)***

Toxic Air Pollutants

Pollutants of primary concern commonly associated with construction-related activities include toxic air contaminants such as diesel particulate matter (DPM) and fugitive dust. Within the project area, the potential to increase occurrences of Valley Fever may result from disturbing soils and increasing fugitive dust.

Construction may result in temporary increases in emissions of DPM associated with the use of off-road diesel-fueled equipment. Since health-related risks associated with diesel-exhaust emissions are primarily associated with long-term exposure and associated risk of contracting cancer, the calculation of cancer risk associated with exposure of toxic air contaminants are typically calculated based on a long-term (e.g., 70-year) period of exposure. Construction activities would occur over an approximate 42-month construction period, which would constitute roughly 5 percent of the typical 70-year exposure period. The use of diesel-fueled equipment for routine maintenance activities would be episodic and would occur over a relatively large area. It is also important to note that construction-generated emissions of PM would not exceed SJVAPCD's significance thresholds for localized impacts. In addition, implementation of Mitigation Measure AIR-3 would further minimize emissions of DPM from off-road equipment and vehicles. For these reasons and given the relatively high dispersive properties of DPM, exposure to construction generated DPM would not be anticipated to exceed applicable thresholds.

Localized Particulate Concentrations

Construction of the Project would include ground-disturbing activities which would be anticipated to result in increased emissions of airborne particulates but short-term construction and long-term operation of the Project would not result in increased daily onsite emissions of particulate matter that would exceed the SJVAPCD's screening thresholds for localized air quality impacts (Appendix 4). If uncontrolled, PM emissions could result in nuisance impacts to occupants of nearby residential dwellings. As a result, exposure to localized concentrations of PM would be considered a potentially significant impact, prior to mitigation implementation.

Mitigation Measure AIR-1 includes measures to ensure compliance with SJVAPCD Regulation VIII for the control of construction-generated emissions of fugitive dust, which would reduce nuisance impacts to occupants of nearby land uses. In addition, Mitigation Measures AIR-2 and AIR-3 would result in additional reductions of mobile-source PM emissions. With mitigation incorporated, this impact would be less than significant.

Carbon Monoxide

Localized concentrations of CO are typically associated with the idling of vehicles, particularly in highly congested areas. Construction of the proposed project would occur in a minimally populated area with low traffic counts and high emission dispersal rates; therefore, concentrations of CO are not likely to occur during construction. Vehicle trips generated during operations would be primarily associated with routine maintenance activities. In comparison to existing agricultural operations, implementation of the Project is not anticipated to result in overall long-term increases in vehicle trips along area roadways or at nearby intersections. As a result, implementation of the Project would not be anticipated to result in a substantial increase in localized CO concentrations having the potential to exceed applicable ambient air quality standards. This impact would be less than significant.

Valley Fever

As noted earlier in this report, Valley Fever is an infection caused by the fungus Coccidioides. Coccidioides spores can become airborne after contaminated soil and dust are disturbed.

Construction activities would include ground-disturbing activities, which could result in an increased potential for exposure of nearby individuals and onsite construction workers to airborne spores. As a result, the potential for increased exposure and contraction of Valley Fever would be considered to have a potentially significant impact, prior to mitigation incorporation.

In addition to the dust control measures specified in Mitigation Measure AIR-1, implementation of Mitigation Measure AIR-2 would require the inclusion of additional measures in the dust control plan to minimize personnel and public exposure to potential Valley Fever–containing dust. These measures would include a program for the training of onsite personnel and identification of measures to be implemented to minimize the potential for exposure to Valley Fever. With mitigation incorporated, this impact would be less than significant.

AIR (d): Would the project result in other emissions, such as those leading to odors, adversely affecting a substantial number of people?

Land uses that may result in potential odor problems include agriculture, wastewater treatment plants, food processing and rendering facilities, chemical plants, composting facilities, landfills, waste transfer stations, and dairies. The proposed project would not result in the creation or use of major sources of odorous emissions. Therefore, the project would not create objectionable odors that would affect a substantial number of people and odor impacts would be less than significant.

4.4 BIOLOGICAL RESOURCES (BIO)

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
Would the Project:				
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	☐	☒	☐	☐
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	☐	☐	☒	☐
c) Have a substantial adverse effect on state or federally protected wetlands (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	☐	☒	☐	☐
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?	☐	☐	☒	☐
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?	☐	☐	☐	☒
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?	☐	☐	☐	☒

4.4.1 Environmental Setting

The San Joaquin River and associated grassland and valley foothill riparian habitats adjacent to cropped lands lie along the Project area's northern boundary. Several ecologically important conservation areas occur just beyond the project area, have some area within the project area, or lie entirely within the project area (Table 4-4). Portions of the western project area boundary are bordered by the James Bypass, the Mendota Wildlife Area, which is bisected by the Fresno Slough, the Alkali Sink Ecological Reserve just northeast of the Mendota Wildlife Area, and a State-owned conservation easement. These areas are conserved and managed by the California Department of Fish and Wildlife (CDFW).

Table 4-4: Ecologically Important Conservation Areas Adjacent to or within the Project Area

Conservation Area	No. of Acres	Activities	Habitat Type(s)
Mendota Wildlife Area	11,800	Wildlife viewing, fishing, restricted hunting	Primarily seasonally flooded freshwater emergent wetland; open water; valley foothill riparian; dispersed alkali sink scrub (adjacent to MAGSA area)
Alkali Sink Ecological Reserve	930	Wildlife viewing	Alkali sink scrub; annual grassland (within MAGSA area)
Kerman Ecological Reserve	1,800	Wildlife viewing, hunting w/ shotgun	Primarily annual grassland; dispersed northern claypan vernal pool and desert alkali scrub (within MAGSA area)
Source: CDFW 2021a			

The following discussion of the affected environment for the Project area was informed by a Project-specific literature review and reconnaissance level field survey in November 2021 (Tetra Tech 2022; Appendix 5).

Agriculture

The Project area consists of actively managed orchards, vineyards, row crops, scattered poultry and dairy product agricultural uses, and a few agricultural product processing facilities (tree nut hulling, raisin, and citrus processors/packers). Agricultural crops including but not limited to almond (*Prunus dulcis*) and pistachio (*Pistacia vera*) orchards, various stone fruit orchards, grape (*Vitus spp*.), alfalfa (*Medicago sativa*), and barley (*Hordeum spp*.) cover the vast majority of the MAGSA area.

Plants

Roadsides in agricultural areas and rows between orchards and vineyards were sparsely vegetated and intentionally maintained to be relatively free of vegetation, but annual/biennial broadleaf ruderal weed species are the dominant vegetation in these areas with lesser amounts of introduced annual and perennial grasses. Broadleaf species recognizable during the field survey included hairy fleabane (*Conyza bonariensis*), tumble pigweed (*Amaranthus albus*), Russian thistle (*Salsola kali*), and jimson weed (*Datura stramonium*). Narrow-leaf milkweed (*Asclepias fascicularis*) and goldenrod (*Solidago* spp.) were observed adjacent to or within the James Bypass area. Annual and perennial grasses included Bermuda grass (*Cynodon dactylon*), Johnson grass (*Sorghum halepense*), crabgrass (*Digitaria* spp.), and ryegrass (*Lolium* spp).

Woody vegetation other than orchards and vineyards or ornamental trees and shrubs planted at settlements is minimal. Riparian areas in the James Bypass adjacent to the Mendota Wildlife Area just beyond the project area contain established shrubs and trees. In the Project area, one area of note was observed adjacent to an impoundment near orchards in the northeastern portion of the Project area where a stand of narrowleaf willow (*Salix exigua)* had established. Goodding's black willow were observed as single scattered trees adjacent to ditches within the Project area and as many established riparian trees west of the Project area near the Mendota Wildlife Area and James Bypass.

Emergent wetland vegetation was found outside of the Project area and away from agriculture-dominated land uses in the shallow, permanently flooded areas in the James Bypass adjacent to the Mendota Wildlife Area, but limited emergent vegetation composed of hardstem bullrush (*Schoenoplectus acutus*) was well established around the shallow fringe areas of an impounded drainage north of SR 180 in the upper northwest portion of the Project area.

Wildlife

Few wildlife, mostly avian species, were observed during the survey. The low diversity of wildlife species likely using the Project area is due to large-scale conversion to agriculture, development, and continual human presence in an area that once supported native riparian habitats, marshes, seasonal wetlands, and perennial grasslands. Within the Project area, observations included red-tailed hawk (*Buteo jamaicensis*), red-winged blackbird (*Agelaius phoeniceus*), American crow (*Corvus brachyrhynchos*), American robin (*Turdus migratorius*), mourning dove (*Zenaida macroura*), western scrub jay (*Aphelocoma californica*), killdeer (*Charadrius vociferus*), barn owl (*Tyto alba*), great egret (*Ardea alba*), great blue heron (*Ardea herodias*), American coot (*Fulica americana),* mallard (*Anas platyrhynchos*), and coyote (*Canis latrans*).

Other wildlife species typical of the southern San Joaquin Valley and tolerant of agricultural areas with frequent disturbances would occur throughout the Project area at different times of the year. Row crops, orchards, and vineyards are intensively managed and frequently disturbed, and available habitats are highly fragmented and therefore of limited value. Functioning wildlife corridors are primarily beyond the Project area in the James Bypass, San Joaquin River corridor and the CDFW reserves and easements to the west. Agricultural fields that are fallowed and rights-of-way within the Project area may serve as wildlife corridors for some adaptable species but are sparse and highly fragmented.

Special Status Plants, Wildlife, and Natural Communities

The Project's biological resources team reviewed the U.S. Fish and Wildlife Service (USFWS) Information for Planning and Consultation (IPaC) database, which lists species protected under the federal Endangered Species Act (ESA) and other protected resources such as critical habitat and migratory birds under the USFWS jurisdiction that are known or expected to occur within the project area or vicinity. The California Natural Diversity Database (CNDDB) was also queried for biological records of occurrence, or detections, for special status species and natural communities reported within the 10 U.S. Geological Survey 7.5-by 7.5-minute quadrangles for the Project area (CDFW 2021b). Plant and wildlife species and natural communities reported are shown in Tables 4-5 and 4-6.

Table 4-5. Special Status Species that May Occur within the Project Area and Vicinity

Scientific Name	Common Name	Fed. Status	State/CNPS Status	Occurrence within the Project Area [1]
Birds				
Agelaius tricolor	Tricolored blackbird	None	T, SSC/-	Possible
Athene cunicularia	Burrowing owl	None	SSC/-	Possible
Buteo swainsoni	Swainson's hawk	None	T/-	Possible
Charadrius montanus	Mountain plover	None	SSC/-	Possible
Coccyzus americanus occidentalis	Western yellow-billed cuckoo	T	E/-	Absent

Scientific Name	Common Name	Fed. Status	State/CNPS Status	Occurrence within the Project Area [1]
Falco columbaris	Merlin	None	None/-	Absent
Plegadis chihi	White-faced ibis	None	None/-	Possible
Riparia riparia	Bank swallow	None	T/-	Possible
Mammals				
Ammospermophilus nelsoni	Nelson's antelope squirrel	None	T/-	Absent
Dipodomys ingens	Giant kangaroo rat	E	E/-	Absent
Dipodomys nitratoides exilis	Fresno kangaroo rat	E	E/-	Absent
Eumops perotis californicus	Western mastiff bat	None	SSC/-	Absent
Lasiurus blossevillii	Western red bat	None	SSC/-	Unlikely
Myotis yumanensis	Yuma myotis	None	None/-	Absent
Perognathus inornatus	San Joaquin pocket mouse	None	None/-	Absent
Taxidea taxus	American badger	None	SSC/-	Possible
Vulpes macrotis mutica	San Joaquin kit fox	E	T/-	Possible
Reptiles				
Anniella pulchra	Northern California legless lizard	None	SSC/-	Absent
Emys marmorata	Western pond turtle	None	SSC/-	Absent
Gambelia sila	Blunt-nosed leopard lizard	E	E, FP/-	Absent
Masticophis flagellum ruddocki	San Joaquin coachwhip	None	SSC/-	Absent
Phrynosoma blainvillii	Coast horned lizard	None	SSC/-	Absent
Thamnophis gigas	Giant garter snake	T	T/-	Possible
Thamnophis hammondii	Two-striped gartersnake	None	SSC/-	Absent
Amphibians				
Ambystoma californiense	California tiger salamander (Central CA DPS)	T	T/-	Absent
Rana draytonii	California red-legged frog	T	SSC/-	Absent
Spea hammondii	Western spadefoot	None	SSC/-	Absent
Fishes				
Hypomesus transpacificus	Delta smelt	T	T/-	Absent
Invertebrates				

Scientific Name	Common Name	Fed. Status	State/CNPS Status	Occurrence within the Project Area [1]
Branchinecta longiantenna	Longhorn fairy shrimp	E	None/-	Absent
Branchinecta lynchi	Vernal pool fairy shrimp	T	None/-	Absent
Lepidurus packardi	Vernal pool tadpole shrimp	E	None/-	Absent
Linderiella occidentalis	California linderiella	None	None/-	Possible
Plants				
Atriplex cordulata var.cordulata	Heartscale	None	None/1B.2	Absent
Atriplex cordulata var.erecticaulis	Earlimart orache	None	None/1B.2	Absent
Atriplex coronate var. vallicola	Lost Hills crownscale	None	None/1B.2	Absent
Atriplex depressa	Brittlescale	None	None/1B.2	Absent
Atriplex minuscula	Lesser saltscale	None	None/1B.1	Absent
Atriplex persistens	Vernal pool smallscale	None	None/1B.2	Absent
Atriplex subtilis	Subtle orache	None	None/1B.2	Absent
Chloropyron palmatum	Palmate-bracted bird's beak	E	E/1B.1	Absent
Delphinium recurvatum	Recurved larkspur	None	None/1B.2	Absent
Eriastrum hooveri	Hoover's eriastrum	Delisted	None/4.2	Absent
Eryngium spinosepalum	Spiny-sepaled button-celery	None	None/1B.2	Absent
Lasthenia chrysantha	Alkali-sink goldfields	None	None/1B.2	Absent
Layia munzii	Munz's tidy tips	None	None/1B.2	Absent
Monolopia congdonii	San Joaquin woollythreads	E	None/1B.2	Absent
Puccinellia simplex	California alkali grass	None	None/1B.2	Absent
Sagittaria sanfordii	Sanford's arrowhead	None	None/1B.2	Unlikely

Scientific Name	Common Name	Fed. Status	State/CNPS Status	Occurrence within the Project Area [1]

[1]**Occurence within the project area:**
Absent: No suitable habitat exists within the Project area and outside of CDFW lands.
Unlikely: No suitable natural habitat exists within the Project area but may exist in the vicinity outside of CDFW lands, or a less than suitable man-made environment may substitute for the natural habitat in the vicinity.
Possible: Less than suitable natural or man-made habitat may occur within the Project area.
Federal status:
E Listed as endangered under the Federal ESA
T Listed as threatened under the Federal ESA
State Status:
E Listed as endangered under the California ESA
T Listed as threatened under the California ESA
SSC Species of concern as identified by the CDFW
FP Fully protected as identified by the CDFW
CNPS Listing:
1B Plant species that are rare, threatened, or endangered in California and elsewhere
4 Plant species that have limited distribution or infrequent throughout a broader area in California
2B Plants considered rare, threatened, or endangered in California, but more common elsewhere
Threat Extension Codes: .1 – Seriously threatened in CA, .2 – Moderately threatened in CA

Table 4-6. Sensitive Rare Natural Communities That Occur in the Project Area or Vicinity

Community Name	Brief Description
Northern Claypan Vernal Pool	Low, amphibious, herbaceous community dominated by annual grasses and herbs; characterized by very low microrelief and small to large pools.
Valley Sacaton Grassland	Tussock-forming grassland dominated by alkali sacaton (*Sporobolus airoides);* usually on sites intergrading with northern claypan vernal pool. Rare and often degraded from past land use.
Coastal and Valley Freshwater Marsh	Usually still, permanently flooded freshwater sites dominated by perennial, emergent monocots (*Schoenoplectus acutus, Typha* spp.).
Valley Sink Scrub	Strongly alkaline, saline playa-like depressions which are seasonally to intermittently flooded responding to localized rainfall; usually dominated by alkali-tolerant Chenopodiaceae.

Table 4-5 indicates 16 listed or otherwise special status plant and 32 listed or otherwise special status wildlife species that were evaluated for their potential to occur within the Project area. For each species, an evaluation of the presence of suitable habitat, information for relevant CNDDB detections, and the potential for impacts from the proposed project is summarized in Appendix 5.

Two plant species evaluated for the Project area and vicinity, palmate bracted bird's beak and San Joaquin woollythreads, have federal ESA and/or state ESA listing. These species would not be expected to occur, have not been recorded as occurring within the Project area, and no suitable habitat for these species occurs within the Project area outside of the CDFW reserves. No listed or otherwise special status plant species were observed within the Project area during the survey. Though some special status plant species have historically been recorded as occurring within the Project area and vicinity, the Project area does not provide suitable habitats outside of the CDFW lands for these plant species and their occurrence is not expected due to the large-scale conversion of the area's natural habitats to agricultural uses and development.

Sixteen of the wildlife species evaluated for the Project area and vicinity have federal ESA or state ESA listing or candidate status. Of these, two have the potential to be impacted by the proposed project due to presence of potential habitat (Table 4-5). In addition, six species with special status in California but not also having federal or state ESA status have the potential to be impacted by the proposed project due to presence of potential habitat (Table 4-5). No listed or otherwise special status wildlife species were observed within the Project area during the biological reconnaissance survey. No special status natural communities having potential to support special status wildlife species were observed within the Project area outside of the CDFW reserves during the survey. No CDFW lands were accessed during the biological reconnaissance survey, but habitats in the eastern edge of the Mendota Wildlife Area were observed from points just east of the area.

Wetlands, Other Waters, and Groundwater Dependent Ecosystems

A query of the National Wetlands Inventory (NWI) and Wetlands Mapper, which produces *reconnaissance level information* for the location, type, and size of potential wetlands and deepwater habitats based on vegetation, visible hydrology, and geography, depicts areas of riverine wetland, freshwater forested/shrub wetland, freshwater emergent wetland, and freshwater pond wetland within the proposed Project area. These areas were visited during the reconnaissance field survey and again during a formal aquatic resources delineation (ARD). The formal ARD was conducted on May 3-5, 2022, to describe, characterize, and report on the irrigation canal and ditch features since the Project will have two possible diversion points to lift or divert water away from the Mendota Pool before being conveyed east through a bi-directional system of constructed canals to recharge facilities. The ARD surveyed for potential jurisdictional Waters of the U.S. following accepted U.S. Army Corps of Engineers (USACE) methodology.

The hydrology of the entire region has been significantly and permanently altered. No natural surface water features occur in the MAGSA boundary. Most areas visited throughout the Project area no longer support wetlands due to manipulation of the natural hydrology as needed to support agricultural uses, are depicted in recent aerial photography as row and field crops, orchards, vineyards, or another agricultural use, and were field verified as areas occupied by row and field crops, orchards, vineyards, or another agricultural use such as tailwater or stock ponds. Surface water features are limited to irrigation runoff ditches and canals, few stock ponds, and usually lined effluent capture ponds. Surface water was observed in some canals and ditches, but most were dry. These excavated features in uplands are characterized by controlled flows and channel forms that are not influenced by channel-forming processes and discharge patterns associated with the local hydrologic regime. Precipitation is not a significant source of hydrology within the review area or the region, and groundwater is the primary source of irrigation water in MAGSA.

No wetlands were delineated in the ARD review area, which consisted of approximately 1,500 acres within MAGSA where project infrastructure construction and operations are planned in the main canal alignments. Approximately 76 acres of non-wetland waters were delineated in the ARD review area. The non-wetland waters (approximately 106,500 linear feet) were mainly linear agricultural irrigation water delivery conveyance and/or runoff (tailwater) and canal features which are manmade and excavated in uplands. The jurisdictional status of these features is under review by the USACE Sacramento District.

In addition to the NWI, the Natural Communities dataset published by the California Department of Water Resources was consulted prior to the field survey. These data do not represent the agency's determination of a groundwater dependent ecosystem (GDE) but are intended for use by GSAs or others as an aid in identifying GDEs in California and includes two habitat classes associated with groundwater: (1) wetland features commonly associated with the surface expression of groundwater under natural, unmodified conditions; and (2) vegetation types commonly associated with the sub-surface presence of groundwater. The wetland features identified in this dataset most often align with a subset of the NWI dataset, and the vegetation features include large trees such as sequoia (*Sequoia sempervirens*), Douglas-fir (*Pseudotsuga menziesii*), and Goodding's black willow (*Salix gooddingii*), and vegetation communities, such as riparian mixed hardwoods, willows, alkaline mixed grasses, and wet meadows. The dataset is limited, and a thorough understanding of geology, groundwater elevations, hydrology, and land use of a certain area is necessary for positive identification of groundwater dependent ecosystems (Klausmeyer et al., 2018).

Given that the average depth of groundwater in MAGSA is very deep, vegetation communities which are likely indicative of potential GDEs, such as Goodding's black willow stands within the Project area are not likely to be hydrologically supported by groundwater. Very few large trees were observed throughout the Project area, and they are associated with settlement areas that are irrigated. Some portions or all of the CDFW reserves habitats in and adjacent to the Project area would qualify as GDEs.

4.4.2 Regulatory Setting

4.4.2.1 Federal

Federal Endangered Species Act (FESA). The FESA protects plants and wildlife that are listed as endangered or threatened by the USFWS and National Oceanic and Atmospheric Administration (NOAA) Fisheries. Section 9 of the FESA prohibits the taking of listed wildlife, where taking is defined as "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in such conduct" (50 CFR 17.3). For plants, this statute governs removing, possessing, maliciously damaging, or destroying any listed plant on Federal land and removing, cutting, digging up, damaging, or destroying any listed plant on non-Federal land in knowing violation of state law (16USC1538). Pursuant to Section 7 of the FESA, Federal agencies are required to consult with the USFWS if their actions, including permit approvals or funding, could adversely affect a listed plant or wildlife species or its critical habitat. Through consultation and the issuance of a biological opinion, the USFWS may issue an incidental take statement allowing take of the species that is incidental to another authorized activity, provided the action will not jeopardize the continued existence of the species. Section 10 of the FESA provides for issuance of incidental take permits to private parties, provided a Habitat Conservation Plan (HCP) is developed.

Migratory Bird Treaty Act (MBTA). The MBTA implements international treaties devised to protect migratory birds and any of their parts, eggs, and nests from activities such as hunting, pursuing, capturing, killing, selling, and shipping, unless expressly authorized in the regulations or by permit. As authorized by the MBTA, the USFWS issues permits to qualified applicants for the following types of activities: falconry, raptor propagation, scientific collecting, special purposes (rehabilitation, education, migratory game bird propagation, and salvage), take of depredating birds, taxidermy, and waterfowl sale and disposal. The regulations governing migratory bird permits are in 50 CFR part 13 General Permit Procedures and 50 CFR part 21 Migratory Bird Permits. The State of California has incorporated the protection of birds of prey in Sections 3800, 3513, and 3503.5 of the California Department of Fish and Game (CDFG) Code.

Federal Clean Water Act (CWA). The Federal Clean Water Act's (CWA's) purpose is to "restore and maintain the chemical, physical, and biological integrity of the nation's waters." Section 404 of the CWA prohibits the discharge of dredged or fill material into waters of the United States without a permit from the U.S. Army

Army Corps of Engineers (ACOE). The definition of waters of the United States includes rivers, streams, estuaries, the territorial seas, ponds, lakes, and wetlands. Wetlands are defined as those areas "that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions (33 CFR 328.3 7b)." The USEPA also has authority over wetlands and may override an ACOE permit. Substantial impacts to wetlands may require an individual permit. Projects that only minimally affect wetlands may meet the conditions of one of the existing Nationwide Permits. A

Water Quality Certification or Waiver pursuant to Section 401 of the CWA is required for Section 404 permit actions; this certification or waiver is issued by the RWQCB.

Bald and Golden Eagle Protection Act. The Bald and Golden Eagle Protection Act (16 USC 668-668c) prohibits anyone, without a permit issued by the Secretary of the Interior, from "taking" bald or golden eagles, including their parts, nests, or eggs. The Act provides criminal penalties for persons who "take, possess, sell, purchase, barter, offer to sell, purchase or barter, transport, export or import, at any time or any manner, any bald eagle ... [or any golden eagle], alive or dead, or any part, nest, or egg thereof." The Act defines "take" as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb."

4.4.2.2 State

The California Endangered Species Act (CESA). The CESA generally parallels the main provisions of the FESA, but unlike its Federal counterpart, the CESA applies the take prohibitions to species proposed for listing (called candidates by the state). Section 2080 of the CDFG Code prohibits the taking, possession, purchase, sale, and import or export of endangered, threatened, or candidate species, unless otherwise authorized by permit or in the regulations. Take is defined in Section 86 of the CDFG Code as to "hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill." The CESA allows for take incidental to otherwise lawful development projects. State lead agencies are required to consult with the CDFG to ensure that any action they undertake is not likely to jeopardize the continued existence of any endangered, threatened, or candidate species or result in destruction or adverse modification of essential habitat. The CDFG administers the act and authorizes take through Section 2081 agreements (except for designated fully protected species).

California Fish and Wildlife Code Sections 1600-1616. Under Sections 1600-1616, CDFW regulates all diversions, obstructions, or changes to the natural flow or bed, channel, or bank of any river, stream or lake, which support fish or wildlife (i.e., bed to bank). The CDFW defines a "stream" (including creeks and rivers) as "a body of water that flows at least periodically or intermittently through a bed or channel having banks and supports fish or other aquatic life. This includes watercourses having surface or subsurface flow that supports or has supported riparian vegetation." The CDFW has interpreted the term "streambed" to encompass all portions of the bed, banks, and channel of any stream, including intermittent and ephemeral streams, extending laterally to the upland edge of riparian vegetation. Construction and maintenance actions that may affect the streambed or divert water from a stream or lake would be subject to creation of a Lake and Streambed Alteration Agreement under Section 1602. This agreement would include measures to protect fish, wildlife, and vegetation that may be affected during construction in the streambed.

California Fish and Wildlife Code Sections 3503 and 3503.5 Protection of Bird Nests and Raptors. Section 3503 of the California Fish and Game Code states that it is unlawful to take, possess, or needlessly destroy the nest or eggs of any bird. Section 3503.5 specifically states that it is unlawful to take, possess, or destroy any raptors (i.e., species in the orders falconiformes and strigiformes), including their nests or eggs. Typical violations of these codes include destruction of active nests resulting from removal of vegetation in which the nests are located. Violation of Section 3503.5 could also include failure of active raptor nests resulting from disturbance of nesting pairs by nearby project construction. This statute does not provide for the issuance of any type of incidental take permit.

California Fish and Wildlife Code Fully Protected Species. Protection of fully protected species is described in Sections 3511, 4700, 5050, and 5515 of the CDFW Code. These statutes prohibit take or possession of fully protected species and do not provide for authorization of incidental take of fully protected species.

Native Plant Protection Act. Regarding listed rare and endangered plant species, the CESA defers to the California Native Plant Protection Act (NPPA) of 1977 (CDFG Code Sections 1900 to 1913), which prohibits importing of rare and endangered plants into California, and the taking and selling of rare and endangered plants. The CESA includes an additional listing category for threatened plants that are not protected pursuant to NPPA. In this case, plants listed as rare or endangered pursuant to the NPPA are not protected pursuant to CESA but can be protected pursuant to the CEQA. In addition, plants that are not state listed, but that meet the standards for listing, are also protected pursuant to CEQA (Guidelines, Section 15380). In practice, this is generally interpreted to mean that all species on lists 1B and 2 of the CNPS Inventory potentially qualify for protection pursuant to CEQA, and some species on lists 3 and 4 of the CNPS Inventory may qualify for protection pursuant to CEQA. List 3 includes plants for which more information is needed on Taxonomy or distribution. Some of these are rare and endangered enough to qualify for protection pursuant to CEQA. List 4 includes plants of limited distribution that may qualify for protection if their abundance and distribution characteristics are found to meet the standards for listing.

California Lake and Streambed Alteration Agreement. Sections 1600 through 1616 of the CDFW Code require that a Lake and Streambed Alteration Program Notification Package be submitted to the CDFW for "any activity that may substantially divert or obstruct the natural flow or substantially change the bed, channel, or bank of any river, stream, or lake." The CDFW reviews the proposed actions and, if necessary, submits to the applicant a proposal for measures to protect affected fish and wildlife resources. The final proposal on which the CDFW and the applicant agree is the Lake and Streambed Alteration Agreement. Often, projects that require a Lake and Streambed Alteration Agreement also require a permit from the ACOE pursuant to Section 404 of the CWA. In these instances, the conditions of the Section 404 permit and the Lake and Streambed Alteration Agreement may overlap.

4.4.2.3 County and Regional

Fresno County General Plan. The Fresno County General Plan addresses goals and policies relevant for Biological Resources within the Project Area in the Wetland and Riparian Areas (Section D), Fish and Wildlife Habitat (Section E), and Vegetation (Section F) sections of *Part 2: Open Space and Conservation Element* of the plan.

4.4.3 Potential Impacts

BIO a): Would the Project have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?

(Less than Significant Impact with Mitigation Incorporated). MAGSA, in coordination with the Bureau of Reclamation, has prepared a Biological Evaluation (BE) to document potential effects to ESA listed species, and has conducted informal consultation with USFWS (Tetra Tech 2022). The BE indicated that the only two federally listed species that may occur in the project area include the San Joaquin kit fox and the giant garter snake, and concluded that the project may affect, but would not adversely affect, these species assuming mitigation measures are incorporated. USFWS has provided a letter concurring with these findings (USFWS 2024; Appendix 6).

Potential habitats observed within the Project area, outside of the CDFW reserves, include limited area of manmade habitats such as impoundments with fringing emergent wetland habitat and irrigation and drainage ditches. These areas may substitute for natural habitat utilized by species dependent on permanently or seasonally flooded habitats but are only marginally suitable due to continual disturbance and human presence. Also, burrowing owl, Swainson's hawk, and San Joaquin kit fox may nest/den in or near rights-of-way and frequently disturbed agricultural zones or hunt preferred prey in agriculture crops.

Although MAGSA intends to avoid potential habitats for these species, the potential for them to occur within the Project area still exists. Therefore, incorporation of mitigation measures BIO-1 through BIO-8 will ensure that impacts to listed or otherwise special status species would be reduced to less than significant with mitigation incorporation.

Species with aquatic or amphibious habitat requirements

- **Potential to Occur:** Although no special status species with these habitat requirements were observed during the biological reconnaissance survey, it is possible for California linderiella, giant garter snake, and tricolored blackbird to occur within the Project area or immediate vicinity.

  California linderiella requires vernal pool habitat which occurs in the Kerman and Alkali Sink Ecological Reserves but may also utilize man-made stock ponds, reservoirs, and ditches, which do occur in the Project area, as habitat. Emergent bulrush wetland habitat adjacent to permanently flooded/ponded shallow water habitat occurs over a limited extent within the Project area and immediate vicinity and may be suitable habitat for giant garter snake and tricolored blackbird. These areas may also offer suitable amphibian/reptilian basking and dispersal upland habitat if it were not frequently disturbed by agricultural uses. No rice fields occur in MAGSA or adjacent to MAGSA.

- **Potential Impacts:** Construction and ground-disturbing activities, including excavation, temporary stockpiling, and heavy equipment presence would occur in inundated features of the Mendota Pool or near manmade features such as agricultural canals offering suitable habitat for the more adaptable of these species like the giant garter snake. However, the giant garter snake is scarce throughout its Central Valley Range. Construction and operation of the Project may therefore result in adverse effects to species with aquatic or amphibious habitat requirements. The project proponent will implement the avoidance and mitigation measures under BIO-2 through BIO-4. By implementing these measures, the potential impacts would be reduced to a level of less than significant.

Burrowing owl

- **Potential to Occur:** Burrowing owls in agricultural environments may use roadsides, fallow fields, and water conveyance structures (earthen ditches, open canals, and drains) surrounded by crops to nest. They are tolerant of human presence. Mammal burrows, like those excavated by the California ground squirrel and observed in various portions of the project area, are also utilized by burrowing owls for nesting. Culverts and pipes may also be used as nest sites.

- **Potential Impacts:** Ground-disturbing activities, including excavation, temporary stockpiling, and heavy equipment presence, during the proposed project's construction may result in destruction of burrowing owl nests and/or burrowing owl injury and mortality. This would constitute a violation of state regulations and would be considered a significant impact. The project proponent will implement the avoidance and mitigation measures under BIO-5. By implementing these measures, the potential impacts would be reduced to a level of less than significant.

Swainson's hawk

- **Potential to Occur:** Several mature trees found within the project area offer nesting habitat for Swainson's hawks. Such trees located in farm residence settlement areas are generally well outside of the area that would be affected by construction. Potential foraging habitat occurs within the project area where field crops and a few weedy and fallowed fields are found. Other areas are intensively managed orchards and row crops that are unlikely to be utilized by Swainson's hawks for foraging.

- **Potential Impacts:** Swainson's hawks may use larger trees in the project area for nesting. Excavation occurring during construction near these trees during the nesting season of February 1–August 31 may result in nest abandonment and directly and adversely affect the hawk's ability to successfully reproduce. This would constitute a violation of state and federal regulations and would be considered a significant impact. The project proponent will implement the avoidance and mitigation measures under BIO-6. By implementing these measures, the potential impacts would be reduced to a level of less than significant.

Fresno kangaroo rat

- **Potential to Occur:** Burrows were found at several locales in and adjacent to the Action Area, along dirt roads, ditches, and at the edges of fields and facilities. Most burrow entrances were between 3-5 inches wide, typical of ground squirrel burrows and larger than typical Fresno kangaroo rat (FKR) burrows. In May 2022, reconnaissance-level surveys targeted an area thought to have conditions potentially supporting FKR, including a fallow field and soil-capped inactive landfill covering approximately 70 acres. However, the area was found to have less than suitable to poor habitat conditions for kangaroo rats (S. McDonald, electronic mail, 20 May 2022). The area had signs of high usage by valley pocket gophers (*Thomomys bottae*) and regular usage by a small population of California ground squirrels (*Otospermophilus beecheyi*). Although the habitat was poor, it is not regularly disturbed and a few smaller areas within the larger fallow field may support kangaroo rats. Subsequent surveys by USFWS biologists found that the habitat would not likely support FKR, and the species is considered absent from the project area.

- **Potential Impacts:** Since this species has been deemed absent from the project area by USFWS, there would be no impact.

San Joaquin kit fox

- **Potential to Occur:** The Project area is within the current and historic range of this species, and four San Joaquin kit fox (SJKF) occurrences are shown within the greater MAGSA boundary in the CNDDB database. However, occurrences are historical (> 20 yrs. old) (CDFW 2021). Intensively managed, frequently disturbed agricultural lands and development related to animal farming operations and crop production offer low-quality habitat for SJKF and their prey base. Aside from the ecological reserves, lands that surround the Action Area are similarly developed and of low quality. SJKF may disperse into agricultural areas if adequate prey species are available, but they would be unlikely to use the project area for any purpose other than to migrate between suitable habitat locations elsewhere in the region. SJKF may use the adjacent MWA, James Bypass, or the San Joaquin River corridors for dispersal.

- **Potential Impacts:** Potential impacts may occur if SJKF, active year-round, were to den in the project area. Squirrel burrows were observed in several areas on and around the project area during the reconnaissance survey (Appendix 5). Squirrel burrows could be modified and used by SJKF, though no SJKF or evidence of SJKF use were observed. SJKF may also den in human-made structures, such as culverts, abandoned pipes, and roadbed banks which occur throughout the project area, including the Main Canal alignment where excavation will occur. Disturbing SJKF dens or harming them during construction excavation activities would constitute a violation of state and federal regulations and would be considered a significant impact. The project proponent will implement the avoidance and mitigation measures under BIO-8. Therefore, the potential impacts will be reduced to a level of less than significant.

BIO b): Would the project have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?

(Less than significant impact). Limited riparian habitat occurs within the Project area. The San Joaquin River and associated valley foothill riparian habitats lie along the northern MAGSA boundary but would not be affected by project construction or operations. The pump stations would be located in an existing turnout and excavated canal with limited riparian habitat and adjacent to entirely agriculture land uses north of the James Bypass riparian habitat. Therefore, less than significant impact would occur to riparian habitat.

Four sensitive communities were identified by the CDFW as occurring within the Project and/or the Project vicinity. These community types are primarily associated with the CDFW reserves (Table 4-6). No Project actions would occur within these community types either within the CDFW reserves or elsewhere in the Project area; therefore, no impact would occur to sensitive natural communities.

BIO c): Would the project have a substantial adverse effect on state or federally protected wetlands (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?

(Less than significant impact with mitigation incorporation). The Project will have two possible diversion points to lift or divert water away from the Mendota Pool where temporary adverse effects to state or federally protected aquatic resources may occur during construction. The first of these is located where Jensen Ave., and the Jensen Canal, meet the eastern edge of the Mendota Wildlife Area. In this location, three pumps move water to the east through a conveyance under a set of railroad tracks to the Jensen Canal; however, this project would require replacement and upgrading of existing infrastructure for additional capacity. The second is at the northwest end of the James Bypass where it connects to the Fresno Slough. Similarly, there is a facility at this location that draws water from the Fresno Slough into an irrigation water conveyance canal, but it would need to be upgraded for additional capacity.

An ARD was completed for the project in June 2022 and submitted to the USACE Sacramento District for an Approved Jurisdictional Determination (AJD). The AJD, when received from the USACE, will be used to support the decisions about whether permits under CWA Sections 404 and 401 will be required.

The proposed construction action has potential to temporarily alter surface water quality at these Mendota Pool pump intake locations. Potential direct effects include increased suspended sediments and turbidity which would remain localized to the immediate work area and would be temporary, occurring only during installation and removal of work area isolations such as sandbag cofferdams or precast concrete barriers. It’s likely a minimal amount of fill would be placed in these waters during construction of the pump stations and culverts. Since water bank infrastructure is primarily being constructed in agriculture areas and is not expected to convert aquatic habitat from its existing condition to another habitat type, no substantial adverse effect would be expected. In addition to maintaining strict compliance with necessary CWA Section 404/401 permit requirements once issued, the Project proponent will implement the avoidance and mitigation measure BIO-4. By implementing this measure and additional BMPs specific to in-water work, the potential impacts would be reduced to a level of less than significant with mitigation incorporation.

BIO d): Would the project interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?

(Less than Significant Impact). Several areas adjacent to but outside of the proposed project area, including the James Bypass, Mendota Wildlife Area, Alkali Sink Ecological Reserve, and an undesignated State conservation easement, are likely used as wildlife corridors and native wildlife nursery areas. Areas with potential habitat will not be directly affected by the proposed Project. Rights-of-way, agricultural areas, and developed areas, even if regularly disturbed and fragmented, are likely used by native wildlife species such as fox, coyote, rabbit, and others at night for movement. Although numerous ditches and irrigation conveyance canals occur throughout the Project area, additional canals constructed for the Project may interfere with the movement of the limited wildlife using the Project area. Any canals will have regular crossings that can be used by wildlife, and this impact be less than significant.

The proposed project is located within the Pacific Flyway used by migratory bird species during annual migrations, and the Mendota Wildlife Area is an Important Bird Area of State significance. Seasonally flooded areas such as the Mendota Wildlife Area and occasionally flooded areas such as fallowed fields provide important stopover points for resting and foraging habitat for migratory waterfowl. Beneficial effects would likely occur in some years when recharge basins developed in eastern portions of the Project area serve as seasonal inundated habitat for migratory shorebirds and waterfowl. Any impacts would be less than significant.

BIO e): Would the project conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?

(No Impact). No local policies or ordinances protecting biological resources have been identified within the proposed Project area; therefore, no impact would occur.

BIO f): Would the project conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?

(No Impact). No adopted Habitat Conservation Plan (HCP), Natural Community Conservation Plan (NCCP), or other approved local, regional, or state habitat conservation plan extends into the proposed Project area. The draft *Aera Energy Southwest San Joaquin Valley HCP and NCCP* extends into Fresno County but not east of Interstate 5; therefore, no impact would occur.

4.5 CULTURAL RESOURCES (CUL)

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
Would The Project:				
a) Cause a substantial adverse change in the significance of a historical resource as defined in §15064.5?	☐	☒	☐	☐
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to §15064.5?	☐	☒	☐	☐
c) Disturb any human remains, including those interred outside of formal cemeteries?	☐	☒	☐	☐

This section relies on the information and findings presented in the Archaeological Resources Investigation for the Aquaterra Groundwater Bank Project (Tetra Tech 2023). The archaeological report details the results of the archaeological resources study and includes delineation of an Area of Potential Effects (APE); records searches conducted by the California Historical Resources Information System (CHRIS) Southern San Joaquin Valley Information Center (SSJVIC); Sacred Lands File (SLF) searches conducted by the California Native American Heritage Commission (NAHC); a review of historical topographic maps and aerial photographs; and pedestrian field surveys.

Tetra Tech archaeologists conducted a Class III Inventory / Phase 1 Cultural Resources Survey over the APE to identify historical resources or historical properties within the Project area. The purposes of the inventory and survey investigation were to assist with compliance with Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended (16 USC 470; 36 CFR Part 800) and CEQA, and to ensure that no significant adverse effects or impacts to historical resources would occur as a result of the construction of this project. The study included:

- A background records search and literature review to determine if any known archaeological sites were present in the project zone and/or whether the area had been previously and systematically studied by archaeologists;
- A search of the NAHC Sacred Lands File to determine if any traditional cultural places or cultural landscapes have been identified within the area;
- An on-foot, intensive inventory of the study area to identify and record previously undiscovered cultural resources and to examine known sites; and
- A preliminary assessment of any such resources found within the subject property.

Although the report is confidential and not available for public review (16 U.S. Code § 470hh, California Government Code § 6254.10), information from the report is used below in the description of baseline conditions, impact analysis, and recommended mitigation measures.

4.5.1 Environmental Setting

The proposed project area (or area of potential effects: APE) is defined as the area within the project boundary and adjacent areas to 200 feet. It is situated in the Great Central Valley of California, which has a long history of human occupation evident from the diversity of recorded cultural resources (i.e., archaeological and built environment) on the landscape. The Central Valley contained a mosaic of biological diversity that was supported by topographic, geological, climatic and hydrological conditions conducive to abundant resource availability (e.g., plants, animals, stone) and aboriginal populations broadly used the landscape south of the San Joaquin River and east of the Fresno Slough. Cultural resource types related to this use have been widely recorded within the region. The project is within the ancestral territory of the Northern Valley Yokuts, who occupied village and seasonal localities throughout the year. Historic use of the landscape is evident by recorded historic era resources primarily associated with agriculture such as historic refuse, structures, canals, and roads. The historic and contemporary disturbances to the landscape include agricultural fields of permanent and rotational crops, seasonal discing of fields in preparation for crops, and supporting infrastructure such as water conveyance systems, roads, farm outbuildings, residences, and other components of the built environment. Deposits within the APE consist of Pleistocene to latest Holocene aged alluvium deposits. Alluvium deposition occurring from the late Pleistocene to the latest Holocene has been deposited over the course of known human occupation in the region and may contain buried cultural deposits (Meyer et al. 2010). This is especially the case in areas near water sources with landforms suitable for habitation. Note that prior agricultural uses such as cultivation of various crops do not preclude the potential for significant resources to be present below the depth of cultivation within alluvium deposits. Secondly, although no longer in their original contexts, there is a possibility that disturbed soils contain tribal cultural resources that are important to tribes.

The record search identified 31 previously recorded resources within the APE: 13 prehistoric sites (Pitkachi Village, habitation sites, cemetery, mounds, lithic and groundstone scatters); 1 dual component (prehistoric/built environment: residence); 1 historic refuse site; and 16 built environment sites: residential structures, Hanford and Summit Lake railroad, Town of Bowles: Chinese American farming community, Big Sandridge Canal, earthen levee, Pacific Gas and Electric Company's (PG&E) Panoche-Kearney 230 kV transmission line, James Bypass – also termed Fresno Slough Bypass, James Irrigation District Lateral R Canal, Raisin City Dragways, and Gates-Gregg 230 kV Transmission line.

The 13 prehistoric archaeological resources (Pitkachi Village, P-10-000074, -000314, -000398, -000495, -000562, -000565, -000567, -0000784, -0021312, -005714, -005715, P-20-00301), one dual component site (P-10-000566), and one historic refuse (P-10-006134) archaeological resource have not been evaluated for eligibility listing to the CRHR or NRHP.

A total of seven built environment previously recorded and 15 newly recorded cultural resources were identified in the Project area (Table 4-7). Of these resources, none are considered historic properties pursuant to Section 106 of the National Historic Preservation Act (NHPA) and historical resources pursuant to CEQA Guidelines Section 15064.5. One of the built environment resources, P-10-004303 (Japanese Bowles buildings and general agricultural area) has not been evaluated for the National Register of Historic Places (NRHP) or the California Register of Historical Resources (CRHR). A built environment and geoarchaeological field study will be completed in Spring of 2024.

Table 4-7: Summary of Identified Cultural Resources

Primary No.	Time Period	Site Type/Name	NRHP Eligibility	CRHR Eligibility
Previously Recorded Resources				
P-10-003930	Historic/Built Environment	Structure: Hanford & Summit Lake Railway: tracks	Not Eligible.	Not Eligible.
P-10-004303	Historic/Built Environment	Japanese Bowles buildings and agricultural area.	Not Evaluated	Not Evaluated
P-10-006614	Historic/Built Environment	Structure: Built Environment: Panoche-Kearney 230 kilovolt transmission line	Not Eligible	Not Eligible
P-10-006640	Historic/Built Environment	Structure: Built Environment, Transmission Line: Gates-Gregg 230 kilovolt Transmission Line	Not Eligible	Not Eligible
P-10-000074	Prehistoric	Habitation	Not Eligible (no longer extant, site location within deep canal).	Not Eligible (no longer extant, site location within deep canal).
P-10-007057	Prehistoric	Isolate: a basalt flake	Not Eligible (no longer extant, site location within deep canal).	Not Eligible (no longer extant, site location within deep canal).
P-10-007058	Prehistoric	Isolate: a basalt flake	Not Eligible (no longer extant, site location within deep canal).	Not Eligible (no longer extant, site location within deep canal).
Archaeological Resources Identified as a Result of the Pedestrian Surface Survey				
P-10-007436	Historic	Historic-era refuse scatter.	Not Eligible	Not Eligible
P-10-007437	Historic	Historic-era refuse scatter, farm equipment, well.	Not Eligible	Not Eligible
P-10-007438	Historic	Historic-era refuse scatter.	Not Eligible	Not Eligible
P-10-007439	Historic	Historic-era refuse scatter.	Not Eligible	Not Eligible
P-10-007440	Historic	Historic-era refuse scatter.	Not Eligible	Not Eligible
P-10-007429	Historic	Isolate: clear glass fragment.	Not Eligible	Not Eligible

Primary No.	Time Period	Site Type/Name	NRHP Eligibility	CRHR Eligibility
P-10-007430	Prehistoric	Isolate: chert biface fragment.	Not Eligible	Not Eligible
P-10-007431	Prehistoric	Isolate: chert biface fragment.	Not Eligible	Not Eligible
P-10-007432	Prehistoric	Isolate: chert biface fragment.	Not Eligible	Not Eligible
P-10-007433	Historic	Isolate: broken green bottle shards (7-Up).	Not Eligible	Not Eligible
P-10-007434	Historic	Isolate: green glass shard, ceramic shards.	Not Eligible	Not Eligible
P-10-007434	Historic	Isolate: earthenware shard.	Not Eligible	Not Eligible
P-10-007441	Historic	Isolate: aqua glass shard.	Not Eligible	Not Eligible
P-10-007434	Historic	Isolate: colorless glass shard (Coca-Cola type)	Not Eligible	Not Eligible
P-10-007443	Historic	Isolate: two Jadeite plate fragments	Not Eligible	Not Eligible

The NAHC Sacred Lands File results were positive and consultation with tribes is required by the lead state agency under Assembly Bill 52. Tribal Cultural Resources and agency consultation is discussed in section 4.18.

4.5.2 Regulatory Setting

4.5.2.1 Federal

National Historic Preservation Act, Section 106: The principal federal law addressing cultural resources is the NHPA of 1966, as amended (16 United States Code [USC], Section 470), and its implementing regulations (36 Code of Federal Regulations 800), which primarily address compliance with Section 106 of the NHPA. The NHPA is the principal federal law guiding federal agency action pertaining to treatment of cultural, archaeological, and historic resources. Section 106 (54 USC Section 306108) of the NHPA requires that federal agencies consider the effects of their undertakings on "historic properties" listed or eligible for listing on the NRHP and give the Advisory Council on Historic Preservation and SHPO a reasonable opportunity to comment on the Undertaking. A historic property is "any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in the National Register of Historic Places" (54 USC Section 306108).

4.5.2.2 State

CEQA (Section 21084.1). This section requires a lead state agency determine whether a project could have a substantial adverse change in the significance of a historical resource or tribal cultural resources (Public Resource Code [PRC] Section 21074 [a][1][A]-[B]).

California Health and Safety Code, Sections 7052 and 7050.5. These sections state that it is a felony to disturb Native American burials. Section 7050.5 requires that construction or excavation be stopped in the vicinity of discovered human remains until the coroner can determine whether the remains are those of a Native American.

California Native American Historical, Cultural, and Sacred Sites Act. The act applies to both state and private lands. The Act requires that upon discovery of human remains, construction or excavation activity cease and that the county coroner be notified.

California Public Resource Code, Section 5097. This code section specifies the procedures to be followed in the event of an unexpected discovery of human remains on non-federal land. The disposition of Native American remains falls within the jurisdiction of the NAHC.

California Code Penal Code Part 1, Title 14, Section 622. This section states that every person, not the owner thereof, who willfully injures, disfigures, defaces, or destroys any object or thing of archaeological or historical interest or value, whether situated on private lands or within any public park or place, is guilty of a misdemeanor.

Assembly Bill 52. Under CEQA, AB 52 requires a lead agency to consult with any California Native American tribe that requests consultation and is traditionally and culturally affiliated with the geographic area of a proposed project.

4.5.2.3 County and Regional

Fresno County General Plan. The current plan, adopted in 2000, is in the process of being amended, and a public review draft was made available in July 2021 (Fresno County 2021a, 2021b, 2021c, 2021d). The Plan provides for a comprehensive, long-term framework designed to protect Fresno County's cultural resources (and other resources) while allowing for economic development. The General Plan's Historical and Cultural Goals and Policies applicable to the proposed project are as follows:

> ***Policy OS-J.1:*** The County shall require that discretionary development projects, as part of any required CEQA review, identify and protect important historical, archaeological, paleontological, and cultural sites and their contributing environment from damage, destruction, and abuse to the maximum extent feasible. Project-level mitigation shall include accurate site surveys, consideration of Project alternatives to preserve archaeological and historic resources, and provision for resource recovery and preservation when displacement is unavoidable.
>
> ***Policy OS-J.2****:* The County shall, within the limits of its authority and responsibility, maintain confidentiality regarding the locations of archaeological sites in order to preserve and protect these resources from vandalism and the unauthorized removal of artifacts.
>
> ***Policy OS-J.3****:* The County shall solicit the views of the local Native American community in cases where development may result in disturbance to sites containing evidence of Native American activity and/or sites of cultural importance.
>
> ***Policy OS-J.4****:* The County shall maintain an inventory of all sites and structures in the County determined to be of historical significance (Index of Historic Properties in Fresno County).
>
> ***Policy OS-J.5****:* The County shall support the registration of property owners and others of cultural resources in appropriate landmark designations (i.e., National Register of Historic Places, California Historical Landmarks, Points of Historical Interest, or Local Landmark).
>
> ***Policy OS-J.6:*** The County shall provide for the placement of historical markers or signs on adjacent County roadways and major thoroughfares to attract and inform visitors of important historic resource sites. If such sites are open to the public, the County shall ensure that access is controlled to prevent damage or vandalism.

Policy OS-J.7: The County shall use the State Historic Building Code and existing legislation and ordinances to encourage preservation of cultural resources and their contributing environment.

Policy OS-J.8: The County shall support efforts of other organizations and agencies to preserve and enhance historic resources for educational and cultural purposes through maintenance and development of interpretive services and facilities at County recreational areas and other sites.

4.5.3 Potential Impacts

CR a): Would the project cause a substantial adverse change in the significance of a historical resource as defined in §15064.5?

(Less than Significant Impact with Mitigation Incorporation) The SSJVIC record search identified seven previously recorded cultural resources within the Project area, including the Bowles Historic District (P-10-004303: Japanese American farmland/community and Buddhist church) that is potentially eligible to the NRHP and CRHR; sites P-10-003930 (railway tracks), P-10-006614 (Panoche-Kearney 230 kV transmission line), and P-10-006640 (Gates-Gregg 230 kV transmission line), which are not eligible to the CRHR; three prehistoric archaeological sites (a lithic scatter, lithic/ceramic scatter, lithic scatter/bedrock milling feature, and lithic scatter/bedrock milling features/hearth), and five historic sites (refuse scatters, glass and ceramic shards, chert fragments). The prehistoric and historic sites are ineligible for the CRHR.

Under CEQA, a significant impact could occur if the proposed project resulted in a substantial adverse change in the significance of a historical resource; such a change includes physical demolition, destruction, relocation, or alteration of the resource or its immediate surroundings such that the significance of the historical resource is materially impaired. Material impairment includes demolition or alteration in an adverse manner to those physical characteristics of the historical resource that convey its historical significant and that justify its inclusion, or eligibility for inclusion, in the California Register. The proposed project would not include the physical alteration of any historical resources in the APE. Any alterations to the immediate surroundings resulting from the proposed project would be minimal since the features proposed for construction are consistent with the surrounding landscape and land uses. Therefore, the proposed project would have a less than significant impact to any historical resources.

Any subsurface resources located within the recharge basins would potentially be subjected to temporary flooding, which may result in erosion and/or siltation (i.e., burying), depending on the rate of water flow at each site's location; or through the construction of open channel systems. If water flows are sufficiently low enough so as to only deposit sediments atop the resources, avoiding erosion and essentially capping them, this would be a beneficial impact that would protect the sites from surface disturbances. However, the rate of water flow at each site location is unclear.

Given the size of the APE, subsurface sampling will only provide information on a relatively small portion of the area that will be disturbed during construction. Therefore, if construction ground disturbance depths extend to native soils, there would be a potential to impact previously unrecorded subsurface cultural resources, including those that may qualify as historical properties, pursuant to Section 106 of the NHPA, or historical resources, pursuant to CEQA Guidelines Section 15064.5. If archaeological resources are discovered, impacts would be significant if the proposed project activities resulted in an adverse effect to, or caused a substantial adverse change in, the significance of an archaeological resource that qualifies as a historic property or historical resource. With implementation of Mitigation Measures CUL-1 and CUL-2, impacts to previously unrecorded cultural resources will be less than significant.

CR b): Would the project cause a substantial adverse change in the significance of an archeological resource as defined in §15064.5?

(Less than Significant Impact with Mitigation Incorporation) The three archaeological resources previously recorded (P-10-000074, P-10-007057, and P-10-007058) in the Project area were field checked during the pedestrian survey and are no longer extant and are presumably destroyed due to the construction of a deeply excavated canal that exists within the previously recorded resource locations. The remaining newly recorded archaeological resources identified within the Project area were evaluated and do not qualify as historic properties, pursuant to Section 106 of the NHPA, or historical resources, pursuant to CEQA Guidelines Section 15064.5, or unique archaeological resources, as defined in PRC Section 21083.2(g). The Project area consists of various ground disturbance levels that could extend below the layers of previous disturbances (specifically, main canal and laterals). Depending upon the Project area, the degree of sensitivity for subsurface archaeological resources ranges from very low to moderately high. It is possible that subsurface ground-disturbing construction activities in undisturbed deposits within the more sensitive locations of the Project area could encounter unrecorded subsurface archaeological deposits. If archaeological resources are discovered, effects/impacts would be significant if proposed project activities result in an adverse effect to or cause a substantial adverse change in the significance of an archaeological resource. Mitigation Measure CUL-1 requires worker training and CUL-2 requires a cultural resource monitoring and inadvertent discovery plan. Therefore, impacts to archaeological resources would be less than significant impact with mitigation incorporated.

CR c): Would the project disturb any human remains, including those interred outside of formal cemeteries?

(Less than Significant Impact with Mitigation Incorporation) No known cemeteries or human remains were identified within the Project area. Also, the land use designations for the Project area do not include cemetery uses. Therefore, the Proposed Project is not anticipated to affect/impact any human remains. However, since the nature of the Proposed Project would involve ground-disturbing activities, it is possible that such actions could unearth, expose, or disturb previously unknown human remains.

Federal and state laws require all project excavation activities to halt if human remains are encountered and the county coroner must be notified. Any discovery of human remains during Project-related activities would be treated in accordance with federal laws and PRC Section 5097.98 and Section 7050.5 of the State Health and Safety Code. Pursuant to State HSC § 7050.5, if human remains and/or cultural items defined by the Health and Safety Code, Section §7050.5, are inadvertently discovered during construction activities, all work within a 100-foot radius of the find or an area reasonably suspected to overlie adjacent remains (whichever is larger) will cease, the find will be flagged and protected for avoidance, and the Fresno County Coroner will be contacted immediately. The remains must be securely protected, and project personnel must ensure confidentiality of the find on a need-to-know basis and ensure that the remains are treated with dignity, not touched, moved, photographed, discussed on social media sources (e.g., Facebook, Twitter), or further disturbed. Work may not resume in the vicinity of the protected area until approvals are received by the lead state and federal agency.

The specific state regulations regarding proper handling of previously unknown human remains encountered during construction are specified above and the Project will comply with the state regulations to avoid significant impacts on human remains. In conjunction with the training, monitoring, and inadvertent discovery procedures identified in Mitigation Measures CUL-1 and CUL-2, impacts to human remains would be less than significant with mitigation incorporated.

4.6 ENERGY (ENE)

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
Would the Project:				
a) Result in potentially significant environmental impact due to wasteful, inefficient, or unnecessary consumption of energy resources, during project construction or operation?	☐	☐	☒	☐
b) Conflict with or obstruct state or local plan for renewable energy or energy efficiency?	☐	☐	☒	☐

4.6.1 Environmental Setting

Most of the natural gas and electricity used in the project area would be provided by Pacific Gas and Electric (PG&E), with some natural gas in the southeast corner of the project area provided by SoCal Gas. Primary uses of energy in the proposed project area are residences, agricultural stationary uses such as groundwater wells and surface water pumps, and agricultural mobile uses such as equipment and associated vehicles. Propane pumps associated with the proposed project would be refueled with truck deliveries to the pump stations as needed.

4.6.2 Regulatory Setting

4.6.2.1 Federal

There are no federal regulations relating to energy that are applicable to the Project or the Project site.

4.6.2.2 State

Warren-Alquist Act. The Warren-Alquist Act was created to respond to energy resource needs in the 1970's and created the California Energy Commission. The California Energy Commission, California Public Utilities Commission and the California Independent System Operator shape policies on energy standards, supply, and usage. California Energy Code is in Title 24, Part 6 of the CCR. It includes standards to increase energy efficiency in residential and non-residential buildings.

Clean Energy and Pollution Reduction Act. The Clean Energy and Pollution Reduction Act (SB 350) establishes clean energy, clean air, and greenhouse gas (GHG) reduction goals, including reducing GHG to 40% below 1990 levels by 2030 and to 80 percent below 1990 levels by 2050. SB 350 increases California's renewable electricity procurement goal from 33 percent by 2020 to 50 by 2030. This objective will increase the use of Renewables Portfolio Standard (RPS) eligible resources, including solar, wind, biomass, geothermal, and others. SB 350 also requires the state to double statewide energy efficiency savings in electricity and natural gas end uses by 2030.

4.6.2.3 County and Regional

San Joaquin Valley Air Pollution Control District Climate Change Action Plan (CCAP). In August 2008, the SJVAPCD Governing Board adopted the CCAP. The CCAP directed the District Air Pollution

Control Officer to develop guidance to assist Lead Agencies, project proponents, permit applicants, and interested parties in assessing and reducing the impacts of project specific GHG emissions on global climate change.

San Joaquin Valley Air Pollution Control District (SJVAPCD) Guidance for Addressing Greenhouse Gas Emissions. On December 17, 2009, the SJVAPCD adopted the guidance: Guidance for Valley Land-use Agencies in Addressing GHG Emission Impacts for New Projects under CEQA and the policy: District Policy – Addressing GHG Emission Impacts for Stationary Source Projects Under CEQA When Serving as the Lead Agency. The guidance and policy rely on the use of performance-based standards, otherwise known as Best Performance Standards (BPS), to assess significance of project specific greenhouse gas emissions on global climate change during the environmental review process, as required by CEQA.

4.6.3 Potential Impacts

ENE a): Would the potential project result in potentially significant environmental impact due to wasteful, inefficient, or unnecessary consumption of energy resources, during project construction or operation?

(Less Than Significant Impact) During construction, there would be a temporary increase in fuel demand (gasoline and diesel) from the use of construction equipment, truck trips, and vehicle trips generated by construction workers. The construction contractor will be required to ensure that they use the most fuel-efficient equipment and methods available. The minimum amount of grading and distribution of soils will be performed, and all excavated soils will be distributed within the project area rather than being hauled to a disposal facility. Most excavated soils will be used either in canal construction or to build recharge basin berms. Idling times will be limited, and any other BMP that may contribute to energy efficiency will be followed.

Construction equipment will be operated in accordance with Title 13, Division 3, Chapter 10 of the California Code of Regulations. This minimizes equipment idling time and eliminates resource wastefulness. Energy consumed during construction activities would not result in the wasteful, inefficient, and unnecessary consumption of energy. Impacts associated with construction would be less than significant.

Title 24 Building Energy Efficiency Standards provides guidance on construction techniques to maximize energy conservation. Contractors and owners are encouraged to use recycled materials and products originating from nearby sources to reduce materials costs. Materials used in construction and construction vehicle fuel energy would not involve the wasteful, inefficient, or unnecessary consumption of energy. Building efficiency standards would be applied to each pump station. Efficiency standards would also be applied to groundwater wells, in compliance with DWR Bulletin 74. Energy impacts associated with long-term operation of pump station buildings and groundwater wells would be less than significant.

Operations. Pumps will only be operated for receiving deposited waters to the groundwater bank, and when needed, to move extracted water back to the Mendota Pool for withdrawal. Energy usage to send extracted water to the Pool will be minimal, because MAGSA slopes down to the west, and most movement will be assisted by gravity. The pumps are expected to operate a maximum of 153 days per year (Table 4-8). Pumps used in this project will include electric, natural gas, and propane pumps. The amount of energy used during project operation would primarily correlate to the size of the proposed pump stations and the energy consumption of associated frequency of use, as well as to the extraction well pumps and any movement needed for extraction.

Table 4-8: Pump and Well Specifications

Pump and Well Specifications		Design Criteria[1]	Unit
Recovery System Required for Maximum Operations			
	Annual	148,000	AF
Recovery Well Station			
	Power	Electric	n/a
	Type	Centrifugal	n/a
	Estimated Pump Capacity[1]	2500	GPM
	Estimated Well Depth[1,2]	450	ft
	Estimated Typical Design Depth to GW during Extraction[3]	450	ft
	Estimated Power (calculated)	284	HP (ideal)
		209	kW
	Estimated Pump Efficiency (typical)[4]	50	%
	Estimated Power (calculated)	568	HP
		418	kW
Maximum Recovery Year			
	Period of Operation[1]	May - Sept	months
	Number of Days	153	days
	Number of Pumps operating simultaneously[1]	88	#
Estimated Annual Maximum Power Demand		**134,995**	**MWh**

Notes
1 Design Criteria for average recovery well station.
2 Well depths estimated in the 300 - 600 ft range. An average depth of 500 ft is assumed
3 Pumping recovery above Corcoran Clay.
4 Agricultural Pumping Efficiency Program. Center for Irrigation Technology.

Groundwater pumping. MAGSA estimates a 135 GWh electrical power demand for groundwater pumping of 148,000 AF from the recovery wells, assuming a year of maximum recovery, average groundwater pumping depth of 450 ft., and 50 percent efficiency for groundwater pumps (MAGSA 2022).

Conveyance pumping. MAGSA estimates conveyance energy demand at 44 GWh during years of maximum operations. These calculations are determined through estimating required lift and volumes by the five recharge zones. Calculations assume recharge and recovery from each recharge zone weighted to the total recharge basin area for each zone. Lift is calculated from the Mendota Pool to the average elevation within each recharge zone and considers if additional lift pumps are needed along the alignment to convey water to the recharge zone during recharge periods, and back to the Mendota Pool during recovery.

Total and annualized energy demands for recovery and recharge periods. These two demand types represent a maximum demand of 46 GWh during years in which maximum recharge has occurred and 160 GWh during years in which maximum recovery is occurring, assuming an additional energy demand of 15 percent from uncertainties. These demands have been normalized to an annual basis using data discussed in the groundwater hydrology report for this document (Appendix 2) using SWP operational data for the period from 1997 through 2021 and historical data in combination with DWR CalSIM predictions under climate change. The results of that analysis indicate that recharge opportunities will occur 46 percent of the time and recovery opportunities 42 percent of the time. Those calculations lead to estimates for annualized energy demands for recharge activities at 21 GWh and for recovery activities of 66.5 GWh, totaling 87.7 GWh required annually.

Percent of regional and California water demand energy use. The calculated energy use by the Project is about 0.08 percent of the annual energy demand by California's water sector (175,950 GWh; PPIC 2018). Calculated current and predicted energy use related to water use in the Central Valley region (San Joaquin Valley, Sacramento River, and Tulare Lake basins) shows the current and future water demand require about 15,000 GWh (Next10 and Pacific Institute 2021). About 25 percent of the energy demand is from urban water users (e.g., residential, industrial, commercial, governmental) and about 75 percent from agricultural uses, similarly distributed across extraction and groundwater pumping, conveyance, distribution and end-use (Next 10 and Pacific Institute 2021). The annualized energy demand for this Project is calculated from these sources and analysis at about 0.6 percent of the energy demand related to water in the San Joaquin Valley and about 2.3 percent when limited to the San Joaquin River Basin.

The project will adhere to energy conservation requirements and greenhouse gas reduction requirements and would not result in wasteful and inefficient use of nonrenewable resources. Therefore, any impacts will be less than significant.

ENE b): Would the potential project conflict with or obstruct state or local plans for renewable energy or energy efficiency?

(Less Than Significant Impact) Both construction and operation of the proposed project will adhere to energy conservation requirements and greenhouse gas reduction requirements and would not result in wasteful and inefficient use of nonrenewable resources. The Greenhouse Gases and Climate Change Section (Section 4.8) of this study summarizes methods the project proponent will implement to meet clean energy goals and comply with energy efficiency plans. Impacts will be less than significant.

4.7 Geology and Soils (GEO)

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
Would the Project:				
a) Directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving:				
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? (Refer to Division of Mines and Geology Special Publication 42.)	☐	☐	☒	☐
ii) Strong seismic ground shaking?	☐	☐	☒	☐
iii) Seismic-related ground failure, including liquefaction?	☐	☐	☐	☒
iv) Landslides?	☐	☐	☐	☒
b) Result in substantial soil erosion or the loss of topsoil?	☐	☒	☐	☐
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?	☐	☐	☒	☐
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code, creating substantial risks to life or property?	☐	☐	☒	☐
e) Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater?	☐	☐	☐	☒
f) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?	☐	☒	☐	☐

4.7.1 Environmental Setting

Geology

The San Joaquin Valley geology is characterized by a deep reservoir of marine sediment deposits, overlain by over 1,000 feet of quaternary continental deposits. Sedimentation began during the Jurassic Period (208 to 144 million years ago) and much of the marine sediments were deposited during the Miocene Epoch (5 to 23 million years ago) when today's valley was an inland sea. When the sea receded, and uplift occurred, erosion of the surrounding topography resulted in the continental Quaternary deposits seen in the San Joaquin Basin today. On average, sediment is an estimated 2,400 feet thick and up to 9,000 feet thick in the Tulare Basin near Fresno (USGS 1999).

The project area is located on the Quaternary Geologic Unit (Q) which consists of Pleistocene-Holocene aged alluvium, lake, playa, and terrace deposits (Brown and Caldwell 2006) (Table 4-9). The project area is generally flat and located on alluvial deposits.

Table 4-9. Geologic Units in the Project Area (adapted from Brown and Caldwell 2006, Table 4-1)

Geologic Unit	Geologic Age	Lithology	Approximate Thickness	Paleontological Significance?
Post Modesto Alluvial Deposits	Holocene	Unconsolidated alluvium (gravel, sand, silt, clay)	< 30 feet	No
Modesto Formation	Late Pleistocene	Alluvium consisting of silt and clay sized material, as well as poorly sorted sand and gravel	10-30 feet	Yes, plants and vertebrates
A-clay [(1)]	*Pleistocene and Holocene*	*Clay, unconfined aquifer. Blue, olive brown, or dark greenish-gray*	*Up to 50 feet*	*No*
Riverbank Formation	Middle Pleistocene	Alluvial fan deposits. Higher fan deposits are coarse, lower are finer and poorly sorted	200-300 feet	Yes, plants
C-clay [(1)]	*Middle Pleistocene*	*Clay, yellowish-brown to grayish blue*	*10-40 feet*	*No*
Tulare Formation (west), Turlock Lake Formation (east)	Early to Mid-Pleistocene	Alluvial fan deposits consisting of boulder to sand size sediment. Silt and clay sediment interbedded in alluvium and terrace deposits	100-1000 feet	Yes, invertebrates, vertebrates, Turlock - plants
E-clay (Corcoran Clay) [(1)]	*Early to Mid-Pleistocene*	*Clay, acts as an aquitard*	*None given, generally thickest clay layer*	*No*
Laguna Formation	Middle to Late Pleistocene	Fine grained, arkosic sand. Some gravel and clay lenses	None given	No

[1]The clay units listed are not continuous lithologic units. They are generally found between the geologic units listed or as a part of (interbedded with) the above or below listed geologic units.

Regional Faults and Seismic Hazards

The project area is located in a region of high seismic activity. However, the project area itself does not experience frequent or large earthquakes. Large earthquakes typically occur along the San Andreas Fault system. The nearest Alquist-Priolo Fault Zones to the project area are the San Andreas Fault (west of the project area) and Owens Valley Faults (east of the project area). Both are active, indicating displacement along the faults withing the last 200 years.). These faults have no record of having been displaced, but their activity is unknown (CDC 2017a). There are two approximately located faults that extend into the northern portion of the project area. These are not Alquist-Priolo faults or fault zones; they are part of the more general geologic mapping, and their activity is unknown (CDC 2020).

The project area is located over 50 miles from the San Andreas Fault system. While seismic shaking from a strong earthquake along the San Andreas fault may be felt in the project area, it would be at a substantially lower magnitude. The California State Geological Survey estimates shaking potential in regions throughout California. The earthquake shaking potential ranges from 0.35 to 0.65 in the project area (expressed as a percentage of standard gravity), which is in the mid to low range of shaking potential. The shaking potential map is updated following each update of the National Seismic Hazard Maps (CDC 2017b).

Liquefaction

Liquefaction can occur when saturated soils are subjected to dynamic forces such as strong shaking. Under these conditions, soils may lose their strength and cohesion. Liquefaction is a high risk in uniformly sandy soils where the water table is low (less than 30 feet below the ground surface) (Fresno 2000a, Fresno 2000b).

The water table (depth to groundwater) in the project area is approximately 155 feet below the surface (MAGSA 2020). Since it is greater than 30 feet, liquefaction is not expected to impact the area. Additionally, the soils in the project area are various sizes of sand and include fine sandy loam and sandy loam (Table 4-9) so liquefaction is not expected to be a high risk. Furthermore, water tables are not expected to rise to within 30 feet from the ground surface.

The California Department of Conservation publishes a map with liquefaction risk areas where liquefaction may occur during a strong earthquake. The map is intended for use by cities and counties to regulate development so buyers and sellers know where certain seismic hazards exist (CDC 2017c). Areas that are identified on the map are areas that are within a seismic hazard zone as defined by the Seismic Hazards Mapping Act of 1990. The project area does not have any liquefaction zones.

Landslides

A landslide is a type of mass wasting event that occurs when the cohesion of material on a slope is changed or exceeded. The cohesion can be changed by triggers such as an earthquake, saturation, or erosion. While shaking from an earthquake or saturation from rainfall could occur in the project area, it is also on and surrounded by flat land, so there is very little risk of landslides from sloped topography. The highest risk is slumping of creek or riverbanks.

The California Department of Conservation publishes a map with landslide risk areas, where a landslide may occur during a strong earthquake. The project area does not have any landslide risk zones and does not have a likelihood of deep landsliding based on regional estimates of rock strength and steepness of slopes (Wills et al. 2011).

Tsunamis and Seiche

The project area is inland and therefore not susceptible to seiches or tsunamis.

Subsidence

Subsidence is the settling or sinking of the Earth's surface. Many conditions can lead to subsidence and all of them have to do with a change in volume of subsurface material such as removal of groundwater, oil, gas, or another substance, or from reorganizing material from compaction or tectonic activity (MAGSA 2020). However, subsidence is also dependent on the soil type; not all volume alterations will result in the same level of subsidence for all soils. Soils with high silt or clay content where the groundwater table has also been drawn down are the most vulnerable to subsidence.

The project area has sandy soils and the groundwater table is approximately 155 feet below the surface (MAGSA 2020). The Groundwater Sustainability Plan (GSP) reports that from 1998 to 2016 the groundwater decline rate is 2 feet per year. Despite these numbers, subsidence in the project area is as little as 0.15-0.3 feet up to 3-7 feet (MAGSA 2020) and is the result of groundwater pumping.

Paleontological Resources

Paleontological resources include fossilized remains or impressions of plants and animals and can have both scientific and cultural importance. The scientific importance of fossils stems from their ability to help us understand historic prehuman environments. Paleontological resources aged mid-Holocene or older (> 5000 years old) are of most significance (SVP 2010).

The University of California Museum of Paleontology Database records search was used to search for paleontological records within Fresno County, California. Records were searched for Vertebrates, Invertebrates, Plants, and Microfossils in the Cenozoic Era. Numerous fossil records were returned. In addition to the important formations noted in the records (The Modesto Formation 10-30 feet, the Riverbank Formation 200-300 feet, and the Tulare Formation / Turlock Formation 100-1000 feet), most of the returned records were in geologic formations from the Miocene, Oligocene, and Eocene. Since all the formations are earlier than the Pliocene, it is unlikely that any of them will be encountered during construction or operations since they occur even deeper below the earth's surface.

Soils

The engineering and physical properties of soils contain important information for the feasibility of construction projects. Some of the more critical properties are listed in Table 410: Soil Data and Percent Area, from SSURGO Database and include texture, drainage class, and erodibility (NRCS 2014). Septic limitations and depth to water are also important, but neither are limitations for this project. In addition, the American Association of State Highway and Transportation Officials (AASHTO) and the Universal Soil Classification System (USCS) are both used to gain information about the engineering properties of project soils and the texture. The AASHTO Soil Classification System is an evaluation of subsurface engineering/geotechnical properties that can affect construction. The USCS is an additional indicator of soil texture and size.

Expansive Soils

Soil expansibility is a critical soil characteristic for construction projects. Expansive soils are those that have a particular type of clay which is capable of substantial increases in volume when it gets wet. This expansion can exert a tremendous force on structures, pipelines, and utilities. Additionally, expansive soils will also shrink upon drying which can further cause damage to foundations and structures. Where expansive soils are present, appropriate construction techniques are necessary to prevent damage.

According to the Expansion Index Tests (Uniform Building Code Standard 29-2), a soil expansion index greater than 20 (determined in accordance with ASTM D4829) indicates expansive soil. Expansive soils within Fresno County generally occur outside the project area (Fresno County 2000a).

Susceptibility to Wind and Water Erosion

The Wind Erodibility Index is ranked from least susceptible (Class 1) to wind and water erosion to most susceptible (Class 6). Each class is associated with a number that indicates the estimated erosion in tons/acre/year. Most soils (74 percent) are Class 3 which is predicted to erode 86 tons per acre annually.

Fourteen percent of soils are Class 4 which is predicted to erode 134 tons per acre annually. As such, soils in the project area are in the medium to high erosivity range.

Soil Texture and Drainage Class

Soil texture, as shown in Table 4-10, is primarily fine sandy loam (39 percent), sandy loam (32 percent), and loamy sand (12 percent).

Soil drainage is defined by Hydrologic Soils Group (HSG):

- Group A. Soils that have high infiltration rate (low runoff potential) when thoroughly wet. These consist of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rates of water transmission.
- Group B. Soils that have a moderate infiltration rate when thoroughly wet. These consist of deep to moderately deep soils that are moderately well drained or well drained. Soils tend to have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.
- Group C. Soils that have a slow infiltration rate when thoroughly wet. These soils typically have a layer that impedes the downward movement of water, or the soils are moderately fine to fine texture. These soils have a slow rate of water transmission.
- Group D. Soils that have a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist of clays that have a high shrink-swell potential, soils that have a high-water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Both the Drainage Class and the HSG show that there is a wide variety of drainage classes among soils in the project area. The Drainage Class indicates that 41 percent of soils are somewhat poorly drained while 39 percent are well drained, and 12 percent are somewhat excessively drained (Figure 1-10). The HSG indicates that within MAGSA, 16 percent of the soils are Group A, 24 percent are Group B, 30 percent are Group C, 27 percent are Group D, and the remainder are unclassified.

Table 4-10: Soil Data and Percent Area, from SSURGO Database

Soil Classification	Acres	% Area
Farmland		
Farmland of statewide importance	56,623	37
Not prime farmland	53,740	35
Prime farmland if irrigated	25,191	16
Prime farmland if irrigated and drained	6,501	4
Prime farmland if irrigated and reclaimed of excess salts and sodium	12,826	8
Texture		
Unclassified	2,544	2
Clay loam	1,204	1
Coarse sand	209	0
Coarse sandy loam	4,298	3
Fine sandy loam	61,071	39
Gravelly sand	16	0
Loam	13,520	9
Loamy coarse sand	3,680	2
Loamy sand	18,274	12
Sand	142	0
Sandy loam	48,797	32
Silt loam	1,121	1
Variable	5	0
Hydrologic Soil Group		
Unclassified	2,759	2
A	25,157	16
A/D	639	0
B	37,877	24
C	47,194	30
D	41,257	27
Drainage Class		
Unclassified	2,549	2
Excessively drained	209	0
Moderately well drained	1,607	1
Poorly drained	2,626	2
Somewhat excessively drained	23,431	15

Soil Classification	Acres	% Area
Somewhat poorly drained	63,358	41
Well drained	61,101	39
Erodibility Index		
48 (Class 1)	8,479	5
56 (Class 2)	7,367	5
86 (Class 3)	114,166	74
134 (Class 4)	21,954	14
160 (Class 5)	209	0
220 (Class 6)	158	0
Unclassified	2,549	2
Unified Soil Classification System		
Unclassified	2,816	2
CL (clays, low to medium plasticity)	1,204	1
ML (silt)	15,128	10
SC (clayey sand)	32,835	21
SM (silty sand)	102,542	66
SP-SM (poorly graded sand with silt and gravel)	356	0
AASHTO Soil Classification System		
Unclassified	2,549	2
A-1-b (subgrade excellent to good)	3,925	3
A-2-4 (subgrade excellent to good)	42,642	28
A-4 (subgrade fair to poor)	104,560	68
A-6 (subgrade poor)	1,204	1

4.7.2 Regulatory Setting

4.7.2.1 Federal

Historic Sites Act of 1935. This Act became law on August 21, 1935 (49 Stat. 666; 16 U.S.C. 461-467) and has been amended eight times. This Act establishes as a national policy to preserve for public use historic sites, buildings, and objects, including geologic formations.

National Earthquake Hazards Reduction Program. The National Earthquake Hazards Reduction Program (NEHRP), which was first authorized by Congress in 1977, coordinates the earthquake-related activities of the Federal Government. The goal of NEHRP is to mitigate earthquake losses in the United States through basic and directed research and implementation activities in the fields of earthquake science and engineering. Under NEHRP, the Federal Emergency Management Agency (FEMA) is responsible for developing effective earthquake risk reduction tools and promoting their implementation, as well as supporting the development of disaster-resistant building codes and standards. FEMA's NEHRP activities are led by the FEMA Headquarters (HQ), Federal Insurance and Mitigation Administration, Risk Reduction Division, Building Science Branch, in strong partnership with other FEMA HQ Directorates, and in coordination with the FEMA Regions, the States, the earthquake consortia, and other public and private partners.

4.7.2.2 State

California Alquist-Priolo Earthquake Fault Zoning Act. The Alquist-Priolo Earthquake Fault Zoning Act (originally enacted in 1972 and renamed in 1994) is intended to reduce the risk to life and property from surface fault rupture during earthquakes. The statute prohibits the location of most types of structures intended for human occupancy across the traces of active faults and regulates construction in the corridors along active faults.

California Seismic Hazards Mapping Act. The Seismic Hazards Mapping Act is intended to reduce damage resulting from earthquakes. While the Alquist-Priolo Earthquake Fault Zoning Act addresses surface fault rupture, the Seismic Hazards Mapping Act addresses other earthquake-related hazards, including ground shaking, liquefaction, and seismically induced landslides. The state is charged with identifying and mapping areas at risk of strong ground shaking, liquefaction, landslides, and other hazards, and cities and counties are required to regulate development within mapped Seismic Hazard Zones.

Uniform Building Code. The California Code of Regulations (CCR) Title 24 is assigned to the California Building Standards Commission, which, by law, is responsible for coordinating all building standards. The California Building Code incorporates by reference the Uniform Building Code with necessary California amendments. The Uniform Building Code is a widely adopted model building code in the United States published by the International Conference of Building Officials. About one-third of the text within the California Building Code has been tailored for California earthquake conditions. In addition, this project is being evaluated pursuant to CEQA.

- Regulation VIII (Rules 8011-8081). This regulation is a series of rules designed to reduce particulate emissions generated by human activity, including construction and demolition activities, carryout and trackout, paved and unpaved roads, bulk material handling and storage, unpaved vehicle/traffic areas, open space areas, etc. If a non- residential area is 5.0 or more acres in area, a Dust Control Plan must be submitted as specified in Section 6.3.1 of Rule 8021. Additional requirements may apply, depending on total area of disturbance.

4.7.2.3 County and Regional

Fresno County General Plan. The Fresno County General Plan includes policies pertaining to potential geologic hazards and unique geologic and palaeontologic resources (Fresno 2000c). The following local policies are relevant to the project:

> ***Policy HS-D.3:*** The County shall require that a soils engineering and geologic-seismic analysis be prepared by a California-registered engineer or engineering geologist prior to permitting development, including public infrastructure projects, in areas prone to geologic or seismic hazards (i.e., fault rupture, ground shaking, lateral spreading, lurch cracking, fault creep, liquefaction, subsidence, settlement, landslides, mudslides, unstable slopes, or avalanche).
>
> ***Policy HS-D.4:*** The County shall require all proposed structures, additions to structure, utilities, or public facilities within areas subject to geologic-seismic hazards as identified in the soils engineering and geologic-seismic analysis to be sited, designed, and constructed in accordance with applicable provisions of the Uniform Building Code (Title 24 of the California Code of Regulations) and other relevant professional standards to minimize or prevent damage or loss and to minimize the risk of public safety.

Policy HS-D.5: Pursuant to the Alquist-Priolo Earthquake Fault Zoning Act (Public Resources Code, Chapter 7.5), the County shall not permit any structure for human occupancy to be placed within designated Earthquake Fault Zones unless the specific provisions of the Act and Title 14 of the California Code of Regulations have been satisfied.

Policy HS-D.7: The County shall ensure compliance with State seismic and building standards in the evaluation, design, and siting of critical facilities, including police and fire stations, school facilities, bridges, large public assembly halls, and other structures subject to special seismic safety design requirements.

Policy HS-D.8: The County shall require a soils report by a California-registered engineer or engineering geologist for any proposed development, including public infrastructure projects, that requires a County permit and is in an area containing soils with high "expansive" or "shrink-swell" properties. Development in such areas shall be prohibited unless suitable design and construction measures are incorporated to reduce the potential risks associated with these conditions.

Policy HS-D.9: The County shall seek to minimize soil erosion by maintaining compatible land uses, suitable building designs, and appropriate construction techniques. Contour grading, where feasible, and revegetation shall be required to mitigate the appearance of engineered slopes and to control erosion.

Policy OS-J.1: The County shall require that discretionary development projects, as part of any required CEQA review, identify and protect important historical, archeological, paleontological, and cultural sites and their contributing environment from damage, destruction, and abuse to the maximum extent feasible. Project-level mitigation shall include accurate site surveys, consideration of project alternatives to preserve archeological and historic resources, and provision for resource recovery and preservation when displacement is unavoidable.

Policy OS-J.9: In approving new development, the County shall ensure, to the maximum extent practicable, that the location, siting, and design of any project be subordinate to significant geologic resources.

4.7.3 Potential Impacts

GEO a): Would the project directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving:

i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault?

(Less than Significant Impact) Although the project area is in a region of high seismic activity, faults located nearest to the project area are Pre-Quaternary and have no record of displacement. The nearest Alquist-Priolo fault or fault zone, the San Andreas Fault system, is located more than 50 miles from the project area. While seismic shaking from a strong earthquake along the San Andreas fault may be felt in the project area, it would be at a substantially lower magnitude than areas closer to the fault. The earthquake shaking potential ranges from 0.35 to 0.65 in the project area which is in the mid to low range of expected relatively long-period (1.0 second) shaking potential. The proposed project is not located near a major urban center and would not result in construction of structures meant for human inhabitance or tall structures that could expose people to collapse risking loss, injury, or death. Canals and berms would be constructed with stable slopes unlikely to experience failure or collapse. Therefore, any impacts would be expected to be less than significant.

ii) Strong seismic ground shaking?

(Less than Significant Impact) The proposed project area is in a region that is at least 50 miles from a known, active fault and there are no known faults in the area. Based on the California Geological Survey earthquake shaking potential map, it is expected that the project area would experience low levels of shaking under most seismic conditions; however, very infrequent earthquakes could cause strong shaking in the project area. The proposed project would not substantially increase human or environmental exposure to risk of loss, injury, or death because of ground shaking, and any impacts would be expected to be less than significant.

iii) Seismic-related ground failure, including liquefaction?

(No Impact) Considering that the depth to groundwater within the MAGSA area averages 155 feet due to the region's reliance on pumped groundwater and that soils are primarily loam soils as opposed to uniformly sandy soils, liquefaction is not expected to be a high risk within the proposed project area. No liquefaction risk areas are depicted on the California Department of Conservation seismic hazard mapping. Therefore, the proposed project would be expected to have no impact related to potential substantial adverse effects resulting from seismic-related ground failure including liquification.

iv) Landslides?

(No Impact) Given the low risk associated with the relatively flat topography within the proposed project area and that no landslide risk areas are depicted on the California Department of Conservation seismic hazard mapping, the proposed project would have no impact related to potential substantial adverse effects resulting from landslides.

GEO b): Result in substantial soil erosion or the loss of topsoil?

(Less Than Significant Impact with Mitigation Incorporation) Undisturbed soils in the project area have a moderate to high potential for erosion caused by wind and water based on the climate, inherent properties of the soils, and vegetation. Agricultural land use also contributes to soil erosion and the loss of topsoil in the project area. Presence of heavy construction equipment during project construction would disturb vegetation and soils. An estimated 2,940 heavy equipment weeks would be required over the anticipated 3-year construction period with up to 19 pieces of heavy equipment operating at the same time throughout the project area. Approximately 2.48 million cubic yards (MCY) of soil would be excavated to construct the canals needed to convey water for the proposed project and up to an additional 1.0 MCY excavated during phased construction of the recharge basins. The project has been designed as a balanced cut/fill excavation project with excavated soils dispersed on farm fields adjacent to excavated canals or used as fill adjacent to recharge basins to construct containment berms. Some soil erosion due to soil disturbance and wind would be anticipated during construction. However, by incorporating temporary erosion and sediment control best management practices (BMPs) into project plans and mitigation measures including an approved fugitive dust control plan (AIR-1) and stormwater pollution prevention plan (WAT-7) and complying with terms and conditions established in the project CWA Section 401 water quality certification, impacts would be less than significant with mitigation incorporation.

GEO c): Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the Project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?

(Less Than Significant Impact) Based on land subsidence monitoring data from the past decade, minimal to moderate subsidence has occurred on the western edge of MAGSA. No known infrastructure (canals, wells, pipelines, roads, etc.) impacts have occurred as a result of subsidence (MAGSA 2020). By contributing to groundwater recharge and sustainability, the project may help to prevent or minimize further subsidence. Liquefaction or liquification induced lateral spreading or collapses are not a high risk in the project area due to the soil properties and deep water table. Given these regional land characteristics, the proposed project would have a less than significant impact.

GEO d): Be located on expansive soil, as defined in Table 18-1-B of the most recently adopted Uniform Building Code (1994) creating substantial risks to life or property?

(Less Than Significant Impact) Soils mapped within the project area are primarily loam textured soils with significant sand fractions and are therefore less likely to contain expansive clays than other soil types found in the region. Soils exhibiting moderately high to high expansion potential within Fresno County generally occur outside the project area, with the closest expansive soils occurring along the Fresno Slough west of the project area (Fresno County, 2000a). Therefore, it is unlikely the project would be constructed in soils considered expansive in the most recently adopted uniform building code. Furthermore, substantial risks to life or property would be unlikely because the project would not construct habitable structures or structures which would create substantial risks to life or property should they fail. Thus, impacts would be less than significant.

GEO e): Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?

(No Impact) No septic tanks or alternative wastewater disposal systems will be constructed or needed during construction or operations of the proposed project. Proposed conveyances and project infrastructure would be constructed at distances greater than 100 feet from dwellings in the project area utilizing septic systems and would not impact the soil properties affecting septic use. Therefore, the project would have no impact.

GEO f): Directly or indirectly destroy a unique paleontological resource or site or unique geologic *feature?*

(Less Than Significant with Mitigation Incorporation) Although numerous fossil records were returned in the search of paleontological records within Fresno County, inclusive of the project area, they are in geologic formations which are deeper than those that would likely be encountered during excavations for the proposed project. Additionally, MAGSA would implement mitigation measure GEO-1, having an on-call, certified paleontologist, to evaluate excavated material should an excavation encounter paleontologically significant resources from the Modesto formation. Thus, impacts would be less than significant with mitigation incorporation.

4.8 Greenhouse Gas Emissions (GHG)

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
Would the Project:				
a) Generate greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment?	☐	☐	☒	☐
b) Conflict with any applicable plan, policy, or regulation adopted for the purpose of reducing the emissions of greenhouse gases?	☐	☐	☒	☐

4.8.1 Environmental Setting

Climate changes resulting from GHG emissions could produce an array of adverse environmental impacts including water supply shortages, severe drought, increased flooding, sea level rise, air pollution from increased formation of ground level ozone and particulate matter, ecosystem changes, increased wildfire risk, agricultural impacts, and ocean and terrestrial species impacts, among other adverse effects. While the emissions of a single project do not cause global climate change, GHG emissions from multiple projects throughout the region, state, and world contribute on a cumulative basis to an adverse impact to the global climate. Although an individual project's GHG emissions would generally not result in direct impacts under CEQA, as the climate change issue is global in nature, an individual project could be found to contribute to a potentially significant cumulative impact.

4.8.2 Regulatory Setting

Federal

U.S. Environmental Protection Agency (EPA)

Currently there are no federal regulations or legislation that specifically address GHG emissions reductions and climate change at the project level. Neither the U.S. EPA nor the Federal Highway Administration (FHWA) has promulgated explicit guidance or methodology to conduct project-level GHG analysis. However, the FHWA recommends that climate change impacts and strategies to reduce GHG emissions should be considered and integrated throughout the transportation decision-making process. Such strategies include implementation of improved transportation system efficiency, use of cleaner fuels and cleaner vehicles, and a reduction in the growth of vehicle hours travelled.

Executive Order 13514

Executive Order 13514 is focused on reducing greenhouse gases internally in Federal agency missions, programs and operations, but also direct Federal agencies to participate in the Interagency Climate Change Adaptation Task Force, which is engaged in developing a national strategy for adaptation to climate change.

State

Assembly Bill 1493

California Assembly Bill (AB)1493 requires CARB to develop and implement regulations to reduce automobile and light truck GHG emissions.

The State also adopted AB 32, which identified GHG reduction goals and noted the effects of increased GHG emissions as they relate to global climate change. Reporting of greenhouse gases by major sources is required by the California Global Warming Solutions Act (AB 32, 2006). Revisions to the existing ARB mandatory GHG reporting regulation were considered at the board hearing on December 16, 2010. The revised regulation was approved by the California Office of Administrative Law and became effective on January 1, 2012. The revised regulation affects industrial facilities, suppliers of transportation fuels, natural gas, natural gas liquids, liquefied petroleum gas, and CO_2, operators of petroleum and natural gas systems, and electricity retail providers and marketers.

Climate Change Scoping Plan

CARB's 2008 Climate Change Proposed Scoping Plan is the State's plan to achieve GHG reductions in California required by AB 32. The Plan contains the main strategies California will implement to achieve reduction of 169 million metric tons (MMT) of CO2e, or approximately 30 percent from the state's projected 2020 emissions level of 596 MMTCO2e under a business-as-usual scenario. The Scoping Plan also includes CARB-recommended GHG reductions for each emissions sector of the state's GHG inventory. A key component of the Scoping Plan is the Renewable Portfolio Standard, which is intended to increase the percentage of renewable energy sources in California's electricity mix to 33 percent by year 2020, resulting in a reduction of 21.3 MMTCO2e. Sources of renewable energy include, but are not limited to, biomass, wind, solar, geothermal, hydroelectric, and anaerobic digestion. Increasing the use of renewable energy sources will decrease California's reliance on fossil fuels, thus reducing GHG emissions.

4.8.3 Regional and County

SJVAPCD

Climate Change Action Plan

On August 21, 2008, the SJVAPCD Governing Board approved the District's Climate Change Action Plan with the following goals:

- Assist local land-use agencies with California Environmental Quality Act (CEQA) issues relative to projects with GHG emissions increases.
- Assist Valley businesses in complying with mandates of AB 32.
- Ensure that climate protection measures do not cause increase in toxic or criteria pollutants that adversely impact public health or environmental justice communities.

The SJVAPCD does not recommend quantitative significance thresholds for the analysis of the impact of a project's GHG emissions on the environment. Instead, the SJVAPCD's approach relies on the application of performance-based standards to assess project-specific GHG emission impacts on global climate change. This is based on the principle that projects whose emissions have been reduced or mitigated consistent with AB 32, the California Global Warming Solutions Act of 2006, should be considered to have a less-than-significant impact on global climate change (SJVAPCD 2015).

Fresno Council of Governments Priority Climate Action Plan The Fresno Council of Governments (COG) received a grant from the U.S. EPA The grant received from EPA to help the COG conduct a comprehensive climate action planning process and prepare a Regional Climate Action Plan for the Fresno region. The Regional Climate Action Plan will cover the 15 incorporated cities in Fresno County and the unincorporated Fresno County areas. The first component of the Regional Climate Action Plan is the Priority Climate Action Plan (PCAP), which includes a GHG inventory, a public outreach process, identification and quantification of priority GHG emissions reduction measures, a benefit analysis for low-income and disadvantaged communities, and identification of implementation authorities. Outreach to stakeholders and the general public, especially the low-income and disadvantaged communities, is a key component of the PCAP and a priority for the Fresno COG. A Comprehensive Climate Action Plan and Status Report will be developed after the PCAP.

4.8.4 Potential Impacts

GHG (a): Would the project generate greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment?

Short-term Construction

Construction of the proposed project would result in temporary generation of emissions associated with site preparation, grading, and the construction of project infrastructure. GHG emissions would result from off-road equipment use and on-road vehicle operations associated with workers commuting to and from the project site and haul truck trips. Estimated increases in GHG emissions associated with construction of the proposed project are summarized in Table 4-2. As shown in Table 4-2, annual emissions of GHGs associated with construction of the proposed project would total approximately 1,266 MTCO2e. Amortized construction-generated GHG emissions, when averaged over the assumed minimum 50-year life of the project, would total approximately 86 MTCO2e per year.

The SJVAPCD has not adopted guidance that would apply to project-generated construction emissions. For the purposes of this analysis, construction-generated emissions were amortized over a 50-year period and included with the operational emissions. Because there is no separate GHG threshold for construction generated GHGs, the evaluation of significance is discussed in the analysis of operational GHG emissions.

Long-term Operations

Estimated operational GHG emissions are summarized in Table 4-3. With the inclusion of amortized construction emissions, the proposed project would generate approximately 9,397 MTCO2e/year including emissions from stationary sources and worker trips for operation and maintenance. GHG emissions would be primarily associated with the operation of off-road equipment and on-road worker commute vehicles. Operational emissions from mobile sources would not exceed the threshold of 1,100 MTCO2e/year. Stationary source GHG emissions would total approximately 9,311 MTCO2e/year and would not exceed the CEQA threshold of 10,000 MTCO2e/year.

The booster and recovery well pumps would be electrically powered, consistent with SJVAPCD's Best Available Control Technology requirements for pumps with engines of at least 50 horsepower, or greater. In addition, implementation of Mitigation Measure AQ-2 includes various measures that would reduce project-generated GHG emissions, including limitation on construction vehicle and equipment idling, the use of newer lower-emission equipment, and the recycling of construction-generated waste. The use of newer lower-emission equipment and idling limitations for off-road equipment and on-road vehicles would further reduce GHG emissions, including emissions of black carbon. Project-generated GHG emissions would be predominantly associated with electricity use and fuel combustion. GHG emissions associated with electricity use and fuel combustion would be subject to the State's Cap and Trade regulations. In accordance with SJVAPCD's recommendations for the evaluation of GHG emissions, emissions that are subject to the State's Cap and Trade regulations would be considered to be mitigated through compliance with the Cap and Trade regulatory requirements and would, therefore, be considered to have a less-than-significant impact. For these reasons, GHG emissions would be considered to have a less than significant impact.

GHG (b.) Would the project conflict with any applicable plan, policy, or regulation adopted for the purpose of reducing the emissions of greenhouse gases?

(Less than Significant Impact) In accordance with SJVAPCD's CEQA thresholds for the evaluation of GHG impacts, a project would not have a significant GHG impact if it is consistent with an applicable GHG-reduction plan. Applicable GHG reduction plans include Fresno County Council of Government's Priority Climate Action Plan and CARB's Climate Change Scoping Plan.

The Project is consistent with the projected land use development patterns identified in the Priority Climate Action Plan, would not interfere to implementation of these strategies, and would not result in a substantial increase in motor vehicle use. As a result, the Project would be consistent with the Priority Climate Action Plan. The proposed project would be consistent with the action items contained in the Climate Change Scoping Plan and would not conflict with its provisions. Therefore, the impact would be less than significant.

4.9 Hazardous Materials (HAZ)

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
Would the Project:				
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?	☐	☒	☐	☐
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?	☐	☒	☐	☐
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	☐	☐	☐	☒
d) Be located on a site included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?	☐	☒	☐	☐
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
f) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?	☐	☐	☒	☐
g) Expose people or structures, either directly or indirectly, to a significant risk of loss, injury or death involving wildland fires?	☐	☐	☒	☐

4.9.1 Environmental Setting

The proposed project is in a primarily agricultural area, and the nearest airport is San Joaquin Airport, found approximately six miles west of the project area.

Raisin City Elementary School, near the southeast project boundary, is the only public school within the project limits (Figure 4-4). All other schools near the project boundary are two or more miles from the project limits (NCES 2023) and are not considered within the sphere of influence for potentially harmful impacts from hazardous materials created, released, or transported from this project.

The American Avenue Solid Waste Landfill, near the center of MAGSA and just north of the planned American Canal, is the only official landfill within the project limits (Figure 4-4). The Midvalley Disposal Transfer Recycling Station and Road Maintenance Area 5 Transfer Station are approximately 1 mile and 2 miles east of the project limits, respectively. These facilities were given special consideration in the planning and design phase as landfills are a widespread, common cause of groundwater contamination.

The Raisin City Oil Field, located in the central part of MAGSA (Figure 1-11), is a monitored source of chloride, boron, and total dissolved solids (TDS). It is likely that pesticides, herbicides, and other agricultural chemicals have been applied throughout the project area due to past and ongoing agricultural practices and may remain in the soil and water. It is also likely that one or more clandestine drug labs (CDLs) are present throughout this mostly rural project area, but this project would not increase the likelihood of hazardous release from such sites.

Within the larger project area, there are eight inactive (cleanup completed) Leaking Underground Storage Tank (LUST) sites, and within 0.25 miles of the conveyance system, there is a single LUST with cleanup completed in 1990. Two active USTs are within the project vicinity, but neither fall within 0.25 miles of the conveyance system or the construction footprint (EDR 2023, Figure 4-4).

4.9.2 Regulatory Setting

4.9.2.1 Federal

Federal regulations on hazardous materials are contained in the CFR primarily Titles 29 Labor, 40 Protection of the Environment, 42 Public Health, and 49 Transportation. The EPA is the principal federal regulatory agency responsible for the safe use and handling of hazardous materials.

Resource Conservation and Recovery Act. The Resource Conservation and Recovery Act (RCRA) enables the EPA to administer a regulatory program that extends from the manufacturing of hazardous materials to their disposal, thus regulating the generation, transportation, treatment, storage, and disposal of hazardous waste at all facilities and sites in the nation.

Comprehensive Environmental Response, Compensation, and Liability Act. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) allows the federal government authority to respond directly to releases of hazardous substances that may cause harm to public health or the environment, provides mechanisms to remediate uncontrolled or abandoned contaminated sites, defines liability and establishes funding sources for the cleanup of contamination. The development of CERCLA enabled revisions to the National Contingency plan, which led to the development of the National Priorities List.

Hazardous Materials Transportation Act. U.S. Department of Transportation (USDOT) regulates hazardous materials transport throughout the United States through the Hazardous Materials Transportation Act (HMTA) 49 USC Section 5101 et seq. This law protects against the risks to life, property, and the environment that are inherent in the transportation of hazardous material in intrastate,

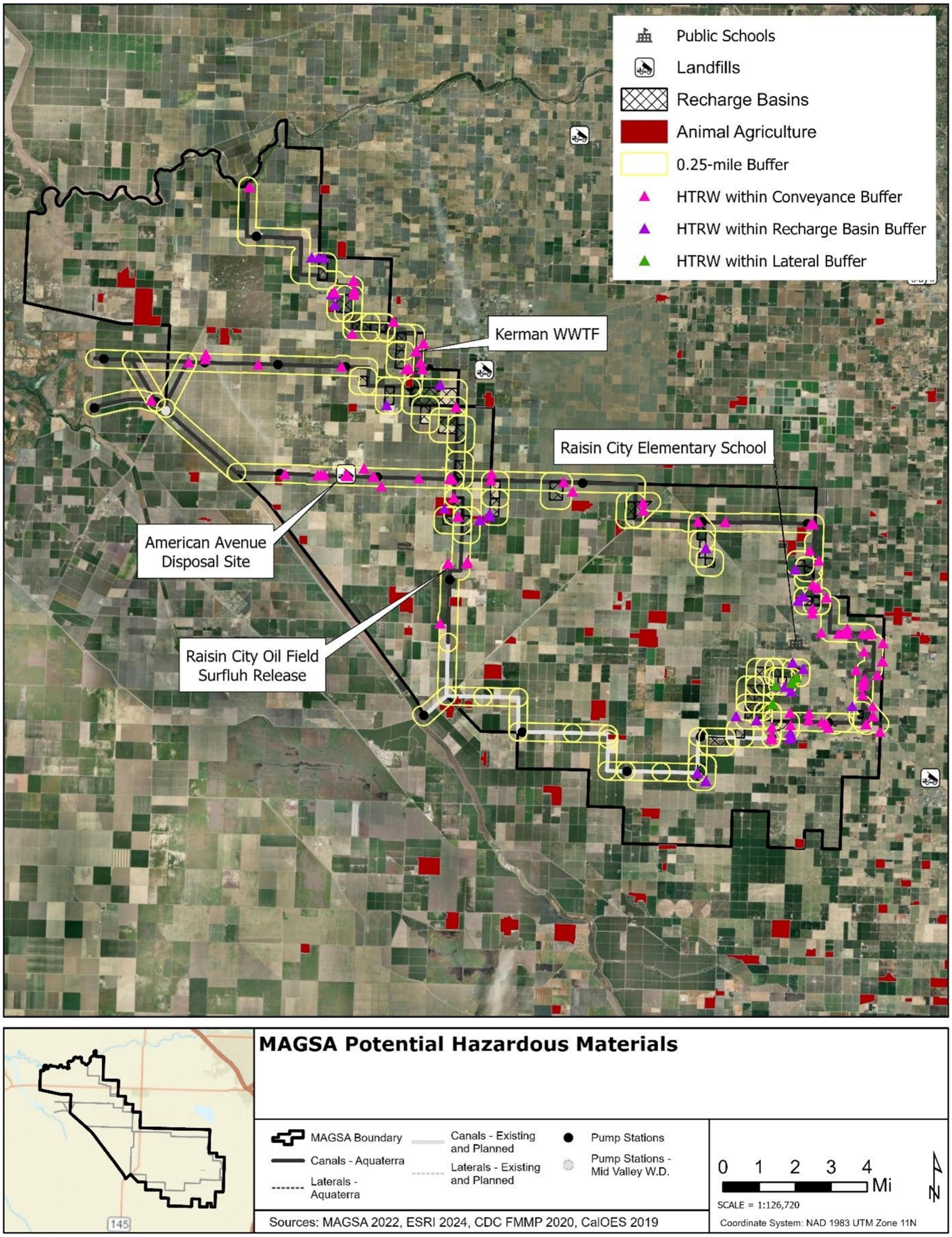


Figure 4-4: Potential Hazardous Materials

interstate, and foreign commerce. The HMTA was amended in 1990 by the Hazardous Materials Transportation Uniform Safety Act and the Hazardous Materials Transportation Authorization Act in 1994. These regulations require employees to be properly trained in safe handling procedures, have complete background checks, and use uniform hazardous materials and hazardous waste packaging and labeling for transport.

4.9.2.2 State

Department of Toxic Substances. The EPA has granted the State of California primary oversight responsibility to administer and enforce hazardous waste management programs. California regulations are equal to or more stringent than federal regulations. The Department of Toxic Substances Control (DTSC) is a sub agency of the California State Environmental Protection Agency (CalEPA) and is authorized to enforce the provisions of RCRA. The DTSC has enforcement authority and tracks hazardous materials management and hazardous waste throughout the state.

Hazardous waste regulations applied by DTSC are contained within Title 22, Division 4.5, Chapter 11 of the California Code of Regulations (CCR). Chapter 11 Article 3 defines hazardous materials as substances that are toxic, ignitable, reactive, or corrosive. California also defines an extremely hazardous material as a substance that shows high acute or chronic toxicity, is carcinogenic, has bioaccumulative properties, is persistent in the environment, or is water reactive. Additional health and safety requirements, management release response plans and liability determinations are outlined California Health & Safety Code (HSC) Division 20, Miscellaneous Health and Safety Provisions. A release of hazardous materials is any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing of into the environment, unless permitted or authorized by a regulatory agency (HSC Section 25501).

State Water Resources Control Board (SWRCB). The SWRCB has the authority to preserve and enhance water resources in the state. The SWRCB regulates and maintains records of releases of hazardous substances and petroleum-based materials and releases that could affect groundwater or surface water. It also regulates point and non-point pollution generators and discharge permits from irrigated agricultural lands.

4.9.2.3 County and Regional

Fresno County regulates the use, storage, transport and disposal of hazardous substances, cleanup and underground storage tanks by issuing permits, monitoring regulatory compliance, and other enforcement activities. The county developed a Hazardous Waste Management Plan (HWMP) in accordance with California Health and Safety Code Section 24135 et seq. It identifies the amount of waste produced, the locations of hazardous waste generators and guidance on reducing the need for future hazardous waste facilities by focusing on hazardous waste reduction techniques. The HWMP has not been approved by the State. Fresno County and the Department of Community Health, Environmental Health System coordinate responses to hazardous waste emergencies.

Fresno County is responsible for enforcing the state regulations governing hazardous substance generation and storage. The Fresno County Department of Public Health regulates the use, storage, and disposal of hazardous substances in the county by issuing permits, monitoring regulatory compliance, and other enforcement activities. The application of agricultural products including pesticides and herbicides is regulated, monitored, and enforced by the Fresno County Department of Agriculture, Weights, and Measures in accordance with the provisions of the California Department of Food and Agriculture Pesticide Regulation Program (PRP) and California Department of Pesticide Regulation (DPR).

Fresno County General Plan. The following policies from the Fresno County General plan may be relevant to the Project:

Policy HS-A.1. The County shall, through the Fresno County Operational Area Master Emergency Services Plan, maintain the capability to effectively respond to emergency incidents, including maintenance of an emergency operations center.

Policy HS-B.1. The County shall review project proposals to identify potential fire hazards and to evaluate the effectiveness of preventive measures to reduce the risk to life and property.

Policy HS-B.2. The County shall ensure that development in high fire hazard areas is designed and constructed in a manner that minimizes the risk from fire hazards and meets all applicable State and County fire standards. Special consideration shall be given to the use of fire-resistant construction in the underside of eaves, balconies, unenclosed roofs and floors, and other similar horizontal surfaces in areas of steep slopes.

Policy HS-C.2. The County shall require that the design and location of dams and levees be in accordance with applicable design standards and specifications and accepted design and construction practices.

Policy HS-C.3. The County shall promote a floodplain management approach in flood hazard areas that are presently undeveloped by giving priority to regulation of land uses over development of structural controls as a method of reducing flood damage.

Policy HS-C.6. The County shall promote flood control measures that maintain natural conditions within the 100-year floodplain of rivers and streams and, to the extent possible, combine flood control, recreation, water quality, and open space functions. Existing irrigation canals shall be used to the extent possible to remove excess stormwater. Retention-recharge basins should be located to best utilize natural drainage patterns.

4.9.3 Potential Impacts

The alignment of the conveyance system and situating of recharge basins is intended to prioritize avoidance of areas that may be contaminated by past or ongoing land uses. For this reason, areas within 0.25 miles of the planned conveyance system and recharge basins were examined for sites with potential sources of hazardous materials, and areas outside of this 0.25-mile buffer are considered only when there is potential for hazardous material to migrate further than 0.25 miles from these sites because of the project.

HAZ a and b): Would the project create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials? Would the project create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?

(Less Than Significant Impact with Mitigation Incorporated). The construction contractor will transport, store, and use hazardous materials such as fuels and lubricants to operate construction equipment. Operating and maintaining the canals and pumps may include the use of fuels, lubricants, and other hazardous materials. As part of Mitigation Measure HAZ-1, the construction contractor is required to develop a project-specific Spill Prevention and Response Plan (SPRP) that conforms to applicable local, state, and federal requirements. The SPRP will be on site during construction. Employees are to be trained on the processes included in the SPRP, which will include measures that ensure the safe transport, storage, use, and disposal of hazardous materials used or encountered during construction. The plan will outline specific handling and reporting procedures for hazardous materials and disposal of hazardous materials removed from the site at an appropriate offsite disposal facility. The SPRP will outline the volume of materials on site, refueling procedures, location of spill kits, sensitive areas and spill response procedures to be followed by the construction contractor. A stormwater pollution prevention plan (SWPPP) with site-specific Best Management Practices (BMPs) will be developed by the contractor to ensure water quality standards are met during construction. Spill response measures related to stormwater runoff will also be outlined in the SWPPP.

Though USTs are a potential source of accidental hazardous materials release in any project involving excavation, their lack of proximity to the construction area makes it unlikely that construction of this project would cause unexpected releases. The SPRP will address accidental discovery of undocumented hazardous material sites, such as unreported underground storage tanks (USTs) or buried drums.

HAZ c): Would the project emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?

(No Impact) Raisin City Elementary is within the larger project area but is not within 0.25 miles of any portion of the conveyance system or construction footprint, so there will be no impacts to this school. All other nearby schools are outside of the project limits.

HAZ d): Would the project be located on a site included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?

(Less Than Significant Impact with Mitigation Incorporated) There is one archived CERCLA (or Superfund) site within the project limits, within the Texaco Inc. Raisin City Oil Field, near the center of the project area, approximately 1 mile west of the nearest conveyance channel (Siskiyou Canal). Another portion of the Raisin City Oil Field, the Surfluh Lease, is found within a quarter mile of the Siskiyou Canal. The Surfluh Lease is a petroleum production and petroleum wastewater discharge facility operated by the Longview Production Company, which is the discharger responsible for operating and maintaining a groundwater monitoring system in place since 2015 (EDR, 2023). Potential releases from this facility into groundwater would be identified via the monitoring wells and remediated per the Monitoring and Reporting Program R5-2015-0067 (California Regional Water Quality Control Board, Central Valley Region 2015). The components of the proposed conveyance system passing through the Raisin City Oil Field area will be lined with concrete to prevent seepage of bank water into the ground in this area.

The Kerman Wastewater Treatment Facility (WWTF), located near the northeast project limits, within the quarter-mile buffer of both the Eastside Canal and a proposed recharge basin, is currently on the Cortese List for several 2022 violations for exceeding Biochemical Oxygen Demand (BOD) limits in discharged effluent (EDR, 2023). Excessive BOD loading does not meet hazardous material criteria.

There are three RCRA Large Quantity Generator (RCRA-LQG) sites within the project limits, two of which fall within 0.25- mile of planned conveyance alignments: American Avenue Solid Waste and Wiggins/Walrond. There is one RCRA Small Quantity Generator (RCRA SQG), Pacific Bell, located within a quarter mile of the conveyance system (EDR 2023). Construction of the project would be unlikely to create unexpected releases of hazardous materials from the Wiggins/Walrond (crude petroleum extractor) or Pacific Bell generators as hazardous materials are removed from their sites for disposal elsewhere in an established and systematic way, and project construction would not interfere with this. Neither Pacific Bell nor Wiggins/Walrond have active violations on the Cortese list.

The American Canal will flow along the southern boundary of the American Avenue Solid Waste Landfill and will be lined with concrete in this area to prevent leachate from entering the waters and to prevent seepage of conveyance flow into this area. Despite the channel alignment on the opposing side of the road-fill prism from the landfill, both proximity and duration of potential exposure increase the risk of hazardous material migration into the channel from this landfill. No hazardous spills or releases have been documented from this landfill since 2005 (EDR 2023), and a groundwater monitoring network that surrounds the landfill provides alerts to landfill operators in case monitoring detects heightened concentrations of CoCs. Extraction wells will avoid this area by at least 0.5 miles, and all extracted waters will be sampled in real time prior to discharge to the Mendota Pool.

While Confined Animal Feeding Operations (CAFOs) are common in this agricultural area and pose some risk of hazardous material release (i.e., toxic levels of nitrogen, phosphorous, etc.), the alignment is designed to avoid such areas. No CAFOs within the project area have open violations on the Cortese List.

In addition to targeted, specialized, and/or required monitoring systems at several of the hazardous materials sites within the project area, MAGSA and other regulatory bodies maintain and operate a significant water quality monitoring system within the project limits. Since the site is located on several sites included on a list of hazardous materials sites compiled pursuant to government code Section 65962.5, and due to the size and nature of these facilities, there is potential for significant impacts. Monitoring systems in place around areas with known contamination will allow for early detection of any possible contamination from any sites or facilities with hazardous materials so Mitigation Measure HAZ-1 can be implemented quickly. This impact will be less than significant with mitigation incorporation.

HAZ e): For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?

(No Impact) There are no airstrips within the project limits. The project area is included in the Airport Influence Area or Land Use Compatibility Zone as identified in the Fresno County Airport Land Use Compatibility Plan (ALUCP) (Coffman 2018). The proposed project will pose no aircraft safety hazards nor create hazards for airstrips, and there will be no impacts.

HAZ f): Would the project impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?

(Less Than Significant Impact) There may be minor, temporary increases in traffic during the mobilization of construction equipment and materials. The contractor’s traffic control plan will ensure unhindered emergency vehicle access. Construction activities impacting traffic flow would cease during an evacuation.

The design of levees will be consistent with Fresno County policies for minimizing health and safety risks resulting from flooding (Goal HS-C, Policy HS-C.2) and seismic and geologic hazards (Goal HS-D, Policy HS-D.3). This project will not impair or impact an emergency response plan or emergency evacuation plan, resulting in a less than significant impact.

HAZ g): Would the project expose people or structures to a significant risk of loss, injury or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?

(Less than Significant Impact) The proposed project area is mostly rural agricultural land and small communities. The risk of wildland fire is low due to lack of unmanaged grasses or underbrush in most of the project area. There is a slightly increased risk of fire during construction due to the potential for sparks from construction machinery. The California Office of the State Fire Marshal mapped the project area as Local Responsibility Area (LRA) Unzoned and determined that this area has no Very High Fire Hazard Severity Zones (Coffman 2018). Impacts associated with wildland fire will be less than significant.

4.10 HYDROLOGY AND WATER QUALITY (WAT)

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
Would the Project:				
a) Violate any water quality standards or waste discharge requirements?	☐	☒	☐	☐
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that the project may impede sustainable groundwater management of the basin?	☐	☐	☐	☒
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would:	☐	☒	☐	☐
i) result in substantial erosion or siltation on- or off-site;	☐	☒	☐	☐
ii) substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or offsite;	☐	☒	☐	☐
iii) create or contribute runoff water which would exceed the capacity of existing planned stormwater drainage systems or provide substantial additional sources of polluted runoff; or	☐	☒	☐	☐
iv) impede or redirect flows?	☐	☒	☐	☐
d) In flood hazard, tsunami, or seiche zones, risk release of pollutants due to project inundation?	☐	☐	☐	☒
e) Conflict with or obstruct implementation of a water quality control plan or sustainable groundwater management plan?	☐	☒	☐	☐

4.10.1 Environmental Setting

The Project area has a Mediterranean climate, with most precipitation falling from October to April. Over the last 20 years, precipitation has averaged about 10 inches per year, ranging from 3 inches in 2013 to 15.5 inches in 2019 (AgACIS 2024). Direct precipitation occurs primarily in the form of rain or fog. Topography in the San Joaquin Valley decreases slightly to the north along the San Joaquin River. Within MAGSA, topography dips to the northwest toward the Fresno Slough.

Surface Water Hydrology

The Kings River originates high in the Sierra Nevada Mountains near the Inyo County line. It flows southwest through the central part of Fresno County and into Tulare County at Reedley. 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. Flood control is managed by the U.S. Army Corps of Engineers, while the releases for irrigation diversion are managed by the Kings River Water Association (KRWA). Additional reservoirs upstream of Pine Flat are owned and operated by Pacific Gas and Electric for hydroelectric power generation. These facilities have a combined storage capacity of about 252,000 acre-feet. 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.

The Kings River provides approximately 85 percent of the surface water used in the Kings Basin (MAGSA 2020). Kings River Water Association (KRWA), consisting of 28 agencies, manages flow on the Kings River. KRWA manages water using analysis of anticipated weather, upstream flows, and ability of downstream users to receive the water. The management options used by KRWA include storing or routing water through alternate sloughs or requesting users accept additional water. Fresno Slough and the James Bypass are usually dry except for groundwater seepage and irrigation returns. Flow is diverted to the South Fork Kings River only in very wet years.

The Kings River and San Joaquin River are over-appropriated under normal flows (MAGSA 2020). However, flood risks present a significant issue in the Kings Basin from January to July. Releases from Pine Flat Reservoir, found upstream of the Planning Area, can be high when the reservoir, which accommodates snowmelt from the Sierra Nevada Range, is anticipated to meet capacity. Flood risk mitigation typically incurs costs up to $20 million per year (Bachand et al. 2014). Large floods in 1983, 1995, and 1997 incurred a total of $1.55 billion (2020 dollars) in damages (Bachand et al. 2014, USBR 2005).

Surface Water Quality

Surface water quality in the upper Kings River is high due to its origins primarily as snowmelt high in the Sierra Nevada mountains. As the river enters the valley, its quality tends to diminish as it receives returns from agriculture. Although the lower Kings River, downstream of the Island Weir near the fork between the north and south Kings River, has elevated levels of salinity, molybdenum, and toxaphene, the elevated levels only warrant a low priority rating by the State Water Resources Control Board (SWRCB) (KBWA 2018). The Water Quality Control Plan (WQCP) for the Tulare Lake Basin covers the Kings River and addresses surface water contamination, most of which is from agricultural drainage (KBWA 2018). The WQCP recommends BMPs, many for on-farm practices, to address potential contamination from agricultural runoff. Another BMP is a surface water monitoring network where samples can be collected, and contaminant levels can be monitored monthly for salinity, pH, and temperature. The WQCP recommends less frequent monitoring for nutrient levels and toxic substances.

The Project area has no natural surface water features. Surface water features in MAGSA are mostly limited to irrigation water delivery and runoff ditches and canals, stock ponds, and effluent capture ponds.

Groundwater Hydrology

Groundwater is the primary source of irrigation water in MAGSA. Wells in the Kings Basin are unmetered private wells, except for those within the James Groundwater Sustainability Agency (GSA) (KSGSA 2021). In the James GSA, all irrigation groundwater wells are owned and operated by the James Irrigation District (JID) (KSGSA 2021).

GSAs in the Kings Basin estimate groundwater use based on the water demands of land use, as described in the Kings Basin SGMA Annual Report (KSGSA 2021). In the 2019/2020 Water Year, total groundwater use in the Kings Basin was estimated to be 1.3 million AF, with 1.2 million AF used for agriculture (KSGSA 2021). Of the groundwater pumped, MAGSA used the second most (0.37 million AF) of all the GSAs in the 2019/2020 WY, second to North Fork Kings GSA (0.38 million AF).

The Kings Basin is over-drafted by more than 120,000 AF annually (MAGSA 2020). Generally, groundwater use outpaces recharge, as groundwater levels have trended downward since the 1980s (KSGSA 2021). After wetter years, such as 2016 and 2017, upward fluctuations have occurred; however, the general trend is down.

In Fall 2021, depth to groundwater measured at wells in the northern Project area varied from 132 to 183 feet below ground surface, and in the southern Project area from 137 to 244 feet below ground surface (Provost & Pritchard 2022). Groundwater elevations decrease toward a cone of depression in the southwest portion of MAGSA. Groundwater elevation contour maps prepared for years 2015 to 2020 show that the general pattern and direction of groundwater flow has remained consistent over this period (KSGSA 2021).

Infiltration rates are an important factor in identifying the most suitable locations for water recharge. NRCS information on Drainage Class and Hydrologic Soils Group provides an overall expectation for drainage and infiltration. Soils with higher infiltration rates can transmit water to the aquifer faster than an area with a low infiltration rate. Infiltration rates vary horizontally and vertically in the soil column and within a single soil unit. It can also vary because of land use, including type of crop grown. In the Project area, 51 percent of the soils are categorized in Drainage Classes of "somewhat excessively drained" and "well-drained" (Figure 1-10, Table 4-10).

The actual infiltration rates are more difficult to estimate. Studies performed for the McMullin On-Farm Capture Expansion Project estimated actual infiltration rates based on saturated hydraulic conductivity values equivalent to the point at which the infiltration rate becomes steady during infiltration rate tests (Bachand et al. 2016, Bachand and Cameron 2022a). These studies estimate infiltration rates at approximately 2.5 to 4.8 inches/day within the Expansion Project area, part of which overlaps the southern portion of the current Project area.

Provost & Pritchard conducted a feasibility study of the MAGSA area to examine geologic properties and identify regions within MAGSA best suited for recharge of surface water supplies to groundwater (MAGSA 2022). Geologic properties reviewed in this evaluation include soil texture and saturated hydraulic conductivity, the Soil Agricultural Groundwater Banking Index (SAGBI) rating, geologic facies, geologic deposits, groundwater contours (Figure 4-5), and presence/absence of regional aquitards. Recharge site areas have a higher saturated hydraulic conductivity relative to other areas of MAGSA, based on the percentage of coarse and moderately coarse sands (Figure 1-10, Table 4-10).

Groundwater pumping has mined resident groundwater within the Kings Basin, resulting in abandoned agricultural and drinking water wells (Figure 4-6). Between 2014 and 2022, eleven wells within the MAGSA boundary were reported dry to the DWR. All wells were reported during dry periods in the state, with 3 reported between 2014-2016, and the rest reported between 2021-2022 (Figure 4-6). The primary use of these wells was to supply household water, with only one used for agriculture/irrigation.

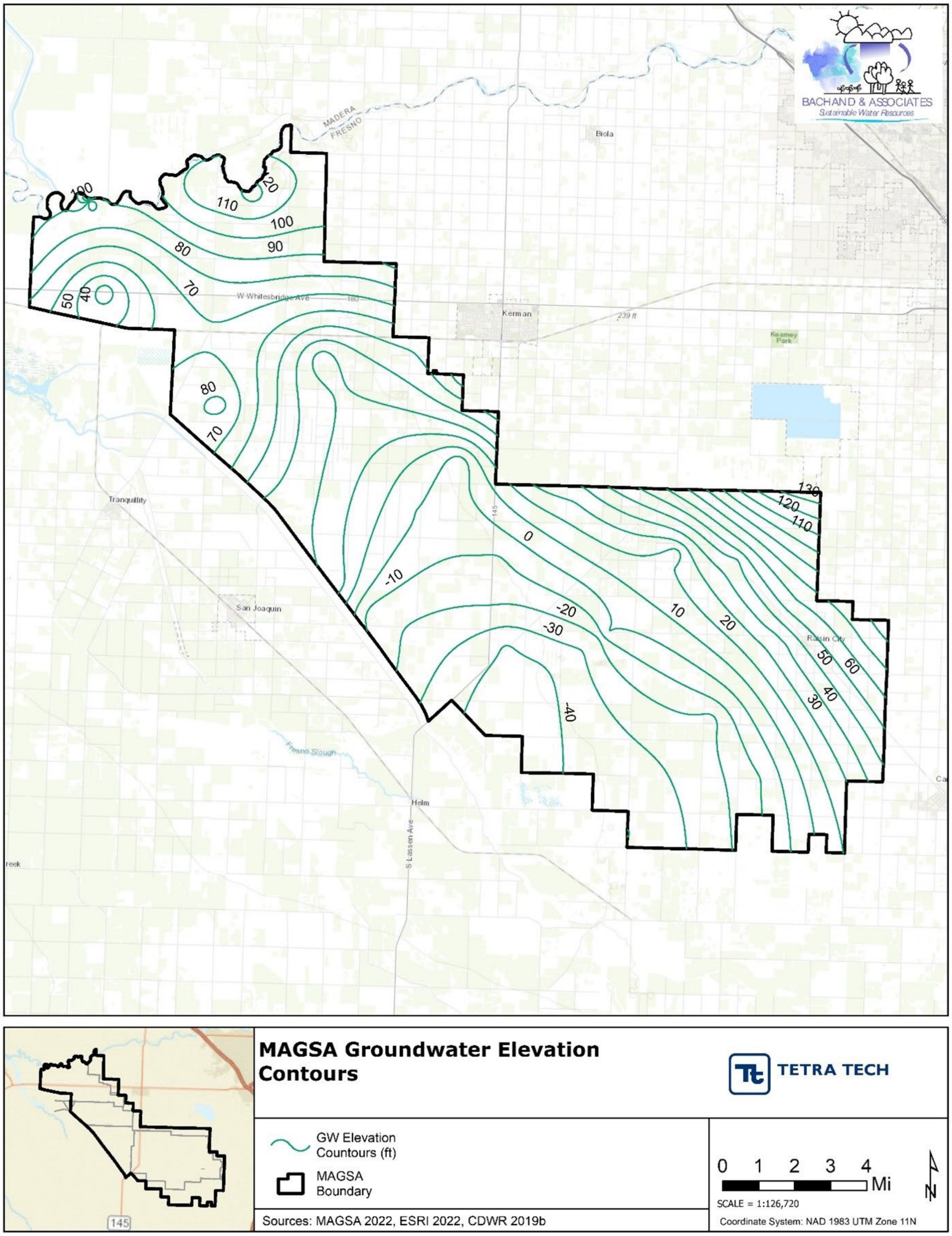


Figure 4-5: Groundwater Elevation Contours

Groundwater Quality

The California SWRCB has enacted a Groundwater Quality Protection Strategy (GWQPS) for the Central Valley region. The SWRCB seeks to maintain high-quality drinking groundwater resources wherever it is present by limiting bacteria, organic and inorganic chemical constituents, and maintaining acceptable taste and odor, so potential beneficial uses are not adversely affected. The GWQPS lists several existing groups and their actions to protect groundwater quality. Because the region is heavily reliant on groundwater for most of its water use, groundwater is used for drinking water, and municipal wells are monitored to comply with safe drinking water standards. Domestic wells, however, are not always monitored.

Groundwater quality within the MAGSA area is generally excellent for agriculture and good for municipal uses (MAGSA 2020). Eight possible constituents of concern (CoCs) have been identified at inconsistent levels over several decades in the MAGSA area. These include arsenic, chloride, 1,2-Dibromo-3-chloropropane (DBCP), manganese, nitrates, sodium, total dissolved solids (TDS), 1,2,3-Trichloropropane (1,2,3-TCP), and uranium. Possible sources of these constituents include agricultural inputs and the Raisin City Oil Field, located in the northeast corner of the study area. Although there have been brief historical exceedances of Maximum Contaminant Levels (MCLs) of some of these constituents, there is no indication of trends that would cause significant concern to MAGSA water quality (MAGSA 2020). Few exceedances of pesticides have been identified (MAGSA 2020).

MAGSA tracks plume expansion or movement through the groundwater monitoring network it maintains around the Raisin City Oil Field and track identified constituents using data from public water supply wells and the NRCS's Groundwater Ambient Monitoring and Assessment Program (GAMA). MAGSA will continue to comply with California Code of Regulations (CCR) Title 22, which requires groundwater monitoring and reporting by community water systems and non-community public supply wells. MAGSA will utilize this data to identify future groundwater quality concerns and implement mitigation measures if needed.

As one of the mandatory requirements of the Irrigated Lands Regulatory Program (ILRP), the Kings Coalition prepared a Groundwater Assessment Report (GAR), which analyzed risks to groundwater from salts and nitrates as the primary CoCs that may originate from irrigated agriculture within the coalition area. The MAGSA area is in the northern portion of the GAR study area. The GAR found very few nitrate detections, but many of those exceedances were above the MCL of 10 mg/L. The GAR found relatively few TDS detections in MAGSA, but many of those detections were above the primary drinking water standard of 1,000 mg/L. The MAGSA area tends to have naturally occurring saline soils with elevated TDS levels due to saline and connate water found within the fresh water-bearing continental deposits. The GAR also found very few pesticide exceedances in the study area.

The findings regarding each of the MAGSA CoCs are summarized below.

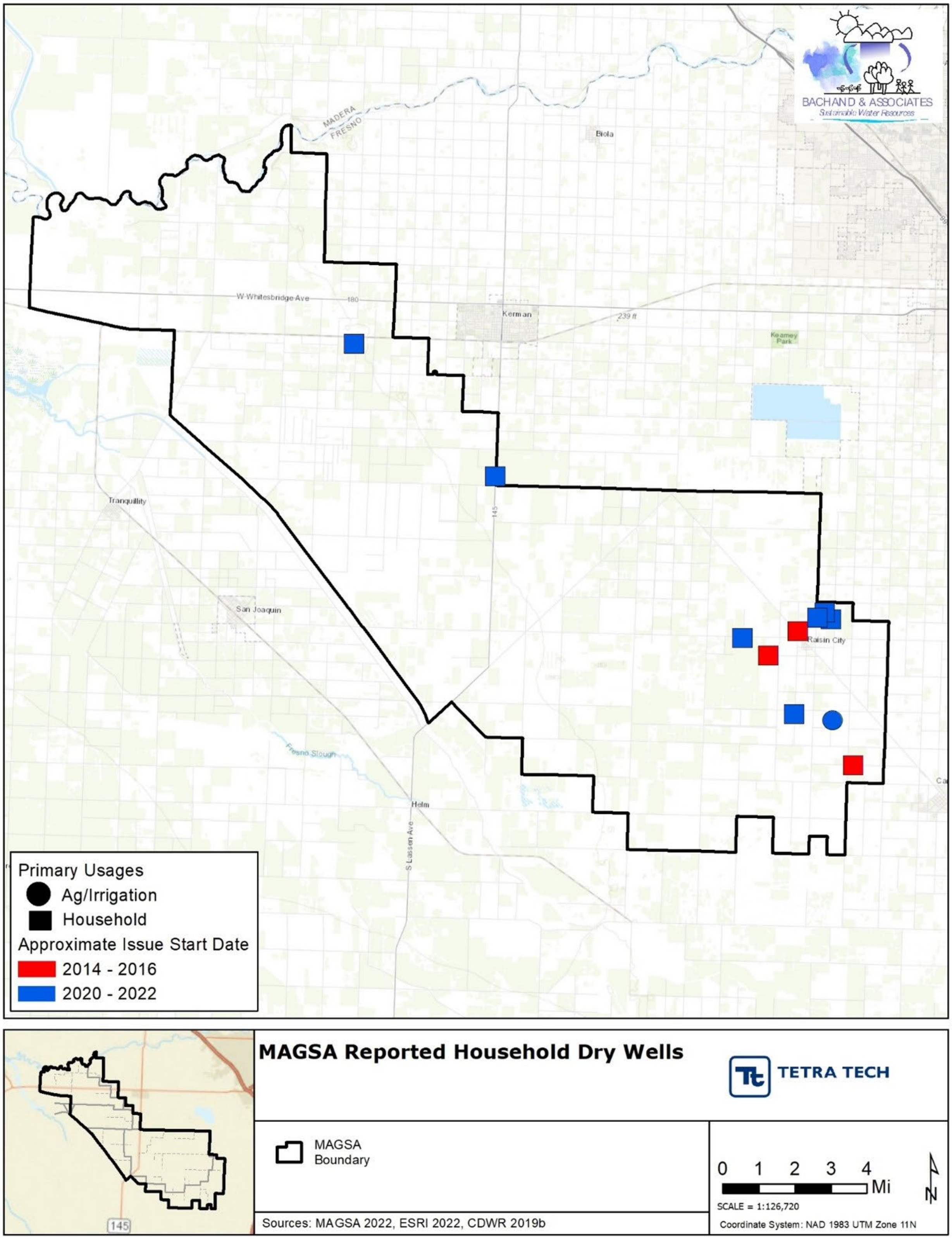


Figure 4-6: Reported Household Dry Wells

Arsenic

Arsenic occurs in natural deposits and has an MCL of 10 ug/L. In 2018, a municipal well southeast of Raisin City had a reported value of 38 ug/L. Arsenic is not of considerable concern for MAGSA, and while historic, sporadic heightened MCL exceedances have been found, there is little indication of a consequential or continuous increase (MAGSA 2020). MAGSA will continue to monitor arsenic through its monitoring network.

Chloride

Chloride is a common constituent in groundwater in the Central Valley of California. It has a secondary Drinking Water Standard (SMCL) of 500 mg/L and is present in monitoring wells and municipal wells of various depths throughout the MAGSA area. Chloride is not of considerable concern for MAGSA, and while historic, sporadic heightened MCL exceedances have been found, there is little indication of a consequential or continuous increase (MAGSA 2020). MAGSA will continue to monitor chloride through its monitoring network.

DBCP

DBCP was used as a fumigant to kill nematodes in soil before planting and was widely used in California until 1977. Its MCL is 0.2 ug/L. In 1993, a DBCP concentration of 2.5 ug/L was sampled at an unspecified well with a total depth of 233 ft. DBCP is not of considerable concern for MAGSA, and while historic, sporadic heightened MCL exceedances have been found, there is little indication of a consequential or continuous increase (MAGSA 2020). MAGSA recognizes the possible presence of this constituent southeast of Raisin City and will continue to monitor DBCP through its monitoring network and from the public water supply system.

Manganese

Elevated levels of manganese have been detected in the MAGSA area (MAGSA 2020). The elevated levels were found in the northern part of the GSA which do not include the Project area. Manganese is not of considerable concern for this project, but MAGSA will continue to monitor it through its monitoring network.

Nitrate-Nitrogen

Nitrate is commonly found in groundwater due to nitrogen fertilizers in irrigated agricultural and landscaped areas, seepage from feedlots and dairies, wastewater and food processing waste ponds, sewage effluent, and leachate from septic system drain fields. The MCL for nitrate as NO3 is 45 mg/L and the MCL for nitrate as nitrogen is 10 mg/L. Using data from NRCS's GAMA Program from 2015 through 2018, MAGSA found no significant exceedances of nitrate and found no indication of consequential or continuous increase (MAGSA 2020). MAGSA will continue to monitor for nitrate and nitrogen through its monitoring network.

Sodium

Sodium is the predominant CoC in MAGSA. Elevated sodium levels are found primarily in areas near the American Avenue Landfill (MAGSA 2020). There is little GAMA data to suggest a consequential or continuous increase. MAGSA will continue to monitor for sodium through its monitoring network.

Total Dissolved Solids (TDS)

TDS has a recommended SMCL of 1,000 mg/L. Throughout the MAGSA area, TDS concentrations at or above the SMCL has been found, but with little regularity or pattern. The presence of TDS is expected as it is mainly representative of the existence of salts. While historical values of TDS have occurred at levels greater than the SMCL, in recent years the monitoring well located near the American Avenue Landfill within MAGSA has shown a decline in TDS concentrations from 2,400 mg/L in 2017 to 1,600 mg/L in 2018 (MAGSA 2020). MAGSA will continue to monitor for TDS through its network of monitoring wells.

1,2,3-TCP

TCP is used industrially as a paint and varnish remover and chemically as a solvent for pesticides. Although there is no federal MCL, California has adopted its own drinking water standard of 5 parts per trillion as of 2018. Although there have been sporadic exceedances of this standard within MAGSA, there is little indication of a significant or continual increase in concentrations of TCP (MAGSA 2020). MAGSA will continue to monitor for TCP through its monitoring network.

Uranium

Uranium occurs naturally in groundwater in parts of the MAGSA area. It is derived from Sierra Nevada granitics and will preferentially adhere to clays. Uranium has not been identified in GAMA data from 2015 through 2018 but is tested for by the state of California through public water supply systems (MAGSA 2020).

4.10.2 Regulatory Setting

4.10.2.1 Federal

Clean Water Act. The CWA is intended to restore and maintain the chemical, physical, and biological integrity of the nation's waters (33 CFR 1251). The regulations implementing the CWA protect waters of the U.S. including streams and wetlands (33 CFR 328.3). The CWA requires states to set standards to protect, maintain, and restore water quality by regulating point source and some non- point source discharges. Under Section 402 of the CWA, the National Pollutant Discharge Elimination System (NPDES) permit process was established to regulate these discharges.

The National Flood Insurance Act (1968). This Act makes available Federal subsidized flood insurance to owners of flood-prone properties. To facilitate identifying areas with flood potential, FEMA has developed Flood Insurance Rate Maps (FIRM) that can be used for planning purposes.

Federal Emergency Management Agency. The Federal Emergency Management Agency (FEMA) administers the National Flood Insurance Program to provide subsidized flood insurance to communities that comply with FEMA regulations limiting development in floodplains. FEMA also issues Flood Insurance Rate Maps that identify land areas subject to flooding. These maps provide flood information and identify flood hazard zones in the community. The design standard for flood protection is established by FEMA, with the minimum level of flood protection for new development determined to be the 1-in-100 annual exceedance probability (AEP) event (i.e., the 100-year flood event). Specifically, where levees provide flood protection, the levee crown is required by FEMA to have 3 feet of freeboard (levee height) above the 1-in-100-AEP water surface elevation, except near a structure such as a bridge, where the levee crown must have 4 feet of freeboard for 100 feet upstream and downstream from the structure.

Executive Order 11988. Executive Order 11988 (Floodplain Management) addresses floodplain issues related to public safety, conservation, and economics. It generally requires Federal agencies constructing, permitting, or funding a project in a floodplain to:

- avoid incompatible floodplain development,
- be consistent with the standards and criteria of the National Flood Insurance Program, and
- restore and preserve natural and beneficial floodplain values.

National Pollutant Discharge Elimination System. The National Pollutant Discharge Elimination System (NPDES) process, established by the CWA, is intended to meet the goal of preventing or reducing pollutant runoff. Projects involving construction activities (e.g., clearing, grading, or excavation) with land disturbance greater than 1 acre must file a Notice of Intent (NOI) with the applicable California RWQCB to indicate the intent to comply with the State General Permit for Storm Water Discharges Associated with Construction Activity (General Permit). This permit establishes conditions to minimize sediment and pollutant loading and requires preparation and implementation of a Storm Water Pollution Prevention Plan prior to construction.

4.10.2.2 State

State Water Resources Control Board. The State Water Resources Control Board (SWRCB), located in Sacramento, is the agency with jurisdiction over water quality issues in the State of California. The SWRCB is governed by the Porter- Cologne Water Quality Act (Division 7 of the California Water Code), which establishes the legal framework for water quality control activities by the SWRCB. The intent of the Porter-Cologne Act is to regulate factors which may affect the quality of waters of the State to attain the highest quality which is reasonable, considering a full range of demands and values. Much of the implementation of the SWRCB's responsibilities is delegated to its nine Regional Boards. The Project site is located within the Central Valley Region.

Sustainable Groundwater Management Act of 2014 (CDWR 2024). In 2014, the California Legislature enacted the Sustainable Groundwater Management Act of 2014 ("Act"). The Act provides authority for local agency management of groundwater and requires implementation of plans to meet the goal of groundwater sustainability established by the Act within basins of high- and medium-priority. The Act's goal of sustainability is met by implementation of sustainability plans that identify and cause implementation of measures targeted to ensure that the applicable basin is operated within its safe yield (Water Code § 10721(t)). Safe yield is defined as the maximum quantity of water that can be withdrawn annually from the groundwater supply without causing an undesirable result and includes within the definition of "undesirable result" chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply and significant and unreasonable reduction in groundwater storage. (Water Code § 10721(w)). The Act recognizes that fallowing of agricultural lands and reduction of pumping may be required to achieve groundwater sustainability. (Water Code §§ 10726.2(c), 10726.4(a)).

Regional Water Quality Control Board. The RWQCB administers the NPDES storm water-permitting program in the Central Valley region. Construction activities on one acre or more are subject to the permitting requirements of the NPDES General Permit for Discharges of Storm Water Runoff Associated with Construction Activity (General Construction Permit). The General Construction Permit requires the preparation and implementation of a Storm Water Pollution Prevention Plan (SWPPP). The plan will include specifications for Best Management Practices (BMPs) that will be implemented during project construction to control degradation of surface water by preventing the potential erosion of sediments or discharge of pollutants from the construction area. The General Construction Permit program was established by the RWQCB for the specific purpose of reducing impacts to surface waters that may occur due to construction activities. BMPs have been established by the RWQCB in the California Storm Water Best Management Practice Handbook (2003) and are recognized as effectively reducing degradation of surface waters to an acceptable level. Additionally, the SWPPP will describe measures to prevent or control runoff degradation after construction is complete and identify a plan to inspect and maintain these facilities or project elements. Groundwater management needs are identified at the local level and may be directly resolved at the local level. If groundwater management needs cannot be directly resolved at the local level, additional actions such as enactment of ordinances by local governments, passage of laws by the Legislature, or decisions by the courts may be necessary to resolve the issues.

AB3030 (Stats. 1992, CH. 947). AB3030 (Stats. 1992, CH. 947), passed in 1992, greatly increased the number of local agencies authorized to develop a groundwater management plan and detailed a common framework for management by local agencies. AB 3030, codified in Water Code Section 10750 et seq., provides for the formulation and adoption of a plan for an identified groundwater basin. Such plans must include the cooperation and involvement of all holders of water rights and the various water users to be adopted. Upon adoption of a plan and with a majority vote in favor of the proposal in a local election, the agency can fix and collect fees and assessments for groundwater management.

California Government Code 65302 (d). This regulation pertains to the establishment of a local general plan conservation element for the conservation, development, and utilization of natural resources including water and its hydraulic force, forests, soils, river and other waters, harbors, fisheries, wildlife, minerals, and other natural resources. That portion of the conservation element including waters shall be developed in coordination with any County-wide water agency and with all district and city agencies which have developed, served, controlled, or conserved water for any purpose for the County or city for which the plan is prepared. Coordination shall include the discussion and evaluation of any water supply and demand information described in Section 65352.5 if that information has been submitted by the water agency to the city or County. The conservation element may also cover:

(1) The reclamation of land and waters.

(2) Prevention and control of the pollution of streams and other waters.

(3) Regulation of the use of land in stream channels and other areas required for the accomplishment of the conservation plan.

(4) Prevention, control, and correction of the erosion of soils, beaches, and shores.

(5) Protection of watersheds.

(6) The location, quantity and quality of the rock, sand and gravel resources.

(7) Flood control.

Water Recycling Policy. In April 2019 the State Water Board adopted an update to the Recycled Water Policy (Resolution No. 2018-0057) to include numeric goals for the use of recycled water, a narrative goal to encourage recycled water use in groundwater-over drafted areas, and annual reporting requirements for the volume of recycled water produced and used (California State Water Resources Control Board 2024a).

Irrigated Lands Regulatory Program (ILRP). The ILRP addresses waste discharge (e.g., sediments, pesticides, nitrates) from commercial irrigated lands. The goal of ILRP is to reduce impacts of agricultural discharges to groundwater and surface water.

4.10.2.3 County and Regional

Fresno County Groundwater Management Ordinance. The Fresno County Groundwater Management Ordinance (Municipal Code Chapter 14.03) requires that a permit be obtained to extract groundwater underlying lands in Fresno County for direct or indirect transfer to lands outside the County. Permits require that a groundwater management plan is adopted pursuant to the SGMA, and that a groundwater monitoring and mitigation program is instituted where applicable. Water exchanges, short-term water transfers, groundwater banking programs, and emergency transfers are exempt from permit requirements. The Groundwater Management Ordinance aims to protect groundwater resources from overdraft and ensure continued availability of groundwater for agricultural production in Fresno County.

MAGSA's Groundwater Sustainability Plan (GSP). The GSP, in compliance with AB3030 and the SGMA, describes the physical and geographical characteristics of surface and ground waters in the McMullin Area, and the interactions of surface and ground waters. This detailed plan includes baseline information on surface and groundwater quality to inform future actions within the basin.

4.10.3 Potential Impacts

WAT a): Would the Project violate any water quality standards or waste discharge requirements or otherwise substantially degrade surface or ground water quality?

(Less than Significant Impact with Mitigation Incorporation) Bachand et al. (2023b, Appendix 3) assesses and summarizes expected water quality effects and recommends associated water quality management and mitigation measures. The analysis primarily relies upon spatial analyses of groundwater data from the California Water Board's GAMA Program (GAMA 2023). The report concludes that contract water is of higher quality than the resident groundwater within MAGSA, and that the quality of resident groundwater will improve with implementation and operations of the Bank, including for key water quality constituents such as salts, nitrate, selenium, and TCP.

Short-term water quality perturbations will occur in resident groundwater underlying and near recharge basins because of legacy nitrate and salts loads being flushed from the vadose zone during initial recharge. This first flush is expected to occur through infiltration of the first 15 – 30 feet of applied contract water. In the long-term, flushing of constituents from the vadose zone is expected to be relatively minor because of both spatial and temporal mixing and dilution (Bachand et al. 2023b).

Mass balance calculations predict groundwater underlying recharge basins and above the Corcoran Clay will initially increase an estimated 350 mg/L for TDS and by 7 mg-N/L for nitrate. This first flush effect is expected to be locally limited near recharge basins to an estimated area up to one square mile (Bachand et al. 2023b). Roy et al. (2017) developed an integrated vadose zone and groundwater modeling framework (calibrated using soils and groundwater data within and near MAGSA) which predicts these increased concentrations will become negligible after 10 years or further than 500 meters away from the recharge basin. They estimate infiltrated contract water exceeding 15-30 feet of recharge will improve groundwater quality. Those conclusions are supported through the hydrologic model developed for this analysis (Bachand et al. 2023a) which finds expected changes in groundwater hydrology resulting from recharge basins will be localized to the recharge basin within an estimated distance of a half mile from the recharge basins.

The Bank will be required to meet State and Federal water quality standards and Non-Project Water return standards for contract water returned to the Bank partners. These water quality standards will include drinking water quality standards as well as Non-Project water quality standards consistent with the California Department of Water Resources policies (DWR 2012). Water quality requirements will be met through design and operations constraints.

Bachand et al. (2023b) concludes that the key water quality constituents (e.g., total dissolved solids [TDS], chloride, sodium), nitrate, selenium, and TCP (1,2,3-Trichloropropane) are lowest in the eastern area of MAGSA, which represents about one third the area of MAGSA. The Bank's design and operations prioritize extracting high quality water from that region and include management to avoid first flush groundwater quality perturbations.

WAT b): Would the Project substantially decrease groundwater supplies or interfere substantially with groundwater recharge such that the Project may impede sustainable groundwater management of the basin?

(No Impact) The Bank will recharge contract water for aquifer storage and then, through coordinated and monitored use of recovery wells, return contract water to its partners, leaving behind 10 percent of received water. Bachand et al. (2023a) used a local scale reduced-order MODFLOW (ROM) model to simulate groundwater mounding and depression potentially induced by Bank operations. The predicted changes of groundwater levels were superimposed onto the baseline groundwater contours within MAGSA and show that impacts from Bank recharge and recovery actions will be minor across the greater groundwater hydrology within MAGSA. Prevailing groundwater conditions include a 100 ft. decline in groundwater elevations from the east and northern boundaries of MAGSA to the southwest corner of MAGSA, with a cone of depression in the southwest of MAGSA to which groundwater flows in all directions (Bachand et al. 2023b). Bachand et al. (2023b) modeled changes in groundwater under three different scenarios for a 24-year period representing a historic condition bookended by a future dry and wet condition. The model results indicate that recharge and recovery efforts during that period will have only minor effects on background groundwater hydrology.

Through their hydrologic analysis, Bachand et al. (2023b) conclude groundwater losses will not occur and the remaining 10 percent of recharged water will help to replenish the over-drafted aquifer. This water will support MAGSA in complying with SGMA requirements and the various measures of groundwater sustainability (e.g., groundwater level, groundwater supply, and subsidence). The prevailing groundwater contours lead groundwater into MAGSA on the east and southeast, and subsequently down toward a cone of depression along the southwest, which stops further movement downstream. Thus, the remaining water will stay within MAGSA and help to increase groundwater supplies and help reach groundwater sustainability in the area.

WAT c): Will the Project substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river or through the addition of impervious surfaces, in a manner which would:

i) result in substantial erosion or siltation on- or off-site?

(Less than significant impact with mitigation incorporated) **Erosion and Siltation During Construction.** Construction activities, especially those occurring during the wet season, could increase erosion and temporarily impact surface water quality by discharging sediment and pollutants bound to sediment. Other pollutants associated with construction, such as trash, solvents, sanitary waste from portable restrooms or sewage treatment facilities, and concrete curing compounds could flow into and adversely affect the quality of any surface water. Bank construction is subject to the requirements of an NPDES Construction General Permit (CGP) because the construction footprint exceeds one acre of disturbance.

As specified under Mitigation Measure WAT-7, a SWPPP will be developed prior to construction to manage potential discharges from the site during construction that could affect area surface water quality. The SWPPP will require the construction contractor to implement measures to:

- Control all pollutants and their sources (e.g., construction, construction site erosion, other activities associated with construction);
- Identify and eliminate all discharges unrelated to stormwater that are not otherwise required to be under a RWQCB permit;
- Implement effective site BMPs to reduce or eliminate pollutants (i.e., stormwater discharges, authorized construction discharges unrelated to stormwater) to the level of Best Available Technology/Best Conventional Technology standards.

Erosion and Siltation During Operations. Because water for the Bank will be pumped from the Mendota Pool, it will not flow uncontrolled into the Bank canals and cause erosion. Received contract water will be low turbidity, with expected maximum turbidity levels of 5 NTU as currently found in water exported from the San Luis Reservoir (USBR 2017) and in line with current pump-in standards for Non-Project water (USBR 2019). With such low turbidity, settling will be negligible with essentially no solids settling from the contract water as it enters and passes through the Bank conveyance system.

ii) substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off- site

(Less than significant impact with mitigation incorporated) **Local effects during rain periods.** Within-farm features of the Bank will be consistent with typical farm features such as irrigation piping, ditches and tailwater ponds. The planned recharge basins and recovery wells are consistent with typical farm infrastructure and practices found within MAGSA. Precipitation within MAGSA is very low, averaging just under 9 inches annually from 1996-2016 (MAGSA 2020). Given the low precipitation rates, and infrastructure and practices typical of those already in use under farming, the Bank will not substantially affect runoff or flooding at the local and farm scale.

Regional effects during rain periods. Ground surface elevations in MAGSA generally decline from northeast to southwest. The fall across MAGSA is slight, averaging about 0.1 percent from the northeast to the southwest. Soils generally range from somewhat poorly drained to somewhat excessively drained. About 40 percent of the soils are somewhat poorly drained, and the remaining soils are moderately drained (1,500 acres), well drained (46,000 acres) and somewhat excessively drained (19,000 acres). Conveyance canals are placed along farm and county roads (Figure 1-5) and generally along areas with well drained soils to intercept and infiltrate surface runoff (Figure 1-10).

The area has little rainfall to drive significant regional runoff and exists across a nearly flat regional elevation. Canals provide potential barriers to local runoff, but area soils provide sufficient infiltration rates to limit any potential for increased surface runoff or flooding from the Bank implementation.

Effects from recharge operations. Under recharge operations, Bachand et al. (2023a) considered potential surface flooding from recharge water backing up through the vadose zone during recharge operations. Based upon model outcomes, they estimated groundwater mounding under recharge basins to range from 35 – 100 feet, depending upon the location, soils, number of basins, and other factors. Since groundwater depths currently range from 110 to 230 feet bgs, recharge water is not likely to back up to the extent that surface flooding or ponding will occur in adjacent lands. Thus, recharge operations will not reduce infiltration of rainwater and cause increased runoff, ponding, or flooding.

Mitigation Measure WAT-5 (Groundwater Monitoring) will be implemented to ensure flooding, ponding and surface runoff does not occur from recharge operations through monitoring groundwater levels. If groundwater levels were to rise sufficiently to substantially increase local runoff, monitoring will allow for adjusting recharge rates and shifting between basins as needed.

iii) create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff

(Less than significant impact with mitigation incorporated) The effects of the Bank infrastructure and its management are considered in the context of 1) potential interference on regional runoff, 2) runoff during construction; and 3) runoff from risks from failures.

During Construction. Prior to commencing construction activities, a SWPPP will be developed and implemented to control erosion, runoff, and release of other pollutants, as specified in Mitigation Measures WAT-7. Construction across the Bank will be stepwise and SWPPPs will be implemented accordingly.

Runoff resulting from infrastructure failures. Failure of the recharge basin berms could release water and cause minor, localized flooding. Any such releases would typically be confined to the immediate area by previously existing water management features such as berms and levees. Releases would occur in very flat areas with little sensitive infrastructure, residences, or municipal features, so the effects of such releases would be minor. Any released water would be high quality contract water and pose no pollution threat. Mitigation measures WAT-8 through WAT-11 include measures for managing potential releases and will ensure that impacts are less than significant.

Recharge basins will be contained within farm property boundaries and are typically planned to be 80 acres each, subdivided into smaller (e.g., 20 acre) checks to limit wind fetch and potential water releases. Recharge basin water depths will typically be shallow (0.5 - 2.0 feet), limiting water storage. The Bank components are surrounded by agricultural fields that may have crops growing in them at any time of year, as well as some farm-related structures and residences. As discussed earlier, farmlands are relatively level and even the least permeable farmlands within MAGSA typically infiltrate at a minimum rate of 2.5 in/d (Bachand et al. 2016). Because of the minor nature of potential water releases and the surrounding agricultural lands and associated infiltration capacities, the Bank does not constitute a risk of injury or death but could lead to losses of root vegetables or other crops if they were maturing in fields that were inadvertently flooded.

iv) impede or redirect flood flows?

***(Less than significant impact with mitigation incorporated*)** Flood flow considerations include flood flows local to MAGSA and flood flows from the upstream areas through the Kings River.

Within MAGSA. Culverts will direct canal flow under roadways and stormwater channels so that the Bank will have no impact on flood flows.

From upstream along the Kings River. The Bank is expected to have only a negligible effect of flood flows through the Kings River. Based on the historical record and as previously discussed, flood flows are lower than 4,000 CFS over 80 percent of the time during the months contract water would be delivered through the Mendota Pool and James Bypass, meaning that ample capacity remains in the 4,750 CFS James Bypass to accommodate Bank discharges.

Mitigation Measure WAT-11 will be implemented to manage Bank diversion and recovery schedules to not interfere with flood releases along the Kings River that pass through the James Bypass, or with contractor deliveries.

WAT d): In flood hazard, tsunami, or seiche zones, will the project risk release of pollutants due to Project inundation?
(Less than Significant Impact)

- **Tsunami or seiche zones.** The proposed project area is located well inland of any area that could be reached by a tsunami or seiche. There would be no impact associated with tsunami or seiche.
- **Inundation of farmlands within FEMA 100-year floodplain or flood hazard zone.** During construction, risk of release of pollutants will be reduced to a less than significant level by implementing a Spill Prevention and Response Plan and ensuring that the construction contractor abides by all regulations for transporting, using, and storing hazardous or potentially polluting materials. The project features have been designed to avoid known or potentially polluted areas including CAFO's, oil fields, landfills, or industrial areas. Operation of the proposed project would not involve use of potentially polluting materials other than minor amounts of fuel for maintenance vehicles or solvents to use on machinery during occasional maintenance.
- **Release of Pollutants.** While the Bank will include inundation of selected basins, the quality of surface water applied to the basins is generally higher than that of the groundwater in the region (Bachand et al., 2023a). Thus, the Bank and its infrastructure are not expected to introduce additional sources of pollution.

WAT e): Conflict with or obstruct implementation of a water quality control plan or sustainable groundwater management plan?

(Less than significant impact with mitigation incorporated) The MAGSA GSP provides a plan to achieve sustainable groundwater conditions by 2040 (MAGSA 2020). The goal can be achieved by increasing or maintaining groundwater supply, or by reducing demand. Sustainable groundwater, as defined under SGMA, considers a balanced water budget that is not achieved by diminishing water quality, increasing subsidence, or reducing the surface water to groundwater connection (MAGSA 2020). The Bank is one of MAGSA's priority actions to move toward sustainable groundwater, as defined by SGMA, because 10 percent of received contract water will not be returned to the contractors but will instead be left behind to help replenish the aquifer.

Groundwater Quality. The Bank will recharge contract water that meets the Pump-in standard, consistent with the DWR (2012) policy for Non Project pump-in standards. A water quality standard will be set for this Project under Mitigation Measure WAT-2. The Mendota Pool Group pump-in standard, which incorporates both drinking water standards and more rigorous standards for select key constituents (e.g., trace metals, salts), will be implemented at the Bank and will improve drinking water quality in the area (e.g., salts, nitrate, selenium, TCP) (Bachand et al., 2023b) although there is potential for short-term degradation related to the first flush of constituents out of the vadose zone.

The Bank will also meet requirements when discharging water back to contractors. Bank operations will be conducted to avoid moving any existing plumes of poor groundwater quality or mobilizing of constituents into groundwater due to recharge activities.

Mitigation measures WAT-1 through WAT-6 are designed to reduce potential impacts on water quality reducing flush of legacy constituents from the vadose zone, importing water that is cleaner than existing groundwater, planning use of recharge basins to optimize groundwater quality, designing Bank components to control water movement and extract high quality water, monitoring to ensure that bank activities are accomplishing intended goals, and farming practices to avoid adding constituents to vadose zone for future mobilization.

Subsidence. Because groundwater levels are expected to generally increase over time with recharge, the Bank will help to reduce subsidence.

Surface water to groundwater connection. The Bank will not decrease the current surface to groundwater connection. Currently, groundwater depth ranges from about 110 to 230 feet below the ground surface where recharge basins are placed. The Bank model results estimate groundwater levels will increase by 50 – 100 ft (Bachand et al. 2023b), indicating surface water and groundwater will not be connected.

4.11 Land Use and Planning (USE)

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
Would the Project:				
a) Physically divide an established community?	☐	☐	☐	☒
b) Cause a significant environmental impact due to a conflict with any land use plan, policy, or regulation adopted for the purpose of avoiding or mitigating an environmental effect?	☐	☐	☐	☒
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?	☐	☐	☐	☒

4.11.1 Environmental Setting

Land Use

The project area is situated in a rural, agricultural area of central Fresno County, to the west and southwest of the city of Fresno. Land use within the project area is primarily agricultural, but also includes residential and labor housing, conservation areas, and a county landfill. The only census-designated place within the project area is Raisin City, which has a population of approximately 300 (U.S. Census Bureau 2019), an elementary school, two churches, and three markets. From the mid-1800s the land has been used for livestock grazing and other types of agricultural production.

The two conservation areas found in the project area, Alkali Sink Ecological Reserve and Kerman Ecological Reserve, are managed by the California Department of Fish and Wildlife (GreenInfo Network 2022). The American Avenue Landfill, found near the center of MAGSA, is owned and operated by Fresno County (Fresno County 2022).

Nearby communities include Kerman (1 mile east), Caruthers (1 mile east), Helm (2 miles west), San Joaquin (2 miles west), Tranquility (2 miles west), and Mendota (4 miles west). The Mendota Wildlife Area is located adjacent to the west side of the project area at the western terminus of the Jensen Canal.

Land Ownership

The vast majority of the project area is privately owned, except for the two ecological reserves, the landfill, and roads owned by the county and state.

Over 95,000 acres within the project area are participating in Williamson Act contracts. Under the Williamson Act, also known as the California Land Conservation Act of 1965, an owner of agricultural land may enter into a contract with the County if the landowner agrees to restrict use of the land to the production of commercial crops for a term of not less than 10 years. The term of the contract is automatically extended each year unless notice of cancellation or nonrenewal is given. Certain compatible uses are also allowed on the property. In return, the landowner is taxed on the capitalization of the income from the land and not on the assessed value (CDC 2021).

4.11.2 Regulatory Setting

4.11.2.1 Federal

There are no federal regulations relating to Land Use and Planning that are applicable to the Project or the Project site because it is not taking place on lands administered by a Federal agency. However, because Federal grant funds are helping to pay for the Project, the Project is subject to the National Environmental Policy Act in addition to CEQA. A separate environmental study under NEPA will be prepares by BOR.

4.11.2.2 State

The proposed project is being evaluated pursuant to CEQA; however, there are no state regulations, plans, programs, or guidelines associated with land use planning that are applicable to the proposed project.

4.11.2.3 County and Regional

County Planning

Two county zoning categories are found in the project area. Of the 120,496 acres found within the project area, 120,430 acres are zoned "AE" Exclusive Agricultural District. In and around Raisin City, 66 acres are zoned "A-1" Agricultural District. These zoning designations are summarized below from the relevant sections of the Zoning Ordinance of the County of Fresno (Fresno County 2018).

Section 816: "AE" Exclusive Agricultural District. This district is meant to be an exclusive district for agriculture and uses that are necessary and integral to agricultural operations, especially by maintaining large parcels of land for agricultural purposes and preventing encroachment from non-agricultural uses. The AE zone is accompanied by a number that indicates the minimum lot size within the district. In the case of the project area, the zoning is AE20, indicating a minimum lot size of 20 acres.

Section 847: "A-1" Agricultural District. This district provides for the development of unincorporated lands and properties in the county that are not included in other classifications. Lands with this designation may be subdivided to allow for more typical residential development. Provisions from Section 816 (described above) and Section 856 (Regulations for Single Mobile Home Occupancy) apply in this area.

Fresno County General Plan. The applicable land use plan for the project area is the Fresno County General Plan (Fresno County 2000). The current plan, adopted in 2000, is in the process of being amended, and a public review draft was made available in July 2021 (Fresno County 2021a, 2021b, 2021c). The Plan provides for a comprehensive, long-term framework designed to protect Fresno County's agricultural, natural, and cultural resources while allowing for economic development.

The county-wide land use diagram included in the General Plan shows the entire project area as Agriculture. Agricultural goals and policies are the primary land use elements that pertain to the project area. Fresno County is among the top agricultural producing counties in the U.S. and maintaining agricultural production capacity in the county through effective land use planning is a high priority. The General Plan's Agricultural Goals and Policies applicable to the proposed project are as follows:

> ***Goal LU-A, Agriculture:*** To promote the long-term conservation of productive and potentially productive agricultural lands and to accommodate agricultural-support services and agriculturally related activities that support the viability of agriculture and further the County's economic development goals.

Policy LU-A.1, Agricultural Land Conservation: The County shall maintain agriculturally designated areas for agriculture use and shall direct urban growth away from valuable agricultural lands to cities, unincorporated communities, and other areas planned for such development where public facilities and infrastructure are available or can be provided consistent with the adopted General or Community Plan.

Policy LU-A.16, Agricultural Land Preservation Programs: The County should implement agricultural land preservation programs for long-term conservation of viable agricultural operations. Examples of programs to be considered should include land trusts, conservation easements, dedication incentives, new and continued Williamson Act contracts, Farmland Security Act contracts, the California Farmland Conservancy Program, agricultural education programs, zoning regulations, agricultural mitigation fee program, urban growth boundaries, transfer of development rights, purchase of development rights, and agricultural buffer policies.

Policy LU-A.18, Land Improvement Programs: The County shall encourage land improvement programs to increase soil productivity in areas containing lesser quality agricultural soils.

Policy LU-A.19, Reduced Soil Erosion: The County shall encourage landowners to participate in programs that reduce soil erosion and increase soil productivity. To this end, the County shall promote coordination between the Natural Resources Conservation Service, resource conservation districts, University of California Cooperative Extension, and other agencies and organizations.

Policy LU-A.20, Water Resources: The County shall adopt and support policies and programs that seek to protect and enhance surface water and groundwater resources critical to agriculture.

Regional Planning
The Kings Basin Water Authority (KBWA) is a coalition of water agencies, cities, counties, and environmental interests in the Kings River Basin that addresses the most pressing local water issues, namely groundwater depletion, supply reliability, and quality. KBWA has developed an Integrated Regional Water Management Plan that "defines issues, guiding principles, regional goals, objectives, strategies, actions, and projects to enhance the beneficial uses of water for the Kings Basin and ensure the sustainability of the water supply." The plan was updated in 2018 (KBWA 2018).

The Plan includes the following Regional Goals (RGs), all of which apply to the project, with RG1, RG2, and RG4 being especially relevant:

- RG1 – Halt the Current Overdraft and Provide for Sustainable Management of Surface and Groundwater
- RG2 – Increase Water Supply Reliability, Enhance Operational Flexibility, and Reduce System Constraints
- RG3 – Improve and Protect Water Quality
- RG4 – Provide Additional Flood Protection
- RG5 – Protect and Enhance Aquatic Ecosystems and Wildlife Habitat

4.11.3 Potential Impacts

USE a) Would the Project physically divide an established community?

(No Impact) The project area is mostly comprised of agricultural land with the exception of Raisin City and a few other small communities such as Perry Colony, Alkali Flats, and Fred Rau Dairy. These communities would not be divided in any manner by the proposed project. Conveyance alignments will run outside of these communities and will not disrupt these communities or their land uses, therefore there will be no impact.

USE b) Would the project cause a significant environmental impact due to a conflict with any land use plan, policy, or regulation adopted for the purpose of avoiding or mitigating an environmental effect?

(No Impact) The proposed project does not conflict with any land use plans or policies and in fact helps Fresno County achieve water sustainability goals identified in both the Fresno County General Plan and the Integrated Regional Water Management Plan (IRWMP). The Fresno County General Plan highlights the importance of agriculture in the County and strives to maintain and grow the agricultural production in the area. The proposed project will contribute to groundwater sustainability and result in a long-term beneficial impact to agriculture in the project area. It has no features that would affect the use or disposition of lands enrolled in Williamson Act contracts. The proposed project also closely aligns with the IRWMP, specifically Regional Goals 1, 2 and 4. The proposed project will contribute to long-term water sustainability, increase the local water supply over time, and provide additional flood protection. The proposed project does not conflict with any land use plans or policies and will have no impact.

USE c) Would the Project conflict with any applicable habitat conservation plan or natural community conservation plan?

(No Impact) The Recovery Plan for Upland Species in the San Joaquin Valley identifies 94 public and conservation lands within its planning area, none of which fall within the project area. There are no other HCPs or conservation plans relevant to the project area, and there will be no impact.

4.12 Mineral Resources (MIN)

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
Would the Project:				
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?	☐	☐	☐	☒
b) Result in the loss of availability of locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?	☐	☐	☐	☒

4.12.1 Environmental Setting

Mineral resources known to exist in Fresno County include fossil fuels such as oil, gas, and coal; aggregate (sand and gravel); metals, including chromite, copper, gold, mercury, and tungsten, molybdenum; and other minerals used in construction or industrial applications, such as asbestos, high-grade clay, diatomite, granite, gypsum, and limestone (Fresno County, 2021c).

Mines

The California Division of Mine Reclamation (DMR) website provides information about the Surface Mining and Reclamation Act of 1975 (SMARA) mines, abandoned mines, laws and regulations, and forms, maps, workshops, and publications. An interactive database (web map) shows the locations of active mines and information submitted annually by mine operators related to annual reporting requirements. This web map indicates that there are no active mines within the project area (DMR 2022). The closest mine is in Mendota, approximately five miles to the northwest, and about eight other mines are located near the City of Fresno over ten miles away. These mines are for sand, gravel, stone, and rock extraction.

Oil and Gas Wells

WellSTAR is an electronic database containing information about oil, gas, and geothermal well tracking, production, permitting, incidents, and reporting. It is maintained and accessed through the CDC's CalGEM (CalGEM 2022b). Well Finder is CalGEM's online mapping application and is publicly accessible. Well Finder provides information about the type of well; whether it is in operation, suspended, idle, or plugged; dates of operation; the location of the well; and its name, well number, and American Petroleum Institute (API) number.

There are 22 active wells within the project area; 19 of these are oil and gas, while three are for water disposal (CalGEM 2022b). The Raisin City Oil Field encompasses 20 of these, and two are located to the south of the oil field.

There are also 113 idle wells and nine cancelled wells within the project area. The remaining 233 wells in the project area have been plugged. Idle oil and gas wells are those that have been inactive for two or more years but have not been permanently sealed. Plugged wells are those that have been permanently sealed. The Idle Well Program revised the regulations in 2019 to encourage operators to plug wells that are idle to prevent contaminants from migrating to groundwater or onto the surface (CalGEM 2022a).

Mineral Resource Zones

The CDC's Division of Geology produces mineral land classification (MLC) documents for certain regions that classify the area into Mineral Resource Zones (MRZs). One of these MLC documents was produced for aggregate materials in the Fresno Production-Consumption Region in 1988 and was updated in 1999 (DMG 1999). This document shows that most of the project area overlaps with the MLC evaluation area and is classified primarily as MRZ-1 with some areas of MRZ-3. There are no MRZ-2 zones of known, important mineral resources in the project area (CDC 2022a, DMG 1999, Fresno County 2021a). The only MRZ-2 zones in the Fresno area are located along the San Joaquin and Kings Rivers, east of the project area (Fresno County 2021a).

4.12.2 Regulatory Setting

4.12.2.1 Federal

There are no federal regulations relating to Mineral Resources that are applicable to the Project or the Project site.

4.12.2.2 State

Regulation of mineral resources in the State of California falls under the California Geologic Energy Management Division (CalGEM) (formerly California Division of Oil, Gas and Geothermal Resources) and DMR, both of which are within the California State Department of Conservation (CDC). The DMR provides oversight for administration of the SMARA, which ensures continued accessibility of important, recognized surface mineral resources. DMR also prioritizes the return of mined lands to usable and safe condition.

SMARA requires the State Geologist to classify MRZs for use in land use planning decisions to ensure continued accessibility of important, recognized surface mineral resources. SMARA is intended to provide local agencies with the information necessary regarding the location and importance of surface mineral resources (DMG 1999). Under SMARA, state agencies guide and regulate city and county enforcement of SMARA, but the local land use jurisdictions are the lead agencies for mineral resource issues. The MRZ categories are defined as follows, with MRZ-2 being the most important due to known or likely presence of valuable mineral resources (Fresno County 2021a):

- MRZ-1: No significant mineral deposits are present or little likelihood exists for their presence.
- MRZ-2: Significant mineral deposits have been identified, or a high likelihood exists for their presence.
- MRZ-3: Mineral deposits exist, but their significance cannot be evaluated from available data.
- MRZ-4: Inadequate information for assignment to any other MRZ.

4.12.2.3 County and Regional

Fresno County General Plan. At a local level, mineral resources policies are established by the Fresno County General Plan. The previous plan was dated 2000 and is in the process of being updated. A public review draft version of the updated plan was released in July 2021 (Fresno County 2021a), and a comparison of proposed changes to the previous General Plan shows that changes to mineral resources have been minimal (Fresno County 2021b). Mineral resources are addressed within the Open Space and Conservation section of the plan.

> ***Goal OS-C:*** To conserve areas identified as containing significant mineral deposits and oil and gas resources for potential future use, while promoting the reasonable, safe, and orderly operation of mining and extraction activities within areas designated for such use, where environmental, aesthetic, and adjacent land use compatibility impacts can be adequately mitigated.

Twenty-one specific sub-goals are indicated for mineral resources; sub-goals OS-C.1 through OS-C.12 are relevant to minerals, while OS-C.13 through OS-C.21 are relevant to oil and gas.

4.12.3 Potential Impacts

MIN a): Would the Project result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?

(No Impact) No MRZ-2 zones of known, important mineral resources occur in the project area. The project area is classified mostly MRZ-1 with some areas of MRZ-3; therefore, there are no known or likely valuable mineral resources in the project area, and none are likely present (CDC 2022a, DMG 1999, Fresno County 2020b). No active mines occur within the project area, and the closest active mine to the project area is a sand and gravel mine located northwest of the project area in Mendota (DMR 2022). Well Finder indicates 368 wells occur in the project area including 22 active wells, 113 idle wells, nine cancelled wells, and 233 plugged wells (CalGEM 2022b). Twenty of the active wells are located within the Raisin City Oil Field. Proposed project infrastructure designs account for locations of active wells and avoid construction actions which would have potential to impact active wells. State and local agency regulations, plans, and permitting reviews would ensure that planned project infrastructure would not impede or preclude access to subsurface mineral resources. The proposed project would not result in the loss of availability of a known mineral resource. Thus, the proposed project would have no impact.

MIN b): Would the Project result in the loss of availability of locally important mineral resource recovery sites delineated on a local general plan, specific plan, or other land use plan?

(No Impact) At the local level, policies intended to preserve the future availability of mineral resources are outlined in the Fresno County General Plan, Policy OS-C.1 through OS-C.20. In general, the County would not permit incompatible land uses within the impact zone of existing or potential surface mining areas or areas designated MRZ-2 (Fresno County 2000a and Fresno County 2000b). The County would not permit land uses which threaten the future availability or preclude the future extraction of such resources. No MRZ-2 zones occur in the project area. No other local plans applicable to the project area delineate mineral resource recovery sites. The proposed project would not result in the loss of availability of local mineral resource recovery sites. Thus, the proposed project would have no impact.

4.13 NOISE (DBA)

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
Would the Project:				
a) Generation of a substantial temporary or permanent increase in ambient noise levels in the vicinity of the project in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?	☐	☐	☒	☐
b) Generation of excessive groundborne vibration or groundborne noise levels?	☐	☐	☒	☐
c) For a project located within the vicinity of a private airstrip or an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒

4.13.1 Environmental Setting

The primary land use zone within the project area is exclusive agricultural use, with a small inclusion of agriculture district zoning in Raisin City. The project area is surrounded primarily by other agricultural lands, as well as the Fresno Slough to the west and the San Joaquin River to the north. Raisin City falls within the project area, while nearby communities include Kerman, Caruthers, Helm, San Joaquin, Tranquility, and Mendota. Most noise sources in this area are associated with agricultural practices, and include heavy equipment, traffic, and stationary sources, such as pumps. Typical noise levels are low, but seasonal practices such as field preparation, planting, fertilizing, and harvesting may cause temporary and substantial increases in noise. Within Raisin City, noise sources would also include those typical of a small community such as vehicle traffic, small commercial operations, and residential areas.

Noise standards identify sensitive receptors, such as residences, hospitals, schools, churches, and libraries. While the project area is not zoned for residential use, there are residential structures and mobile homes distributed throughout the project area associated with farm ownership and employment. There are no hospitals in or near the project area.

The only school within the project area is Raisin City Elementary School. There are several other schools near the project area; most of them are associated with neighboring communities, but some are in rural areas. Table 4-11 shows the details of these schools and approximate distances from the project area.

Table 4-11: Schools Near the Project Area

School Location and Type	In Project Area?	Approximate Distance and Direction
Raisin City Elementary School	Yes	Within Project Area
American Union Elementary School	No	2 miles east
Caruthers High School	No	1 mile east
Burrel Elementary School	No	1 mile south
Helm Elementary School	No	2 miles west
San Joaquin Elementary School	No	2 miles west
Tranquility Elementary School	No	2 miles west
Tranquility High School	No	2 miles west
Mendota Schools (5x, Elementary to High School)	No	4 miles west
Kerman Schools (9x, Preschool to High School)	No	≥1 mile east
Kerman Rural Schools (3x)	No	≥1 mile east

No libraries are within the project area. Several branches of the Fresno County Public Library are located near the project area, and are associated with communities including Caruthers, San Joaquin, Tranquility, Mendota, and Kerman. There are three churches within the project area, including the Raisin City Community Church, the Raisin City Holiness Church, and the Iglesia Fuerzas del Calvario #3 (situated to the east of Raisin City).

4.13.2 Regulatory Setting

4.13.2.1 Federal

Noise is federally regulated through the Clean Air Act (Title IV – Noise Pollution), the Noise Control Act of 1972, and the Quiet Communities Act of 1978. However, the EPA decided in 1981 that general noise issues were best handled by state and local governments (EPA 2022). While the EPA retains authority to investigate and respond to noise-related matters, most enforced federal regulations pertaining to noise are relevant to specific industries, activities, manufacturing standards, or occupational exposure standards.

4.13.2.2 State

The California Noise Control Act of 1973. This Act gave local governments jurisdiction over the regulation of noise. As a result, noise elements are included in local government general plans, and are meant to ensure that noise levels are compatible with adjacent land uses. Most jurisdictions also have noise ordinances, which serve as enforcement mechanisms for controlling noise.

4.13.2.3 County and Regional

Fresno County General Plan. The Fresno County General Plan contains nine policies related to noise, of which the following may apply to this project:

Policy HS-G.4. Noise Mitigation Design and Acoustical Analysis: So that noise mitigation may be considered in the design of new projects, the County shall require an acoustical analysis as part of the environmental review process where:

- Noise sensitive land uses are proposed in areas exposed to existing or projected noise levels that are "generally unacceptable" or higher according to the Figure HS-1: "Land Use Compatibility for Community Noise Environments;"
- Proposed projects are likely to produce noise levels exceeding the levels shown in the County's Noise Control Ordinance at existing or planned noise-sensitive uses.

Policy HS-G.6. Construction-related Noise: The County shall regulate construction-related noise to reduce impacts on adjacent uses in accordance with the County's Noise Control Ordinance.

Policy HS-G.8. Noise Levels Compatibility: The County shall evaluate the compatibility of Proposed Projects with existing and future noise levels through a comparison to Figure HS-1, "Land Use Compatibility for Community Noise Environments."

The Fresno County Noise Control Ordinance (Fresno County Code Chapter 8.40) specifies standards for sources of excessive noise affecting residences, schools, hospitals, churches, and libraries (Fresno County 2022a). Sources causing exterior noise levels in sensitive areas that exceed 50 dBA daytime or 45 dBA nighttime over 50 percent of the time (30 minutes of each hour) are prohibited by the ordinance, and non-emergency construction activities are limited to daytime hours. Noise from air conditioning and refrigeration equipment, waste and garbage collection equipment, and electrical substations are also specifically addressed by the ordinance. The County health officer is responsible for enforcement of the ordinance. This code section also exempts noise from construction-related activity between 6:00 am and 9:00 pm weekdays and between 7:00 am and 5:00 pm on weekends.

4.13.3 Potential Impacts

DBA a): Would the project result in the generation of a substantial temporary or permanent increase in ambient noise levels in the vicinity of the project in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?

(Less Than Significant Impact) Noise may result from use of heavy equipment during construction and from use of pumps during operations. Construction equipment likely in use will include air compressors, excavators, backhoes, scrapers, cement trucks, and dump trucks. Typical noise emission levels from these sources are shown in Table 4-12.

Table 4-12: Construction Equipment Noise Emission Levels

Type of Equipment	Typical Noise Level at 50 ft from Source (dBa)	
	Without Feasible Noise Control	With Feasible Noise Control [1]
Air Compressor	80	75
Backhoe	80	75
Cement Truck	85	75
Grader	85	75
Excavator	88	80

Scraper	85	80
Source: FTA 2018.		

The noise levels shown above assume that the receptor is 50 feet away from the sources. Guidance from the Federal Transit Administration (FTA) indicates that noise levels attenuate by an average of 5 decibels for every additional 50 feet of distance. Most receptors will be located at a distance of at least one mile from the construction area, a distance at which noise will have attenuated to background levels. A few residences are likely to be located within 200 feet of the construction area, a distance at which the highest noise levels would have attenuated to 65 decibels, which is considered "Conditionally Acceptable" in agricultural areas according to Fresno County noise standards. The construction contractor will implement all feasible noise control features, including intake mufflers, exhaust mufflers, and engine shrouds, which will further reduce noise levels. Construction noise will be temporary and will cease upon completion of construction.

The Fresno County Code exempts construction-related activity between 6:00 am and 9:00 pm weekdays and between 7:00 am and 5:00 pm on weekends (Section 8.40.060C of the Fresno County Code). Since construction would occur during normal weekday hours, construction noise would fall within the exemption periods and would be consistent with Fresno County's General Plan policies and noise standards.

Pumps used during operations of the proposed project would operate only when flows are available for capture or groundwater is being discharged. Most pumps will be run by electric motors, which generate minimal noise. Noise generated by pumps running on natural gas or propane will be consistent with normal noises occurring in an agricultural setting and will be consistent with Fresno County noise standards. These impacts will be occasional and temporary and will be consistent with existing noise levels; therefore, impacts will be less than significant.

DBA b): Would the project result in the generation of excessive groundborne vibration or groundborne noise levels?

(Less Than Significant Impact) Fresno County has not adopted specific policies pertaining to vibration levels. Typically, substantial ground borne vibration and noise levels occur because of blasting, tunneling through rock, pile driving, geotechnical exploration, and passing trains. Construction vibrations can be transient, random, or continuous and are normally perceptible to humans at approximately 65 VdB, while 85 VdB is the vibration level that is acceptable only on an infrequent basis. Soils in the area are deep and loamy and are not conducive to transmission of vibration or ground borne noise.

Table 4-13: Typical Construction Equipment Vibration Levels

Equipment	[1]PPV at 25 ft (in/sec)	[2]RMS at 50 ft
Large Bulldozer	0.031	81
Caisson Drilling	0.031	81
Loaded Trucks	0.027	80

Notes (Source: FTA 2018)**:**

[1] Peak Particle Velocity (PPV): The peak signal value of an oscillating vibration velocity waveform. Usually expressed in inches/second in the United States.

[2] Root Mean Square (RMS): The square root of the arithmetic average of the squared amplitude of the signal.

Construction of the proposed project would require the use of heavy equipment that would temporarily increase groundborne noise and ground vibration levels at properties near the work area. Groundborne vibration or groundborne noise impacts may be produced by construction equipment and by large trucks and would be limited to the construction phase of the project. Construction activity groundborne noise levels at and near the project areas would fluctuate, depending on the type, number, and duration of uses of various pieces of construction equipment. These impacts would be temporary.

Construction activities would occur between the hours within the construction exemption period specified in the Fresno County General Plan. Project operations would not generate noticeable groundborne vibration or groundborne noise, nor would they exceed FTA thresholds for vibration at the nearest residences. This impact will be less than significant.

DBA c): For a project located within the vicinity of a private airstrip or an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?

(No Impact) The project area is not within two miles of any public or private airports. The San Joaquin Airport CA-32 is approximately five miles east of the project. The Du Bois Ranch Airport is approximately 5.5 miles north of the project. The project area is included in the Airport Influence Area or Land Use Compatibility Zone as identified in the Fresno County Comprehensive Airport Land Use Plan (ALUCP). The project would not expose people residing or working in the area to excessive noise levels. There would be no impact.

4.14 Population and Housing (POP)

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
Would the Project:				
a) Induce substantial unplanned population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)?	☐	☐	☐	☒
b) Displace substantial numbers of existing people or housing, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒

4.14.1 Environmental Setting

The estimated population of Raisin City, a city within the project boundary, has a current population of approximately 377, a nearly 65 percent increase from the 2010 population of 231 (US Census Bureau 2020). The age demographics of Raisin City have not changed drastically but have seen a shift, with 27percent of the population under the age of 18, 55 percent ranging from 19-64, and 18 percent over the age of 65 in 2020; whereas in 2010, 40 percent of the population was under the age of 18, 48 percent was 19-64, and 3 percent was over the age of 65. In addition to Raisin City, three small communities lie within the project area and have populations as low as 24 and as high as 100 (Figure 4-7).

The city of Kerman, approximately 2 miles northeast of the MAGSA boundary, had a total population of 14,920 in 2020 which grew from 12,708 in 2010 (US Census Bureau 2020). The age demographics have nearly remained unchanged since the 2010 census with about 34 percent of the population being under the age of 18, 57 percent ranging from 19-64 in age, and 9 percent being over the age of 65 in 2020; whereas in 2010, about 35 percent of the population was under the age of 18, 56 percent were in the 19-64 age range, and 9 percent were over the age of 65.

4.14.2 Regulatory Setting

4.14.2.1 Federal

There are no federal laws associated with population and housing that will affect the project area however, under Executive Order 12898 federal agencies are required to identify and address low-income communities and minority populations to address environmental justice. Executive Order 14096 requires agencies to notify communities if toxic or hazardous materials are released from a federal facility. The EO emphasizes the importance of public participation and Tribal participation in federal actions (FR 88 25251).

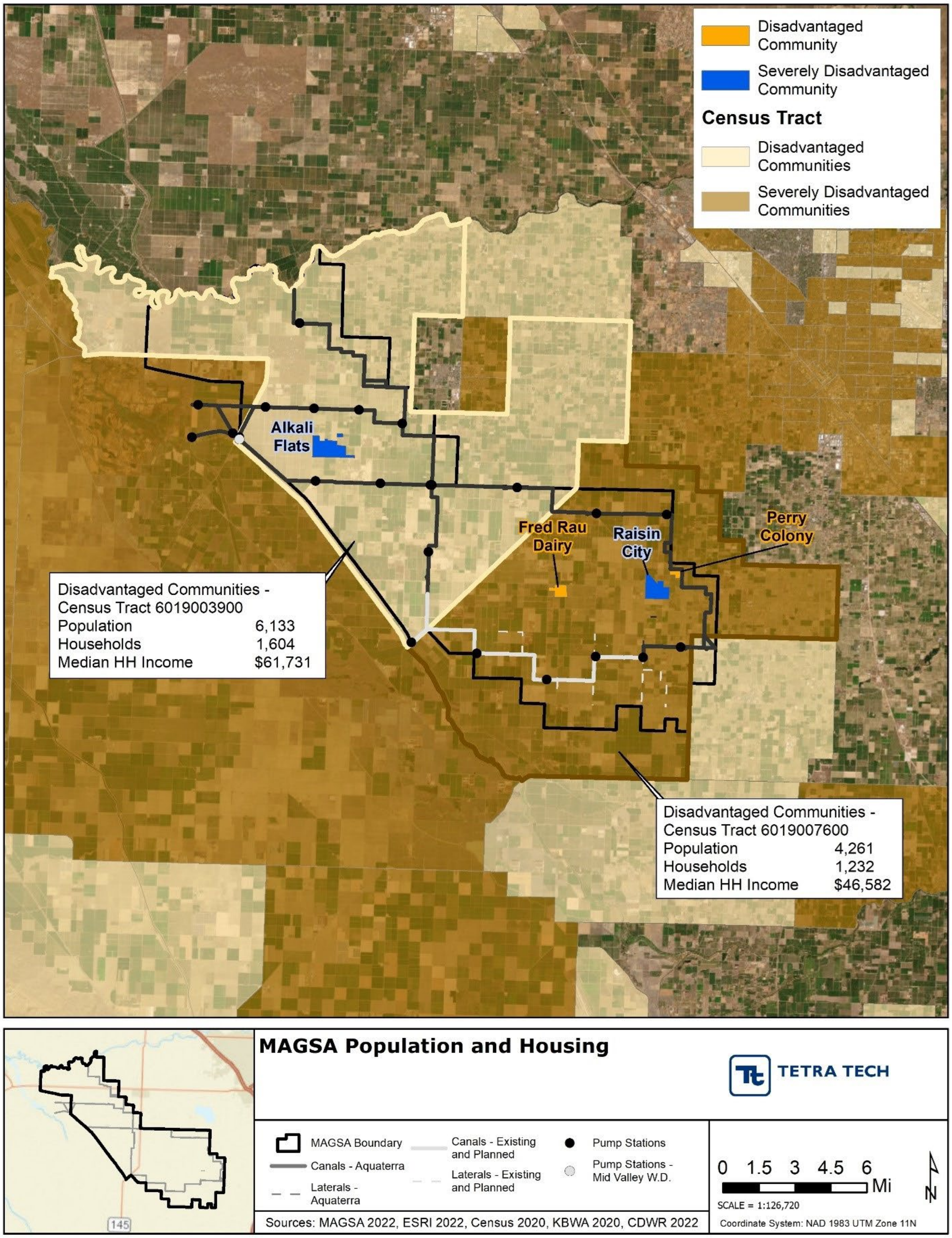


Figure 4-7: Population and Housing

4.14.2.2 State

The state of California, since 1969, requires that all local governments adequately plan to meet the housing needs of everyone in the community after the enactment of the California Housing Element law (CDHCD 2021). This law acknowledges that for the private market to adequately address housing needs, local governments must adopt plans and regulatory systems that provide opportunities for housing development. Local governments abide by this law by providing a general plan. The California Department of Housing and Community Development (HCD) estimates California's project population growth that has the potential to occur in each county in the state based on population projections created by the Department of Finance and assigns a particular housing need. Local governments are required to update their housing element every eight years and the HCD must approve the plan.

4.14.2.3 County and Regional

In 2016, the Fresno Multi-Jurisdictional 2015-2023 Housing Element (Fresno COG 2015) was created and includes the project area. The document contains goals and regulations associated with new housing development, affordable housing, housing and neighborhood conservation, special needs housing, fair and equal housing opportunities, and sustainable development.

Fresno County General Plan. Housing through zoning ordinances is addressed in the Fresno County General Plan (Fresno County 2000). Most of the project area is zoned AE-20, or Exclusive Agriculture with a 20-acre minimum lot size and no more than 1 residence for each 5 acres. Raisin City is zoned A-1, or Agricultural District, and lot sizes must be at least 100,000 square feet.

4.14.3 Potential Impacts

POP a): Would the proposed project induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)?

(No Impact) The proposed project will take place in primarily agricultural land and will not result in or contribute to the construction of new roads, homes, or other developments and therefore will not directly result in increased population growth.

During the construction phase of the project, there will be a temporary increase in the local daytime population, as contractors and construction crews are working on site. These construction crews and contractors will typically not stay within the local community and contribute towards the local population after the completion of the project. Additional housing and infrastructure will not be needed during the construction phase of the project.

POP b): Would the proposed project displace substantial numbers of existing people or housing, necessitating the construction of replacement housing elsewhere?

(No Impact) The proposed project will take place in primarily agricultural land with little to no residential areas and is designed to avoid any dwellings so people and/or housing will not be displaced. The project will not include the removal of existing infrastructure, including housing, so there will be no impact.

4.15 PUBLIC SERVICES (PUB)

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
Would the Project:				
a) Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services:	☐	☐	☐	☒
Fire protection?	☐	☐	☐	☒
Police protection?	☐	☐	☐	☒
Schools?	☐	☐	☐	☒
Parks?	☐	☐	☐	☒
Other public facilities?	☐	☐	☐	☒

4.15.1 Environmental Setting

Fire stations with jurisdiction in the project area include Fresno County Fire Protection Districts (FCFPD) located in the cities of Fresno, Mendota, and Tranquillity. The North Central Fire Protection District serves the city of Kerman and unincorporated areas around Fresno and Kerman.

The Fresno County Sheriff's Office (FCSO) provides patrol services for its more than 6,000 square miles. In 1983, patrol services were decentralized and divided into four patrol areas. Each area is commanded by a lieutenant who supervises field services from a substation located in each of the areas. Portions of the project area overlay with Patrol Areas 1 and 3. Patrol Area 1 covers most of the project area, from Mendota east to Kerman and south to the Helm area. While personnel are still assigned to work out of the Patrol Area 1 substation in San Joaquin, the substation is currently closed to the public due to staffing shortages. Patrol Area 3 comprises the Raisin City, Caruthers, and Riverdale regions.

Emergency response services are provided through dialing 911. American Ambulance Posts are located in the towns of Fresno, Kerman and San Joaquin and provide emergency transportation from the project area to the nearest emergency facility. The nearest emergency medical centers providing 24-hour care include Adventist Health Medical Office in Kerman and Community Regional Medical Center in Fresno. Other emergency rooms in Fresno include Saint Agnes Medical Center and Kaiser Permanente Fresno Medical Center.

Other nearest services are provided in the cities of San Joaquin, Tranquillity, and Mendota. Each city has a County Branch Library, City Hall, and senior/community centers. Elementary schools are found in

Helm, San Joaquin, Tranquillity, Mendota, Kerman, and Raisin City. High schools are found in Tranquility, Mendota, and Kerman.

Applicable public services for the area include:

- Fresno County Fire Protection District, Tranquility Station 95, 25101 Morton Street, PO Box 645, Tranquility, CA 93668, (559) 698-5500
- Fresno County Fire Protection District, Mendota Station 96, 101 McCabe Ave, Mendota, CA 93640, (559) 655-4107
- North Central Fire Protection District, Station 55 Headquarters, 14850 W. Kearney Blvd, Kerman, CA, 93630, (559) 275-5531
- Fresno County Fire Protection District Headquarters, 210 S. Academy, Sanger, CA 93657, (559) 493-4300
- Fresno County Sheriff's Headquarters, 2200 Fresno Street, Fresno, CA 93721, (559) 600-8400.

- Adventist Health Medical Office – Kerman Central, 275 S Madera Ave # 201, Kerman, CA 93630, (559) 846-5240
- Community Regional Medical Center, 2823 Fresno St, Fresno, CA 93721, (559) 459-6000
- San Joaquin Branch Library, 8781 Main Street, San Joaquin, CA 93660 (559) 693-2171
- Tranquillity Branch Library, 25561 Williams Street, Tranquility, CA 93668, (559) 698-5158
- Mendota Branch Library, 1246 Belmont Ave, Mendota, CA 93640, (559) 600-9291
- Kerman Branch Library, 15081 W Kearney Blvd, Kerman, CA 93630, (559) 846-8804
- San Joaquin Community Center, 22058 Railroad St, San Joaquin, California 93660, (559) 693-4311
- Kerman Senior Center, 720 S 8th St, Kerman, CA 93630, (559) 846-8643
- Mendota Community Center, 295 Tuft St, Mendota, CA 93640, (559) 655-4927

4.15.2 Regulatory Setting

4.15.2.1 Federal

National Fire Protection Association. The National Fire Protection Association (NFPA) is an international nonprofit organization that provides consensus codes and standards, research, training, and education on fire prevention and public safety. The NFPA develops, publishes, and disseminates more than 300 such codes and standards intended to minimize the possibility and effects of fire and other risks. The NFPA publishes the NFPA 1, Uniform Fire Code, which provides requirements to establish a reasonable level of fire safety and property protection in new and existing buildings.

4.15.2.2 State

California Fire Code and Building Code. The 2013 California Fire Code (Title 24, Part 9 of the California Code of Regulations) establishes regulations to safeguard against hazards of fire, explosion, or dangerous conditions in new and existing buildings, structures, and premises. The Fire Code also establishes requirements intended to provide safety and assistance to fire fighters and emergency responders during emergency operations. The provision of the Fire Code includes regulations regarding fire-resistance rated construction, fire protection systems such as alarm and sprinkler systems, fire service features such as fire apparatus access roads, fire safety during construction and demolition, and wildland urban interface areas.

4.15.2.3 County and Regional

Fresno County General Plan. The Fresno County general plan policies relevant for public services for the Project are:

PF-C.21. The County shall promote the use of surface water for agricultural use to reduce groundwater table reductions.

PF-E.2. The County shall encourage the agencies responsible for flood control of storm drainage to coordinate the multiple use of flood control and drainage facilities with other public agencies.

PF-E.12. The County shall coordinate with the local agencies responsible for flood control or storm drainage to ensure that future drainage system discharges comply with applicable State and Federal pollutant discharge requirements.

PF-E.17. The County shall encourage the local agencies responsible for flood control or storm drainage retention-recharge basins located in soil strata strongly conducive to groundwater recharge to develop and operate those basins in such a way as to facilitate year-round groundwater recharge.

PF-G.1. The County shall ensure the provision of effective law enforcement services to unincorporated areas in the county.

PF-H.1. The County shall work cooperatively with local fire protection districts to ensure the provision of effective fire and emergency medical services to unincorporated areas within the county.

4.15.3 Potential Impacts

PUB a): Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services including fire protection, police protection, schools, parks, or other services?

(No Impact) The proposed project will not change the need for public services because it will not increase population in the area or create hazards requiring an on-going public service response. No changes in levels of school or park use are anticipated. There is a potential for construction-related accidents to require public emergency service personnel, but these are not likely to be frequent and hospital service levels would not be affected. Local vector control agencies will be involved in implementing measures to control outbreaks of mosquitoes and other pests but will be able to do so using existing capacity. Impacts will be less than significant.

Fire Protection The proposed project would not lead to any residential or commercial development or any changes in land use, and no additional services would be required from the FCFPD. There will be no impacts associated with fire protection.

Police Protection The proposed project would not lead to any residential or commercial development or any changes in land use, and no additional services would be required from the FCSO. There will be no impacts associated with police protection.

Schools The proposed project would not result in any new residential structures or developments or alter existing land uses. The proposed project would not result in an increase of population that would impact existing school facility service levels or require additional school facilities to be constructed. There will be no impacts to schools.

Parks The proposed project would not result in a population increase and would not increase the number of employees in the area. There would be no need for new or expanded parks or recreational facilities, and there will be no impact.

Other Public Facilities The proposed project would not lead to any population increases, and would not increase the need for libraries, senior care centers, community centers, or other services. The project would help to recharge groundwater supplies and lead to more reliable groundwater supplies within the project area. There will be no impacts to other public facilities.

4.16 Recreation (REC)

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	☐	☐	☐	☒
b) Does the project include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?	☐	☐	☐	☒

4.16.1 Environmental Setting

The project area, as well as the vicinity around the project area, is comprised primarily of agricultural and rural land.

Within the project area, the main protected areas with recreational opportunities are the Kerman Ecological Reserve (ER) and the Alkali Sink ER, both of which are managed by the California Department of Fish and Wildlife and offer wildlife viewing. Hunting is also available at the Kerman ER on a seasonal basis. The nearby Mendota Wildlife Area (MWA) offers a variety of recreational opportunities such as fishing, hunting, and wildlife viewing. The majority of the MWA is located adjacent to the northwest boundary of the project area and the Alkali Sink ER. The only parks located within the project area are the Easton Caruthers Baseball Field Complex and the playground located at the Raisin City Elementary School, both within the boundaries of Raisin City. Bikeways have been identified by the Fresno County General Plan along several primary roads, including SR-180, SR-145, McMullin Grade, and Manning Avenue (Fresno County 2000, 2013). No hiking trails or scenic roadways are located within the project area.

Outside the project area, three small federal parcels associated with the Tranquility Land Retirement Demonstration Site are located approximately 4 miles to the west of the project area. The next closest protected federal lands are over ten miles away (GreenInfo Network 2022). City parks outside the project area can be found within San Joaquin (approximately 2 miles) to the west, Kerman (approximately 1 mile) and Fresno (approximately 6 miles) to the east, and Selma (approximately 13 miles) to the southeast. The nearest Fresno County recreational facility is Kearney Park situated between Kerman and Fresno. In addition, playgrounds are associated with several schools and municipal parks in populated areas outside the project area.

4.16.2 Regulatory Setting

4.16.2.1 Federal

There are no federal regulations relating to recreation that are applicable to the Project or the Project site.

4.16.2.2 State

There are no state regulations relating to recreation that are applicable to the Project or the Project site.

4.16.2.3 County and Regional

The Fresno County General Plan. The Plan includes goals and policies to enhance recreational opportunities by encouraging development of public and private recreation lands and requiring developers to help fund additional parks and recreation facilities when developing new housing projects (Fresno County 2000, 2021c).

> ***Goal OS-H (Policies OS-H.1 – OS-H.5).*** To designate land for and promote the development and expansion of public and private recreational facilities to serve the needs of residents and visitors.

4.16.3 Potential Impacts

REC a): Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?

(No Impact) The California Protected Areas Database (CPAD) is an inventory of all land in California that is protected in fee ownership primarily for open-space use. It includes everything from small urban parks to large national parks. Any recreational areas indicated by CPAD that fall within the project area, as described above, will be avoided by the project canal alignment (GreenInfo Network 2022). The proposed conveyance canals may cross existing and planned bikeways designated by the Fresno County General Plan along several primary roads (Fresno County 2000, 2013). These road crossings will be constructed by using jack-and-bore methods, which will avoid any traffic disruption, including bike traffic, and therefore there will be no impacts to the bikeways. There are no established hiking trails or scenic roadways passing through the project area (Fresno County 2000, 2013). The only local parks in the project area are within the boundaries of Raisin City, and all project features fall outside the Raisin City boundaries. Construction and operation of the proposed project does not include a recreational component. Flooded recharge basins may result in increased migratory bird use of the area, increasing opportunities for bird watching and hunting. The proposed project is not growth-inducing and would not increase the use or deterioration of any established recreational facilities. The project will not impact recreational features.

REC b): Would the proposed project include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?

(No Impact) The proposed project does not include recreational features. The project, as planned, would not result in construction or expansion of recreational facilities that would attract visitors to the area. Although there is a potential for future recreational use, such as using dedicated recharge areas for wildlife viewing or hunting during wet years, this would not be expected to attract visitors from outside the regional vicinity. No additional visitors would be attracted to the area due to the proposed project, aside from workers during construction, and no expansion of existing recreational facilities would occur. The proposed project will have no impact on recreational resources, and no new recreational resources are planned that could have an adverse physical effect on the environment.

4.17 Transportation and Circulation (TRA)

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
Would the Project:				
a) Conflict with a program, plan, ordinance or policy addressing the circulation system, including transit, roadway, bicycle and pedestrian facilities?	☐	☐	☒	☐
b) Would the project conflict or be inconsistent with CEQA Guidelines section 15064.3, subdivision (b)?	☐	☐	☐	☒
c) Substantially increase hazards due to a geometric design feature (e.g., sharp curves or dangerous intersections) or incompatible uses?	☐	☐	☐	☒
d) Result in inadequate emergency access?	☐	☒	☐	☐

4.17.1 Environmental Setting

The project area is accessed by numerous state highways, local paved and unpaved roadways, and served by railroads, airports, and mass transit (Figure 4-8). The main arterials through the region include SR-145, which runs north-south from Helm to Kerman, and SR-180, running east-west from Mendota to Kerman. SR-145 is a two-lane conventional highway designated as a Surface Transportation Assistance Act (STAA) Terminal Access Route, which allows for large trucks to operate on the Interstate and certain primary routes collectively called the National Network, for goods movement (Fresno County 2021a). SR-180 transitions from a two-lane to four-lane highway through the project area. The Fresno County General Plan regional circulation diagram identifies the roadways in the project area, including proposed freeways (SR-180), expressways (SR-145, McMullin Grade Rd., Manning Rd.) and arterials (American Ave., James Rd., and W. Kamm Ave.) in the project area (Fresno County 2000). The Level of Service for all roads within the project area is categorized as a "D," which is defined as approaching unstable flow, where freedom to maneuver in the traffic stream is severely limited, and with average speeds over 46 mph (Fresno County 2000).

The southernmost east-west road is Conejo Rd. The easternmost north-south road is S. Brawley Ave. The westernmost north-south road is W. Whitesbridge Rd. The northernmost boundary is formed by the San Joaquin River. There are several other paved and two-lane collector roads in the vicinity, most of which serve agricultural transportation needs.

Average Annual Daily Traffic (AADT) counts provide the average daily number of vehicles passing by a particular intersection, calculated by taking the total count for the year and dividing by 365 days. There are several AADT count locations in the project area. AADT counts are typically taken for both directions at the count location, and in some cases, differentiating between cars and trucks. Table 4-14 shows the AADT for the number of cars (and trucks, when that value was available) passing through several count locations in the project area (California State Geoportal 2021). At each count location, the number of

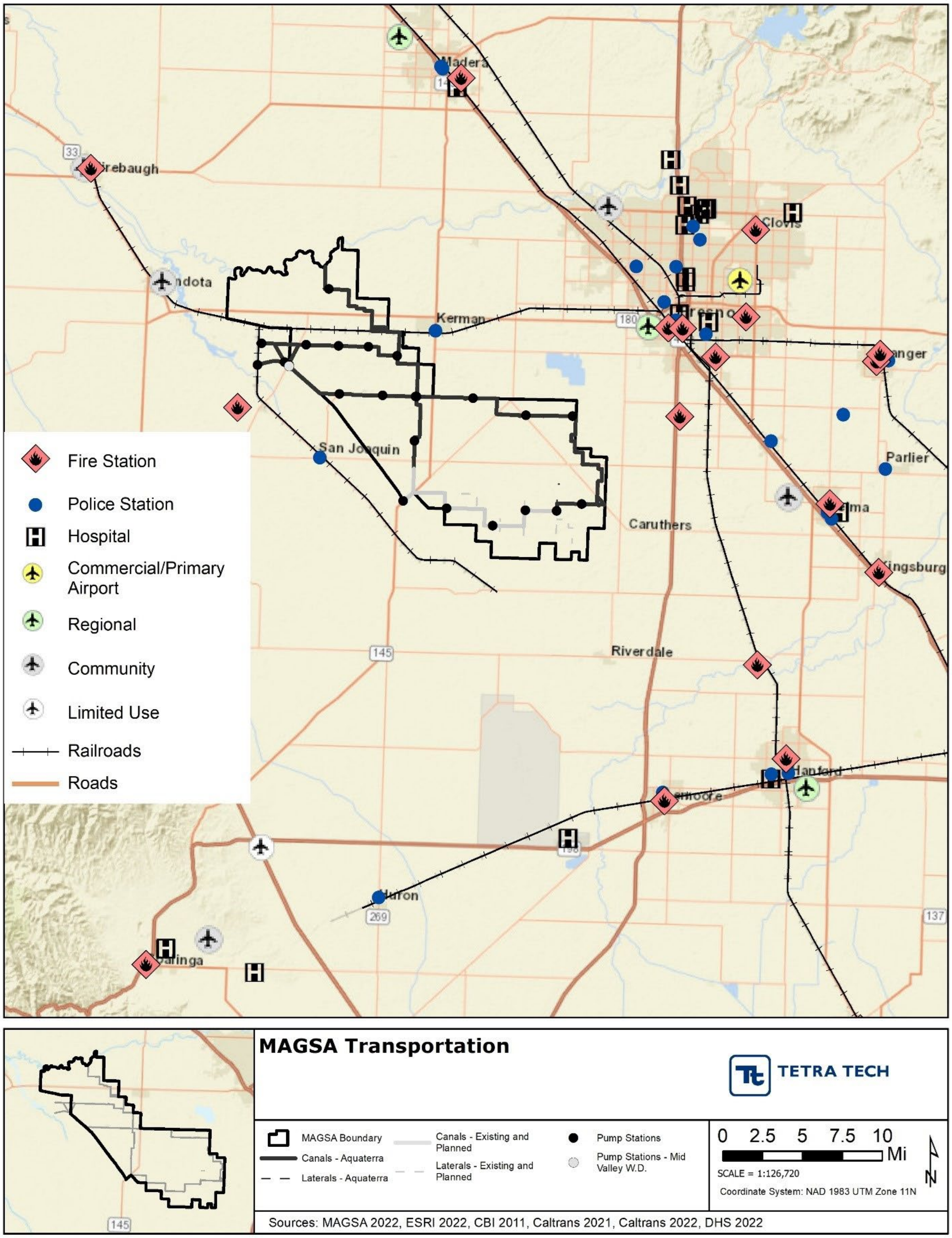


Figure 4-8: Transportation

vehicles passing in both directions is counted (called "ahead" and "back"). Many more passenger cars pass through the project area than trucks, but the greatest numbers of both are traveling along SR-180 and SR-145. Trucks counted include those with two to five axles.

Table 4-14: Average Annual Traffic Counts for 2019

Traffic Count Location	Vehicle AADT	Truck AADT
SR-180 at SR-145, Ahead	15,300	1,888
SR-180 at SR-145, Back	15,600	1,258
SR-180 at Panoche Rd, Ahead	7,500	NA
SR-180 at Panoche Rd, Back	7,400	NA
SR-180 at James Rd., Ahead	8,000	1,120
SR-180 at James Rd., Back	7,300	684
SR-145 at SR-180, Ahead	8,900	830
SR-145 at SR-180, Back	12,400	NA
SR-145 and American Ave, Ahead	6,600	NA
SR-145 and American Ave, Back	4,300	NA
SR-145 and McMullin Grade Rd., Ahead	2,200	NA
SR-145 and McMullin Grade Rd., Back	5,900	NA

Amtrak serves the region with one stop in the city of Fresno, but there are no passenger trains serving the project area (Amtrak 2022). An abandoned rail line runs through the project area from Raisin City to Kerman.

Fresno County Rural Transit Agency provides bus service within and to the project area (FCRTA 2022). The San Joaquin Intercity Transit line runs from San Joaquin to Tranquility and Kerman and reaches nearly to Mendota. The Westside Transit line provides bus service from Fresno to Kerman and Mendota via SR-180.

Fresno County's General Plan Transportation and Circulation Element identifies SR-145 as a proposed rural bikeway that will be included in the updated Regional Bikeways Plan. Fresno County's Regional Bicycle and Recreational Trails Master Plan identifies a proposed location for future development of a Class II Planned Rural Bikeway (Fresno County 2013). This bike lane would travel along Mc Mullin Grade Rd. south to Manning Ave, west to San Joaquin, and north to Tranquility and Mendota via Jefferson Ave and Santa Fe County Rd. This bike lane would be designated along an established street, separated from traffic by a 6-inch-wide stripe. The General Plan shows no existing or proposed formal pedestrian facilities or recreational trails in the project area (Fresno County 2000).

4.17.2 Regulatory Setting

4.17.2.1 Federal

Title 49, CFR, Sections 171-177 (49 CFR 171-177). Title 49 governs the transportation of hazardous materials, the types of materials defined as hazardous, and the marking of the transportation vehicles.

Title 49 CFR 350-399, and Appendices A-G, Federal Motor Carrier Safety Regulations. These regulations address safety considerations for the transport of goods, materials, and substances over public highways.

Title 49 CFR 397.9, the Hazardous Materials Transportation Act of 1974. This act directs the U.S. Department of Transportation to establish criteria and regulations for the safe transportation of hazardous materials.

Federal Aviation Administration. The Federal Aviation Administration (FAA) regulates aviation at regional, public, and private airports. The FAA regulates objects affecting navigable airspace.

4.17.2.2 State

The California Department of Transportation (CalTrans). Caltrans manages the operation of State Highways, including the freeways and State Routes passing through the Central Valley.

State of California Transportation Department Transportation Concept Reports. Each District of CalTrans prepares a Transportation Concept Report (TCR) for every state highway or segment portion thereof in its jurisdiction. The TCR usually represents the first step in Caltrans' long-range corridor planning process. The project is within CalTrans District 6, and the TCRs for SR-145 and SR-180 identify how these highways will be developed and managed.

Agricultural Industries Transportation Services. Caltrans commissioned the Agricultural Industries Transportation Services (AITS) Needs Assessment and Pilot Program in 2001 to meet the transportation needs of the State's agricultural worker population and to improve transportation safety and affordability for agricultural workers. The program provides a transportation service for farm workers using certified vanpool vehicles and operators.

4.17.2.3 County and Regional

Fresno Council of Governments (FCOG) Regional Transportation Plan (2014). The FCOG has the responsibility for all regional transportation planning and programming activities within unincorporated Fresno County. The Regional Transportation Plan (RTP) identifies short-term improvements and long-term strategies for the highway and County's transportation network. Under the RTP, FCOG coordinates with transportation programs that serve commuters and agricultural workers, including AITS. The RTP also recognizes the importance of providing efficient distribution routes to active elements of the regional agricultural industry.

Fresno County Transportation and Circulation. The following objectives and policies from the Transportation and Circulation Element of the General Plan for Fresno County may be relevant for the Project:

> ***Policy TR-A.2 Level of Service.*** The County shall plan and design its roadway system in a manner that strives to meet LOS D on urban roadways within the spheres of influence of the Cities of Fresno and Clovis and LOS C on all other roadways in the county.
>
> ***TR-A.8 Development Impact Fees.*** The County shall assess fees on new development sufficient to cover the fair share portion of that development's impact on the local and regional transportation system.

4.17.3 Potential Impacts

TRA a): Would the project conflict with a program, ordinance, or policy addressing the circulation system, including transit, roadway, bicycle, and pedestrian facilities?

(Less than Significant Impact) The proposed project will generate minor increases in truck and passenger vehicle traffic during construction. Up to 25 employee roundtrips and up to 30 truck trips per day are anticipated during construction. Such increases are well within the capacity of the area's roadways and will not affect LOS.

There will be minor increases in traffic during operations due to occasional vehicle use for periodic inspections and maintenance of pump stations and conveyance features. Vehicle trips will originate in Fresno, Kerman, Helm, or other local towns. The project will not result in permanent operational changes to any transportation facilities, including those for bicyclists, pedestrians, and transit riders. Temporary traffic disruptions may occur during construction or material deliveries , but such impacts will be minor and temporary.

There is expected to be virtually no change in the operating conditions of the roadways from current conditions, and the proposed project will not conflict with any applicable plan, ordinance, or policy establishing measures of effectiveness for the performance of circulation systems. Any impact to local roadways will be less than significant.

TRA b): Would the project conflict or be inconsistent with CEQA Guidelines section 15064.3, subdivision (b)?

(No Impact) "Vehicle miles traveled" refers to the amount and distance of automobile travel attributed to a project. A maximum of 25 workers would be required during construction of the proposed project. Transportation trips for these workers would be temporary over the approximately three-year construction period and would not result in any perceivable increase in vehicle miles traveled or an increase that would exceed a County threshold of significance. There would be no new regular vehicle trips associated with the proposed project other than locally generated trips for routine inspection and maintenance. The proposed project would be consistent with CEQA Guidelines Section 15064.3 subdivision (b), and no impact would occur.

TRA c): Would the project substantially increase hazards due to a geometric design feature (e.g., sharp curves or dangerous intersections) or incompatible uses?

(No Impact) The proposed project does not include the design or construction of any permanent roadway infrastructure that would cause a safety risk to vehicle operations. The proposed project will not alter the physical configuration of the existing roadway network serving the area, nor will it introduce new road uses or types of vehicles that are incompatible with existing uses of the road system. There would be no impact.

TRA d): Would the project result in inadequate emergency access?

(Less Than Significant Impact with Mitigation Incorporation) During the construction phase of the proposed project, slow-moving traffic in the area could affect emergency response times on roads in the project vicinity. Additionally, temporary traffic delays may be required to allow egress or ingress of haul trucks or construction equipment where proposed conveyance alignments cross beneath roadways. Staging areas would be located along existing roadways, either improved or unimproved, and would be readily accessible to emergency responders. An unimproved access road would be located alongside the conveyances. Potential impacts would be less than significant upon implementation of Mitigation Measure TRA-1, which requires that the construction contractor prepare a Traffic Safety Plan which will prioritize emergency access.

4.18 TRIBAL CULTURAL RESOURCES (TCR)

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
Would the project cause a substantial adverse change in the significance of a tribal cultural resource, defined in Public Resources Code section 21074 as either a site, feature, place, cultural landscape that is geographically defined in terms of the size and scope of the landscape, sacred place, or object with cultural value to a California Native American tribe, and that is:				
a) Listed or eligible for listing in the California Register of Historical Resources, or in a local register of historical resources as defined in Public Resources Code section 5020.1(k), or	☐	☒	☐	☐
b) A resource determined by the lead agency, in its discretion and supported by substantial evidence, to be significant pursuant to criteria set forth in subdivision (c) of Public Resources Code Section 5024.1. In applying the criteria set forth in subdivision (c) of Public Resources Code Section 5024.1, the lead agency shall consider the significance of the resource to a California Native American tribe.	☐	☒	☐	☐

4.18.1 Environmental Setting

The project area and surrounding region is within the ancestral land traditionally occupied by the Southern Valley Yokuts. The Yok-Utian language is divided into only two distinct subbranches: the Miwok-Costanoan and Yokuts (Golla 2007). An ethnographic review of tribal cultural resources was performed via the SSJVIC record search, NAHC SLF search, and review of available ethnographic documents.

This section relies on the information and findings presented in *Archaeological Resources Investigation for the Aquaterra Groundwater Bank Project* (Tetra Tech 2023). The archaeological report details the results of the archaeological resources study and includes: delineation of an Area of Potential Effects (APE); records searches conducted by the California Historical Resources Information System (CHRIS) Southern San Joaquin Valley Information Center (SSJVIC); Sacred Lands File (SLF) searches conducted by the California Native American Heritage Commission (NAHC); a review of historical topographic maps and aerial photographs; a general assessment of subsurface archaeological sensitivity (a separate geoarchaeological study was conducted for the project); and pedestrian field surveys.

In a letter dated February 27, 2023, the NAHC indicated that the SLF results were positive and provided a list of California Native American tribes to contact for information. On January 22, 2024, MAGSA sent coordination letters to tribes listed by the NAHC informing them of the proposed project and requesting information regarding known tribal resources in the area. The letters included figures depicting the location and features of the proposed project. Responses were received from four tribes. The Tuolumne Me-Wuk tribe and the Dunlap Band of Mono Indians had no comments. The Santa Rosa Rancheria Tachi Yokut Tribe and the Table Mountain Rancheria requested consultation with MAGSA. MAGSA is coordinating with the Rancherias regarding measures to prevent disturbance of tribal resources and curating any resources that are discovered during construction or operations.

4.18.2 Regulatory Setting

A project with an effect that may cause a substantial adverse change in the significance of a tribal cultural resource may have a significant effect on the environment (PRC 21084.2). As specified in the PRC Section 21080.31, as amended by AB 52, a lead agency is required to consult with any California Native American tribe that requests consultation and is traditionally and culturally affiliated with the geographic area of a proposed project. Consultations must include discussing the type of environmental review necessary, the significance of tribal cultural resources, the significance of the project's impacts on the tribal cultural resources, and alternatives and mitigation measures recommended by the tribe (PRC 21080.3.1 (a) and 20184.3(b)(a)), and Government Code 65352.4).

Public Resource Code (PRC) section 21074 defines tribal resources as follows:

(a)"Tribal cultural resources" are either of the following:

(1) Sites, features, places, cultural landscapes, sacred places, and objects with cultural value to a California Native American tribe that are either of the following:

(A) Included or determined to be eligible for inclusion in the California Register of Historical Resources.

(B) Included in a local register of historical resources as defined in subdivision (k) of Section 5020.1.

(2) A resource determined by the lead agency, in its discretion and supported by substantial evidence, to be significant pursuant to criteria set forth in subdivision (c) of Section 5024.1. In applying the criteria set forth in subdivision (c) of Section 5024.1 for the purposes of this paragraph, the lead agency shall consider the significance of the resource to a California Native American tribe.

(b) A cultural landscape that meets the criteria of subdivision (a) is a tribal cultural resource to the extent that the landscape is geographically defined in terms of the size and scope of the landscape.

(c) A historical resource described in Section 21084.1, a unique archaeological resource as defined in subdivision (g) of Section 21083.2, or a "nonunique archaeological resource" as defined in subdivision (h) of Section 21083.2 if it conforms with the criteria of subdivision (a).

14 California Code of Regulation 15120(d) Confidentiality

Section 15120(d) of the California Code of Regulations states that information and locational information regarding archaeological sites, sacred lands, or other information is confidential and is restricted from disclosure in public documents.

Also see California Health and Safety Code, Section 7052 and 7050.5 and California Public Resource Code, Section 5097 discussed in Section 6.5.2.

4.18.3 Potential Impacts

TCR) Would the project cause a substantial adverse change in the significance of a tribal cultural resource, defined in Public Resources Code section 21074 as either a site, feature, place, cultural landscape that is geographically defined in terms of the size and scope of the landscape, sacred place, or object with cultural value to a California Native American tribe, and that is:

- **a) Listed or eligible for listing in the California Register of Historical Resources, or in a local register of historical resources as defined in Public Resources Code section 5020.1(k)? and,**
- ***b)* A resource determined by the lead agency, in its discretion and supported by substantial evidence, to be significant pursuant to criteria set forth in subdivision (c) of Public Resources Code Section 5024.1. In applying the criteria set forth in subdivision (c) of Public Resources Code Section 5024.1 for the purposes of this paragraph, the lead agency shall consider the significance of the resource to a California Native American Tribe?**

(Less Than Significant with Mitigation Incorporated) The SSJVIC record search identified three prehistoric archaeological sites (a lithic scatter, lithic/ceramic scatter, lithic scatter/bedrock milling feature, and lithic scatter/bedrock milling features/hearth), and five historic sites (refuse scatters, glass and ceramic shards, chert fragments). The prehistoric and historic sites are ineligible for the CRHR. Due to positive findings from the NAHC SLF search, MAGSA is coordinating with tribes to avoid impacts during construction and to ensure proper notification and protection in case of inadvertent discovery. Since the proposed project includes ground-disturbing activities, there remains the potential that indigenous archaeological resources could be encountered, including those that meet the definition of tribal cultural resources. If encountered, tribal cultural resources may be eligible for listing in the California Register or in a local register as defined in PRC Section 5020.1(k), or may be determined by the lead agency, in its discretion and supported by substantial evidence, to be significant pursuant to criteria set forth in subdivision (c) of PRC Section 5024.1. Effects/impacts would be significant if construction or operations cause a substantial adverse change in the significance of a tribal cultural resource. Mitigation Measures CUL-1 and CUL-2 require worker training, construction monitoring, avoidance of resources, and treatment of inadvertent discoveries. Therefore, impacts to tribal cultural resources would be less than significant with mitigation incorporated.

4.19 Utilities and Service Systems (USS)

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
Would the Project:				
a) Require or result in the construction of new or expanded water or wastewater treatment or storm water drainage, electric power, natural gas, or telecommunication facilities, the construction of which could cause significant environmental effects?	☐	☐	☒	☐
b) Have sufficient water supplies available to serve the project and reasonably foreseeable future development during normal, dry and multiple dry years?	☐	☐	☒	☐
c) Result in a determination by the wastewater treatment provider which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?	☐	☐	☐	☒
d) Generate solid waste in excess of State or local standards, or in excess of the capacity of local infrastructure, or otherwise impair the attainment of solid waste reduction goals?	☐	☐	☒	☐
e) Comply with federal, state, and local management and reduction statutes and regulations related to solid waste?	☐	☐	☐	☒

4.19.1 Environmental Setting

Electric transmission lines in the project area are owned and operated by Pacific Gas and Electric (PG&E) and include overhead single circuit 60kV and double circuit 230kV high-voltage transmission lines and the Kerman, Caruthers, and McMullin substations (PG&E 2022a). The transmission lines are suspended on large, steel towers that are mounted on concrete platforms in farm fields and run either north-south or west-east through the project area. PG&E's overhead electrical distribution service lines are dispersed throughout the project area delivering electricity for farming and associated settlement areas and businesses. The County of Fresno – Special District County Service Area (CSA) 43 provides street lighting and community park maintenance to unincorporated Raisin City. PG&E is also the natural gas service provider with transmission lines supplying local distribution lines and connecting to individual service lines throughout the project area (PG&E 2022b).

Telecommunication and internet services are available from various service providers depending on location within the project area. Water demand is met through groundwater extraction from the underground aquifer in the Kings subbasin. Pumped groundwater supplies homes, businesses, and most farming operations throughout the project area. CSA 43W provides water service accounts in Raisin City. Wastewater treatment in unincorporated, rural areas within the project area is accomplished through onsite septic systems. Wastewater treatment facilities near the project but beyond its boundary include the City of Kerman's treatment plant and the Fresno/Clovis Regional Wastewater Reclamation Facility. Non-recyclable and non-hazardous solid waste collected within the project area is taken to the American Avenue Landfill, owned and operated by Fresno County.

There is no designated underground stormwater collection infrastructure in the project area other than in Raisin City, which will not be affected by the proposed project. The project area has relatively little impervious surface area owing to the overwhelmingly rural setting and farming land use. Typically, stormwater runoff is directed into roadside ditches to percolate into the ground or may be directed into larger surface water detention basins and/or flowing surface water conveyances, such as the James Bypass, during larger precipitation events.

4.19.2 Regulatory Setting

4.19.2.1 Federal

Clean Water Act and National Pollutant Discharge Elimination System NPDE). As authorized by the CWA, the NDPES Permit Program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. In California, it is the responsibility RWQCBs to preserve and enhance the quality of the state's waters through the development of water quality control plans and the issuance of waste discharge requirements (WDRs). WDRs for discharges to surface waters also serve as NPDES permits (California State Water Resources Control Board 2024). Fresno County is within the Central Valley RWQCB's jurisdiction.

Obtaining a NPDES permit requires preparation of detailed information, including characterization of wastewater sources, treatment processes, and effluent quality. Any future development that exceeds one acre in size would be required to comply with NPDES criteria, including preparation of a SWPPP and the inclusion of any appropriate BMPs to control erosion and offsite transport of soils.

4.19.2.2 State

State Water Resources Control Board. State regulations pertaining to the treatment, storage, processing, or disposal of solid waste are found in Title 27, CCR, Section 20005 et seq. (hereafter Title 27). In general, the WDRs Program (sometimes also referred to as the "Non Chapter 15 (Non 15) Program") regulates point discharges that are exempt pursuant to Subsection 20090 of Title 27 and not subject to the Federal Water Pollution Control Act. Exemptions from Title 27 may be granted for nine categories of discharges (e.g., sewage, wastewater, etc.) that meet, and continue to meet, the preconditions listed for each specific exemption. The scope of the WDRs Program also includes the discharge of wastes classified as inert, pursuant to Section 20230 of Title 2786. Several programs are administered under the WDR Program, including the Sanitary Sewer Order and recycled water programs.

Department of Resources Recycling and Recovery. The Department of Resources Recycling and Recovery (CalRecycle) is the State agency designated to oversee, manage, and track the 76 million tons of waste generated each year in California. CalRecycle develops laws and regulations to control and manage waste, for which enforcement authority is typically delegated to the local government. The board works jointly with local government to implement regulations and fund programs.

The Integrated Waste Management Act of 1989 (PRC 40050 et seq. or Assembly Bill (AB 939, codified in PRC 40000). This act, administered by CalRecycle, requires all local and county governments to adopt a Source Reduction and Recycling Element to identify means of reducing the amount of solid waste sent to landfills. This law set reduction targets at 25 percent by the year 1995 and 50 percent by the year 2000. To assist local jurisdictions in achieving these targets, the California Solid Waste Reuse and Recycling Access Act of 1991 requires all new developments to include adequate, accessible, and convenient areas for collecting and loading recyclable and green waste materials.

Regional Water Quality Control Board. The primary responsibility for the protection of water quality in California rests with the State Water Resources Control Board (State Board) and nine Regional Water Quality Control Boards. The State Board sets statewide policy for the implementation of state and Federal laws and regulations. The Regional Boards adopt and implement Water Quality Control Plans (Basin Plans) which recognize regional differences in natural water quality, actual and potential beneficial uses, and water quality problems associated with human activities.

Title 8, Section 1541 of the California Code of Regulations. This requires excavators to determine the approximate locations of subsurface installations, such as sewer, telephone, fuel, electric, and water lines (or any other subsurface installations that may reasonably be encountered during excavation work) prior to excavation.

California Government Code §4216 et seq. This law requires owners and operators of underground utilities to become members of and participate in a regional notification center. Underground Service Alert Northern California (USA North) covers Northern and Central California, including Fresno County. USA North receives planned excavation reports from public and private excavators and transmits that information to all participating members who may have underground facilities at the location of excavation. The USA North members mark or stake their facility, provide information, or give clearance to dig.

4.19.2.3 County and Regional

Fresno County General Plan. The following policies from the Fresno County General Plan are relevant for Utilities and Service Systems within the Project Area:

> ***PF-J.1.*** The County shall encourage the provision of adequate gas and electric, communications, and telecommunications service and facilities to serve existing and future needs.
>
> ***PF-J.2.*** The County shall work with local gas and electric utility companies to design and locate appropriate expansion of gas and electric systems while minimizing impacts to agriculture and minimizing noise, electromagnetic, visual, and other impacts on existing and future residents.
>
> ***PF-J.3.*** The County shall require all new residential development along with new urban commercial and industrial development to underground utility lines onsite.
>
> ***PF-J.4.*** The County shall require compliance with the Wireless Communications Guidelines for siting of communication towers in unincorporated areas of the County.

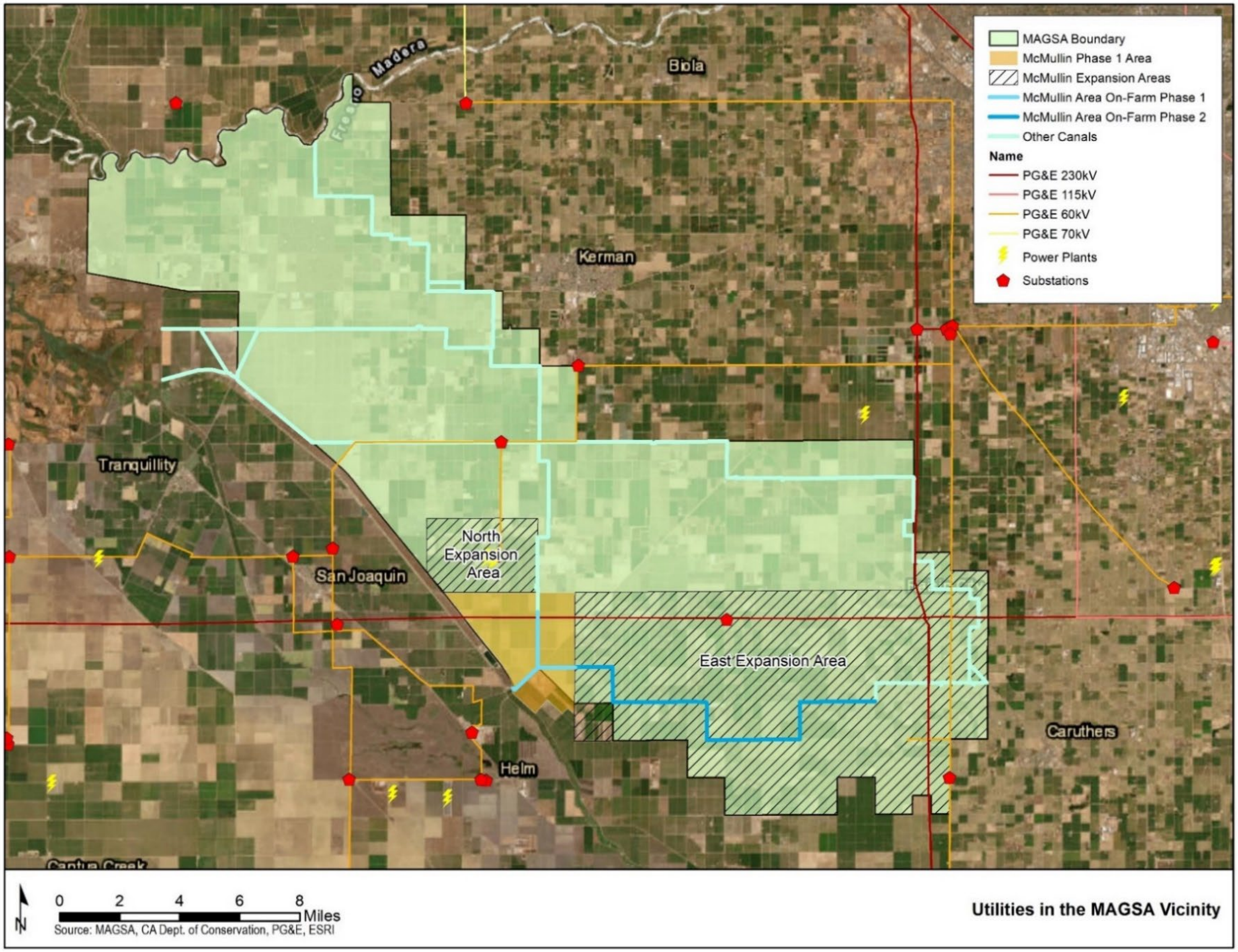


Figure 4-9: Utilities in the MAGSA Vicinity

4.19.3 Potential Impacts

USS a): Would the project require or result in the construction of new or expanded water or wastewater treatment or stormwater drainage, electric power, natural gas, or telecommunication facilities, the construction of which could cause significant environmental effects?

(Less than Significant Impact) No new or expanded sewer hookups will be needed and no wastewater facilities are required for this project. Operations of the proposed project will not generate wastewater, and there will be no impacts.

The proposed project will add minor amounts of impervious surfaces with the construction of the diversion and lift pump stations. The amount of runoff from these impervious surfaces will be minimal and is not expected to increase flood flows or require new measures to detain stormwater runoff. Runoff from the pump station foundations in the interior of the area will be minimal and will be contained within the surrounding berms. Road crossings for the proposed conveyances will replace pavement during construction but are not anticipated to add impervious surface. There will be no other features that would affect stormwater drainage, and impacts will be less than significant.

The proposed project will result in construction of three diversion pump stations and 19 lift pump stations. These pump stations will be operated using a combination of electric, natural gas, and propane pumps. Approximately 82 percent of pumps will be electric, 11 percent will be natural gas, and 7 percent will be propane. The pump stations will require new associated natural gas, electrical, and control facilities with telecommunication networks to power and control their operation. In addition, it is estimated that approximately 90 electric recovery wells will be installed in various locations within recharge basin footprints. None of PG&E’s transmission lines, towers, or platforms will be affected by construction or operations. Some pump station locations will require expansion of the overhead electrical distribution service lines to extend power from an existing PG&E distribution service system to the pump stations. Buried telecommunication services may also need to be extended from existing distribution points for controls integration. Environmental impacts associated with installation of new overhead electrical distribution lines and buried telecommunication lines where necessary will be minimal because utility poles have a very small footprint and underground conduits can be installed with minimal excavation and standard BMPs for erosion and dust control. Impacts associated with constructing new electrical, natural gas, and telecommunication utility infrastructure will be less than significant.

USS b): Would the project have sufficient water supplies available to serve the project and reasonably foreseeable future development during normal, dry and multiple dry years?

(Less Than Significant Impact) Sufficient water supplies are available for construction of the proposed project. Operations of the proposed project will primarily require the water supplies involved in the bank deposits and withdrawals, and minor volumes for water quality sampling. The proposed project, recognized by Reclamation as a water bank, would contribute to aquifer storage through the required “leave behind”, estimated to be approximately 10 percent of water bank deposits. The water bank will also enable bank partners to better manage their water supplies in nearby water management areas by reducing spillage losses. Spillage occurs when State and Federal water contractors have allocated water available in specific locations during wet seasons, but with insufficient storage capacity in the reservoir, they cannot be used for the intended purposes and instead must be released from the reservoir without being used. The project is not expected to result in an increased water demand for any purpose, including residential, commercial, agricultural, or industrial. It is expected to improve groundwater sustainability to facilitate continued long-term residential and agricultural use of water in the area. Since irrigation and municipal water supplies in MAGSA are inherently dependent on pumping groundwater from the aquifer, it is anticipated that the proposed project will be beneficial for the groundwater supply and will have a less than significant impact on the available water supply.

USS c): Would the project result in a determination by the wastewater treatment provider which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?

(No Impact) The area of the project is not served by a centralized sewer or wastewater treatment provider, and instead relies primarily on septic treatment. Minimal amounts of wastewater will be generated during construction through normal construction processes and will be appropriately disposed of depending on its contents. Operation of the proposed project will not generate wastewater or sewage and is not expected to induce population growth in the area. The projected demand of the area will be unchanged from the current demand because of the project; therefore, there will be no impact associated with wastewater treatment capacity.

USS d): Would the project generate solid waste in excess of State or local standards, or in excess of the capacity of local infrastructure, or otherwise impair the attainment of solid waste reduction goals?

(Less Than Significant Impact) Construction of the project will not generate substantial amounts of solid waste, other than minor amounts of waste, such as packaging materials, scrap wood or metals, waste concrete, and other standard materials generated during construction. Such waste is expected to total less than 1,000 cy, which is well within the capacity of the nearby American Avenue Landfill, which is expected to fill by 2031. Excavated soils will be distributed on adjacent fields, and no soil will be removed from the site or sent to solid waste disposal sites. Project operations will not generate solid waste, but maintenance activities will occasionally generate insignificant amounts of solid waste such as packaging. Therefore, impacts will be less than significant.

USS e): Would the project comply with federal, state, and local management and reduction statutes and regulations related to solid waste?

(No Impact) Solid wastes generated during construction will be disposed of in accordance with all statutes and regulations related to solid waste. The construction contractor will prepare a Waste Management Plan and maintain a Waste Log prior to applying for a building permit from Fresno County. No solid waste will be generated during operations. There will be no impact.

4.20 WILDFIRE (WDF)

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
If located in or near state responsibility areas or lands classified as very high fire hazard severity zones, would the project:				
a) Substantially impair an adopted emergency response plan or emergency evacuation plan?	☐	☐	☐	☒
b) Due to slope, prevailing winds, and other factors, exacerbate wildfire risks, and thereby expose project occupants to, pollutant concentrations from a wildfire or the uncontrolled spread of a wildfire?	☐	☐	☐	☒
c) Require the installation or maintenance of associated infrastructure (such as roads, fuel breaks, emergency water sources, power lines or other utilities) that may exacerbate fire risk or that may result in temporary or ongoing impacts to the environment?	☐	☐	☐	☒
d) Expose people or structures to significant risks, including downslope or downstream flooding or landslides, as a result of runoff, post-fire slope instability, or drainage changes?	☐	☐	☐	☒

4.20.1 Environmental Setting

The project area is comprised primarily of maintained and irrigated cropland, and wildfire risk is low. The Office of the State Fire Marshall has developed Fire Hazard Severity Zone Maps that designate local responsibility areas (LRAs), state responsibility areas (SRAs), and federal responsibility areas (FRAs). The project area is entirely within LRA zones. Most of the project area is located on agricultural lands that are LRA unzoned, but it also includes a few areas that are LRA moderate fire hazard severity zones. These moderate zones include non-agricultural areas such as the Kerman Ecological Reserve, the Alkali Sink Ecological Reserve, and parcels near the American Avenue Landfill. The project area does not contain any LRA high or LRA very high fire hazard severity zones (CAL FIRE 2007). Wildfires in Fresno County typically occur in the foothill and mountainous areas in the east and west ends of the county (Fresno County 2023), which fall under SRA and FRA zones (California Board of Forestry and Fire Protection 2022).

In addition to state regulations about fire management, regulations for emergency planning at the federal level and local levels are also relevant. At the federal level, Homeland Security Presidential Directive 5 initiated formation of the National Incident Management System, which guides all levels of government, nongovernmental organizations, and the private sector to work together to prevent, protect against, mitigate, respond, and recover from incidents, including wildfire. Presidential Policy Directive 8 March 30, 2011, National Preparedness, is aimed at strengthening the security and resilience of the United States through systematic preparation for the threats that pose the greatest risk to the security of the nation, including acts of terrorism, cyber-attacks, pandemics, and catastrophic natural disasters.

At the county and regional level, the Fresno County Master Emergency Services Plan (Fresno County 2023) establishes a local emergency management system, completes a comprehensive emergency management plan, and specifies policies, roles, resources, and activities necessary to manage an emergency among other purposes. The Fresno County Multi-Jurisdictional Hazard Mitigation Plan (Amec Foster Wheeler 2018) addresses hazards and risks in Fresno County. Based on the risk assessment, a hazard mitigation planning committee identified goals and objectives for reducing the county's vulnerability to hazards. To meet identified goals and objectives, the plan recommends several mitigation actions, including actions specific to each participating jurisdiction. This plan has been formally adopted by the County and the participating jurisdictions and will be updated at minimum every five years.

4.20.2 Regulatory Setting

4.20.2.1 Federal

Homeland Security Presidential Directive 5, National Incident Management System. This directive initiated formation of the National Incident Management System, which guides all levels of government, nongovernmental organizations, and the private sector to work together to prevent, protect against, mitigate, respond, and recover from incidents, including wildfire.

Presidential Policy Directive 8 March 30, 2011, National Preparedness. This policy directive is aimed at strengthening the security and resilience of the United States through systematic preparation for the threats that pose the greatest risk to the security of the nation, including acts of terrorism, cyber-attacks, pandemics, and catastrophic natural disasters.

4.20.2.2 State

California Government Code Section 51179. This section states "a local agency shall designate, by ordinance, very high fire hazard severity zones in its jurisdiction within 120 days of receiving recommendations from the director pursuant to subdivisions (b) and (c) of Section 51178." The Office of the State Fire Marshall has developed local responsibility area and state responsibility area Fire Hazard Severity Zone Maps.

4.20.2.3 County and Regional

The Fresno County Master Emergency Services Plan (Fresno County 2017) establishes a local emergency management system; completes a comprehensive emergency management plan; and specifies policies, roles, resources, and activities necessary to manage an emergency among other purposes.

The Fresno County Multi-Jurisdictional Hazard Mitigation Plan (Amec Foster Wheeler 2018) addresses hazards and risks in Fresno County. Based on the risk assessment, a hazard mitigation planning committee identified goals and objectives for reducing the county's vulnerability to hazards. To meet identified goals and objectives, the plan recommends several mitigation actions, including actions specific to each participating jurisdiction. This plan has been formally adopted by the County and the participating jurisdictions and will be updated at minimum every five years.

4.20.3 Potential Impacts

WDF- all

(No Impacts) The proposed project is not located in or near state responsibility areas or lands classified as very high fire hazard severity zones, therefore none of the criteria are applicable. No impacts to wildfire risk, response, management, or evacuation procedures would result from the proposed project.

5 MANDATORY FINDINGS OF SIGNIFICANCE (MFS)

MFS (a): Does the project have the potential to substantially degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, substantially reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?

(Less Than Significant With Mitigation Incorporated) The analysis presented in this Initial Study/Mitigated Negative Declaration results in a determination that the proposed project will have a less than significant impact to Federally protected wetlands or other sensitive natural communities and no impact to habitat conservation plans or local policies or ordinances protecting biological resources. The analysis finds that the proposed project will have a less than significant effect on potential movement of any native or resident or migratory fish or wildlife species. The analysis determines less than significant effect with mitigation incorporated for habitat modification for State- and/or Federal-identified candidate, sensitive, or special status species. The analysis determined there would be no unavoidable impacts as a result of the proposed project.

MFS (b): Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?

(Less Than Significant With Mitigation) The project's impacts would not be cumulatively considerable. Construction impacts would be temporary and mitigable, and operations impacts would be either beneficial or less than significant; therefore, any potential cumulative impacts would be less than significant. No other projects are currently proposed in the vicinity of the project that, when combined with the effects of the proposal, would result in significant impacts. The project would have beneficial impacts to groundwater levels and would reduce downstream flood risk. Additionally, with incorporation of mitigation measures, any adverse impacts from the project would be less than significant.

MFS (c): Does the project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?

(Less Than Significant With Mitigation) As identified and described in this Initial Study, the project would have potentially significant impacts on air quality, biological resources, cultural and tribal resources, geology and soils, hydrology and water quality, hazards and hazardous materials, and traffic and transportation that would be mitigated from potentially significant to less than significant. The project would have less than significant impacts on aesthetics, greenhouse gases, noise, utilities and service systems, and public services. The project would have no impact on population and housing, recreation, agriculture and forest resources, land use and planning, and mineral and energy resources. As a result, the proposed project would have no environmental effects that would cause substantial adverse effects on human beings, either directly or indirectly.

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7 ACRONYMS

AADT	Average Annual Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
AB	Assembly Bill
AEP	Annual Exceedance Probability
AF	acre-feet
AFD	acre-feet per day
AFY	acre-feet per year
AITS	Agricultural Industries Transportation Services
AJD	Approved Jurisdictional Determination
ALUCP	Airport Land Use Compatibility Plan
APE	Area of Potential Effects
API	American Petroleum Institute
ARD	Aquatic Resource Determination
BAT	Best Available Technology
BCT	Best Conventional Technology
BE	Biological Evaluation
bgs	Below Ground Surface
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
BPS	Best Performance Standards
CAA	Clean Air Act
CAFOs	Confined Animal Feeding Operations
Cal/EPA	California Environmental Protection Agency
Cal/OSHA	California Occupational Safety and Health Administration
Caltrans	California Department of Transportation
CARB	California Air Resources Board
CCAP	Climate Change Action Plan
CCR	California Code of Regulations
CCR	California Code of Regulations
CCR	California Code of Regulations
CDC	California Department of Conservation
CDFG	California Department of Fish and Game
CDFW	California Department of Fish and Wildlife
CDLs	clandestine drug labs
CEQA	California Environmental Quality Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act

CESA	California Endangered Species Act
CFR	Code of Federal Regulations
CFS	cubic feet per second
CGP	Construction General Permit
CGP	Construction General Permit
CHRIS	California Historical Resources Information System
CNDDB	California Natural Diversity Database
CNPS	California Native Plant Society
CO	Carbon Monoxide
CO2	Carbon Dioxide
CoC	Constituents of Concern
CPAD	California Protected Areas Database
CPAD	California Protected Areas Database
CRA	California Resources Agency
CRHR	California Register of Historic Places
CRHR	California Register of Historical Resources
CSA	County Service Area
CVP	Central Valley Project
CVRWQCB	Central Valley Regional Water Quality Control Board
CWA	Clean Water Act
cy	Cubic Yard
dB	Decibel
dBA	A-weighted Decibel
DBCP	Dibromo-3-chloropropane
DMC	Delta Mendota Canal
DMR	California Division of Mine Reclamation
DPR	California Department of Pesticide Regulation (DPR)
DTSC	Department of Toxic Substances Control
DTSC	Department of Toxic Substances Control
DWR	Department of Water Resources
EPA	Environmental Protection Agency
ER	Ecological Reserve
FAA	Federal Aviation Administration
FCFPD	Fresno County Fire Protection Districts
FCOG	Fresno Council of Governments
FCSO	Fresno County Sheriff's Office
FEMA	Federal Emergency Management Agency
FESA	Federal Endangered Species Act
FFCP	Flood Flow Capture Plan
FIRM	Flood Insurance Rate Maps

FKR	Fresno Kangaroo Rat
FRAs	federal responsibility areas
ft	feet
FTA	Federal Transit Administration
GAMA	Groundwater Ambient Monitoring and Assessment Program
GAR	Groundwater Assessment Report
GDE	Groundwater Dependent Ecosystem
GHG	Greenhouse Gas
GPM	Gallons per minute
GSA	Groundwater Sustainability Agency
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
GSP	Groundwater Sustainability Plan
GWh	Gigawatt hours
GWQPS	Groundwater Quality Protection Strategy
HCD	California Department of Housing and Community Development
HCP	Habitat Conservation Plan
HMTA	Hazardous Materials Transportation Act
HSC	California Health & Safety Code
HSG	Hydrologic Soils Group
HSG	Hydrologic Soils Group
HWMP	Hazardous Waste Management Plan
ILRP	Irrigated Lands Regulatory Program
IPaC	Information for Planning and Consultation
IRWMP	Integrated Regional Water Management Plan
KBWA	Kings Basin Water Authority
KRWA	Kings River Water Association
LOS	Level of Service
LQG	Large Quantity Generator
LRA	Local Responsibility Area
LUST	Leaking Underground Storage Tank
MAGSA	McMullin Area Groundwater Sustainability Agency
MBTA	Migratory Bird Treaty Act
MCLs	Maximum Contaminant Levels
MLC	Mineral Land Classification
MM	Mitigation Measures
MRZ	Mineral Resource Zone
NAHC	Native American Heritage Commission
NAHC	Native American Heritage Commission

NEHRP	National Earthquake Hazards Reduction Program
NFPA	The National Fire Protection Association
NHPA	National Historic Preservation Act
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NPPA	California Native Plant Protection Act
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NWI	National Wetlands Inventory
PG&E	Pacific Gas and Electric
PPV	Peak Particle Velocity
PRC	Public Resources Code
PRP	California Department of Food and Agriculture Pesticide Regulation Program
RCRA	Resource Conservation and Recovery Act
RMS	Root Mean Square
ROG	Reactive Organic Gases
RPS	Renewables Portfolio Standard
RTP	Regional Transportation Plan
RWQCB	Regional Water Quality Control Board
SAGBI	Soil Agricultural Groundwater Banking Index
SB	State Bill
SGMA	Sustainable Groundwater Management Act
SIP	State Implementation Plan
SJKF	San Joaquin Kit Fox
SJR	San Joaquin River
SJVAPCD	San Joaquin Valley Air Pollution Control District
SLF	Sacred Lands File
SLR	San Luis Reservoir
SMARA	Surface Mining and Reclamation Act
SMCL	Secondary Drinking Water Standard
SPRP	Spill Prevention and Response Plan
SPRP	Spill Prevention and Response Plan
SQG	Small Quantity Generator
SRAs	State Responsibility Areas
SSJVIC	Southern San Joaquin Valley Information Center
SSURGO	Soil Survey Geographic Database
SWP	State Water Project
SWPPP	Stormwater Pollution Prevention Plan

SWRCB	State Water Resources Control Board
SWRCB	State Water Resources Control Board
TCP	Trichloropropane
TCR	Transportation Concept Report
TDS	Total Dissolved Solids
ug/L	Micrograms per liter
US	United States
USACE	United Sates Army Corps of Engineers
USC	United States Code
USCS	Universal Soil Classification System
USDOT	U.S. Department of Transportation
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
USTs	Underground Storage Tanks
VDE	Visible Dust Emissions
WDRs	Waste Discharge Requirements
WQCP	Water Quality Control Plan
WWTF	Wastewater Treatment Facility

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Appendix 1

Implications of Using On-Farm Flood Flow Capture To Recharge Groundwater and Mitigate Flood Risks Along the Kings River, CA (Bachand et al 2014)

Environmental Science & Technology

Article

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Implications of Using On-Farm Flood Flow Capture To Recharge Groundwater and Mitigate Flood Risks Along the Kings River, CA

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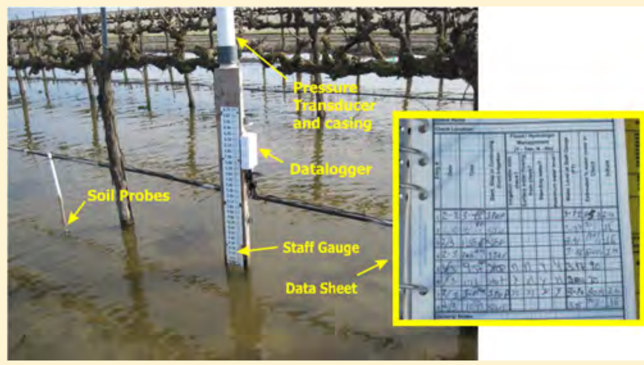
Supporting Information

ABSTRACT: The agriculturally productive San Joaquin Valley faces two severe hydrologic issues: persistent groundwater overdraft and flooding risks. Capturing flood flows for groundwater recharge could help address both of these issues, yet flood flow frequency, duration, and magnitude vary greatly as upstream reservoir releases are affected by snowpack, precipitation type, reservoir volume, and flood risks. This variability makes dedicated, engineered recharge approaches expensive. Our work evaluates leveraging private farmlands in the Kings River Basin to capture flood flows for direct and *in lieu* recharge, calculates on-farm infiltration rates, assesses logistics, and considers potential water quality issues. The Natural Resources Conservation Service (NRCS) soil series suggested that a cementing layer would hinder recharge. The standard practice of deep ripping fractured the layer, resulting in infiltration rates averaging 2.5 in d^{-1} (6 cm d^{-1}) throughout the farm. Based on these rates 10 acres are needed to infiltrate 1 cfs (100 m^3 h^{-1}) of flood flows. Our conceptual model predicts that salinity and nitrate pulses flush initially to the groundwater but that groundwater quality improves in the long term due to pristine flood flows low in salts or nitrate. Flood flow capture, when integrated with irrigation, is more cost-effective than groundwater pumping.



INTRODUCTION

The agriculturally productive San Joaquin Valley (SJV) relies heavily on both surface water and groundwater for irrigation. The Kings River (KR) basin in the southern part of the SJV (Figure SI-S1) typifies the region: an annual 2.7 million acre-ft (M ac-ft; 3.33×10^9 m^3) of demand for irrigation water met through surface water and groundwater sources with an average annual overdraft of 0.16 M ac-ft.[1] In the nearby town of Helm, groundwater levels have dropped 60–80 feet (18–24 m) over the past century.[1] Now 200 feet (60 m) below ground elevations, groundwater pumping is expensive, costing greater than $90/ac-ft.[2,3] In California, 1–2 M ac-ft is overdrafted annually to meet 30–40% of urban and agricultural water demands.[4] Over 70% of the overdraft occurs in the Central Valley's (CV's) Sacramento, San Joaquin, and Tulare Basins,[4] affecting more than 7 million irrigated acres.[5] Under the current California drought, groundwater provides 53% of California's irrigation water needs.[6]

Groundwater value depends upon both availability and quality. Nitrate, primarily from fertilizers, septic tanks, and dairies, and salts, locally occurring but also exacerbated by farming practices, irrigation waters, and wastes, are two quality issues affecting CV groundwater sustainability.[7−10] Many efforts are now underway to define and manage these contaminant sources.[11−13]

Ironically, the KR basin also faces flood risks. Precipitation occurs predominantly during the winter months, yet during wet years flood risks can exist from December through July; Pine Flat Reservoir releases water in anticipation of achieving reservoir capacity due to snowmelt runoff from the Sierra Nevada. Over a 42-year record, KR flood flows ranged from 500 to 5,500 cubic feet per second (cfs; 14–160 m^3 per second, m^3 s^{-1}) with a median of 1,560 cfs (Figure SI-S2). Flows have exceeded the 4,750 cfs flood design criterion for the river channel on a 7-year recurrence interval (Figure SI-S2). Floods in 1983, 1995, and 1997 resulted in total losses greater than $1.2 billion (2012 dollars).[14]

Climate change will exacerbate both these hydrologic challenges. Models project greater precipitation variance for

Received: March 5, 2014
Revised: October 14, 2014
Accepted: October 27, 2014
Published: November 13, 2014

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dx.doi.org/10.1021/es501115c | Environ. Sci. Technol. 2014, 48, 13601−13609

Table 1. Experimental Design

			crop[d]			method				analyses and statistics		
						infiltration	subsurface effects			infiltration as a function of		
field	check	hydrologic treatment[c]	winter	summer	soil ID[b]	pressure transducers/ staff gauges	soil probes	soil cores[a]	WQ analyses	within field variance	between crops	between soils
7	F07	Fl	Al	Al	Fu	×			×		×	
16	F16CN	Fl	WG	WG	Fu	×			×		×	×
21	F21CN	OI	WG	WG	Fx	×		×	×	×	×	×
21	F21CS	OI	WG	WG	Cb	×	×	×	×	×	×	×
22	F22CN	Fl	WG	WG	Cb	×		×	×	×	×	×
22	F22CS	Fl	WG	WG	Fx	×	×	×	×	×	×	×
24	F24CN	Fl	F	T	Pt	×			×		×	
28	F28CW	Fl	WG	WG	Pt	×			×		×	
32	F32C1/ C2	Fl	F	T	CfB/ Pt	×			×		×	
4	F4N	Dr	WG	WG	Fx			×	×			
4	F4S	Dr	WG	WG	Fx			×	×			

[a]Soil cores subdivided by depth (cm): 0–15, 15–30, 30–60, 60–100, 100–150, 150–200, 200–250, 250–300, 300–400, and 400–500. [b]Fu = Fresno fine sandy loam; Fx = Fresno-Traver complex; Cb = Cajon loamy coarse sand, saline alkali; CfB = Calhi loamy sand, 3 to 9% slopes; Pt = pond fine sandy loam. [c]Hydrologic treatment: Fl = flooding for direct recharge; OI = overirrigation; Dr = drip inigation. [d]WG = wine grapes; Al = alfalfa; F = fallow; T = tomatos.

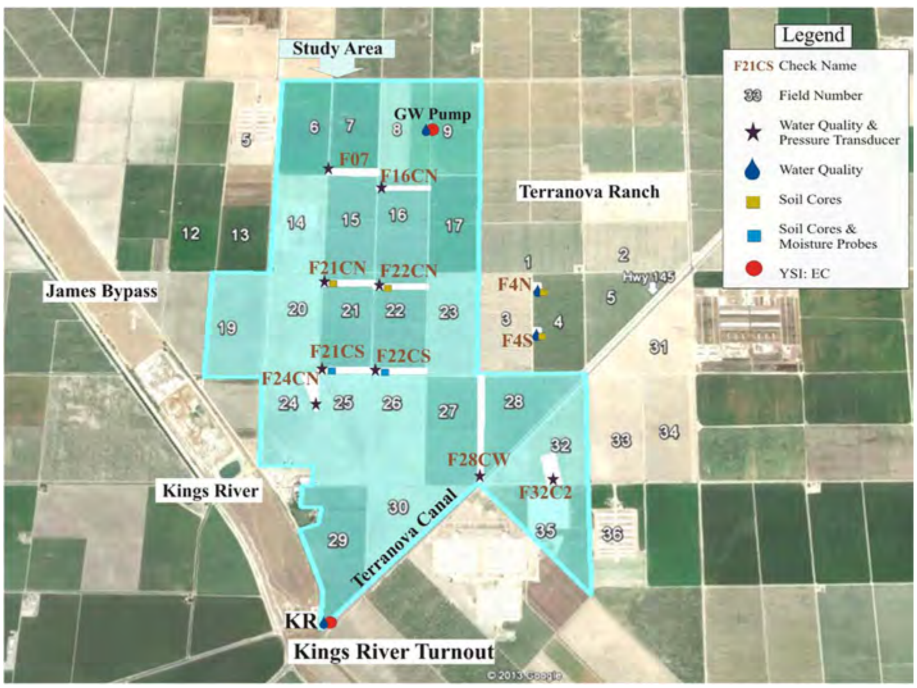

Figure 1. Study site. The study site was conducted on approximately 1,000 acres. Intensive hydrologic, soil, and water quality monitoring were conducted at check locations as identified in the above map: Pressure Transducer = pressure transducers for water level measurements; YSI: EC = YSI datasondes for EC and temperature; Soil Cores = Soil Cores for lithology and soil moistures; Moisture Probes = soil moisture probes for EC, VWC, and temperature; Water Quality = discrete water quality sampling; GW Pump = groundwater pump; KR = Kings River Sampling Location. Study checks are indicated with a white outline and labeled in brown; field names are in white.

California watersheds,[15] challenging California's reservoirs system to manage flood risks and water supply.[4,16] Increasing groundwater recharge capacity is considered one cost-effective tool for adapting to climate change.[17,18]

Over the last two decades, farmers and landowners have worked with the Kings River Conservation District (KRCD) and other water agencies to develop recharge strategies and facilities. Near the James Bypass (Figure SI-S1), engineered recharge basins on 67 dedicated acres were proposed to potentially capture 230–800 ac-ft of stormwater monthly.[19,20] The Kings Basin Integrated Regional Water Management Plan recommended developing 2,600 acres for dedicated recharge facilities through acquisitions and easements.[21] These types of hard engineering approaches are expensive and inefficient due to land or easement acquisition costs, engineering requirements, and underutilization of lands during dry conditions.

Alternatively, working agricultural lands can be leveraged to receive flood flows for *in lieu* (where crops are irrigated with surplus surface water instead of groundwater) and direct recharge. We investigated the technical and logistical feasibility of this approach: quantified achievable flood flow capture rates; investigated nitrate and salt leaching from the unsaturated zone to groundwater; showed controlled flooding did not harm some deciduous crops; and conducted a preliminary economic assessment. Although geologic conditions and associated infiltration rates vary with location, this feasibility study addresses many important issues for implementing this technology. Conventional units are used when discussing flows and volumes, as they are most commonly used by the engineering and agriculture community. SI units, used throughout the scientific literature, are used for analytical data such as chemistry.

■ METHODS

Site Description. This investigation was conducted on 1,000 acres of Terranova Ranch (TR) located in western Fresno County, California (36°34′27.18″N, 120°5′39.69″W) and adjacent to the James Bypass, a section of the KR (Figure SI-S1). TR grows vineyard, orchard, field, and row crops and pumps groundwater for irrigation. The Mediterranean climate averages 7.4 in. (188 mm) of rain annually and average high and low temperatures of 24.7 and 9.9 °C, respectively. The site overlays sandy loams and loamy sands (e.g., Fresno sandy loam − Fs, Fresno fine sandy loam − Fu, Fresno-Traver complex − Fx, Traver fine sandy loam − Tt), with cemented duripan 0.5−1 m deep in some areas. Area soil cores show silty clay and clay lenses within the upper 30 m of the soil profile.[22−24]

Check Studies. Fields were divided into checks separated by berms to enable shallow controlled flooding throughout the field (15−30 cm depth). With 11 study checks, we assessed potential infiltration rates for different field crops and soil types; tested within-field effects, between-field effects, and between-crop effects (Table 1, Figure 1); and assessed impacts to soil chemistry, vadose zone water quality, and potential transport to groundwater. Study checks were located on three types of fields representing a representative mix of annual and perennial crops potentially suitable for this application: fallow (before the planting of summer row crops), wine grapes, and alfalfa. Underlying soils had five different soil series classifications. The control included two wine grape study checks, F4CN and F4CS, irrigated as usual with drip irrigation of groundwater.

Managing and Quantifying Study Check Hydrology. KR flood flows were diverted to TR from January to July 2011 (Figure 1). Except for the control, each study check received water for direct recharge (Table 1). Fields under a flooding regime were managed to maintain flooded conditions as long as logistically possible. Overirrigated fields had shorter periods of flooding. After flooding ceased for the season, both treatments were irrigated with groundwater via drip irrigation.

Pressure transducers (PTs) with data loggers and staff gauges were installed in each study check receiving flood flows (Table 1, Figure 1). Checks were flooded, and then inflows and outflows ceased as infiltration and evapotranspiration lowered water levels. Irrigators measured staff gauges at the beginning and end of each cycle, which was used to calibrate PT readings. Direct recharge rates were calculated from infiltration rates after accounting for ET losses using reference ET and crop coefficients.[25]

A depth range for the applied water front within the vadose zone was calculated using estimated minimum and maximum water capacity.[22,26] Water capacity for soils down to 30 m was approximated by determining the available water capacity for each core based upon soil types and averaging across all cores.

Water Quality, Soils Analyses, and Soils Mass Budgets at Study Checks. Water quality samples were collected in 200 mL amber bottles and concurrently measured for EC (YSI datasonde, Yellow Springs, OH) at several locations: from the KR at the Terranova canal, at check locations where flood flows were applied, and from a groundwater well 60 m (200 ft) deep (Figure 1). Samples were stored on ice and analyzed at the University of California (UC) Davis Soil Biology and Biochemistry lab for dissolved solids (TDS; mg L^{-1}; Method 2540B);[27] dissolved nitrogen species as nitrogen (nitrate NO_3−N, ammonium NH_4−N;[28] total dissolved nitrogen TDN; mg-N L^{-1});[29] dissolved available phosphate PO_4−P;[29] total dissolved phosphorus (TDP; mg-P L^{-1});[30] dissolved organic carbon (DOC) (mg L^{-1}; Phoenix 8000, Teledyne-Tekmar, Mason, OH); and electrical conductivity (EC) (dS m^{-1}; Model 220 Conductivity Meter, Denver Instruments, Bohemia, NY).

Decagon ECH2O TE soil probes (Pullman, WA) were installed in replicate ($N = 3$) within two checks to measure EC and volumetric water content (VWC) on 15 min intervals. Probes were installed at depths of 15 and 60 cm at F21CS and F22CS and also at 120 cm at F21CS, through 45° angle boreholes with bentonite plugs every 15 cm to prevent preferential flow. Soil cores collected during installation were analyzed for EC and gravimetric moisture content.

Field capacity was estimated by observing changes in slope of moisture content data over time.[31] We defined a wilting point surrogate, the wilting point index, as the minimum moisture content achieved during the study. Available water capacity was estimated as the difference between field capacity and wilting point index and was compared to values estimated using regional soil data.

Soil cores were collected in November 2011 using a Geoprobe (Geoprobe Systems, Salina, KS) at checks F21CS, F21CN, F22CS, F22CN, F4N, and F4S to a depth of 3 m with 3 replicate cores at each location, plus an additional core collected to 5−8 m. Soils were analyzed for EC and nitrate.

The mass of salt that could be flushed from the soils was calculated from soil core profile data. We assumed conditions at nonflooded locations F4N and F4S corresponded to initial preflush conditions before recharge. Geoprobe soil EC data (0−8 m; Figure SI-S3) and groundwater EC data from wells on Terranova were integrated to calculate TDS mass volumes in the vadose zone using site specific EC versus TDS relationships.[24] For soil depths exceeding 8 m, we assumed porewater EC concentrations were equal to groundwater EC concentrations. This assumption resulted in a TDS mass estimate at the high end of the likely range because groundwater EC was higher than porewater EC at 8 m. The salt mass in the vadose zone profile was calculated as the product of calculated porewater TDS concentrations and the vadose zone field capacity moisture content. By subtracting the salt mass at each study check from the salt mass under preflush conditions, we determined the salt lost from the vadose zone.

Farm Water Budget. We developed a farm water budget using farm operation and flow records. A Teledyne ISCO Acoustic Velocity Meter (AVM) recorded inflows to Terranova Canal at location KR (Figure 1) on 15 min intervals. Irrigators recorded pump start and stop times, fields receiving water, and percent water delivered to each field (Table SI-S1). Irrigator data were cross checked against KR AVM data. These data were combined with CIMIS precipitation and ET data to calculate a water budget for each study field (Table SI-S2 and SI-S3). All statistics were performed using STATISTICA software.[32]

Costs. TR staff tracked costs associated with project implementation: field preparation, installation and rental of

Table 2. Infiltration Rates and Seasonal Totals of Flood Flows Applied at Study Checks[b]

check	date range	N^a	infiltration rates in/day	daily total ft	season total ft	estimated depth of infiltration (ft) for min and max available water capacity (%) 8%	14%
F16CN	1/27/11–7/30/11	30	3.8	0.26	7.8	98	56
F21CN	4/30/11–7/31/11	7	15.8	0.41	2.8	35	20
F21CS	5/6/11–8/3/11	5	14.2	0.51	2.6	32	18
F22CN	1/29/11–7/9/11	34	3.3	0.28	9.5	118	68
F22CS	1/29/11–7/10/11	31	2.7	0.20	6.2	78	45
F24CN	1/15/11–2/4/11	23	2.7	0.11	2.6	32	18
F28CW	4/12/11–7/11/11	5	3.5	0.57	2.9	36	20
F32C2	1/29/11–2/4/11	10	3.5	0.16	1.6	20	11
F07	4/19/11–7/28/11	6	6.0	0.34	2.1	26	15

[a]Number of infiltration events. Each event is roughly 1 day long. [b]Recharge rate is infiltration rate minus ET; infiltration rates were about 2% lower than recharge rates during the study period.

equipment and infrastructure, labor, energy, and project support.

RESULTS

Potential Recharge of Applied Surface Water at Study Checks. Recharge rates measured at the study checks averaged 4.2 in d^{-1} (10.7 cm d^{-1}), ranging from an average low of 2.6 in d^{-1} (6.8 cm d^{-1}) at check F22CS to an average high of 16 in d^{-1} (40 cm d^{-1}) at F21CN (Table 2). Infiltration rate differences were analyzed within fields, between fields, between crops, and between soils. The only statistically significant difference between treatments was soil type Fx (Field 21), which had statistically significant higher infiltration rates. Measured recharge rates represent potential achievable infiltration rates. Recharge rates were highest during initial flooding, decreased after two flood days to range from 2–3 in d^{-1} (5.1–7.6 cm d^{-1}), and then declined only slightly over longer periods.

Seasonal totals of applied water on the study checks ranged from 0.5 m at F32C2 for 10 days of flooding to nearly 3 m at F22CN for 34 days of flooding. Total seasonal volumes at a given field depended primarily on number of days flooded (r^2 = 0.86, $p < 0.05$). Based on soil water capacity estimates, recharge water extended into the vadose zone 11 to 20 ft (3–6 m) at F32C2 but up to 118 ft (36 m) at F22CN (Table 2).

Surface and Subsurface Water Quality and Soil Cores at Study Checks. KR flood flow water quality was equivalent to that of laboratory blanks for nitrogen and phosphorus species, DOC and TDS concentrations (Figure 2). Groundwater had elevated concentrations: TDN concentrations averaged 45 mg L^{-1} with 40% as ammonium and 30% as nitrate; TDP concentrations averaged 0.5 mg L^{-1} with 60% as phosphate; DOC concentrations averaged 15 mg L^{-1}; and TDS concentrations averaged 900 mg L^{-1}. When fields were flooded, the resulting standing water on the fields had elevated TDS, phosphate, TDP, DOC, and TSS concentrations, presumably from equilibration with soils.

During recharge periods (January into February; mid-March through early June) VWC measured at the study checks F21CS and F22CS reached a maximum of about 0.3 m^3/m^3 at 15 and 60 cm below the ground surface and remained elevated while fields had standing water. Once flooding ceased, VWC dropped over the next few days to field capacity. When VWC is above field capacity, water migrates downward. From the moisture probe data, we estimated field capacity at 18% for Field 21 (Figure SI-S4) and at 25% for Field 22 (Figure SI-S5). The moisture probe VWC results correlated well with the VWC calculated from the gravimetric water content of soils collected during probe installations. We determined the wilting point index from Field 22 at about 13.5%. These data suggest that the available water capacity of the Cajon loamy coarse sand, saline alkali soils (Cb) in Field 22 is about 4–5%, consistent with NRCS soils data predicting a range of 6–10%.[22]

Salinity (EC) data from F22CS and F21CS show prolonged flushing decreased pore water salt levels (Figure 3). The hydrologic treatment of flood capture and recharge greatly decreased root zone salt levels. At Field 22 (F22CS) EC decreased from about 0.8 dS m^{-1} to 0.1 dS m^{-1} at a soil depth of 15 cm and from 0.65 to <0.1 dS m^{-1} at a soil depth of 60 cm (Figures 3 and SI-S5). Greatest decreases occurred during the first 3–4 weeks of flooding. EC increased slightly to about 0.25–0.3 dS m^{-1} at 15 cm and to 0.15–0.2 dS m^{-1} at 60 cm during summer drip irrigation with groundwater (Figure 3).

In comparison, Field 21 study checks received about 40% of the applied surface water and were not flooded until late April. EC levels decreased from about 0.3 dS m^{-1} to 0.1 dS m^{-1} at 15 cm. Flood flow applications were insufficient to decrease EC levels much below 0.3 dS m^{-1} in deeper soils, where EC was initially 0.8 dS m^{-1} at 60 cm and 0.55 dS m^{-1} at 120 cm (Figure SI-S3). With each flood event, EC levels at both locations increased slightly in response to flood initiation, suggesting applied surface waters remobilized soil column salts. With summer drip irrigation, EC levels increased to about 80% of initial conditions.

From November (post recharge, post summer irrigation) soil core data, nitrate distribution differed between the different study checks (Fields 21, 22 and 4; Figure SI-S3). Field 4 study checks received only groundwater via drip irrigation and represented soil conditions typical to preflood conditions. In Field 4, nitrate concentrations were elevated from 0–40 cm depths, typically ranging from 20–100 mg NO_3-N kg^{-1}. In comparison, soil samples in Fields 21 and 22 were in the 0–20 mg NO_3-N kg^{-1} range except for some exceptions at F22CN. The relationship between EC and nitrate concentrations was significantly correlated (r^2 = 0.85, p = 0.0000; Figure SI-S3)). Fields 21 and 22 nitrate concentrations were significantly lower ($p < 0.05$) than Field 4 concentrations.

We calculated nitrate mass (Nitrate-N g m^{-2}) in the soil cores for depths of 0–100 cm and 100–300 cm (Figure SI-S6).

dx.doi.org/10.1021/es501115c | Environ. Sci. Technol. 2014, 48, 13601–13609

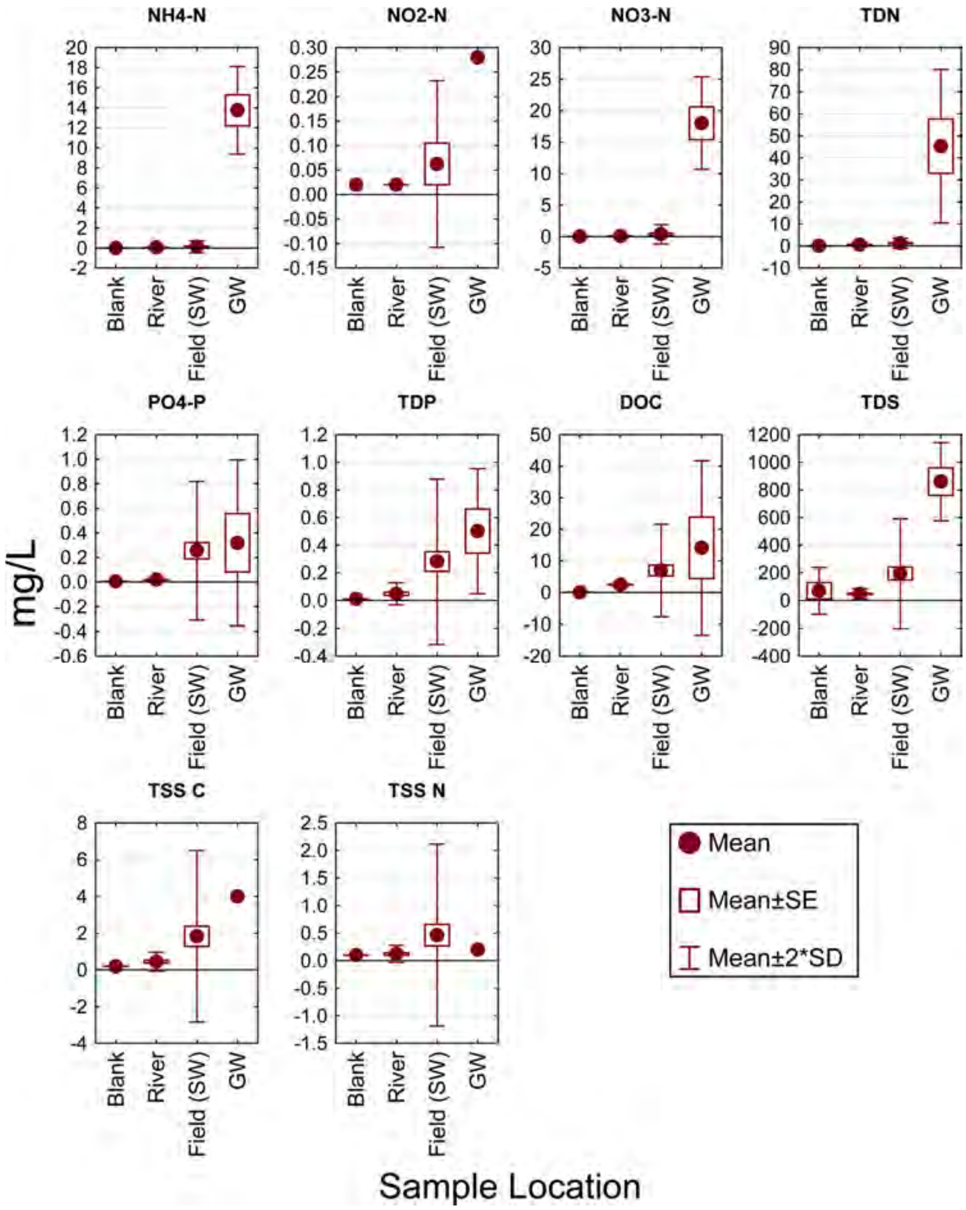

Figure 2. Water Quality Analyses Results. Samples taken on 5/5/2011, 5/17/2011, and 6/15/2011 at the Kings River. Data analyzed across four locations: from the Kings River (River), at checks being irrigated with diverted storm flows (Field (SW)), from a groundwater pump (GW), and a blank. Means with box (standard error: SE) and whisker (standard deviation multiplied by two: 2*SD).

Checks F21CN, F21CS, and F22CS ranged from 3−15 NO_3−N g m^{-2}. Check F22CN had a total of 100 NO_3−N g m^{-2}. NO_3−N concentrations in Field 4 were uniformly higher (146−352 NO_3−N g m^{-2}). On average, nitrate mass found in the soil cores in Fields 21 and 22 was less than 15% of the nitrate mass in Field 4 soil cores (Figure SI-S6).

Achievable Farm Water Budget. From January to early July 2011, flows diverted from the KR ranged from 2−22 cfs (0.06−0.6 m^3 s^{-1}), resulting in a 3,116 ac-ft (3.8×10^6 m^3) diversion. Almost 2,000 ac-ft were applied during the growing season, from April through mid-July (Table SI-S1). About 15% of the applied water went to direct recharge and 85% went to *in lieu* recharge (Table SI-S2). Direct recharge occurred in wine grape fields through May and in pistachio and alfalfa fields in April (Table SI-S3). The controlled flooding did not affect plant vigor or yield.[2]

DISCUSSION

Direct Recharge Capacity. Soil hydrologic characteristics and farm infrastructure constrain recharge rates. The check studies showed field recharge rates for extended inundation ranged from 2 to 44 in d^{-1} for all crops and soil types. Fresno-related soil series data typical of these locations suggests recharge rates would be an order of magnitude lower because of a cementing layer at 60 to 90 cm depths and classifies them in Hydrologic Soil Group D.[22,23] However, the soil at TR is periodically ripped, a standard practice to fracture the cementing layer and improve root penetration. This practice enhanced infiltration, creating conditions with higher recharge rates more typical of Hydrologic Soil Group C.[33,34] Some checks were inundated for 30 or more days, resulting in 2 to 3 m of applied water, with only 1 to 3% lost to ET. For a typical 70 acre field, this yields 450 to 700 ac-ft per month of direct recharge.

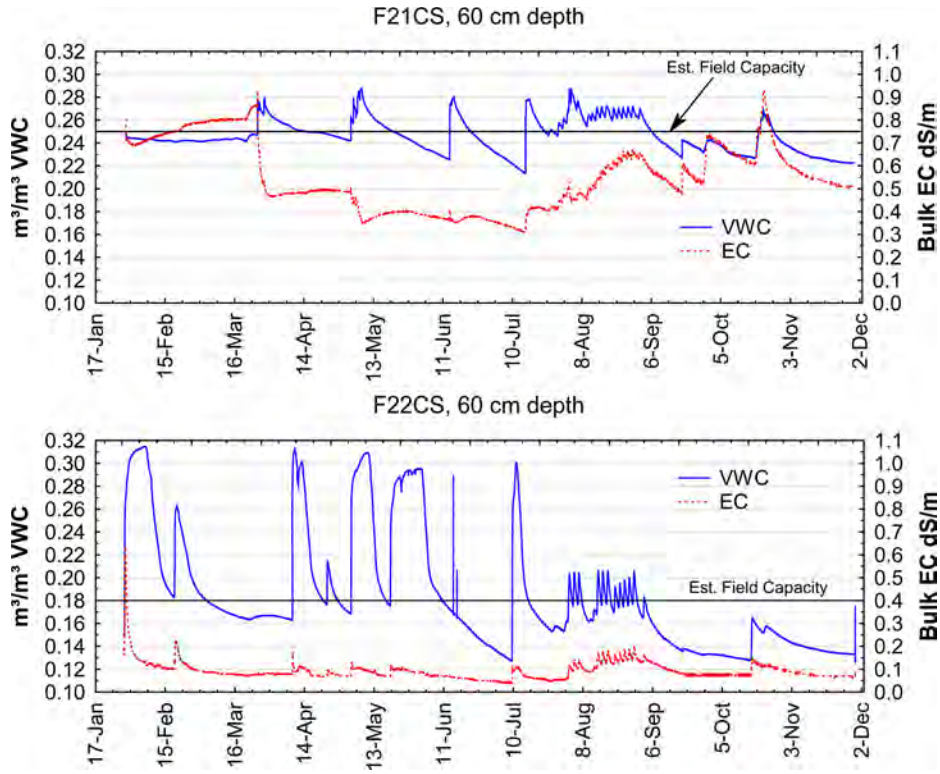

Figure 3. Volumetric Water Content (VWC; m^3 m^{-3}) and EC (dS m^{-1}) 60 cm into the root zone for study checks F21CS and F22CS, 2011. The study check at Field 21 (F21CS) received about 40% of the applied surface flood flow water than the study check at Field 22 (F22CS; Table 2). EC levels in the soils were higher at F21CS than at F22CN. Application of flood flows reduced EC levels to about 0.1 dS/m at a 15 cm depth (Figures SI-S4 and SI-S5) but did not reduce EC levels below 0.3 dS/m at 60 cm. Once flood flow application ceased and groundwater drip irrigation began, EC levels at F21CS increased steadily to a range of 0.6−1 dS/m. At F22CS, EC levels dropped to less than 0.1 dS/m at both 15 and 60 cm depths (Figure SI-S5). When flood flows stopped and drip irrigation began, EC levels increased but never exceeded 0.2 dS/m at 60 cm depth.

The farm scale component of this study highlights infrastructure limitations. Field preparation (e.g., check levees) was rapid and generally inexpensive.[24] Farm conveyance facilities (e.g., piping and pumps) designed for meeting crop ET (ET_c) demand limited floodwater application rates. In the check studies, application rates were an order of magnitude greater than ET_c losses. For the farm in general, about 70% of flood flows captured went toward *in lieu* recharge, and only about 30% went toward direct recharge. For fields specifically targeted for direct recharge (e.g., Fields 16, 22, and 28), about half of total flood flows were used for direct recharge. Water was applied to fields with existing flood irrigation system; thus individual outflow rates were similar to irrigation flow rates and did not cause erosion or scour.

Vadose Zone Hydrologic and Salinity Budget; Implications for Groundwater Management. The deep water table and groundwater quality pose challenges for irrigation. Pumped groundwater during 2007−2009 was of much lower quality than diverted KR flood flows during 2011.[24] Mean nitrate levels were about 3 mg NO_3−N L^{-1}, ranging up to 11 mg NO_3−N L^{-1} and 1−2 orders of magnitude greater than measured flood flow concentrations (Figure 2). Mean EC levels were about 1 dS m^{-1}, up to 3 dS m^{-1} and typically about 50 times higher than flood flows.[24] Nitrate and salts are key constituents of concern with regard to CV groundwater.[1,7,10−13]

EC levels were similar to those found in the shallow root zone at depths of 60 and 120 cm (Fields 21 and 22) when this project was initiated (Figures 3, SI-S4, and SI-S5).[24] EC levels above 2 dS m^{-1} stresses yields for sensitive and moderately sensitive crops, a number of which are grown at TR (e.g., grapes, almonds, alfalfa).[35] These data support the concept that groundwater quality at the site, particularly salinity, poses long-term risks as it does in many areas of California.[10]

A conceptual model for flood recharge impacts on the saturated zone and water quality was developed (Figure SI-S7). Root zone water quality constituents such as salts and nitrates migrate into deeper layers during each infiltration event, reducing EC levels in the root zone, decreasing plant stress, and potentially increasing yields. With continued flood flow applications, root zone constituent concentrations within the flooded zone decreases through advective and diffusive transport. Once flood flows cease, advective flow in the upper root zone also ceases, but the front continues to migrate downward as the moisture content in deeper soil rises above field capacity. Eventually water and salt movement through the soil profile stops. During subsequent flood events, the cycle repeats flushing salts from soil pores through advection and diffusion, resulting in a salinity/nitrate front migrating down the soil profile. This front raises groundwater salinity/nitrate concentrations until constituents have been flushed from the unsaturated zone, after which groundwater salinity and nitrate levels begin decreasing.

This conceptual model suggests groundwater salinity concentrations will improve over time, consistent with the predictions of others that suggest high quality surface water would improve groundwater quality throughout the Kings Basin.[36] Our mass balance calculations estimate 12 m^3 m^{-2} of recharge water will need to be displaced in the unsaturated zone at TR to displace the salts, moving 11 kg TDS m^{-2} throughout the unsaturated zone into the groundwater (Table SI-S4).[24] Depending upon the initial groundwater quality regarding the constituent of concern, different volumes of flushing will be needed to return the groundwater to its original background concentration. For median salt values measured at TR, we estimate a similar water volume is needed to return underlying groundwater to current salinity levels (Table SI-S4) with greater volumes further decreasing groundwater salinity.[24]

Considerations for Regional and Local Implementation Logistics. On-Farm Flood Capture and Recharge (OFFCR) represents a new paradigm for the farming community: actively integrating flood flow capture and recharge into farm management to address chronic and severe groundwater overdraft. We estimated for an infiltration rate of 2.5 in d^{-1}, 1 cfs is captured on 10 acres (Figure SI-S8). For the infiltration rates typical of TR (2.6−5.7 in d^{-1}), 1 cfs captured requires 4−10 acres. With 0.16 M ac-ft overdrafted annually in the KR basin,[1] a meaningful effort requires substantial acreage. Median flood flows past the James Bypass during years in which they occur are about 1,500 cfs, 280,000 ac-ft over a 3-month period. Assuming infiltration rates similar to those measured here, about 15,000 acres would be needed; more permeable soils would further reduce the footprint.

Many logistical factors need consideration to implement OFFCR including a sustainable cost structure that might include irrigation savings and cost reimbursement from partnering organizations and easements; appropriate conveyance infrastructure; built-in flexibility for farm-scale implementation and coordination with agronomic BMPs; and regional coordination.

Costs and Sustainability. In the CV, the current drought has caused least 410,000 acres to be fallowed, farm revenue losses of $800 M and increased groundwater pumping costs of $447 M.[6] Much of the CV is moving toward higher profit permanent crops. For these crops, groundwater has a high value as a drought buffer, providing a reliable water source when surface flows are not available.[6] This model requires sustainable groundwater management and secure farm profits. For this reason, farmers have a strong economic incentive to participate in sustainable groundwater management.[37] OFFCR is economical compared to other direct recharge methods and provides an opportunity to secure sustainable groundwater and a profit. Over a 25-year period OFFCR costs were $36/ac-ft. Recharge costs using an engineering basin system has been estimated to range from $5−97/ac-ft, with a median cost of $51/ac-ft.[38] James Irrigation District charges consumers $88−91/ac-ft for irrigation purposes and relies primarily on groundwater.[3] Because some captured flood flows are utilized for *in lieu* recharge, the costs of pumping groundwater are avoided. Pumping groundwater is estimated to cost TR about $95/ac-ft but may be as high as $120/ac-ft.[2] Figure SI-S9 shows the combined cost to irrigate and capture flood flow for recharge on an acre-foot basis. When flood flows are captured but not utilized for *in lieu* recharge purposes, the cost to capture and irrigate is $131/ac-ft: the cost of OFFCR ($36/ac-ft) plus the cost of groundwater pumping ($95/ac-ft). When 100% flood flows are used for *in lieu* recharge, the total cost decreases to only the OFFCR costs as groundwater is not needed. For this project irrigation costs drop when 25% or more of the captured flood flows are utilized for irrigation. The avoided costs form a basis for investing in and saving money with groundwater recharge practices.

Not included in this farm-scale cost assessment are regional benefits. Besides slowing regional groundwater declines, these practices also reduce flood damage risks. Large floods in 1983, 1995, and 1997 along the KR and the San Joaquin River caused $1.2 billion dollars (2012 dollars) in damages.[14] A Hydrologic and Hydraulic assessment found implementing a 500 cfs diversion at TR to divert flood flows from the KR had a benefit:cost ratio near 2 over 50 years, with $800,000 annual savings from avoided flood damages along the Kings and San Joaquin Rivers.[39] The first phase of the full project, which will divert 150 cfs, is under construction and projected to save $300,000 annually.

■ ASSOCIATED CONTENT

Supporting Information

Figures include the following: A map of the region showing the study site, USGS flow data at the James Bypass, geoprobe pore water EC and nitrate soil profiles, root zone VWC and EC at F21CS, root zone VWC and EC at F22CS, nitrate mass in the top 300 cm of soil, a conceptual model of nitrate and salt movement during annual periods of OFFCR, a graph of predicted acres/CFS ratio needed for direct recharge, and a graph of costs of combined irrigation and direct recharge. Tables include the following: volume of water applied to fields from April through July, crop and field water budgets during flood flows, monthly water budgets for crops that received flood flows, and hydrologic/mass balance calculations to flush salts from the vadose zone. This material is available free of charge via the Internet at http://pubs.acs.org.

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Notes

The authors declare no competing financial interest.

■ ACKNOWLEDGMENTS

This project was funded through a NRCS CIG grant, and we appreciate the help of Chris Hartley and Dave Krietemeyer of the NRCS in helping us achieve our goals. TR provided significant matching funds, collaboration, and assistance. We acknowledge Steve Haugen of KRWA and John Mallyon of James Irrigation District for keeping us informed of KR water management. We appreciate the support of Rick Hoelzel and Eric Osterling of KRCD. Finally, we thank UC Davis scientific staff for providing expertise on laboratory methods and data collection.

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Appendix 2

The Aquaterra Water Bank: Predicting Groundwater Responses and Anticipating Hydrologic Management (Bachand et al 2023)

The Aquaterra Water Bank: Predicting Groundwater Responses and Anticipating Hydrologic Management

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November 2023

The Aquaterra Water Bank: Predicting Groundwater Responses and Anticipating Hydrologic Management

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Key Themes

Three water bank recharge and recovery scenarios were tested to consider potential climate conditions on California State Water Project allocations and resulting effects on the Aquaterra Water Bank (Bank) operations: Wet, Dry, and Historical. The Historical Scenario is based on the CalSim allocation schedule under climate change supplemented with historical data. The model was run over a 24-year period.

Recharge is expected to increase local groundwater levels underneath recharge basins up to 100 feet (ft) depending upon the density and number of recharge basins, the soils, and the model uncertainty. Beyond the area affected by local mounding, estimated at a quarter to a half mile, levels are expected to change by less than 5 ft during a given **season** of recharge (November through March, wetter years). Recovery wells are estimated to drawdown groundwater up to 10 – 20 ft locally. These local groundwater mounding and depressions will not affect surface water flooding or drainage.

The greater head difference and greater flow rates of recharge basins versus recovery wells create conditions in which basins more effectively push water out than recovery wells pull water back.

Implementing the Bank will affect groundwater flows. For instance, our estimates predict an increase of groundwater flows by about 10% through Raisin City Oil Field and expected to reinforce groundwater flows through the eastern half of MAGSA. Thus, a regional recovery basin and well distribution will affect groundwater flows to some degree. Changes in that distribution under a regional strategy would be expected to help manage Bank effects on groundwater through reinforcing and suppressing groundwater flow paths. Thus, a strategy can be implemented to promote groundwater recovery of contract water withdrawals in areas with better water quality, such as the eastern half of the McMullin Area Groundwater Sustainability Agency (MAGSA), as well as to suppress effects on groundwater flows through particular areas such as the Raisin City Oil Field.

Minimal losses are expected from the Bank operations because of the 100 ft groundwater drop from the north and eastern borders of MAGSA to the groundwater depression in the southwest corner of MAGSA. Bank operations will affect groundwater levels throughout MAGSA though the model suggests those operations will not affect the underlying flows from the north and east of MAGSA to the existing depression cone located in the southwest corner of MAGSA.

Long-term Bank operations will help increase groundwater supplies in MAGSA and help in complying with the Sustainable Groundwater Management Act (SGMA).

Hydrologic and water quality monitoring are being planned as part of Bank operations. Monitoring will be critical for real-time operational decisions and regulatory requirements. Monitoring will also provide baseline data for development of an Operational Model and its further refinement.

An Operational Model can provide guidance on the Bank design and planning. During Bank operations, the model can be used to support water accounting. With refinement and validation, the Operational Model will be able to test different management and operational scenarios to develop near- and long-term strategies to optimize Bank operations and their value.

Executive Summary

This report analyzes the potential effects Aquaterra Water Bank's (Bank's) operations will have on the McMullin Area Groundwater Sustainability Agency (MAGSA) groundwater and hydrology (e.g., sustainable groundwater supplies, drainage patterns, and groundwater quality). Based on the principle of superposition (Reilly, 1987), a 3-dimensional (3D), local-scale reduced-order MODFLOW (ROM) groundwater model with refined model grid that directly inherits the stratigraphy and aquifer properties from the Central Valley Hydrological Model (CVHM)[1] was developed to predict the potential groundwater level rises and declines exclusively induced by Bank recharge and recovery operations, and to assess the areal extent impacted. The model results were superimposed onto 2021 groundwater elevations to contextualize them in terms of real-world considerations and constraints.

Introduction and Modeling Approach

The Bank includes conveyance, recharge, and recovery infrastructure to enable diversion and recharge of up to 208,000 Acre-Feet per year (AFY) and recovery of up to 148,000 AFY. Recharge is planned to occur over the 5-month period from October through April and recovery over a 5-month period from May through September. The historical data suggest recharge opportunities will occur in about 46% of the years and recovery opportunities in 42%, though these periods will typically be below the maximum design capacities. Bank operations are expected to be integrated into the operations of banking partners resulting in most of the banking water being moved regionally and predominantly for agriculture.

ROM Model

A 3D local-scale reduced-order MODFLOW (ROM) model was then developed based on the principle of superposition (Reilly et al, 1987) and the well-calibrated USGS CVHM model (Faunt et al., 2010; USGS, 2023) to simulate groundwater responses exclusively induced by the Bank operations alone. The ROM model was constructed by directly inheriting the stratigraphy and heterogenous aquifer properties from the regional Central Valley Hydrological Model (CVHM) developed by the USGS (Faunt et al., 2010) first, and then by removing all existing boundary conditions from the 3D local-scale groundwater model. The CVHM model, updated recently (USGS, 2023), is considered to be a realistic representation of soils and hydrologic drivers based upon rigorous calibration and validation of the CVHM model. By removing all existing boundary conditions from the 3D local-scale groundwater model, the ROM model simulates the groundwater level changes exclusively induced by the Water Bank operations alone, greatly improving the computational efficiency and avoiding the need for full characterization of the existing groundwater conditions and the uncertainties associated with the existing conditions. The predicted water level changes from the ROM model are then "superimposed" to the existing baseline groundwater contours for interpreting the potential impacts of Water Bank operations in the context of real-world hydraulic limitations and constraints. *Thus, we define the calculations from this effort as "ideal," recognizing the limits and uncertainties associated with the model.*

[1] CVHM has been developed by the United States Geological Survey (USGS) (Faunt et al., 2010)

Climate Scenarios

Recharge and recovery periods are based upon a 24-year period (Water Year 1997 – 2020). Simulated future deliveries from the California State Water Project (SWP) were taken from CalSim for the water years from 1997 – 2015 under climate change. Deliveries for water years of 2016 – 2020 were taken from historical records. Based on State Water Project (SWP) allocation data, we define 60% allocation as the trigger for contractors to use the Bank to store water and 40% of the allocation as the trigger for contractors to use the Bank for recovery. The model assumes maximum recharge and recovery of Bank operations at design capacity. This approach results in the Historical Scenario characterized by a wet period over the first 12 years and a dry period over the second 12 years. We developed two additional scenarios (both wetter and drier) to represent climate scenarios. The Wet scenario repeated the first historical 12-year wet period. The Dry scenario repeated the second historical 12-year dry period. *As model input, recharge and recovery periods are assumed to be at full capacity according to the design targets*. These assumptions resulted in the following recovery and recharge inputs for the three scenarios:

- **Historical:** Net Recharge = 0.6 MAF, 11 Recharge Years, 10 Recovery Years
- **Wet:** Net Recharge = 1.0 MAF, 12 Recharge Years, 8 Recovery Years
- **Dry:** Net Recharge = 0.3 MAF, 10 Recharge Years, 12 Recovery Years

Spatial layout of basins and wells

Recharge basins are distributed relatively evenly across five recharge zones upgradient of the rest of MAGSA along the existing groundwater flow gradients. The basin area within each zone targeted approximately 10% of the available acreage, evenly distributed to limit groundwater mounding and depressions from recharge and recovery wells. Basins were generally not placed along the very eastern edges of MAGSA to limit recharge water spread east outside of MAGSA's borders. Recovery wells were placed under a local and a regional strategy. The local strategy is to recover a percent of the recharged water at a given recharge basin. We assume not all recharged water will be recoverable at that location due to large groundwater gradients during recharge pushing water beyond the area of the cone of depression of the recovery well. The regional strategy places wells either 1) to reinforce flow gradients downstream of recharge basins to capture the groundwater that has escaped from upstream basins recharge/recovery systems or 2) to suppress flow gradients to limit movement of recharged groundwater further downstream.

Model Results

Model results consist of spatial-temporal evolutions of groundwater levels, simulated hydrographs at monitoring wells along transects and water budgets.

A spatial analysis of hydrology

During the seasonal recharge periods (Table 1, *November through March on wetter years*), ideal groundwater levels underlying and near recharge basins can rise up to about 100 ft above baseline conditions, depending upon the location. These conditions persist as long as recharge occurs. As the recharge season persists, groundwater mounds widen. In areas where basin complexes[2] exist, regional mounding appears broader. With the ROM model lacking an underlying baseline groundwater flow regime, “ideal” groundwater responses extend widely in all directions. With the cessation of recharge activities, groundwater mounding relaxes, dropping and further spreading groundwater more extensively.

During wetter periods as defined by more frequent years in which recharge was undertaken, “ideal” groundwater levels spread further than during drier periods. Not constrained by an existing regional groundwater gradient, groundwater spreading is similar in all directions from the recharge basins.

Groundwater responses to recovery are more gradual than to recharge; groundwater depressions are less dramatic than groundwater mounding; and the spreading of groundwater effects occurs over a longer time. The relaxing of groundwater depressions appears to be slower. This effect could be due to the greater number of recovery points (more wells than basins) and less extreme changes in head.

At the end of a recovery period, the model typically depicts the region with elevated “ideal” water levels as more extensive than the region with lowered “ideal” groundwater levels. This outcome tells us the *recharge basins more effectively push groundwater out laterally than recovery wells pull it back*.

Hydrographs along transects

Five transects of monitoring were conducted to provide real-world context to “ideal” simulated spatial results.

In the short term during active recharge efforts, the model predicts groundwater levels underneath and adjacent recharge basins rise rapidly up to ~35 – 100 ft. Large recharge basin complexes appear to have greater water level increases than smaller complexes. These groundwater mounding effects become muted with distances of a quarter to a half mile. From one half to two miles away ideal groundwater levels increase during recharge periods from 2 – 5 ft. Recovery wells have a lesser effect on groundwater.

Underlying the recharge and recovery system, the model predicts that groundwater levels decline up to 10 – 20 ft during periods of active recovery. Additionally, the recovery flows are about half of the recharge flow rates. Under the model and based on the design, a typical 80-acre recharge basin delivers 33 acre-feet per day (AFD) of contract water for recharge. Conversely, the designed recovery well withdrawals at about half that rate. Together, these effects explain why recharge basins more effectively push water out than recovery wells pull water back, explaining the phenomena that shows up in the spatial analysis of groundwater mounding and depression dynamics.

These local groundwater level swings from recharge and recovery will likely affect subsurface redox conditions. As discussed by Bachand et al. (2023), these redox changes could potentially mobilize selenium and other redox-sensitive trace elements like arsenic. This effect should be considered in the context of “normal” groundwater elevation changes in an irrigated aquifer. In MAGSA, groundwater levels vary about 15 – 20 ft from natural groundwater flows through the region and from groundwater pumping for irrigation. In comparing the subsurface volumes affected by the Bank operations and the frequency to the volume annually affected by irrigation, the increase in the swings (by volume affected) would be about 15% annually if the Bank is operated at maximum design rates. Given that the Bank is

[2] Have defined basin complexes as groups of basins located adjacent or nearby to each other.

likely to operate at a lower capacity, we estimate this increase will be less than 10%. *Thus, Bank operations are expected to only have a minor effect on increasing risk for mobilizing redox sensitive species*.

Over years of extended recharge where the frequency of recharge years is relatively high, the model predicts groundwater levels may gradually increase by around 20 ft up to two miles away. Thus, changes in groundwater levels could potentially be observed upgradient and across groundwater contours up to 20 ft higher. Elevation changes upgradient would be gradual and increasingly slight the further upgradient.

The model results suggest regional recovery wells can reinforce or suppress groundwater flow paths. In the eastern half of MAGSA, recovery wells appear to reinforce flow paths by more broadly dropping groundwater levels. Near the oil fields, recovery wells appear to change flow paths and suppress downstream groundwater flow. These examples support strategic placement and utility of recovery wells to moderate the groundwater system in response to recharge and recovery actions.

Changes in groundwater flows through the Raisin City Oil Field

Based on changes in groundwater gradients through the Raisin City Oil Field for the distribution of recharge basins and recovery wells modeled for this exercise, groundwater flow estimated increases through the oil field are predicted at about 10% under Bank operations, slightly more for the Wet Scenario and slightly less for the Dry Scenario. The current infrastructure distribution shows recovery wells located along the north of the oil field placed to capture recharge water prior to entering the oil field. An increase in the wells along those upstream locations would be expected to reduce groundwater flows through the oil field by decreasing the groundwater gradient across the oil field. These considerations should be included in location and operating recharge basins and recovery wells, and for planning monitoring programs.

Current baseline groundwater contours constraining migration and losses from recharge and recovery

The currently existing baseline groundwater contours in MAGSA will constrain eastward groundwater migration much more than depicted in the ROM model, which predicts the water level rises and declines induced only by Water Bank operations. The baseline groundwater level changes across the modeled period and outside of the immediate localized mounding and depression was calculated at approximately 20 ft and possibly 30 ft if we consider uncertainties. In that case, groundwater mounds could travel upgradient 20 – 30 ft. Beyond that, groundwater elevations could be indirectly affected by changes in the overall gradient. Essentially, the 20 – 30 foot climb upgradient represents a reasonable constraint for eastern migration upgradient from MAGSA. Because of the existing groundwater gradients in MAGSA, more water could conversely spread west and south.

In short, the ROM model appears to vastly overstate the eastern spread of groundwater and the potential for losses of recharged water east and upgradient of MAGSA. Importantly, within MAGSA groundwater elevations drop 100 ft from its northern and eastern borders to the cone of depression in the southwest corner. Recharge water that flows south out of MAGSA will not flow past the existing cone of depression. After superimposing the model-predicted water level changes onto the currently existing groundwater baseline contours, it is clear that the Bank deliveries and withdrawals will not significantly affect the fundamental groundwater flow patterns. In the short term, recharge water may spread outside of MAGSA, but in the long term regional groundwater flow paths will pull it back in. Underlying and relatively recalcitrant groundwater flow paths will ensure recovery of contract water introduced into the Bank through recharge.

Recommendations

Regional well and basin placement strategy

The phenomena of recharge pushing water further laterally than can be recovered means some percent of water deposited at a recharge basin will move beyond the local recovery zone for that basin. Thus, regional wells are required to recapture that water. However, regional wells can also be placed to reinforce or suppress groundwater flow gradients to benefit the region and optimize the Bank and its value. Model depictions and data support the contention that recovery wells placed along the southern east-west conveyance corridor has encouraged preferential withdrawal of groundwater in that area.

The data also suggests recharge and recovery operations under the Bank will increase groundwater flows under through the Raisin City Oil Field by about 10% across the three different modeled operational scenarios. Strategic placement and operations of basins and wells would be expected to affect groundwater flows and could be implemented for their management across the oil field and other identified areas.

Monitoring to support operations and operational strategies

Hydrologic and water quality monitoring are being planned by the Bank. Monitoring will be critical in real-time operational decisions and for regulatory requirements. Monitoring will also provide baseline data for development of an Operational Model as well as its further refinement.

Operational Modeling for Today and Tomorrow

An Operational Model can provide guidance on the Bank's design and planning. With Bank operations, the model can be used to support water accounting. With refinement and validation, the Operational Model will be able to test different management and operational scenarios to develop near- and long-term strategies to optimize Bank operations and their value.

Table of Contents

Contents

Key Themes iii

Executive Summary iv

Introduction and Modeling Approach iv

ROM Model iv

Climate Scenarios v

Spatial layout of basins and wells v

Model Results v

A spatial analysis of hydrology v

Hydrographs along transects vi

Changes in groundwater flows through the Raisin City Oil Field vii

Current baseline groundwater contours constraining migration and losses from recharge and recovery vii

Recommendations viii

Regional well and basin placement strategy viii

Monitoring to support operations and operational strategies viii

Operational Modeling for Today and Tomorrow viii

Acronyms and Abbreviations xiv

I. Background Information 1

1 Introduction 1

2 Overview of Water Bank and its Operations 3

3 Methods Used 4

3.1 Central Valley Hydrologic Model (CVHM) 4

3.2 Reduced-Order MODFLOW (ROM) Model of Aquaterra Water Bank 5

3.2.1 Construction 6

3.2.2 Recharge and Recovery Hydraulic Inputs, 3 Scenarios 9

3.3 Recharge Basin and Recovery Well Spatial Distribution 15

3.3.1 Recharge Basins 15

3.3.2 Recovery Wells 15

3.4 Key Limitations 16

3.4.1 One-Size Fits All: Maximum Deliveries and Withdrawals....16

3.4.2 Does Not Include Baseline Groundwater Contours....17

3.4.3 Uncertainty....17

3.4.4 Ideal Findings and Usefulness in Identifying Trends....17

II. ROM Model Results and Analysis....19

4 Spatial Analysis Results....19

4.1 Hydrology of Recharge....19

4.1.1 1999 Water Year Simulation, Recharge during a wet period, Historical Scenario....19

4.1.2 2016 Water Year Simulation, Recharge after a dry period, Historical Scenario....20

4.2 Hydrology of Recovery/Extraction....28

4.2.1 2008–2009 Water Year Simulation, Extraction after a wet period, Historical Scenario....28

4.2.2 2015 Water Year Simulation, Extraction after a dry period, Historical Scenario....28

4.3 Twenty Four Years Under the Historical Scenario....36

4.4 End of 24-Year Simulation across Climate Scenarios....40

4.5 Superposition of ROM Model over 2021 Groundwater Elevation Contours....44

5 Hydrographs....49

5.1 Hydrographs....52

5.1.1 SJR Transect: Losses and Gains from the SJR....52

5.1.2 Highway 180 Transect: Effects of Recharge....53

5.1.3 North-South Transect on Southeast side of MAGSA: Recharge Basin Groundwater Effect Extent....54

5.1.4 East-West Transect on South Side of MAGSA: Recharge and Recovery Basin Groundwater Effect Extent....55

5.1.5 North-South Transect: Assess Recharge and Recovery Groundwater Effects on Oil Field....55

6 Discussion....65

6.1 Recharge Basin and Recovery Well Effects are Localized....65

6.2 Water Quality considerations regarding selenium....65

6.3 Percent Recovery Issues....68

6.3.1 ROM Model Outcomes....68

6.3.2 Considerations of Assumptions and Implications for Real World Outcomes to the East....69

6.3.3 Real World Outcomes to the West and South....70

6.3.4 Percent Bank Water Loss from MAGSA....70

6.4 Locating Recharge and Recovery Infrastructure to Meet Bank Operation Targets 71
6.4.1 Leverage flow paths to enhance recovery by the Bank 72
6.4.2 Place recharge basins in the east but limit eastward losses 73
6.4.3 Limit Flow through Oil Field 73
7 Key Effects Findings and Management 76
7.1 Considering Bank Effects 76
7.1.1 Will the bank decrease groundwater supplies or interfere with groundwater recharge and impede sustainable groundwater management? 76
7.1.2 Will surface drainage patterns be affected by changes in groundwater? 78
7.1.3 Will the bank create hydrologic conditions that impede groundwater quality or groundwater use? 78
7.1.4 Swings in groundwater elevations 79
7.1.5 Hydrologic flow paths that decrease water quality 79
7.1.6 Subsurface flow conditions that challenge operations and management 80
7.1.7 Creating conditions that promote water losses 80
7.2 Management and Design 80
7.2.1 Reinforcing and suppressing groundwater flow paths for beneficial outcomes 81
7.2.2 Monitoring and the Operational Model 81
8 Citations 82

Tables

Table 1. ROM Model Input Summary. 9
Table 2. Recharge and recovery periods defined based on SWP allocations. 13
Table 3. Recharge and Recovery Scheduling Summarized for Different Scenarios 13
Table 4. Allocation schedules developed for the Historical, Wet and Dry Scenarios 14
Table 5.Estimated change in groundwater flow through the oil field 57
Table 6. Vadose zones affected by redox changes. 68

Figures

Figure 1. Aquaterra Water Bank (Bank) Conveyance, Recharge and Recovery Infrastructure. 2
Figure 2. The 3D soil texture and stratigraphy of USGS CVHM model (Faunt et al, 2010)........................... 5
Figure 3. (a) Hydraulic conductivity field of the USGS CVHM model within and adjacent to MAGSA and (b) Corcoran Clay. Data available from the Conservation Biology Institute (Data Basin, 2020). 7
Figure 4. Aquaterra Water Bank model grid with local grid refinements near recharge basins and recovery wells. 8
Figure 5. State Water Project allocation schedule for CalSIM model in comparison to the historical allocation.. 11
Figure 6. 1997 – 2022 Water Year Modeling Scenario. 11
Figure 7. Depths to Groundwater 18
Figure 8. Recharge Year in a Wet Series of Years (third of four consecutive recharge years; 1999 Water Year).. 22
Figure 9. Recharge Year in a Dry Period (First year after three successive dry, recovery years, 2016 Water Year).. 25
Figure 10. Recovery Period after wet decade (2008 – 2009 WY).. 30
Figure 11. Recovery Year in Dry Period (Second of three consecutive dry years, 2015 - 2016 Water Year) 33
Figure 12. Long-term Series Overy Model's Duration (Historical Scenario).. 37
Figure 13. Net Recharge for Three Scenarios: Historical (orange), Wet(grey) and Dry (yellow)................ 41
Figure 14. Total recharge, recovery, and net recharge over Historical, Wet and Dry Scenarios 42
Figure 15. September 2020 for Historic, Wet and Dry Model Scenarios. 43
Figure 16. Superimposing 1999 WY Model over Groundwater. 45
Figure 17. Superimposing 2014 WY Model over Groundwater. 47
Figure 18. Model Inspection Well Nodes and Areas of Interest. 50
Figure 19. Groundwater elevations (ft-NAVD) and aquifer flow paths. 51
Figure 20. GW Head and Elevation Responses along SJR Transect 58
Figure 21. GW Head and Elevation Responses along Northern MAGSA.. 59
Figure 22. GW Head and Elevation Responses along eastern North-South Transect 60
Figure 23. GW Head and Elevation Responses along southern East-West Transect.................................. 61
Figure 24. GW Head and Elevation Responses along 145, Historic Scenario.. 62
Figure 25. Groundwater gradient along Transect 145 for the Climate Scenarios 63
Figure 26. Statistics for percent fall for the Climate Scenarios 64
Figure 27. Typical annual groundwater trends, MAGSA 67
Figure 28. Corrected September 2020 for Historic, Wet and Dry Model Scenarios. 74
Figure 29. Actions to enhance operations and success. 75

Acronyms and Abbreviations

3D	Three dimensional
AF	Acre-feet (volume)
AFD	Acre-feet per day (flow)
AFY	Acre-feet per year (flow)
Bank	Aquaterra Water Bank
BOR	U.S. Bureau of Reclamation (used in citations)
CDWR	California Department of Water Resources
cfs	cubic feet per second (flow)
CVHM	Central Valley Hydrologic Model
CVP	Central Valley Project
EPA	U.S. Environmental Protection Agency
Ft	feet
Ft-NAVD	feet standardized to elevation standard
gpm	gallons per minute (flow)
MAF	Million acre-feet (AF x 106)
MAGSA	McMullin Area Groundwater Sustainability Agency
Reclamation	U.S. Bureau of Reclamation
SGMA	The Sustainable Groundwater Management Act
SJR	San Joaquin River
SWP	State Water Project
USGS	United States Geological Survey

I. Background Information

1 Introduction

The Aquaterra Water Bank (Bank) is a project currently under design. The Bank is being established within the McMullin Area Groundwater Sustainability Agency (MAGSA) jurisdiction in California and is adjacent to the Mendota Pool (Figure 1).

The Bank will accept contract water from banking partners through the Fresno Slough with the design capacity to 1) divert up to 208,000 acre-feet per year (AFY) over the 5-month period during late fall and early winter (October through April) and 2) infiltrate the underlying aquifer across approximately 3500 acres of farmland under employment as recharge basins. The Bank is being designed for up to 800,000 acre-feet (AF) of storage.

The Bank will have a design recovery capacity of up to 148,000 AFY to withdraw groundwater as contract water back to banking partners. Recovery will be conducted through a series of recovery wells located locally near recharge basins and regionally along the conveyance system and roads. Recovery is expected to occur over a 5-month period from May through September.

Based on historical data, recharge opportunities are predicted to occur 46% of the years and recovery opportunities 42% of the years (Bachand et al., 2023).

This report assesses the groundwater hydrology of the Bank through review and interpretation of a 3D local-scale groundwater model that directly inherits the stratigraphy and aquifer properties from the well-calibrated Central Valley Hydrologic Model (CVHM) developed by the United States Geological Survey (USGS) (USGS, 2010) and designed specifically to model groundwater hydrology related only to Bank recharge and recovery operations. This model has been designed to consider potential hydrologic effects from implementing and operating the Bank. Three potential effects are as follows:

1. Will the bank decrease groundwater supplies or interfere with groundwater recharge and impede sustainable groundwater management?
2. Will surface drainage patterns be affected by changes in groundwater?
3. Will hydrologic conditions be created that impede groundwater quality or groundwater use?

Report Goals

This report analyzes the potential effects the Bank's operations will have on MAGSA groundwater and hydrology (e.g., sustainable groundwater supplies, drainage patterns, groundwater quality). This goal was conducted through superimposing a reduced-order groundwater model specific to this purpose over the currently existing groundwater baseline contours and contextualizing those results in terms of real-world considerations and constraints.

Hydrologic conditions that impede groundwater quality or use include the following:

- Swings in groundwater elevations that mobilize or transport water quality constituents,
- Flow paths that move poor quality water to areas with higher quality water, and
- Large declines in groundwater elevation that exceed the depths of the various drinking water and irrigation wells.

In conducting this analysis, we have considered the results of the ROM Model as well as the model's underlying assumptions and construction. This holistic approach has enabled us to interpret the model results in consideration of real-world conditions.

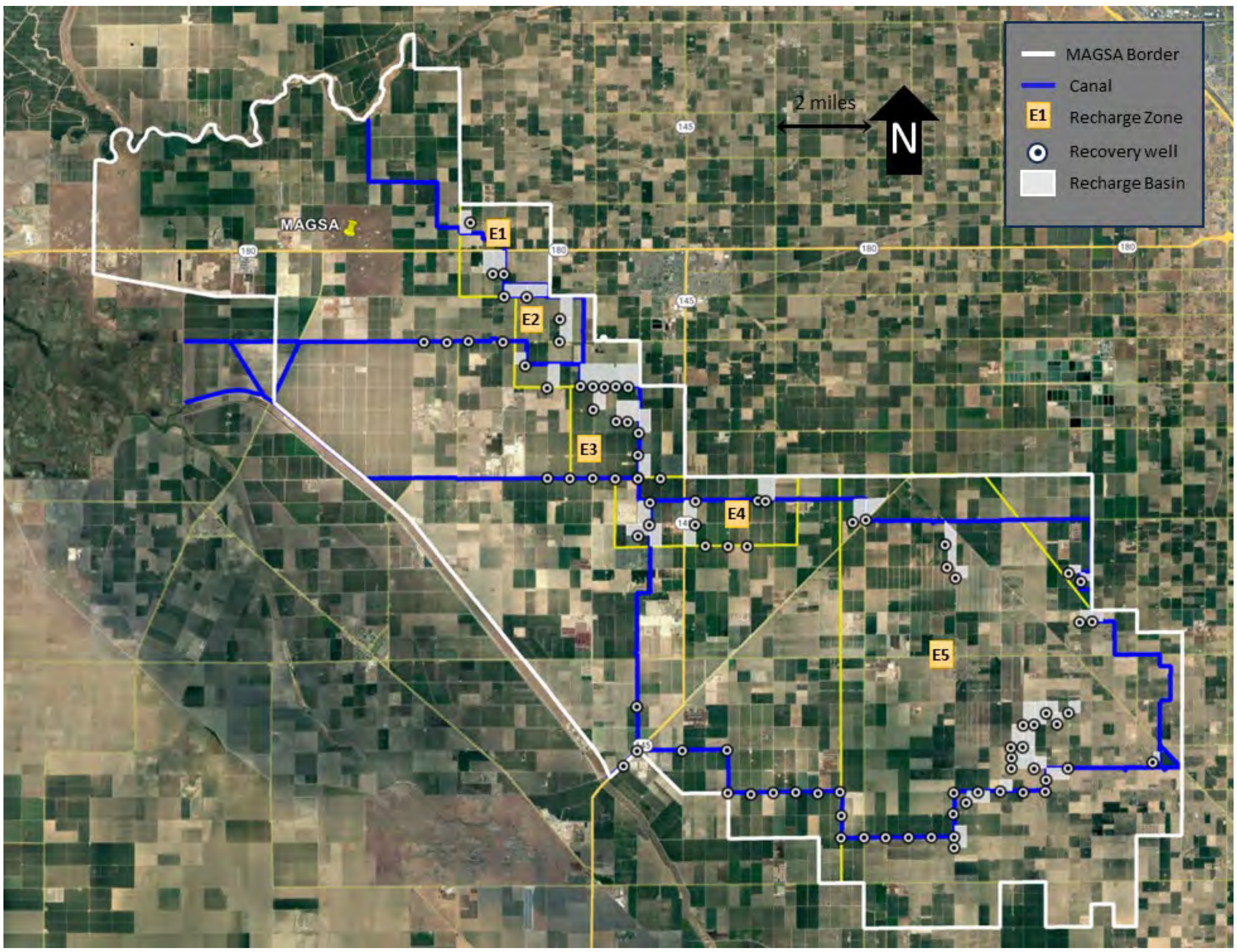


Figure 1. Aquaterra Water Bank (Bank) Conveyance, Recharge and Recovery Infrastructure. The Bank includes conveyance, recharge, and recovery infrastructure. Over 60 miles of conveyance canals varying in capacity from 300 – 500 CFS will divert contract water from the Kings Bypass and the Mendota Pool to 3500 acres of recharge fields for infiltrating contract water to groundwater as inputs into the Bank. Over 90 recovery wells will withdraw banked contract water and return it back to the Mendota Pool using the conveyance system. The Bank is being designed for a maximum annual diversion and recharge of 208,000 AF and a maximum annual recovery up to 148,000 AF. The Bank is being designed for 800,000 AF.

2 Overview of Water Bank and its Operations

The Bank and its operations are described in detail within the main environmental documents associated with the California Environmental Quality Act (CEQA, Initial Study – IS) and the National Environmental Policy Act (NEPA, Environmental Analysis – EA). A brief summary is provided here.

The Bank will exist within MAGSA's underlying aquifer. Its proximity to existing State and federal water system infrastructure will make it well suited to receive contract water from SWP and CVP contractors, and others (e.g., local MAGSA partners, consortiums). Establishment of the water bank will require construction of conveyance, recharge, and recovery facilities. These facilities are presented Figure 1. Conveyance facilities will divert contract water from the northern end of the Fresno Slough just south of Mendota Pool for distribution through MAGSA's jurisdiction utilizing approximately 60 miles of main canals, ranging in capacity of 300 – 500 CFS depending upon their location and its expected capacity requirements. Recharge basins totaling approximately 3500 acres lay adjacent or in the vicinity of the main canals. Diversion of contract water and its infiltration into the Bank will occur during November through March during most years. Water stored in the underlying aquifer will lie above the Corcoran Clay, which ranges from about 350 – 500 feet below ground elevations.

Banked contract water will be recovered through a series of groundwater wells. These wells are located to withdraw from each recharge basin as well as along groundwater flow paths through MAGSA. Over 90 groundwater wells will be installed to enable a maximum recovery rate of 148,000 AFY. Recovery wells are expected to extend 300 – 450 feet below ground surface to ensure extraction of groundwater above the Corcoran clay layer. Ten percent of each deposit will be left behind in the water bank for this Project. For each 100 AF deposited by a subscriber, 90 AF will be available for subsequent withdrawal by the subscriber and 10 AF will be left behind to offset losses (e.g., operational, evaporative) and improve subsurface conditions through in lieu recharge (i.e., improving unsaturated zone water content to benefit crops and plants). Losses will occur primarily within the Project area as the volume of water for deposit will be metered when it enters the adjacent Mendota Pool and will move directly into the water bank conveyance system for distribution through MAGSA and recharge within the identified recharge zones. Recovery will typically occur from the 5-month period of May through September. This period represents both the regional growing season when irrigation drives higher water demand, and California dry season when other demands increase (e.g., streamflows for fisheries, recreational use, urban and suburban irrigation).

The Water Bank and Its Operations

The Aquaterra Water Bank includes conveyance, recharge, and recovery infrastructure to enable diversion and recharge of up to 208,000 Acre-Feet per year (AFY) and recovery of up to 148,000 AFY. Recharge is planned to occur over the 5-month period from October through April and recovery over a 5-month period from May through September. The historical data suggests recharge opportunities will be presented about 46% of the years and recovery opportunities 42%, though these periods will typically be below the maximum design capacities. Bank operations are expected to be integrated into operations of the banking partners resulting in most banking water being moved regionally and predominantly for agriculture.

The Bank will provide an additional tool for contractors and partners in managing contract water. Using a "banking" model, many (water) deliveries and withdraws are expected to be on paper as contractors manage their water portfolios. Under that expectation, "wet" water is expected to generally be used regionally and largely by agriculture. As an additional water management and storage tool, the Bank Project will make regional and California water resources more sustainable and increase flexibility in their management.

As part of Bank operations, a percent of water will be left behind. Locally, the leave behind of a percent of deposited waters will provide new water for replenishing the over-drafted aquifer.

3 Methods Used

The analysis conducted for this report included development of a 3D local scale, reduced-order MODFLOW (ROM) model based on the well-calibrated United States Geologic Survey Central Valley Hydrologic Model (CVHM) (Faunt et al., 2010) (CVHM 2023) to simulate groundwater level rises and declines induced by Bank operations under various recharge and recovery scenarios. Results from this ROM model were "superimposed" onto existing baseline groundwater contours within MAGSA to interpret simulation results in consideration of model limitations and of real-world limitations and constraints.

Overview of Methods

A local scale reduced-order MODFLOW (ROM) model was developed to simulate groundwater mounding and depression exclusively induced by Bank operations. The predicted changes of groundwater levels are then "superimposed" onto the existing baseline groundwater contours within MAGSA. Results from the Superposition Model were interpreted in the context of the model's underlying assumptions and real-world hydraulic limitations and constraints.

3.1 Central Valley Hydrologic Model (CVHM)

CVHM is a model (Faunt et al, 2010) developed and updated recently (USGS, 2023) for the Central Valley and predicts groundwater responses to hydrologic sources and sinks. The CVHM model was built upon an extensive analysis of drilling logs and geophysical survey data in developing high-fidelity 3 dimensional (3D) stratigraphy and soil texture models, and rigorously calibrated and validated against surface and subsurface hydrologic data (Figure 2). Thus, the underlying data that is the foundation of CVHM is itself considered a validated and calibrated data set that reasonably represents subsurface conditions and drivers in the Central Valley.

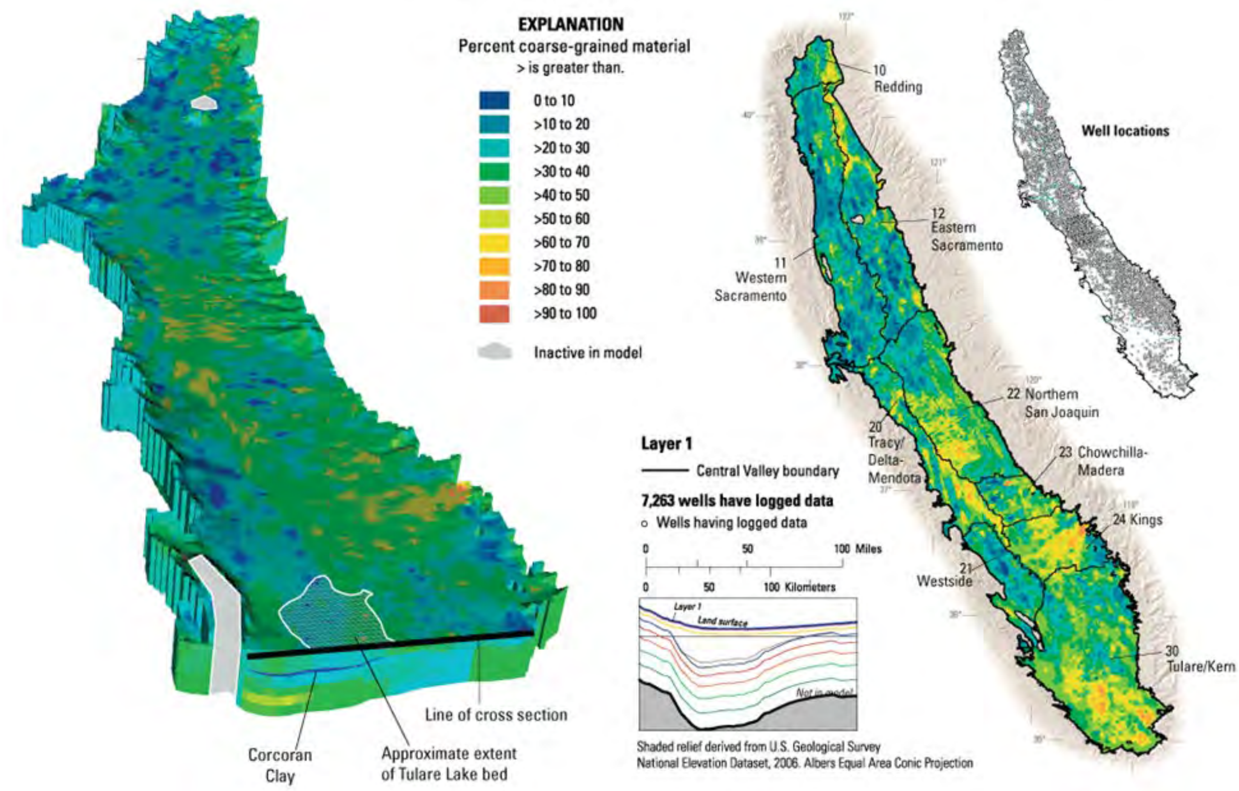


Figure 2. The 3D soil texture and stratigraphy of USGS CVHM model (Faunt et al, 2010)

3.2 Reduced-Order MODFLOW (ROM) Model of Aquaterra Water Bank

A fully populated groundwater model usually considers all hydrological stresses, e.g., river leakage, groundwater pumping, precipitation & irrigation recharges, evapotranspiration, etc., in addition to aquifer lateral and vertical heterogeneities. For this analysis, to avoid the needs of full characterization and quantification of these existing hydrological stresses within MAGSA and adjacent areas, many of which are likely to be highly uncertain, a 3D local scale reduced-order MODFLOW (ROM) model was developed. The ROM model is based on the principle of superposition (Reilly et al., 1987) and CVHM model (Faunt et al, 2010; USGS, 2023) was used to simulate groundwater responses exclusively induced by the Aquaterra Water Bank operations alone. The principle of superposition states the net effect of multiple applied stresses equals the sum of the effects of each individual applied stress. The advantages of superposition are summarized by Reilly et al. (1987) as follows:

1. The effects of a specified stress (e.g., groundwater pumping, managed recharge) on the system can be evaluated even if other stresses are unknown.
2. The effects of a change in stress on the system can be evaluated even if the initial conditions are unknown.
3. The effect of one stress on the system can be isolated from the effects of all other stresses on the system.

Simulated groundwater level changes by the ROM model are then “superimposed” onto the existing baseline groundwater contours to assess potential impact of Bank operations in context of real-world hydrological constraints. In addition to the computational efficiency, this “superposition” approach greatly simplifies analysis and presentation of results for simulations involving managed recharge, curtailment of groundwater pumping, transfer of water right diversion locations, and mitigation activities. The following sections describe model construction, inputs, outputs, and limitations.

3.2.1 Construction

The local scale 3D ROM Model has been constructed to specifically model hydrologic responses to water bank operations. The model uses hydrologic and soils data that are the foundation of CVHM:

- A spatial grid from CVHM and increased the density of grid nodes within MAGSA to increase the spatial resolution;
- Soil profiles, textures, and stratigraphy (e.g., Figure 2);
- Aquifer hydrologic properties (e.g., hydraulic conductivity, storage coefficient);
- Initial and boundary conditions; and
- All existing transient source and sink terms (e.g., wells, precipitation, farmland infiltrations, surface, and groundwater flow sources).

CVHM has been rigorously calibrated and validated. Thus, the foundational data are considered reasonable representations of real-world conditions.

Two data sets are discussed as important examples of CVHM’s dataset utility. Hydraulic conductivity defines the range of horizontal and vertical flows that can occur under saturated conditions based on soil textures (e.g., clay, sediment, sand, loam), their combinations, and the lateral/vertical continuities. CVHM provides that data and its hydrogeological unit layering within the resolution of the model (Figure *3*a). Thus, representative hydraulic conductivity field was extracted from CVHM to build the local scale 3D ROM model.

The Corcoran clay is an important layer throughout much of the Central Valley that restricts groundwater interactions and hydrology. Within MAGSA, the Corcoran clay defines the lower boundary of the groundwater interacting with the Bank (Figure 43b). Most wells within MAGSA are above the Corcoran Clay (Bachand et al., 2023) and recharge effects are mainly limited to groundwater above the Corcoran Clay. CVHM provides the extent of the Corcoran Clay and the areas where groundwater interactions above and below the clay can occur.

MODFLOW-USG (Panday et al., 2017) was selected to develop the local scale 3D Aquaterra Water Bank groundwater model. Figure 4 shows the model grid used. The model domain was chosen large enough to avoid potential boundary effects on the simulation results. The model grid has an overall resolution of 400 ft throughout the model domain, with local grid refinement to 200 ft adjacent to recharge basins and recovery wells. The vertical grid layering follows the exact same vertical grid layers as the CVHM model within the local model domain; a total of 10 model layers are used to represent vertical aquifer heterogeneities. The local ROM model has a total of 210,290 active grid cells. The ROM model directly inherited the stratigraphy and 3D aquifer property fields (e.g., hydraulic conductivity, specific yield and specific storage) of the CVHM model, but with refined grid resolution to accommodate the density and distribution of recharge basins and recovery wells, and the resolution needed to model spatial variations of groundwater level changes induced by Bank operations. The external model boundaries are modeled as general head boundaries to allow groundwater flow into or out of the model domain, a typical approach for a local scale model that is embedded within a larger regional aquifer. Following the principle of superposition approach, the only active source and sink terms represented in the ROM model are the Bank recharge (i.e., recharge basin infiltration) and recovery well pumping, respectively. Therefore, the ROM model simulates the groundwater level changes exclusively induced by the Bank operations alone.

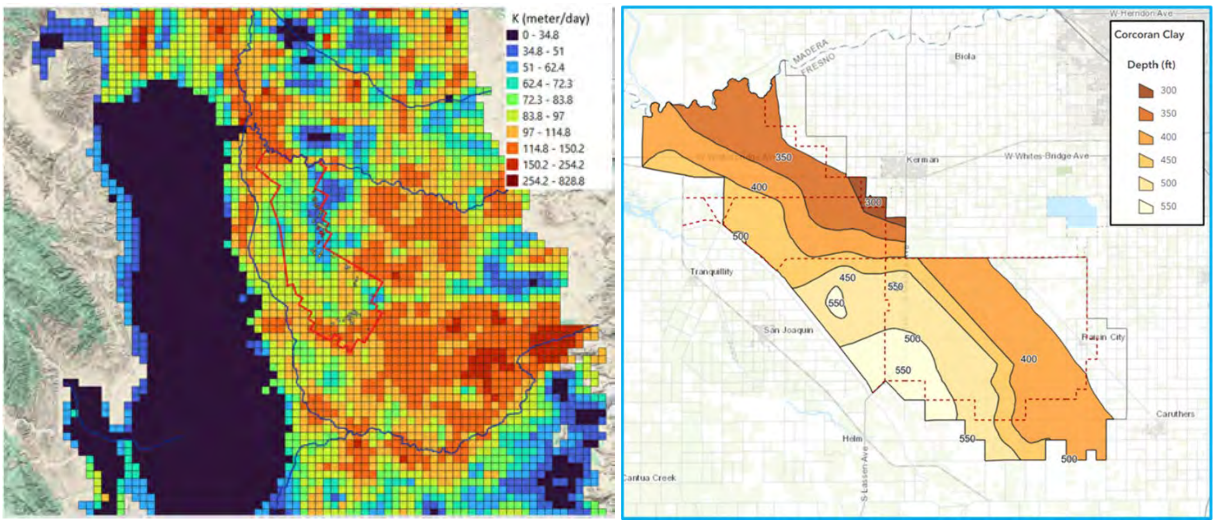


Figure 3. (a) Hydraulic conductivity field of the USGS CVHM model within and adjacent to MAGSA and (b) Corcoran Clay. Data available from the Conservation Biology Institute (Data Basin, 2020).

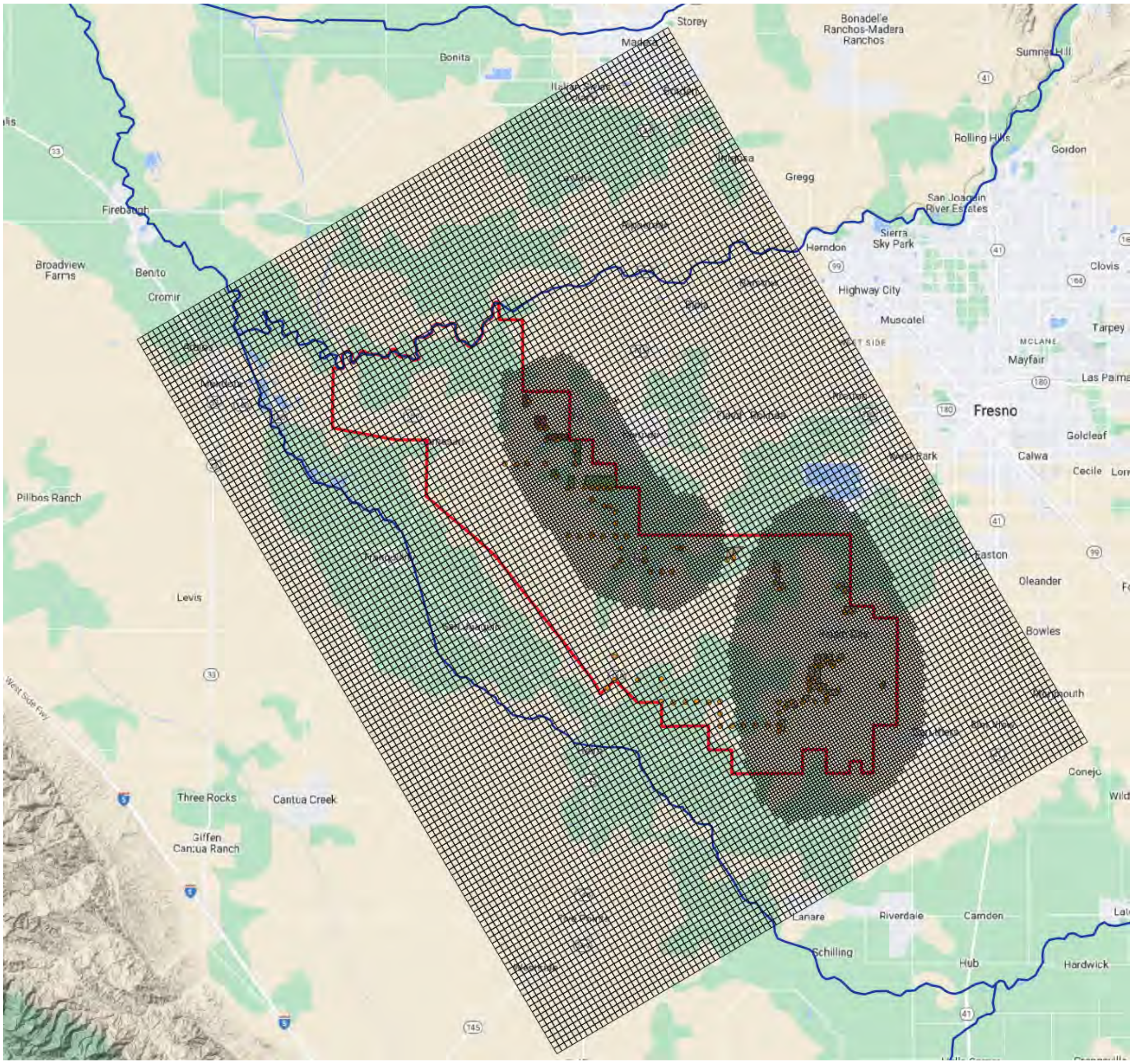


Figure 4. Aquaterra Water Bank model grid with local grid refinements near recharge basins and recovery wells.

3.2.2 Recharge and Recovery Hydraulic Inputs, 3 Scenarios

Model hydraulic inputs included –

- Defining the recharge and recovery specifications for the Bank,
- Defining periods of recharge and recovery that were to be modeled, and
- Introducing uncertainty with dry and wet scenarios.

Integrating this information together defined the hydraulic inputs to the Bank for the ROM Model.

3.2.2.1 Defining Specifications for Recharge and Recovery Years

Recharge and recovery had been defined in the Aquaterra Bank Feasibility Study (MAGSA, 2022). Based primarily on that blueprint and reflecting evolution of the Bank during the design process, recharge years assumed 208,000 AFY deposited into the Bank through recharge basins, and recovery years assumed 148,000 AFY withdrawn from the Bank through recovery wells located above the Corcoran Clay. Details regarding the recharge basins, their acreage and design infiltration rates, and recovery well design and numbers are summarized in Table 1.

Table 1. ROM Model Input Summary.

Description	Specification	Unit
Recharge and Recovery Periods		
Recharge Periods		
Annual Volumes	208,000	AF/Year
Acreage	3480	acres
Infiltration Rates	5	in/d
Months of Recharge	Nov - March	
Number of Months	5	
Recovery Periods		
Annual Volumes	148,000	AF/Year
Number of Wells	88	acres
Pump Rate	2,500	GPM
Months of Recovery	May - Sept	
Number of Months	5	
Climate Scenarios		
Historical + CALSIM		
CALSIM Climate Change Scenarios	1997 - 2015	Water Years
Historical Data	2016 - 2020	Water Years
Wet		
First 12 months Historical Data, Repeated	2x(1997 - 2008)	Water Years
Dry		
Second 12 months Historical Data, Repeated	2x(2009 - 2020)	Water Years

3.2.2.2 Defining Recharge and Recovery Using SWP Allocation Schedule

Periods of recharge were defined by 1) identifying years that could be used in developing an allocation schedule for the Bank, and 2) defining years in which recharge or recovery might occur for that allocation schedule.

Allocation Schedule. A twenty-four-year (24 year) record for recharge and recovery scheduling was developed for this modeling effort under a "Historical" scenario. For this scenario, recharge and recovery periods were developed for a simulation period of water years 1997 – 2020 (using a combination of the CalSim[3] delivery schedule for use in simulations (CDWR 2022) and historical data. CalSIM is a model used for simulating operations of the State Water Project and the Central Valley Project. An allocation schedule based on CALSIM was developed through 2015. The CalSim scenario that included an adjustment for climate change was used for this Project.

Historical State Allocation Schedule 1997 – 2020 using CalSIM and historical data

Future recharge and recovery periods were based on a 24-year historic period (1997 – 2020). Future deliveries from the State Water Project were simulated using CalSim for 1997 – 2015 under current and future climate conditions. Delivery estimates from 2016 – 2020 were based on historical records.

The last five years of the simulation schedule was based upon the historical record. Figure 5 shows the close alignment between the various CalSim delivery schedules and the historical record for the period of 1997 – 2020. Figure 6 shows the combined schedule used to simulate the historical record with an operational adjustment for climate change.

[3] CalSIM is a water allocation model jointly developed and supported by the California Department of Water Resources and the Bureau of Reclamation. CalSim is used to simulate California State Water Project (SWP)/Central Valley Project (CVP) operations. https://water.ca.gov/Library/Modeling-and-Analysis/Central-Valley-models-and-tools/CalSim-II

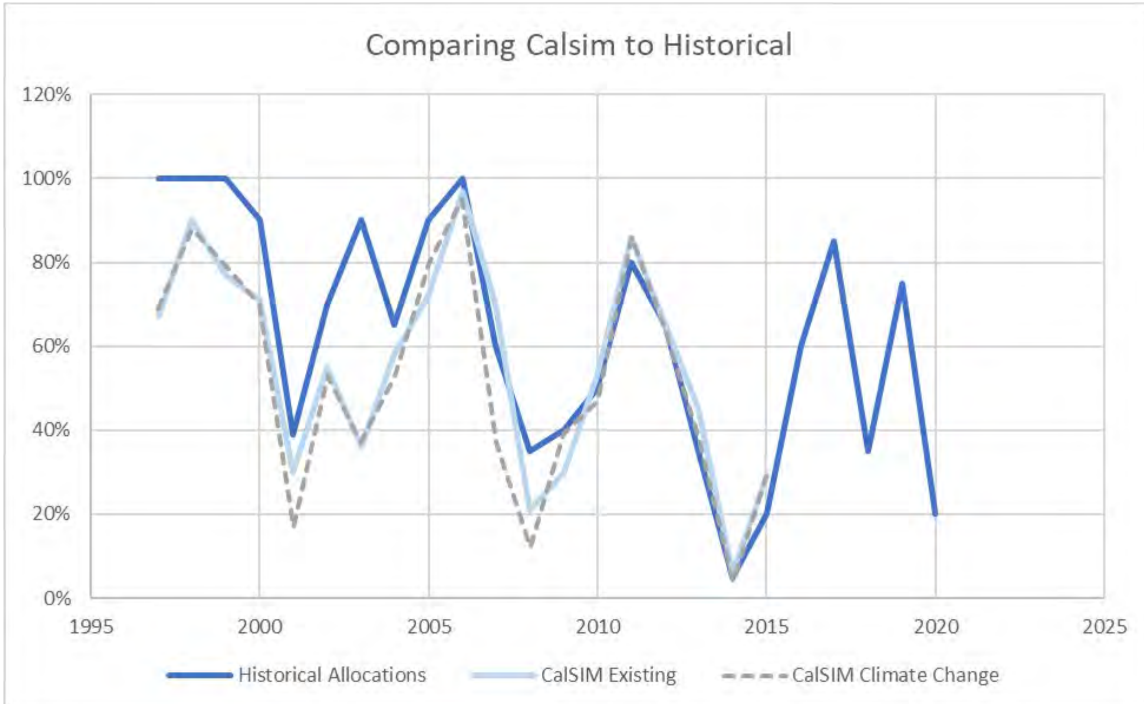


Figure 5. State Water Project allocation schedule for CalSIM model in comparison to the historical allocation.

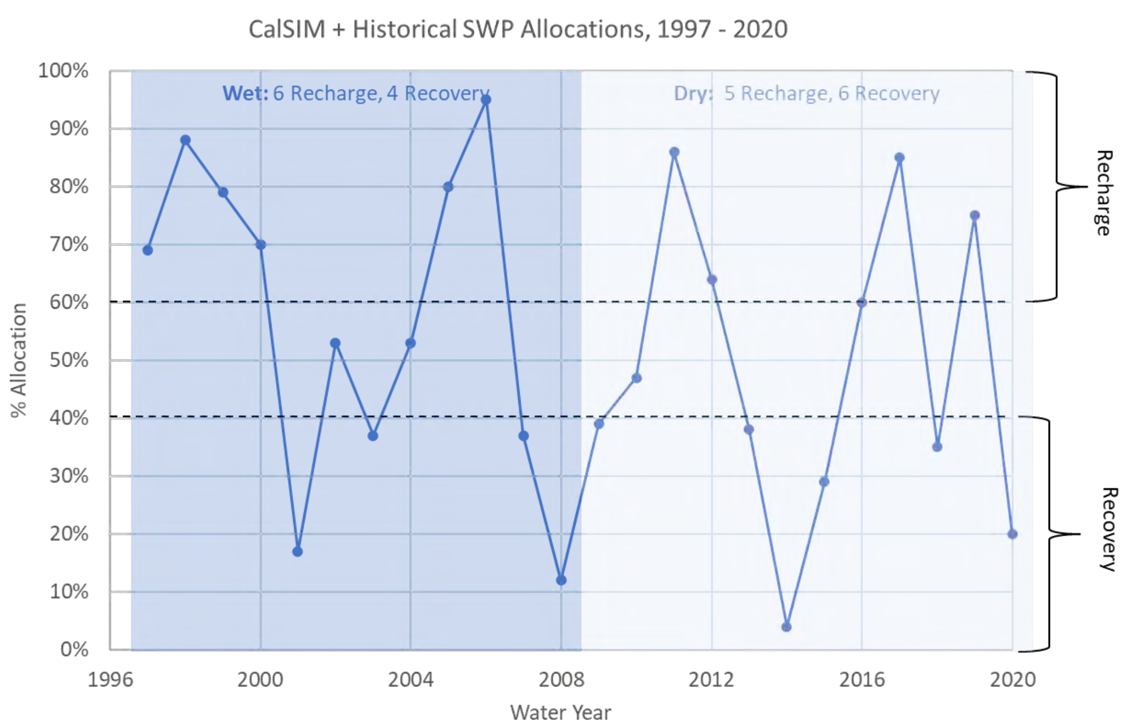


Figure 6. 1997 – 2022 Water Year Modeling Scenario.

Defining years of recharge and recovery within schedule. For the Historical Scenario, we estimated when recharge and recovery might occur based on the SWP allocation schedule percent allocations. CDWR (2022) presents information on "Article 56 carryover requests"[4] from 2021. These requests essentially are the record requests made by agencies in 2021 to store water in surface facilities for additional yeas beyond the current as related to SWP allocations. CDWR's information on these requests provide data that informs the level of allocations that trigger these requests (and could trigger decisions by agencies to store water in the Bank). That table shows at 30%, contractors had minimal interest in saving water through an Article 56 carryover request, that at 60% allocations, the interests are much greater, and the requested total amount begins to potentially exceed storage capacity. At this point, some contract water could be lost by contractors and the Water Projects through spilling of the San Luis Reservoir to accommodate current year runoff. Based on these data, a reasonable case can be made that 60% is a cutoff for when SWP contractors generally would be interested in paying to store water in the Bank.

The trigger for when SWP allocations would suggest pumping groundwater is not as clear from the data. We have estimated that for SWP allocations of 0 – 40%, recovery would occur.

A 40 – 60% SWP allocation defaults to no extractions or recharge at the Bank.

These assumptions for triggering recharge and recovery periods based on the allocation schedule are shown in Table 2. Table 3 shows the resulting recharge and recovery schedule. For the Historical Scenario, recharge occurs 11 years, recovery occurs 10 years and neither occurs 3 years. (Table 3).

Converting Allocation Schedule to Contractor Likelihood to Engage Bank in Recharge of Recovery

For 2021, contractors greatly increased their carryover requests[4] when SWP allocations reached 60%. It is possible that their stored water in San Luis Reservoir could be lost through spilling to allow the reservoir to be able to accommodate current year runoff. Based on these results, we defined 60% allocation as the trigger for contractors to use the Bank to store water. The data is less clear on recovery triggers. We selected 40% as the trigger for recovery from the Bank.

Three Scenarios: Historical, Dry and Wet

The Historical Scenario is characterized by a wet period for the first 12 years and a dry period for the second 12 years. The Wet scenario repeated the first 12 years. The Dry scenario the second.

[4] Each year from water sources available to the project, the State allocates interruptible water to contractors. in accordance with the laws. These allocations cannot be carried over to subsequent years. A "Article 56 carryover request" is a request to store water in State surface water storage facilities for delivery in a subsequent year or years. These requests therefore represent years in which contractors are concerned that there allocated water will be loss from the system through surface water releases.

Table 2. Recharge and recovery periods defined based on SWP allocations.

Scenario	State Water Project Allocation	
	Low	High
Recovery	**0%**	**40%**
No Action	40%	60%
Recharge	60%	100%

3.2.2.3 Dry and Wet Scenarios to Introduce Climate Change Uncertainty

To consider climate change in the model, we developed a “wet” and ”dry” allocation schedule.

In the Historical Scenario, the twenty-four year period can be subdivided into two periods. The first half of the Historical Scenario, the period is wet with six recharge years and four recovery years (Figure 6). The second twelve years reflect a dry period with one less recharge year over the 12-year period (five), and two more recovery year (six).

For the Wet Scenario, we ran the first twelve years twice in succession. For the Dry Scenario, we ran the second twelve years twice in succession. This resulted in each scenario having different numbers of recharge and recovery events (Table 3). Table 4 summarizes the allocation schedules developed for the Historical, Wet and Dry Scenarios.

Table 3. Recharge and Recovery Scheduling Summarized for Different Scenarios

		Wet	Historical	Dry
Scenario Year Types (4)				
	Recharge	12	11	10
	Recovery	8	10	12
	No Action	4	3	2
	Total	**24**	**24**	**24**
Totals Volumes (AF)				
	Recharged (AF)	2,243,921	2,056,721	1,869,521
	Recovered (AF) (2)	1,178,196	1,474,196	1,563,190
	Aquifer Storage (AF) (3)	800,000	582,524	306,331
	Additional Surplus (1)	**265,724**	**0**	**0**
Notes				
	1. Additional surplus could remain in aquifer storage or been used for other purposes			
	2. Recovery managed to avoid overdraft of water bank.			
	3. Aquifer Storage based upon up to 800,000 AF, consistent with average historical scenario			
	4. Year types based on frequeny of SWP deliveries from 1997 - 2020			

Table 4. Allocation schedules developed for the Historical, Wet and Dry Scenarios

Simulation Year	Calendar Year	Historical	Wet	Dry
1	1997	Recharge	Recharge	Recovery
2	1998	Recharge	Recharge	No Action
3	1999	Recharge	Recharge	Recharge
4	2000	Recharge	Recharge	Recharge
5	2001	Recovery	Recovery	Recovery
6	2002	No Action	No Action	Recovery
7	2003	Recovery	Recovery	Recovery
8	2004	No Action	No Action	Recharge
9	2005	Recharge	Recharge	Recharge
10	2006	Recharge	Recharge	Recovery
11	2007	Recovery	Recovery	Recharge
12	2008	Recovery	Recovery	Recovery
13	2009	Recovery	Recharge	Recovery
14	2010	No Action	Recharge	No Action
15	2011	Recharge	Recharge	Recharge
16	2012	Recharge	Recharge	Recharge
17	2013	Recovery	Recovery	Recovery
18	2014	Recovery	No Action	Recovery
19	2015	Recovery	Recovery	Recovery
20	2016	Recharge	No Action	Recharge
21	2017	Recharge	Recharge	Recharge
22	2018	Recovery	Recharge	Recovery
23	2019	Recharge	Recovery	Recharge
24	2020	Recovery	Recovery	Recovery
Recharge		11	12	10
Recovery		10	8	12
Both		0	0	0

3.2.2.4 Summary Built Scenarios

Three input scenario schedules resulted from this process above: Historical, Wet and Dry. For years in which recharge was planned from the schedule, maximum recharge was input into the model (Table 1), distributed across months evenly and across all the basins. For years in which recovery was planned from the schedule, extraction was distributed evenly across pumps and months. An exception occurred based upon the status of water storage in the model. If the running total of stored groundwater has dropped below zero, recovery was not conducted with the assumption that the Bank will need to operate in compliance with SGMA.[5]

[5] Under SGMA and management for sustainable groundwater, groundwater levels and volumes are generally required to not decrease.

3.3 Recharge Basin and Recovery Well Spatial Distribution

In Figure 1, recharge basin and groundwater wells were laid out in accordance with the current Project design as of March 2023. The design decisions regarding the placement of recharge basins and recovery wells were based on a number of strategies and objectives as discussed below.

3.3.1 Recharge Basins

Recharge basins were distributed according to a number of objectives and strategies.

- **Distribute Recharge Zones evenly through the eastern areas of MAGSA.** The Aquaterra Feasibility Study identified five recharge zones (MAGSSA 2022). Recharge basins were distributed across those five zones. These zones are generally in the eastern areas of MAGSA. Groundwater moves towards the southwest and to the south, so these areas represented zones upgradient of the rest of MAGSA. The distribution within each zone targeted approximately 10% of the available acreage. The relatively even distribution was to limit the aggregating of basins (and associated recovery wells) that could potentially increase groundwater mounding and depressions.

- **Limit Far Eastern Placement of Recharge Basins.** Recharge basins, particularly in Recharge Zone 5, were placed away from the eastern edge of MAGSA over concerns of recharge water moving eastward outside of MAGSA.

3.3.2 Recovery Wells

Recovery wells were distributed according to a various objectives and strategies.

- **Well design determined number of recovery wells.** The typical recovery well was planned for a pump rate of 2500 GPM. Based upon that pumping rate and the target recovery for the Project, approximately 90 recovery wells are required (Table 1).

- **Local Strategy for Recovery Wells.** Recovery wells were placed downstream of recharge basins and

Recharge Basin and Recovery Well Distribution Strategies

Recharge basins were distributed relatively evenly across five recharge zones upgradient of the rest of MAGSA along the groundwater flow gradients. The even distribution was approximately about 10% the area of each zone with the goal to limit groundwater mounding and depressions from recharge and recovery wells. Basins were also generally not placed along the very eastern edges of MAGSA to limit recharge water spread east outside of MAGSA's borders.

Recovery wells were placed under a local and a regional strategy. The local strategy was to recover recharged water at a given basin. We assumed that not all recharged water would be recoverable at that location due to large groundwater gradients during recharge pushing water beyond the area the recovery well would service. The regional strategy was to place wells to either 1) reinforce flow gradients downstream of recharge basins in order to capture the groundwater that had escaped from upstream basins recharge/recovery systems; or 2) hinder flow gradients to limit movement of recharged groundwater further downstream.

complexes. The locations are generally at the southeast corner of the basin(s). About two thirds of the recovery wells were placed under this local strategy, with one recovery well per basin.

- **Regional Strategies for Recovery Wells.** Some infiltrated water at every recharge location will likely be outside the recovery for each local well due to gradients during recharge driving this groundwater eastward. Under the regional strategy, recovery wells were placed to enforce or dampen groundwater flow paths. In some areas, recovery wells were located along expected groundwater flow paths to capture recharged water no longer within the local recovery zone of a recharge basin or complex. In other cases, recovery wells were placed perpendicular to flow paths to hinder the movement of recharged water to an undesirable location. This general strategy was to direct groundwater flow to meet banking objectives. About one third of wells were placed under the regional strategy.

3.4 Key Limitations

In understanding the construction and assumption of the ROM Model, two key limitations affect outcomes.

3.4.1 One-Size Fits All: Maximum Deliveries and Withdrawals

Hydraulic inputs based on recharge and recovery schedules (Table 4) assume maximum conditions of both recharge and recovery (Table 1). Thus, groundwater mounding, elevation swings and depressions are maximized at each recharge location and occur uniformly throughout MAGSA. This assumption maximizes the hydrologic inputs and the system response, and limits management opportunities. A more realistic expectation is more tempered: e.g.:

- Not all recharge basins and recovery wells are engaged all the time;
- In some years, recovery or recharge are not maximized;
- Recharge and recovery efforts will be distributed according to management needs, operations strategies, and monitoring data; and
- All basins and wells will be operated according to their characteristics, design, and capacities.

The modeled scenarios with maximum recharge and recover conditions yield maximum hydrologic effects with no management and operational flexibility.

ROM Model Assumptions and Limitations

This modeling exercise has three key limitations.

1. It has a one-size-fits-all approach during scheduled years of recovery and recharge. This approach exaggerates hydrologic effects from recharge and recovery actions and underestimates opportunities associated with management and planning.
2. It does not incorporate baseline groundwater contours, exaggerating groundwater response upgradient and the opposite downgradient.
3. Model parameters (e.g., hydraulic conductivity) used in the model can vary by percent to orders of magnitudes. All calculations have uncertainty.

3.4.2 Does Not Include Baseline Groundwater Contours

The ROM Model uses foundational data such as stratigraphy and 3D heterogeneous aquifer properties from the well-calibrated CVHM model but does not include baseline groundwater conditions that can only be modeled properly by including all historic and future hydrological stresses. Figure 7 shows that depth to groundwater greatly varies through MAGSA, with groundwater elevations typically dropping 100 ft from the north and from the east to the southwestern corner of MAGSA. The simulated groundwater level effects by the ROM model from recharge or recovery operations are not constrained by this background groundwater flow conditions within and adjacent to MAGSA area. The ROM model is likely to exaggerate the hydrologic effects upgradient. Downgradient, the ROM model may underestimate the hydrologic effects.

This ROM model approach has been taken out of necessity because calibrating and validating a full model is beyond the scope and resources of this investigation and analysis. In interpreting results, we have incorporated into our analysis consideration of this design limitation of the model as it relates to real-world outcomes.

3.4.3 Uncertainty

The ROM Model inherits the soils and conditions from the CVHM model. These foundational data is a calibrated and validated dataset that provides a reasonable modeling foundation.

The ROM model predicts changes in groundwater elevations and mounding. These numbers depend upon the underlying parameters used for the various variables (e.g., hydraulic conductivity, water storage, field capacity). Some of these variables vary by percent (e.g., field capacity, water storage) and others can differ by orders of magnitude (e.g., saturated hydraulic conductivity). Thus, all findings from the modeling effort are estimates that include uncertainty.

3.4.4 Ideal Findings and Usefulness in Identifying Trends

In considering the above assumptions and resulting uncertainties and interpretations, we discuss the results as "ideal"; e.g., ideal changes in groundwater level, ideal groundwater elevations. This terminology is incorporated to acknowledge the model limitations and recognize that results likely stray from reality in their magnitudes and numeric values. Importantly, the ROM Model does not include prevailing groundwater gradients that may alter groundwater flow paths from recharge or recovery activities.

Thus, the model results need to be placed in context with their limitations. Context is included in discussions and interpretations of model results. Importantly, the ROM Model is constructed with a data set from the rigorously calibrated and validated CVHM model developed by USGS and incorporates the full suite of driving physical and hydrologic processes. Thus, though the exact numbers have uncertainty, the underlying processes driving the model do not.

"Ideal" results and certain physics

The calculations from this effort are termed "ideal", recognizing that each calculation has uncertainty even though the data and parameters used in constructing the model are reasonable. Importantly, the model also incorporates known physical and hydrologic processes. Thus, though the model results are "ideal", the underlying processes and trends are known.

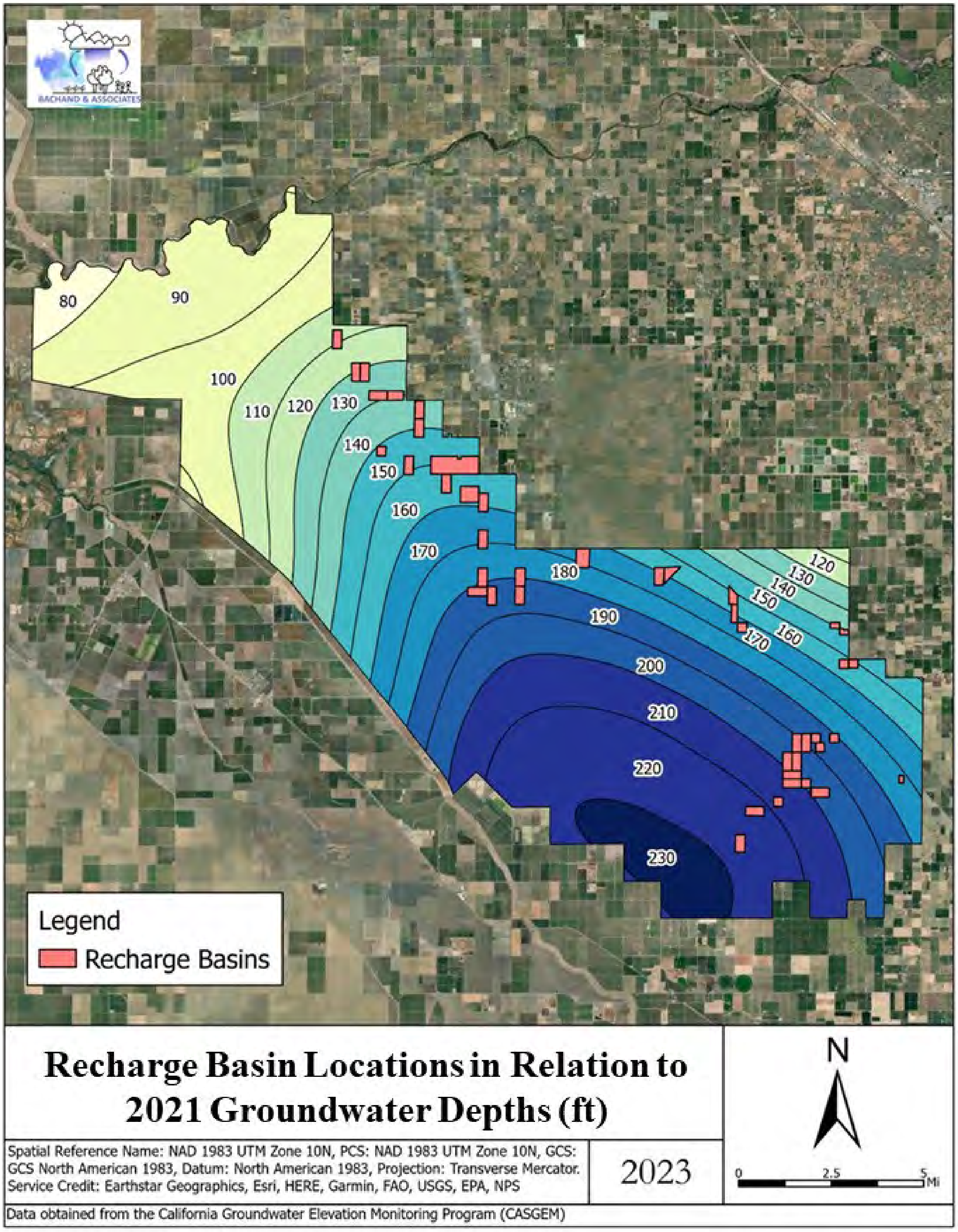


Figure 7. Depths to Groundwater

Depth of groundwater is provided through DWR SGMA data portal (CDWR 2021)

II. ROM Model Results and Analysis

4 Spatial Analysis Results

The spatial analysis represents the ideal groundwater levels and elevations predicted by the ROM Model. The analysis includes 1) hydrology associated with recharge, 2) hydrology associated with recovery, 3) groundwater responses throughout the simulation period, 4) effects of the different scenarios on groundwater responses and 5) superposition of results onto the underlying 2021 groundwater elevations.

Results and Analysis

Model data was analyzed using spatial analysis, hydrographs and flux. Findings are given with consideration of the model limitations.

4.1 Hydrology of Recharge

The ideal groundwater hydrologic response to recharge is presented in this report for specific water years modeled with the ROM Model. These model years represent different baseline conditions (Table 4):

- The 1999 Water Year (October 1998 – September 1999) represents a wet period in which the model allocation schedule implements recharge over four consecutive years. The 1999 Water Year is the third of the four years.
- The 2016 Water Year represents a dry period in which recharge occurs after three consecutive dry years in which recovery was implemented.

Both presented examples are for the model simulation using Historical Scenario inputs, representing bookend scenarios of recharge during a series of wet years and during a series of dry years.

4.1.1 1999 Water Year Simulation, Recharge during a wet period, Historical Scenario

The 1999 water year simulation begins in October with ideal water levels slightly elevated throughout MAGSA due to previous recharge years, up to fifteen feet above baseline groundwater conditions (Figure 8a). December represents the second month of recharge (Table 1) and ideal water levels below the recharge basins raise up to 100 feet above baseline groundwater levels, with maximum increases underlying the recharge basins (Figure 8b). High water levels continue through February and April, with groundwater mounds widening. By April, areas with ideal groundwater levels more than 30 feet above baseline elevations are four to five miles wide in places. Areas in which groundwater elevations are more than 45 feet above baseline elevations are an estimated two to three miles wide (Figure 8d). These effects are greatest where recharge basins are most dense, along the eastern spine of MAGSA and in the southeast area.

The recharge basins along the eastern spine push recharge water outside of MAGSA to the east, as represented by modeled elevated ideal groundwater levels east of MAGSA in February and April (Figure 8c and d).

With the end of recharge, ideal groundwater levels decline from their highest heights, though near the end of the water years, ideal groundwater levels greater than 30 feet above baseline elevation are still extensive along MAGSA's eastern spine. During this post recharge period, groundwater mounds decline and widen. This effect results in groundwater mounding extending slightly more eastward outside of MAGSA with ideal groundwater fifteen to 30 feet above baseline conditions.

The 1999 water year represents the period in which the greatest modeled increases in ideal groundwater levels occur. At the beginning of the water year, groundwater effects, mostly increases in groundwater levels, were primarily within MAGSA's region. By the end of the water year, increases in ideal groundwater elevations, though relatively small (i.e., 1 – 15 ft) extend a mile to a few miles outside of MAGSA. It is important to note that the ROM model results likely exaggerate groundwater mounding east of MAGSA because it does not account for prevailing groundwater flow pushing toward the west and southwest.

4.1.2 2016 Water Year Simulation, Recharge after a dry period, Historical Scenario

The 2016 water year simulation was the sixteenth year of the simulation period. The 2016 Water Year represents a wet year after three consecutive dry years with groundwater extraction. With the water years starting in October, Figure 9 presents groundwater conditions beginning in October (2015), at the beginning of the recharge period, through August (2016).

The spatial range of the area affected by groundwater mounding is slightly less than the area shown at the end of the 1999 water year simulation. Unlike the 1999 Water Year, when water levels started out elevated from previous recharge, the 2016 water year begins with lowered groundwater elevations in and east of the lower half of MAGSA. Groundwater below that area is one to fifteen feet below baseline groundwater elevations due to dry conditions and recovery of groundwater from the Bank.

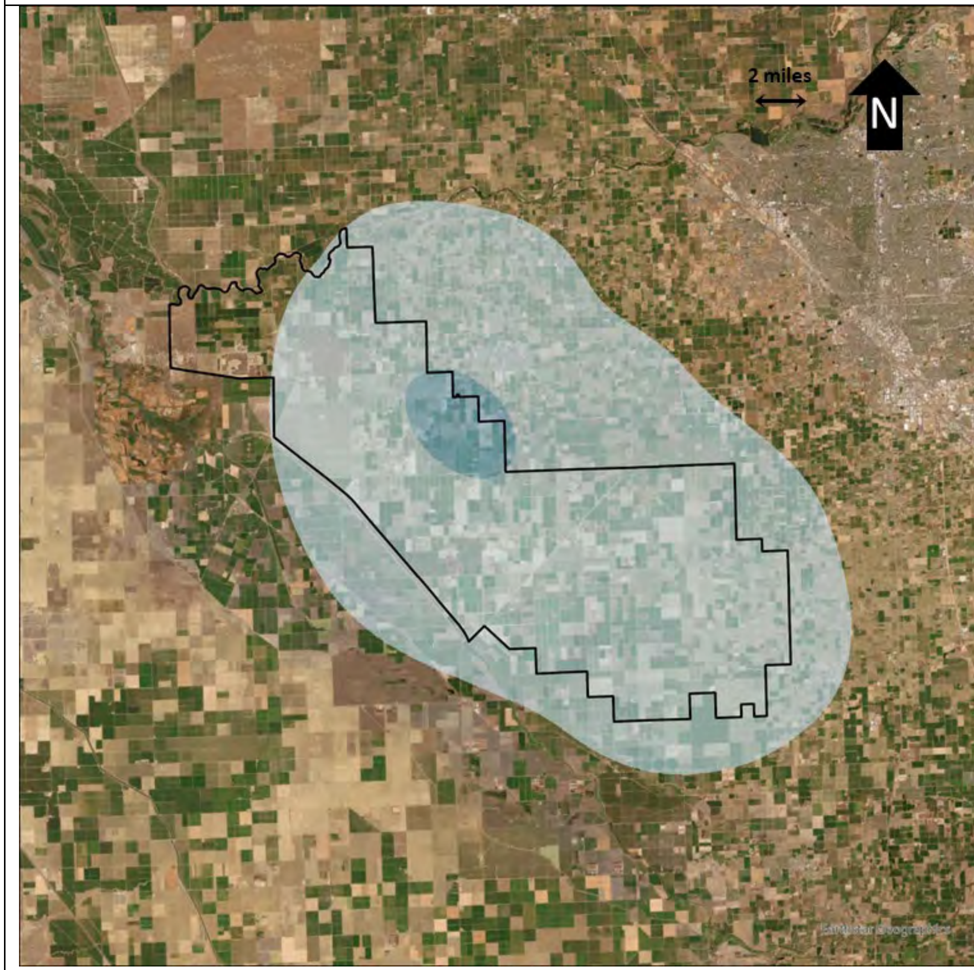
As with the wet period simulation, groundwater levels near the recharge basins increased, starting in December and further increasing into February. The trend continues into

"Ideal" Spatial Effect from Recharge

The hydrology of recharge is similar during extended wet and dry periods. Under recharge, ideal groundwater levels underlying and near basins can rise 100 feet above baseline conditions at some locations. These conditions persist as long as recharge occurs. As the recharge season persists, groundwater mounds widen. Areas where basins are aggregated result in large regional mounding across the recharge complex. These "ideal" groundwater responses (in the absence of ambient background groundwater gradients) extend wide. After recharge ends, the groundwater mounding relaxes with groundwater levels more evenly distributed and extensively spread. During wetter periods, the areas with elevated "ideal" groundwater levels are broader and more uniform than during drier periods. The lack of an ambient background groundwater gradient results in the model showing groundwater spreading relatively the same in all directions around the MAGSA footprint of recharge basins.

April with also a widening of the area affected extending about a half mile out (Figure 9c,d). Those groundwater mounds decline in elevation and spread similar to the model depictions for the 1999 Water Year (Figure 9e,f). By the end of the water year simulation, groundwater levels along the eastern spine have recovered to near baseline groundwater elevations in response to recharge (Figure 9f), with any elevated water levels within fifteen-feet of baseline.

A. October 1998



B. Dec 1998

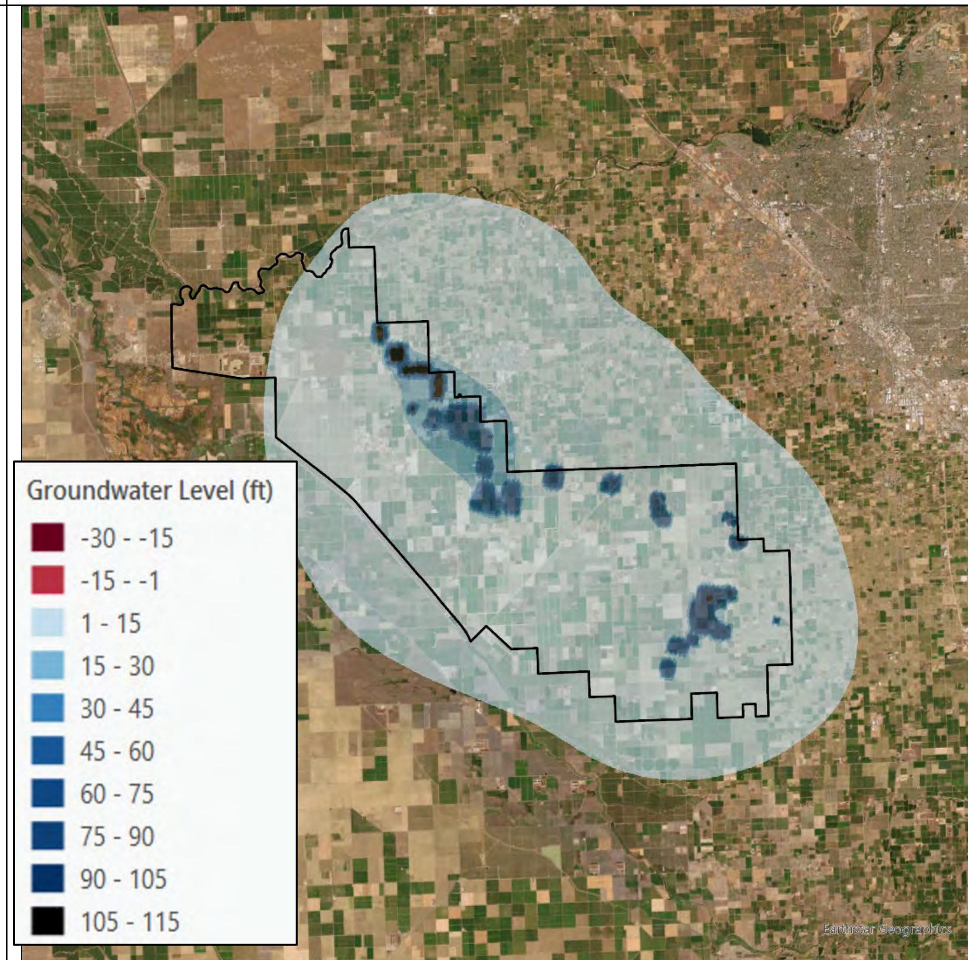


Figure 8. Recharge Year in a Wet Series of Years (third of four consecutive recharge years; 1999 Water Year)

C. February 1999 D. April 1999

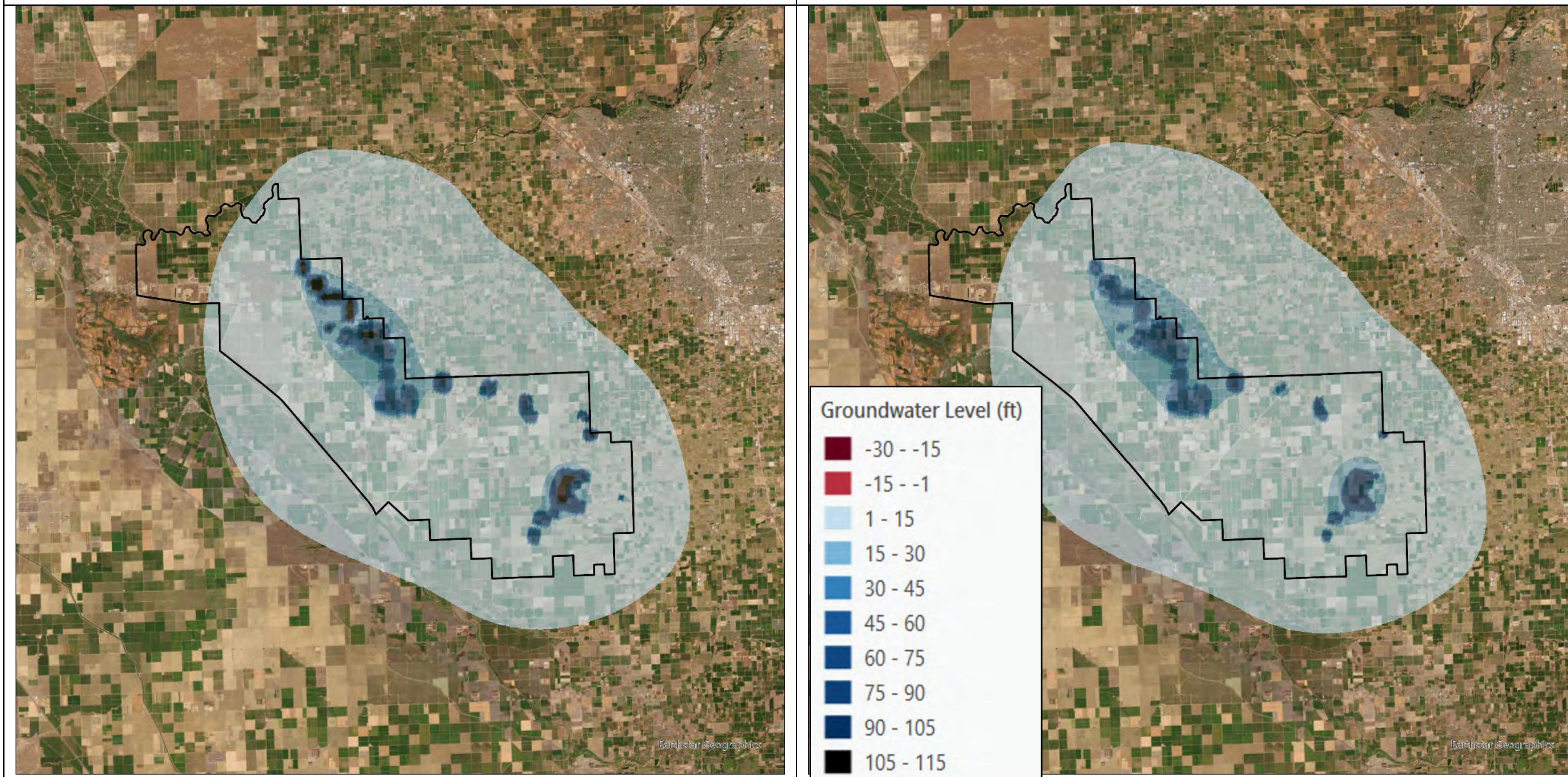
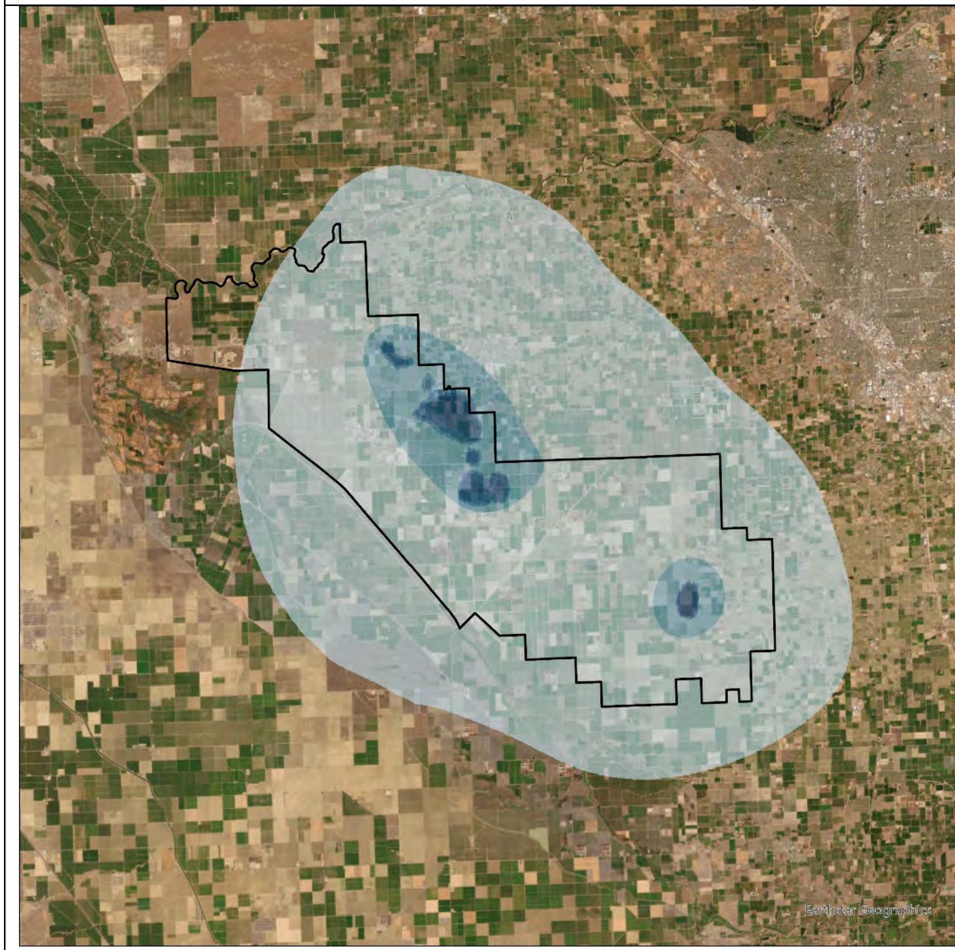


Figure 8. Recharge Year in a Wet Series of Years (third of four consecutive recharge years; 1999 Water Year) *(continued)*

E. June 1999



F. August 1999

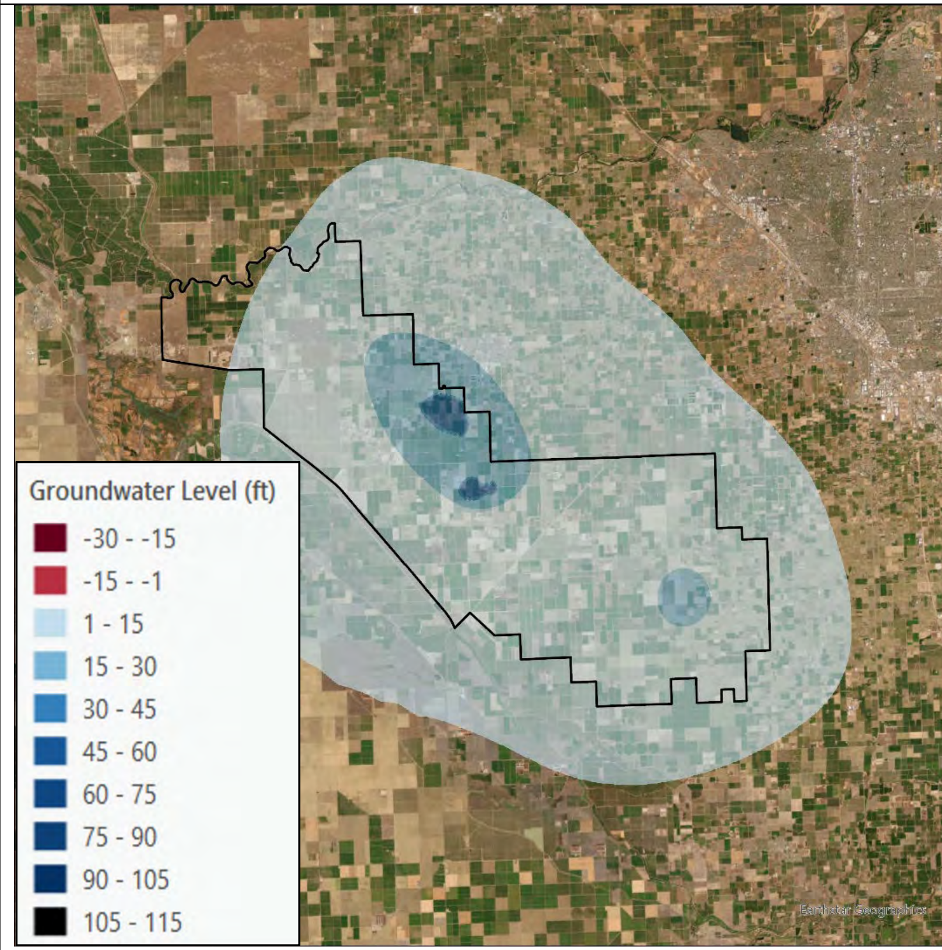


Figure 8. Recharge Year in a Wet Series of Years (third of four consecutive recharge years; 1999 Water Year) *(continued)*

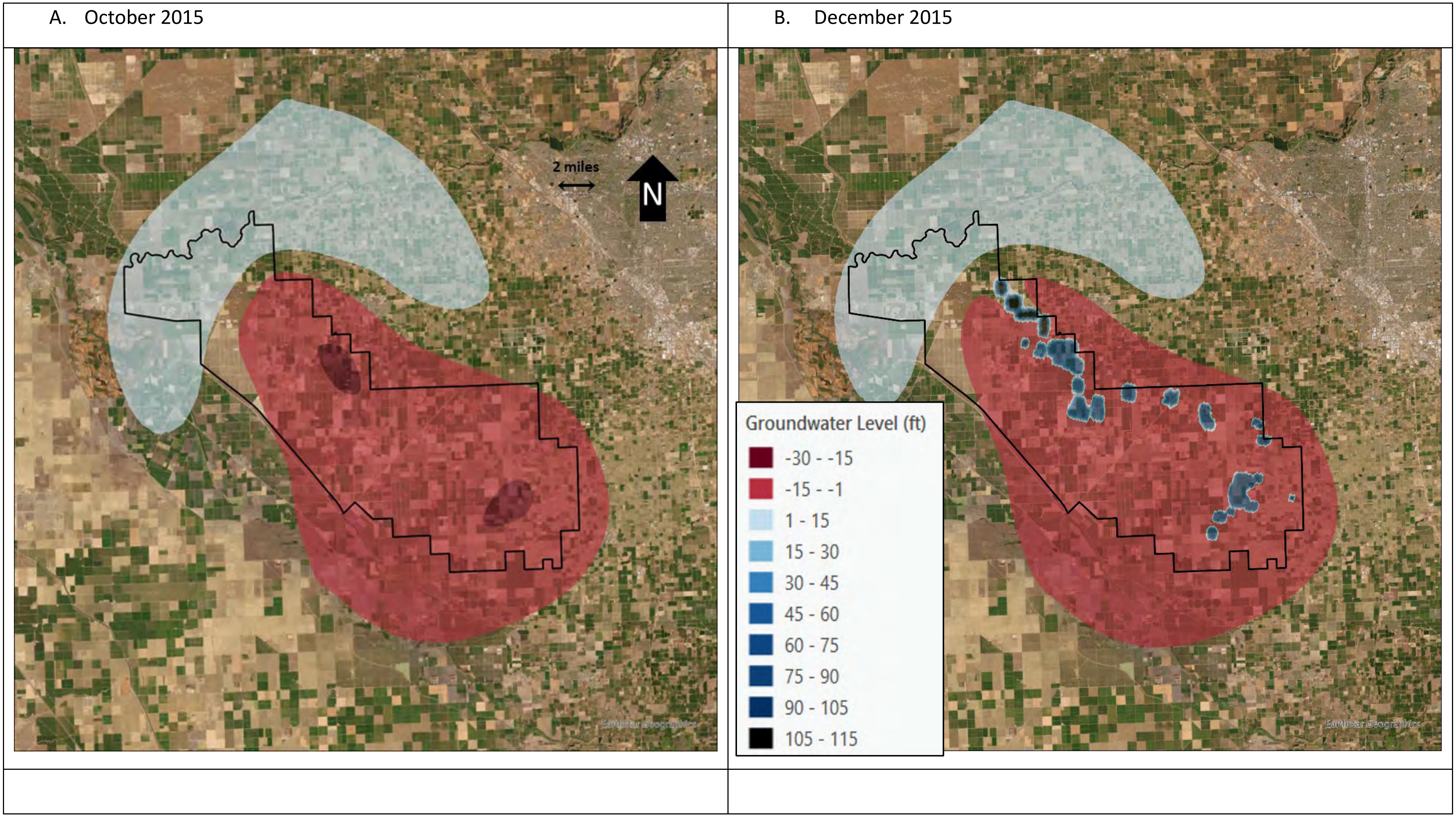
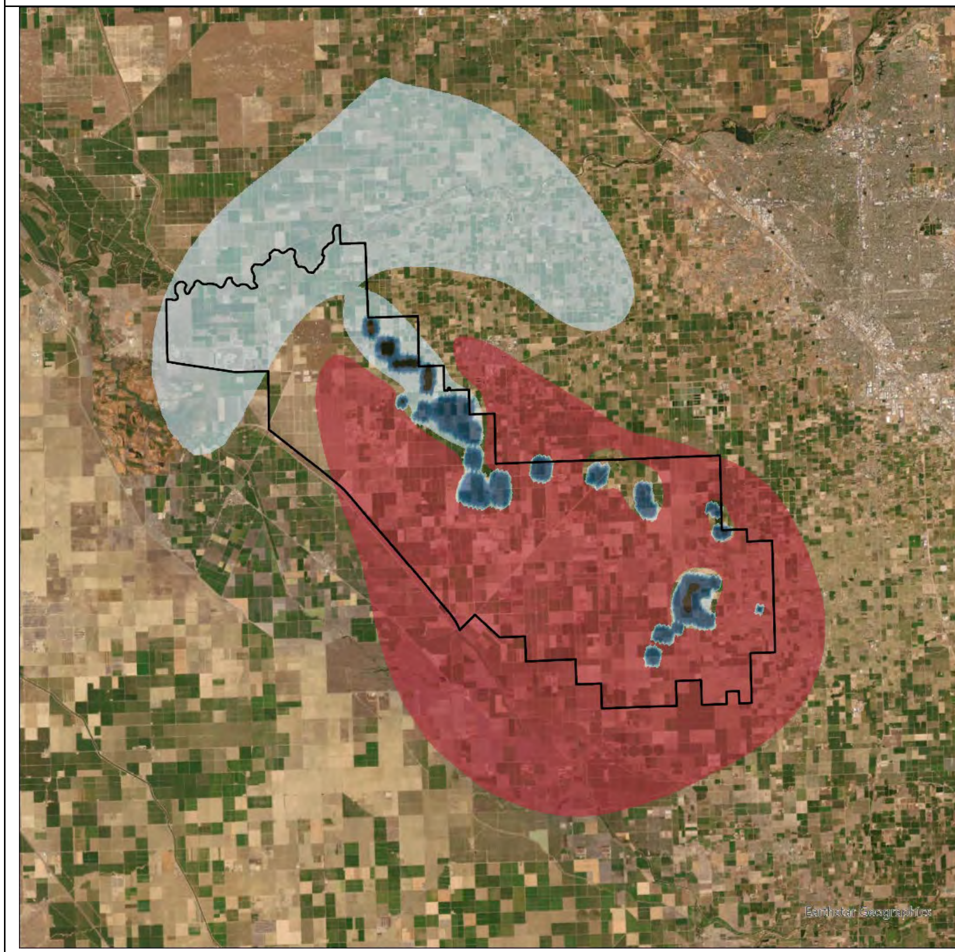


Figure 9. Recharge Year in a Dry Period (First year after three successive dry, recovery years, 2016 Water Year)

C. February 2016



D. April 2016

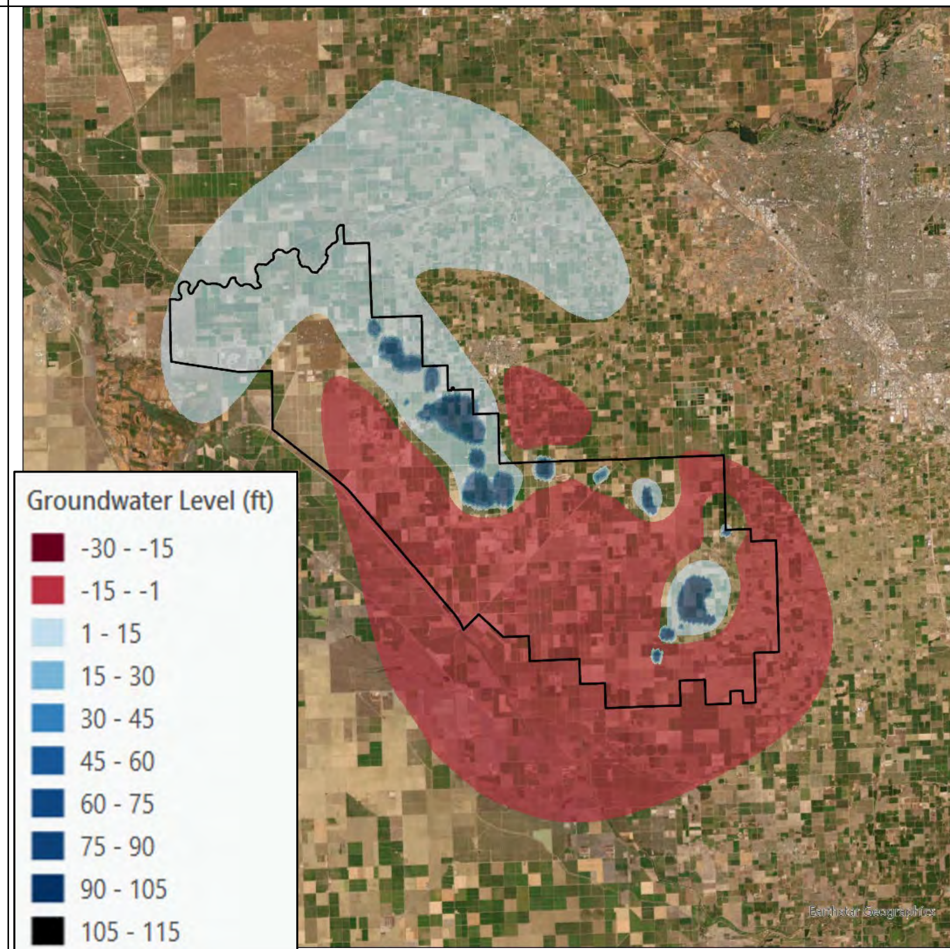


Figure 9. Recharge Year in a Dry Period (First year after three successive dry, recovery years, 2016 Water Year) *(continued)*

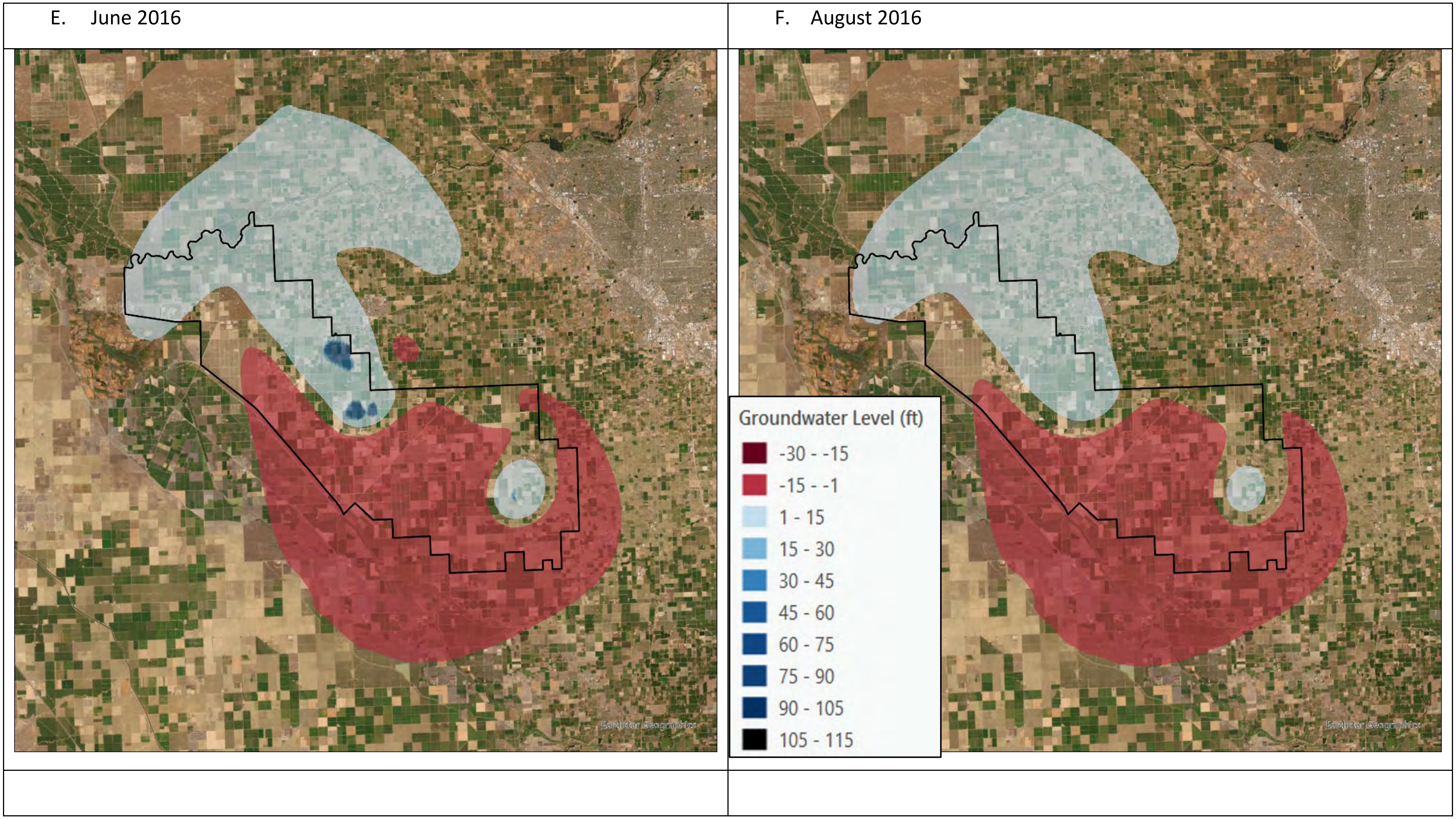


Figure 9. Recharge Year in a Dry Period (First year after three successive dry, recovery years, 2016 Water Year) *(continued)*

4.2 Hydrology of Recovery/Extraction

The ideal groundwater hydrologic response to recovery is presented in this report for different water years representing different baseline conditions (Table 4):

- The 2008 Water Year (October 2007 – September 2008) represents a generally wet period with recovery occurring for the second consecutive year after a period of twelve years in which over half were wet.
- The 2015 Water Year represents a dry period, being the last of three consecutive dry years.

Both examples are for a model simulation using Historical Scenario inputs and represent bookend scenarios of recovery during generally wetter and drier conditions.

Unlike the recharge examples that begin and end with a water year, these recovery examples begin in December near the end of the recharge period and extend through October beyond the end of the recovery period. Thus, each recovery simulation spans from the middle of one water year to the middle of the next.

"Ideal" Spatial Effect from Recovery

Groundwater responses to recovery (extraction) are more gradual than to recharge: groundwater depressions are less dramatic than groundwater mounds; spreading of groundwater effects are slower in time, and effects from recovery show up much later. These effects could be due to the greater number of recovery points (more wells than basins) and less extreme changes in head.

4.2.1 2008–2009 Water Year Simulation, Extraction after a wet period, Historical Scenario

The ROM model depicts for April most of the MAGSA area and well outside of MAGSA having groundwater levels one to 15 feet above baseline levels (Figure 10a). Unlike periods in which recharge is the focus, groundwater level changes during the extraction period are more gradual. For instance, steep groundwater mounds form under recharge basins during infiltration periods (Figure 8, Figure 9), but groundwater depressions at extraction wells do not appear in the spatial depiction (Figure 10b,c,d). The groundwater effects are subtle; the eastern half of MAGSA has modeled ideal groundwater levels above baseline conditions in April before recovery has begun (Figure 10a) and by August, the same area is slightly below baseline (Figure 10C). Those groundwater depressions generally persist through December and into the following February (Figure 10e,f).

4.2.2 2015 Water Year Simulation, Extraction after a dry period, Historical Scenario

Ideal groundwater level conditions at the beginning of this model period (April 2014) reflect the previous drier period, with ideal groundwater levels slightly depressed through the lower half of MAGSA (Figure 11a) and below the slightly elevated groundwater conditions depicted for April 2008 (Figure 10a) The ROM model depicts similar groundwater changes in both wet and dry scenarios. Ideal groundwater levels are depicted as declining in June and August with the region of depressed groundwater growing

(Figure 11b,c). Subsequently, groundwater contours throughout the modeled area generally stabilize with little changes from October through the following February (Figure 11d,e,f).

All these within-year trends are evident and similar through both water year simulations (Figure 10, Figure 11). The main difference between the wet and dry period extraction results are due to differing initial baseline conditions before beginning extraction. The 2008 – 2009 simulation begins with higher groundwater levels in April 2008. Extraction leads to areas that previously had groundwater elevations above baseline conditions in April to having groundwater elevations depressed below baseline conditions by February the next year (Figure 10). The area of depressed groundwater is generally restricted to within the lower south half of MAGSA. The 2014 – 2015 simulation begins with lower groundwater conditions at the beginning of the recovery period in April 2014 and result in lower groundwater elevations at the end of recovery when compared to groundwater elevations across the 2009 – 09 simulation period.

Recovery well pulls less than Recharge

At the end of a recovery (extraction) period, the model typically depicts the region with elevated "ideal" water levels more expansive than the region with lowered "ideal" groundwater levels. This outcome tells us the recharge basins more effectively push groundwater out laterally than recovery wells pull it back.

A. April 2008

B. June 2008

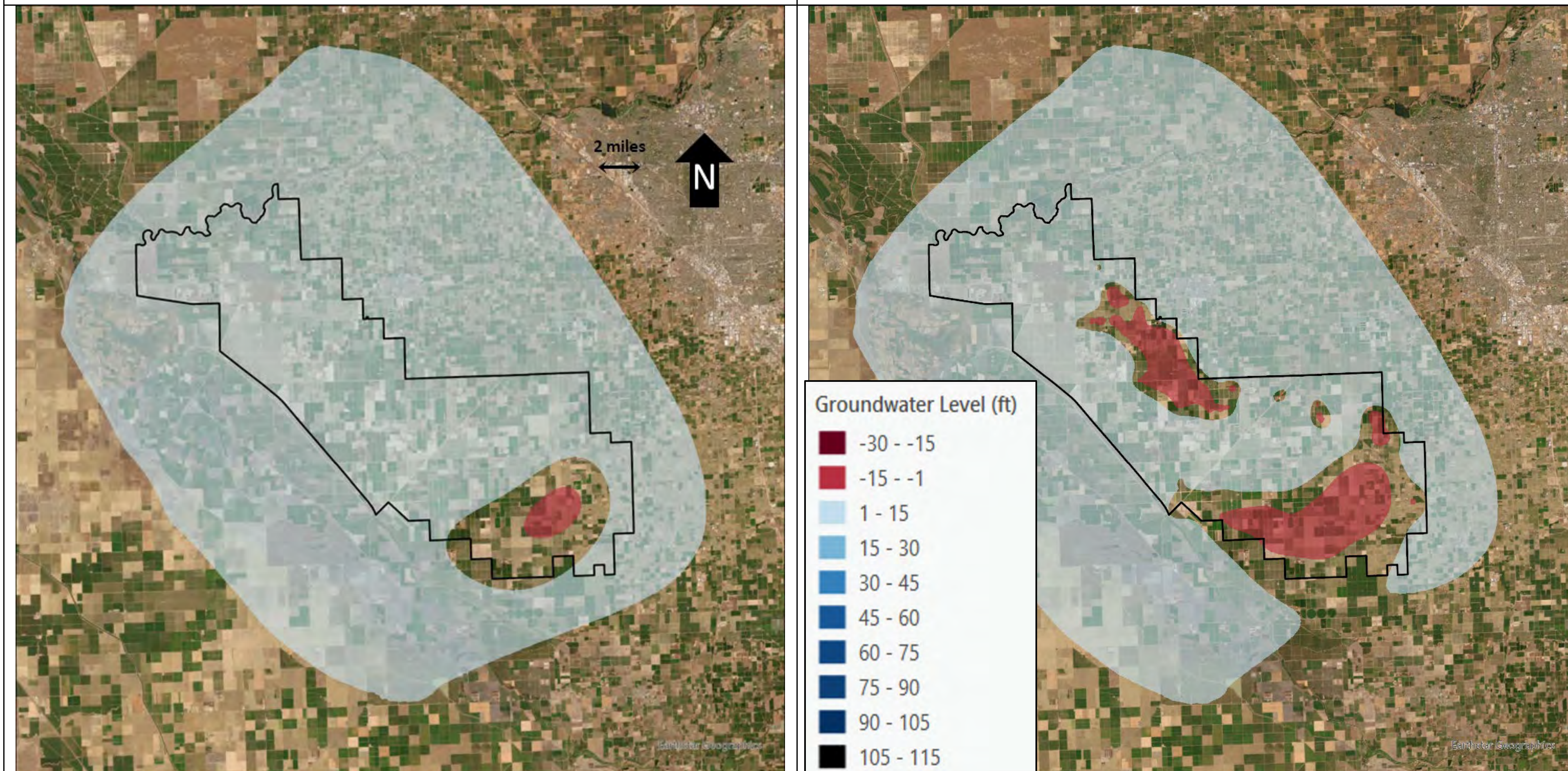


Figure 10. Recovery Period after wet decade (2008 – 2009 WY)

C. August 2008

D. October 2008

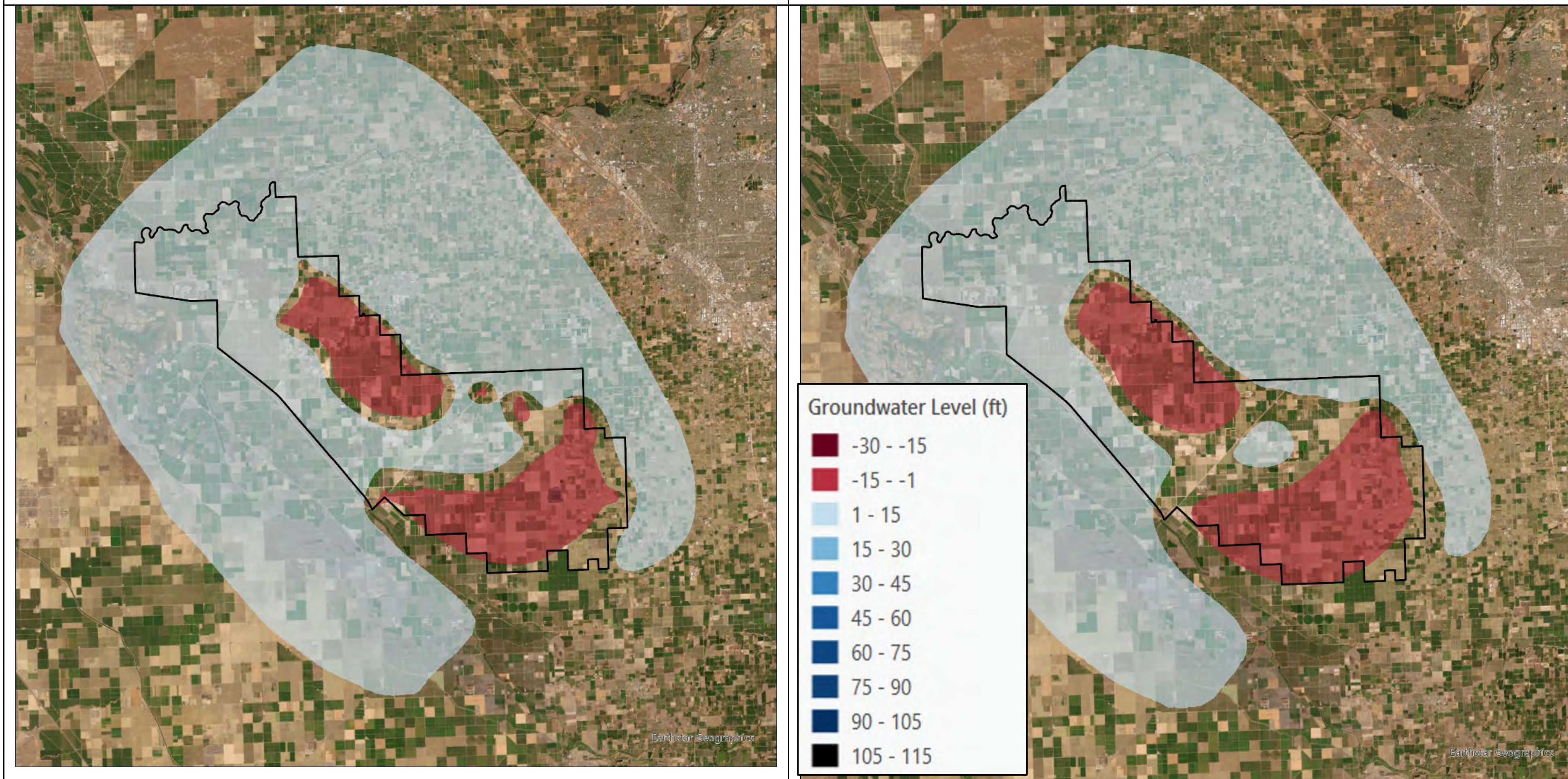
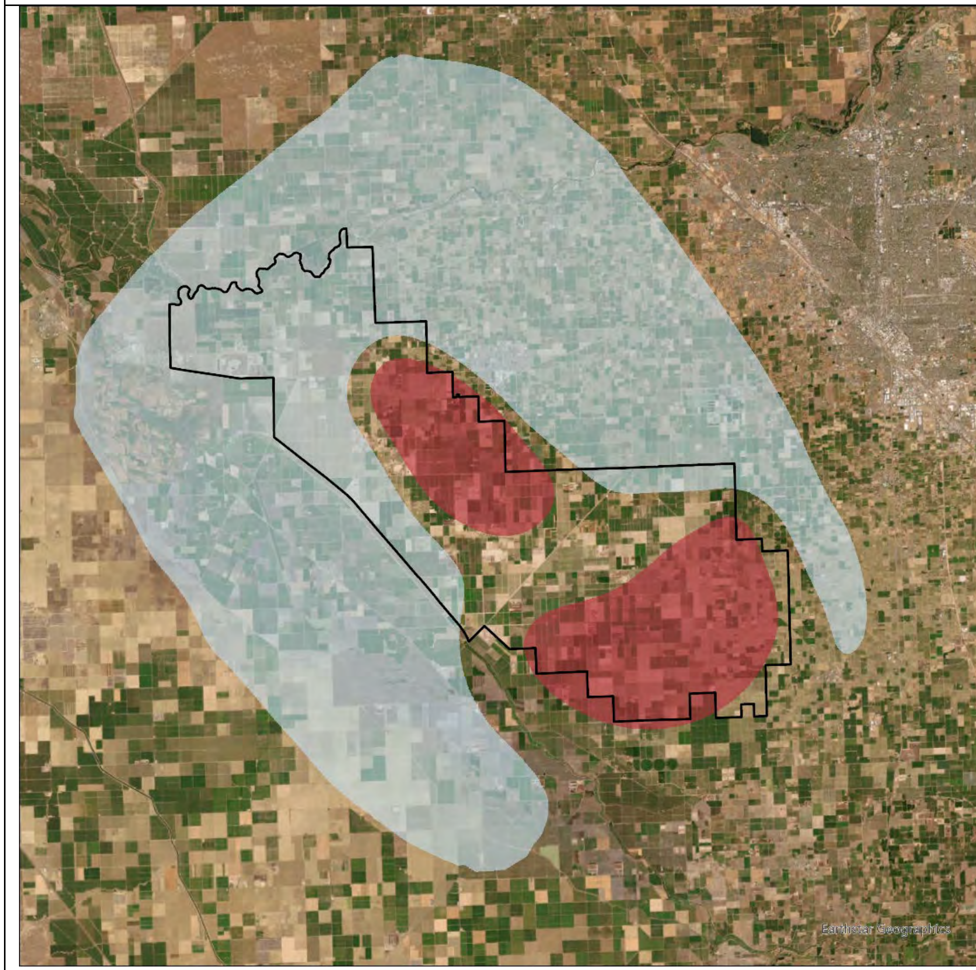


Figure 10. Recovery Period after wet decade (2008 – 2009 WY) *(continued)*

E. December 2008



F. February 2009

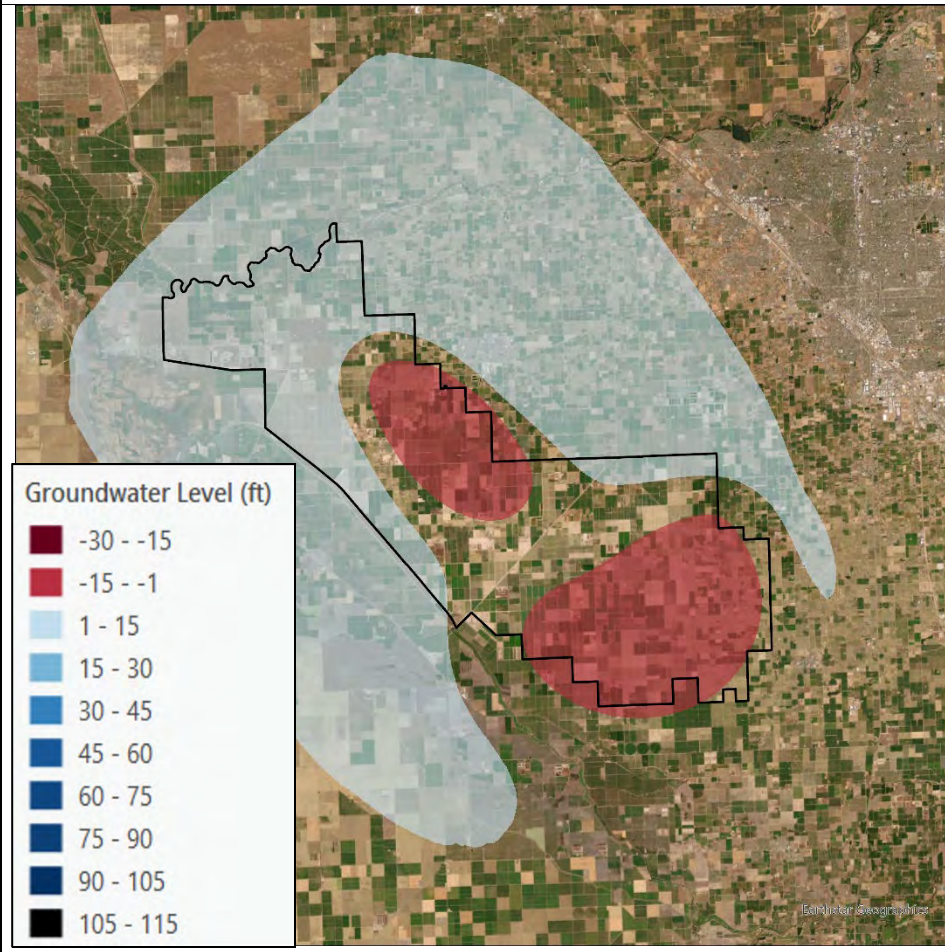


Figure 10. Recovery Period after wet decade (2008 – 2009 WY) *(continued)*

A. April 2014	B. June 2014

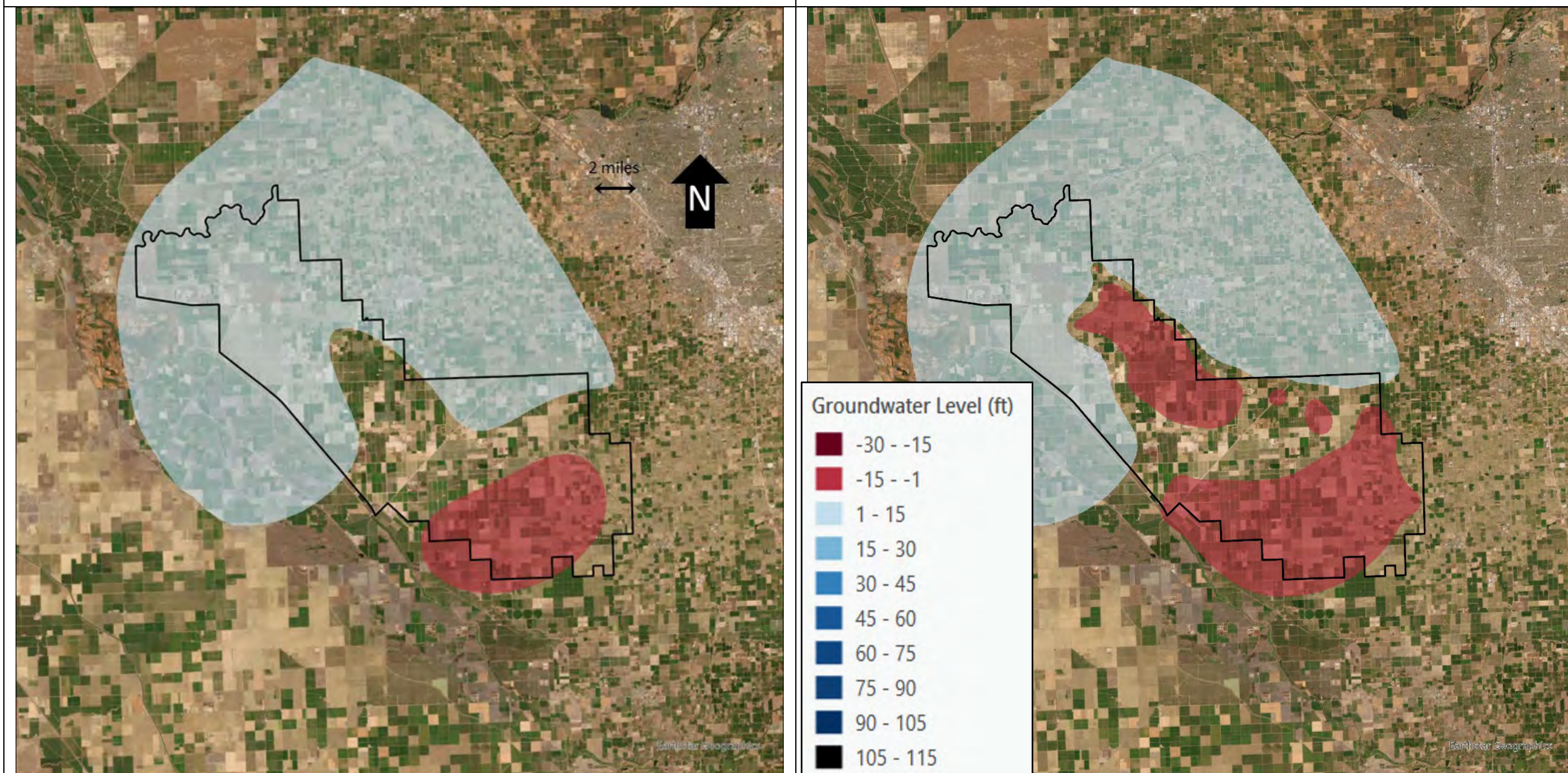
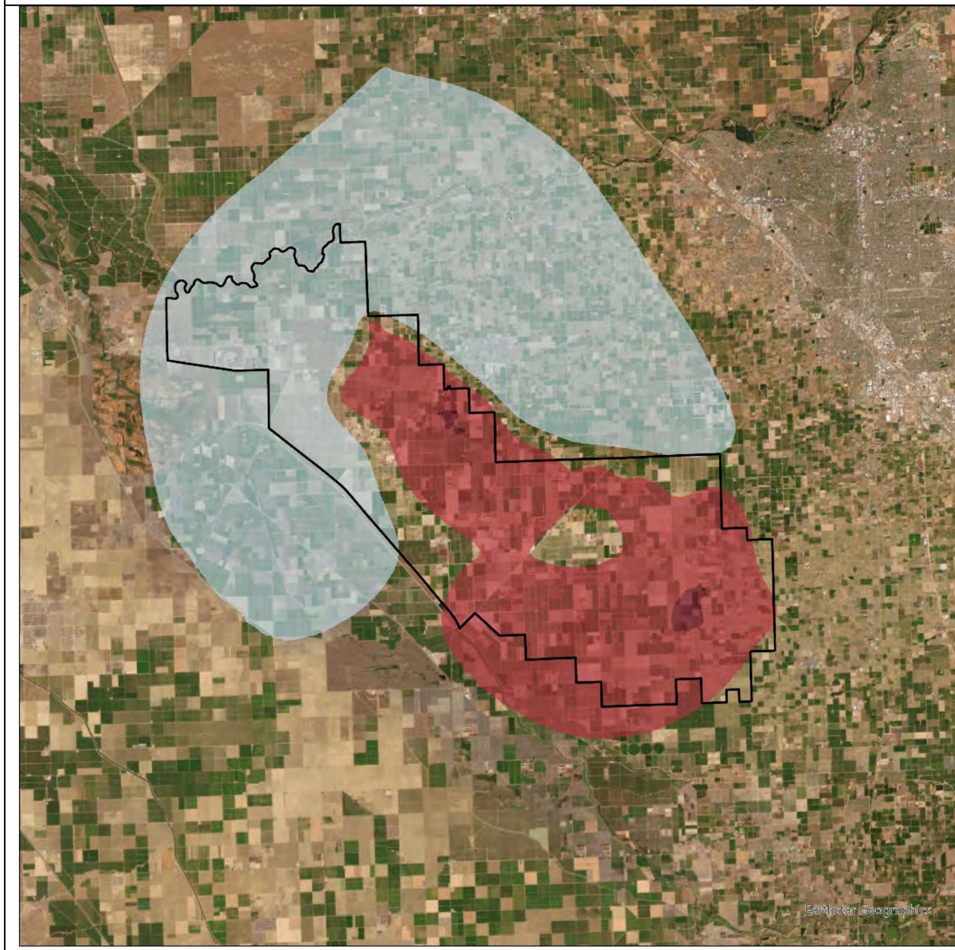


Figure 11. Recovery Year in Dry Period (Second of three consecutive dry years, 2015 - 2016 Water Year)

C. August 2014



D. October 2014

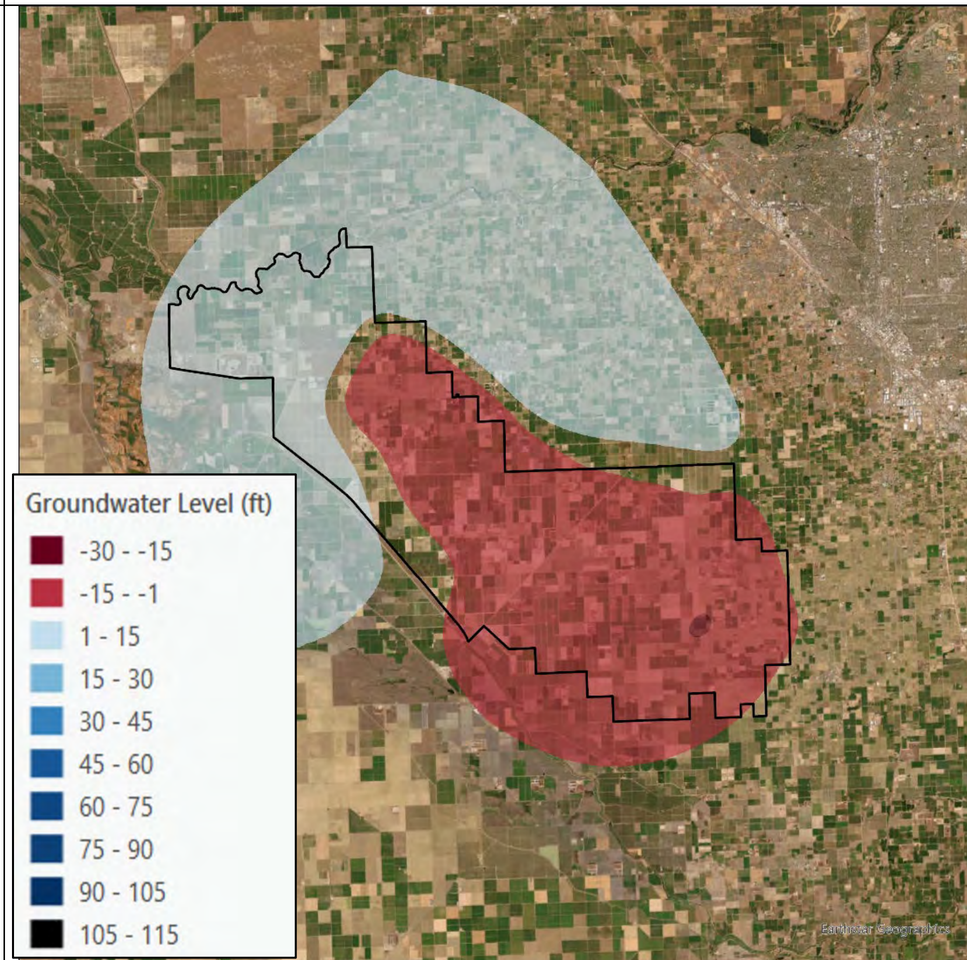
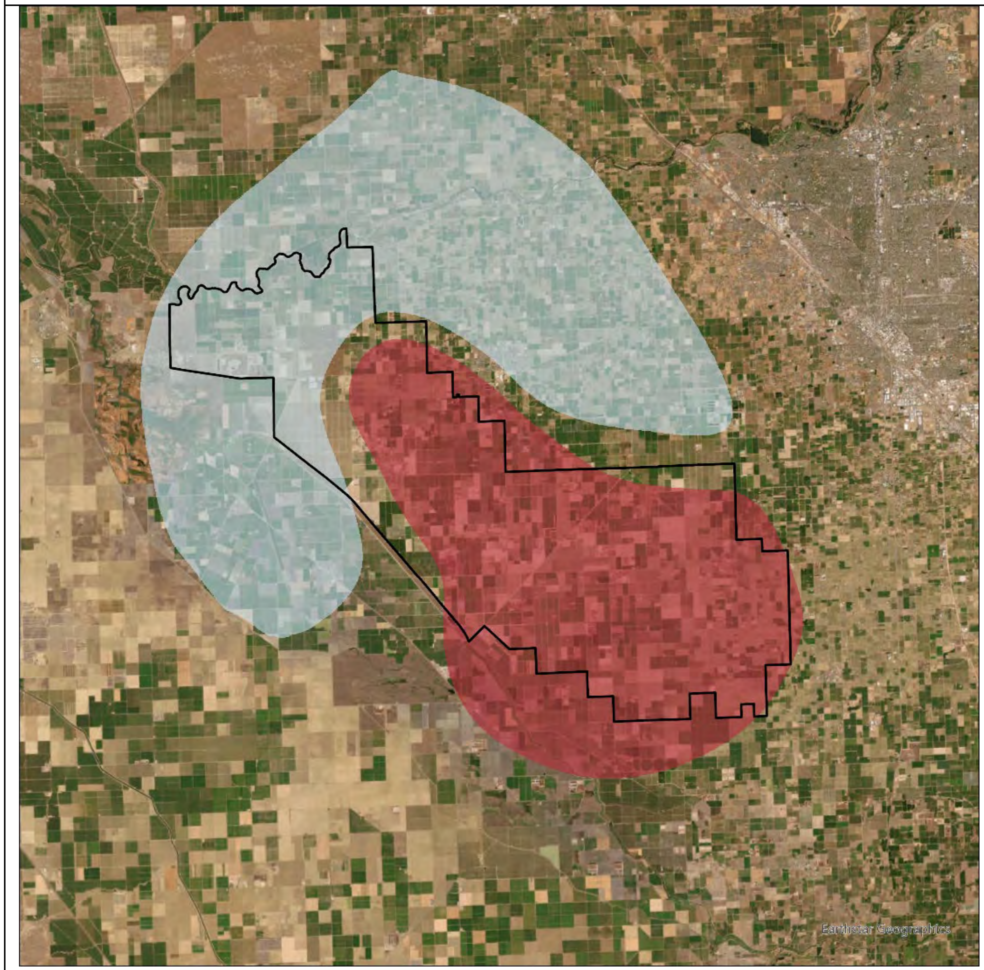


Figure 11. Recovery Year in Dry Period (Second of three consecutive dry years, 2015 - 2016 Water Year) *(continued)*

E. December 2014



F. February 2015

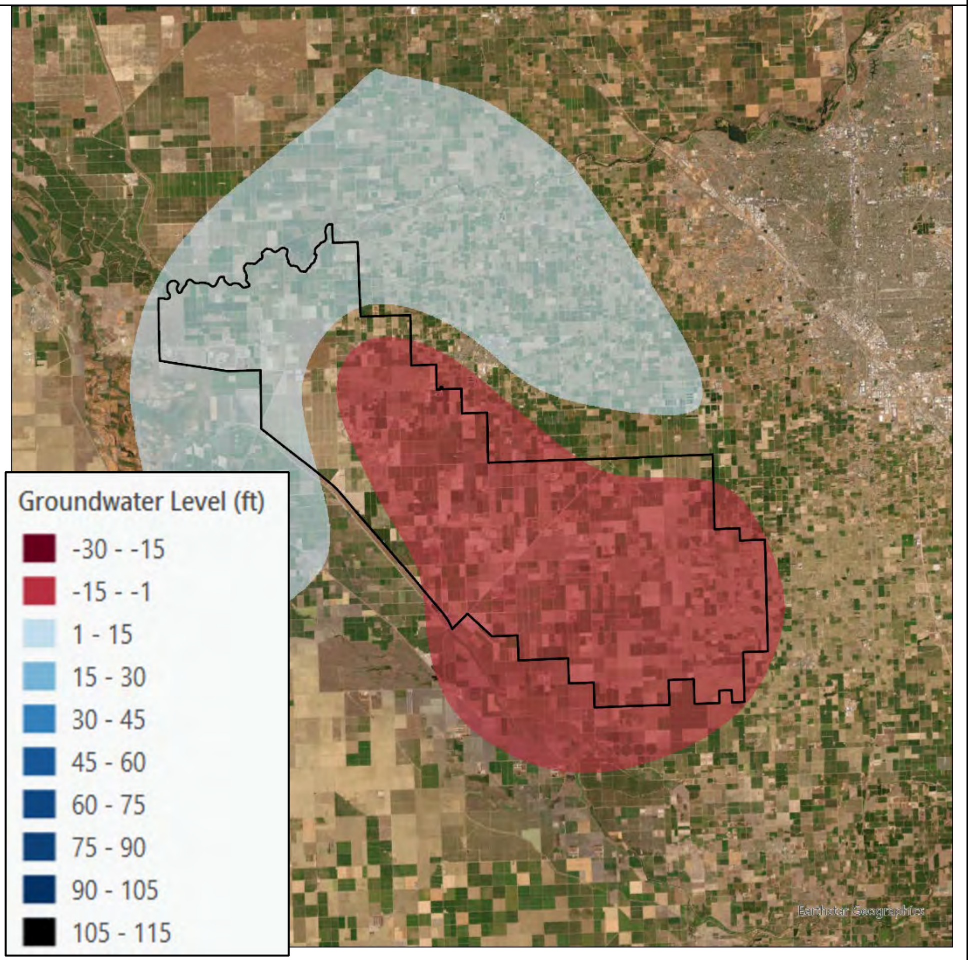


Figure 11. Recovery Year in Dry Period (Second of three consecutive dry years, 2015 - 2016 Water Year) *(continued)*

4.3 Twenty Four Years Under the Historical Scenario

Figure 12 presents changes in ideal water levels within and adjacent to MAGSA through the 24-year modeling period, stepping through the period at four-year intervals (1998, 2002, 2006, 2010, 2014, 2018).

Under the modeled period, the first two Water Years (**1997 – 1998)** were both recharge years. Ideal groundwater levels increased well beyond the recharge basins extending three to five miles beyond an area under recharge (Figure 12a). Ideal groundwater levels below and adjacent to recharge basins showed very high levels in the range of 70 – 100 ft above baseline water levels because of recent recharge.

The subsequent four water years from **1999 – 2002** starts with two recharge years, followed by one recovery year and ending with no activity. By April 2002 (Figure 12b), ideal groundwater levels continue to be above baseline conditions throughout much of region and extending further out then in April 1998 (Figure 12a). By April 2002, all groundwater mounds have disappeared with all of groundwater 1 – 15 feet above baseline conditions.

The **2003 – 2006** period continues to be another wet period with the last two years being recharge years. Those two recharge years lead to very high ideal groundwater levels below and adjacent to the recharge basins (Figure 12c), similar to in 1998 (Figure 12a). The range of elevated groundwater levels continue to extend beyond the MAGSA region as shown in 2002 (Figure 12b).

24 years under the Historical Scenario

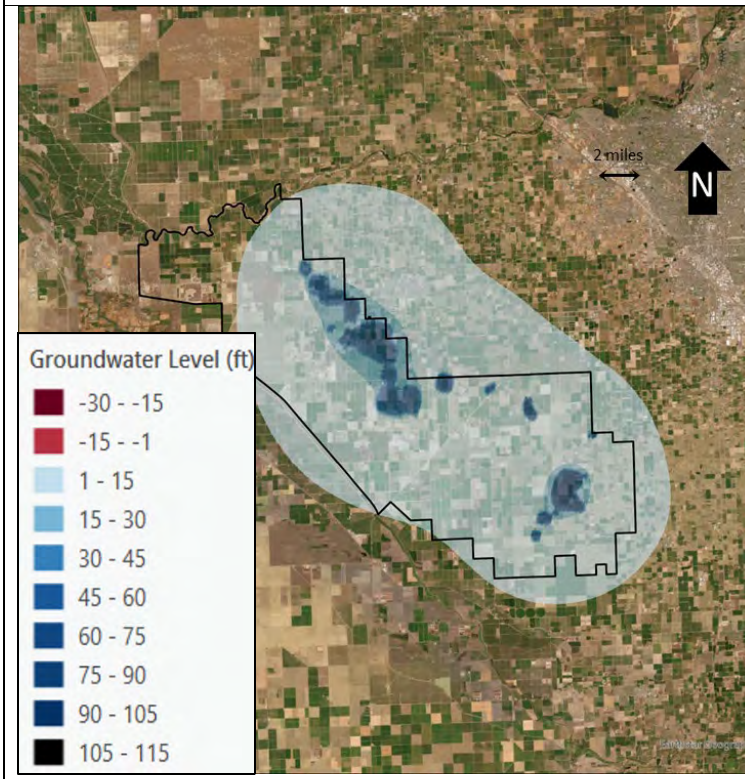
Recharge periods are characterized by dramatic mounds and groundwater levels extending in all directions. No action periods are represented by groundwater levels relaxing with broad areas of "ideal" groundwater levels uniformly slightly above or below baseline conditions. During recovery periods, groundwater levels decline. The effects spread broadly outside of MAGSA under "ideal" 1) conditions of maximum recharge and recovery and 2) no underlying groundwater gradient.

The **2007 – 2010** period is the beginning of the drier half of the simulation with the first three years in recovery. These three consecutive recovery years result in water levels in about the lower two thirds of MAGSA to go from ideal groundwater levels -1 – 15 feet above baseline conditions to 1 – 15 feet below baseline conditions (Figure 12d). Ideal groundwater levels outside of MAGSA remain above baseline conditions in the upper half of the affected region. Thus, under the ROM Model, ideal groundwater levels outside of MAGSA and a few miles beyond recharge basins are not affected by extraction, even when temporally intense.

The **2011 – 2014** period represents a period with two recharge and two recovery years. The distribution of areas with ideal groundwater levels above and below baseline conditions (Figure 12e) are similar to the distribution shown for 2010 (Figure 12d). The main difference over this four year period in comparison to the previous four years cycle is higher groundwater in the north of MAGSA.

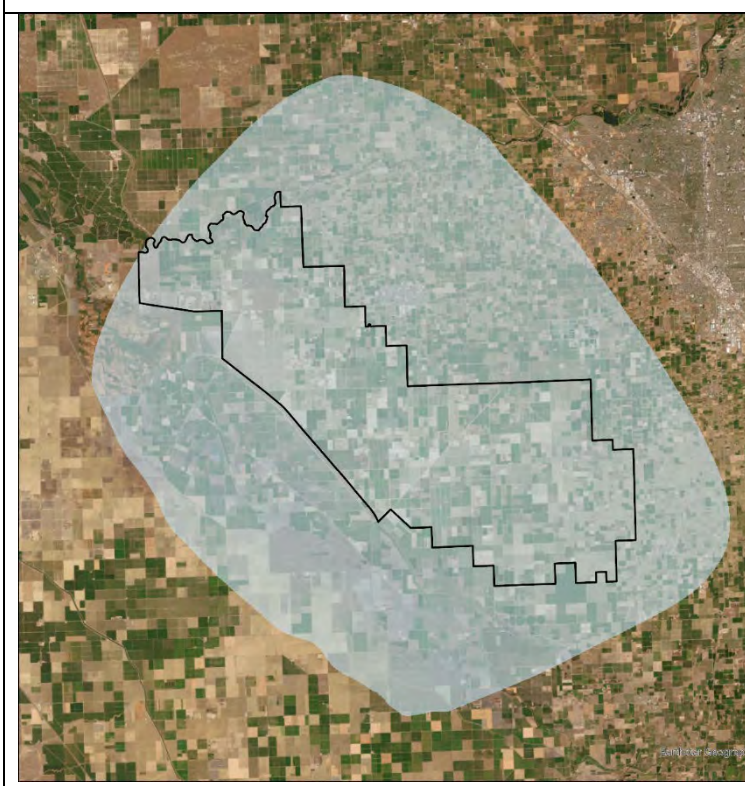
The **2015 – 2018** period also has two recharge and two recovery years. Further infilling occurs during this period (Figure 12f) as the previous. West of MAGSA, an area with depressed ideal groundwater levels is depicted by the model.

A. April 1998



Simulation Year	Water Year	Historical
1	1997	Recharge
2	1998	Recharge
3	1999	Recharge
4	2000	Recharge
5	2001	Recovery
6	2002	No Action
7	2003	Recovery
8	2004	No Action
9	2005	Recharge
10	2006	Recharge
11	2007	Recovery
12	2008	Recovery
13	2009	Recovery
14	2010	No Action
15	2011	Recharge
16	2012	Recharge
17	2013	Recovery
18	2014	Recovery
19	2015	Recovery
20	2016	Recharge
21	2017	Recharge
22	2018	Recovery
23	2019	Recharge
24	2020	Recovery

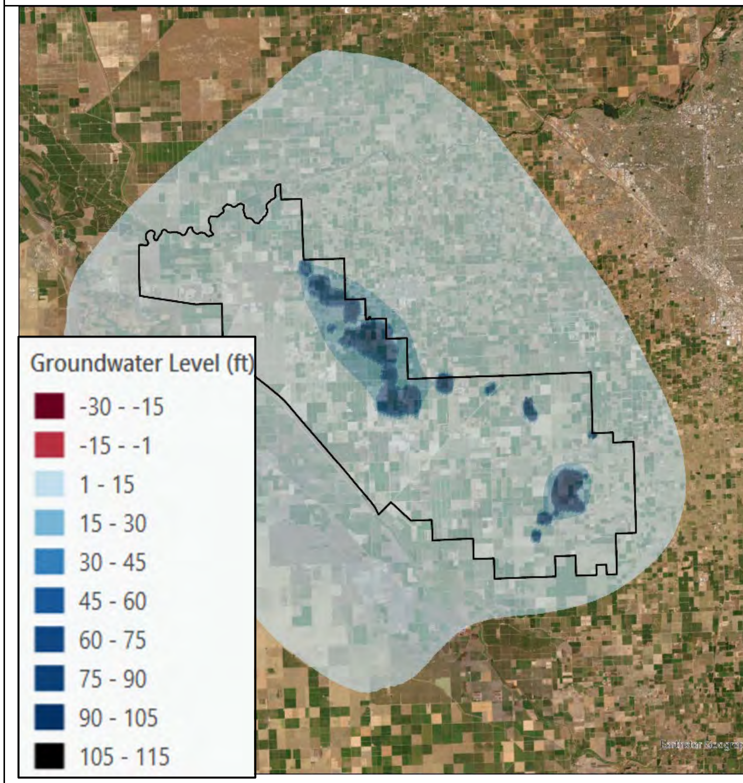
B. April 2002



Simulation Year	Water Year	Historical
1	1997	Recharge
2	1998	Recharge
3	1999	Recharge
4	2000	Recharge
5	2001	Recovery
6	2002	No Action
7	2003	Recovery
8	2004	No Action
9	2005	Recharge
10	2006	Recharge
11	2007	Recovery
12	2008	Recovery
13	2009	Recovery
14	2010	No Action
15	2011	Recharge
16	2012	Recharge
17	2013	Recovery
18	2014	Recovery
19	2015	Recovery
20	2016	Recharge
21	2017	Recharge
22	2018	Recovery
23	2019	Recharge
24	2020	Recovery

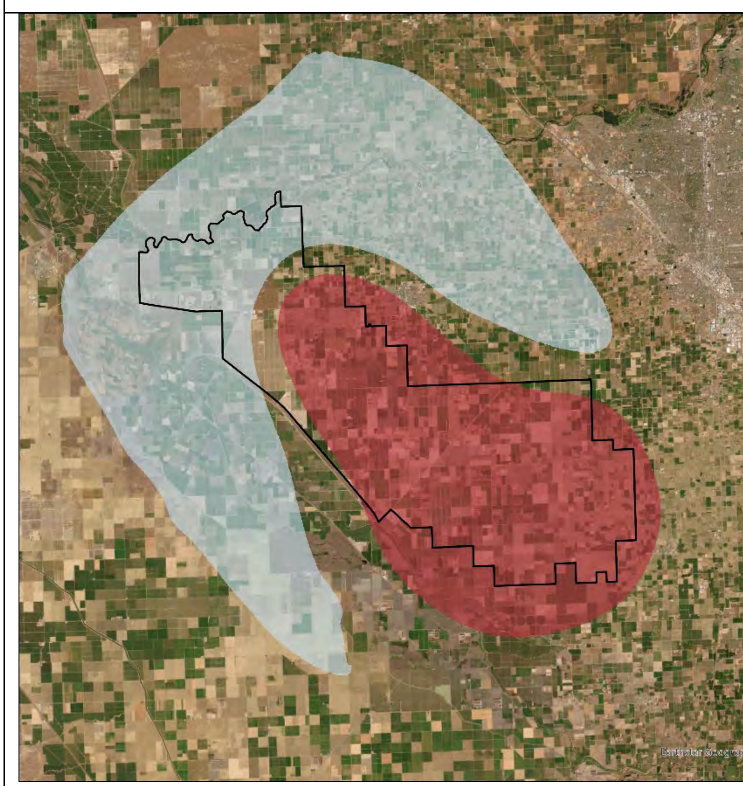
Figure 12. Long-term Series Overy Model's Duration (Historical Scenario)

C. April 2006



Simulation Year	Water Year	Historical
1	1997	Recharge
2	1998	Recharge
3	1999	Recharge
4	2000	Recharge
5	2001	Recovery
6	2002	No Action
7	2003	Recovery
8	2004	No Action
9	2005	Recharge
10	2006	Recharge
11	2007	Recovery
12	2008	Recovery
13	2009	Recovery
14	2010	No Action
15	2011	Recharge
16	2012	Recharge
17	2013	Recovery
18	2014	Recovery
19	2015	Recovery
20	2016	Recharge
21	2017	Recharge
22	2018	Recovery
23	2019	Recharge
24	2020	Recovery

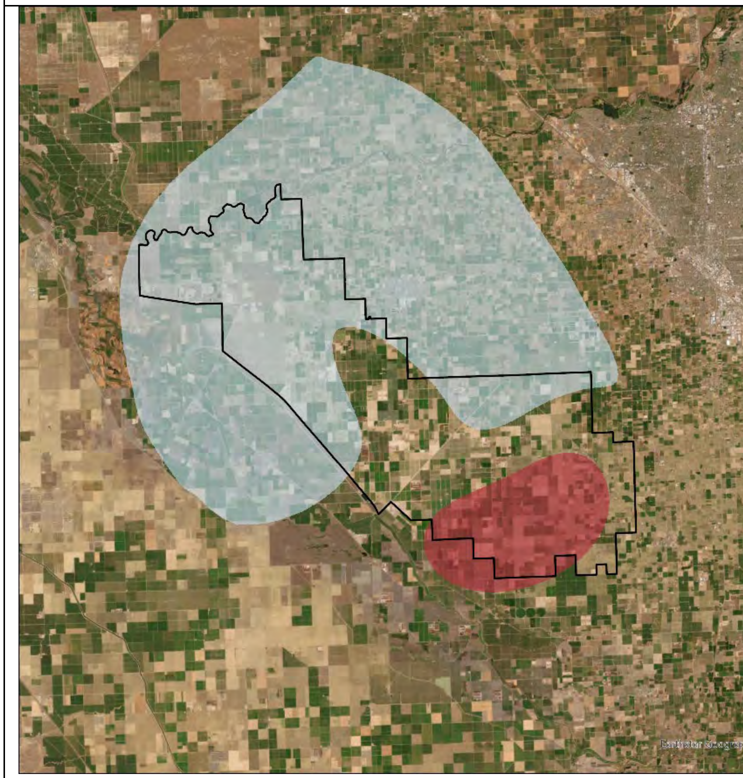
D. April 2010



Simulation Year	Water Year	Historical
1	1997	Recharge
2	1998	Recharge
3	1999	Recharge
4	2000	Recharge
5	2001	Recovery
6	2002	No Action
7	2003	Recovery
8	2004	No Action
9	2005	Recharge
10	2006	Recharge
11	2007	Recovery
12	2008	Recovery
13	2009	Recovery
14	2010	No Action
15	2011	Recharge
16	2012	Recharge
17	2013	Recovery
18	2014	Recovery
19	2015	Recovery
20	2016	Recharge
21	2017	Recharge
22	2018	Recovery
23	2019	Recharge
24	2020	Recovery

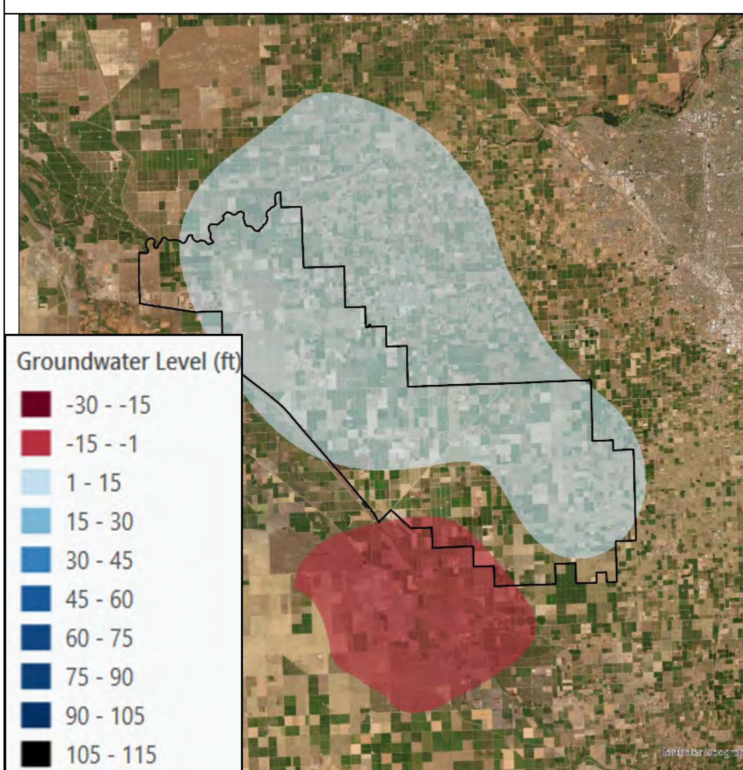
Figure 12. Long-term Series Overy Model's Duration *(Historical Scenario, continued)***.**

E. April 2014



Simulation Year	Water Year	Historical
1	1997	Recharge
2	1998	Recharge
3	1999	Recharge
4	2000	Recharge
5	2001	Recovery
6	2002	No Action
7	2003	Recovery
8	2004	No Action
9	2005	Recharge
10	2006	Recharge
11	2007	Recovery
12	2008	Recovery
13	2009	Recovery
14	2010	No Action
15	2011	Recharge
16	2012	Recharge
17	2013	Recovery
18	2014	Recovery
19	2015	Recovery
20	2016	Recharge
21	2017	Recharge
22	2018	Recovery
23	2019	Recharge
24	2020	Recovery

F. April 2018



Simulation Year	Water Year	Historical
1	1997	Recharge
2	1998	Recharge
3	1999	Recharge
4	2000	Recharge
5	2001	Recovery
6	2002	No Action
7	2003	Recovery
8	2004	No Action
9	2005	Recharge
10	2006	Recharge
11	2007	Recovery
12	2008	Recovery
13	2009	Recovery
14	2010	No Action
15	2011	Recharge
16	2012	Recharge
17	2013	Recovery
18	2014	Recovery
19	2015	Recovery
20	2016	Recharge
21	2017	Recharge
22	2018	Recovery
23	2019	Recharge
24	2020	Recovery

Figure 12. Long-term Series Overy Model's Duration *(Historical Scenario, continued)*.

4.4 End of 24-Year Simulation across Climate Scenarios

Bracketing the historic scenario were two scenarios to represent drier and wetter scenarios and to provide some information regarding climate change effects. Figure 13 shows the scenarios and the calculated net recharge (recharge minus recovery) that occurs under each: 1.0M AF under the wet scenario, 0.6 MAF under the historic scenario and 0.3 MAF under the dry scenario. That figure is provided further information in Figure 14. The Wet Scenario shows the most recharge, the least recovery, and the highest net recharge over the twenty-four-year period (1.07M AF). The Dry Scenario shows the opposite, with net recharge slightly more than 30% of the Wet Scenario at 0.3M AF. The Historical Scenario falls in the middle, with the middle amount of recharge, the middle amount of recovery and the middle amount of net recharge at 0.6 MAF.

Scenarios by the numbers:

Historic: Net Recharge = 0.6 MAF, 11 Recharge Years, 10 Recovery Years.

Wet: Net Recharge = 1.0 MAF, 12 Recharge Years, 8 Recovery Years.

Dry: Net Recharge = 0.3 MAF, 10 Recharge Years, 12 Recovery Years.

The different net recharge volumes across the model period affected ideal groundwater levels by the end of the simulation. Under the Historic scenario about half the affected region is above baseline conditions and about half below. The upper third of MAGSA and much the area to the east of MAGSA's spine has ideal groundwater levels one to fifteen feet above baseline conditions with the remaining affected area, primarily in the southern half is 1 – 15 feet below baseline conditions (Figure 14a).

The Wet Scenario differs from the Historic Scenario in a few ways. More frequent recharge resulted in generally higher ideal groundwater levels and groundwater mounds that extended further from the MAGSA area (Figure 14b). Correspondingly, the areas with ideal groundwater levels up to fifteen feet below baseline conditions is less than half the area calculated for the Historic Scenario. Finally, under the Wet Scenario, no areas outside of MAGSA show depressed ideal groundwater levels.

The Dry Scenario shows about one third of the area in which ideal groundwater levels were elevated for the Historic Scenario (Figure 15c vs Figure 15a). A similar area of depressed ideal groundwater levels is modeled at the end of both the Dry and Historic Scenarios.

It is important to reiterate that the results are 'idealized' and that the ROM model does not include prevailing groundwater levels which would affect the spreading of groundwater mounds and depressions. See section 6.3 for more discussion.

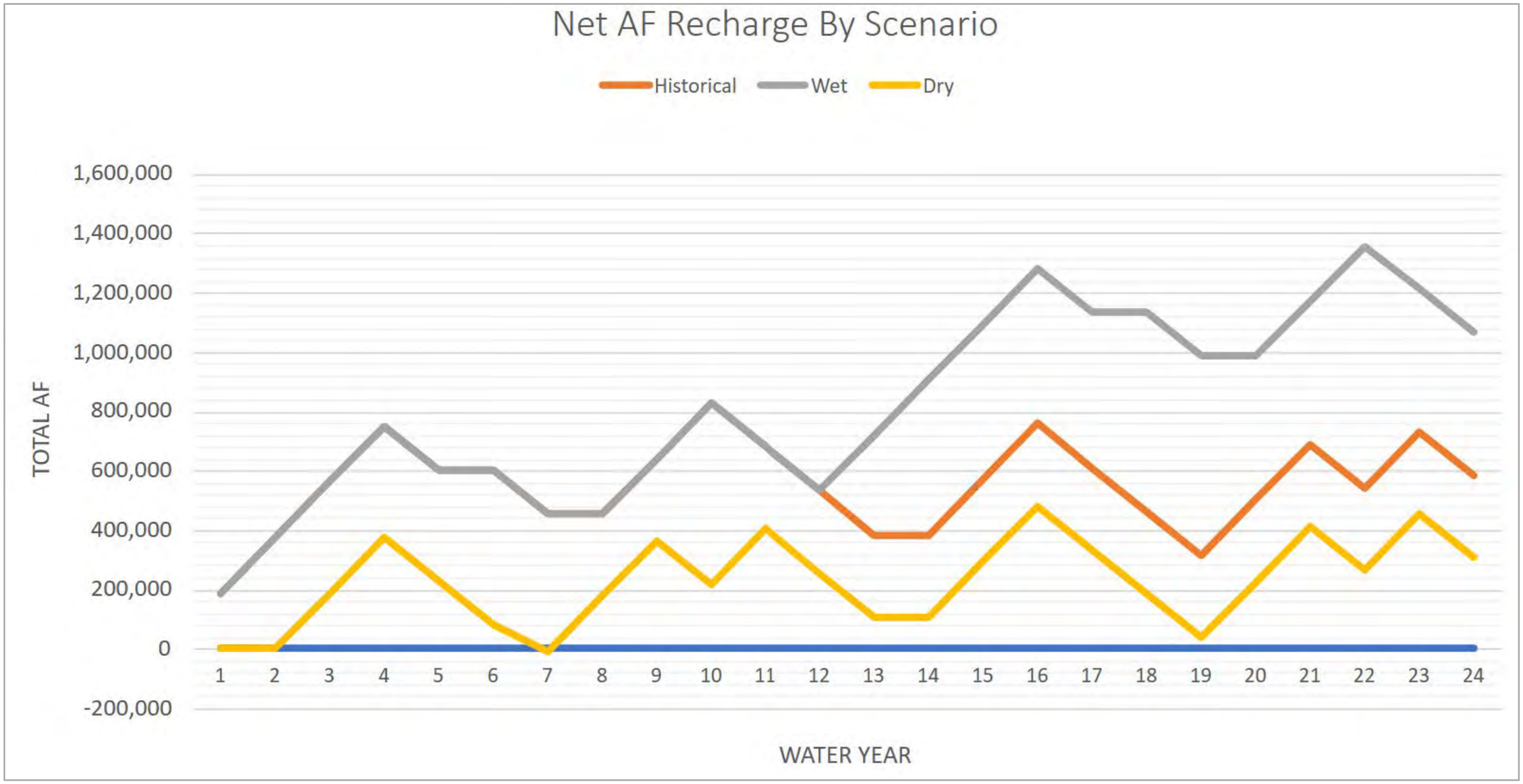


Figure 13. Net Recharge for Three Scenarios: Historical (orange), Wet(grey) and Dry (yellow)

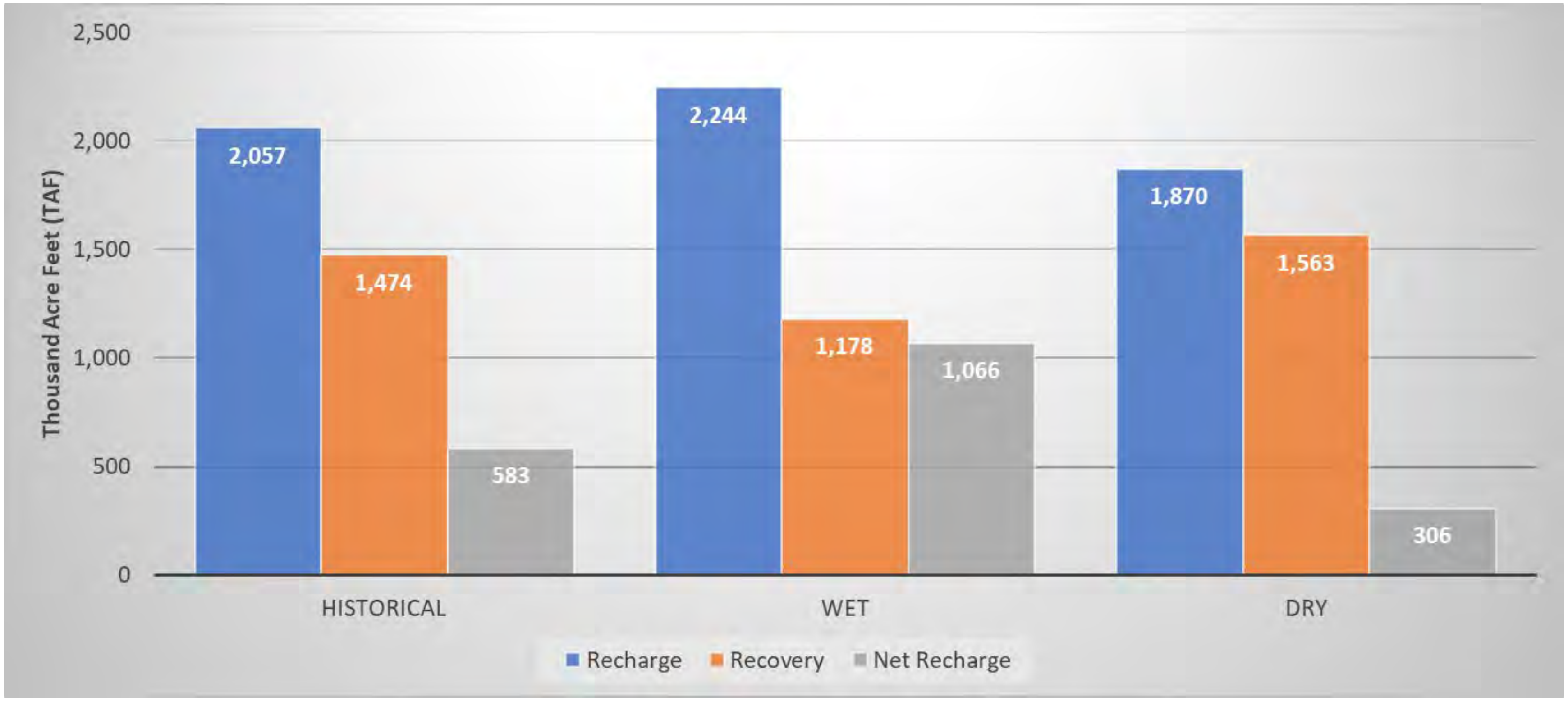


Figure 14. Total recharge, recovery, and net recharge over Historical, Wet and Dry Scenarios

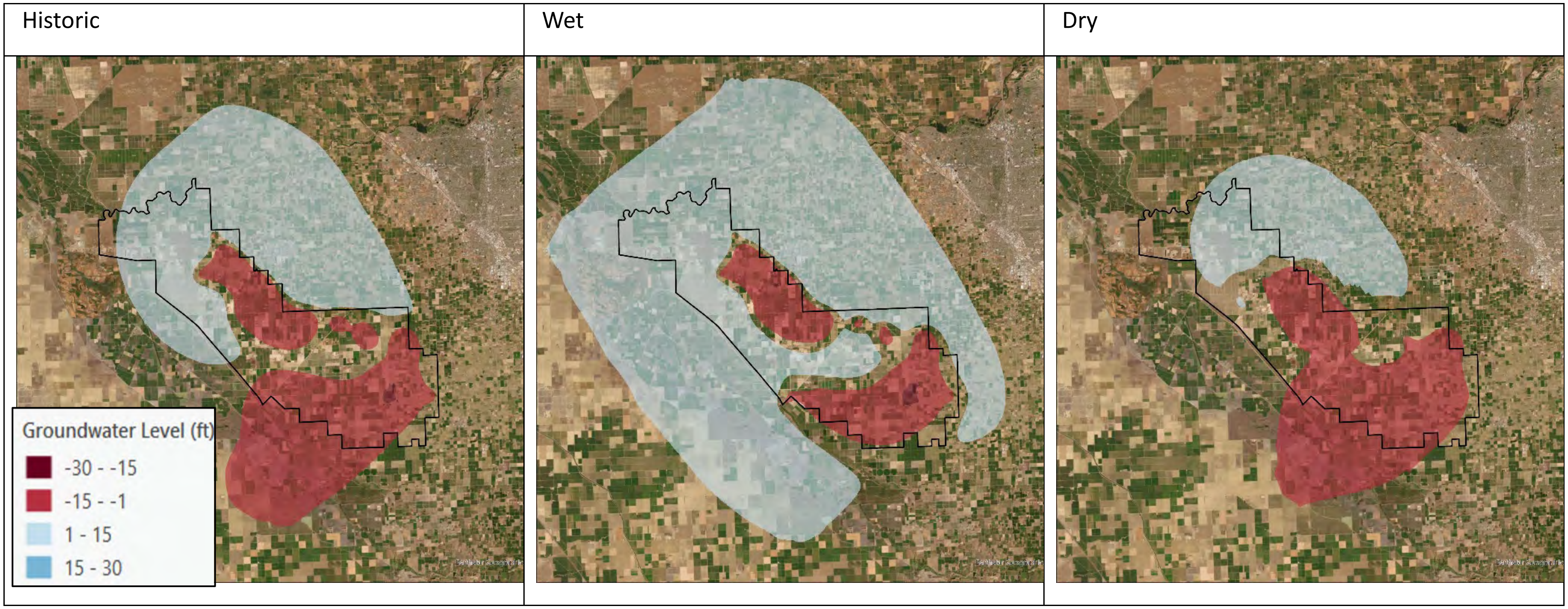


Figure 15. September 2020 for Historic, Wet and Dry Model Scenarios.

Scenario Outcomes

- Wet scenario most extensive regions of elevated ideal levels
- Dry scenario most extensive regions of lowered ideal levels
- All scenarios preferentially lowered groundwater in the eastern half of MAGSA
- All scenarios broadly affected “ideal” groundwater levels outside of MAGSA, either slightly higher, slightly lower or a combination.

4.5 Superposition of ROM Model over 2021 Groundwater Elevation Contours

The ideal spatial results discussed in the past sections were overlaid over 2021 groundwater elevations at MAGSA. Two periods are considered in this analysis: October 1998 through October 1999, and October 2014 through October 2015.

October 1998 – October 1999 represents changes during a recharge year in which recharge occurred from November 1998 to April 1999. This scenario was previously discussed in relation to recharge during a wet period (Chapter 4.1.1, Figure 9). In that discussion, we found ideal groundwater elevations increased by April but decreased thereafter, though still extending a few miles outside of MAGSA in some areas (Figure 9), a mile to a few miles outside of MAGSA.

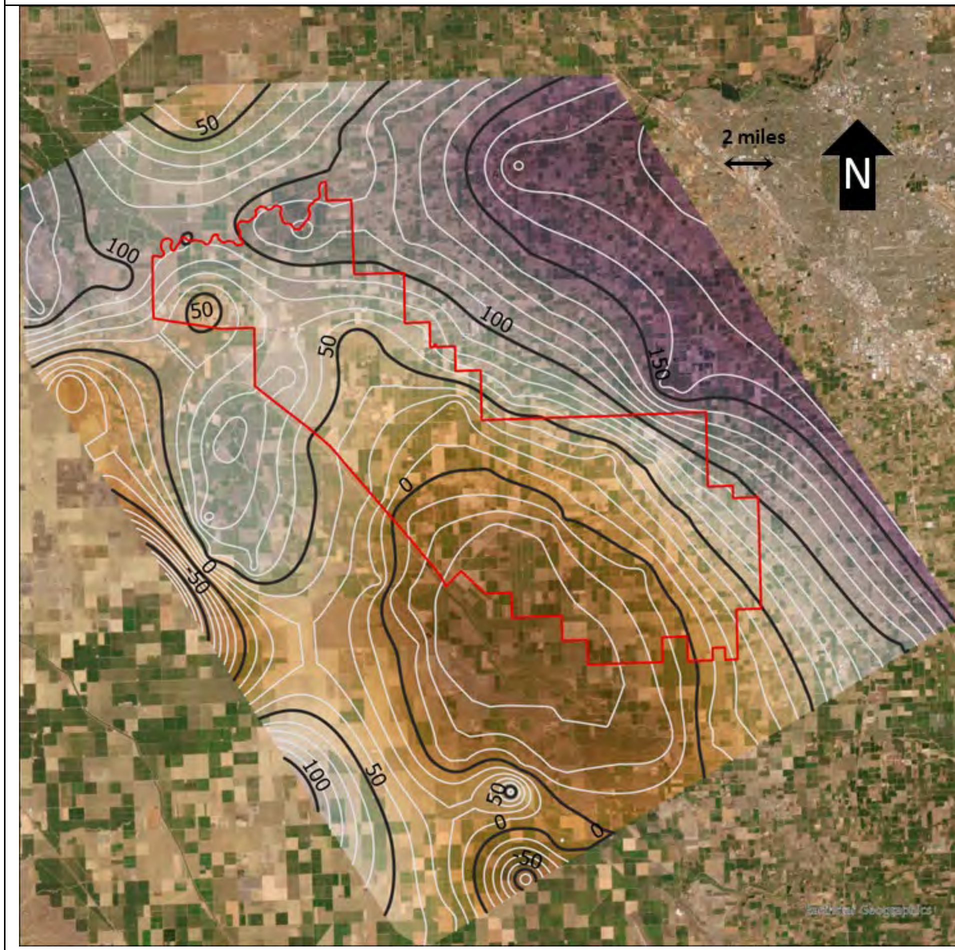
First glimpse: overlaying "ideal" effects over 2021 groundwater contours

Effects on groundwater levels are generally subtle after the relaxation of groundwater mounds and depressions.

Figure 16 shows these effects. Figure 16a and Figure 16b compare ideal groundwater elevations in October 1998 and April 1999 respectively. Figure 16b shows mounding of more than 50 ft at recharge basins, with ideal groundwater elevations of these mounds exceeding 100 ft NAVD. Figure 16c and Figure 16d show groundwater mounds have disappeared through declining groundwater levels and mound spreading. The main noticeable difference between the October 1998 and October 1999 is infill of the center of groundwater depression from the year of recharge, raising about 10 (Figure 16C,D).

October 2014 through October 2015 represents a dry period, the last of three consecutive dry years in which recovery occurred successively (Chapter 4.2). During this water year, ideal groundwater elevations are unchanged from October 2014 through April 2015 as no actions occur during this period (Figure 17a, b). After April, modeled recovery shows groundwater levels drop across about two thirds of MAGSA. However, the superimposed model results show only subtle changes in ideal groundwater elevation with a slight widening of the cone of depression (Figure 17c, d).

A. October 1998



B. April 1999

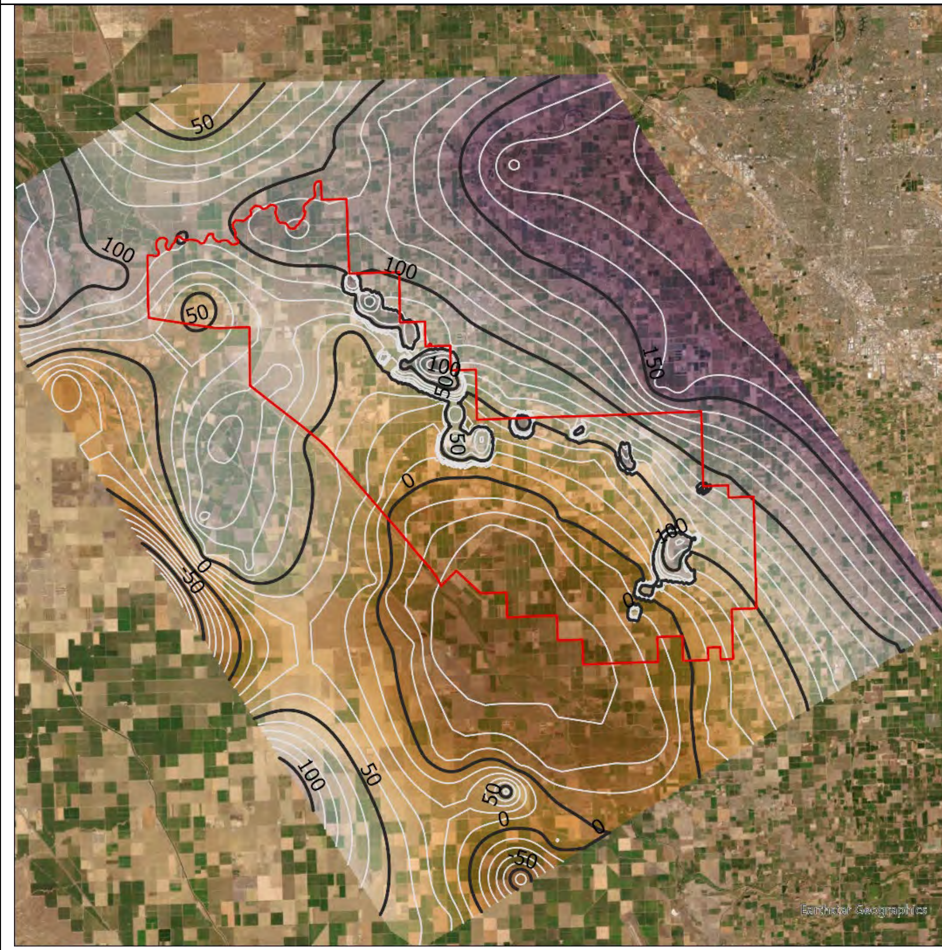
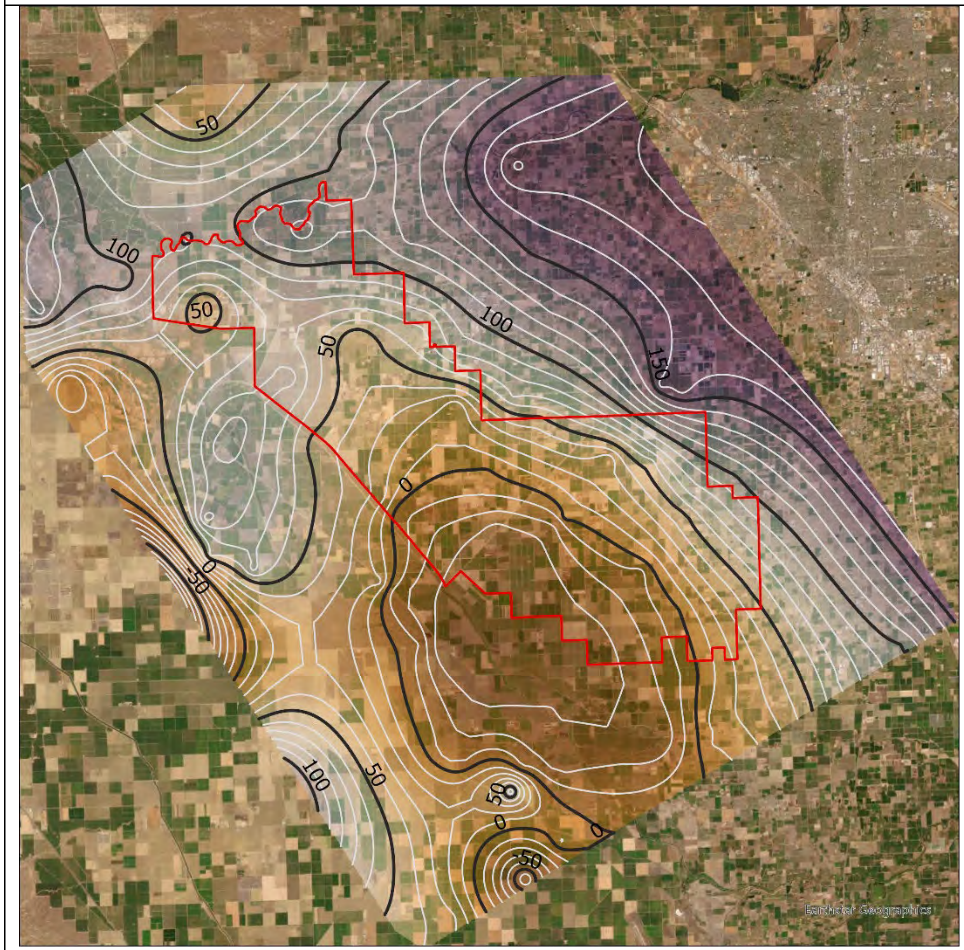


Figure 16. Superimposing 1999 WY Model over Groundwater.

C. October 1998



D. October 1999

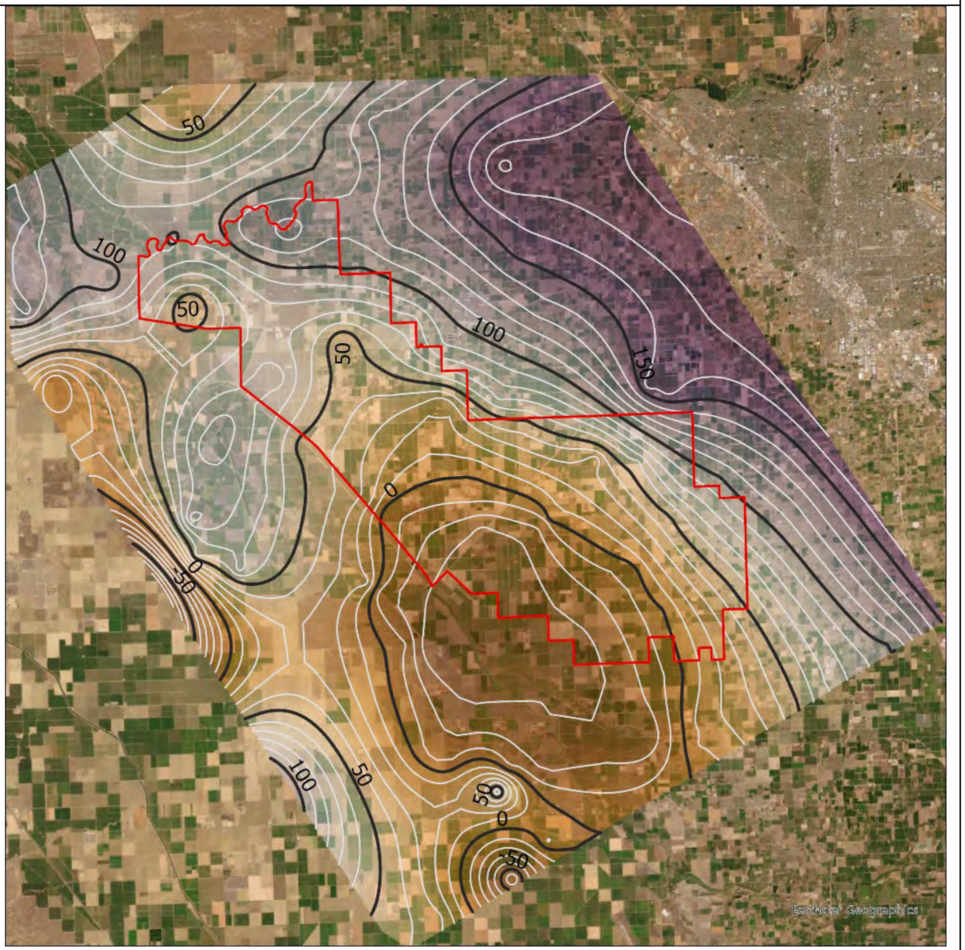
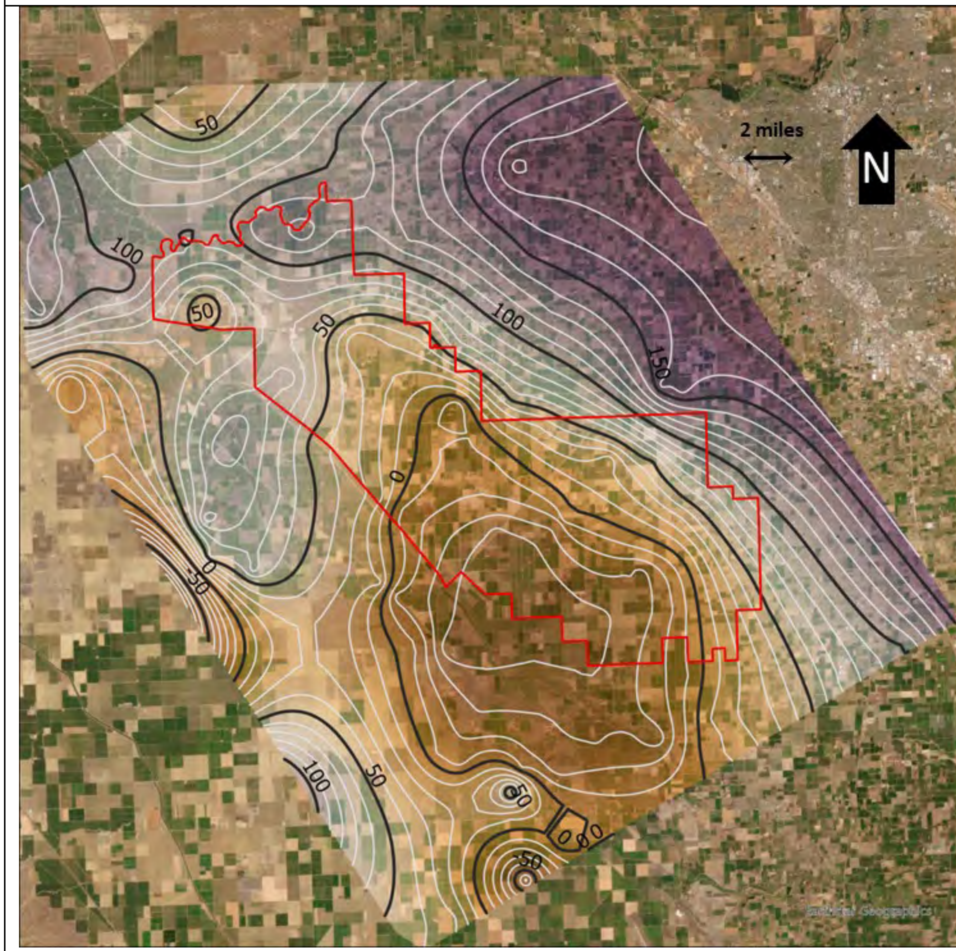


Figure 16. Superimposing 1999 WY Model over Groundwater ***(continued)*****.**

A. October 2014



B. April 2015

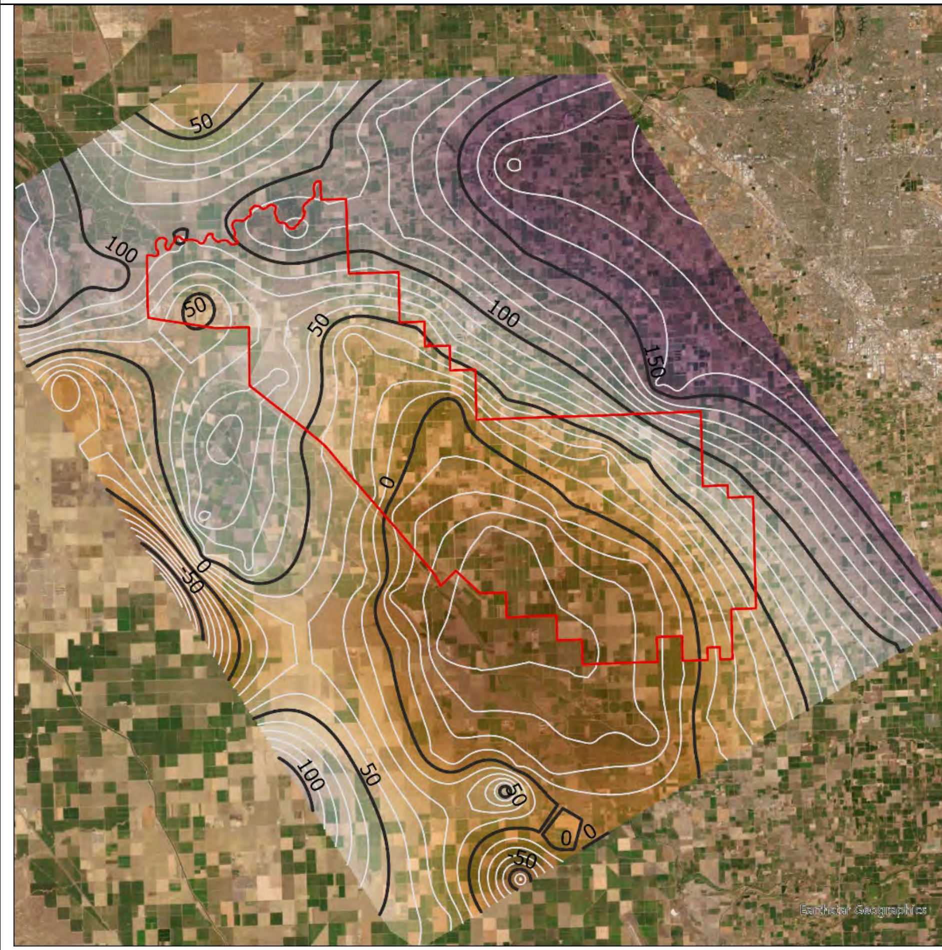
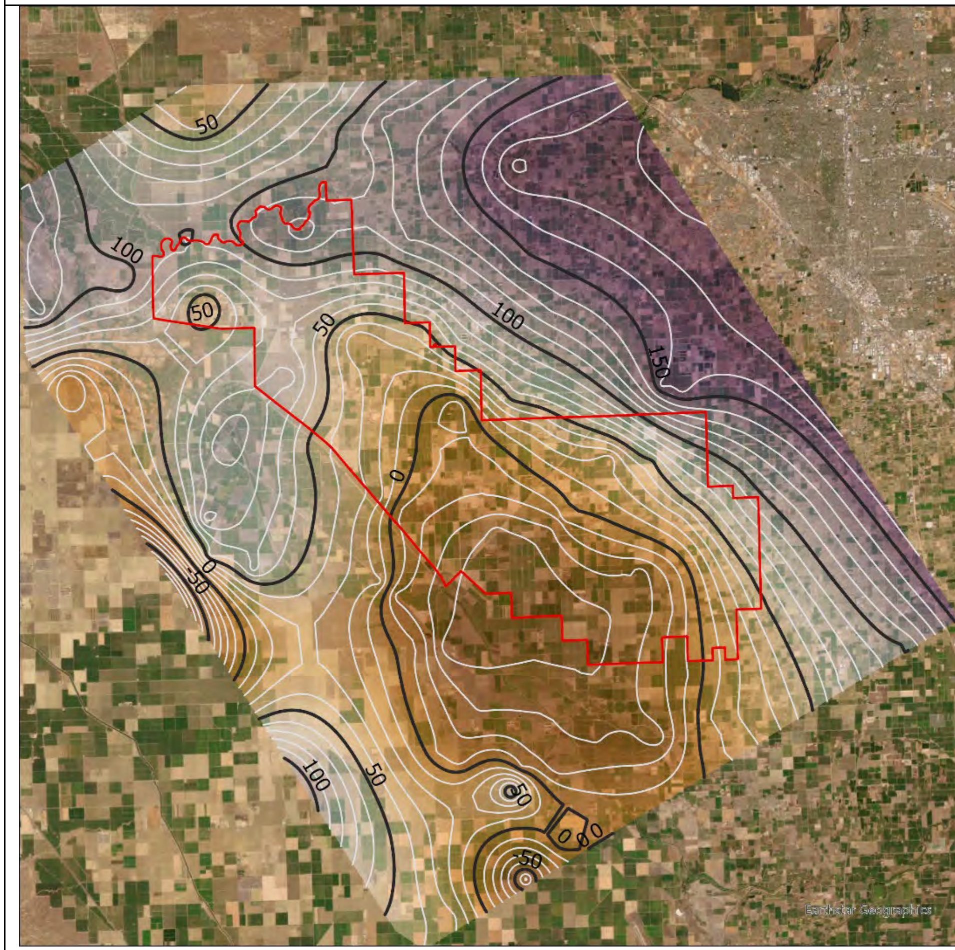


Figure 17. Superimposing 2014 WY Model over Groundwater.

C. October 2014



D. October 2015

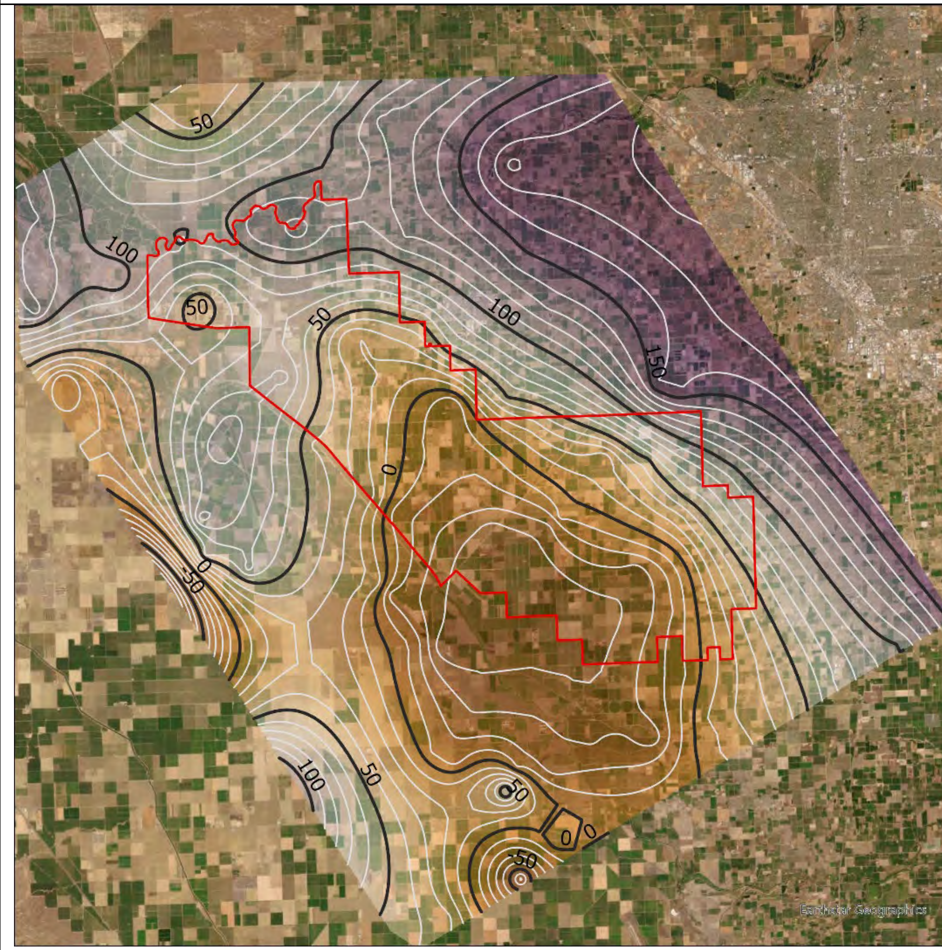


Figure 16. Superimposing 1999 WY Model over Groundwater ***(continued)*****.**

5 Hydrographs

Hydrographs were developed from the ROM Model to investigate changes in ideal groundwater levels (Figure 18). Each of the five hydrographs has its own goals:

1. A San Joaquin River (SJR) Transect to assess groundwater gradients changes from recharge and recovery and their potential on affecting SJR losses or gains from the Bank;
2. An E-W Transect in the north of MAGSA (at Highway 180) to assess groundwater fluxes westward or eastwards from recharge basins in that area;
3. A N-S Transect through the recharge areas in the southeastern region of MAGSA and potential effects throughout that region;
4. A E-W Transect through the southern region of MAGSA will similarly analyze groundwater effects throughout that region.
5. A N-S Transect through the Raisin City Oil Field to assess potential groundwater fluxes into, from or through the oil field as affected by the Bank and across different climate scenario.

"Ideal" to Real-World

Five transects and 2 flux calculations conducted to provide real-world context to "ideal" spatial results through informing on hydrologic processes and constraints.

These analyses were conducted to provide some context of ideal groundwater level and elevation results from the ROM Model in light of underlying groundwater elevations and groundwater flow paths.

Figure 7 shows the groundwater depths from 2021. Figure 19 presents the 2021 groundwater elevations. The cone of depression drops to an elevation of -40 ft NAVD. Highest groundwater elevations are approximately 130 ft-NAVD at the corner of MAGSA just east of Transect Node E5-NS2. Groundwater elevations are in the range of 90 – 100 ft NAVD along the SJR.

Figure 19 shows arrows to represent groundwater flow paths in the area based on contour lines.[6] Groundwater flows converge on the cone of depression in the southwest corner of MAGSA. Groundwater within and east of MAGSA flows from the northeast to the southwest. In the north of MAGSA, groundwater flows from the north-northwest to the south-southwest. Groundwater west of MAGSA also flows east toward the cone of depression.

[6] Flow gradients are perpendicular to groundwater contour lines.

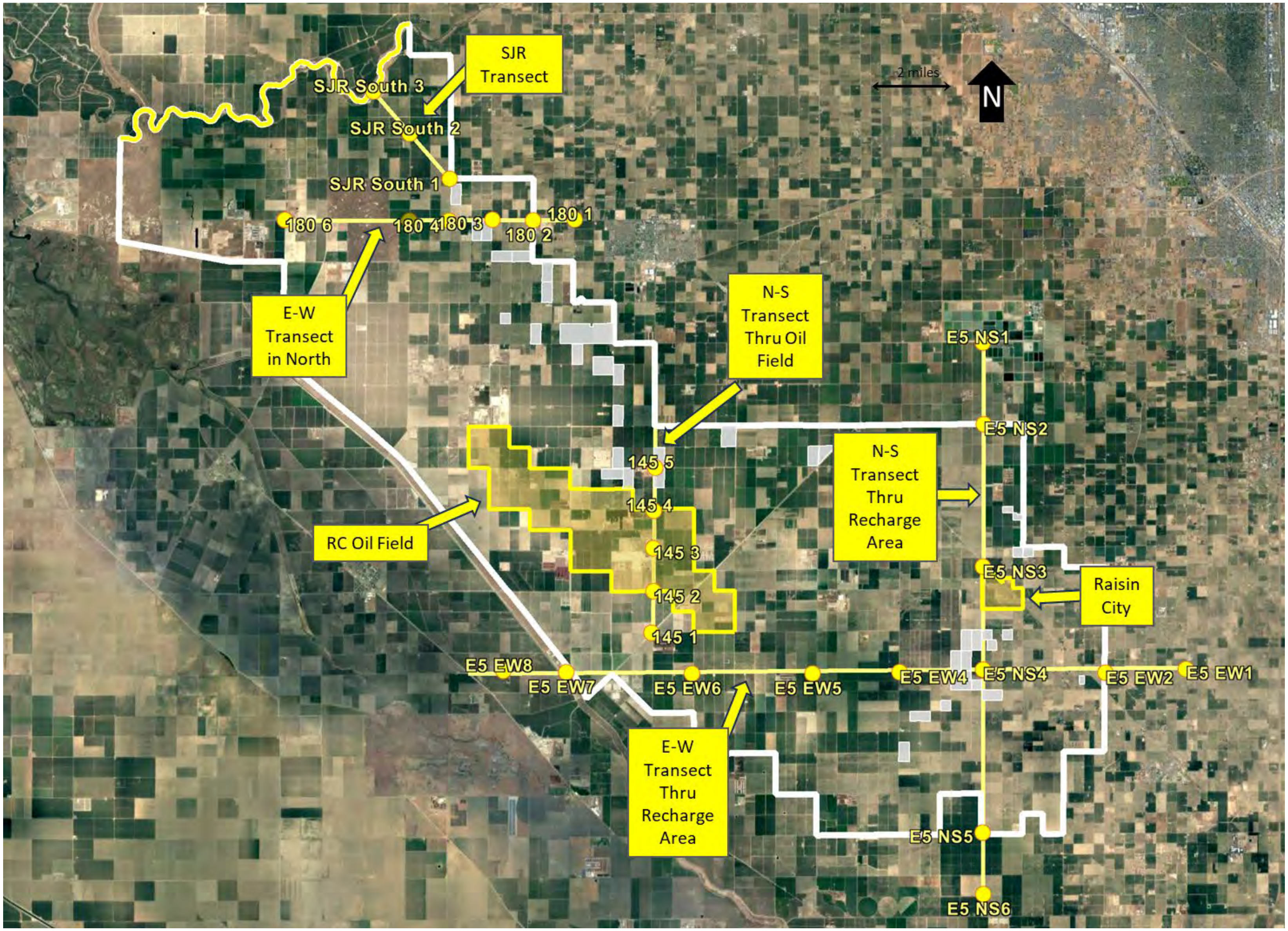


Figure 18. Model Inspection Well Nodes and Areas of Interest.

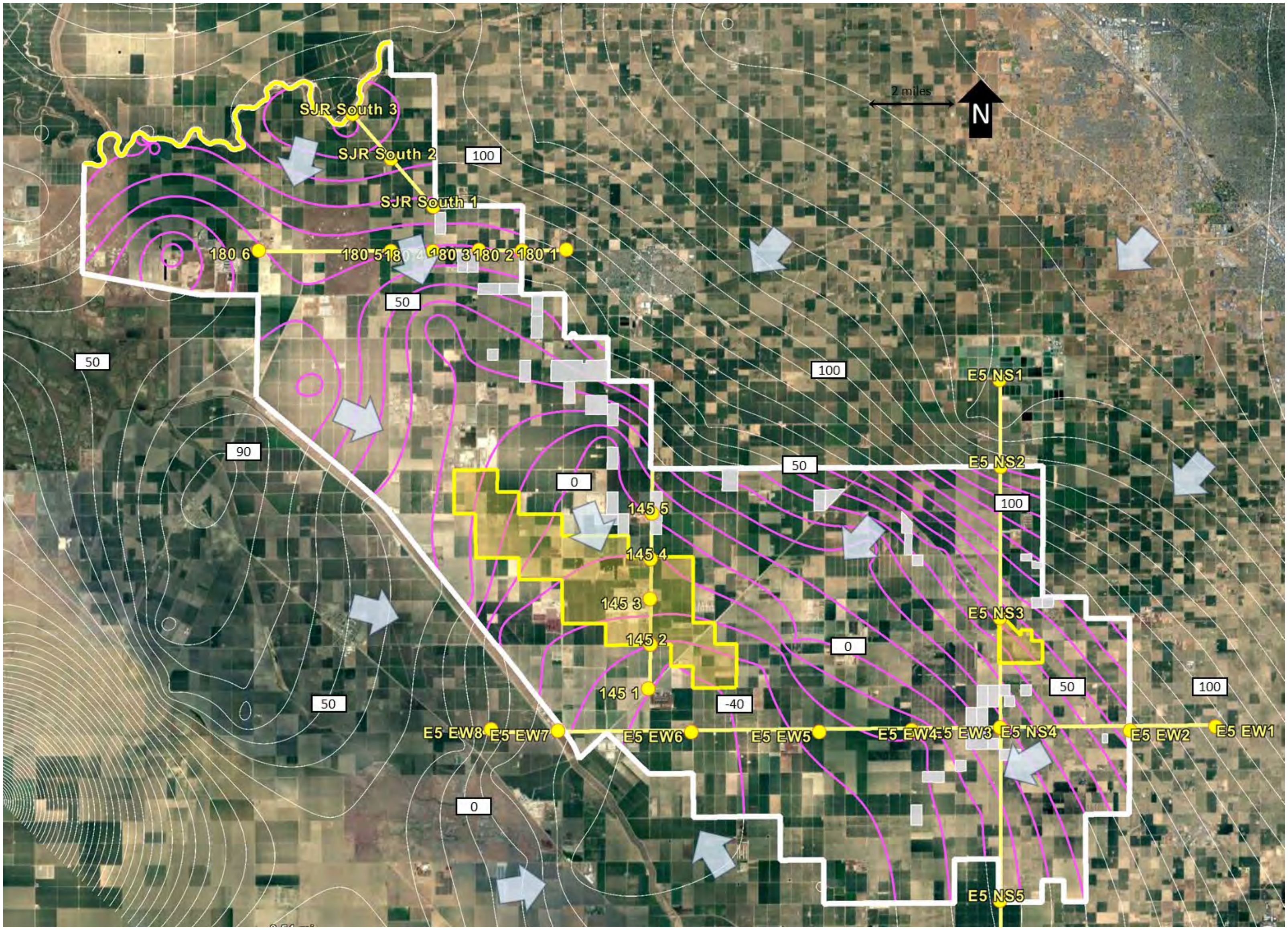


Figure 19. Groundwater elevations (ft-NAVD) and aquifer flow paths.

5.1 Hydrographs

Five transects were placed in the modeling domain to better understand local effects and physical and hydrologic drivers (Figure 18). Along these transects we placed inspection wells at nodes approximately one to 3 miles apart depending upon the location and the transects' goals. Each of these transects is discussed below.

Short term Groundwater Responses to Active Recharge Efforts.

In the short term during active recharge efforts, the model depicts groundwater levels underlying and adjacent recharge basins rise rapidly 50 – 100 ft. Large recharge basin complexes appeared to have greater increases that smaller groups. Model data suggests those effects are noticeable but of much lower magnitude as close as a quarter to a half mile away, At this distance, modeled ideal groundwater levels raise by 2 – 5 ft during recharge activities.

5.1.1 SJR Transect: Losses and Gains from the SJR

The planned goal of this transect was to assess the effects of recharge on groundwater flows flowing down gradient from the San Joaquin River (SJR).

Figure 20 presents the ideal groundwater level (head, ft) response along the three nodes that define the 3-mile SJR transect. Node *SJR South 1* is adjacent to a recharge zone and node *SJR South 3* is adjacent to the San Joaquin River. In Figure 20, The ROM model predicts an *approximate 50-ft rise in ideal groundwater elevations* during each recharge period which take about a *year to relax* and return back to more baseline conditions (Figure 20A). The groundwater level responses are muted further from the recharge basins. Each recharge event causes ideal groundwater levels to increase *1 – 2 ft about 1.5 miles* away at node *SJR South 2* and about half of that at node SJR South 3 adjacent to the SJR. Overall, at nodes *SJR South 2* and *SJR South 3*, changes in ideal groundwater levels are gradual in response to recharge or recovery events. Thus, *large, and dramatic groundwater mounding that results from recharge activities is constrained to areas under and adjacent to recharge basins*.

Not affecting San Joaquin River

Groundwater flow paths and levels adjacent to the San Joquin River will not be affected by the Bank.

The changes in ideal groundwater levels are overlaid on groundwater elevations to calculate ideal groundwater elevations (Figure 20B). The groundwater gradients (i.e. elevation difference) away from the river between node *SJR South 3* and node *SJR South 2 is* relatively stable showing groundwater *flow rates below the river are unchanged by the recharge and recovery events south of the river*.

Thus, this transects analysis demonstrates planned recharge and recovery events near the SJR will not affect SJR river trends. Additionally, under this analysis, the ROM Model calculates 50-ft groundwater mounding underlying and adjacent to recharge basins that relaxes over about a year.

5.1.2 Highway 180 Transect: Effects of Recharge

Figure 21 presents nodes set along Highway 180. The planned goal of this transect was to better understand lateral flows from recharge basins along the northern area of MAGSA in which recharge basins are situated primarily in the east. The transect is 7 miles long with nodes *180-1* through Node *180-5* at approximate 1-mile spacing.

Similar to the SJR Transect (Figure 20a), infiltration effects on groundwater levels are greatest near the recharge basin (Figure 21a) as shown by trends at node *180-3*. Node *180-3 experiences maximum of* ~98ft increase in ideal groundwater levels in response to recharge at two 80-acre recharge basins. Groundwater levels increase and decrease sharply after the onset and cessation of recharge.

Node *180-4* is the next nearest node, located a half mile west and a quarter mile south of recharge basins. Node *180-4* has *more gradual ideal groundwater level increases of about 5 feet at its distance of a quarter to half miles from the recharge basins* (Figure 21a).

These more gradual groundwater level changes persist spatially: Node *180-1* in the east outside of MAGSA, *180-2* along the MAGSA border and *180-5* to the west have similar responses as shown in Node *180-4* (Figure 21a*). The gradual changes in ideal groundwater levels extend one to 1 ½ miles from the nearest recharge basins*.

Upgradient increases in groundwater levels in response to extended recharge periods

After several years of recharge, the model predicts groundwater levels can increase by around 20 ft up to two miles away. This result means that increases in groundwater levels could potentially be observed upgradient (across groundwater contours) 20 ft. These changes would be gradual and increasingly slight the further upgradient.

Eventually, these effects start to diminish over distance with changes at Node *180-6* (approximately 4 miles away from the closest recharge basin), showing a maximum of ~3ft water level rise induced by the recharge.

Figure 21B overlays the ideal groundwater levels (heads) calculated from the ROM model onto groundwater elevations. After four consecutive recharge events, total increases in ideal groundwater elevations after relaxation of the initial recharge mounds are up to about 20 ft at nodes *180-1 through 180-4,* and about half that at node *180-5*. *The similar effect across the three miles between nodes 180-1 and 180-4 shows these groundwater responses can potentially persist for up to one and half to two miles when the underlying groundwater levels are relatively flat*.[7] Moreover, considering these groundwater effects of about 20-ft, *recharge activities could impact groundwater levels upgradient against a 20-ft head difference.*

[7] All effects shown are based upon perimeters inherited from CVHM and associated constants set accordingly. These data represent reasonable values and modeling results are "reasonable" estimates with inherent uncertainty.

5.1.3 North-South Transect on Southeast side of MAGSA: Recharge Basin Groundwater Effect Extent

Figure 22 presents groundwater levels and elevations along a North-South gradient in southeastern MAGSA. This transect bisects the largest recharge basin aggregation, with over 700 acres of recharge basins near Node *E5 NS4*. The goal of this analysis is to assess groundwater level responses from a larger recharge complex in an area with more transmissive soils.

The transect is about 10 miles long from node *E5 NS2* on the north boundary of MAGSA to node *E5 NS5* on the south boundary, with middle nodes E5 NS3 and E5 NS4 two to 3 miles apart. The 2021 groundwater elevations are about 20 ft-NAVD at node *E5 NS4* near the recharge basins, about 130 ft NAVD north at node *E5 NS2* (110 feet higher), and -10 ft NAVD south at node *E5 NS5* (30 feet lower).

Ideal groundwater levels central to the recharge complex (node *E5-NS4) rapidly rise and fall about 70 - 80 feet in response to the initiation and cessation of recharge activities* (Figure 22A). These responses are similar to modeled results under recharge basins along Transect 180 (Figure 21) and slightly higher than estimated for Transect SJR (Figure 20).

This transect also shows more *evidence of recovery wells depressing groundwater levels in the vicinity of the recharge basins*. Here, recovery wells pull ideal groundwater levels down 10 – 15 ft during each cycle.

Regional Recovery Well Strategy

Model depictions suggest the regional recovery well strategies are tools that can reinforce or suppress groundwater flow paths. In the eastern half of MAGSA, recovery wells appear to reinforce flow paths by more broadly dropping groundwater levels. Near the oil fields, recovery wells appear to change flow paths and suppress downstream groundwater trends. These examples in the hydrograph data support strategic placement and utility of recovery wells to moderate the groundwater system.

The two nodes at the edges of MAGSA, *E5 NS2* in the north and *E5 NS5* in the south, show gradual changes in ideal groundwater elevation. The ROM Model thus depicts that, *at distances of several miles away from recharge/recovery zones, the groundwater mounds and depressions become gradual rises and falls of at most 10 feet*.

Figure 22B presents the superposition of ideal groundwater level changes over 2021 groundwater elevations. A clear result here is that *groundwater mounding from these recharge basins will not be sufficient to overcome the groundwater gradient to the edge of MAGSA (E5 NS2) and is unlikely to extend north of Raisin City (E5 NS3)*.

5.1.4 East-West Transect on South Side of MAGSA: Recharge and Recovery Basin Groundwater Effect Extent

Figure 23 presents data from a southern east-west transect that bisects the main bank of recharge basins in the east and underlying *E5 EW3* (*identical to* node *E5 NS4*). This analysis is along the nine miles from *E5 EW1* to *E5 EW5*. The goal is to assess the effects from a large recharge complex and of the regional recovery wells generally located along or in parallel to this transect. *For the eastern half of MAGSA, the regional recovery well strategy was to reinforce groundwater flow paths and encourage recovery from that region*.

Recharge better at Pushing Water out than Recovery at Pulling Water back

The model shows local ideal groundwater levels increase 50 – 100 ft under recharge and decline 10 – 15 feet under recovery. The greater head difference under recharge will push water away for effectively than water can be pulled back under recovery.

As discussed earlier for Node *E5 NS4*, i*deal groundwater levels rapidly rise about 70 - 80 feet in response to recharge activities(*Figure 23A and *decline 10 – 15 ft during recovery cycles* (Figure 23A).

Ideal groundwater levels about two miles west at Node *E5 EW4* reflect those groundwater trends, though as observed in other transects, the effects are muted in magnitude and more extended in duration, particularly as related to recharge. At this location, ideal groundwater levels rise about 5 – 10 feet with recharge events.

Nodes E5 EW4 and E5 EW5 are near recovery wells distributed under the regional strategy (Figure 1, Chapter 3.3) and therefore show greater recovery effects further from the local recharge/recovery zones. At node E5 WE4, groundwater declines about 10 ft and at node E5 EW 5 groundwater declines about 5 feet. *These results show regional recovery wells are affecting groundwater levels throughout the eastern half of MAGSA. This outcome appears to validate the regional recovery well strategy applied to this area of MAGSA*.

Considering 2021 groundwater contours within MAGSA (Figure 19), node *E5 EW2* is approximately 50 ft higher than the recharge/recovery zone. Thus *E5 EW1* and *E5 EW2* are likely outside the area affected by recharge basins located near E*5 EW3.* The gradual changes in groundwater elevations shown in Figure 23A for those two nodes are probably unrealistically high.

5.1.5 North-South Transect: Assess Recharge and Recovery Groundwater Effects on Oil Field

Figure 24 presents the ideal groundwater levels and elevations along a transect along Highway 145. The transect spans four miles from Node *145 5* in the north to *145 1* in the south, and crosses through the Raisin City Oil Field. Just east of this area, a set of regional recovery wells are located to pull recharge water to the east away from the oil field (Figure 2).

The goal of this through the Raisin City Oil Field to assess potential groundwater fluxes into, from or through the oil field as affected by the Bank and across different climate scenario.

Groundwater responds similarly at this transect as for previously described transects. Node *145 5* underlies recharge basins and, as has occurred elsewhere, ideal groundwater levels increase in response to recharge by about *70 – 80 feet near the basins* (Figure 24A). Node *145 4*, *approximately one mile south, shows muted mounding in response to recharge with increases of about five feet*. Further away, *groundwater mounds are not as noticeable* though there are upward and downward trends in response to periods of recharge and extraction.

Ideal groundwater level depressions also occur at *Node 145* 5 in response to recovery, dropping about 10 feet (Figure 24A). These depressions are muted at *Node 145 4* a mile away. Further away, the main groundwater level effect is gradual declines during a period of extended extraction.

This reduction in movement is also potentially reflected with the longer term temporal trends. Moving southward along the gradient, the longer term temporal trends associated with ideal groundwater levels are similarly shaped but their magnitude decreases (Figure 24A). At Node *145 – 4* at the northern boundary of the oil field, ideal groundwater levels over the course of the simulation reach a maximum level of about 18 ft and a minimum level of about -10 ft. Further away, these effects are muted. For Node *145 3,* the maximum level is about 15 ft and the minimum level about -5 feet. Nodes *145 1 and 145-2* have similar values, with a maximum value of about 10 feet and a minimum of about -4 ft.

We considered the effects of the recharge and recovery operations under the different climate scenarios to further consider if these operations would be expected to promote groundwater flows across the oil field. This assessment was done in consideration on the potential to encourage migration of poorer quality groundwater underlying the oil field (Bachand et al, 2023). For this analysis, we considered changes in groundwater gradients across the oil field from Node 145 4 to Node 145 1. Groundwater flows are driven by groundwater gradients in accordance with Darcy's Law with changes in head across a region linearly affecting changes in groundwater flow. Thus, increases in groundwater gradients under the different scenarios would indicate the differences in underlying groundwater flows.

Changes in Groundwater Flow from Recharge and Recovery Operations

Implementing the Bank will affect groundwater flows. Based on changes in groundwater gradients through the Raisin City Oil Field, groundwater flows are predicted to increase by about 10% under Bank operations, slightly more for the Wet Scenario and slightly less for the Dry Scenario. Because of this outcomes dependency upon basin and well locations, changes in their distribution would be expected to affect this outcome. The current design shows recovery wells located along the north of the oil field to capture recharge water prior to entering the oil field. An increase in wells along those upstream locations would be expected to reduce groundwater flows through the oil field by further decreasing the groundwater gradient resulting from recharge and recovery operations. operations. These changes are based on the recharge basin and recovery well distribution shown used for the ROM model. Changes in basin and groundwater well locations would be expected to affect these changes.

Figure 25 shows calculated changes in the groundwater gradient from Nodes 145 4 to 145 1. Each climate scenario resulted in temporal changes in the groundwater gradient. This result shows on a year to year basis, the recharge and recovery actions would either increase or decrease groundwater flows specific to the management occurring. Figure 25 shows the baseline gradient for the groundwater conditions represented in this document (Figure 19) at 0.19%. Groundwater flows across the oil field would expect to increase when the gradient is greater than 0.19% and decrease when less than.

Figure 26 relates these gradient changes across the entire simulation period for the different climate scenarios. For all the scenarios, the median gradient hovers around 0.21%. This value is an increase over the baseline gradient of 0.19%. Based simply on Darcy's Law, this increase in the gradient suggests groundwater flows will increase by about 10%.

Table 5 estimates the average increase for the different scenarios across the entire scenario. Under the Historic Scenario, an 11% increase is estimated whereas the increase is estimated at 9% for the Dry Scenario and 14% for the Wet Scenario. These data suggest given the recharge and recovery distribution shown in this report, the Bank is expected to increase groundwater flow through the oil field by about 10%, relatively similar across all scenarios. Because of the dependency upon basin and well locations, changes in the infrastructure distribution would be expected to affect this outcome. The current design shows recovery wells located along the north of the oil field to capture recharge water prior to entering the oil field. An increase in wells along those upstream locations would be expected to reduce groundwater flows through the oil field by further decreasing the groundwater gradient resulting from recharge and recovery operations.

Table 5.Estimated change in groundwater flow through the oil field

	Median GW Gradient	Increase in GW flow (1)
Historic	0.211%	11%
Dry	0.207%	9%
Wet	0.217%	14%

Note

1. Estimated from Darcy's law where flow is proportional to change in head

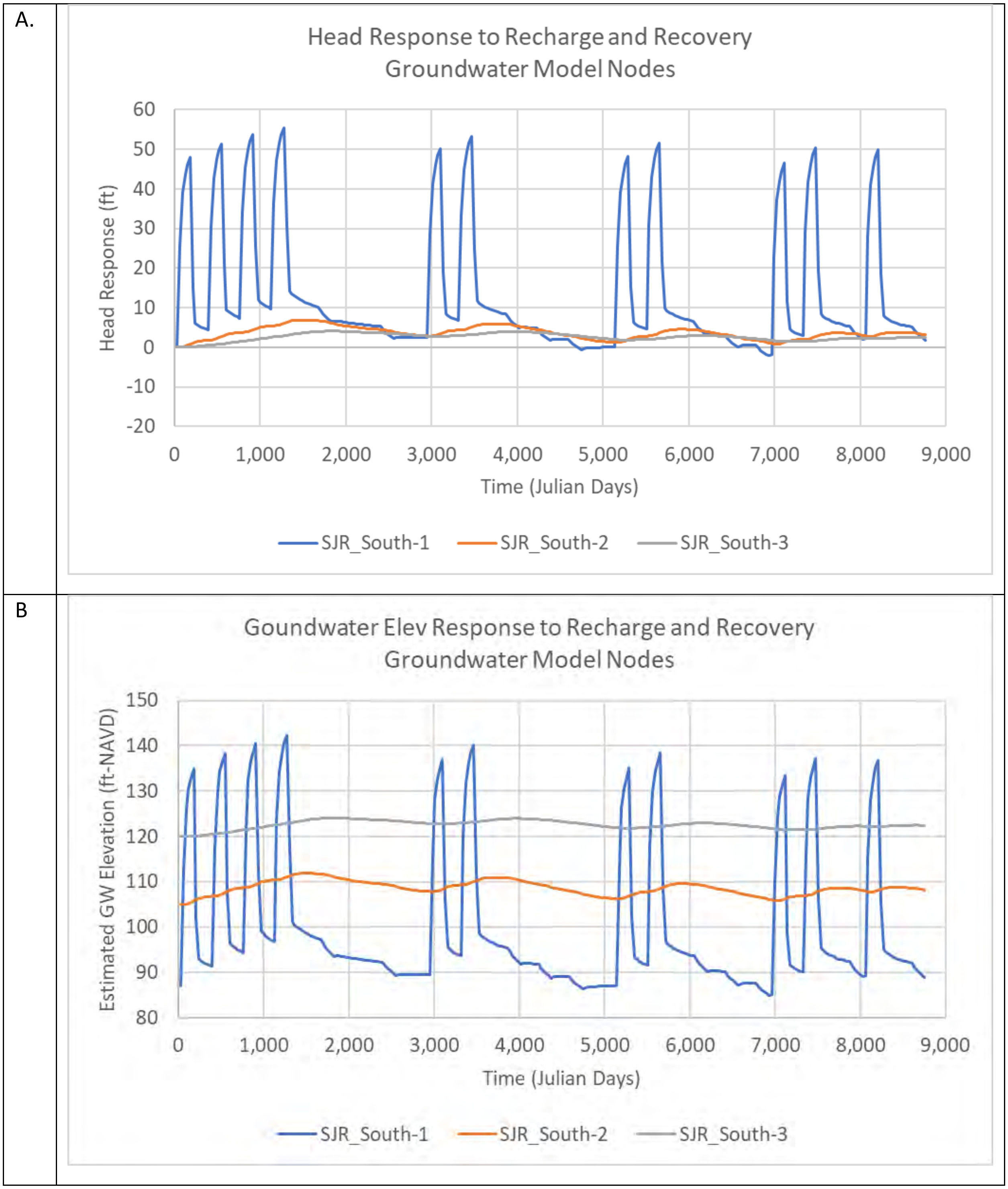
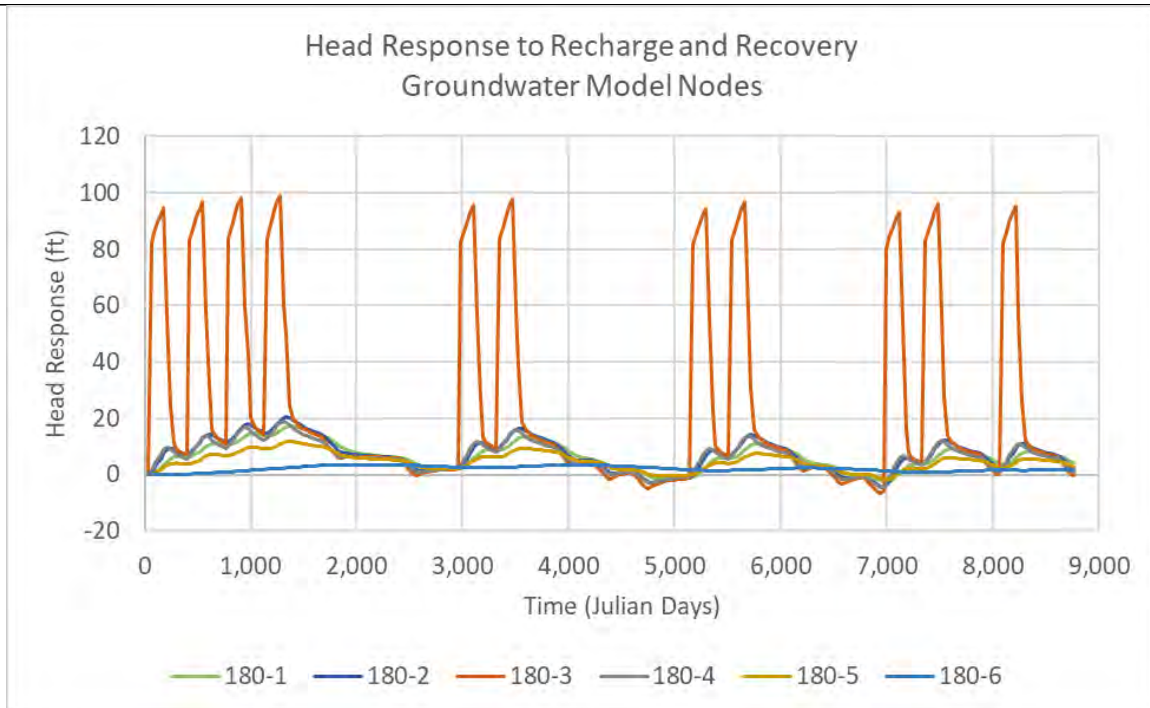


Figure 20. GW Head and Elevation Responses along SJR Transect



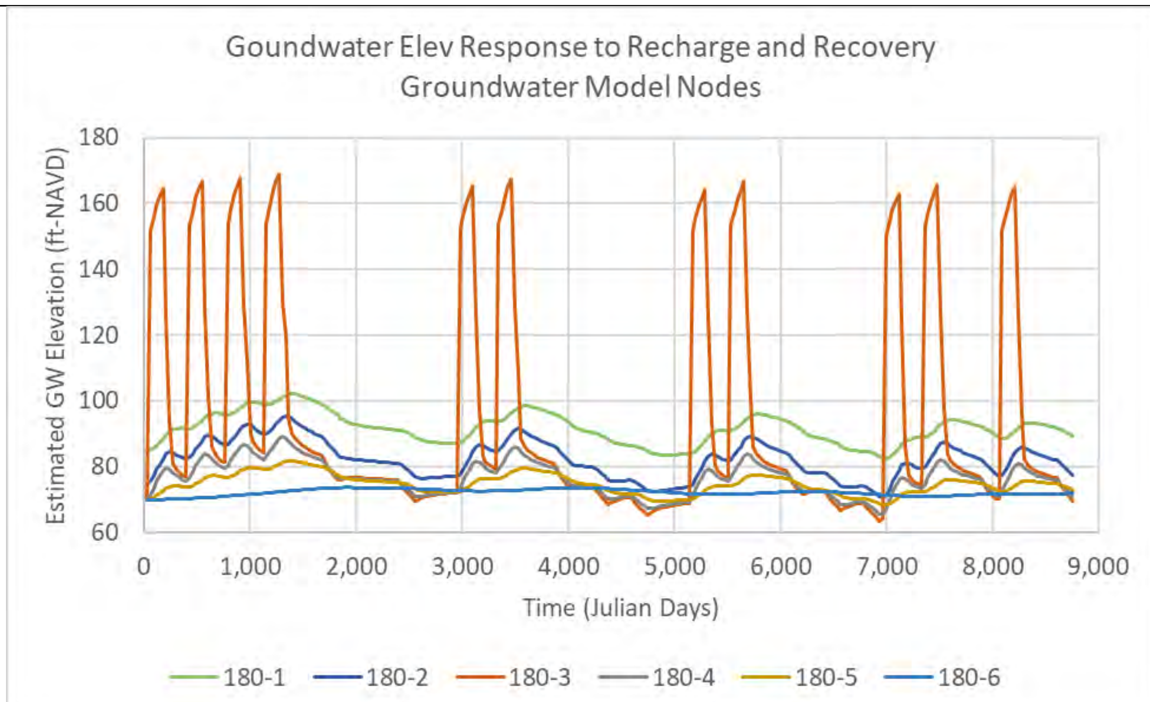


Figure 21. GW Head and Elevation Responses along Northern MAGSA

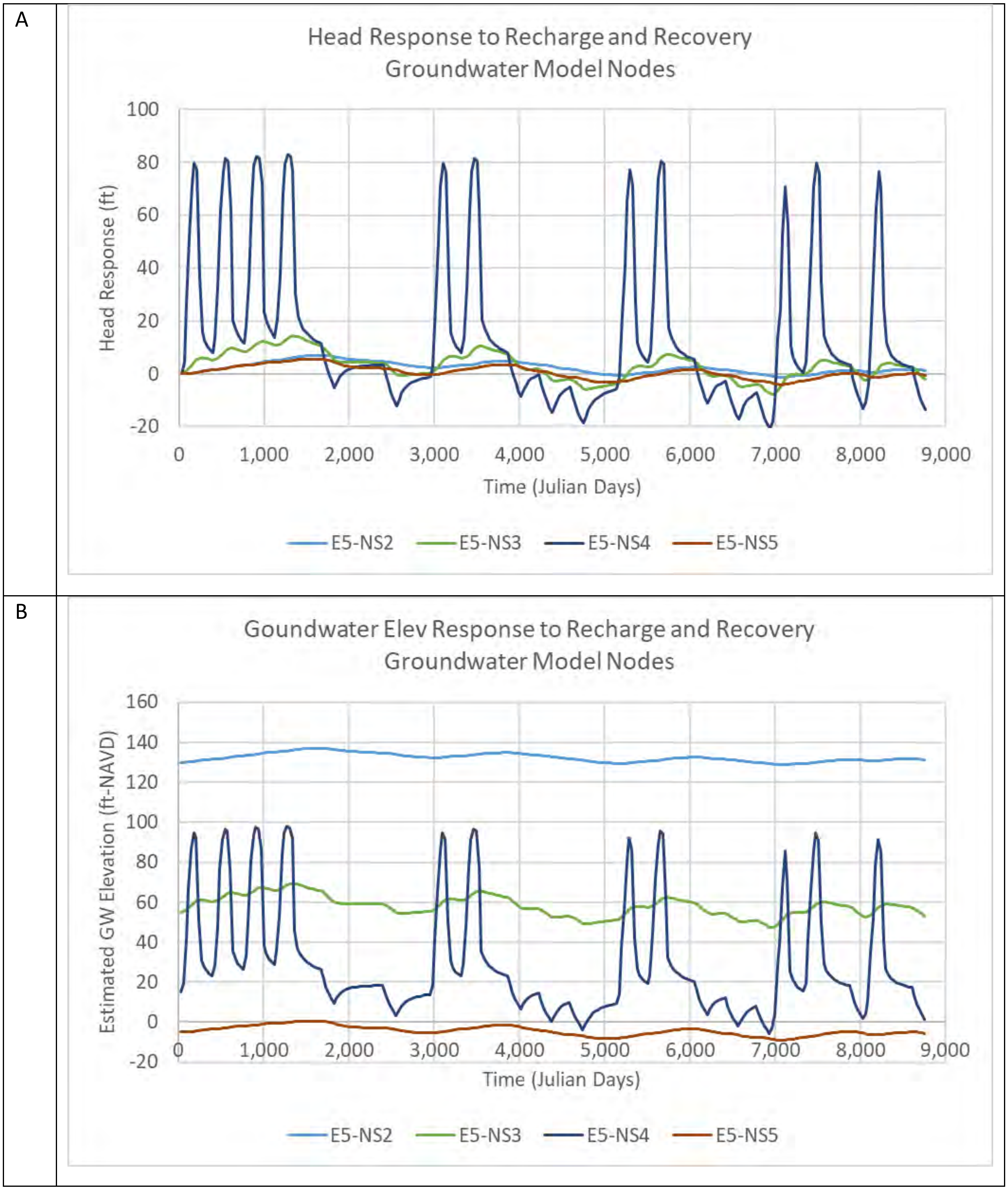


Figure 22. GW Head and Elevation Responses along eastern North-South Transect

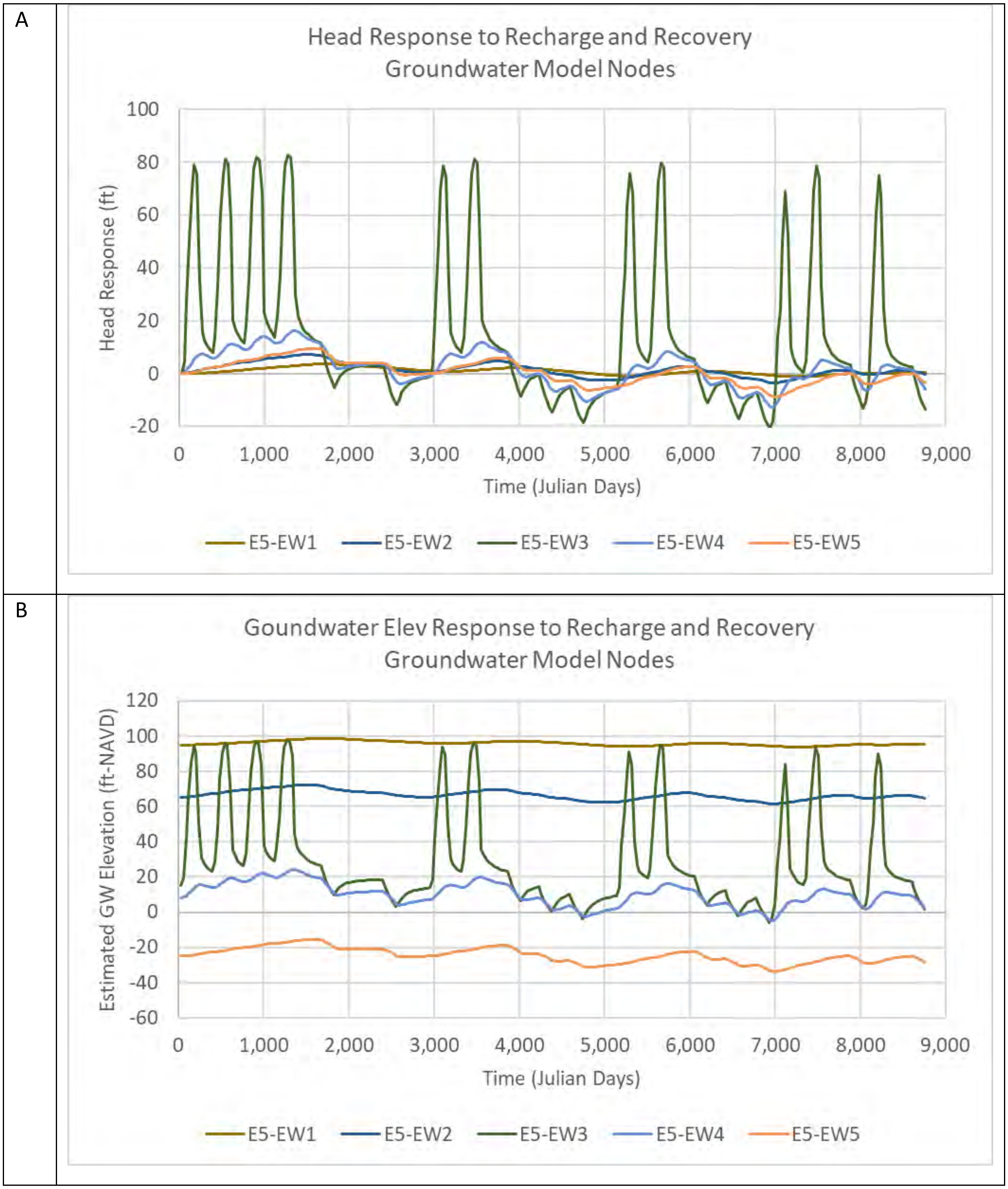


Figure 23. GW Head and Elevation Responses along southern East-West Transect

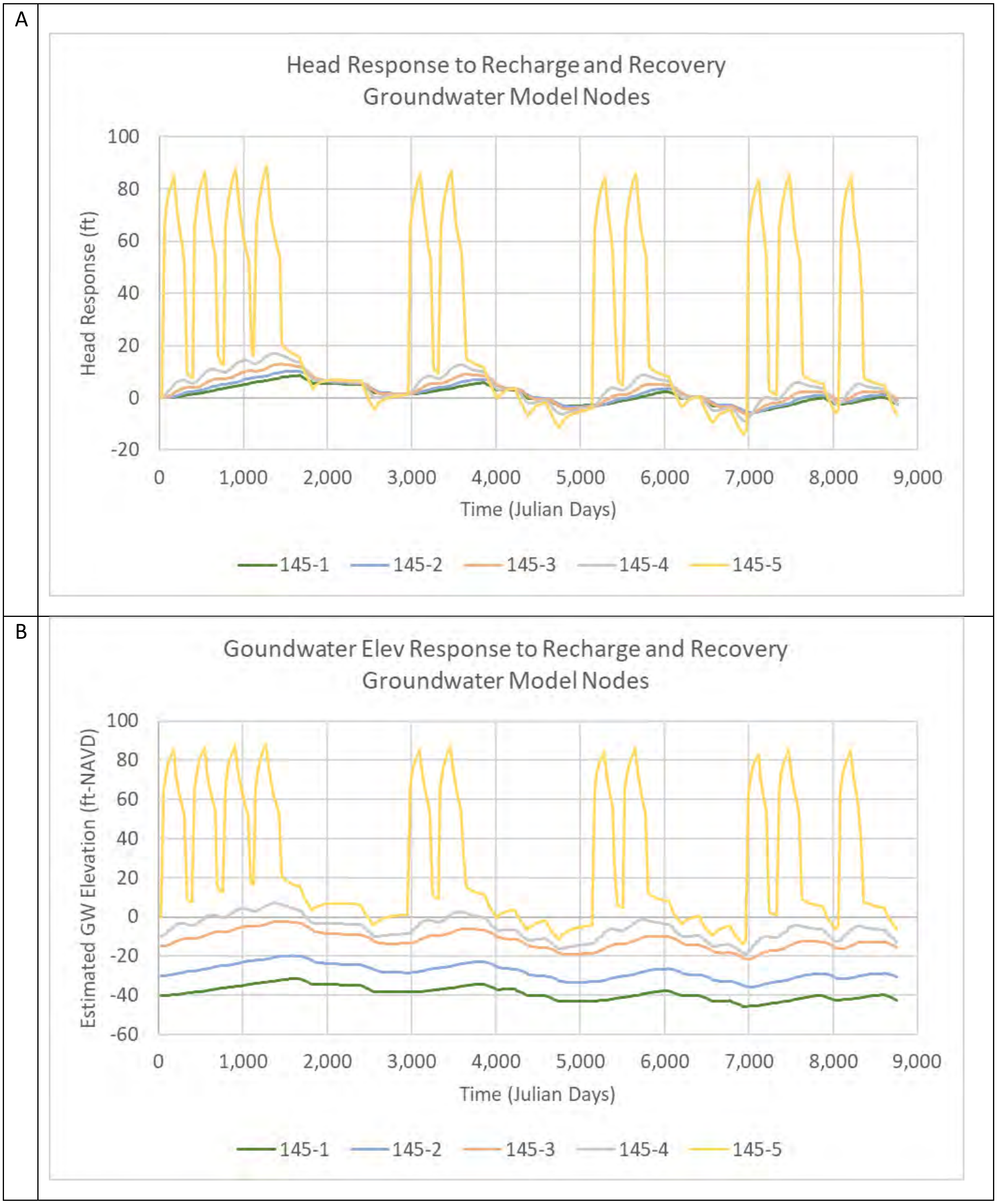


Figure 24. GW Head and Elevation Responses along 145, Historic Scenario

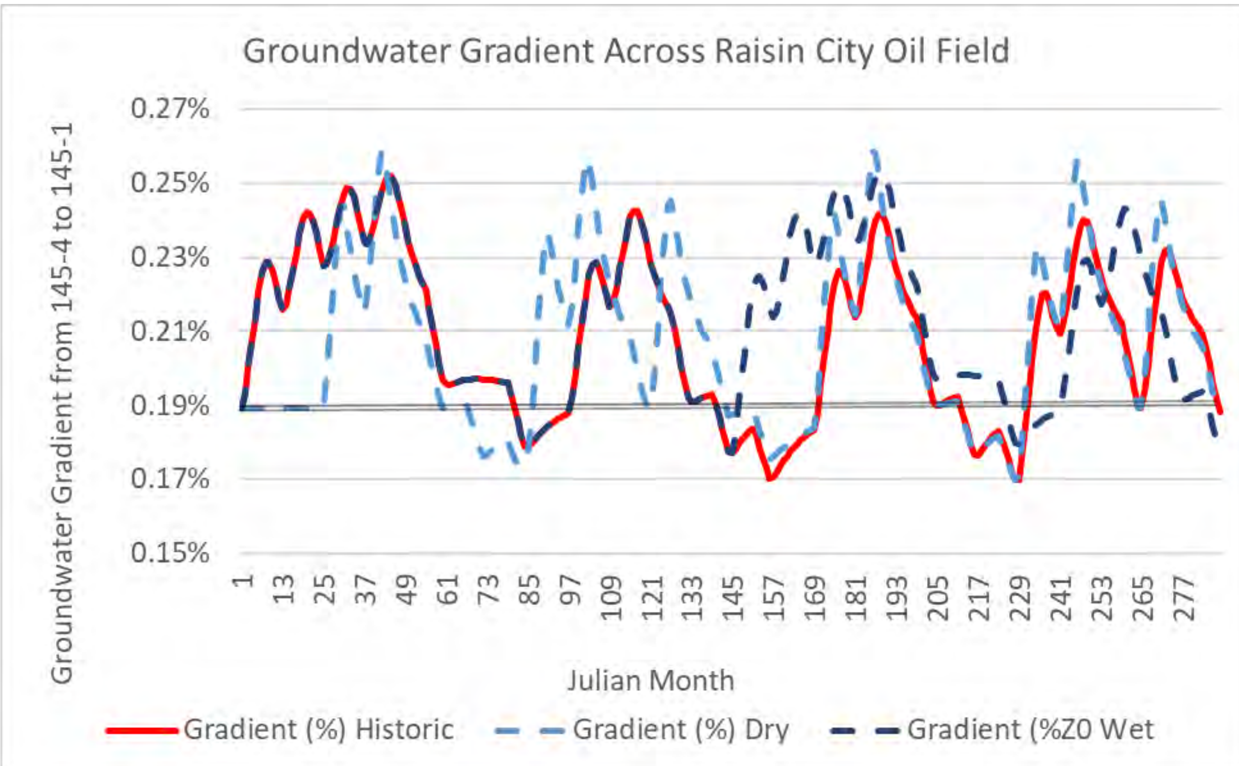


Figure 25. Groundwater gradient along Transect 145 for the Climate Scenarios
The fall shown is for Julian Months beginning in October 1996 and is calculated from nodes 145-4 to 145-1 for the different scenarios: Historic, Dry, Wet. The current baseline groundwater gradient is 0.19% as shown in the above figure.

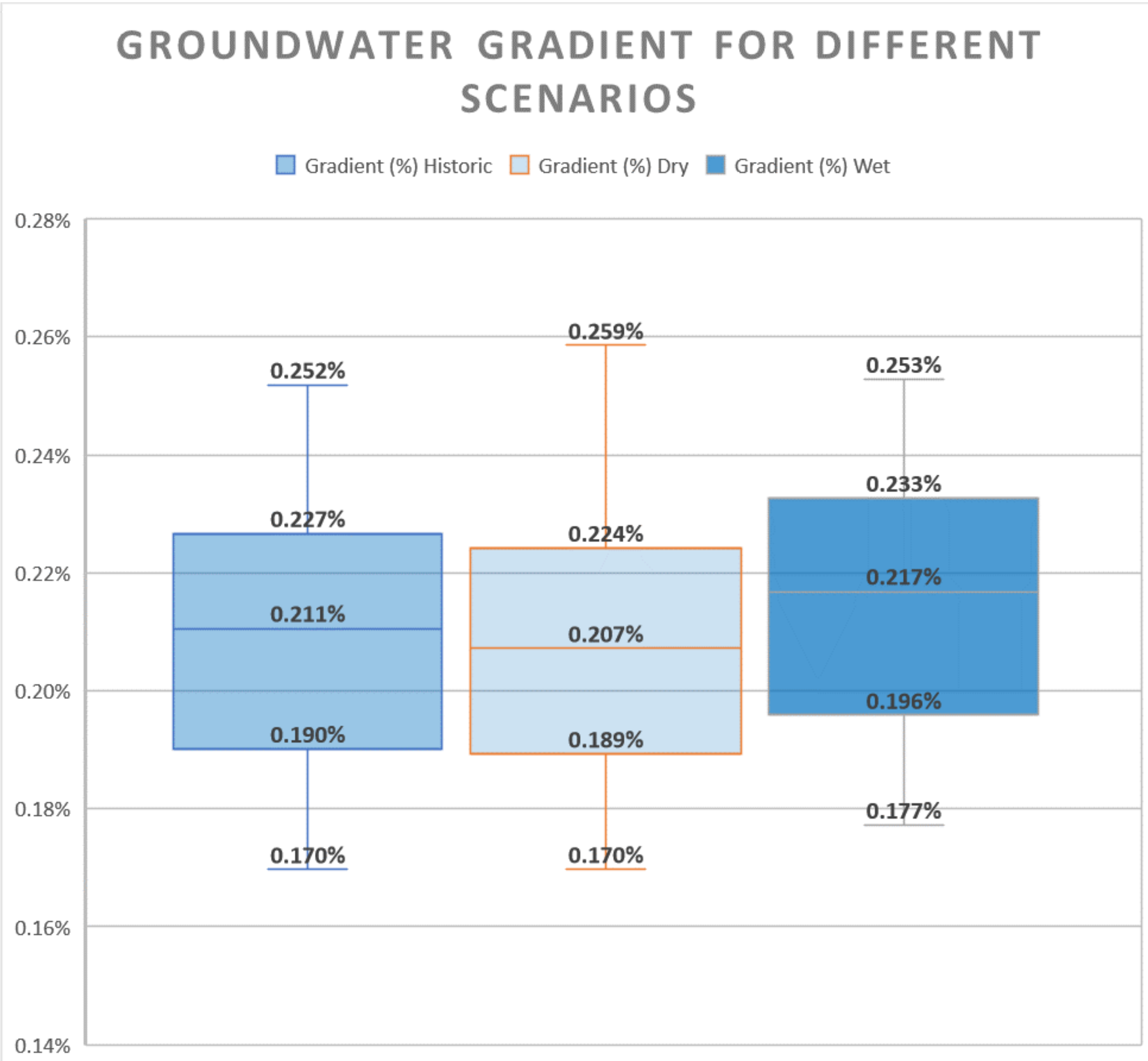


Figure 26. Statistics for percent fall for the Climate Scenarios
The figures show the median, 25th and 75th quartiles and the min/max for the climate scenario data shown in Figure 25

6 Discussion

6.1 Recharge Basin and Recovery Well Effects are Localized

Recharge basin effects are localized, with groundwater underlying the basins dramatically affected and then a limited area around the basin having more muted groundwater effects.

Several simulation examples from the ROM Model predict a relatively rapid groundwater level rise of between 50 – 100-ft with the onset of recharge, greatest with the number of basins and size of the complex (Figure 20 through Figure 24). This relatively consistent response shows up across the model domain. When recharge stops, the underlying groundwater levels as represented in the model decline rapidly as well.

Recovery wells have a less dramatic effect on local groundwater elevations underlying a recharge basin. Wells appear to drop water levels by about 10 – 15 ft. This less dramatic effect is likely due to the lower hydraulic capacity of a well in comparison to a recharge basin and the broader distribution of wells, both locally in the recharge zones and regionally throughout MAGSA.

Local Effects of Recharge vs Recovery

The model shows local ideal groundwater levels increase 50 – 100 ft under recharge and decline 10 – 15 feet under recovery. The design calls for about 90 recovery wells at 2500 GPM (~11AFD). Thus there are about twice as many extraction wells as recharge basins, each pumping out at twice the rate as recharge at each basin.

The regional extent of the affected area is relatively small. When comparing responses along the transects at different groundwater measurement nodes, the groundwater effects, whether from recharge or recovery are muted typically within a mile or two. Typically, at nodes one to two miles from a recharge basin, groundwater levels increase in response to recharge by a maximum of 10 to 20 ft. Those effects extend over a longer time, a softening and widening of the groundwater effect.

6.2 Water Quality considerations regarding selenium

Based upon transects presented (Figure 20 through Figure 24), the vadose zone underlying recharge basins could be expected to commonly experience groundwater elevation changes of 70 – 100 ft and these changes would occur relatively rapidly. In these soil profiles during periods of rising groundwater levels, soil moisture content would increase from field capacity[8] up to levels to near or at saturation. With that increased soil water content, redox conditions in the vadose zone could become more reduced and with the subsequent draining, become more oxidized. These changing redox conditions could

[8] Field capacity is the moisture content in soils above which any additional water added to the soils will subsequently be removed through gravity.

mobilize formerly immobile forms of some trace elements, the two most commonly considered being arsenic and selenium. Bachand et al (2023) discuss this phenomenon as related to the Bank and discuss selenium in particular as related to environmental standards.

How important are these redox effects? That question is both a question of scale and dilution.

The scale of this effect can be assessed by considering the volumes of the vadose zone affected and the frequency of it in comparison to similar groundwater level swings occurring typically under agricultural production within MAGSA. Figure 27 presents typical depth to groundwater data from the southern area of MAGSA from April 2022 through March 2023. That data shows groundwater changed about 15 feet over the year, from about 232 ft depth to a maximum depth of about 247 feet around August at the heigh of pumping, and then a recovery to about 227 feet by the following spring. We assume those changes are relatively similar throughout MAGSA as agriculture covers nearly all of MAGSA and that agriculture relies entirely on groundwater.

Table 6 quantifies the volume of the vadose zone affected by these annual irrigation cycles. For the 120,000-acre MAGSA region and typical cycling of groundwater estimated at 15-ft, the estimated volume of the vadose zone affected by this cycling is about 1.8M AF. That effect occurs annually so the rate of that vadose zone effect is 1.8M AF per year (annually).

Selenium

Groundwater level swings from recharge and recovery will likely affect subsurface redox conditions that could potentially mobilize selenium and other redox dependent trace elements like arsenic. These swings occur under irrigation in MAGSA. Groundwater level typically vary by 15 – 20 feet or so in the southern area of MAGSA. These results suggests that under maximum recharge and recovery operations, the vadose zone volume experiencing these groundwater swings would increase by about 15% annually if the Bank is operating at maximum levels. More realistically, the vadose volume experiencing those swings will likely increase by <10%. Thus additional mobilization due to banking activities is not expected to be significant.

Table 6 also quantifies the volume estimated locally to recharge basins based on the aforementioned groundwater analyses of ROM Model data. For the 3500 acres of recharge basins, we assume twice the affected vadose zone area (7000 acres), and an 80-ft swing in local groundwater, the affected vadose zone volume is 560,000 AF. That volume is about 30% of the vadose zone volume estimated as affected by agriculture through groundwater pumping.

This estimate for the recharge basins likely overestimates the affected vadose zone volume. For some examples, simulated groundwater elevation swings under recharge were ~35-100ft, localized around recharge basins. The 80ft essentially represents a conservative estimate of the thickness of the vadose zone that is potentially experiencing change of redox condition induced by the Bank operations. Additionally, the swing calculated from the model assumed maximum recharge during the years recharge occurred. That assumption assumes maximum flows of basins and the maximum number (and acreage) of basins. Those assumptions are very conservative. Thus, the calculated affected volume at 560,000 AF is very likely an overestimate when normalized across all recharge years.

The Historical record suggests recharge could occur every other year, thus the average annual affected volume is 280,000 AF/y. That annual volume is about 16% of the annual volume associated with normal agricultural operations

Selenium exported to groundwater will be diluted by recharge water and regional groundwater As discussed in Bachand et al (2023) in relation to salts and nitrate, that dilution would be significant.

These two considerations strongly suggest any additional mobilization of selenium should be relatively minimal in comparison to mobilization through normal agricultural practices.

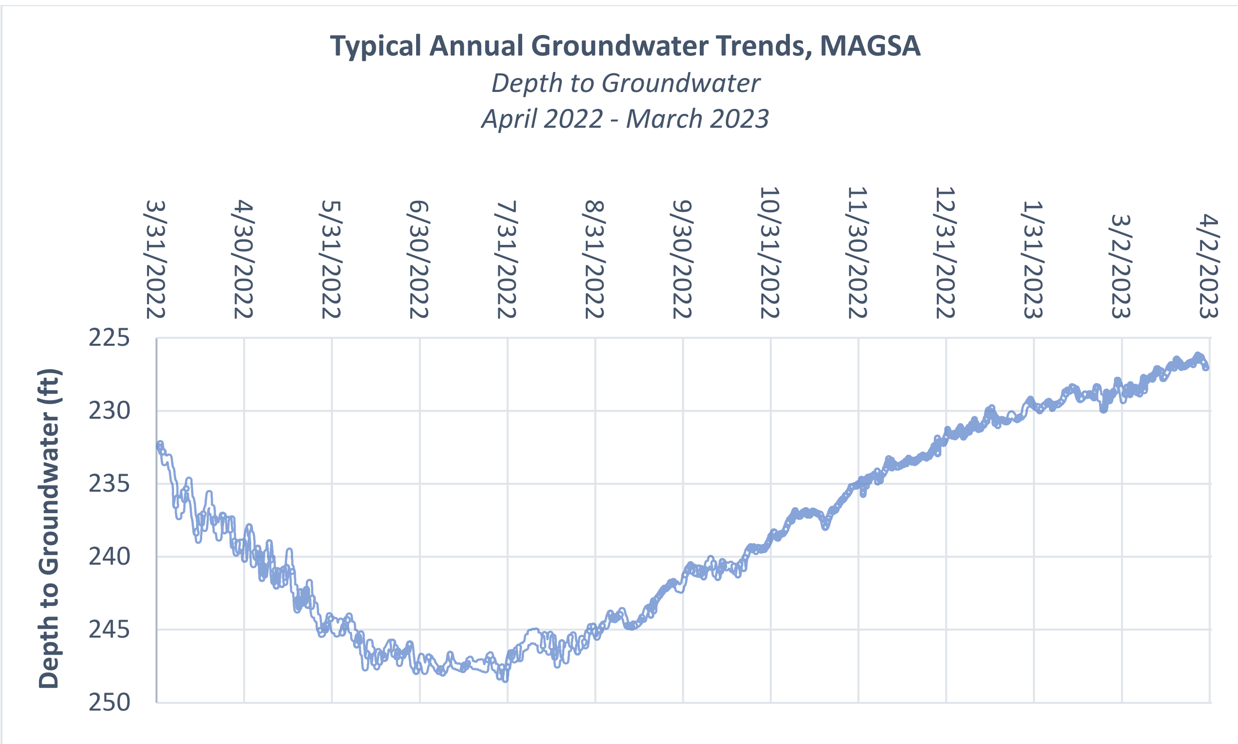


Figure 27. Typical annual groundwater trends, MAGSA

Table 6. Vadose zones affected by redox changes.

	Calculations	Recharge Driven Affect Local to Recharge Basins (2)	Typical Agricultural	Units	Re:Ag
Volume of Recharge Zone					
	Estimated affected areas of vadose zone	7,000	120,000	Acres	6%
	Typical annual groundwater elevation change (1)	80	15	Ft	533%
	Affected vadose zone volume	560,000	1,800,000	Ac-Ft	31%
Schedule of the Cycling through elevation change					
	Period	Biennial (every 2 years)	Annually		
	Frequency	1	1	per year	50%
Volume Rate of Affected Zone					
		280,000	1,800,000	AC-Ft/y	16%
Note					
1	From a maximum level to a minimum level and back.				
2	Assuming maximum recharge every year water is available. Assumption is very conservative.				

6.3 Percent Recovery Issues

MAGSA is targeting 90% recovery of deposited Bank water to be returned to contractors, with only 10% estimated as loss. The ROM Model suggests that target would be difficult to meet.

6.3.1 ROM Model Outcomes

The ROM Model estimates that recharged water will be pushed outside of MAGSA through the 24-years simulations. Figure 15 summarizes this outcome for the three modeling scenarios. In all three scenarios, groundwater levels are elevated well outside MAGSA's borders, including well east. The degree depends upon the amount of recharge and recovery under each scenario.

The fundamental processes driving that spreading are the differences in head levels and the gradients that result, and the rates of recharge and recovery.

As discussed previously throughout this document, the ROM Model predicts groundwater levels to typically increase about 35 – 100 ft local to a recharge basin. Recharge basins are modeled to infiltrate at about 5 in/d and are typically about 80 acres in the current

Why the ROM Model results show water pushed far out from the basins?

The model depicts a 50 – 100 ft increase in groundwater under a recharge basin delivering at 33 AFD. Conversely, recovery wells draw groundwater down locally 10 – 15 ft and pulling out 11 AFD. Groundwater mounds 5x higher (than recovery groundwater depressions) and equilibrium flows 2x higher (than recovery well pumping rates) drive recharge water further and faster out from the source than it can subsequently be pulled back in later. Those factors result in water pushing far outside MAGSA's borders and staying there.

design (Table 1). That corresponds to an estimated recharge rate of 33 AFD. Under these conditions, a steep gradient and a high flow rate push lots of water laterally. That effect shows up throughout the ROM Model simulations when considering recharge years (e.g., Figure 8, Figure 9).

In comparison, the ROM Model calculates depressions from recovery well pumping to a maximum depth of about 10 – 15 ft. The recovery wells are expected to typically pump at 2,500 GPM (Table 1) or about 11 AFD. Thus, at each recovery well location the groundwater head differences are less dramatic and the flows about half. Thus, the ROM Model shows recovery wells as affecting groundwater levels less dramatically than recharge basins (Figure 10, Figure 11).

Under the ROM Model, these underlying factors drive groundwater outside of MAGSA and limit its recovery back into MAGSA. In short, lower annual volumes and less head differences during recovery periods as compared to recharge periods drive spreading out recharge water beyond regions it can be recovered as modeled.

6.3.2 Considerations of Assumptions and Implications for Real World Outcomes to the East

A fundamental underlying assumption for the ROM Model is it does not consider the existing groundwater gradients. Depths to groundwater increase by over 100 feet from the east and over 140 feet from the north (Figure 7). Groundwater elevations decrease from about 100 ft-NAVD in the east and north of MAGSA to -40 ft NAVD at the cone of depression along the southwest corner of MAGSA. The baseline groundwater gradients are not included in the ROM Model.

That assumption significantly affects the model's spatial results. From the temporal data, we estimate that groundwater levels will increase by about 20 ft during recharge a half to 1.5 miles from a recharge basin. Thus, recharge basins should be able to transport water up gradient.

We assume a recharge-induced groundwater mound could overcome up to a 30-ft gradient. Figure 28 overlays that assumption onto Figure 15, the groundwater elevations from 2021. That boundary is 30- upgradient of the most eastern recharge basins. The boundary identifies the groundwater elevation barrier to upgradient mound spreading, based on 2021 contours. This boundary is effectively the upstream eastern limit to changes groundwater level from recharge.

How Far Can Groundwater Really Spread Eastwards

The model depicts that for areas beyond the localized mounding, groundwater levels can increase by 20 ft over time in response to extended periods of recharge. Uncertainties in the underlying constants suggests that number is an estimate. If we conservatively assume an average rise of about 30 ft, then we can assume direct recharge effects can climb upgradient about 30 ft +/-.

In reality, groundwater elevations contour lines will shift through the seasons and years. This line will thus shift in relation to the recharge basins. However, because groundwater levels will be changing universally, the boundary, based on relative groundwater differences, will likely not dramatically move. Figure 28 shows the lines uncertainty to be about 1.5 – 2 miles to accommodate those seasonal and annual effects.

The ROM Model overestimates the eastward extent of upgradient groundwater spread; in reality the extent of upgradient movement will likely be on the order of one to three miles (Figure 28).

6.3.3 Real World Outcomes to the West and South

The same assumption that leads the ROM Model to overestimate groundwater effects upgradient may contribute to it underestimating groundwater effects to the west and south. The underlying groundwater contours show general flow paths are towards MAGSA from all directions because the cone of groundwater depression is in the southwest corner of MAGSA (Figure 19). These flow paths suggest the western and southern extent of groundwater effects from recharge will be somewhat limited by the existing cone of depression, though the degree unknown.

The ROM Model suggests some overdraft could occur west of MAGSA and within MAGSA. However, with less water moving east upgradient during recharge, it is likely that groundwater declines during extraction will be less than predicted by the model. Uncertainty on the extent and degree exists around that outcome.

6.3.4 Percent Bank Water Loss from MAGSA

Based on this analysis, we expect some recharge water deposited to the Bank will move east upgradient outside of MAGSA. Long-term improvements in groundwater levels adjacent and to the east of MAGSA could occur, potentially extending on the order of one to three miles east. Some depressions in groundwater elevations to the south and west of MAGSA could also occur as predicted by the ROM Model. Not including existing or representative groundwater gradients in the model creates great uncertainty regarding the distribution and extent of those effects to the west and south.

Short and Long Term Bank Losses

Less water will migrate east than depicted by the Rom Model because of existing groundwater gradient constraints. More water could migrate west and south because of those same groundwater factors. Groundwater levels are thus likely to change outside of MAGSA.

Those changes represent movement to semi-equilibrium conditions in which changes in groundwater elevations and levels drive groundwater flows and their flow paths. Yet within MAGSA, groundwater elevations drop 100 ft from its northern and eastern borders to the cone of depression in the southwest corner. The Bank with its water deliveries and withdrawals will not significantly affect that fundamental characteristic. In the short term, recharge water may spread outside of MAGSA but in the long term groundwater flow paths will pull it back in. Underlying and relatively recalcitrant existing groundwater flow paths will ensure recovery of contract water introduced into the Bank through recharge.

Other factors not presented in this report are also likely to affect groundwater levels. These include changes in groundwater pumping within MAGSA and throughout the Kings Basin as well as more broad distribution of recharge throughout the Kings Basin. These actions are included in Groundwater Sustainability Plans by Groundwater Sustainability Agencies throughout the Kings Basin. These actions will no doubt affect groundwater elevations and could affect groundwater elevations within MAGSA as well.

Recovery Well Two-Way Strategy

In the model, recovery wells are deployed according to a local and regional strategy.

The ROM model illustrates changes in groundwater levels which drive groundwater flows and directions due to banking operations, assuming an initial level groundwater table surface. Yet within MAGSA, groundwater elevations drop about 100 ft from MAGSA's boundaries in the north and east to the cone of depression in the southwest of MAGSA. The implementation of the Bank with deposit and withdrawals of contract water will not significantly affect that fundamental characteristic. in the short term recharge water may spread outside of MAGSA but in the long term groundwater flow paths will pull it back in. Thus, underlying and relatively recalcitrant groundwater flow paths will ensure recovery of contract water introduced into the Bank through recharge.

6.4 Locating Recharge and Recovery Infrastructure to Meet Bank Operation Targets

The ROM Model reinforces the expectation that strategic placement of recharge and recovery infrastructure can affect the Bank's performance.

In the distribution of recharge basins and recovery wells a number of goals were identified:

1. Leverage flow paths to enhance recovery by the Bank Water,
2. Place basins in the east to limit eastward losses, and
3. Limit flow through the Raisin City Oil Fields.

Results of the ROM Model superimposed onto existing groundwater contours suggest the placement of the infrastructure supported these goals.

Recharge Water Escapes Local Recovery Zone

The phenomena of recharge pushing water moving further laterally than can be recovered the local extraction well means some percent of water deposited at a recharge basin will move beyond the recovery zone for that basin. Regional wells are thus required, at a minimum, to recapture this water.

6.4.1 Leverage flow paths to enhance recovery by the Bank

One design target has been to leverage existing groundwater flow paths to enhance Bank operations. This action has a number of objectives:

1. Capture recharge water lost outside of local recovery well capabilities;
2. Reinforce flow paths to preserve Bank groundwater flow characteristics; and
3. Target capture from the eastern half of MAGSA where water quality is highest.

The ability of the Bank to recover groundwater requires recovery at the recharge basins and downstream, when "lost" from those basin systems.

Towards this goal, two strategies have been employed in the Project:

1. **Local well strategy:** Recovery wells local to recharge basins to capture Bank water "deposited" at those basins; and
2. **Regional well strategy:** Recovery wells located down gradient to capture Bank water moving out of reach of that local system.

The clearest example of the regional well strategy is recovery wells along the main conveyance canal running east-west in the southern end of MAGSA (Figure 29). That E-W conveyance channel runs along groundwater flow paths (Figure 19). Having wells along the groundwater flow path will enable capture of recharge water that has moved beyond wells installed for local recovery from the associated recharge basin. ROM results indicate the strategy will work; it showed preferential lowering of groundwater levels along that region during years recovery occurred (Figure 10, Figure 11).

Regional Well Strategies

The minimum requirement for a regional well strategy is to capture recharged water that has moved outside the recovery zone for a basin and cannot be locally recovered.

Recovery wells placement and operation can reinforce or suppress groundwater flow paths to achieve management or operational objectives. Model depictions and data support the contention that recovery well placed along the southern east-west conveyance corridor has reinforced the groundwater flow paths and allow preferential withdraw of groundwater in that area. The data also supports the contention strategic placement of recovery wells limit flows of recharged water through the Raisin City Oil Field.

The placement and operations of recovery wells is critical for Bank management.

The two remaining objectives of reinforcing flow paths are to preserve Bank groundwater flow characteristics; and target capture from the eastern half of MAGSA where water quality is highest. ROM results indicate both these goals are met through preferential lowering of groundwater in the eastern half of MAGSA (Figure 10, Figure 11). Figure 15 shows these objectives are met through all climate scenarios for the 24-year simulation period. In all scenarios, groundwater is preferentially lower in the eastern half of MAGSA. That outcome would preserve groundwater flow paths, including the cone of depression (Figure 19). The preferential lowering of groundwater also means the preferential removal. This eastern area in which groundwater is preferentially collected through the regional recovery wells is the region with the highest water quality as discussed by Bachand et al (2023).

6.4.2 Place recharge basins in the east but limit eastward losses

One design consideration is minimizing potential impacts due to recharge on areas adjacent to MAGSA. As most recharge basins are along the eastern spine and half of MAGSA, this concern focuses primarily on regions east of MAGSA. Accompanying potential impacts, such as dramatic swings in groundwater levels, this concern also relates to pushing groundwater far east outside of MAGSA as is presented in the spatial results from the ROM Model.

To accommodate this potential issue, recharge basins as planned have not been located along the eastern edges (Figure 29). Hydrograph results from the ROM Model (Figure 20 through Figure 24) indicate that a mile from recharge basins, groundwater levels will increase up to 20 feet due to recharge. That finding has allowed us to identify an eastern border that defines the influence of recharge (Figure 28). That figure shows that in areas in which recharge basins were placed to limit eastern losses, the effects on groundwater expected from recharge are not expected to extend eastward beyond MAGSA's borders.

6.4.3 Limit Flow through Oil Field

Finally, regional recovery wells are modeled north and east of the Raisin City Oil Field. The goal of those wells is to limit flow through the oil field. Placed perpendicular across flow paths, the recovery wells are laid out to suppress groundwater flow paths that drive groundwater through the oil field.

That result is achieved as discussed in Chapter 1 in which calculated flows through the oil field are a small percent of recharge flows. Thus, in this instance, recovery well have been placed to suppress rather than reinforce flow paths.

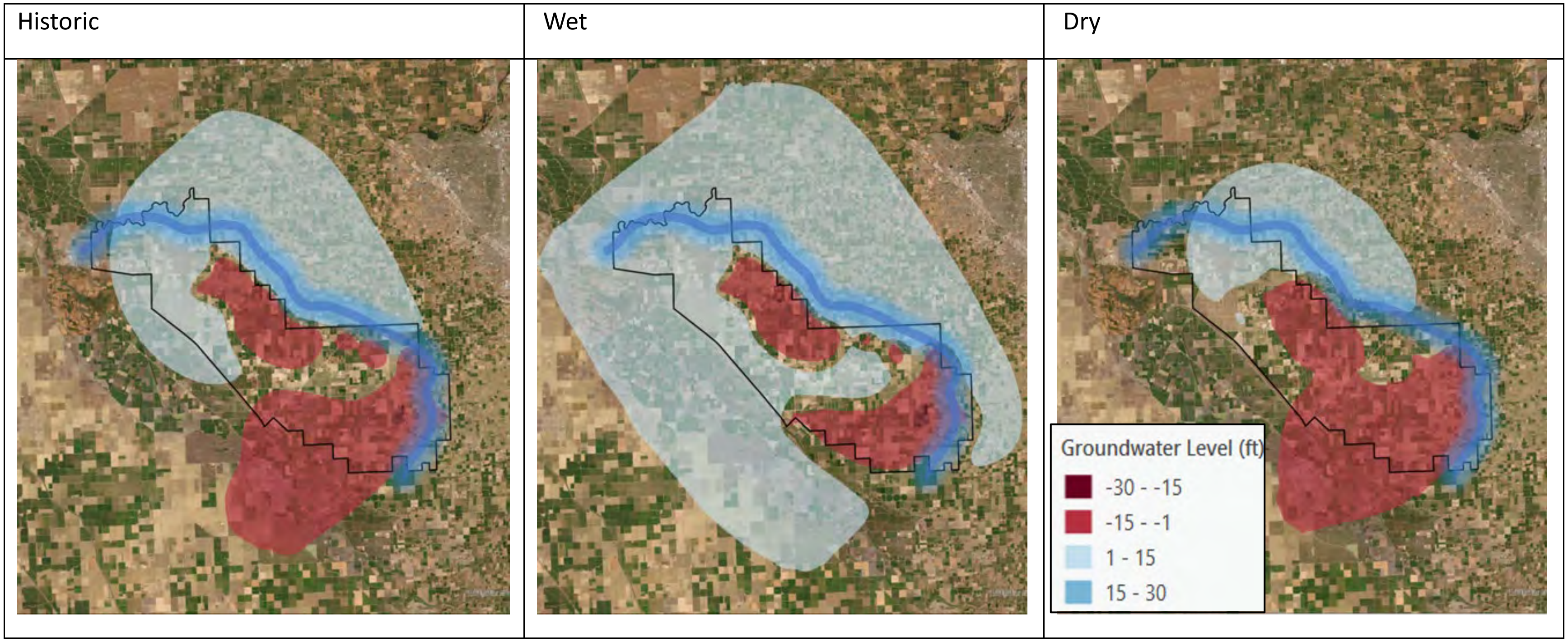


Figure 28. Corrected September 2020 for Historic, Wet and Dry Model Scenarios.
Blue line shows maximum north and east movement of recharge water.

ROM Model Exaggerates the Extent of Groundwater Effects East of MAGSA

The projected extent represents a 30-ft climb east and north of recharge basins. This border represents a truer analysis of the extent east and north groundwater elevations would be directly affected by recharge. The width of the line is about 1.5 miles to represent uncertainty. Areas further east could potentially be affected indirectly by decreasing groundwater gradients.

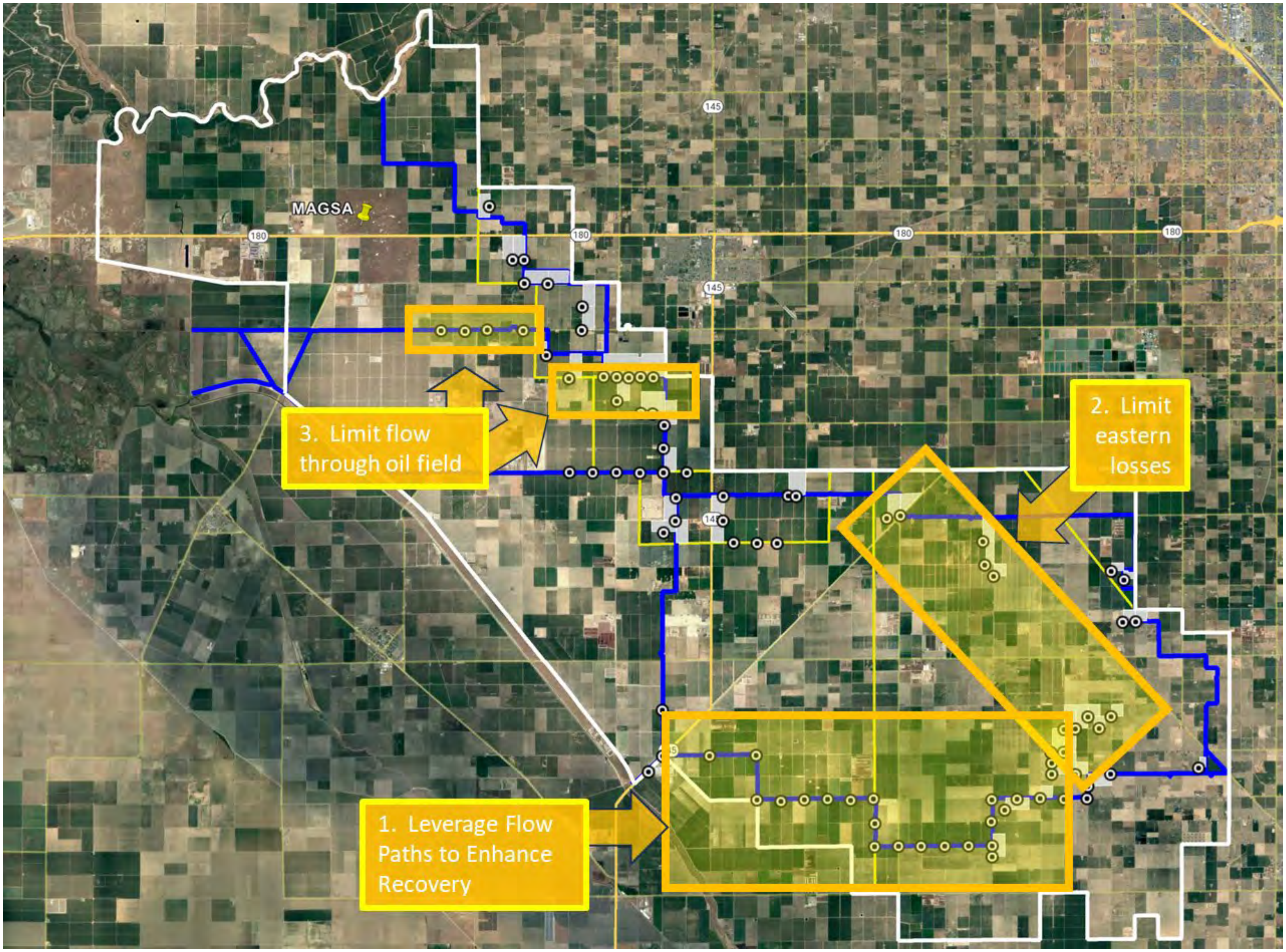


Figure 29. Actions to enhance operations and success.

7 Key Effects Findings and Management

This report assesses the groundwater hydrology of the Bank through review and interpretation of a reduced-order MODFLOW (ROM) that uses the Central Valley Hydrologic Model (CVHM) characteristics and inputs. The ROM model is designed specifically to track groundwater hydrology response and effects specific to Bank recharge and recovery operations. Potential hydrologic effects from implementing and operating the Bank include effects to groundwater supplies, surface water resources and water quality of groundwater. Some questions that can be answered through the ROM model include:

1. Will the bank decrease groundwater supplies or interfere with groundwater recharge and impede sustainable groundwater management?
2. Will surface drainage patterns be affected by changes in groundwater?
3. Will the bank create hydrologic conditions that impede groundwater quality or groundwater use?

Hydrologic conditions that impede groundwater quality or use include swings in groundwater elevations that mobilize or transport water quality constituents, flow paths that move poor quality water to areas with higher quality water, and large declines in groundwater elevation that exceed the depths of the various drinking water and irrigation wells.

Each of these three questions are discussed below, including potential management needs. These management efforts are subsequently discussed.

Key Hydrologic Considerations

1. Will the bank decrease groundwater supplies or interfere with groundwater recharge and impede sustainable groundwater management?
2. Will surface drainage patterns be affected by changes in groundwater?
3. Will the bank create hydrologic conditions that impede groundwater quality or groundwater use?

7.1 Considering Bank Effects

7.1.1 Will the bank decrease groundwater supplies or interfere with groundwater recharge and impede sustainable groundwater management?

The Bank will not decrease groundwater supplies. Results from the model suggest groundwater mounding up to ~100 ft and depressions of up to 15 feet at the recharge basins and their local recovery systems. Predicted groundwater elevation changes 1 mile beyond these localized regions will have much more modest elevation changes of less than ~5-20ft. These elevation changes will rapidly begin to occur with the initiation of recharge or recovery activities, and rapidly reverse with those activities cease. After that period, groundwater elevations will relax to levels near surrounding conditions. These surrounding conditions will slightly move up and down depending upon if there are extended periods of recharge or recovery.

In general, the model predicts a few characteristics of the semi-equilibrium conditions that subsequently follow periods of recharge and recovery activities. First, with the relaxation of groundwater levels, minor elevation changes of up to a few feet above or below “baseline” conditions are predicted depending upon the period having extended periods of recharge or recovery. Second, the processes of recharge and recovery will tend to move recharged water away from basins because recharge results in greater head differences and flow rates compared to recovery. This factor explains why under all climate scenarios, the model predicts groundwater levels are slightly raised outside of MAGSA and that some slight depression occurs within MAGSA, when there are depressions.

Minimal hydrologic effects and long-term progress towards sustainability.

The model will have modest effects on groundwater throughout MAGSA except in the local vicinity of recharge basins where dramatic groundwater swings can occur. The existing underlying groundwater contours will provide primary controls of groundwater and hydrologically contain it. In the long term the Bank will increase local groundwater supplies and improve groundwater supply sustainability.

The model overstates the extent of water spreading outside of MAGSA. The model predicts that outside of the immediate groundwater mounds and depressions local to recharge basins and their recovery systems, groundwater changes will be much more modest, on the order of a few feet at most. After a series of years with frequent recharge activities, modeled groundwater elevations near those facilities (e.g., a half mile to two miles) could rise up to 20 ft. Assuming that number is conservative and uncertain, we have estimated that the gain could be up to 30 feet. In short, groundwater levels of 30 feet in the vicinity of the basin could potentially climb up gradient the equivalent head, 30 ft. In that case, upgradient areas that may be affected by these 30 ft groundwater elevation gains are defined by groundwater contour lines 30 feet higher than of the recharge basins. When considering this physical boundary, the extent of groundwater spreading to the east is clearly and greatly overstated by the model and effects are expected to be at most a couple miles east of MAGSA’s eastern border (Figure 28).

The model also does not consider the groundwater elevation fall across MAGSA and its overall “pull” of groundwater regionally and within MAGSA. Groundwater elevations in MAGSA decrease 100 feet from the northern and eastern borders of MAGSA to the cone of depression MAGSA’s southwest corner (Figure 19). Banking recharge and recovery will have some effects on quasi-equilibrium conditions defined by slightly differing groundwater elevations. Regardless, the groundwater contours characteristic to MAGSA will pull recharged water that moves outside of MAGSA back into MAGSA along its flow paths, essentially resulting in zero recharged water losses within the hydrologically contained bank.

The Bank will increase groundwater supplies and support MAGSA’s goals for sustainable groundwater management. The Bank will operate with its partners leaving a percent of recharged (deposited) contract water below during recovery (withdrawal) of their contract water. As the above discussion and analysis determines no groundwater losses will occur in the Bank and its operations, any water left behind will help in replenishing groundwater. MAGSA considers the Bank one tool to help achieve sustainable groundwater management.

> **No changes in surface drainage patterns from Bank management of groundwater**
>
> Local groundwater level increases at recharge basins could be as high as 100 ft but are still expected to below the surface. Thus, no affect is anticipated in surface water flooding or drainage patterns.

7.1.2 Will surface drainage patterns be affected by changes in groundwater?

Drainage patters will not be affected by Bank Operations. Groundwater depth ranges from about 110 to 230 feet below the ground surface where recharge basins are placed. The model results estimate ideal groundwater levels can increase ~35 – 100 ft. These groundwater increases represent equilibrium conditions as set by infiltration rates from the surface and percolation rates through the profile. These results were consistent across all the profiles suggesting soils in areas where recharge is planned are similar with regard to soils such as hydraulic conductivity, field capacity and storage potential. Importantly, losses and declines are not only from vertical flows downward but also from lateral flows sideways. Although estimates of groundwater levels rising up to 100 feet seem conservative, a large increase would still result in very few areas in MAGSA having any potential of surface flooding from the backing up of recharge water in the vadose zone (Figure 7).

A final consideration for this Project is that Bank recharge facilities will generally be owned by landowners participating in the recharge program through agreements with MAGSA[9]. These properties will be otherwise agricultural. Recharge basins as presented in the environmental analysis are designed for maximum water depths of a few feet, with basins having shallow slopes, and subdivided into smaller (e.g., 20 acre) checks. Because of this design, risks of flooding from operations are low because water storage in the basins is limited, and water releases from these systems expected to be contained on landowner farms and ranches in this highly rural and level area.

All these factors together show surface drainage patterns will not be affected by the process or operation of groundwater recharge activities under the Bank.

7.1.3 Will the bank create hydrologic conditions that impede groundwater quality or groundwater use?

Hydrologic conditions that impede groundwater quality or use include swings in groundwater elevations that mobilize or transport water quality constituents, flow paths that move poor quality water to areas with higher quality water, and large declines in groundwater elevation that exceed the depths of the various drinking water and irrigation wells.

[9] Sustainability efforts under MAGSA require partnering with landowners. MAGSA represents its landowners and is governed by a Board composed of landowners. Landowner agreements will be a foundation of these efforts and operations and be part of efforts to manage groundwater sustainably with all the tools available (e.g., monitoring, water credits, within MAGSA water trades and transfers).

7.1.4 Swings in groundwater elevations

Groundwater level elevations will rise and fall under the recharge basins during years in which recharge occurs. The model calculates increased elevations of up to ~100 ft below recharge basins based on its underlying assumptions regarding soil properties and basin operations, specifically operating under maximum recharge (e.g., design infiltration rates, duration). Declines local to those locations will be from recovery wells during recovery periods. Those local groundwater declines are calculated at up to 15 ft. From the model and the data generated, we expect groundwater responses to be much more muted a quarter to a half mile beyond the basins. The model calculates responses of a few feet in response to recharge and that, over extended periods of recharge, groundwater elevations may rise and fall on the order of 20 feet.

These calculations are estimates and have uncertainty. However, the underlying physics and hydrologic processes are well defined. Thus, we conclude that the general trends presented here are reasonable though the exact numbers and magnitudes have error. Given the depth to groundwater, these trends in groundwater should cause no effects on surface water hydrology, such as local flooding or drainage limitations.

Using design and operations to reinforce and suppress groundwater flow paths

Recharge basins and recovery wells can be located and operated to reinforce some groundwater flow paths and suppress others. The model provides data suggesting this result. Thus, the Bank operations should be able to achieve the goal of management to benefit groundwater quality and favorable hydrology.

7.1.5 Hydrologic flow paths that decrease water quality

In general, groundwater quality is expected to improve with the Bank introducing contract water generally of higher quality than resident groundwater, with regard to key water quality constituents fin the area (e.g., salts, nitrate, selenium, TCP) (Bachand et al, 2023). Based on the characteristics of the local recharge/recovery systems, these systems will be more effective at pushing water out than pulling it back in. *Thus, higher quality recharge water will tend to not only move downward but also spread laterally, providing a mechanism for these recharge waters to mix with resident groundwater and improve its quality through dilution*.

The hydrologic model demonstrates that a regional strategy for distributing and operating recovery wells can influence subsurface flow paths. *Aligning and concentrating recovery wells parallel to and along flow paths reinforces groundwater gradients. Placing recovery wells long transects perpendicular to flow paths diverts subsurface flows and suppresses flow paths.*

Two hydrograph transects created to test the objective of using recovery wells to help manage subsurface flows, particularly as related to recharge. In the model, recovery wells along the main conveyance in the eastern half of MAGSA were placed to preferentially extract along and reinforce the groundwater gradient. The ROM Model provided data in support of those goals. Ideal groundwater levels declined in the eastern half of MAGSA. In the model, recovery wells were also placed on the northern end of the Raisin City Oil Field in other areas perpendicular to flow paths to prevent upstream recharge water from passing through the oil field and to direct it away. The data showed water flow in and out of the oil field appeared mostly due to local groundwater elevation changes and much less so to directional flows through the oil field. Data from both transects support the contention that flow paths can at least be partially managed through decisions regarding the placement and operations of recovery wells.

7.1.6 Subsurface flow conditions that challenge operations and management

Local recharge/recovery systems will tend to push recharged water away more effectively than pulling it back due recharge basins having higher recharge rates and creating much greater head in comparison to paired recovery wells pumping rates and depressions. These phenomena overlay a groundwater system in which groundwater elevations drop about 100 feet from the northern and eastern edges of MAGSA to its southwest corner where a cone of depression keeps groundwater from moving further. These underlying groundwater elevations and gradient will be a primary control of subsurface conditions. These conditions may change over time due to other factors such as changes in operations throughout the Kings Basin and the associated GSAs to achieve sustainable groundwater management, and the effects those overlying efforts have on groundwater levels and gradients throughout the Kings Basin as well as within MAGSA.

The 24-years scenarios have a net recharge between 0.3 and 1.1 MAF. The model predicted groundwater levels over that time across all scenarios vary with some areas increasing levels by 1 – 15 ft and some areas decreasing by an equivalent amount. These groundwater elevation changes by the Bank operations will not significantly affect the underlying groundwater gradient that control general subsurface flow paths.

7.1.7 Creating conditions that promote water losses

As discussed in the previous section the underlying groundwater gradient will prevent water losses from the Bank.

7.2 Management and Design

Bachand et al. (2023) discuss Bank management as related to water quality. They conclude recharge will flush legacy salts and nitrate from the vadose zone during first flush, which could temporarily reduce water quality and pose challenges for returning water back to contractors. Bachand et al. (2023) conclude that these effects are manageable through –

- operations that in the near term prioritize withdrawals from the eastern half of MAGSA for return to the contractors,
- a strong monitoring effort to collect real-time water quality and hydrology data, and

Monitoring for real-time operations and supporting strategy development

Hydrologic and water quality monitoring are being planned under development of the Bank. Monitoring will be critical in real-time operational decisions and for regulatory requirements. Monitoring will also provide baseline data for development of an Operational Model as well as its further refinement.

- development and refinement of an operational model that can guide near and longer-term strategies for operating the Bank through developing and testing different scenarios.

7.2.1 Reinforcing and suppressing groundwater flow paths for beneficial outcomes

Importantly, both the initial design, particularly as related to placement of recharge and recovery facilities, and operations will affect hydrology and water quality in MAGSA. As discussed, groundwater levels are expected to increase by as much as 100 feet below recharge basins. Otherwise, groundwater levels are expected to change relatively modestly and gradually in response to periods of extended recharge and recovery.

Nonetheless, the model suggests operations can affect the transport of recharge flows and operations reinforce or suppress existing regional groundwater flows. In short, Bank operations of basins and wells should be flexible and able to respond to monitoring results regarding groundwater flow quality.

Operational Model for Today and Tomorrow

An Operational Model can provide guidance on Bank design and planning. With Bank operations, it can be used to support water accounting. With refinement and validation, the Operational Model will be able to test different management and operations scenario to develop near and long term strategies to optimize Bank operations and value.

7.2.2 Monitoring and the Operational Model

Monitoring will be a key requirement for the Bank, particularly as related to operations. Monitoring will provide real-time data to inform on where recharge and recovery should occur, and the quality of Bank water for both drinking water locally and for withdrawal by contractors. Monitoring will provide the data needed to optimize water quality and minimize losses from the MAGSA area. Monitoring will also be needed to provide an accounting of Bank “deliveries” and “withdrawals”.

The Operational Model will provide a tool to further leverage that data. Data collected can be used in the development and further refinement of the Model. The Model can be used to chart short-term and long-term strategies for operations and management of the Bank.

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Appendix 3

The Aquaterra Water Bank: Water Quality Considerations, Benefits, Constraints, and Management
(Bachand et al 2023)

The Aquaterra Water Bank: Water Quality Considerations, Benefits, Constraints, and Management

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November 2023

The Aquaterra Water Bank: Water Quality Considerations, Benefits, Constraints, and Management

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Key Themes

The California State Water Project contract water is in general of higher quality than found in McMullin Area Groundwater Sustainability Agency (MAGSA). If transport and recharge of that water to MAGSA is managed to maintain its quality, the introduction of that water should improve the groundwater within MAGSA.

Based upon our analysis of residential water quality in MAGSA, expected water quality cycling and transformation, and water usages, the identified salts (e.g., total dissolved solids [TDS], chloride, sodium), nitrate, selenium, and TCP (1,2,3-Trichloropropane) are the key water quality constituents on which to focus monitoring and management.

Generally, a spatially rectified water quality analysis is critical when considering the state of water quality and associated constraints, opportunities, and management. Groundwater quality in MAGSA is generally better than what a simple statistical analysis of well data, done without consideration of spatial and temporal relationships, would suggest.

Management will be needed to ensure the Aquaterra Water Bank (Bank) will produce water that meets expected pump-in requirements. About one third of MAGSA, primarily in the eastern area, has groundwater at the necessary water quality to meet expected pump-in requirements. In the short-term, recharge activities will reduce groundwater with 1) flushing from the vadose zone near recharge basins, with increases in salts and nitrate, and 2) potential mobilization of other constituents like selenium. Bank management will need to implement Bank recharge and recovery operations to manage those potential effects. In the long-term, flushing of constituents from the vadose zone is expected to be relatively minor because of both spatial and temporal mixing and dilution.

Proper management will include developing and enforcing import water quality standards, and careful locating and operation of infiltration basins and recovery wells.

Monitoring should be of sufficient temporal and spatial frequency to guide current Bank management, which will be altered in response to unexpected conditions, and to support development and refinement of the Operational Model. The Operational Model, further calibrated with monitoring data, will evaluate potential future management actions, thus helping to optimize decision making and strategy development.

Executive Summary

Introduction

The Aquaterra Water Bank (Bank) includes conveyance, recharge, and recovery infrastructure to enable diversion and recharge of up to 208,000 acre-feet per year (AFY) and recovery of up to 148,000 AFY. Recharge is planned to occur over the 5-month period from November through March and recovery over a 5-month period from May through September. The historical data suggest recharge opportunities will be presented about 46 percent of the years and recovery opportunities 42 percent, though these periods will typically be below the maximum design capacities. Bank operations are expected to be integrated into operations of the banking partners resulting in most banking water being moved regionally and used predominantly for agriculture.

Understanding Water Quality Considerations

An appreciation of water quality constituent cycling, transformation, and transport is a key element in understanding groundwater quality considerations related to the Bank and potential management strategies as needed for managing and even improving groundwater quality.

Constituent cycling and transport associated with the Bank are largely controlled by subsurface physical, biological, and chemical processes that can mobilize, immobilize, and transform constituents and their speciation. These processes include adsorption, desorption, oxidation, microbial processing, advection, and diffusion. Some of these processes are affected by the soil redox chemistry of which a primary driver is hydrology (e.g., moisture content). Others are affected by past practices, such as the accumulation of constituents in vadose zone pore waters, which can subsequently be mobilized by advection and diffusion when water for recharge is infiltrated. Exported water quality will depend upon source water to the Bank, surface and subsurface constituent cycling and transformations, and export operations.

Water quality will differ between the input water to the Bank and water exported back to the contractors. Input water to the Bank will be contract water sourced from the San Luis Reservoir for "deposit." That water is of higher quality as related to salts, nitrate, trace metals and elements, and other water quality constituents than the groundwater underlying McMullin Area Groundwater Sustainability Agency (MAGSA). Our analyses of water quality at the O'Neill Forebay in 2021 and 2022 indicated this water exceeded current California State and federal Water Project standards, including drinking water standards and Non-Project Pump-in standards. Contract water returned from the Bank to the respective partners will need to meet similar standards. However, water passing through the Bank will change in quality through the different chemical, physical, and biological processes.

Pump-in and Drinking Water Standards

The Mendota Pool Group 20-Year Exchange Final Environmental Impact Statement/Environmental Impact Report (EIS/EIR) provides a template for the Bank as required returns of contract water. This document requires compliance with drinking water standards as well as special Pump-in specific requirements associated with salts and trace metals, with real-time monitoring of salinity in support of the latter. Total dissolved solids (TDS) and selenium are two identified groundwater constituents within MAGSA that are included in these Pump-in specific requirements.

Characterizing Water Quality in Resident MAGSA Groundwater

Previous MAGSA's and non-Project Pump-In environmental studies identified salts (sodium, chloride, TDS), nitrate, specific trace elements (arsenic, selenium, boron, manganese, molybdenum), specific volatile organic carbons (VOCs) (dibromochloropropane [DBCP], TCP) and uranium as potential water quality concerns.

For this analysis, we used the water quality data provided in the current Groundwater Ambient Monitoring and Assessment (GAMA, 2023) dataset. The GAMA dataset provides water quality data for groundwater sampled primarily over the last two decades. The dataset includes groundwater data from the California Department of Pesticide Regulation, United States Geological Survey (USGS), local groundwater projects, the California State Water Board and GAMA Special Studies and Domestic Wells for a variety of well types (e.g., domestic, irrigation, industrial, monitoring, municipal, water supply), serving as the best available groundwater data in MAGSA.

Simple statistical analyses of these data enable rapid assessment of water quality. A simple statistical analyses of GAMA data support MAGSA's prioritizing the water quality constituents of salts, nitrate, some trace elements (arsenic, boron, manganese, selenium) and VOCs (TCP, DBCP) as well as radionuclides in relation to drinking water and environmental standards. Median values and estimates of exceedances reflected the sampling effort. One such finding was that the median value of TDS samples was 1,400 mg/l, and that 76 percent of TDS samples exceeded the California Drinking Water standard of 1,000 mg/l. This high-level analysis is cursory in that it does not consider temporal or spatial water quality data distributions and treats all data as independent measurements.

Temporal and Spatially Rectified Analyses

We evaluated water quality constituents both temporally and spatially. In all, we assessed the key constituents identified by MAGSA and other constituents highlighted in the monitoring for the Pump-in requirements. Ultimately, we considered salts (sodium, chloride, TDS), nitrate, specific trace elements (arsenic, selenium, boron, manganese, molybdenum), specific VOCs (DBCP, TCP), and gross alpha radioactivity.

From the temporal analyses, salt levels in groundwater appeared to be decreasing in magnitude and variance during the past couple of decades. These trends could be associated with 1) more efficient agricultural fertilizer and amendment management in response to the Irrigated Lands Regulatory Program which adopted its first agricultural discharge permits in 2003; and 2) improving water resources management in response to the Sustainable Groundwater Management Act passed in 2014 and with the first Groundwater Sustainability Plans adopted in the Kings Basin in 2020.

For the spatial analyses, we used the natural neighbor interpolation methods to develop a spatially rectified groundwater dataset from GAMA groundwater data within and adjacent to MAGSA. This method produced a spatial model that estimates groundwater concentrations and distributions throughout the MAGSA area. This model is an estimate with uncertainties due to the limitations of the GAMA dataset. Therefore, the analyses are estimates for planning of initial operations. Prior to operations, more robust and reliable data will need to be developed that can then inform operations and management, including as it pertains to water quality.

The spatial analysis of TDS suggests water quality in MAGSA is better than what would be first ascertained with simple, high-level statistical analyses of well sample data. Water quality problems associated with TDS, sodium, chloride, nitrate, and boron appear over-stated with the simple statistical analysis. For instance, median TDS concentrations from well data was 1,400 mg/l but about 671 mg/l for the spatially rectified dataset. The spatial model estimates TDS concentrations in groundwater exceed drinking water standards (1,000 mg/l) across 30 percent of MAGSA, and sodium concentrations exceed the environmental standard (69 mg/l) across nearly 70 percent. About 45 percent of MAGSA has TDS concentrations below the expected 600 mg/l Pump-in standard for TDS, and about 30 percent under the lower standard of 450 mg/l. Salt hotspots are parallel to the James Bypass along the western spine of MAGSA with much of it overlying the Raisin City Oil Field.

The spatial model estimates nitrate concentrations in groundwater exceed drinking and environmental standards (10 mg-N/l [milligrams as N per liter]) in only about 16percent of MAGSA, with about 50 percent of MAGSA having groundwater concentrations less than 5 mg-N/l. Unlike for salts, areas with higher nitrate levels tend to be more generally in the eastern half of MAGSA. Nitrate hotspots are scattered in the eastern half as well as overlying the Raisin City Oil Field.

Manganese, boron, and molybdenum do not appear to pose challenges for meeting environmental, drinking water, or Pump-in standards. Arsenic concentrations are estimated to exceed drinking water standards in about 20 percent of MAGSA. However arsenic management is not expected to be difficult with median concentrations in MAGSA less than 60 percent of the drinking water standard (10 µg/l). Selenium poses the greatest challenge. This challenge is not related to the 50 µg/l drinking water standard, but instead to the 2 µg/l environmental standard. The spatial estimates suggest 75 percent of MAGSA has groundwater exceeding that standard. Different trace metals have different hotspot locations throughout MAGSA. Only the selenium hotspot appears relevant in planning to manage selenium and its potential impacts on the Bank and its operations.

The spatial model estimates about 80 percent of MAGSA has TCP groundwater concentrations exceeding the drinking water quality standard of 0.005 µg/l. DBCP does not appear to be a challenge as related to groundwater management in relation to the Bank.

Gross alpha is used here as a surrogate for uranium and other radionuclides. Uranium is derived from Sierra Nevade granitics. Spatial estimates suggest over 60 percent of MAGSA has groundwater exceeding the drinking water standard of 15 pCi/l. The hotspot is estimated near the Raisin City Oil Field.

First Flush of Legacy Constituents from the Vadose Zone

Legacy nitrate and salts loads from past agricultural practices will be flushed from the vadose zone into MAGSA's groundwater when recharge basins are initially employed for use in the Bank. First flush is expected to occur through recharge of the first 15 to 30 feet of water.

Simple mass balance model calculations predict groundwater underlying recharge basins will initially increase by an estimated 350 mg/l for TDS and by 7 mg-N/l for nitrate. The latter is consistent with a subsurface transport model. Effects are predicted to diminish with time and space.

Nitrate pulses from flushing legacy nitrate are greatest underlying the recharge basins and diminish with time and distance. The model estimated groundwater pulses to become negligible after 10 years or further than 500 meters away.

Implementation of recharge basins is estimated to provide a legacy TDS load from the vadose zone equivalent to 70 mg/l averaged across all groundwater in MAGSA and 1 mg-N/l of nitrate. Offsetting those loads will be high quality contract water with average nitrate and TDS concentrations much below those found in MAGSA. Over time, these high-quality recharge waters should offset legacy loads and improve groundwater quality related to salts and nitrate through dilution.

Salts and nitrates are highly soluble and mobile. Trace elements form species that have differing levels of mobilization. Arsenic and selenium are redox sensitive and can be immobilized or re-mobilized through redox changes. TCP and DBCP are slightly soluble in water with the water solubilized forms mobile. Gross Alpha Radioactivity mobilization is less mobile due to various soil processes.

Management, Monitoring, and Guiding with an Operational Model

The Bank has a current blueprint for monitoring at key locations (e.g., import, export, recovery wells, recharge basins) for a variety of data (e.g., salts, nitrate, key constituents, electrical conductivity – EC, flow) at various frequencies (e.g., real-time, weekly, monthly) using a variety of methods for supporting planning, operations, strategic planning, and regulatory. Net mobilization expectations and spatial analysis suggests salts, nitrate, TCP, and selenium are the key constituents to consider in initial planning and management of the Bank. Implementation of ongoing monitoring and utilization of the Operational Model can help further refine Bank operations.

To manage water quality, management practices are expected to be required for the following four items: 1) the import of water from contractors to the Bank, 2) the recovery and export program, 3) screening and operations of recharge basins, and 4) development and implementation of the Operational Model.

Key tools for managing import water will be determining a water quality standard and then monitoring for compliance with that standard. Contract water Pump-in standards as defined by the Mendota Pool Group EIS/EIR requires water meet drinking water standards as well as higher standards as related to TDS and selenium[1]. Those standards require higher quality water as related to salts, nitrate, and selenium than typically found in the groundwater under MAGSA. Over time, that requirement would improve groundwater quality within MAGSA. Water found in the San Luis Reservoir exceeds the Pump-in standards. If import water continued to be at water quality currently found in the San Luis Reservoir,

[1] Mendota Pool Group 20-Year Exchange Program. Final Environmental Impact Statement/Environmental Impact Report. State Clearinghouse #2013041028. Us Department of the Interior, Bureau of Reclamation and Westlands Water District. October 2019. https://www.usbr.gov/mp/nepa/includes/documentShow.php?Doc_ID=41118

MAGSA groundwater quality would improve more quickly. More rapid improvement of MAGSA groundwater would help in operational flexibility of the Bank in returning water from the Bank.

Management of the Recovery and Export program will benefit water quality of both surface water and groundwater. Four sets of practices have been defined for this program: 1) Prioritizing the locations of recovery wells, 2) groundwater monitoring, 3) surface water monitoring, and 4) water quality management. These efforts focus on minimizing and managing the first flush effects on groundwater quality and ensuring exported water will meet Pump-in standards. Within this program is establishment of a dense groundwater monitoring program that accurately captures groundwater changes during Bank operations, the difference is deeper and shallower groundwater, and capturing first flush events with data.

The first flush of nitrate, salts, and other constituents will create local water quality challenges for the Bank. Selecting basins with lower expected legacy loading will help mitigate those challenges. A two-step screening program based first on public crop and nutrient datasets and second validated with deep field cores will allow the selection of basins with lower legacy loads. This is important as soil core data shows TDS and nitrate legacy loads in the vadose zone can vary by an order of magnitude across locations.

This effort supports the regional thinking that the Raisin City Oil Field compromises groundwater quality. Our analysis shows the Raisin City Oil Field is a hotspot for TDS and nitrate. Therefore, recharge should not be implemented there unless further and more robust water quality data shows otherwise. Other areas in MAGSA may also be unfit for locating recharge basins.

Recharge basins are expected to benefit domestic wells by diluting existing water quality constituents such as TDS, nitrate, and selenium. This expectation depends on the quality of import water for recharge and on successful recharge basin establishment and operations to minimize legacy loading to groundwater. Locating recharge basins on lands that are determined to have relatively lower legacy loads would be a good first step.

Stepwise and incremental introduction of recharge basins will reduce vadose zone first flush impacts by lessening the impact at any one time (e.g., spreading it over time).

The Monitoring Plan and associated quality assurance/quality control (QA/QC) will evolve with the development of the Bank. The two key goals will be for real-time management decisions and for developing and refining the Operational Model to help test and refine different operational scenarios with regard to meeting Bank goals.

Table of Contents

Key Themes ... iii

Executive Summary ... iv

- Introduction ... iv
- Understanding Water Quality Considerations ... iv
- Pump-in and Drinking Water Standards ... iv
- Characterizing Water Quality in Resident MAGSA Groundwater ... v
- Temporal and Spatially Rectified Analyses ... v
- First Flush of Legacy Constituents from the Vadose Zone ... vi
- Management, Monitoring, and Guiding with an Operational Model ... vii

Acronyms and Abbreviations ... xv

I. Background Information ... 16

1 Introduction ... 16

2 Overview of Water Bank and its Operations ... 18

3 Constituent Cycling and Transformations ... 20

- 3.1 Internal Water Quality Transformations in the Banking Operations ... 20
- 3.2 Groundwater Conditions that Can Cause Undesirable Effects ... 21

4 Non-Project Water Quality Considerations ... 23

- 4.1 San Luis Reservoir Water Quality, Project Source Water ... 23
- 4.2 Mendota Pool Group 20-Year Exchange Group Final Environmental Impact Statement/Environmental Impact Report (EIS/EIR) ... 30
- 4.3 Lateral 7 Example for Non-Project Water Pump-in Program in practice ... 30
- 4.4 Summary ... 35

II. Groundwater Data Analyses and Results ... 36

5 Water Quality Data Sources Within MAGSA: Limitations, Qualifiers, and Expectations ... 36

- 5.1 Data Considerations and Limitations for Groundwater Quality Analyses ... 36

6 Water Quality Within MAGSA ... 40

- 6.1 Summary of Findings from Previous Assessments ... 40
  - 6.1.1 GSP Water quality constituents of concern ... 41
  - 6.1.2 Water Bank Feasibility Study Groundwater Data – Salts, Hardness, and Alkalinity ... 42
- 6.2 Water Quality trends with Depth ... 43
- 6.3 Statistical Review of GAMA data ... 45

6.4 Temporal Water Quality Trends 46
6.5 Refining Groundwater Quality Assessments with Spatial Analyses 51
6.5.1 Salts and Major Ions 53
6.5.2 Nutrients 65
6.5.3 Trace Metals and Trace Elements 69
6.5.4 Volatile Organics 85
6.5.5 Radionuclides 92
6.6 Spatial Analysis Summary 96
7 Potential Nitrate and TDS Mobilization under Recharge 97
7.1 Nitrate and Salt Loading to Groundwater, First Flush 97
7.1.1 Quantify vadose zone loads and groundwater storage of salts and nitrate 97
7.1.2 Estimating vadose zone mass flushed to groundwater 97
7.1.3 Estimating the scale of the affected groundwater area to consider first flush effects on underlying groundwater 100
7.2 Period and Extent of Impact 101
7.3 Long-term Legacy Loading Effects 106
7.4 Expectations Regarding Loading of Other Constituents 107

III. Management and Monitoring 109
8 Water Quality Management and Monitoring Strategies 109
9 Water Quality Management Practices 110
9.1 For Managing Imported Water 110
9.1.1 Import water quality standard 110
9.1.2 Implementing surface water quality and flow monitoring program 111
9.2 For Managing the Recovery and Export Program 111
9.2.1 Prioritize Recovery Well Locations 111
9.2.2 Groundwater Monitoring 112
9.2.3 Surface Water Quality Monitoring 113
9.2.4 Water Quality Management 113
9.3 For Managing Recharge Basins 113
9.3.1 Recharge Basin Location Screening 113
9.3.2 Recharge Basin Operations 115
9.4 For Planning through the Operational Model 116
10 Monitoring Blueprint 119

10.1 Basin Screening 119
10.2 Operations 119
10.2.1 Real time, current needs 119
10.2.2 Operational Model 120
10.3 Regulatory 120
11 References 121

IV. Attachments 123

A. Salt and Nitrate Transport Under On-Farm Recharge A-1
B. Non-Project Water Pump-In Program B-1
C. Ranking Nitrogen Loading Potential with MAGSA C-1

Tables

Table 1. Water Quality Measured at San Luis Reservoir, 2021 – 2022 25

Table 2. Water Quality Sampling History During 2021 and 2022 at O'Neill Forebay, San Luis Reservoir ... 26

Table 3. Non-Project Water Quality Requirements 31

Table 4. Water Quality Standards, Short List (Reclamation 2017) 31

Table 5. Water Quality Standards, Full Title 22 Analyses 32

Table 6. Sampling frequency from Lateral 7 (Reclamation 2017) 35

Table 7. Number of wells for each group of wells found in MAGSA. 37

Table 8. Summarizing Sampling Well depth within MAGSA 38

Table 9. GAMA data summary for groundwater sampling within MAGSA exceeding drinking water 48

Table 10. Prioritizing Water Quality Constituents as Related to Expected Standards 49

Table 11. Well and Spatial Statistics and Expected Water Quality Standards. 52

Table 12. Estimated acreage below and above TDS water quality thresholds and standards. 54

Table 13. Estimated acreage below and above sodium water quality thresholds and standards. 55

Table 14. Estimated acreage below and above chloride water quality thresholds and standards. 56

Table 15. Comparing 90th percentile "hotspot" thresholds to expected pump-in standards. 57

Table 16. Estimated acreage below and above nitrate water quality thresholds and standards. 65

Table 17. Estimated acreage below and above arsenic water quality thresholds and standards. 70

Table 18. Groundwater samples exceeding 2 µg/l over the entire sampling period. 70

Table 19. Estimated acreage below and above water quality thresholds and standards. 71

Table 20. Estimated acreage below and above water quality thresholds and standards. 71

Table 21. Estimated acreage below and above water quality thresholds and standards. 72

Table 22. Estimated acreage below and above water quality thresholds and standards. 73

Table 23. Estimated acreage below and above water quality thresholds and standards 86

Table 24. Estimated acreage below and above water quality thresholds and standards 86

Table 25. Estimated acreage below and above water quality thresholds and standards 92

Table 26. Summary of constituents above potential threshold 96

Table 27. Some typical nitrogen and TDS loading found in the San Joaquin Basin (0- 30 ft depths) 99

Table 28. Mass Balance estimates of typical mass loading to aquifers in recharge zones from first flush of nitrate and salts. 100

Table 29. Mass Balance estimates of long-term increases in salts and nitrate in the aquifer under Bank operations. 106

Table 30. Summary of Loading and Mobilization 108

Table 31. Managing the Bank 118

Figures

Figure 1. Aquaterra Water Bank (Bank) Conveyance, Recharge and Recovery Infrastructure. 17
Figure 2. Processes affecting water transport and its water quality. 22
Figure 3. Changes in concentrations of selected water quality constituents. 28
Figure 4. Medians, quartiles and non-outlier ranges for key constituents. 29
Figure 5. Characterizing Well Type and Depth within MAGSA. 38
Figure 6. Well Types used in the GAMA dataset within MAGSA. 39
Figure 7. TDS concentrations grouped by total well depths. 44
Figure 8. NO3-N concentrations grouped by total well depths. 44
Figure 9. Reported analyte concentration rounded for 1960, 2010 and 2020. 50
Figure 10. Spatial interpolation of TDS using data from 2000 onward. 58
Figure 11. Areas below and above environmental, public health and Pump-in thresholds for TDS. 59
Figure 12. Spatial interpolation of sodium using data from 2000 onward. 60
Figure 13. Areas below and above environmental, public health and Pump-in thresholds for sodium..... 61
Figure 14. Spatial interpolation of chloride using data from 2000 onward. 62
Figure 15. Areas below and above environmental, public health and Pump-in thresholds for chloride. .. 63
Figure 16. Estimated salts hotspots. 64
Figure 17. Spatial interpolation of nitrate using data from 2000 onward. 66
Figure 18. Areas below environmental, public health and Pump-in thresholds for nitrate. 67
Figure 19. Estimated nitrate “hotspots.” 68
Figure 20. Spatial interpolation of arsenic using data from 2000 onward. 74
Figure 21. Areas below environmental, public health and Pump-in thresholds for arsenic. 75
Figure 22. Spatial interpolation of selenium using data from 2000 onward. 76
Figure 23. Areas below environmental, public health and Pump-in thresholds for selenium. 77
Figure 24. Spatial interpolation of boron using data from 2000 onward. 78
Figure 25. Areas below environmental, public health and Pump-in thresholds for boron. 79
Figure 26. Spatial interpolation of manganese using data from 2000 onward. 80
Figure 27. Areas below environmental, public health and Pump-in thresholds for manganese. 81
Figure 28. Spatial interpolation of molybdenum using data from 2000 onward. 82
Figure 29. Areas below environmental, public health and Pump-in thresholds for molybdenum. 83
Figure 30. Trace elements “hotspots.” 84
Figure 31. Spatial interpolation of DBCP using data from 2000 onward. 87
Figure 32. Areas below environmental, public health and Pump-in thresholds for DBCP. 88
Figure 33. Spatial interpolation of TCP using data from 2000 onward. 89

Figure 34. Areas below environmental, public health and Pump-in thresholds for TCP. 90
Figure 35. Volatile organic “hotspots.” 91
Figure 36. Spatial interpolation of GAR using data from 2000 onward. 93
Figure 37. Areas below environmental, public health and Pump-in thresholds for GAR. 94
Figure 38. Radionuclide “hotspots.” 95
Figure 39. Estimated Percent Removal From Vadose Zone under OFR 99
Figure 40. Daily and cumulative mass fluxes for tomatoes and grapes. 103
Figure 41. Nitrate concentrations (mg-N/L) in domestic wells and downstream. 104
Figure 42. Nitrate concentrations (mg-N/L) in production well zone and downstream. 105
Figure 43. Ranking fields within MAGSA based on recharge potential loading of nitrogen. 117

Acronyms and Abbreviations

AF	Acre-feet
AFY	Acre-feet per year
Bank	Aquaterra Water Bank
CEQA	California Environmental Quality Act
CFS	cubic feet per second
CVP	Central Valley Project
DBCP	Dibromochloropropane, volatile organic compound
DPH	California Department of Public Health
DWR	Department of Water Resources
EA	Environmental Analysis
EC	Electrical Conductivity
EPA	U.S. Environmental Protection Agency
EIS/EIR	Environmental Impact Statement/Environmental Impact Report
GSA	Groundwater Sustainability Agency
GAMA	(California) Groundwater Ambient Monitoring and Assessment Program
IS	Initial Study
MAGSA	McMullin Area Groundwater Sustainability Agency
NEPA	National Environmental Policy Act
MCL	Maximum contaminant level
mg/l	milligrams per liter,
mg-N/l	milligrams as N per liter, used for nitrogen species
QA/QC	quality assurance and quality control
Reclamation	U.S. Bureau of Reclamation
SMCL	Secondary Maximum Contaminant Level
SGMA	The Sustainable Groundwater Management Act
SWP	State Water Project
TCP	1,2,3-Trichloropropane, volatile organic compound
TDS	Total dissolved solids
Title 22	California laws and regulations as related to treated and recycled water quality requirements
TKN	Total Kjeldahl Nitrogen
µg/l	micrograms per liter, parts per billion in aqueous solutions, ppb
mS/cm	millisiemens per centimeter, a measure of electrical conductivity
USGS	United States Geological Survey
VOC	volatile organic compound

I. Background Information

1 Introduction

The Aquaterra Water Bank (Bank) in California is being established with the McMullin Area Groundwater Sustainability Agency (MAGSA) jurisdiction and is adjacent to the Mendota Pool (Figure 1). The Bank will accept State Water Project (SWP) and Central Water Project (CVP) contract water through the Fresno Slough with the capacity to 1) divert up to 208,000 acre-feet per year (AFY) over the 5-month period during late fall and early winter (October through April) and 2) infiltrate to the underlying aquifer across approximately 3500 acres of farmland. The Bank is being designed for up to 800,000 acre-feet (AF) of storage. A series of recovery wells will be placed throughout the underlying MAGSA area to recover water at a rate of up to 148,000 AFY from May through September over a 5-month spring though summer period. This report assesses water quality considerations associated with the Bank and its operations and identifies measures to be taken to manage and mitigate water quality. Based on historical data, recharge opportunities are predicted to occur 46% of the years and recovery opportunities 42% (Bachand et al., 2023).

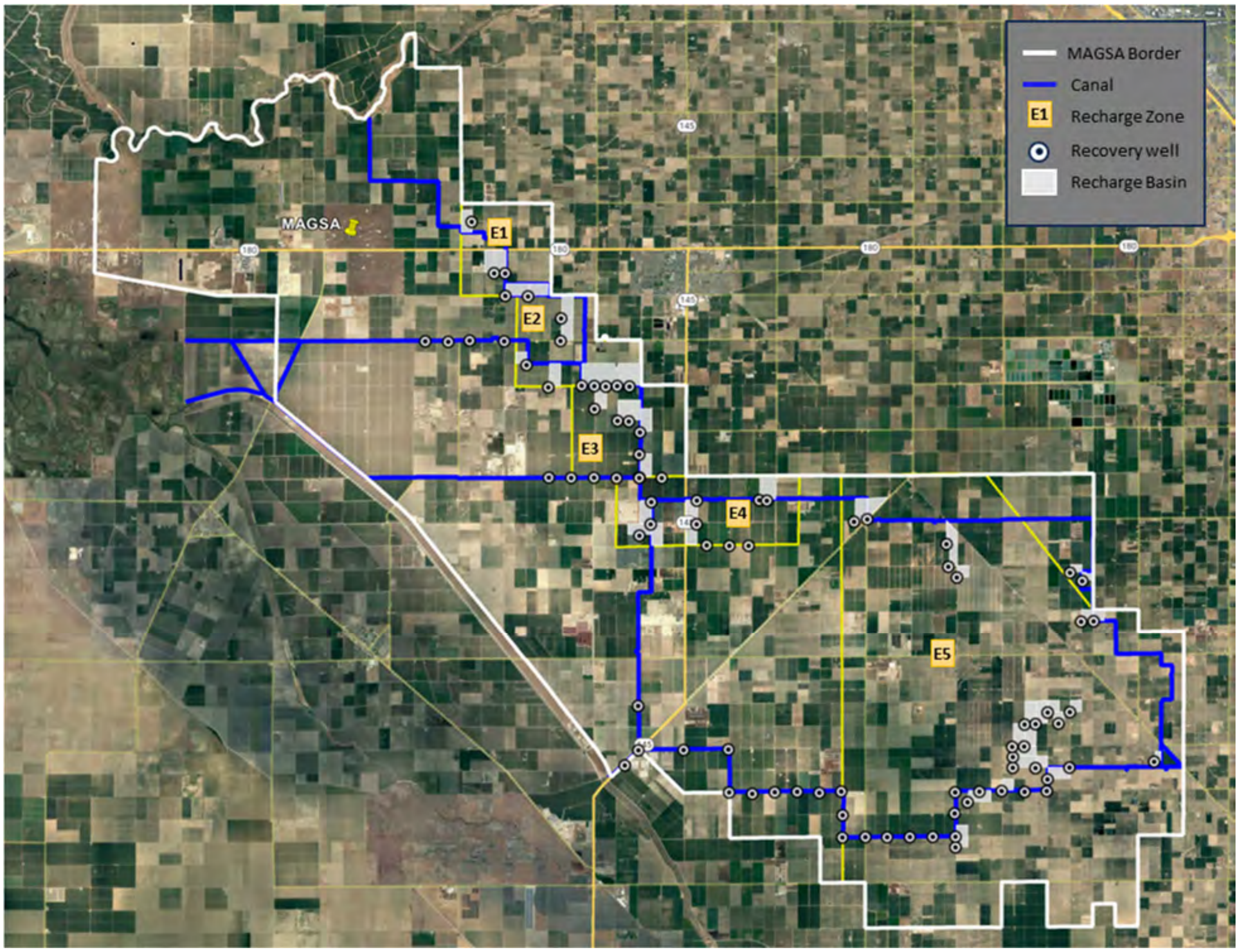


Figure 1. Aquaterra Water Bank (Bank) Conveyance, Recharge and Recovery Infrastructure.
The Bank includes conveyance, recharge, and recovery infrastructure. Over 60 miles of conveyance canals varying in capacity from 300 to 500 cubic feet per second (CFS) will divert contract water from the Kings Bypass and the Mendota Pool to 3500 acres of recharge fields for infiltrating contract water to groundwater as inputs into the Bank. Over 90 recovery wells will withdraw banked contract water and return it back to the Mendota Pool using the conveyance system. The Bank is being designed for a maximum annual diversion and recharge of 208,000 AF and a maximum annual recovery of up to 148,000 AF. The Bank is being designed for 800,000 AF of storage.

2 Overview of Water Bank and its Operations

The Bank and its operations are described in detail within the main environmental documents associated with the California Environmental Quality Act (CEQA, Initial Study – IS) and the National Environmental Policy Act (NEPA, Environmental Assessment – EA). A brief summary is provided here.

The Bank will exist within MAGSA's underlying aquifer. Its proximity to existing State and federal water system infrastructure will make it well suited to receive contract water from State Water Project (SWP) and Central Valley Project (CVP) contractors, and others (e.g., local MAGSA partners, consortiums). Establishment of the Water Bank will require construction of conveyance, recharge, and recovery facilities. These facilities are presented in Figure 1. Conveyance facilities will divert contract water from the northern end of the Fresno Slough just south of Mendota Pool for distribution through MAGSA's jurisdiction utilizing approximately 60 miles of main canals, ranging in capacity from 300 to 500 CFS depending upon their location and its expected capacity requirements. Recharge basins totaling approximately 3500 acres lay adjacent or in the vicinity of the main canals. Diversion of contract water and its infiltration into the Bank will occur during November through March during most years. Water stored in the underlying aquifer will lie above the Corcoran Clay, which ranges from about 350 to 500 feet below ground elevations.

The Water Bank and its Operations

The Bank includes conveyance, recharge, and recovery infrastructure to enable diversion and recharge of up to 208,000 AFY and recovery of up to 148,000 AFY. Recharge is planned to occur over the 5-month period from November through March and recovery over a 5-month period from May through September. The historical data suggests recharge opportunities will be presented about 46% of the years and recovery opportunities 42% of the years, though these periods will typically be below the maximum design capacities. Bank operations are expected to be integrated into operations of the banking partners resulting in most banking water being moved regionally and predominantly for agriculture.

Banking contract water will be recovered through a series of groundwater wells. These wells are located to withdraw from each recharge basin as well as along groundwater flow paths through MAGSA. Over 90 groundwater wells will be installed to enable a maximum recovery rate of 148,000 AFY. Recovery wells are expected to extend 300 – 450 feet below ground surface to ensure extraction of groundwater above the Corcoran clay layer. Ten percent of each deposit will be left behind in the Water Bank for this Project. For each 100 AF deposited by a subscriber, 90 AF will be available for subsequent withdrawal by the subscriber and 10 AF will be left behind to offset losses (e.g., operational, evaporative) and improve subsurface conditions through in-lieu recharge (i.e., improving unsaturated zone water content to benefit crops and plants) or direct recharge (i.e., replenishing the over-drafted underlying aquifer). Losses will occur primarily within the Project area as the volume of water for deposit will be metered when it enters the adjacent Mendota Pool, and it will move directly into the water bank conveyance system for distribution through MAGSA and recharge within the identified recharge zones. Recovery will typically occur from the 5-month period of May through September. This period represents both the regional growing season when irrigation drives higher water demand and the California dry season when other demands increase (e.g., stream flows for fisheries, recreational use, and urban and suburban irrigation).

The Bank will provide an additional tool for contractors and partners in managing contract water. Using a "Banking" model, many (water) deposits and withdrawals are expected to be on paper as contractors manage their water portfolios. Under that expectation, "wet" water is expected to generally be used regionally and largely by agriculture. As an additional water management and storage tool, the Bank Project will make regional and California water resources more sustainable and increase flexibility in their management.

3 Constituent Cycling and Transformations

Constituent cycling and transport associated with the Bank are largely controlled by subsurface physical, biological, and chemical processes that can mobilize, immobilize, and transform constituents and their speciation. We provide an overview of the various processes as background for subsequent analyses, results, and discussions. These processes are important in understanding constituent processing and for identifying and discussing management opportunities and constraints.

Understanding Processes to Understand Groundwater Data

Constituent transport and cycling associated with the Bank are largely controlled by subsurface physical, biological, and chemical processes that can mobilize, immobilize, and transform constituents and their speciation. These processes include adsorption, desorption, oxidation, microbial processing, advection, and diffusion. Some of these processes are affected by the soil redox chemistry of which a primary driver is hydrology (e.g., moisture content). Others are affected by past practices, such as the accumulation of constituents in vadose zone pore waters, which can be subsequently mobilized by advection and diffusion. Constituent cycling and transformation will depend upon source water to the Bank, redox changes, and export operations. An appreciation of these processes is important in understanding water quality considerations and management.

3.1 Internal Water Quality Transformations in the Banking Operations

Figure 2 presents a conceptual model of water quality transformations under these field recharge practices. Imported contract water from the Mendota Pool will be infiltrated through the shallow vadose zone, then through the deeper vadose zone, until it enters groundwater. Groundwater will subsequently be pumped to export that water into the conveyance system where blending will occur. Water infiltrating through the vadose zone will advectively transport constituents downward, either removing or adding constituents to the more tightly bound soil pore water through diffusion. Nitrate and salts in these pore waters will diffuse because of their higher concentrations into the recharge water passing downward through the soil profile. Thus, transport of water quality constituents will be through advection in more loosely bound pore water and further diffusion from more tightly bound pore water. Constituents moving through the vadose zone could be further affected by microbial and chemical processes.

These processes will depend upon the redox conditions in the vicinity. For instance, denitrification occurs upon the emergence of nearby zones that lack oxygen, both in gas form and as dissolved oxygen in water. At lower redox conditions, ferric iron converts to the dissolved form of ferrous iron, releasing adsorbed or held elements such as phosphorus, zinc, and copper.

Selenium and arsenic are two important metals affected by redox conditions (Saha et al., 2017). Selenium solubility is governed by adsorption under oxidized and moderately reduced conditions and by precipitation and dissolution under more reduced conditions (Masscheleyn and Patrick 1993, Nakamaru and Altansuvd 2014). Selenium can co-precipitate or adsorb with iron (Nakamaru and Altansuvd 2014) under conditions in which recharge water is more oxic as indicated by the presence of dissolved oxygen and nitrate. If conditions become more reduced, precipitated forms of iron can become dissolved and potentially release associated selenium (Nakamaru and Altansuvd 2014). Conversely, selenium precipitates or co-precipitates formed under more reduced conditions are less likely to be re-mobilized, particularly when formed under sulfate-reducing conditions (Ho et al. 2022). Kumar and Riyazuddin (2011) report groundwater recharge can remobilize selenium when groundwater becomes more oxidized as indicated by the presence of dissolved oxygen. In short, selenium cycling and migration between dissolved forms that can be mobilized versus more immobile forms depends on many factors and is complicated by redox dependent reactions (Nakamaru and Altansuvd 2014, Ho et al. 2022, Kumar and Riyazuddin 2011).

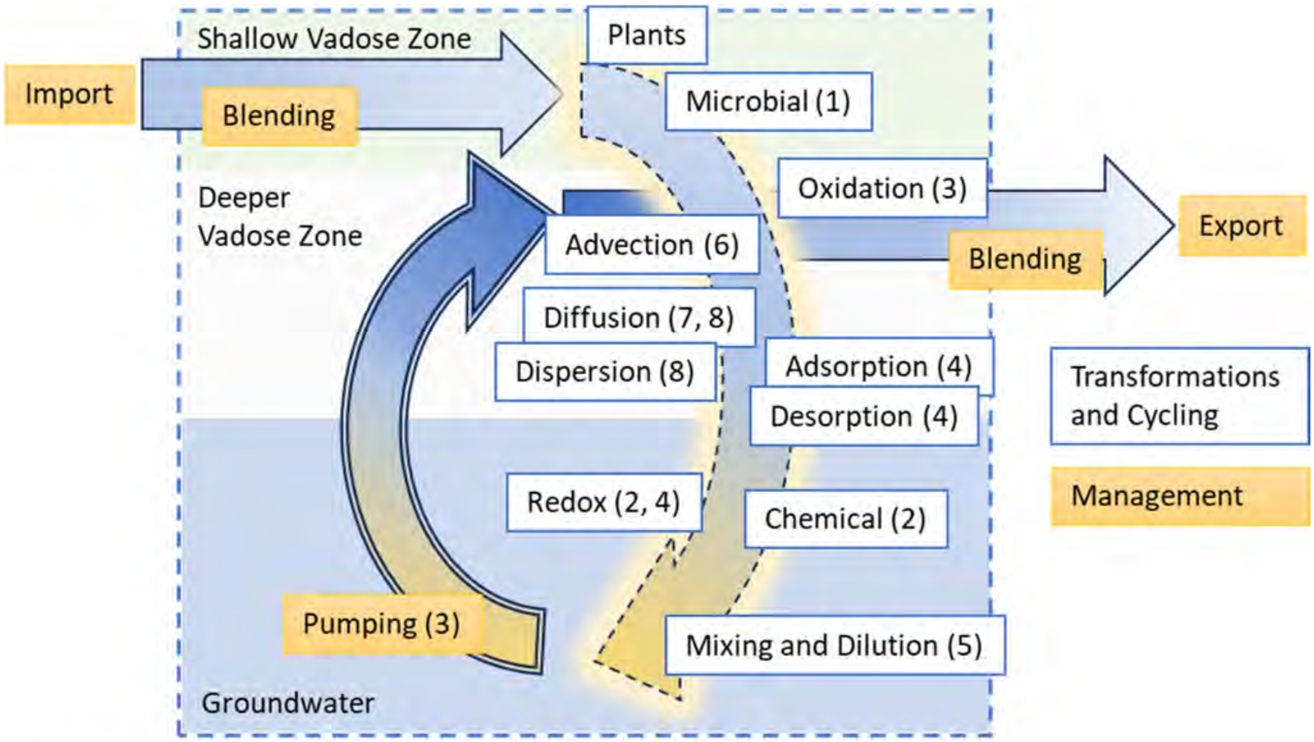
Arsenic is similarly mobilized through changing redox conditions. In reduced conditions such as the groundwater aquifer, arsenic is present in a variety of mineral forms (Oremland and Stolz, 2003). With pumping, the saturated zone becomes an unsaturated zone, and the more oxidized conditions lead to arsenic accumulating on minerals such as ferric irons as well as arsenic bioaccumulation in microbial biomass and associated organic matter. Recharge could lead to saturated soil profiles and reduced conditions that could re-mobilize arsenic through the dissolution of ferric irons to ferrous irons, or the breakdown of associated organic matter. As with selenium, soil profiles under recharge could remobilize arsenic, enable its transport with the recharge water, and increase the arsenic concentration in area groundwater.

3.2 Groundwater Conditions that Can Cause Undesirable Effects

The Groundwater Sustainability Plan (MAGSA 2022b) identifies a number of groundwater conditions relevant to the Bank that could degrade groundwater:

1. Past and current fertilizer applications and other farming practices leading to further accumulation of constituents of concern (e.g., nitrates, salts) in groundwater.
2. One-time releases from sources of chemical contamination such as from fuel storage tanks.
3. The accumulated effects of regulated and unregulated waste discharge streams from wastewater treatment facilities, septic systems, industry, and food processors.
4. Declining groundwater levels can cause pumped groundwater to have higher concentrations of some naturally occurring chemicals, which may be either health concerns, such as arsenic or uranium.
5. Groundwater pumping mobilizing groundwater contaminant plumes.
6. Recharge projects that are improperly located, causing downward movement of contaminants in the vadose zone or mobilize groundwater contaminant plumes.

The operations of the Bank can be used to manage potential effects. For instance, areas can be avoided altogether to avoid conditions that will contaminate groundwater from storage tanks and other regulated and unregulated discharges (2. and 3. above). Recharge fields can either be fallowed or have farming practices managed to minimize impacts from current farm practices on transporting constituents of concern to groundwater (1. above). Areas can be preferentially selected for recharge with an understanding of potential legacy accumulation of water quality constituents of concern (1. above). Recovery pumping and recharge can be managed to minimize opportunities to mobilize water quality constituents of concern through changes in redox conditions, introducing constituents from known plumes or other processes resulting in large swings of water content in the saturated and unsaturated zones (4. – 6. above).



Notes:

1. Microbial communities and the processes they conduct required organic carbon and depend upon redox conditions. Microbial processes are expected to be more active in the upper vadose zone because of greater organic carbon concentrations.
2. More reduce redox conditions will occur in areas depleted of oxygen, either as a gas in air or as dissolved form in water. Changing redox conditions will affect the speciation of metals such as iron, arsenic and selenium. The changes in speciation can mobilize these metals.
3. Returned water will be more reduced than surface water and will become oxidized with exposure to air as its return will be through a well.
4. Desorption and adsorption will depend upon adsorptive minerals (e.g., calcium, magnesium, iron) and redox conditions
5. Mixing and dilution will occur within groundwater and can be increased through area groundwater pumping and effects on groundwater flow paths.
6. Groundwater advectively moves downward through pores and can short-cut along preferential flow paths. The advective transport moves water quality constituents downward with the water flow. Non-ideal advective flow results in dispersive flow.
7. Diffusion transports constituents from higher concentrations to lower concentrations. Transport of water quality constituents to and from more tightly-bound soil pore water is primarily through this mechanism.
8. Diffusion and dispersion are the main process slowing and retarding the transport of flow (dispersion) and water quality constituents (dispersion and diffusion).

Figure 2. Processes affecting water transport and its water quality.

4 Non-Project Water Quality Considerations

The Department of Water Resources (DWR) has a formal policy for accepting Non-Project water into the California Aqueduct and SWP. The DWR policy regarding Acceptance of Non-Project Water into the SWP (DWR 2012) 1) identifies *for that time* the California Department of Public Health (DPH) Title 22 parameters and water quality constituents. The Aquaterra Bank Feasibility Study (MAGSA 2022a) discussed non-project water quality requirements as protective surface water thresholds for returning Bank Water back to the California and federal water projects, presenting arsenic, boron, molybdenum, selenium, and total dissolved solids (TDS) data (MAGSA 2022a). In the formal Non-Project Water Pump-in policy, DWR (2012) states those parameters will change over time.

Three sources are provided in developing expectations for this Project regarding an expected Pump-in standard for the Water Bank and considerations of source water:

1. Current water quality monitoring being conducted at the O'Neill Forebay of the San Luis Reservoir to demonstrate and characterize discharge water quality;
2. The Mendota Pool Group 20-Year Exchange Program Final EIS/EIR (Reclamation 2019) identify the standards expected for returning Bank Water to contractors and partners; and
3. Recent (2017) water quality constituents being monitored at Lateral 7 as an example of Non-Project water sampling for the San Luis Canal (Reclamation 2017).

Drinking Water and Non-Projects Pump-In Standards Drive Water Quality Requirements

Contract water that will be sourced from the San Luis Reservoir for deposit within the Bank will be high quality water. That water typically exceeds current standards as related for the Water Projects, including drinking water standards and Non-Project Pump-in standards. Contract water returned from the Bank to the respective partners will need to meet similar standards. Current Non-Project pump-in standards required an initial weekly sampling of a short list of drinking water constituents and every three years for a long list. Additionally, pump-in standards for TDS and selenium are more stringent than drinking water standards, which is required for groundwater in MAGSA used for potable water.

4.1 San Luis Reservoir Water Quality, Project Source Water

Table 1 summarizes the 2021 to 2022 water quality monitoring data collected at the O'Neill Outlet in the San Luis Reservoir (California Aqueduct) (Water Data Library, 2023). These data represent the current water quality monitoring being conducted for contract water being delivered from the San Luis Reservoir into the State and federal water project, and the expected water quality for water originating in the San Luis Reservoir.

At the outlet, these water quality constituents are sampled monthly except for the organic pesticides, herbicides, and insecticides, which are sampled quarterly (Table 2):

- Standard water quality parameters (i.e., temperature; turbidity; conductance; solids – dissolved, volatile, total; alkalinity; and hardness). *Monthly*.
- Inorganic anions (i.e., bromide, chloride, sulfate, and potassium). *Monthly*.
- Inorganic cations (i.e., sodium, calcium, and magnesium). *Monthly*.
- Major nutrients (i.e., nitrogen – Total Kjeldahl Nitrogen (TKN), nitrate, nitrite, ammonia; phosphorus – ortho, total) *Monthly*.
- Other dissolved elements (i.e., boron, molybdenum, and mercury). *Monthly*.
- Dissolved and total metals and elements (i.e., aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, copper, iron, lead, manganese, nickel, selenium, silver, and zinc). *Monthly*.
- Pesticides, herbicides, and insecticides (i.e., 3-Hydroxycarbofuran, Aldicarb, Aldicarb sulfone, Aldicarb sulfoxide, Carbaryl, Carbofuran, Methiocarb, Methomyl, Oxamyl, Propoxur*). Quarterly*.

Water Quality at the O'Neill Forebay Provides High Quality Water for the Bank

Water quality in the O'Neill Forebay at the outlet of the San Luis Reservoir has been consistently high quality over the last two years and month to month. These source waters offer opportunities to improve groundwater quality within MAGSA through dilution.

Figure 3 shows monthly sampling of selected water quality constituents of interest for the Bank based upon the prior and upcoming discussion and analyses. These data are from 2021 and 2022 and represent monthly samples. The fitted line represents a quadratic polynomial fit with a 95 percent confidence band.

Several constituents are below, and oftentimes well below, the reported maximum contaminant levels (MCLs) throughout the year (e.g., arsenic, boron, chloride, manganese, nitrate, selenium, sulfate, TDS). Only sodium is near the required MCL, generally in the 60 to 70 mg/l (milligrams per liter) range in comparison with an MCL of 69 mg/l. Seasonal trends have not proven consistent among constituents with some showing slight elevations in late summer and early fall (i.e., arsenic), some showing slight declines mid-year (e.g., nitrate, sodium, TDS), and the rest not consistent between the years. Concentrations between years were generally consistent across all constituents (Figure 4), reflected in the median values and to a lesser degree in the ranges measured.

Table 1. Water Quality Measured at San Luis Reservoir, 2021 – 2022

Group (2)	Analyte	Dissolved			Total			Units
		Ave.	SD	Note (1)	Ave	SD	Note (1)	
Standard and Field	Field pH	8.1	0.5					pH
	Field Turbidity	4.0	1.5					ntu
	Temperature	17.5	4.4					deg C
	Specific Cond.	572.0	27.4					uS/cm@25 °C
	Field Specific Cond.	566.8	27.1					uS/cm@25 °C
	Alkalinity				88.3	7.3		mg/L as CaCO3
	Hardness	118.8	8.8					mg/L as CaCO3
	TDS	310.7	15.9					mg/l
	TSS				4.3	2.0		mg/l
Organic Carbon	Organic Carbon	4.7	1.1		4.5	1.0		mg/l
Phosphorus	Ortho	0.1	0.0	<MDL				
	Total				0.1	0.0		mg-P/l
Nitrogen	Nitrate	1.5	1.4					mg-N/L
	Nitrate + Nitrite	0.4	0.3					mg-N/L
	Ammonia	0.1	0.0	<MDL				mg-N/L
	TKN				0.4	0.1		mg-N/L
Anions and Cations	Bromide	0.3	0.0	<MDL				mg/l
	Calcium	23.7	2.3					mg/l
	Chloride	84.8	9.7					mg/l
	Magnesium	14.5	0.8		33.8	15.4		mg/l
	Potassium	4.0	0.3					mg/l
	Sodium	64.0	3.9					mg/l
	Sulfate	36.8	6.2					mg/l
Metals and elements	Aluminum	10.0	0.0	<MDL	95.8	53.5		ug/l
	Antimony	1.0	0.0	<MDL	1.0	0.0	<MDL	ug/l
	Arsenic	2.7	0.5		2.7	0.5		ug/l
	Barium	37.8	3.8		40.1	2.9		ug/l
	Beryllium	1.0	0.0	<MDL	1.0	0.0	<MDL	ug/l
	Cadmium	1.0	0.0	<MDL	1.0	0.0	<MDL	ug/l
	Chromium	1.1	0.3		1.0	0.1		ug/l
	Copper	2.3	1.7		4.4	3.7		ug/l
	Iron	15.6	18.6		116.7	61.1		ug/l
	Lead	1.0	0.0	<MDL	1.0	0.0	<MDL	ug/l
	Manganese	6.4	2.3					ug/l
	Nickel	1.4	0.2					ug/l
	Selenium	1.3	0.2					ug/L
	Silver	1.0	0.0	<MDL				ug/L
	Zinc	5.2	0.7					ug/L
Other dissolved elements	Boron	0.2	0.0	<MDL				mg/l
	Mercury	0.2	0.0	<MDL				ug/l
	Molybdenum	5.0	0.0	<MDL				ug/l
Notes								
1	When value is less than MDL, MDL = average value provided.							
2	Pesticides, herbicides and insecticides sampled have been below detection limits							

Table 2. Water Quality Sampling History During 2021 and 2022 at O'Neill Forebay, San Luis Reservoir

	2021										2022											
	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
EPA 170.1																						
Field Water Temperature																						
EPA 180.1 [D]																						
Field Turbidity																						
EPA 120.1																						
Field Specific Conductance																						
Std Method 2510-B																						
Specific Conductance																						
EPA 150.1																						
Field pH																						
Std Method 2540 C																						
Total Dissolved Solids																						
EPA 160.2, 160.4																						
Total, Volatile Suspended Solids																						
Std Method 2540 D, E																						
Total, Volatile Suspended Solids																						
Std Method 2320 B																						
Total Alkalinity																						
Std Method 2340 B (D)																						
Dissolved Hardness																						
EPA 200.7 (D)																						
Dissolved Boron																						
Dissolved Calcium																						
Dissolved Magnesium																						
Dissolved Potassium																						
Dissolved Sodium																						
EPA 200.8 (D, T)																						
Dissolved, Total Aluminum																						
Dissolved, Total Antimony																						
Dissolved, Total Arsenic																						
Dissolved, Total Barium																						
Dissolved, Total Beryllium																						
Dissolved, Total Cadmium																						
Dissolved, Total Chromium																						
Dissolved, Total Copper																						
Dissolved, Total Iron																						
Dissolved, Total Lead																						
Dissolved, Total Manganese																						
Dissolved Molybdenum																						
Dissolved, Total Nickel																						
Dissolved, Total Selenium																						
Dissolved, Total Silver																						
Dissolved, Total Zinc																						
EPA 200.8 (Hg Dissolved)																						
Dissolved Mercury																						

Table 2. Water Quality Sampling History During 2021 and 2022 at O'Neill Forebay, San Luis Reservoir *(continued)*

		2021										2022											
		M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
EPA 300.0																							
	Dissolved Bromide																						
	Dissolved Chloride																						
	Dissolved Nitrate																						
	Dissolved Sulfate																						
Std Method 4500-NO3-F																							
	Dissolved Nitrate + Nitrite																						
EPA 350.1 (D)																							
	Dissolved Ammonia																						
EPA 351.2																							
	Total Kjeldahl Nitrogen																						
EPA 365.1																							
	Dissolved ortho-Phosphate																						
EPA 365.4																							
	Total Phosphorus																						
EPA 415.3 (D, T)																							
	Dissolved, Total Organic Carbon																						
Std Method 5310C (D, T)																							
	Dissolved, Total Organic Carbon																						
EPA 531.1																							
	3-Hydroxycarbofuran																						
	Aldicarb																						
	Aldicarb sulfone																						
	Aldicarb sulfoxide																						
	Carbaryl																						
	Carbofuran																						
	Methiocarb																						
	Methomyl																						
	Oxamyl																						
	Propoxur																						
EPA 547																							
	Glyphosate																						

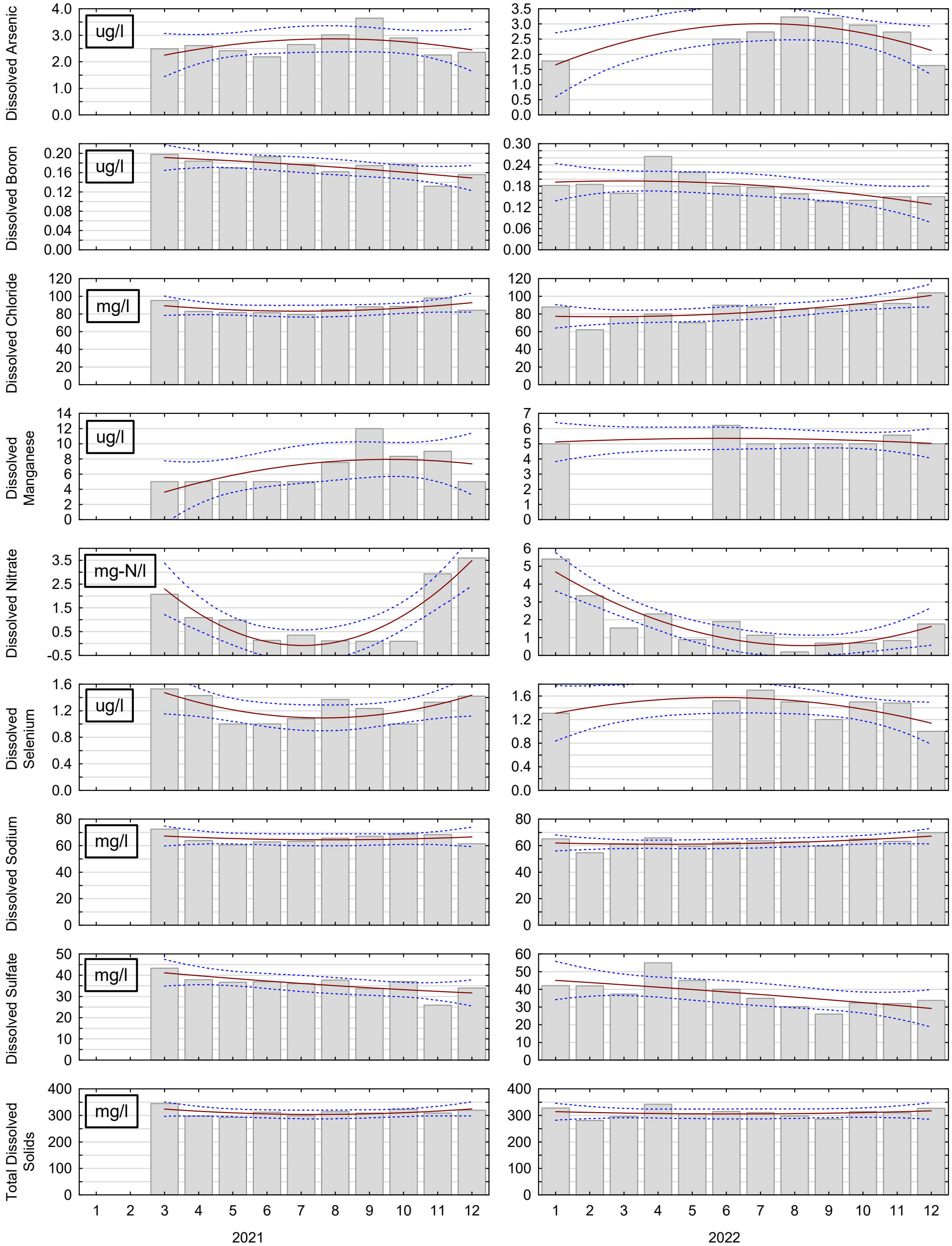


Figure 3. Changes in concentrations of selected water quality constituents.
Values generally represent single samples per month though occasionally up to 2.

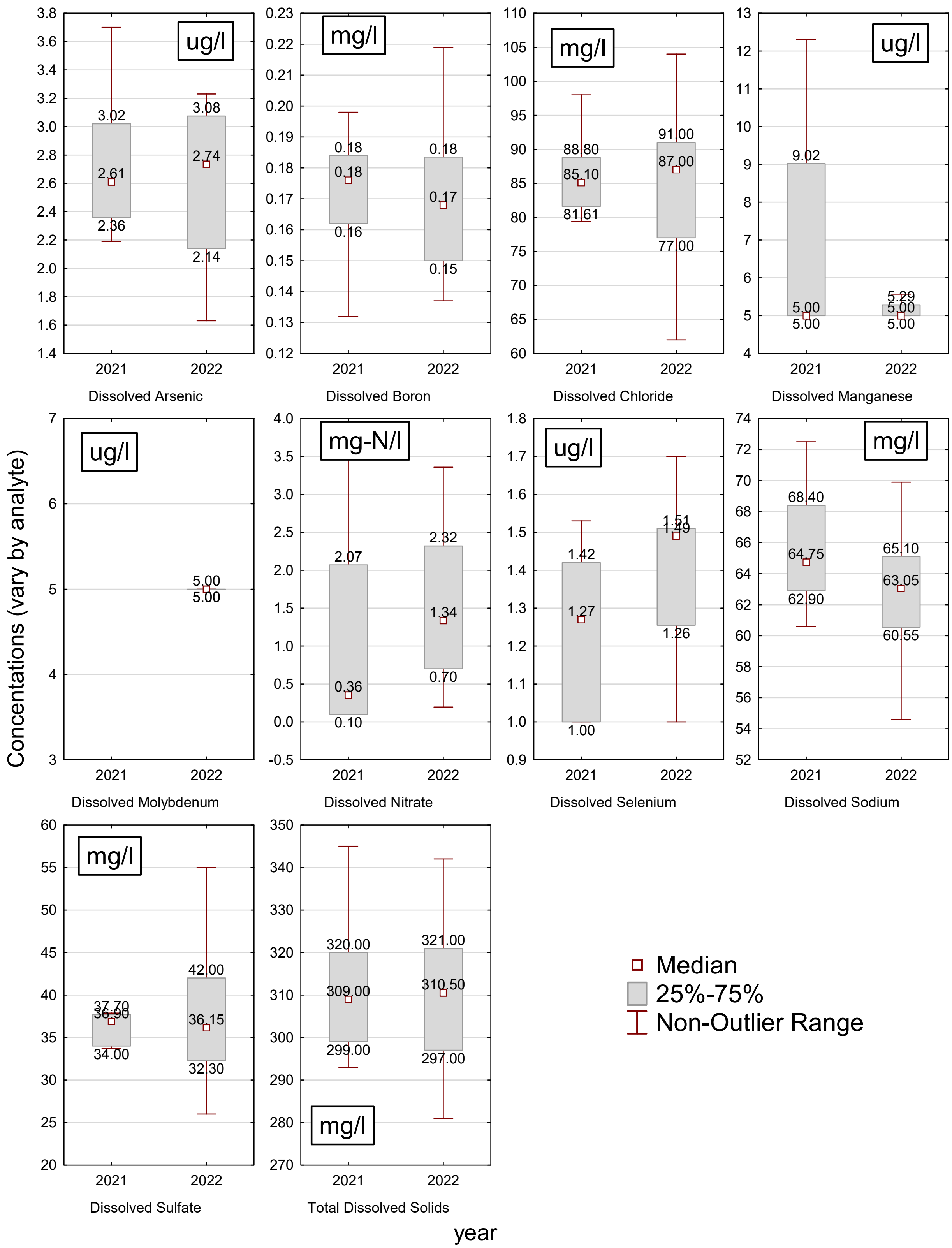


Figure 4. Medians, quartiles and non-outlier ranges for key constituents.

4.2 Mendota Pool Group 20-Year Exchange Group Final Environmental Impact Statement/Environmental Impact Report (EIS/EIR)

The Final Mendota Pool Group 20-Year Exchange Program Final EIS/EIR sets controls on non-CVP water being pumped as part of the Exchange Program. *This document provides a general blueprint for the Pump-in standards that would be expected for water returned to contractors from the Bank* (Table 3) (Reclamation 2019):

- TDS monthly average levels do not exceed 450 mg/l during the period of September through November, and not exceed 600 mg/l the remaining months or annually.
- Wells that had selenium concentrations equal to or greater than 2 µg/L will be shut off. That level will be the surface water quality threshold.
- Wells with boron concentrations equal to or greater than 800 µg/L will be shutoff. That level will be the surface water quality threshold.

Expectations for Non-Project Pump-in Standards for the Bank

The Mendota Pool Group 20-Year Exchange Final EIS/EIR provides a template for the Bank as required returns of contract water. This document requires compliance with drinking water standards as well as special Pump-In specific requirements associated with salts and trace metals, with real-time monitoring of salinity in support of the latter. TDS and selenium are two identified groundwater constituents within MAGSA that are included in these Pump-In specific requirements.

4.3 Lateral 7 Example for Non-Project Water Pump-in Program in practice

The Non-Project Water Pump-in Program standard for the San Luis Canal (2017 Water Quality Monitoring Program) (Reclamation 2017) provides *additional requirements that would be expected for Bank Water returned to contractors*:

1. All sources of non-project water must *comply with California Drinking Water standards* (Title 22). No in-canal dilution is allowed.
2. Each source of non-project water must be *tested regularly* to confirm that it is consistent, predictable, and acceptable in quality.
3. U.S. Bureau of Reclamation (Reclamation) and DWR have used *real-time monitoring of salinity and turbidity* in water in the canal to identify any problems caused by the addition of the non-project water.

These standards provide an example of what the requirements presented by the Mendota Pool Group (Reclamation 2019) may look like in practice. Table 4 and Table 5 show required water quality monitoring.

Table 4 represents priority water quality constituents as a Short List. The Short List sampling for Lateral 7 has been initially defined weekly for four successive weeks when delivering non-project water to the San Luis Canal and then monthly thereafter for the duration of deliveries (Table 6). The Short List (Table 4) includes six of the eight water quality constituents of concern identified by MAGSA (2022b) in the GSP: arsenic, chloride, manganese, nitrate, sodium, sulfate, and TDS.

Table 5 represents the broader suite of Title 22 requirements as well as some additional water quality constituents as described in the table notes. Sampling for these constituents is every three years (Table 6). We have added TCP as a constituent of concern to Table 5 because of the findings by MAGSA (2022b). In both tables, water quality constituents of concern for MAGSA are shaded in orange.

Table 3. Non-Project Water Quality Requirements

EIR/EIR requirements are from Reclamation 2019. The data sources are originally from the Central Valley Regional Water Quality Control Board Sacramento-San Joaquin Valley Basin Plan. Reclamation's standard for selenium concentration in non-Project water introduced into federal facilities or for exchange is ≤ 2 ppb with no allowance for dilution and based upon the Central Valley Regional Water Quality Control Board 1996 selenium objective. More information regarding the EIR/EIS requirements can be found in Reclamation 2019.

Constituent	EIR/EIS Requirement	Title 22 Drinking Water Requirement	Units	Notes
Metals				
Arsenic	10	10	ug/L	During pumping to Mendota Pool
Boron	800	700	ug/L	
Molybdenum	19	10	ug/L	
Selenium	2	50	ug/L	
Salts				
	600		mg/l	Dec - Aug
TDS	450	1000	mg/L	Sep - Nov
	450		mg/L	Annual

Table 4. Water Quality Standards, Short List (Reclamation 2017)

Constituent (1)	Units	Maximum Contaminant Level	Detection Limit	CAS Registry Number	Recommended Analytical Method
Arsenic	mg/L	0.01	0.002	7440-38-2	EPA 200.8
Boron	mg/L	0.7		7440-42-8	EPA 200.7
Bromide	mg/L				
Chloride	mg/L	250		16887-00-6	EPA 300.1
Chromium, total	mg/L	0.005	0.001	7440-47-3	EPA 200.7
Hexavalent chromium	mg/L	0.01	0.0004	18540-29-9	EPA 200.8
Manganese	mg/L	0.05		7439-96-5	EPA 200.7
Nitrate (as N)	mg/L	10	0.4	7727-37-9	EPA 300.1
Selenium	mg/L	0.002	0.0004	7782-49-2	EPA 200.8
Sodium	mg/L	69		7440-23-5	EPA 200.7
Specific Conductance	µS/cm	1,600			SM 2510B
Sulfate	mg/L	500		14808-79-8	EPA 300.1
TDS	mg/L	1,000			SM 2540C
TOC	mg/L				EPA 415.3
Gross alpha (*)	pCi/L	15	3		SM 7110C

Notes

1. Water Quality Constituents of Concern Identified in GSP shaded orange

Table 5. Water Quality Standards, Full Title 22 Analyses

Table and listed sources are from Reclamation (2017) for Non-Project water quality sampling for the San Luis Canal. Orange water quality constituents as determined by MAGSA (2022b) are shown in orange. DBCP is not listed in Reclamation (2017) though added here because of designation by MAGSA (2022b).

Constituent	Units	Max. Contaminant Level		Detection Limit for Reporting		CAS Registry Number	Recommended Analytical Method
		Value	Notes	Value	Notes		
Primary							
Aluminum	mg/L	1	1	0.05	2	7429-90-5	EPA 200.7
Antimony	mg/L	0.006	1	0.006	2	7440-36-0	EPA 200.8
Arsenic	mg/L	0.01	1	0.002	2	7440-38-2	EPA 200.8
Asbestos	MFL	7	1	0.2 MFL>10um	2	1332-21-4	EPA 100.2
Barium	mg/L	1	1	0.1	2	7440-39-3	EPA 200.7
Beryllium	mg/L	0.004	1	0.001	2	7440-41-7	EPA 200.7
Cadmium	mg/L	0.005	1	0.001	2	7440-43-9	EPA 200.7
Chromium, total	mg/L	0.05	1	0.01	2	7440-47-3	EPA 200.7
Copper	mg/L	1.3				7440-50-8	EPA 200.7
Cyanide	mg/L	0.15	1	0.1	2	57-12-5	EPA 335.2
Fluoride	mg/L	2	1	0.1	2	16984-48-8	EPA 300.1
Hexavalent Chromium	mg/L	0.01	1	0.001	2	18540-29-9	EPA 218.7
Lead	mg/L	0.015	9	0.005	8	7439-92-1	EPA 200.8
Mercury	mg/L	0.002	1	0.001	2	7439-97-6	EPA 245.1
Nickel	mg/L	0.1	1	0.01	2	7440-02-0	EPA 200.7
Nitrate (as N)	mg/L	10	1	0.4	2	7727-37-9	EPA 300.1
Nitrate + Nitrite (sum as N)	mg/L	10	1			14797-55-8	EPA 353.2
Nitrite (as N)	mg/L	1	1	0.4	2	14797-65-0	EPA 300.1
Perchlorate	mg/L	0.006	1	0.004	2	14797-73-0	EPA 314/331/332
Selenium	mg/L	0.002	10	0.0004	2	7782-49-2	EPA 200.8
Thallium	mg/L	0.002	1	0.001	2	7440-28-0	EPA 200.8
Thiobencarb	mg/L	0.07				28249-77-6	EPA 527
Secondary							
Aluminum	mg/L	200	6			7429-90-5	EPA 200.7
Chloride	mg/L	500	7			16887-00-6	EPA 300.1
Color	units	15	6				EPA 110
Copper	mg/L	1	6	0.05	8	7440-50-8	EPA 200.7
Iron	mg/L	0.3	6			7439-89-6	EPA 200.7
Manganese	mg/L	0.05	6			7439-96-5	EPA 200.7
Methyltertbutyl ether (MTBE)	mg/L	0.013	4			1634-04-4	EPA 502.2/524.2
Odor threshold	units	3	6				SM 2150B
Silver	mg/L	0.1	6			7440-22-4	EPA 200.7
Specific Conductance	µS/cm	1,600	7				SM 2510 B
Sulfate	mg/L	500	7			14808-79-8	EPA 300.1
Thiobencarb	mg/L	0.001	6			28249-77-6	EPA 527
Total Dissolved Solids	mg/L	1,000	7				SM 2540 C
Turbidity	units	5	6				EPA 190.1/SM2130B
Zinc	mg/L	5	6			7440-66-6	EPA 200.7
Other Required Analyses							
Boron	mg/L	0.7	13			7440-42-8	EPA 200.7

Constituent	Units	Max. Contaminant Level		Detection Limit for Reporting		CAS Registry Number	Recommended Analytical Method
		Value	Notes	Value	Notes		
Molybdenum	mg/L	0.01	11			7439-98-7	EPA 200.7
Sodium	mg/L	69	12			7440-23-5	EPA 200.7
Radioactivity							
Gross Alpha	pCi/L	15	3	3	3		SM 7110C
Organic Chemicals							
(a) Volatile Organic Chemicals (VOCs)							
Benzene	mg/L	0.001	4	0.0005	5	71-43-2	EPA 502.2/524.2
Carbon Tetrachloride	mg/L	0.0005	4	0.0005	5	56-23-5	EPA 502.2/524.2
1,2Dichlorobenzene.	mg/L	0.6	4	0.0005	5	95-50-1	EPA 502.2/524.2
1,4Dichlorobenzene.	mg/L	0.005	4	0.0005	5	106-46-7	EPA 502.2/524.2
1,1Dichloroethane	mg/L	0.005	4	0.0005	5	75-34-3	EPA 502.2/524.2
1,2Dichloroethane	mg/L	0.0005	4	0.0005	5	107-06-2	EPA 502.2/524.2
1,1Dichloroethylene	mg/L	0.006	4	0.0005	5	75-35-4	EPA 502.2/524.2
cis1,2Dichloroethylene	mg/L	0.006	4	0.0005	5	156-59-2	EPA 502.2/524.2
trans1,2Dichloroethylene	mg/L	0.01	4	0.0005	5	156-60-5	EPA 502.2/524.2
Dichloromethane.	mg/L	0.005	4	0.0005	5	75-09-2	EPA 502.2/524.2
1,2Dichloropropane.	mg/L	0.005	4	0.0005	5	78-87-5	EPA 502.2/524.2
1,3Dichloropropene.	mg/L	0.0005	4	0.0005	5	542-75-6	EPA 502.2/524.2
Ethylbenzene.	mg/L	0.3	4	0.0005	5	100-41-4	EPA 502.2/524.2
Methyltertbutyl ether	mg/L	0.013	4	0.003	5	1634-04-4	EPA 502.2/524.2
Monochlorobenzene	mg/L	0.07	4	0.0005	5	108-90-7	EPA 502.2/524.2
Styrene.	mg/L	0.1	4	0.0005	5	100-42-5	EPA 502.2/524.2
1,1,2,2Tetrachloroethane.	mg/L	0.001	4	0.0005	5	79-34-5	EPA 502.2/524.2
Tetrachloroethylene (PCE)	mg/L	0.005	4	0.0005	5	127-18-4	EPA 502.2/524.2
Toluene	mg/L	0.15	4	0.0005	5	108-88-3	EPA 502.2/524.2
1,2,3-Trichloropropane (TCP) (10)	mg/L	0.000005	15	0.000005	15	96-18-4.	EPA 504.1/524.3.
1,2,4Trichlorobenzene	mg/L	0.005	4	0.0005	5	120-82-1	EPA 502.2/524.2
1,1,1Trichloroethane	mg/L	0.2	4	0.0005	5	71-55-6	EPA 502.2/524.2
1,1,2Trichloroethane	mg/L	0.005	4	0.0005	5	79-00-5	EPA 502.2/524.2
Trichloroethylene (TCE)	mg/L	0.005	4	0.0005	5	79-01-6	EPA 502.2/524.2
Trichlorofluoromethane	mg/L	0.15	4	0.005	5	75-69-4	EPA 502.2/524.2
1,1,2Trichloro1,2,2Trifluoroethane.	mg/L	1.2	4	0.01	5	76-13-1	SM 6200B
Vinyl Chloride	mg/L	0.0005	4	0.0005	5	75-01-4	EPA 502.2/524.2
Xylenes	mg/L	1.750*	4	0.0005	5	1330-20-7	EPA 502.2/524.2
(b) Non-Volatile Synthetic Organic Chemicals (SOCs)							
Alachlor	mg/L	0.002	4	0.001	5	15972-60-8	EPA 505/507/508
Atrazine	mg/L	0.001	4	0.0005	5	1912-24-9	EPA 505/507/508
Bentazon	mg/L	0.018	4	0.002	5	25057-89-0	EPA 515.1
Benzo(a)pyrene	mg/L	0.0002	4	0.0001	5	50-32-8	EPA 525.2
Carbofuran	mg/L	0.018	4	0.005	5	1563-66-2	EPA 531.1
Chlordane	mg/L	0.0001	4	0.0001	5	57-74-9	EPA 505/508
2,4D	mg/L	0.07	4	0.01	5	94-75-7	EPA 515.1
Dalapon	mg/L	0.2	4	0.01	5	75-99-0	EPA 515.1
Dibromochloropropane (DBCP)	mg/L	0.0002	4	0.00001	5	96-12-8	EPA 502.2/504.1
Di(2ethylhexyl)adipate	mg/L	0.4	4	0.005	5	103-23-1	EPA 506
Di(2ethylhexyl)phthalate	mg/L	0.004	4	0.003	5	117-81-7	EPA 506
Dinoseb	mg/L	0.007	4	0.002	5	88-85-7	EPA 5151-4

Constituent	Units	Max. Contaminant Level		Detection Limit for Reporting		CAS Registry Number	Recommended Analytical Method
		Value	Notes	Value	Notes		
Diquat	mg/L	0.02	4	0.004	5	85-00-7	EPA 549.2
Endothall	mg/L	0.1	4	0.045	5	145-73-3	EPA 548.1
Endrin.	mg/L	0.002	4	0.0001	5	72-20-8	EPA 505/508
Ethylene Dibromide	mg/L	0.00005	4	0.00002	5	106-93-4	EPA 502.2/504.1
Glyphosate (Roundup)	mg/L	0.7	4	0.025	5	1071-83-6	EPA 547
Heptachlor.	mg/L	0.00001	4	0.00001	5	76-44-8	EPA 508
Heptachlor Epoxide	mg/L	0.00001	4	0.00001	5	1024-57-3	EPA 508
Hexachlorobenzene	mg/L	0.001	4	0.0005	5	118-74-1	EPA 505/508
Hexachlorocyclopentadiene	mg/L	0.05	4	0.001	5	77-47-4	EPA 505/508
Lindane (gammaBHC)	mg/L	0.0002	4	0.0002	5	58-89-9	EPA 505/508
Methoxychlor	mg/L	0.03	4	0.01	5	72-43-5	EPA 505/508
Molinate	mg/L	0.02	4	0.002	5	2212-67-1	EPA 525.1
Oxamyl	mg/L	0.05	4	0.02	5	23135-22-0	EPA 531.1
Pentachlorophenol	mg/L	0.001	4	0.0001	5	87-86-5	EPA 515.1-3
Picloram	mg/L	0.5	4	0.001	5	2/1/1918	EPA 515.1-3
Polychlorinated Biphenyls	mg/L	0.0005	4	0.0005	5	1336-36-3	EPA 130.1
Simazine	mg/L	0.004	4	0.001	5	122-34-9	EPA 505
Thiobencarb (Bolero)	mg/L	0.07	4	0.001	5	28249-77-6	EPA 527
Toxaphene	mg/L	0.003	4	0.001	5	8001-35-2	EPA 505
2,3,7,8TCDD (Dioxin)	mg/L	3 x 10-8	4	5 x 10-9	5	1746-01-6	EPA 130.3
2,4,5TP (Silvex)	mg/L	0.05	4	0.001	5	93-72-1	EPA 515.1
Other Organic Chemicals							
Chlorpyrifos	µg/l	0.015	11			2921-88-2	EPA 8141A
Diazinon	µg/l	0.1	11			333-41-5	EPA 8141A

Sources: Recommended Analytical Methods:
https://www.nemi.gov/home/
Maximum Contaminant Levels: Title 22. The Domestic Water Quality and Monitoring Regulations specified by the State of California Health and Safety Code (Sections 4010-4037), and Administrative Code (Sections 64401 et seq.), as amended.

1. Title 22. Table 64431A Maximum Contaminant Levels, Inorganic Chemicals
2. Title 22. Table 64432A Detection Limits for Reporting (DLRs) for Regulated Inorganic Chemicals
3. Title 22. Table 64442 Radionuclide Maximum Contaminant Levels (MCLs) and Detection Levels for Purposes of Reporting (DLRs)
4. Title 22. Table 64444A Maximum Contaminate Levels, Organic Chemicals
5. Title 22. Table 64445.1A Detection Limits for Purposes of Reporting (DLRs) for Regulated Organic Chemicals
6. Title 22. Table 64449A Secondary Maximum Contaminant Levels "Consumer Acceptance Contaminant Levels"
7. Title 22. Table 64449B Secondary Maximum Contaminant Levels "Consumer Acceptance Contaminant Level Ranges"
8. Title 22. Table 64678A DLRs for Lead and Copper
9. Title 22. Section 64678 (d) Lead Action level

http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/lawbook/dwregulations20150716.pdf
California Regional Water Quality Control Board, Central Valley Region, Fourth Edition of the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins. Revised June 2015

10. Basin Plan, Table III1 (µg/l) (selenium in Grasslands water supply channels)
11. Basin Plan, Table III2A. 4day average (chronic) concentrations of chlorpyrifos & diazinon in San Joaquin River from Mendota to Vernalis

http://www.waterboards.ca.gov/centralvalley/water_issues/basin_plans/sacsjr.pdf
Ayers, R. S. and D. W. Westcot, Water Quality for Agriculture, Food and Agriculture Organization of the United Nations Irrigation and Drainage Paper No. 29, Rev. 1, Rome (1985).

12. Ayers, Table 1 (mg/L) (sodium)
13. Ayers, Table 21 (mg/L) (boron)

http://www.fao.org/DOCREP/003/T0234E/T0234E00.HTM

14. Requested by State Water contractors, no MCL specified. revised: 27 July 2017
https://www.mcmullinarea.org/gsp/
McMullin Area GSP
15. Not included in analyses required for Non-Project Water monitoring per San Luis Canal 2017 Water Quality Monitoring Plan. Water Quality Constituent of Concern for MAGSA per GSP

Table 6. Sampling frequency from Lateral 7 (Reclamation 2017)

Water Quality Constituent	Freqency at Lateral 7
EC	First 4 weeks then monthly for duration
Turbidity	
Short List	
Full list	Every 3 years

4.4 Summary

The source of contract water will be from the San Luis Reservoir. Discharge data from the San Luis Reservoir will be high quality, with concentrations of water quality constituents identified by MAGSA (2022a, 2022b) generally 20 to 40 percent or less of the MCL for most constituents (e.g., arsenic, boron, chloride, manganese, nitrate, sulfate, TDS) with selenium higher and sodium near the MCL. Water quality trends suggest this quality is relatively uniform throughout the seasons. Thus, water being discharged from the San Luis Reservoir by contractors and partners will be of high quality.

Water returned to the contractors from the Bank will need to meet pump-in standards likely similar to those shown in Table 4 (weekly initially) and Table 5 (every three years) (Reclamation 2017, 2019). Notably, contract water delivered to the Bank will provide high quality water that will help meet these Pump-in standards for several constituents through dilution.

II. Groundwater Data Analyses and Results

The following sections outlines the data analyses and associated results. Spatial analyses were conducted using ESRI (2023) and statistical analysis were conducted using TIBCO (2023).

5 Water Quality Data Sources Within MAGSA: Limitations, Qualifiers, and Expectations

The most comprehensive data source for groundwater quality is California's Groundwater Ambient Monitoring and Assessment Program (GAMA). This dataset includes different well categories (e.g., the Department of Pesticide Regulation, GAMA United States Geological Survey [USGS], local groundwater projects, Water Board Cleanup and Permitted Sites), and data sources (e.g., Division of Drinking Water, Department of Water Sources, GAMA Special Studies and Domestic Wells, USGS National Water Information System) for a variety of well types (e.g., domestic, irrigation, industrial, monitoring, municipal, water supply). The GAMA dataset includes data collected from the 1950s and 1960s, but the bulk of the data was collected over the last two decades.

The GAMA data used for this project was sampled from groundwater wells within MAGSA (Figure 6). These wells include domestic, irrigation, and industrial, monitoring, municipal, and others according to the distribution shown in Figure 5. Analyzing the subset of wells in which depth data is provided, we conclude all the GAMA wells are located at or above the Corcoran Clay layer (Table 8).

5.1 Data Considerations and Limitations for Groundwater Quality Analyses

The GAMA well data provides a good source of data for preliminary assessment of groundwater conditions within MAGSA. The resulting analysis provides insight into potential spatial trends and challenges. However, a number of factors affect the uncertainty of these data. Such factors can include the spatial distribution and its uniformity, the

Water Quality Analysis of the GAMA Dataset and Inherent Uncertainty

The GAMA dataset provides water quality data for groundwater sampled primarily over the last two decades. The dataset includes groundwater data from the Department of Pesticide Regulation, USGS, local groundwater projects, the State Water Board, and GAMA Special Studies and Domestic Wells for a variety of well types (e.g., domestic, irrigation, industrial, monitoring, municipal, water supply), serving as the best available groundwater data.

Simple statistical analyses of these data enable rapid assessment. However, there is uncertainty when projecting across a region because of dataset limitations (e.g., spatial well distributions and density, well types and depth, temporal changes in groundwater quality). Thus, simple statistical analyses of GAMA data can be useful in developing groundwater priorities and management strategies, though exact certainties are not known.

types of wells and their design, well depths, the sampling program and its quality control, and the time frame:

Spatial distribution and uniformity: The spatial density is low and not completely uniform within MAGSA. Less than 20 well clusters are distributed across MAGSA (Figure 6), which covers approximately 120,000 acres, about 190 square miles. Thus, these clusters are spaced at approximately one cluster per 10 square miles. The density of these clusters is not entirely uniform, with nearly two thirds of all well clusters located within two areas shown on Figure 6.

Well types and design: The aforementioned well clusters are composed of wells of different types from monitoring wells designed to sample selectively at a given depth to wells used for water supply screened to capture groundwater from within productive zones. Municipal, drinking water, and domestic wells are shallower than irrigation wells generally within MAGSA (Figure 6, Table 7). Irrigation wells represent the category with the fewest wells, less than 10 percent of the number of monitoring wells, which alone exceed all the other wells combined. Monitoring wells are largely located surrounding the American Avenue Landfill (Figure 6).

Sampling program and quality control: The GAMA dataset includes well data from sampling for different programs (e.g., the Department of Pesticide Regulation, GAMA USGS, local groundwater projects, Water Board Cleanup and Permitted Sites), and data sources (e.g., Division of Drinking Water, Department of Water Sources, GAMA Special Studies and Domestic Wells, USGS National Water Information System). Constituent sampling for each organization is designed to address those program priorities and missions. This characteristic has led to non-uniform sampling and analyses across the broad spectrum of water quality constituents and that outcome is reflected in the different spatial and temporal sampling associated with the different constituents. These different programs and participants active in sampling and analyses likely also lead to differences in quality assurance and quality control (QA/QC).

Time frame: The time frame for the GAMA data used in these analyses is approximately the last 20 years. These data provide a general snapshot of an average condition over that period. The data do not incorporate changes that have occurred over the last decade, particularly the creation and implementation of the Sustainable Groundwater Management Act (SGMA) and its focus on moving the region towards groundwater sustainability, or a greater emphasis on better integrating groundwater and surface water supplies through implementation of such activities as recharge programs.

All these factors result in uncertainty in the groundwater data. The GAMA dataset is the most comprehensive, publicly available, dataset currently in California. Analyses of the GAMA data provide insights into trends, opportunities, and constraints in the general context of known but not quantified uncertainty.

Table 7. Number of wells for each group of wells found in MAGSA.

Well Types	# of Wells	Minimum Depth (ft)	Average Depth (ft)	Maximum Depth (ft)	Avg NO3-N (mg/L)
Domestic	183	123	267	417	5
Irrigation / Industrial	65	115	371	532	2
Monitoring	761	30	62	280	13
Municipal	222	60	129	250	5
Water Supply, Other	202	166	203	295	1

Table 8. Summarizing Sampling Well depth within MAGSA
Nitrate is the most sampled analyte within MAGSA. Depth data for these wells in which nitrate was sampled are considered representative of all wells used for groundwater monitoring and with the GAMA system across MAGSA.

			Value	Unit
Number of Wells Sampled for Nitrate			306	#
		Domestic	*97*	
		Irrigation/Industrial	*23*	#
		Monitoring	*44*	
		Municipal	*22*	
		Water Supply, Other	*120*	
Wells with Depth or Screening Information			79	#
	Percent of total wells		26%	%
	Median Depth		233	Ft
	Max Depth		610	Ft
	95th Percentile		500	Ft

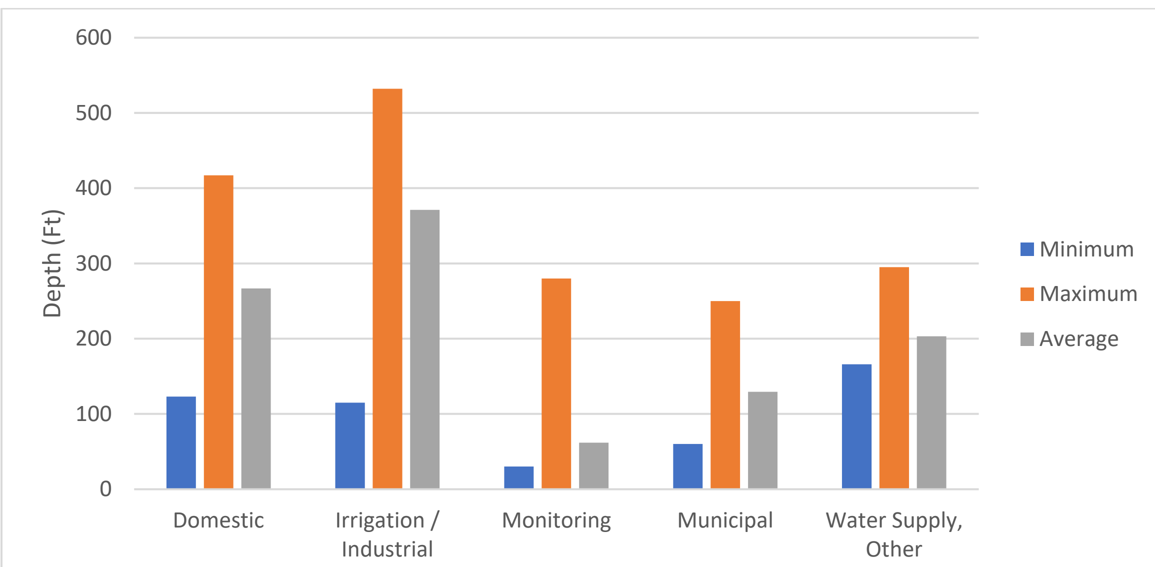


Figure 5. Characterizing Well Type and Depth within MAGSA.

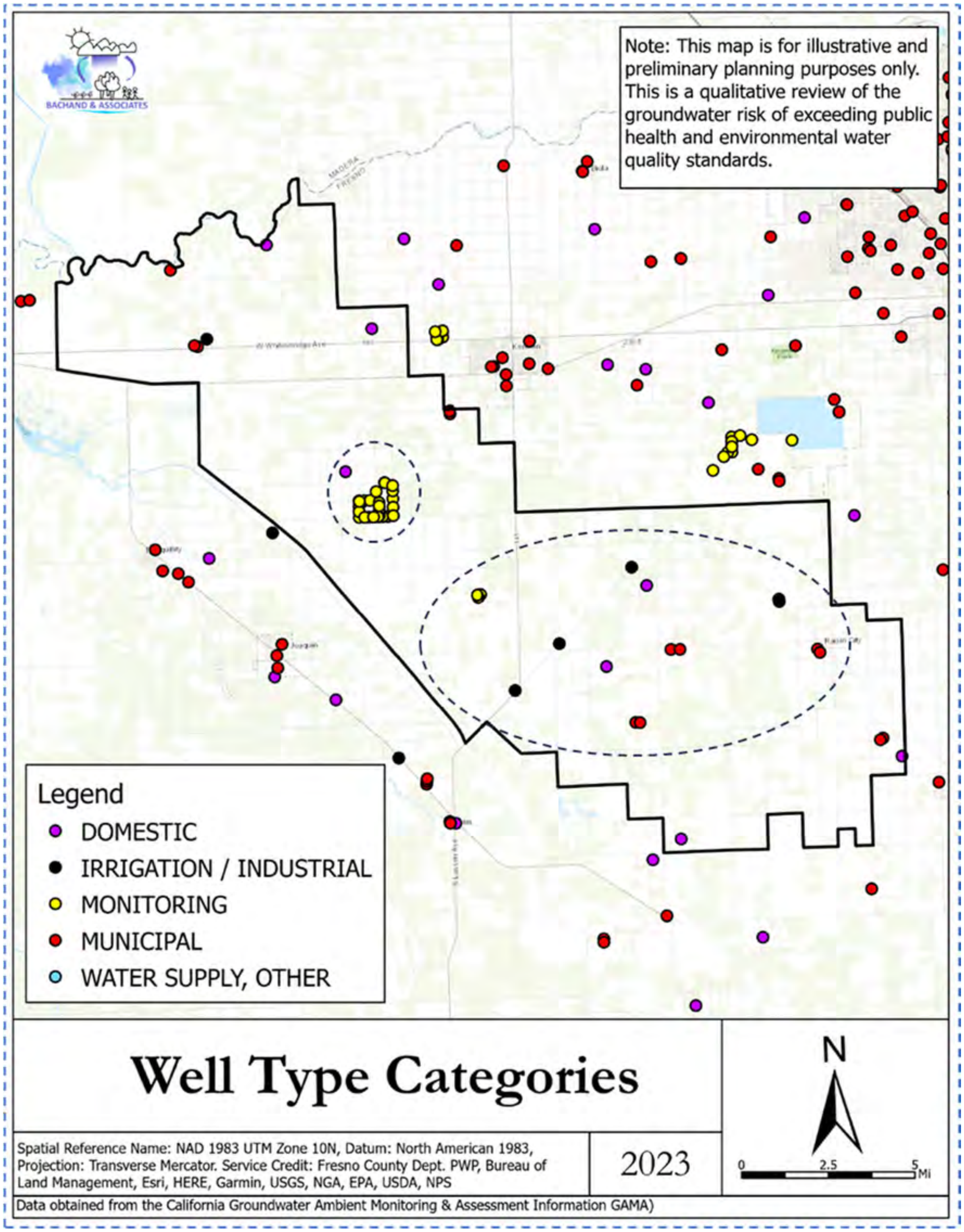


Figure 6. Well Types used in the GAMA dataset within MAGSA.
About two thirds of all groundwater well clusters are within two general areas.

6 Water Quality Within MAGSA

After a review of MAGSA's studies and non-Project Pump-in standards and requirements, we flagged several water quality constituents for consideration including salts (sodium, chloride, TDS), nitrate, specific trace element/metals (arsenic, selenium, boron, manganese, molybdenum), specific VOCs (DBCP, TCP), and gross alpha radiation. The GAMA dataset (post 2020) was used for the analysis and included statistical analyses of well data and spatial interpolations (ESRI, Natural Neighbor) of the GAMA data including mapping and statistics. Additional analyses considered were temporal trends and changes with depth.

This assessment of water quality includes a summary from previous assessments and a closer look using the aforementioned GAMA dataset. That dataset is used to assess the potential difference in water quality with depth and provide some estimates of general distribution of key water quality constituents to support discussions related to presenting operational, management, and monitoring plans for the Bank.

Key groundwater constituents: salts, nitrate, selenium, TCP, and gross alpha radionuclides

Previous MAGSA and non-Project Pump-in environmental studies identify salts (sodium, chloride, TDS), nitrate, specific trace elements (arsenic, selenium, boron, manganese, molybdenum), specific VOCs (DBCP, TCP), and uranium as potential water quality concerns. This chapter presents temporal, statistical, and spatial analyses of the GAMA dataset with regard to the above water quality constituents. These analyses suggest salts, nitrate, selenium, TCP, and gross alpha radioactivity are of greatest concern within MAGSA in relation to the Bank. This conclusion is in a framework of uncertainty because of the limitations associated with GAMA groundwater data and trends suggesting groundwater quality improvements, potentially from improved water and water quality management implemented over the last couple of decades.

6.1 Summary of Findings from Previous Assessments

Previous assessments of water quality have been conducted by MAGSA in the Groundwater Sustainability Plan (MAGSA 2020, 2022b) and in the Aquaterra Feasibility Study (MAGSA 2022a).

The Groundwater Sustainability Plan developed by MAGSA (2020, 2022b) identified and analyzed possible water quality constituents of concerns through the review of GAMA and other data:

- arsenic,
- salts (sodium, chloride and TDS),
- manganese,
- nitrates,
- 1,2 Dibromo-3-chloropropane (DBCP),
- 1,2,3 Trichloropropane (1,2,3 TCP), and
- uranium.

6.1.1 GSP Water quality constituents of concern

In the review of GAMA and other data, MAGSA (2020) identified and analyzed possible water quality constituents of concern, which were updated in a revised GSP (MAGSA 2022b). The GSP (MAGSA 2020, 2022b) is summarized below as related to the water quality constituents of concern. Specific details from these studies can be found through links included in the Reference section.

6.1.1.1 Arsenic

Arsenic occurs in natural deposits and has an MCL of 10 mg/L. In 2018, a municipal well southeast of Raisin City had a reported value of 38 ug/L. MAGSA (2020) noted historic, sporadic heightened MCL exceedances but did not identify a trend of consequential or continuous increasing levels (MAGSA 2020). MAGSA (2020) states arsenic will continue to be monitored. MAGSA (2022b) 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 Groundwater Sustainability Agency (GSA), and additional monitoring or policy development will be addressed by the GSA board as needed (MAGSA 2022b).Salts – Chloride, Sodium and TDS

Chloride has a Secondary Drinking Water Standard (Secondary Maximum Contaminant Level [SMCL]) of 500 mg/L and is present in monitoring wells and municipal wells of various depths throughout the MAGSA area. MAGSA (2020) states chloride is not of considerable concern, noting historic, sporadic heightened MCL exceedances but little indication of a consequential or continuous increase (MAGSA 2020). The American Avenue Landfill is a potential contamination source and will continue to be monitored by the GSA (MAGSA 2022b).

Sodium is identified by MAGSA (2020) as the *predominant water quality constituent of concern in MAGSA*. The MCL for sodium is 50 mg/L. Between 2017 and 2020, sodium was detected in MAGSA. MAGSA (2020) notes an indication of elevated sodium levels in the MAGSA area. As with chloride they note little data suggesting a consequential or continuous increase in chloride concentrations.

TDS aggregates the concentrations of salts (e.g., chloride, sodium, sulfate), and is thus inclusive of chloride and sodium above. TDS has a recommended SMCL of 1,000 mg/L. MAGSA (2020) finds little regularity or pattern with regard to TDS groundwater concentrations. While MAGSA (2020) finds historical TDS concentrations exceeding the SMCL, they note TDS concentration declined recently at some locations. MAGSA (2020) states it will continue to monitor for these salts.

6.1.1.2 Manganese

MAGSA (2020) finds elevated manganese levels found in the northern part of the GSA. MAGSA (2020) states an intent to continue monitoring though they did not consider it a water quality constituent of concern. The SMCL for manganese is 50 μg/l (MAGSA 2022b).

6.1.1.3 Nitrate-Nitrogen

Nitrate is commonly found in groundwater as a result of nitrogen fertilizers in irrigated agricultural and landscaped areas, seepage from feedlots and dairies, wastewater and food processing waste ponds, sewage effluent, and leachate from septic system drain fields. The MCL for nitrate (NO_3) is 45 mg-NO3-

N/L or 10 mg-N/L. MAGSA (2020) determines through using GAMA, 2015 through 2018, no significant nitrate exceedances or indications of consequential or continuous incline. MAGSA (2020) states plans to continue nitrogen monitoring of the groundwater.

6.1.1.4 DBCP

1,2-Dibromo-3-Chloropropane (Dibromochloropropane [DBCP]) was used as a fumigant to kill nematodes in the soil before planting and was widely used in California until 1977. Its MCL is 0.2 μg/L. In 1993, an unspecified well with a depth of 233 feet captured a value for DBCP of 2.5 μg/L. MAGSA (2020) does not consider DBCP a water quality constituent of concern, noting while historic, sporadic heightened MCL exceedances have been found, there is little indication of a consequential or continuous increase. MAGSA recognizes the possible presence of this constituent southeast of Raisin City and will continue to monitor DBCP through its monitoring network and from the public water supply system (MAGSA 2020).

6.1.1.5 1,2,3 TCP

1,2,3-Trichloropropane (TCP) is used industrially as a paint and varnish remover and chemically as a solvent for pesticides. Although there is no federal MCL, California has adopted its own drinking water standard of 5 parts per trillion as of 2018. Although there have been sporadic exceedances of this standard, there is little indication of a consequential or continual increase in concentrations of TCP (MAGSA 2020). MAGSA will continue to monitor for TCP through its monitoring network (MAGSA 2020).

6.1.1.6 Uranium

Uranium occurs naturally in groundwater in parts of the MAGSA area, derived from Sierra Nevada granitics and preferentially adhering to clays.

6.1.2 Water Bank Feasibility Study Groundwater Data – Salts, Hardness, and Alkalinity

The Feasibility Study (MAGSA 2022a) summarizes groundwater quality within MAGSA in consideration of the Bank and more narrowly than the GSP (MAGSA 2022b). The Feasibility Study primarily focused on water quality constituents associated with salts, hardness, and alkalinity.

The report showed sampled TDS concentrations varying widely within MAGSA for sampling during an approximate 60-year period. TDS levels in some areas exceed 500 mg/L and could potentially increase TDS concentrations in the Mendota Pool. One such area is near the Raisin City Oil Field where oilfield extractions and disposal of excess brines on the land have locally degraded groundwater quality nearby, with some areas experiencing TDS concentrations over 1,300 mg/L, approximately 1000 mg/L higher than concentrations measured 60 years ago. For areas today that typically have TDS concentrations averaging 500 mg/L and with some near 1,000 mg/L, TDS concentrations in the 1950s and 60s were near 300 mg/L.

6.2 Water Quality trends with Depth

The GAMA dataset suggests groundwater quality tends to improve with depth. Figure 7 and Figure 8 show the median value and range within MAGSA for TDS and nitrate, respectively. Figure 7 includes the lower of the Mendota Pool Group's Pump-in standard of 450 mg/l. Figure 8 shows the MCL for nitrate at half that value. From the two figures, the highest levels for both TDS and nitrate are found in wells in less than a 300-ft depth range. Figure 8 shows the average nitrate concentrations for both municipal and domestic wells at 5 mg-N/l and 2 mg-N/l for the typically deeper irrigation wells. Given the similar distributions of TDS and nitrate with depth, groundwater being used for irrigation likely has lower TDS concentrations than found in domestic or municipal wells. The average depth of domestic and municipal wells are less than 300 ft, with all municipal wells shallower than 300 ft (Figure 6).

Suggestions of Improved Groundwater Quality with Depth

The GAMA dataset shows shallower groundwater has typical TDS and nitrate levels higher than usual. This result shows up in well water quality, with wells for potable water typically having higher levels of nitrate than those wells for other uses.

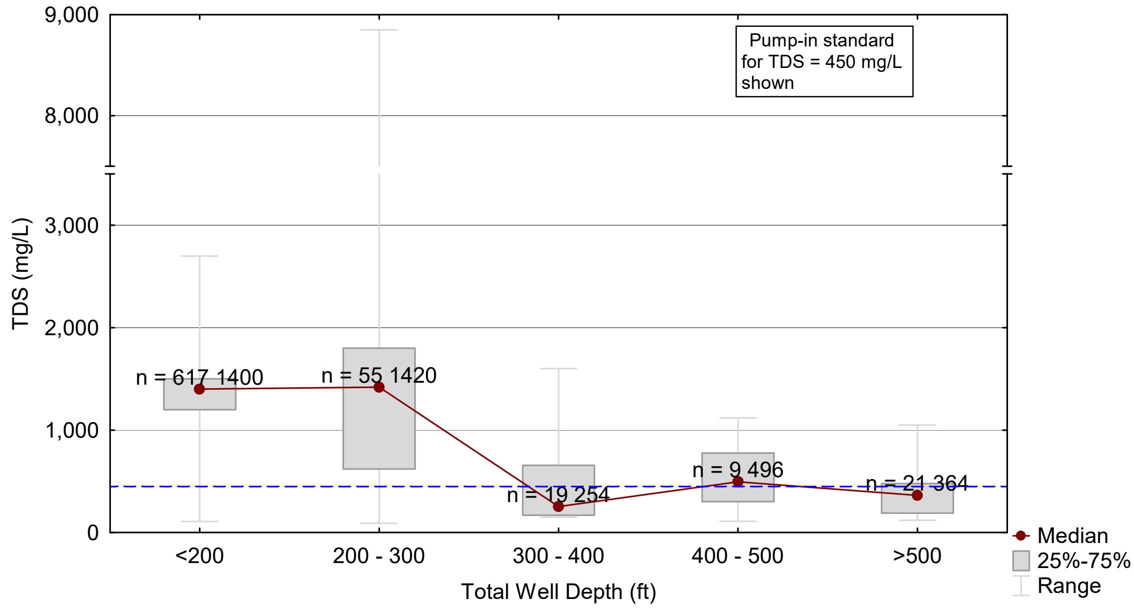


Figure 7. TDS concentrations grouped by total well depths.

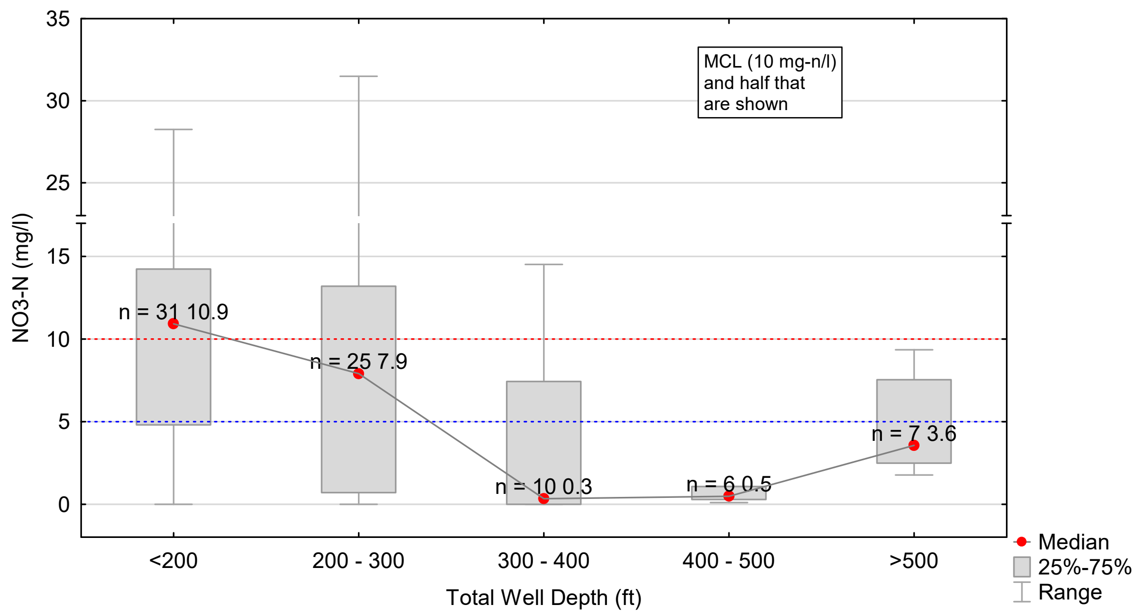


Figure 8. NO3-N concentrations grouped by total well depths.

6.3 Statistical Review of GAMA data

Groundwater within MAGSA when used for drinking water will need to meet drinking water standards. In consideration of the Pump-in standard as has been recently practiced, water returned to the contractor from the Bank will also need to meet drinking water standards.

Table 9 summarizes GAMA data from within MAGSA as related to the drinking water requirements. Several constituents have exceeded the MCLs:

- Sodium (N = 854)[2], gross alpha radioactivity (N = 94), arsenic (N = 280), nitrate (N = 2416), and TDS (N = 929) have exceeded the drinking water MCL in more than 25 percent of the analyzed water quality samples;
- Chloride, boron, manganese, and TCP have exceeded the drinking water MCL in more than 5 to 24 percent of the analyzed water quality samples; and
- DBCP (N = 902), barium (N = 184), selenium (N = 183), and vanadium (N = 152) in more than 0 to 4 percent of the analyzed water quality samples.

Most of these constituents have previously been identified by MAGSA (2022a,b) as important water quality constituents for monitoring under the GSP, except for barium and vanadium, which are radionuclides. MAGSA (2022b) identifies uranium as an important water quality constituent.

High level and Cursory Groundwater Analysis

A statistical analysis of GAMA data supports prioritizing the water quality constituents of salts, nitrate, some trace elements (arsenic, boron, manganese, selenium) and VOCs (TCP, DBCP) as well as radionucleotides in relation to drinking water and environmental standards. This high-level analysis is cursory in that it does not consider temporal or spatial water quality data distributions which allow more robust groundwater quality assessment and provide a greater basis for future groundwater planning and management.

For this analysis, we substitute gross alpha radioactivity for the radionuclides. Gross alpha is a type of radiation emitted by some radionuclides. U-238, Ra-226, and Rd-222 are examples of alpha particle emitters (SWRCB 2017), which are health risks. Radium causes bone cancer in high doses. Breathing radon in indoor air can cause lung cancer and is the second leading cause of lung cancer, behind smoking. Drinking water that contains radon can cause internal organ cancers, primarily stomach cancer, and accounts for 11 percent of stomach cancer caused by drinking water. Exposure to uranium can result in both chemical and radiological toxicity. Natural uranium consists primarily of U-238, very weakly radioactive and not a hazardous radioactive substance. However, uranium is a weak chemical poison able to seriously damage the kidneys at high blood concentrations. The uranium ion (uranyl) can also deposit on bone surfaces and be detected in the bone matrix for several years following exposure. Health effect of alpha particles depends upon the type of exposure. Alpha particles inhaled, ingested, or absorbed into the blood stream can expose living tissue with an increased risk of cancer, particularly lung cancer.

The Mendota Pool Group Final EIS/EIR adds additional requirements for its non-project water Pump-in standards (Reclamation 2019) (Table 10). These requirements include salt management and the inclusion

[2] N = number of samples

of environmental standards as related to selenium. This change increases the water quality samples of selenium exceeding an expected standard from less than 1 percent exceeding the drinking water standard to about 71 percent exceeding the environmental standard. These requirements also increase the number of water quality samples that would exceed TDS standards. About three quarter of water quality samples have exceeded the drinking water standard for TDS. However, with the inclusion of the environmental standards (Reclamation 2019), that number increases to slightly more or less than 90 percent depending on if one is considering the different seasonal TDS requirements of 450 and 600 mg/l.

Importantly, this high level analysis does not consider factors needed to better characterize groundwater quality within MAGSA and its distribution. Specifically for this analysis, these data do not consider temporal or spatial considerations, and are essentially a brute force review.

The two following sections provide both temporal and spatial context with regard to the GAMA water quality data to better characterize groundwater quality within MAGSA and reduce some uncertainty.

Suggestions of Temporal Decreases in Salt Level in Groundwater Coincide with Regional Regulatory Developments

Salt levels in groundwater appear to be decreasing in magnitude and variance during the past couple of decades. These trends could be associated with 1) more efficient agricultural fertilizer and amendment management in response to the Irrigated Land Regulatory Program which adopted its first agricultural discharge permits in 2003, and 2) improving water resources management in response to the Sustainable Groundwater Management Act passed in 2014 and with the first GSPs adopted in the Kings Basin in 2020. Considering groundwater state and future sustainable management will be done in the context of these and other appropriate regulatory frameworks.

6.4 Temporal Water Quality Trends

Temporal trends are presented to enable greater understanding of the potential long-term water quality trends within MAGSA and to provide a better basis for future resource planning and management.

The GAMA dataset shows initial groundwater data began in the 1950s and 1960s, sporadically afterwards until 2000, but since then groundwater quality sampling has increased. Figure 9 shows these data for the three main water quality sampling periods that are found in the GAMA dataset for these constituents: 1960, 2010, and 2020[3]. Potassium, sulfate, chloride, and TDS all fall under the characterization as salts. All these salts increased by about 70 percent to 150 percent during the 50 years from the 1960 sampling period through the 2010 sampling period, with the greatest increase in sulfate[4] (Figure 9). These increases most likely reflect increased inorganic fertilizer use over that period resulting in the accumulation of associated salts in the groundwater. Importantly, from the 2010 to 2020 sampling

[3] These dates reflect sampling periods rounded to the year shown: 1960 (1956 – 1965), 2010 (2006 – 2015) and 2020 (2016 – current).

[4] Sulfate is also applied with gypsum.

period, the data suggest a potential improvement in salts. TDS, an aggregate measure of salts, remained relatively stable with regard to its median concentration but saw a large decrease in the upper 95 percent measurements.

Hardness and alkalinity both include calcium, magnesium, and bicarbonate. As with salts, these constituents increased in the fifty years after the 1960s, mostly with both calcium and bicarbonate increasing by about 80 percent (Figure 9). Like salts, these constituents appear relatively stable over the 2010 and 2020 sampling periods.

In line with the promising downward trends across many of the medians, variance has tended to decrease from the 2010 to the 2020 sampling periods. Calcium, magnesium, bicarbonate, sulfate, chloride, fluoride, and TDS all had decreased variance from the 2010 to the 2020 sampling periods, all opposite of what was seen from the 1960 to 2010 sampling periods.

Recent amendments and water management could be driving these positive water quality trends. More regulatory oversight has been implemented within the Kings Basin and elsewhere in the San Joaquin Valley through the Irrigated Lands Regulatory Program,[5] implemented initially to improve surface waters through preventing agricultural runoff and later expanded to include groundwater regulations. Agricultural pollutants regulated through this program include pesticides, fertilizers, salts, and sediment. For instance, reduction in gypsum (calcium, sulfate) and limestone (calcium carbonate) would be expected to decrease sulfate and salt loading past the root zone to groundwater. These improved controls could be both reducing the total loads and the variance in the loads.

The 2014 passage of SGMA might also be affecting groundwater quality. Through the Kings Basin, GSAs are required to consider both groundwater quality and groundwater quantity as requirements for sustainable groundwater management. Through this critically overdrafted region, GSPs went into effect in 2020, and actions have begun throughout the region towards groundwater sustainability.

These recent efforts to improve groundwater quality, quantity, and sustainability may be showing up in the area's groundwater data measurements and be reflected by the temporal results (Figure 9). With these regulations in place and progressing, groundwater quality in the region would be expected to improve over time.

[5] https://www.waterboards.ca.gov/centralvalley/water_issues/irrigated_lands/ . First permits were adopted for managing agricultural discharges in 2003.

Table 9. GAMA data summary for groundwater sampling within MAGSA exceeding drinking water
Data analysis is across all depths. Exceedances of MCL do not include spatial or temporal considerations.

Water Quality Constituents	*Total Samples*	Max Detection	MCL	Units	*% Exceeding MCL*	0 - 4%	5 - 24%	25 - 100%
Major Ions								
Calcium	*856*	1400	n/a	MG/L	*0%*			
Chloride	*1142*	5740	500	MG/L	*16%*		x	
Magnesium	*1076*	190	n/a	MG/L	*0%*			
Potassium	*1018*	70	n/a	MG/L	*0%*			
Sodium	*854*	1300	50	MG/L	*96%*			x
Sulfate	*1062*	4713	500	MG/L	*0%*			
Radionuclides								
Gross Alpha radioactivity	*94*	362	15	pCi/L	*30%*			x
Gross beta	*2*	0	50	pCi/L	*0%*			
Radium 226	*18*	4.86	5	pCi/L	*0%*			
Radium 228	*26*	3.89	5	pCi/L	*0%*			
Pesticides								
1,2 Dibromoethane (EDB)	*865*	0	0.05	UG/L	*0%*			
1,2-Dibromo-3-chloropropane (DBCP)	*902*	8.3	0.2	UG/L	*4%*	x		
Atrazine	*256*	0	1	UG/L	*0%*			
Simazine	*258*	0.13	4	UG/L	*0%*			
Volatile Organiic Compound								
1,1-Dichloroethane (1,1 DCA)	*840*	1.2	5	UG/L	*0%*			
1,2 Dichloroethane (1,2 DCA)	*840*	0	0.5	UG/L	*0%*			
1,2,3-Trichloropropane (1,2,3 TCP)	*867*	3.2	0.005	UG/L	*10%*		x	
Benzene	*840*	17	1	UG/L	*0%*			
Carbon Tetrachloride	*840*	0	0.5	UG/L	*0%*			
cis-1,2 Dichloroethylene	*823*	0.57	6	UG/L	*0%*			
MTBE (Methyl-tert-butyl ether)	*763*	0.17	13	UG/L	*0%*			
Tetrachloroethene (PCE)	*840*	1	5	UG/L	*0%*			
Total Trihalomethanes	*51*	0	80	UG/L	*0%*			
Trichloroethene (TCE)	*840*	0.53	5	UG/L	*0%*			
Trichlorofluoromethane (Freon 11)	*832*	0.84	150	UG/L	*0%*			
Trace Elements								
Aluminum	*242*	7400	1000	UG/L	*0%*			
Antimony	*166*	3.4	6	UG/L	*0%*			
Arsenic	*280*	38	10	UG/L	*27%*			x
Barium	*184*	1.6	1	MG/L	*1%*	x		
Beryllium	*176*	1.7	4	UG/L	*0%*			
Boron	*289*	4.5	1	MG/L	*10%*		x	
Bromate		0	10	UG/L				
Cadmium	*187*	1	5	UG/L	*0%*			
Chromium	*184*	46	50	UG/L	*0%*			
Manganese	*256*	1500	50	UG/L	*11%*		x	
Mercury	*160*	0.65	2	UG/L	*0%*			
Perchlorate	*71*	4.26	6	UG/L	*0%*			
Selenium	*183*	90	50	UG/L	*1%*	x		
Thallium	*164*	0.8	2	UG/L	*0%*			
Vanadium	*152*	130	50	UG/L	*3%*	x		
Zinc	*180*	1.1	5	MG/L	*0%*			
Nutrients								
Nitrate as N	*2416*	153.0023	10	MG/L	*38%*			x
TDS								
Total Dissolved Solids	*929*	11200	1000	MG/L	*76%*			x

Table 10. Prioritizing Water Quality Constituents as Related to Expected Standards
Exceedances greater than 25% are shaded. Graph identifies constituents identified in the GSP (MAGSA 2022b). Yellow shading represents data in which analysis of statistics on spatially rectified data was below statistics on well data alone. Green represents data in which analysis of statistics on spatially rectified data exceed that of well data alone. Data analyzed is across collected across various depths and well depths.

	Statistics	Salts			Nutrients	Trace Elements					VOC		Radio.
		TDS	Na	Cl	NO3-N	As	B	Mn	Mo	Se	DBCP	TCP	GAR
		mg/l	mg/l	mg/l	mg-N/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	cPi/l
1	*Well Data*												
2	Statistics												
3	25th	1,200	114	320	4.4	2.8	39	0.0	0.9	1.8	0.000	0.000	2.1
4	Median	1,400	170	380	9.7	4.7	144.0	0.0	2.4	3.5	0.000	0.000	5.6
5	75th	1,600	230	470	14.0	12.0	735.0	5.5	6.9	5.0	0.000	0.000	22.0
6	90th	1800.0	290.0	530.0	18.0	15.0	1200.0	29.0	7.3	7.6	0.010	0.017	123.0
7	*Spatial Interpolation*												
8	Statistics												
9	25th	379	62	44	0.5	4.1	36	18	2.0	2.0	0.009	0.008	8.4
10	Median	671	101	78	4.9	5.7	82	32	3.6	3.2	0.019	0.029	34.9
11	75th	1110	212	221	8.1	9.3	242	65	6.9	5.3	0.060	0.065	90.0
12	90th	1500	358	407	11.5	11.2	583	123	9.8	8.8	0.169	0.123	121.4
13	Local standard (as related to drinking water)												
14	MCL	1000	50	500	10	10	700	50	10	50	0.2	0.005	15
15	Spatial Med: MCL	67%	***202%***	16%	49%	57%	12%	65%	36%	6%	10%	***583%***	***233%***
16	Export standard (for banking partners)												
17	Std.	450 / 600	50	500	10	10	1000	50	10	2	0.2	0.005	15
18	Spatial Med: Std	***112%***	***202%***	16%	49%	57%	8%	65%	36%	***159%***	10%	***583%***	***233%***

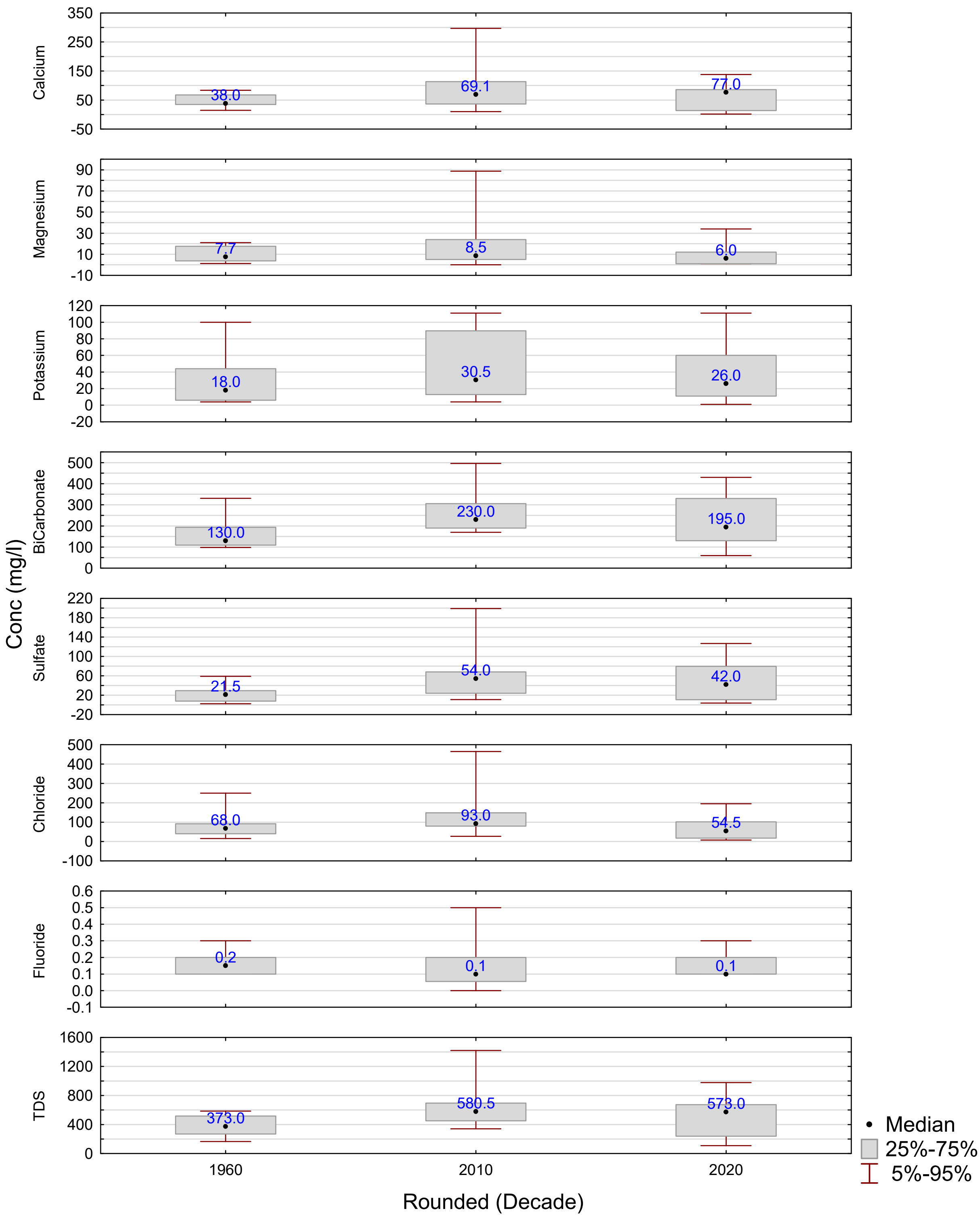


Figure 9. Reported analyte concentration rounded for 1960, 2010 and 2020.
Constituents shown here were analyzed in the Bank Feasibility Study (MAGSA 2020a). This analysis was conducted to revisit those data and assess temporal trends in those data.

6.5 Refining Groundwater Quality Assessments with Spatial Analyses

MAGSA (2022b) has identified several water quality constituents planned to be monitored under the GSP and in compliance with SGMA. The water quality summary from the GAMA datasets shows the percent exceedances (Table 8). Several constituents identified under the GSP by MAGSA have exceedances in the GAMA dataset.

This section discusses results from spatially rectifying groundwater well data and using Natural Neighbor interpolation methods (ESRI 2023) to develop water quality contours for the water quality constituents being considered. The Natural Neighbor interpolation tool algorithm finds the input samples closest to a query point and applies weights to them based on the proportionate areas to interpolate a value (Sibson 1981). It does not infer trends nor produce peaks, pits, ridges, or valleys not already represented by the input samples. The interpolation surface is smooth everywhere except at input data locations (ESRI 2023). The interpolation created approximately 2000 to 3000 datapoints for each analyte.

The spatial results provide more information to understand current groundwater conditions in consideration of the Bank 1) as related to local groundwater uses and for export to partners, and 2) to develop management strategies and priorities.

Spatial Analysis Provides the Foundation to Better Characterize Groundwater

A spatial analysis of groundwater has been conducted to better characterize groundwater. These results provide an understanding of groundwater chemistry and provide a basis for prioritizing water quality constituents and improving their management. This information can provide a foundation for assessing Bank groundwater quality issues and developing initial management methods and objectives.

The spatial analysis conducted is 2-dimensional (2D) and does not include depth (3D).

Table 11 compares statistics from the well data directly (rows 3 – 6) to statistics based on this spatial analysis (rows 9 – 12). *The spatial analysis file represents a geospatial dataset with the data spatially rectified.* The spatial analyses suggest groundwater quality is better as related to salts, nutrients, and boron than predicted from the well data alone, and manganese and VOCs are worse.

The median values calculated from the spatial dataset (row 10) are also compared to drinking water standards (row 14) and its ratio (row 15). This comparison considers local use of groundwater within MAGSA as drinking water. The median values are also related to the export standards (row 17 and 18). These comparisons show sodium, TCP, and gross alpha could be problematic within MAGSA for the aquifer as a drinking water source. The results suggest TDS and selenium could be above the export standards with the median values exceeding the environmental standards. Importantly, the 25th percentile for those two constituents is at or below the environmental standard.

These spatially rectified results provide 1) a better understanding of groundwater and (2) a better basis for prioritizing groundwater quality constituents and improving their management. This information can provide a foundation for assessing the Bank and its groundwater and developing initial management objectives. The subsequent section presents spatial models for each constituent. These models should be considered as reasonable estimates of groundwater conditions and serve as planning tools for moving forward.

Table 11. Well and Spatial Statistics and Expected Water Quality Standards.
Median values of the spatial interpolation (row 10) are shaded yellow if they (and the associated statistical metrics) suggest water quality is better than suggested from the well data statistics. Orange if the spatial analysis suggests worse for a given constituent.

	Statistics	Salts			Nutrients	Trace Elements					VOC		Radio.
		TDS	Na	Cl	NO3-N	As	B	Mn	Mo	Se	DBCP	TCP	GAR
		mg/l	mg/l	mg/l	mg-N/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	cPi/l
1	*Well Data*												
2	Statistics												
3	25th	1,200	114	320	4.4	2.8	39	0.0	0.9	1.8	0.000	0.000	2.1
4	Median	1,400	170	380	9.7	4.7	144.0	0.0	2.4	3.5	0.000	0.000	5.6
5	75th	1,600	230	470	14.0	12.0	735.0	5.5	6.9	5.0	0.000	0.000	22.0
6	90th	1800.0	290.0	530.0	18.0	15.0	1200.0	29.0	7.3	7.6	0.010	0.017	123.0
7	*Spatial Interpolation*												
8	Statistics												
9	25th	379	62	44	0.5	4.1	36	18	2.0	2.0	0.009	0.008	8.4
10	Median	671	101	78	4.9	5.7	82	32	3.6	3.2	0.019	0.029	34.9
11	75th	1110	212	221	8.1	9.3	242	65	6.9	5.3	0.060	0.065	90.0
12	90th	1500	358	407	11.5	11.2	583	123	9.8	8.8	0.169	0.123	121.4
13	Local standard (as related to drinking water)												
14	MCL	1000	50	500	10	10	700	50	10	50	0.2	0.005	15
15	Spatial Med: MCL	67%	***202%***	16%	49%	57%	12%	65%	36%	6%	10%	***583%***	***233%***
16	Export standard (for banking partners)												
17	Std.	450 / 600	69	500	10	10	1000	50	10	2	0.2	0.005	15
18	Spatial Med: Std	***112%***	***147%***	16%	49%	57%	8%	65%	36%	***159%***	10%	***583%***	***233%***

6.5.1 Salts and Major Ions

Salts and major ions include sodium, chloride, and sulfate, as well as the aggregate TDS. Sulfate is not included in these analyses as there are no occurrences of sulfate exceeding the different water quality standards and requirements.

Spatial Model Estimates: Salts

The spatial model estimates TDS concentrations in groundwater exceed drinking water standards (1,000 mg/L) in 30% of MAGSA, and that sodium concentrations exceed the environmental standard (69 mg/l) in nearly 70% of MAGSA. About 45% of MAGSA have TDS concentrations below the expected 600 mg/L pump-in standard for TDS, and about 30% under the lower standard of 450 mg/l. Salt hotspots are parallel to the James Bypass along the western spine of MAGSA with much of it overlying the Raisin City Oil Field.

6.5.1.1 TDS

TDS is an aggregate measure of salts and major ions. As discussed previously and summarized in Table 11, the drinking water standard for TDS is 1,000 mg/L and the expected Pump-in standard is based on experience at Lateral 7 water quality monitoring (Reclamation 2017). The Mendota Pool Group Final EIS/EIR (Reclamation 2019) would be expected to be less than 600 mg/L from December through August and less than 450 mg/L from September through November. Diversion from the Bank to the Mendota Pool is expected to occur from October through April. During that time, the Non-Project Pump-in standard would be 450 mg/L during the first two months of diversion and 600 mg/l thereafter. Recovery back to the Mendota Pool from May through September, a period corresponding with a 600 mg/L TDS standard except during September when the standard is 450 mg/l.

The spatial analysis estimates a median concentration of 671 mg/l, less than the drinking water standard for TDS but higher than the export standards of 450 and 600 mg/l (Table 11). This spatially rectified median is about half the value calculated from the analyses of groundwater samples alone (Table 11).

Figure 10 presents the spatial interpolation using the Natural Neighbor method (ESRI 2023), and Figure 11 shows the areas in relation to the various standards discussed above. These spatial models estimate about two thirds of MAGSA is likely to have TDS concentrations in groundwater less than the drinking water standard and about one third above (Table 12). The estimated area of 31 percent of the region exceeding the drinking water standard is much less than the GAMA data analyses of water quality samples that resulted in 76 percent exceedances.

About one third of MAGSA would be expected to be below 450 mg/L, the lowest expected export standard; about 45 percent below 600 mg/L, the highest expected export standard; and about 70 percent below the drinking water standard (Table 12). Thus, the model estimates over 80,000 acres within MAGSA meet the TDS drinking water standard, and about 50,000 acres reside over water meeting the export standard during periods that standard is set at the 600 mg/l threshold. Those areas are predicted largely in the eastern half of MAGSA and along the north-eastern spine (Figure 11).

Table 12. Estimated acreage below and above TDS water quality thresholds and standards.
The drinking water standard is 1000 mg/L. The pump-in standard is 450 mg/l and 600 mg/l, varying through the seasons (Chapter 0). Concentration data is in mg/l and from samples across all depths.

TDS Range	Acres	%
< 450	37,361	31%
450 - 600	16,987	14%
600 - 1000	29,626	24%
> 1000	37,867	31%
Total	**121,841**	

6.5.1.2 Sodium

Figure 12 presents the interpolated water quality contours for sodium. Figure 13 was developed from that interpolation, showing the areas of MAGSA estimated with sodium levels below 69 mg/L, the standard set in the Mendota Pool Group Final EIS/EIR (Reclamation 2019), and below 50 mg/l, the drinking water standard (Reclamation 2017) (Table 11).

The spatial analysis estimates a median concentration of 101 mg/l. This median value exceeds both the local drinking water standard and the environmental standard (Reclamation 2019) (Table 11). The 25 percent quartile value is less than the environmental standard (Reclamation 2019).

Figure 12 shows the Natural Neighbor interpolation model. Figure 13 shows the model areas below each standard. Approximately 14 percent of the acres of MAGSA are estimated to have groundwater with sodium concentrations below 50 mg/l and approximately 68 percent above 69 mg/L (Table 13). The defined area with groundwater with sodium at or below 69 mg/l (32%) roughly corresponds to the area with TDS predicted to be less than 600 mg/l (Figure 11, Figure 13). A similar finding is for estimated areas with TDS at or below 450 mg/l and sodium at or below 50 mg/l. These areas are located in the southeast end of MAGSA and improve eastward according to the interpolated result and the available GAMA data.

The spatial estimate that 86 percent of the region exceeds the drinking water standard is less than the expected exceedances based on analyses of water quality samples under GAMA. Those water quality samples had 96 percent exceedances (

Table 10).

Table 13. Estimated acreage below and above sodium water quality thresholds and standards. Concentration data is in mg/l and from samples across all depths.

Sodium Range	Acres	%
< 50	16,964	14%
50 - 69	21,714	18%
> 69	83,125	68%
Total	**121,804**	

6.5.1.3 Chloride

The spatial analysis estimates a median concentration of 78 mg/l. This median value is much below both the local drinking water standard and the environmental standard (Reclamation 2019) (Table 11), and the 90th percentile value is also below the two standards. Analyses of the spatially rectified data result in much higher water quality for groundwater as related to chloride than would be expected from the GAMA data statistics alone (Table 11).

Figure 14 presents the spatial interpolation of the chloride data and Figure 15 shows the areas above and below the 250 mg/l EIR/EIS water quality requirement (Reclamation 2019). An estimated 78 percent of the acres within MAGSA are expected to have chloride levels in groundwater below 250 mg/l (Table 14).

Table 14. Estimated acreage below and above chloride water quality thresholds and standards. Concentration data is in mg/l and from samples across all depths.

Chloride Range	Acres	%
< 250	94,153	78%
> 250	26,690	22%
Total	**120,844**	

6.5.1.4 Salt “Hotspots”

The estimated Natural Neighbor interpolations provide us with an ability to identify potential hotspots. For this analysis, we considered the distribution of the 90th percentile value for each constituent as found from groundwater sampling within MAGSA (Table 15). For these local hotspots, both sodium and TDS are more than 3 times higher than the planned Pump-in standard (Table 10). Chloride is less than 2 times the expected standard, below the drinking water standard of 500 mg/l.

Figure 16 overlays those estimated hotspots. The salts hotspots are parallel to and east of the MAGSA western border and the James Bypass/Fresno Slough. The hotspots show some correspondence with the Raisin City Oil Fields and the Kerman and Alkali Sink Ecological Reserves.

Table 15. Comparing 90th percentile "hotspot" thresholds to expected pump-in standards.

		MAGSA Hotspot threshold (1)	Expected Pump-In Standard (2)	Units	Ratio (3)
Salts					
	TDS	1500	450	mg/l	333%
	Cl	407	250	mg/l	163%
	Na	358	69	mg/l	519%
Nutrients					
	NO3-N	12	10	mg-N/l	120%
Trace Elements					
	As	11	10	ug/l	110%
	B	583	800	ug/l	73%
	Mn	123	50	ug/l	246%
	Mo	10	19	ug/l	53%
	Se	9	2	ug/l	450%
Radionucleotides					
	GAR	121	15	pCI/l	807%
VOC					
	TCP	0.123	0.005	ug/l	2460%
	DBCP	0.169	0.2	ug/l	85%

Notes

1 Based on 90th percentile of all groundwater samples collected from 2000 onward

2 Based on Mendota Pool Group EIR/EIS (BOR 2019)

3 = hotspot/expected pump-in standard

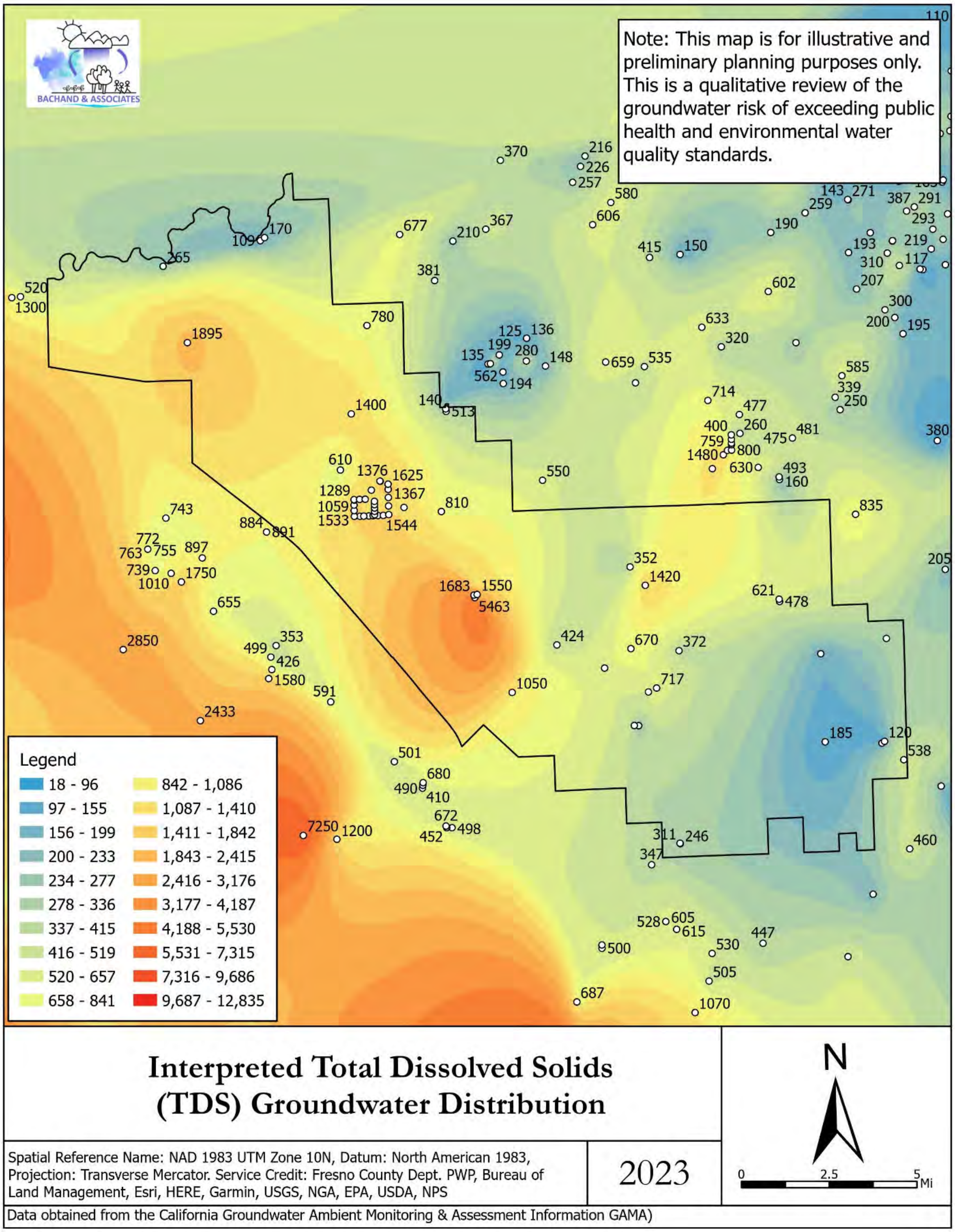


Figure 10. Spatial interpolation of TDS using data from 2000 onward.

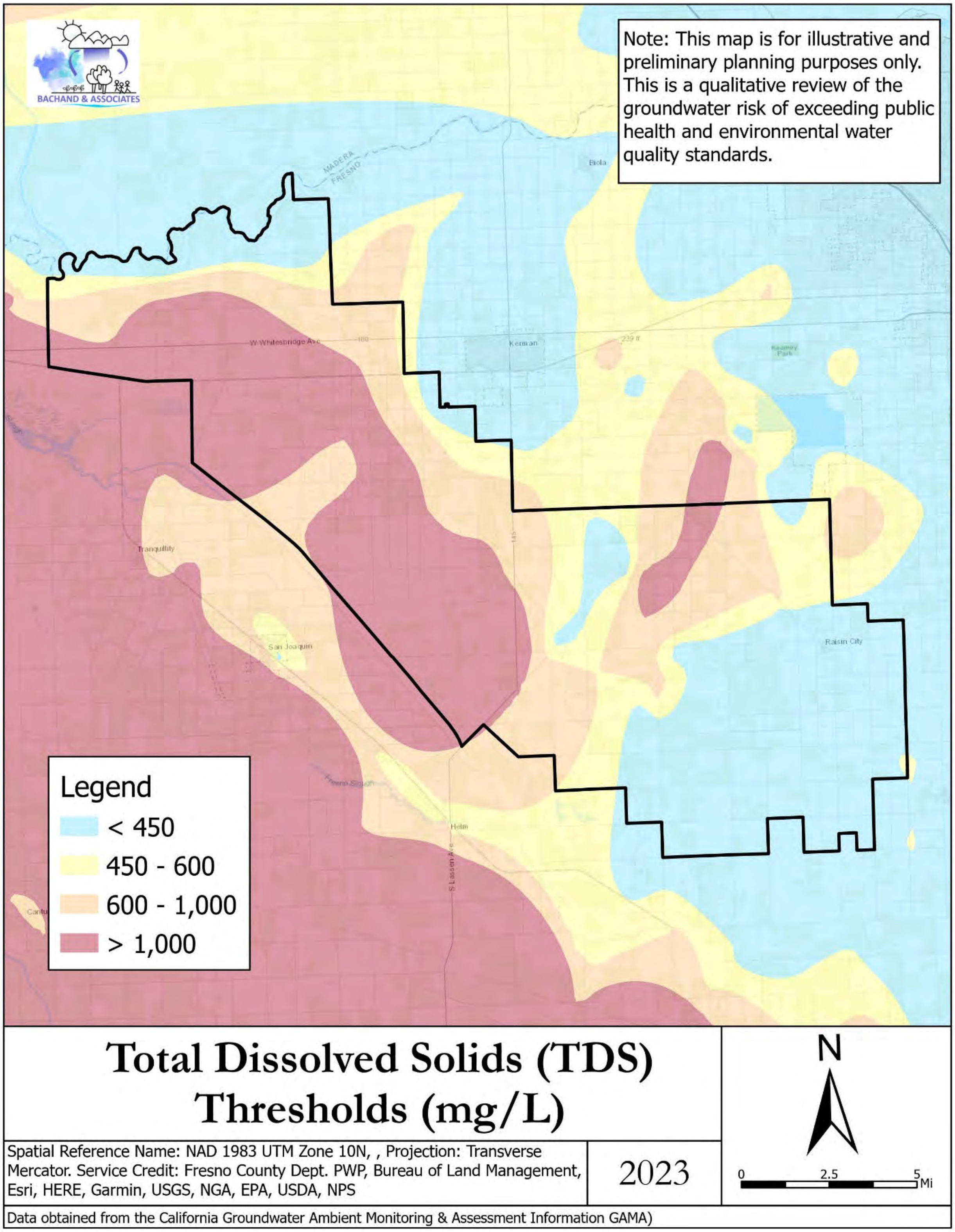


Figure 11. Areas below and above environmental, public health and Pump-in thresholds for TDS.

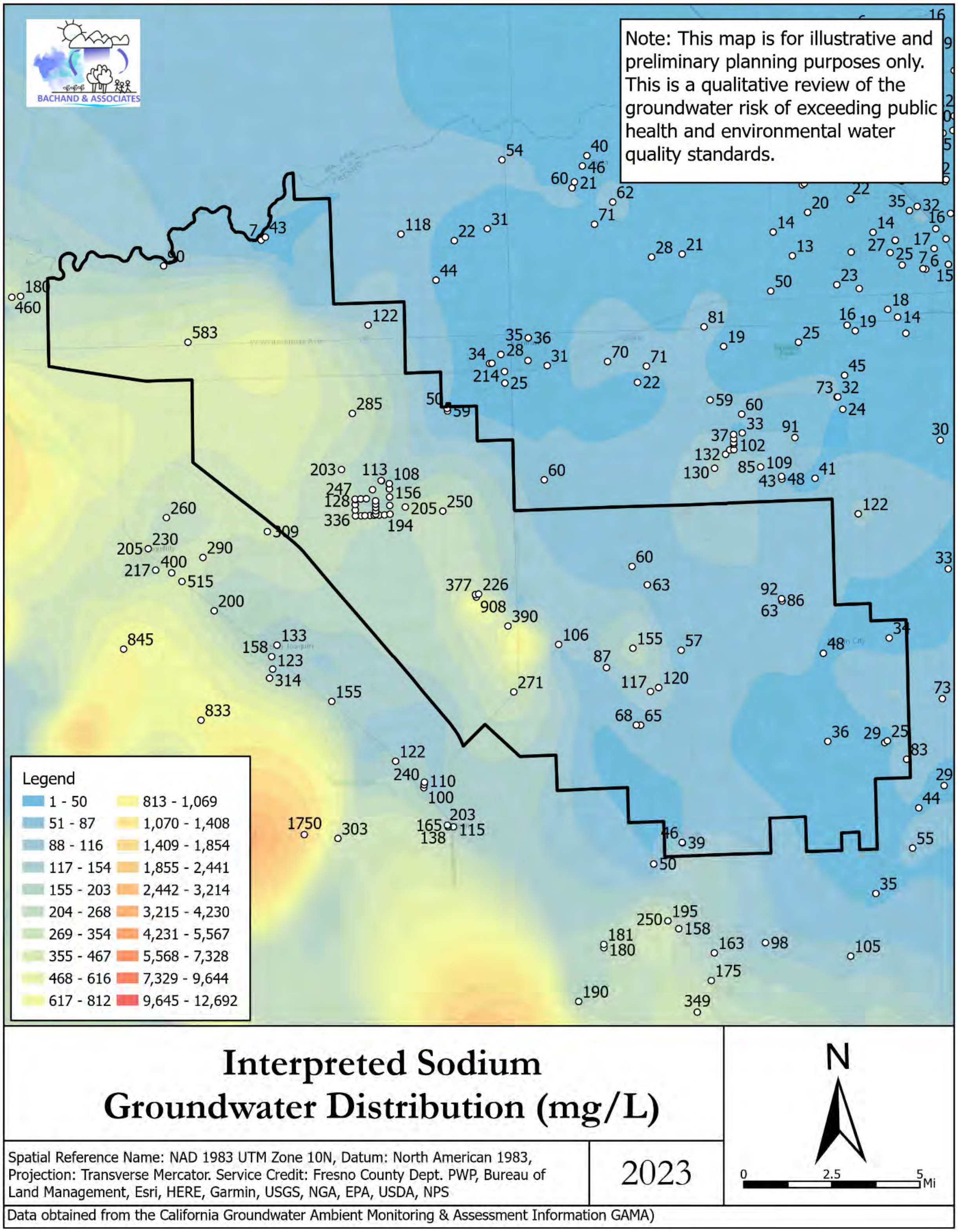


Figure 12. Spatial interpolation of sodium using data from 2000 onward.

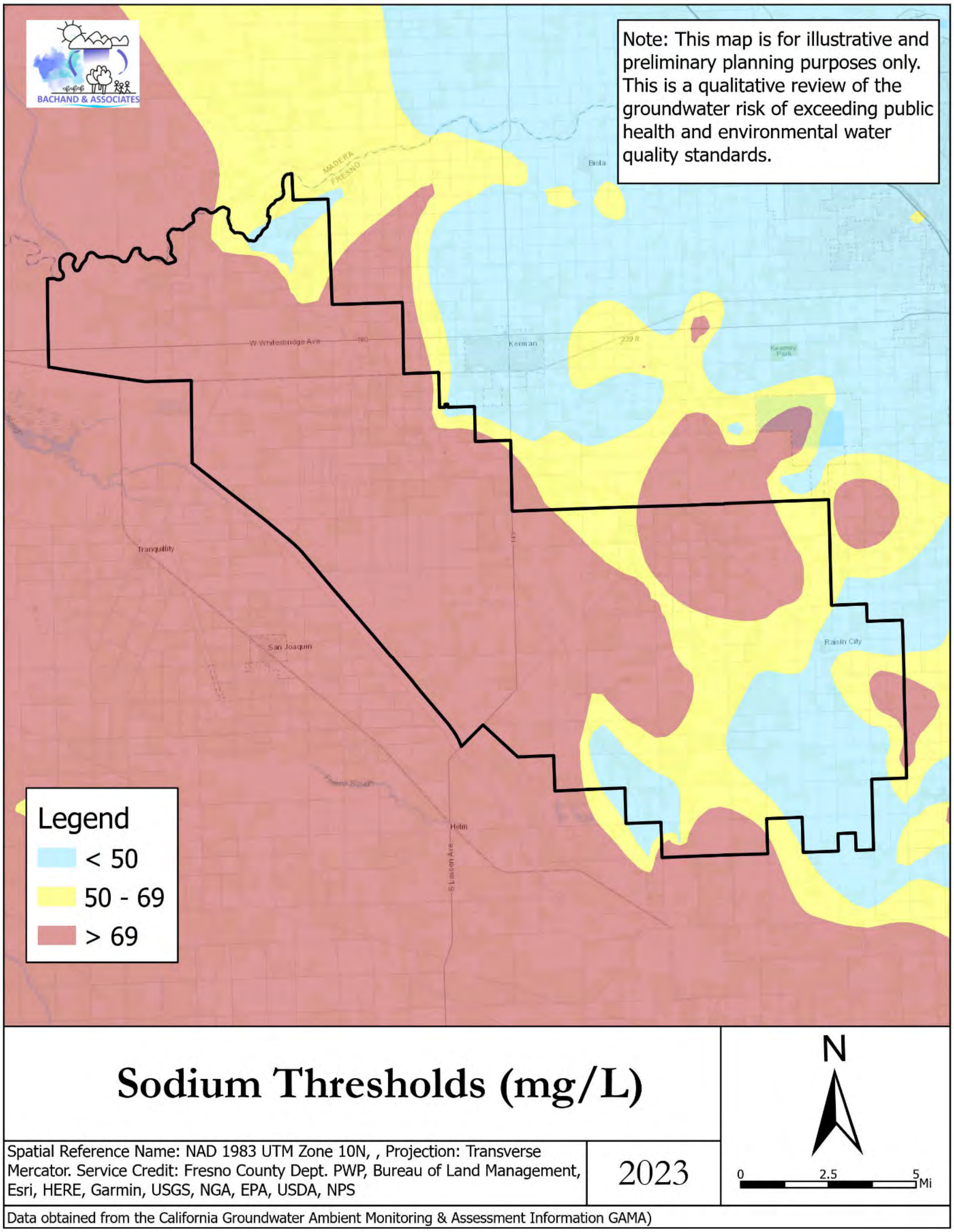


Figure 13. Areas below and above environmental, public health and Pump-in thresholds for sodium.

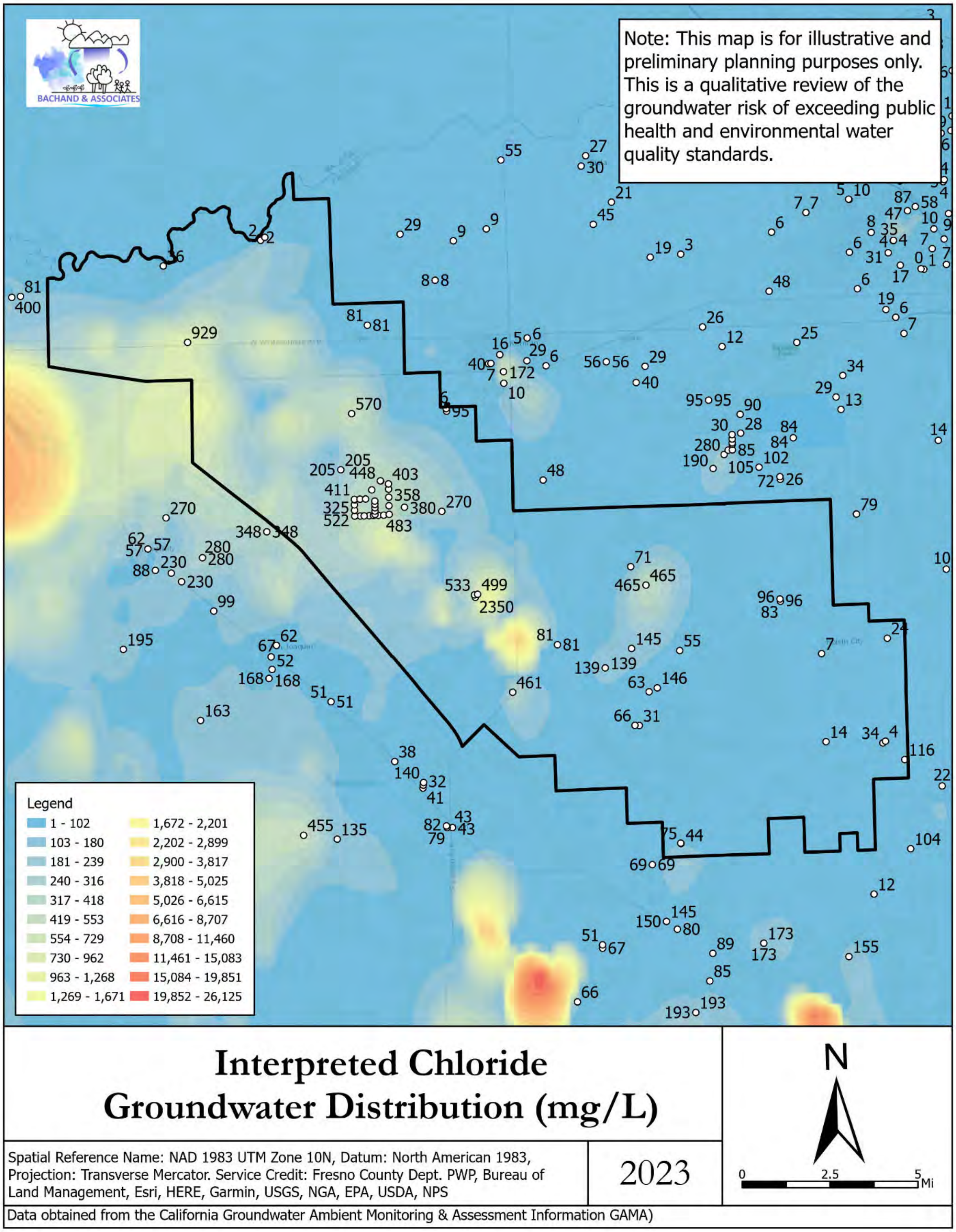


Figure 14. Spatial interpolation of chloride using data from 2000 onward.

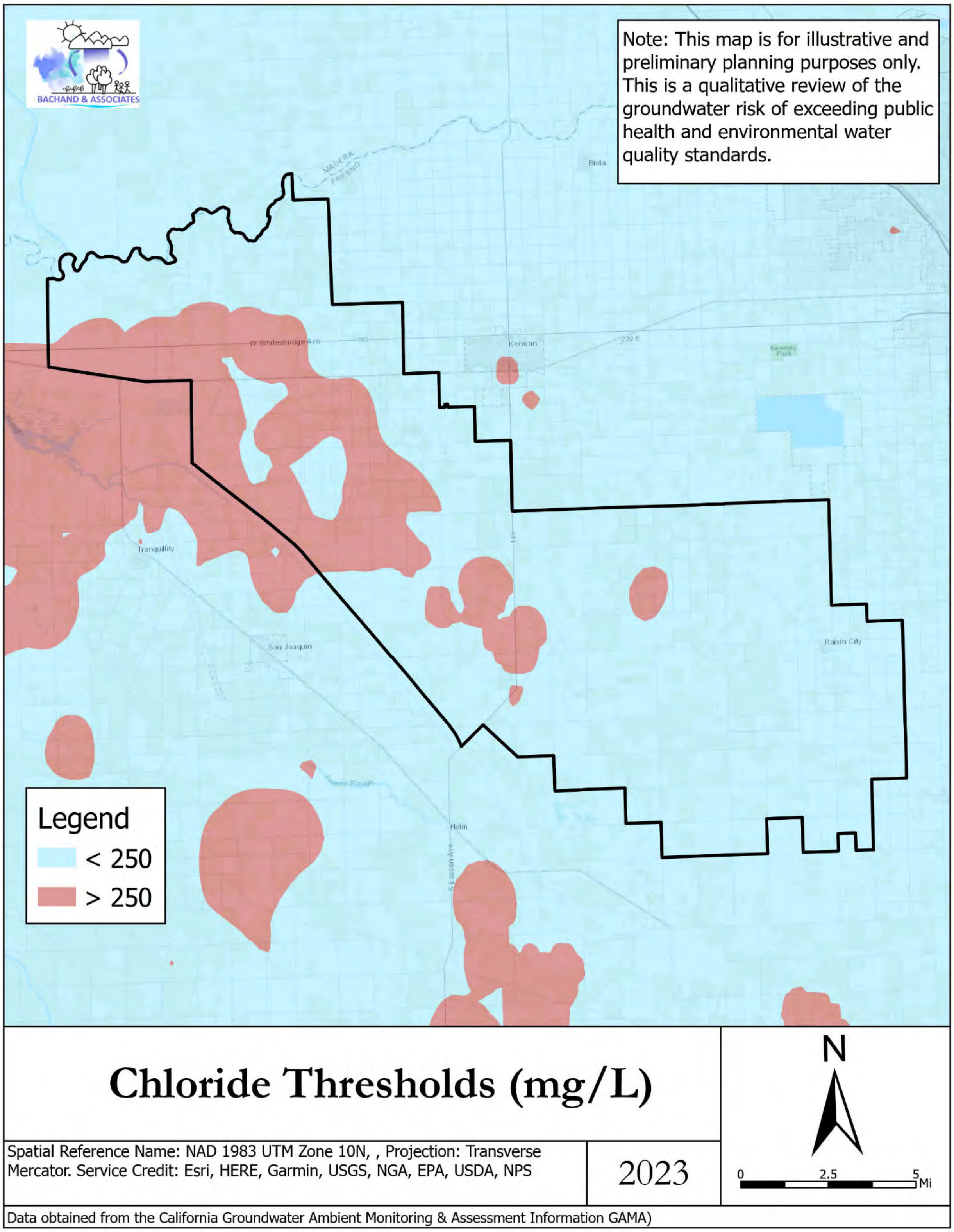


Figure 15. Areas below and above environmental, public health and Pump-in thresholds for chloride.

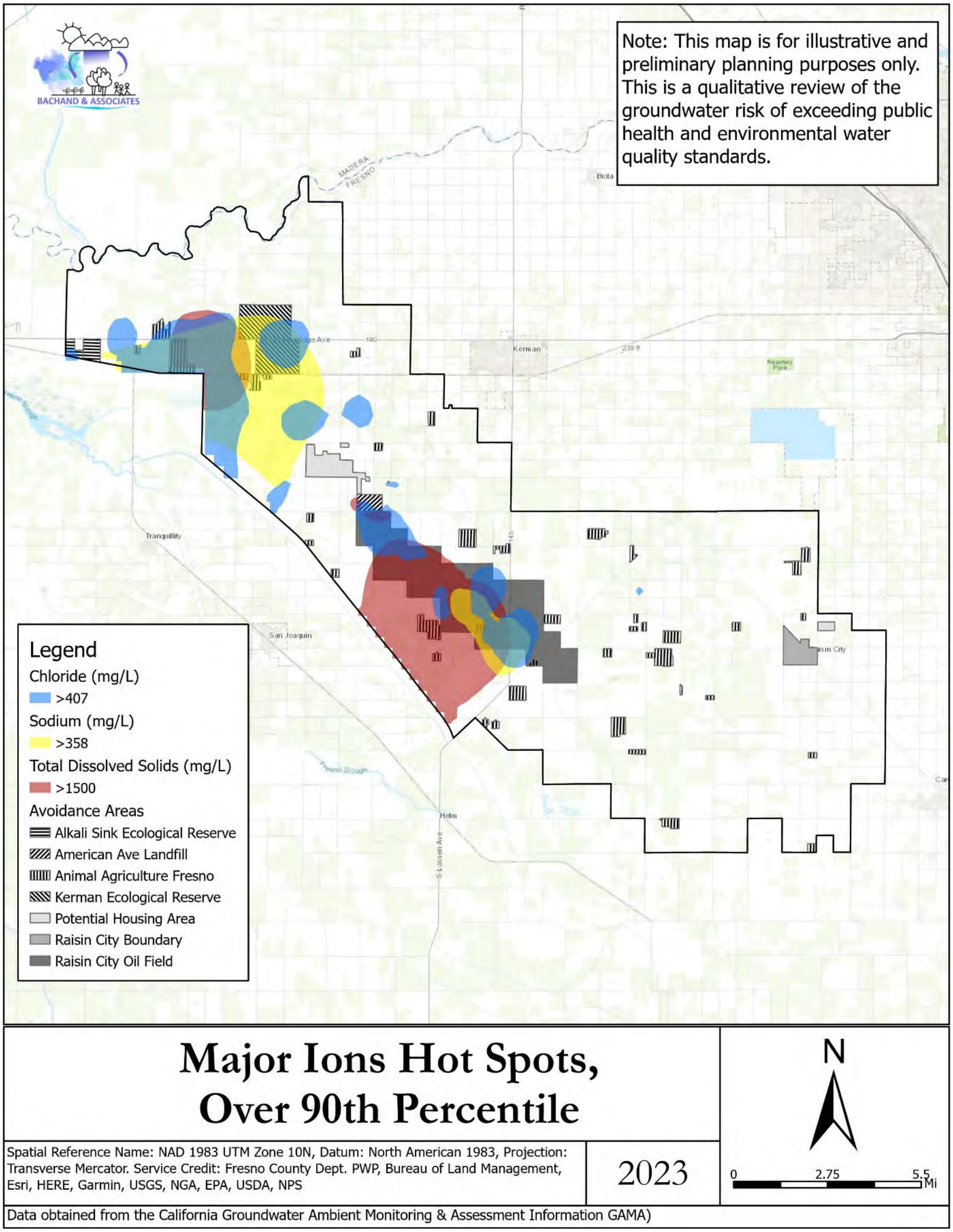


Figure 16. Estimated salts hotspots.

6.5.2 Nutrients

Nitrate is he only nutrient found to have exceedances for public health, environmental, and pump-in project water standards (Table 11). Nitrate is commonly found in groundwater as a result of nitrogen fertilizers in irrigated agricultural and landscaped areas, seepage from feedlots and dairies, wastewater and food processing waste ponds, sewage effluent, and leachate from septic system drain fields. The MCL for nitrate (NO_3) is 45 mg-NO3-N/L or 10 mg-N/L.

Over two thousand (2,416) groundwater samples have been analyzed for nitrate within MAGSA, distributed through MAGSA but concentrated around the landfill (Figure 17). The spatial analyses show the estimated median concentration for nitrate throughout MAGSA is less than 5 mg-N/l (Table 11). This value is half both the water quality and environmental standard, and also about half the median value from analyses of water quality samples included in GAMA.

Figure 18 presents the spatial data as related to the various thresholds, the drinking water standard, and half the drinking water standard. The spatial models estimate about 16 percent of MAGSA has groundwater concentrations above the drinking water standard (Table 16). Of the 84 percent of the acreage estimated to have groundwater concentrations below the drinking water standard, about 40 percent of that (34% of total acreage) is estimated to have nitrate concentrations in the 5 to 10 mg-N/l range.

Figure 19 provides information on hotspots for nitrate and other mobile forms of nitrogen (total dissolved nitrogen, TDN). Importantly, the 90th percentile corresponds to 12 mg-N/l (Table 15), just slightly above the drinking water standard (Table 4, Table 10). The figure shows the hotspot mainly over the Raisin City Oil Field, and then lightly distributed in the eastern half, generally nearer animal facilities than not (Figure 19).

Spatial Model Estimates: Nitrates

The spatial model estimates nitrate concentrations in groundwater exceed drinking and environmental standards (10mg-N/l) in only about 16% of MAGSA, with about 50% of MAGSA having groundwater concentrations less than 5 mg-N/l. Unlike for salts, areas with higher nitrate levels tend to be more generally in the eastern half of MAGSA. Nitrate hotspots are scattered in the eastern half as well as overlying the Raisin City Oil Field.

Table 16. Estimated acreage below and above nitrate water quality thresholds and standards. Concentration data is in mg-N/l and from samples across all depths.

Nitrate Range	Acres	%
< 5	60,828	50%
5 - 10	40,778	34%
> 10	19,001	16%
Total	**120,607**	

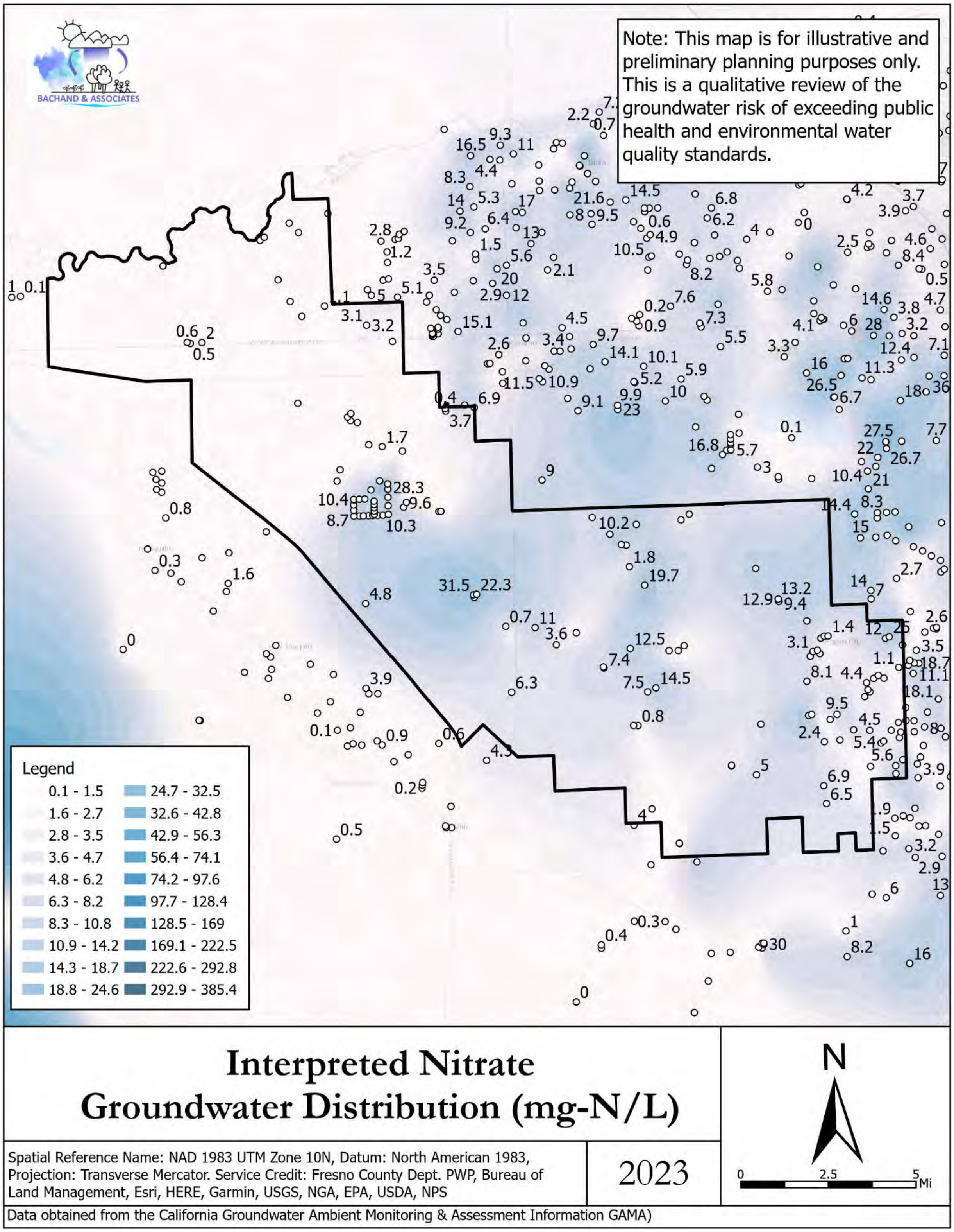


Figure 17. Spatial interpolation of nitrate using data from 2000 onward.

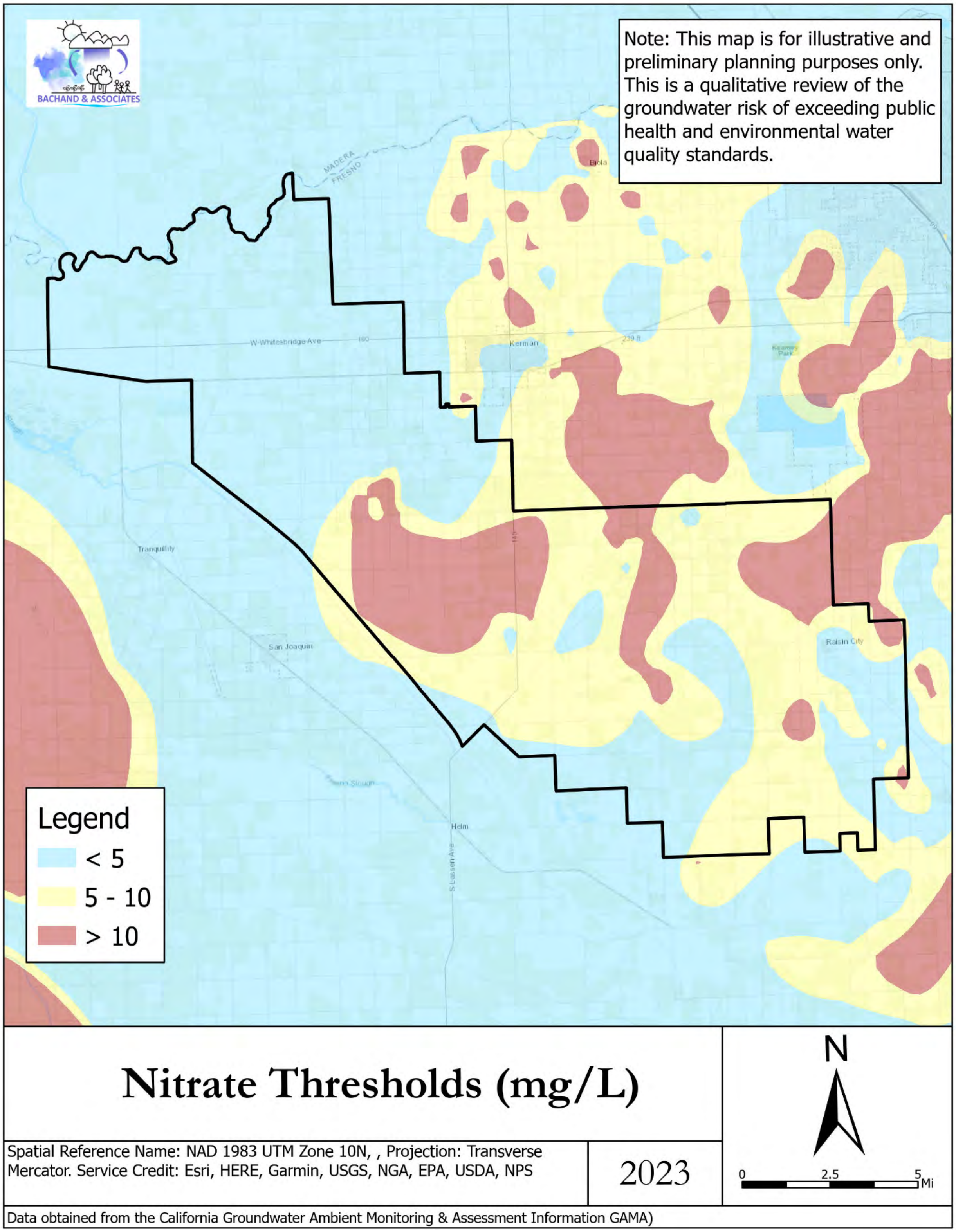


Figure 18. Areas below environmental, public health and Pump-in thresholds for nitrate.

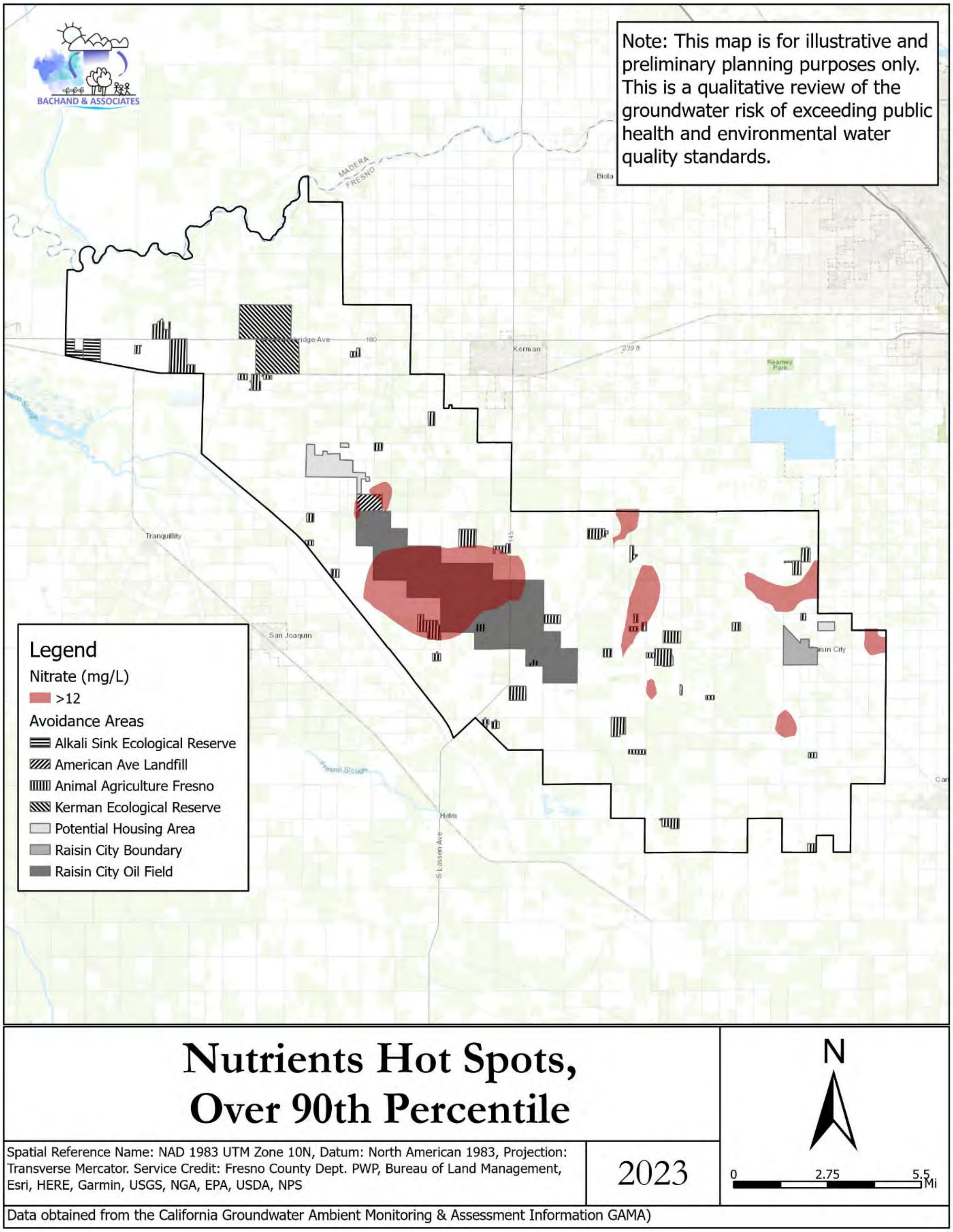


Figure 19. Estimated nitrate "hotspots."

6.5.3 Trace Metals and Trace Elements

Several trace elements/metals have been identified by both the Mendota Pool Group Final EIS/EIR in relation to defining pump-in standards (Reclamation 2019) and by MAGSA as related to SGMA (MAGSA 2022b). The trace metals/elements identified in these two sources are arsenic, selenium, boron, manganese, and molybdenum (Table 3). Of these, arsenic and selenium are most likely to be mobilized through changing redox conditions (Attachment 3).

This section presents the Natural Neighbor interpolation for the trace metal data. The well distribution is similar to that found for sampling of salts and nitrate; presumably many of the same wells have been used for trace metal and element water quality sampling and analyses. The number of samples collected are much less than for the other constituents. On the order of a thousand samples have been collected for salts; over 2000 have been collected for nitrate (Table 9). In comparison, arsenic, manganese, and boron have had fewer than 300 samples taken; selenium less than 200; molybdenum around 50 (Table 9). Fewer samples correspond with greater uncertainty as discussed in Chapter 5.

6.5.3.1 Arsenic

Two hundred and eighty (280) water quality samples are shown for arsenic in the GAMA dataset (Table 9). Wells are relatively evenly distributed throughout MAGSA as presented in Figure 20.

The spatial model suggests a relatively small area of MAGSA has arsenic concentrations exceeding standards (Figure 21). The spatial interpolation suggests approximately 20 percent of MAGSA is expected to have groundwater exceeding the arsenic standards (Table 17).

The spatial analysis for arsenic shows fairly similar water quality as ascertained from statistical analyses of GAMA well data alone (Table 11).

Spatial Model Estimates: Trace Metals and Elements

Manganese, boron, and molybdenum do not appear to pose challenges for meeting environmental, drinking water, or pump-in standards. Arsenic concentrations are estimated to exceed drinking water standards in about 20% of MAGSA. However arsenic management is not expected to be difficult with median concentrations in MAGSA less than 60% of the drinking water standard (10 ug/l). Selenium poses the greatest challenge. This challenge is not related to the 50 ug/l drinking water standard, but instead to the 2 ug/l environmental standard. The spatial estimates suggest 75% of MAGSA has groundwater exceeding that standard. Different trace metals have different hotspot locations throughout MAGSA. Only the selenium hotspot appears relevant in planning to manage selenium and its potential impacts on the Bank and its operations.

Table 17. Estimated acreage below and above arsenic water quality thresholds and standards. Concentration data is in µg/l and from samples across all depths.

Arsenic Range	Acres	%
< 10	99,242	81%
> 10	22,599	19%
Total	**121,841**	

6.5.3.2 Selenium

One hundred and eighty-three (183) water quality samples are shown for selenium in the GAMA dataset (Table 9). Selenium is an important trace element for the environment, with the environmental standard over an order of magnitude below the drinking water standard (Table 10). Selenium is also mobilized through changes in redox conditions (Attachment 3, Figure 2).

The selenium water quality standard is 50 µg/l (Table 5) but the environmental standard is 2 µg/l (Table 11). About 80 percent of selenium sampling has occurred in monitoring wells, primarily around the landfill and none exceeding the 2 µg/l standard (Table 18). Domestic and municipal wells make up most of the remaining wells and together have about two thirds of the samples exceeding the environmental standard. Fifteen samples have been collected from irrigation or industrial wells, with selenium concentrations not exceeding the 2 µg/l environmental standard in those samples.

Wells are relatively evenly distributed throughout MAGSA as presented in Figure 22. The estimated spatial model presents no exceedances of the drinking water standard of 50 µg/l within MAGSA. However, exceedances above 2 µg/l, the environmental standard (Reclamation 2017), are widespread throughout MAGSA (Figure 23). Figure 22 shows selenium concentrations measured as greater than 2 µg/l common across and widely distributed throughout MAGSA. Based on this mode, approximately seventy-five percent of MAGSA's spatial area is estimated to have selenium concentrations exceeding 2 µg/l (Table 18).

The spatial analysis for selenium shows similar water quality as ascertained from statistical analyses of GAMA well data alone, not considering temporal or spatial factors (Table 11).

Table 18. Groundwater samples exceeding 2 µg/l over the entire sampling period.

Well Type	Number of Samples	Greater than 2 ug/l	
		Total	%
Domestic	17	4	24%
Irrigation / Industrial	15	0	0%
Monitoring	113	93	82%
Municipal	38	33	87%
Grand Total	183	130	71%

Table 19. Estimated acreage below and above water quality thresholds and standards.
Concentration data is in µg/l and from samples across all depths.

Selenium Range	Acres	%
< 1	6,977	6%
1 - 2	23,812	20%
2 - 50	91,002	75%
> 50	51	0%
Total	**121,841**	

6.5.3.3 Boron

Two hundred and eighty-nine (289) water quality samples are shown for boron in the GAMA dataset (Table 9). Wells are relatively evenly distributed throughout MAGSA as presented in Figure 24. The MCL for boron is 700 µg/l (Table 11) based on drinking water standards (Table 9) and its practice at the Lateral 7 (Reclamation 2017). The requirement from the Mendota Pool Group Final EIS/EIR is 800 µg/l (Table 3).

Figure 24 presents the spatial model based upon the groundwater samples. Figure 25 presents the areas below the 800 µg/l standard used for the Mendota Pool Group non-Project water (Table 3, Table 10), areas between that and the drinking water standard of 1 mg/L (Table 5).

Water quality sample concentrations have nearly always been below the 800 µg/l level (Table 9), below the drinking water standard. Exceedances above 0.8 mg/l have occurred in about 10 percent of water quality samples (Table 9) but spatially estimated across only about 2 percent of MAGSA (Table 20).

The spatial analysis for boron suggests higher water quality for boron (lower general concentrations) in comparison to water quality as ascertained from statistical analyses of GAMA well data alone, not considering temporal or spatial factors (Table 11).

Table 20. Estimated acreage below and above water quality thresholds and standards.
Concentration data is in µg/l and from samples across all depths.

Boron Range	Acres	%
< 800	114,795	96%
800 - 1000	2,764	2%
> 1000	2,292	2%
Total	**119,851**	

6.5.3.4 Manganese

Two hundred and fifty-six (256) samples are shown for arsenic in the GAMA dataset (Table 9). Wells are relatively evenly distributed throughout MAGSA as presented in Figure 26. The drinking water standard and pump-in requirement for manganese is 50 µg/l (Table 10). The median manganese value in the groundwater samples beginning in 2000 was 32 µg/l with an 18 – 65 µg/l within the 25thto 75th quartile range (Table 11). Exceedances have occurred on 11 percent of the over 250 manganese groundwater samples since 2000 (Table 9). Most of those exceedances have occurred in the southwest area of MAGSA (Figure 26). These trends are reflected in Figure 27 showing the areas with manganese below and above the threshold. Approximately one-third of MAGSA has been spatially estimated to have manganese at levels higher than the threshold (Table 21).

The spatial analysis for manganese suggests lower water quality for manganese (higher general concentrations) in comparison to water quality as ascertained from statistical analyses of GAMA well data alone, not considering temporal or spatial factors (Table 11).

Table 21. Estimated acreage below and above water quality thresholds and standards.
Concentration data is in µg/l and from samples across all depths.

Manganese Range	Acres	%
< 50	79,459	66%
> 50	41,148	34%
Total	**120,607**	

6.5.3.5 Molybdenum

Fifty-three (53) samples are shown for molybdenum in the GAMA dataset (Table 9). Wells are relatively evenly distributed throughout MAGSA as presented in Figure 28. The median molybdenum value estimated from the spatial analysis is 3.6 µg/l (Table 11). That value is less than the drinking water and environmental standards. Even the 90th value for molybdenum estimated from the spatial analysis is below the two standards. These groundwater samples have been relatively evenly distributed throughout most of MAGSA, with some focus on the landfill in particular (Figure 28).

For molybdenum, the drinking water MCL is 10 µg/l and the environmental requirement under the Mendota Pool EIR/EIS is 19 µg/l (Table 10, Reclamation 2019). The Non-Project Pump-in standard under the Mendota Pool EIR is based on the latter requirement and is expected to carry over into the Bank. No samples have exceeded the 19 µg/l specified in the Mendota Pool EIR/EIS (Reclamation 2019), and the spatial prediction is the same with no area estimated to have exceeded the 19 µg/l threshold (Figure 29).

The spatial analysis for molybdenum suggests higher water quality for molybdenum (lower general concentrations) in comparison to water quality as ascertained from statistical analyses of GAMA well data alone, not considering temporal or spatial factors (Table 11).

Table 22. Estimated acreage below and above water quality thresholds and standards.
Concentration data is in µg/l and from samples across all depths.

Molybdenum Ran	Acres	%
< 10	109,056	90%
10 - 19	11,470	10%
> 19	0	0%
	120,527	

6.5.3.6 Trace elements "hotspots"

Figure 30 shows the "hotspots" for the different trace elements: arsenic, selenium, boron, manganese, and molybdenum. "Hotspots" have been estimated from the 90th percentile for each constituent as sampled within MAGSA since 2000.

The estimated spatial footprints for the various trace elements do not show any trends regarding their overlap or with regard to avoidance areas considered under the Aquaterra environmental analyses: ecological reserves, American Avenue Landfill, potential housing areas, Raisin City, the Raisin City Oil Field, animal agriculture. The 90th percentile as compared to the expected pump-in standard for this project (and based on the Mendota Pool Group EIS/EIR) (Table 15) varied for the different trace elements.

Two key results can be gleamed from this analysis. First, the 90th percentile calculations for manganese and selenium exceed the pump-in standard values by about 250 percent or more (Table 15), whereas arsenic, boron and molybdenum were about equal or less than the pump-in standard value (Table 15). In that context, the "hotspot" representations for arsenic, boron, and molybdenum do not represent areas of concern given their relatively low concentrations of those 90th percentile hotspot thresholds. Second, most of these hotspots are located parallel to and near the western edge of MAGSA.

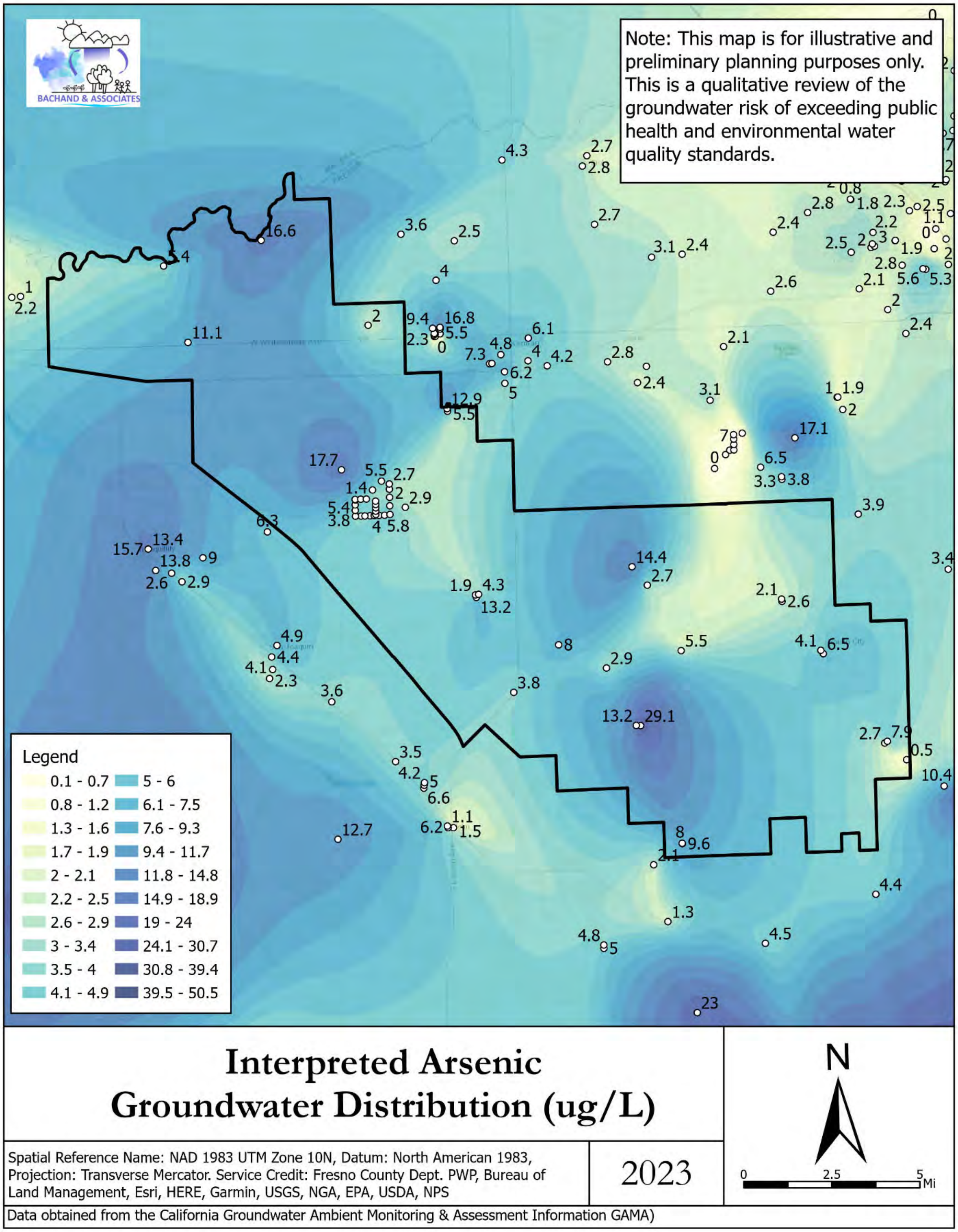


Figure 20. Spatial interpolation of arsenic using data from 2000 onward.

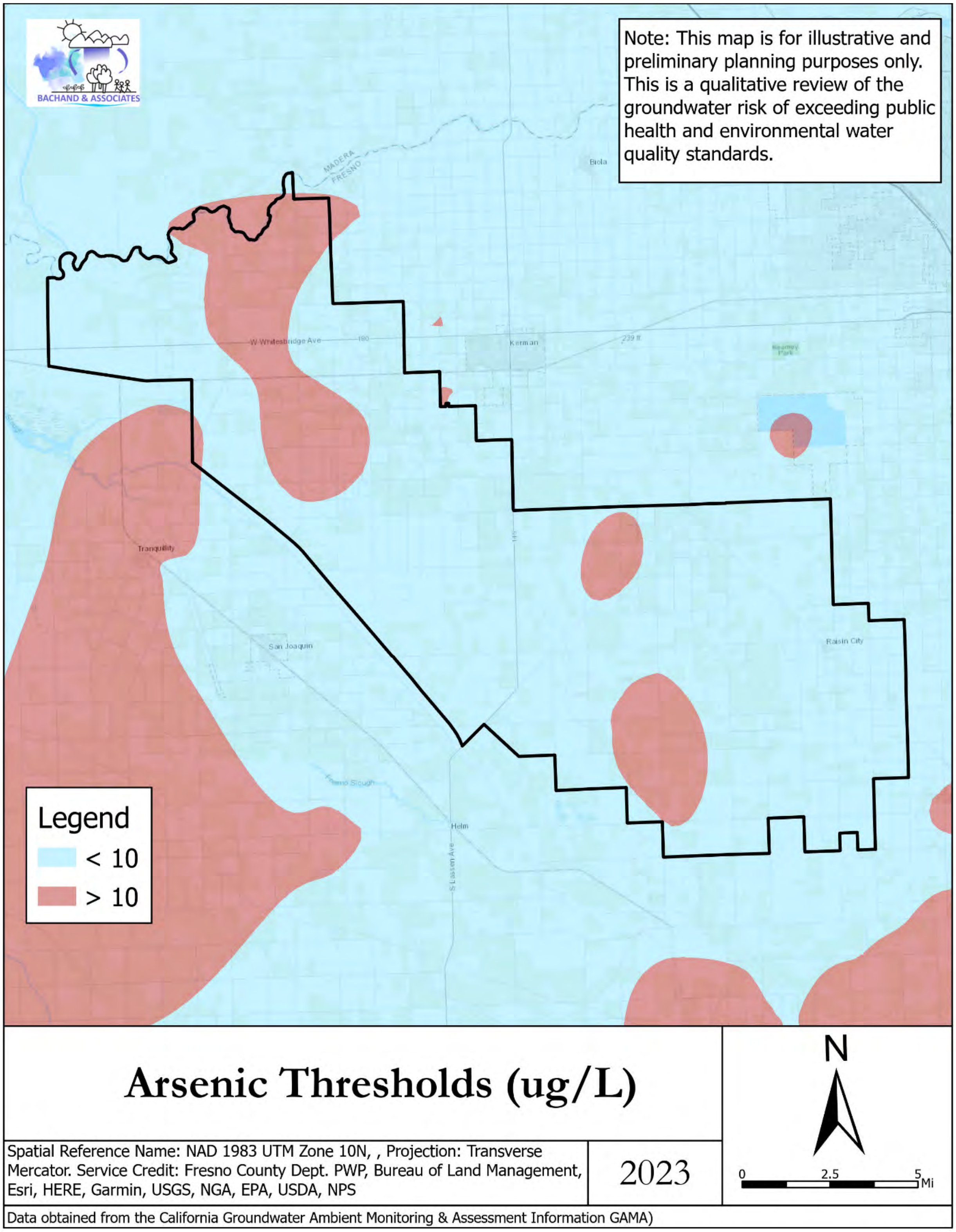


Figure 21. Areas below environmental, public health and Pump-in thresholds for arsenic.

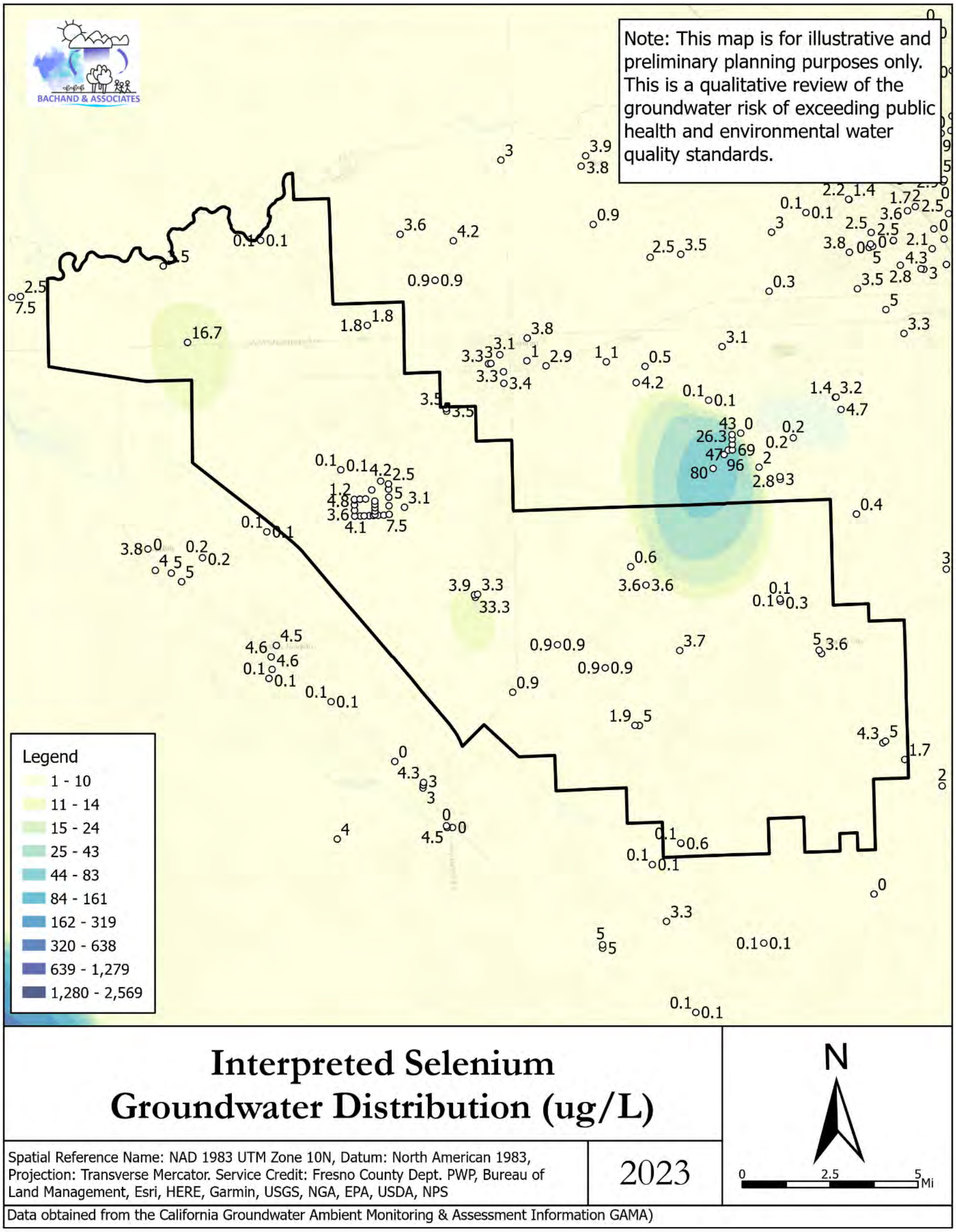


Figure 22. Spatial interpolation of selenium using data from 2000 onward.

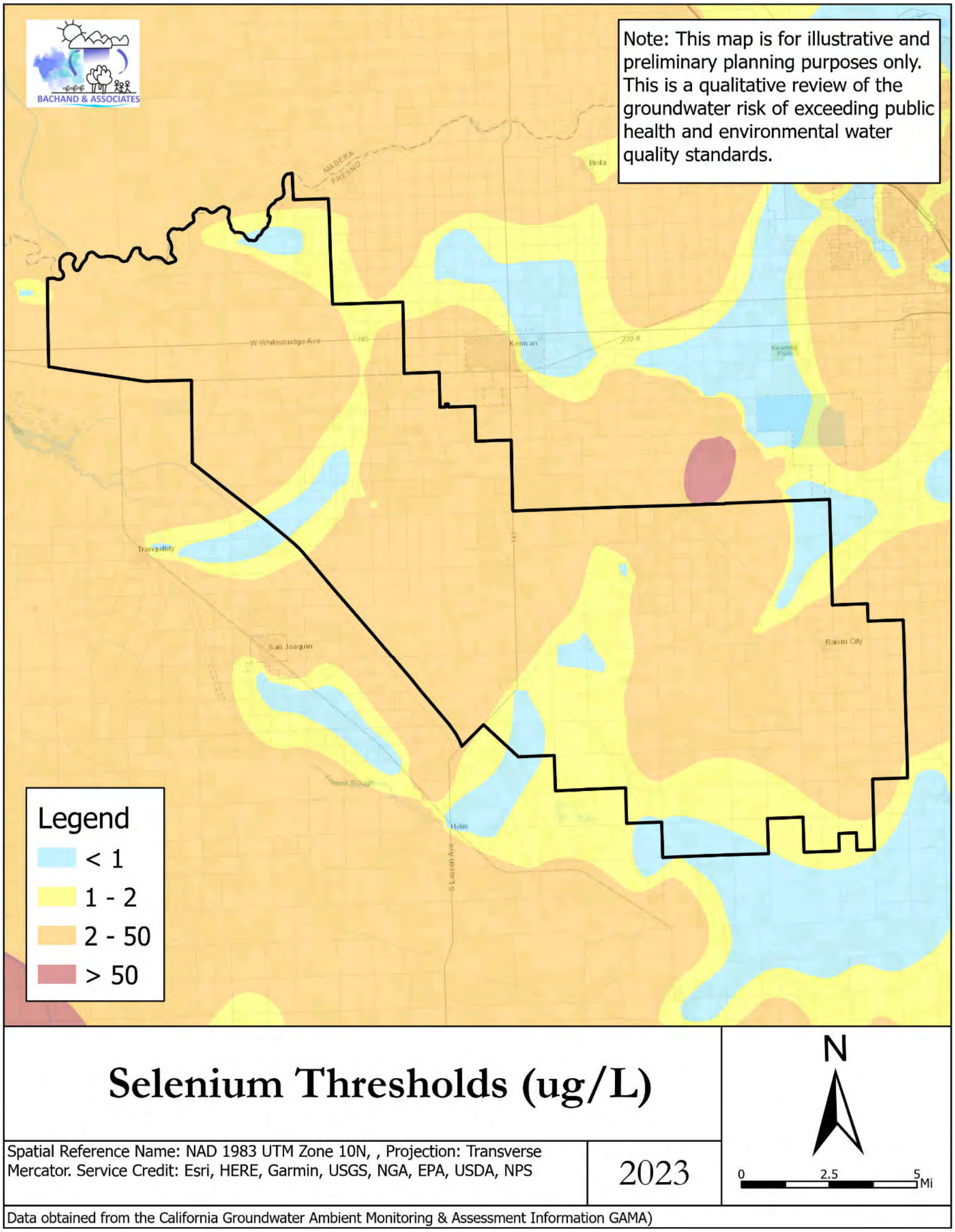


Figure 23. Areas below environmental, public health and Pump-in thresholds for selenium.

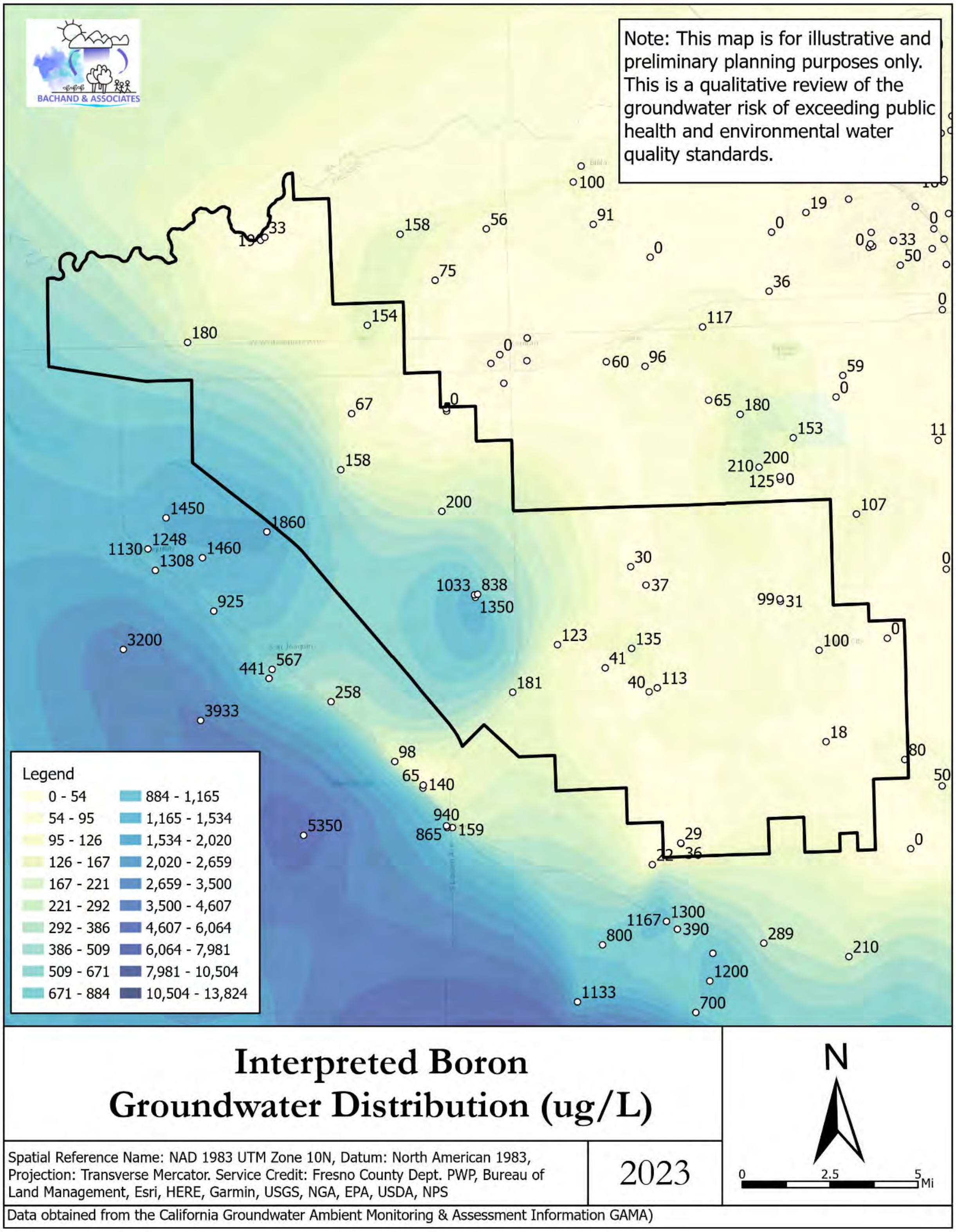


Figure 24. Spatial interpolation of boron using data from 2000 onward.

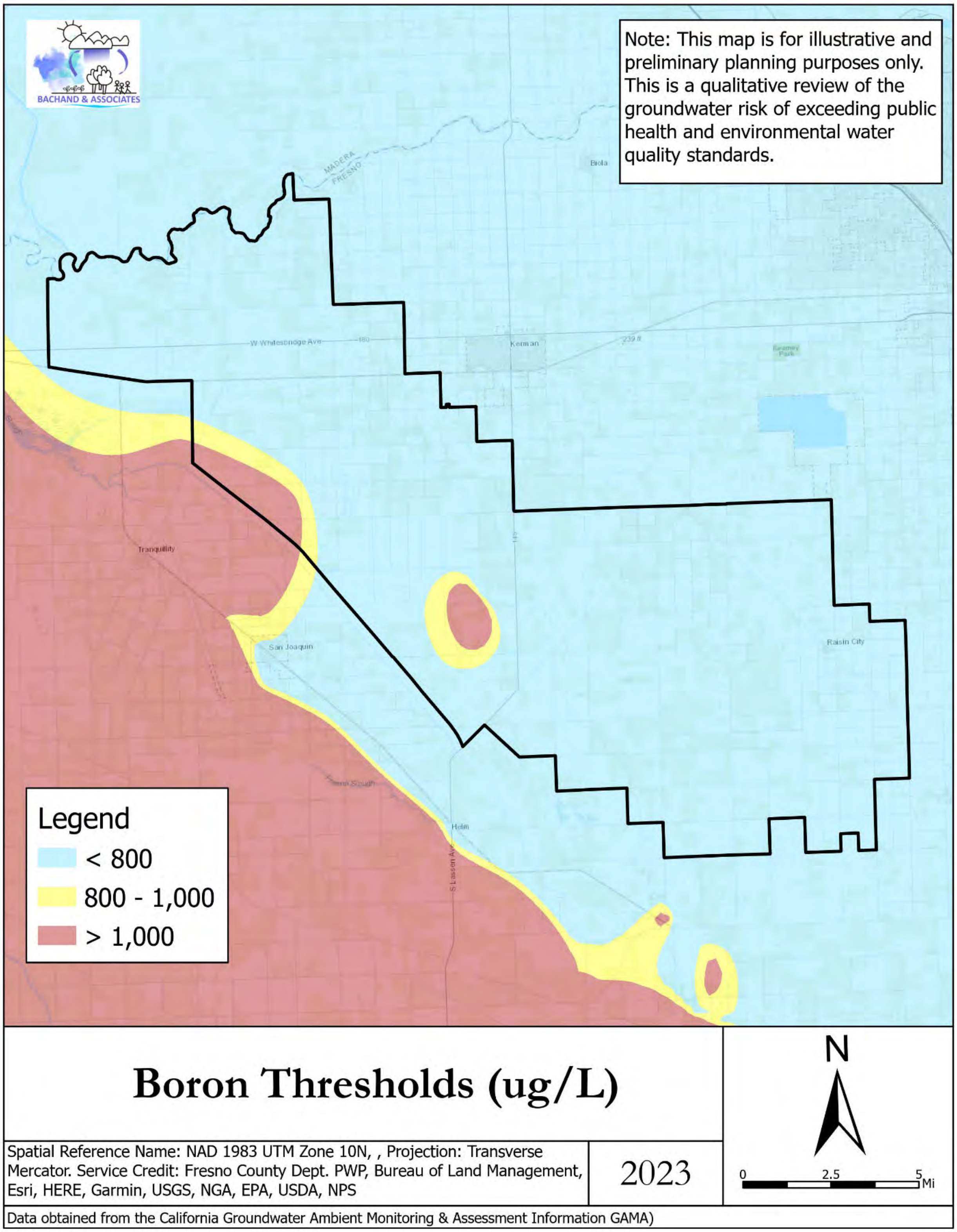


Figure 25. Areas below environmental, public health and Pump-in thresholds for boron.

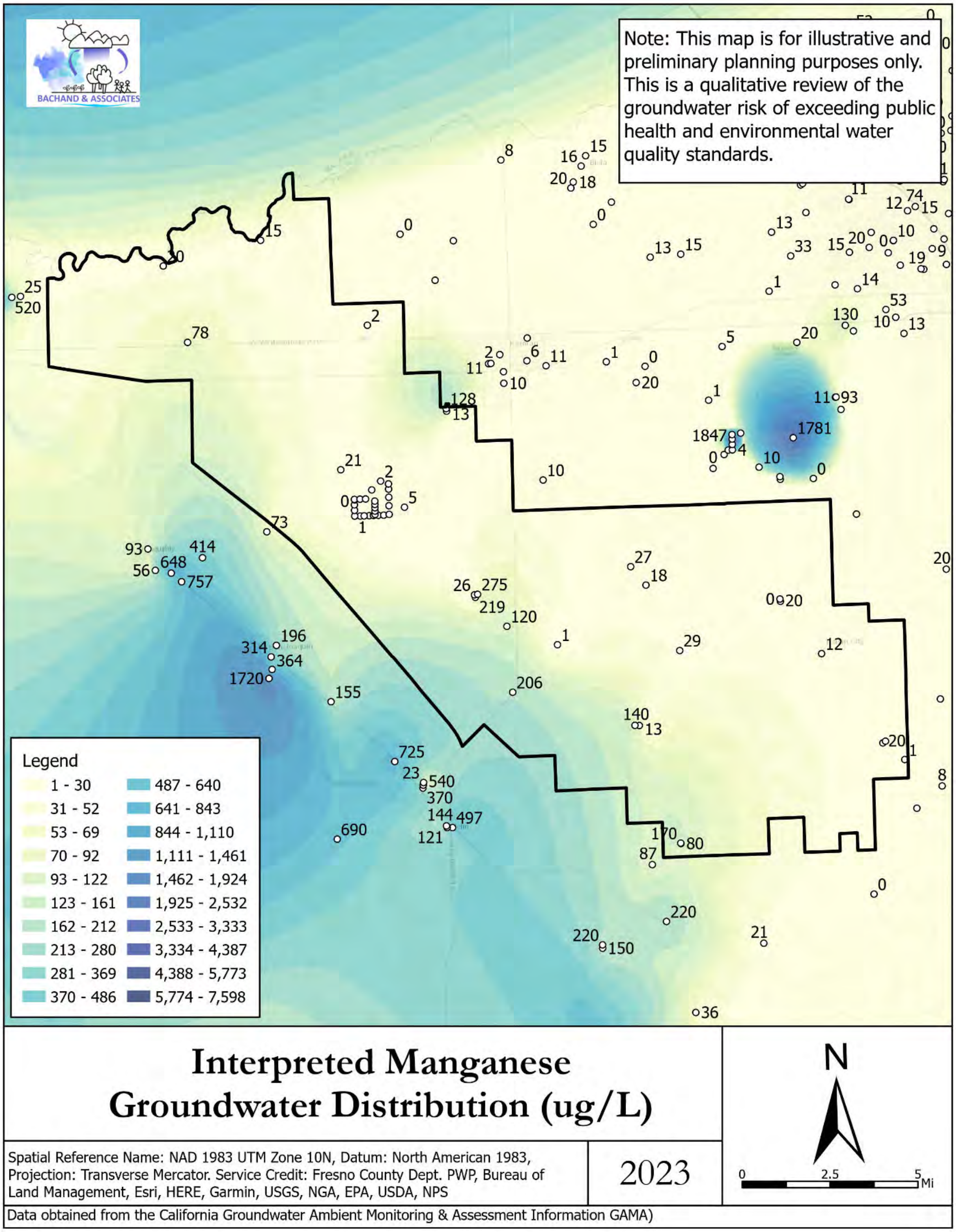


Figure 26. Spatial interpolation of manganese using data from 2000 onward.

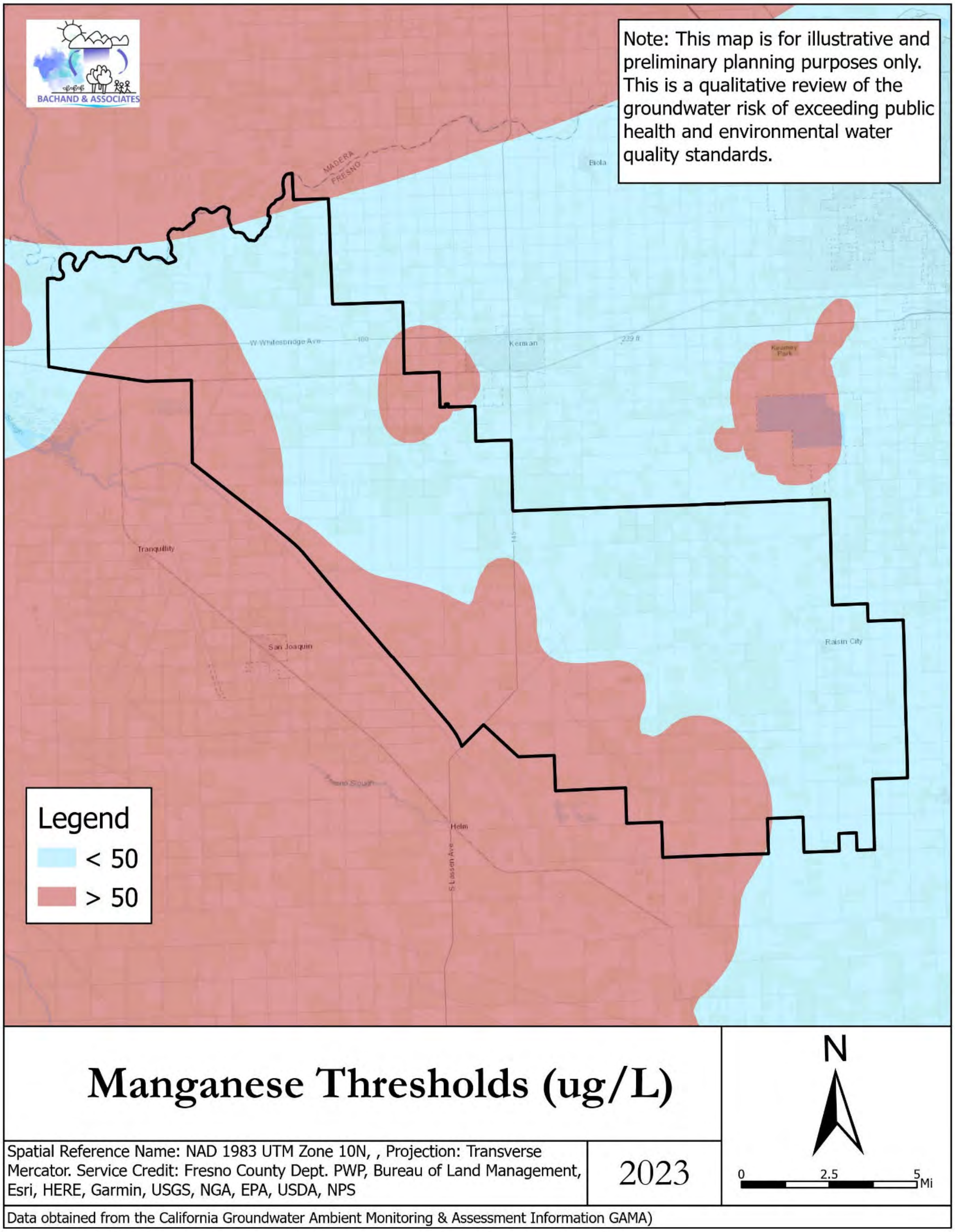


Figure 27. Areas below environmental, public health and Pump-in thresholds for manganese.

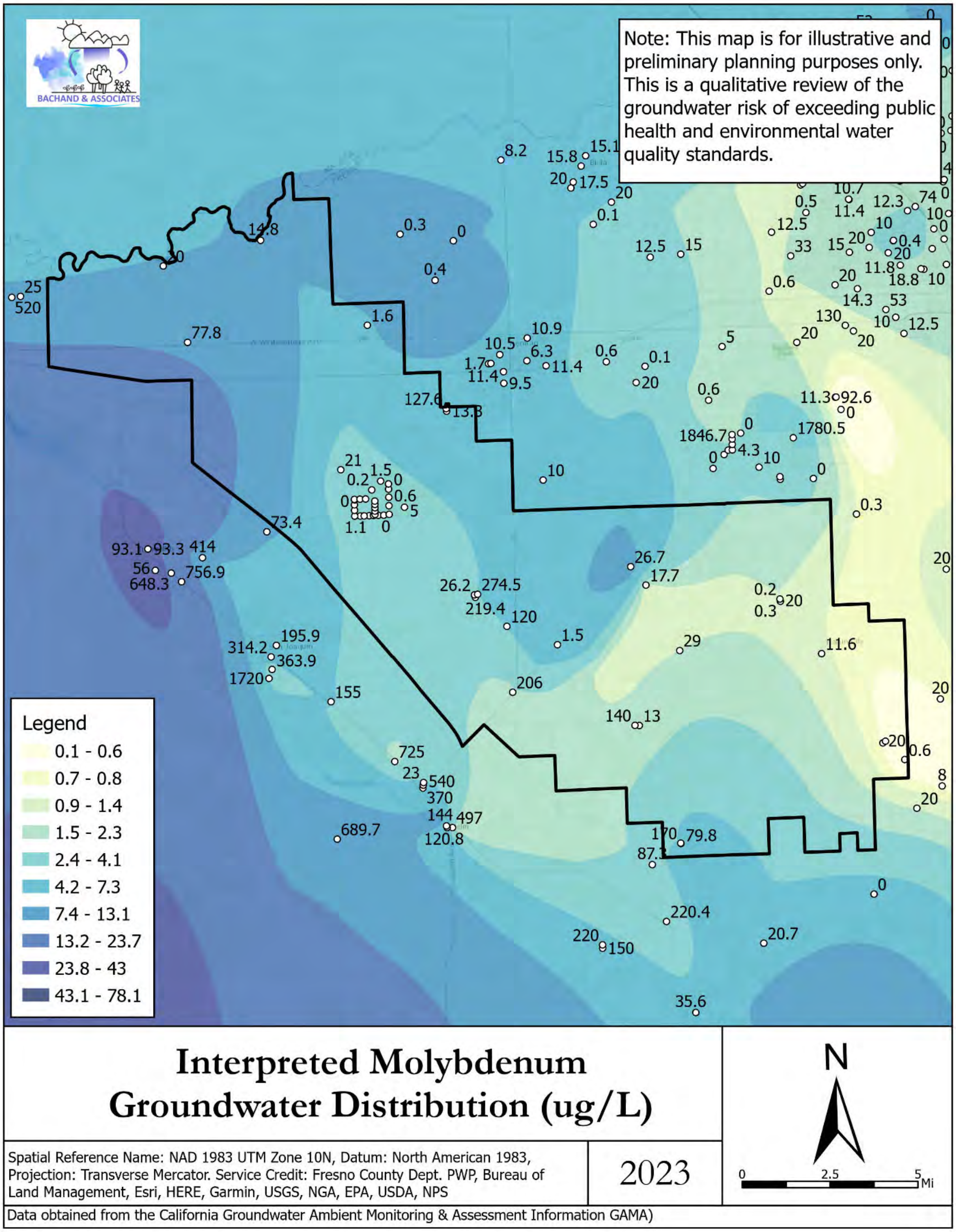


Figure 28. Spatial interpolation of molybdenum using data from 2000 onward.

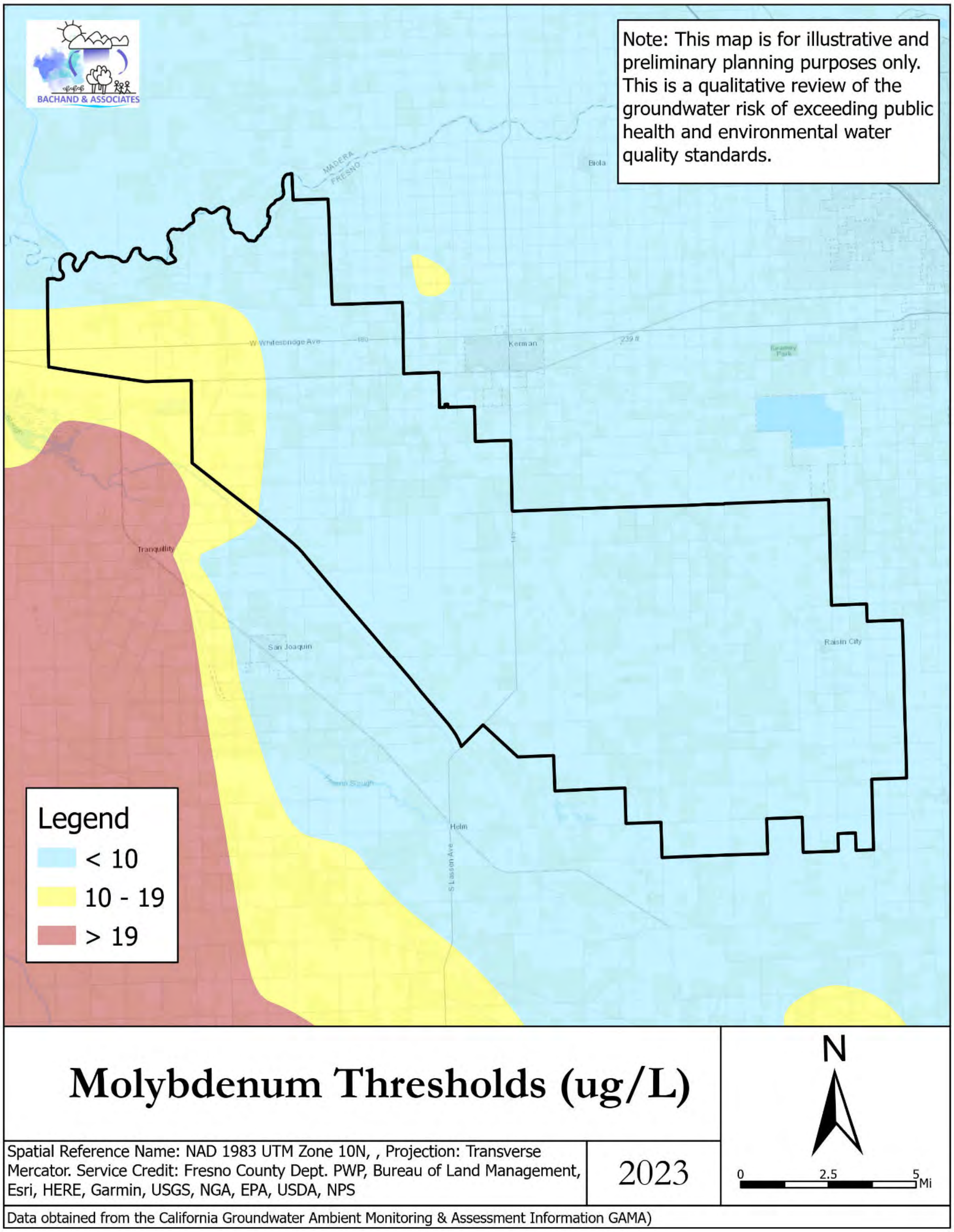


Figure 29. Areas below environmental, public health and Pump-in thresholds for molybdenum.

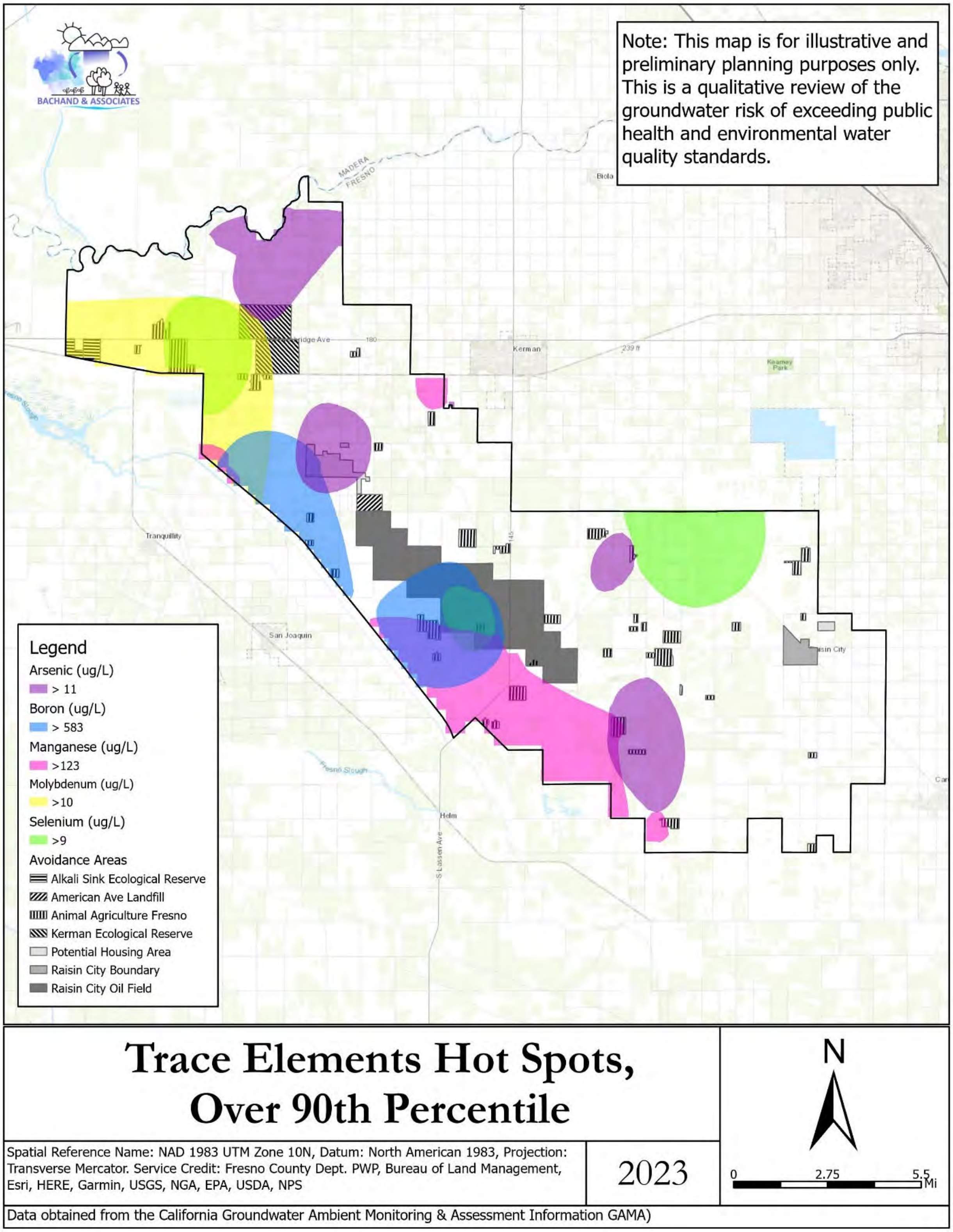


Figure 30. Trace elements "hotspots."

6.5.4 Volatile Organics

The spatial distribution of wells from which VOCs were samples are similar to those for other constituents monitored. Over 900 groundwater samples have been taken for both (Table 9**).**

6.5.4.1 DBCP

1,2-Dibromo-3-Chloropropane (Dibromochloropropane [DBCP]) was used as a fumigant to kill nematodes in soil before planting and was widely used in California until 1977. The spatial median value in the groundwater samples was 0.019 µg/l with a 0.009 – 0.060 µg/l within the 25th-75th quartile range (Table 11).

DBCP sampling has been relatively evenly distributed within and near MAGSA's jurisdiction (Figure 31). A visual inspection shows DBCP levels are below the threshold. The spatial interpolation estimates about 7 percent of MAGSA will have groundwater concentrations exceeding the DBCP requirement (Figure 32). That interpolation is largely based upon a single measured value of 0.5 µg/l (Figure 31). Without that measurement, nearly all of MAGSA would be below the 0.2 µg/l threshold.

Spatial Model Estimates: Volatile Organic Carbon (VOC)

The spatial model estimates about 80% of MAGSA has TCP groundwater concentrations exceeding the drinking water quality standard of 0.005 ug/l. DBCP does not appear to be a challenge as related to groundwater management in relation to the Bank.

6.5.4.2 1,2,3 TCP

TCP is used industrially as a paint and varnish remover and chemically as a solvent for pesticides. The spatial median TCP value in the groundwater samples was 0.029 µg/l with a 0.008 – 0.065 µg/l within the 25th-75th quartile range (Table 11). Although there is no federal MCL, California adopted its own drinking water standard of 5 parts per trillion (0.005 µg/l) as of 2018.

TCP sampling has been relatively evenly distributed within and near MAGSA's jurisdiction (Figure 33). A visual inspection shows DBCP levels are below the threshold. The spatial interpolation estimates about 80 percent of MAGSA will have a groundwater concentration exceeding the TCP requirement (Figure 34).

Table 23. Estimated acreage below and above water quality thresholds and standards

DBCP Range	Acres	%
< 0.2	111,447	93%
> 0.2	8,684	7%
Total	**120,131**	

Table 24. Estimated acreage below and above water quality thresholds and standards

TCP Range	Acres	%
< 0.005	21,080	18%
> 0.005	97,870	82%
Total	**118,950**	

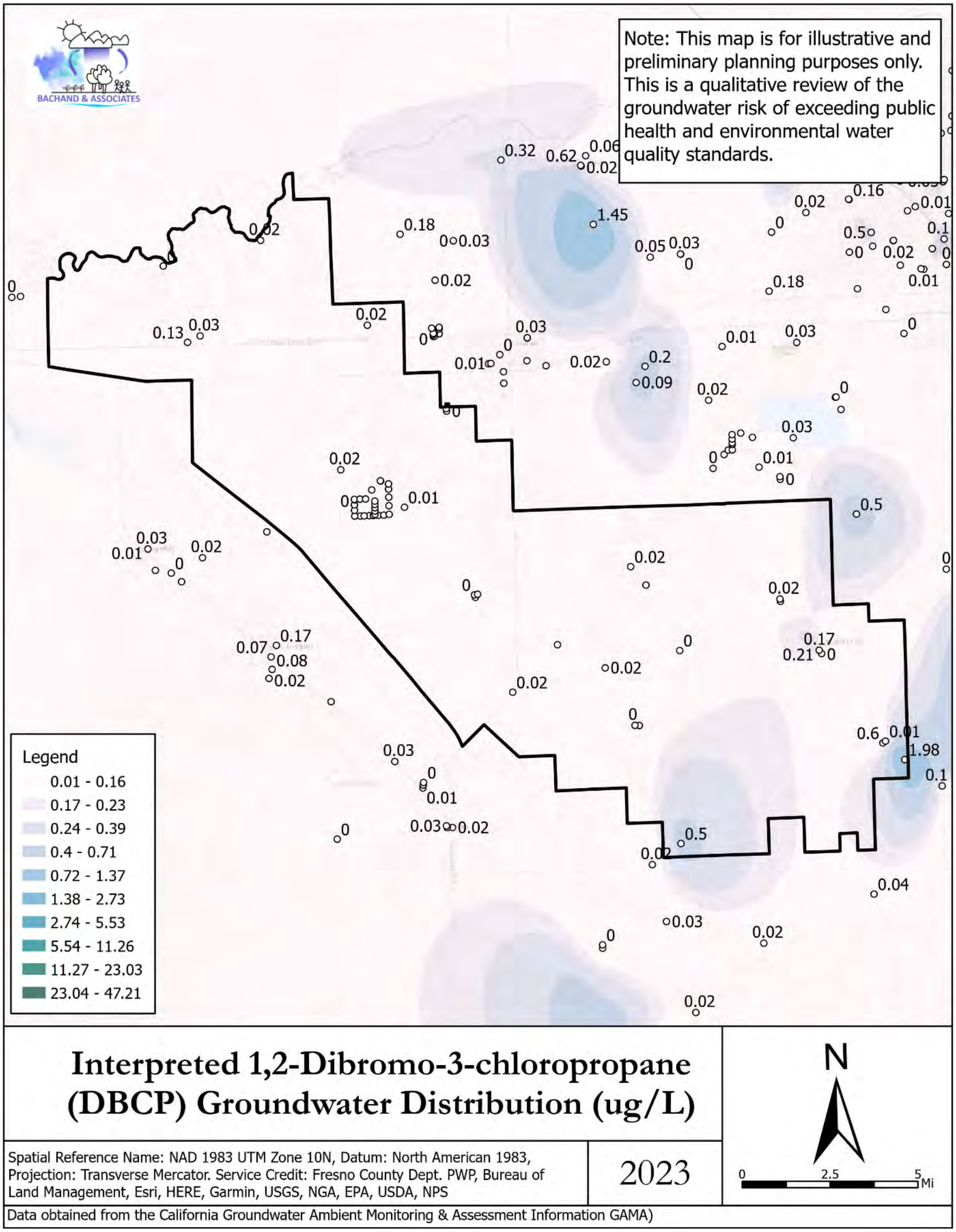


Figure 31. Spatial interpolation of DBCP using data from 2000 onward.

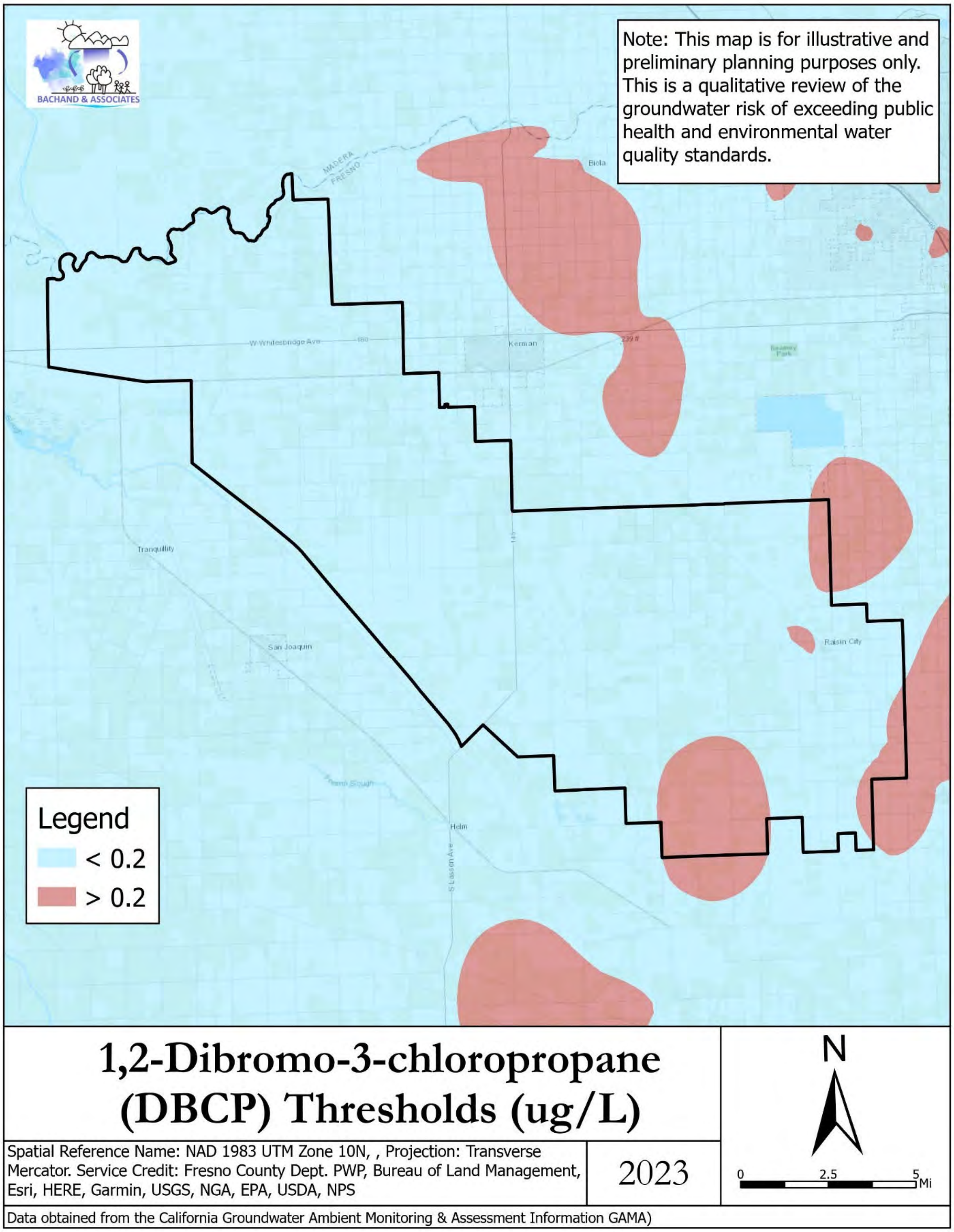


Figure 32. Areas below environmental, public health and Pump-in thresholds for DBCP.

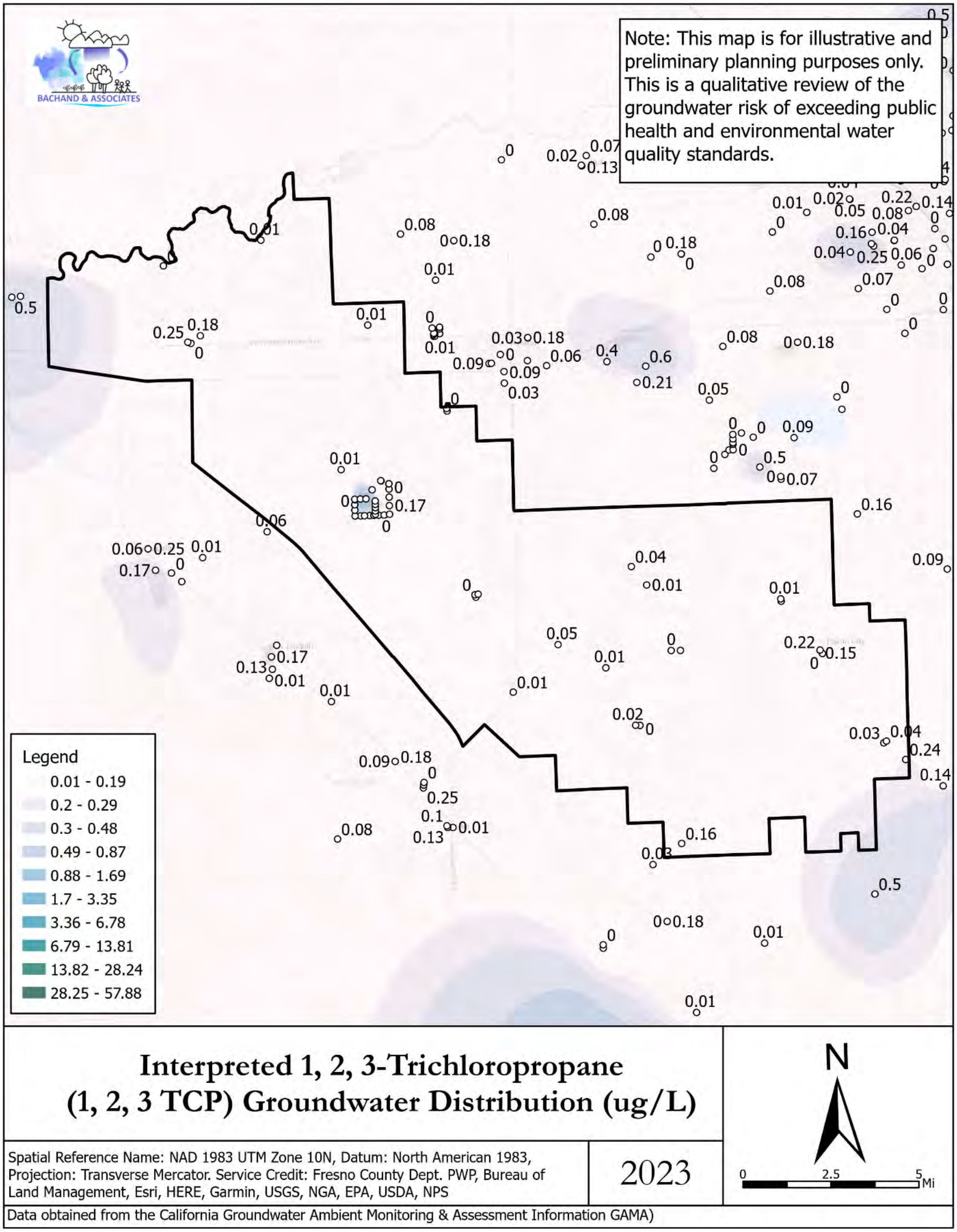


Figure 33. Spatial interpolation of TCP using data from 2000 onward.

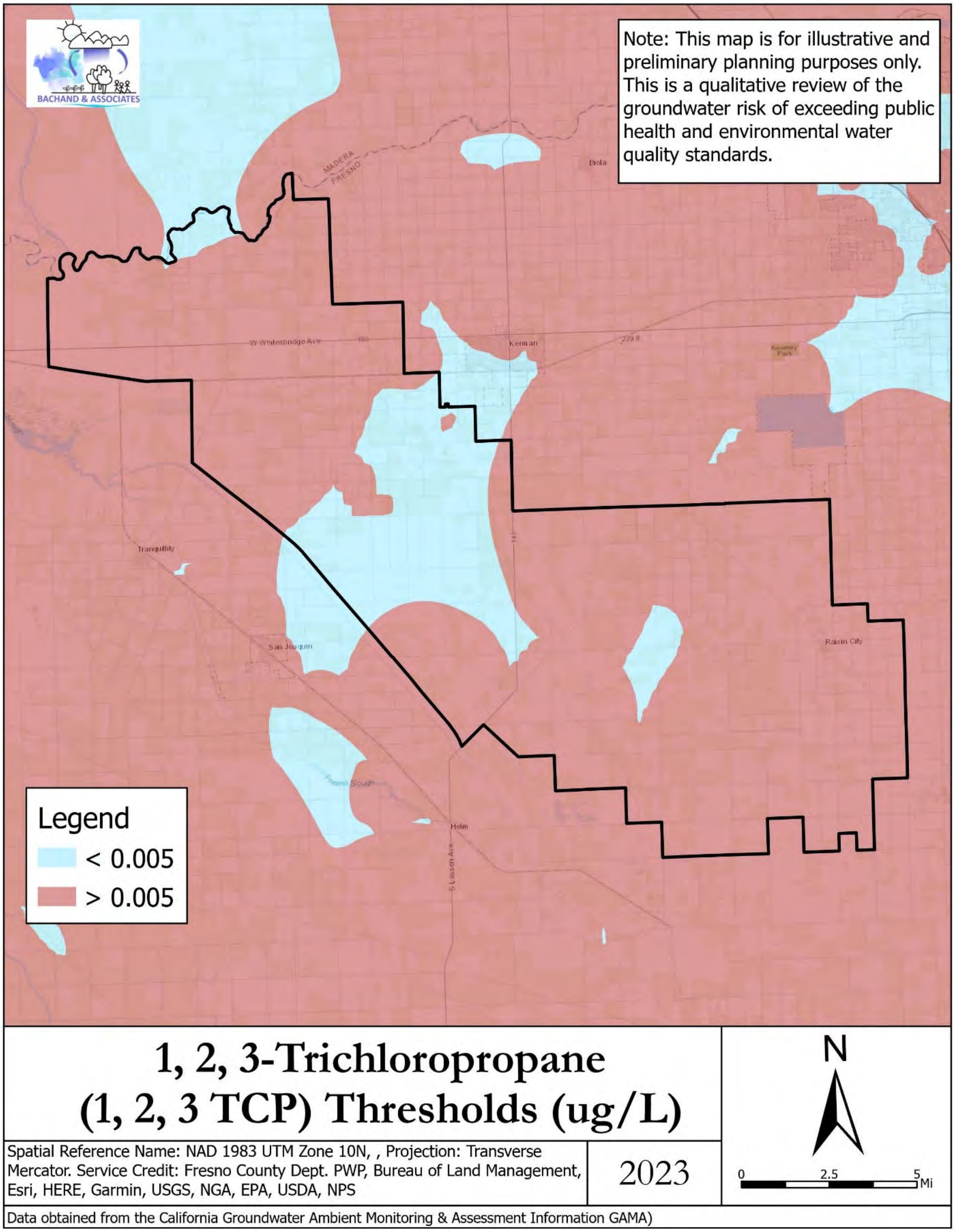


Figure 34. Areas below environmental, public health and Pump-in thresholds for TCP.

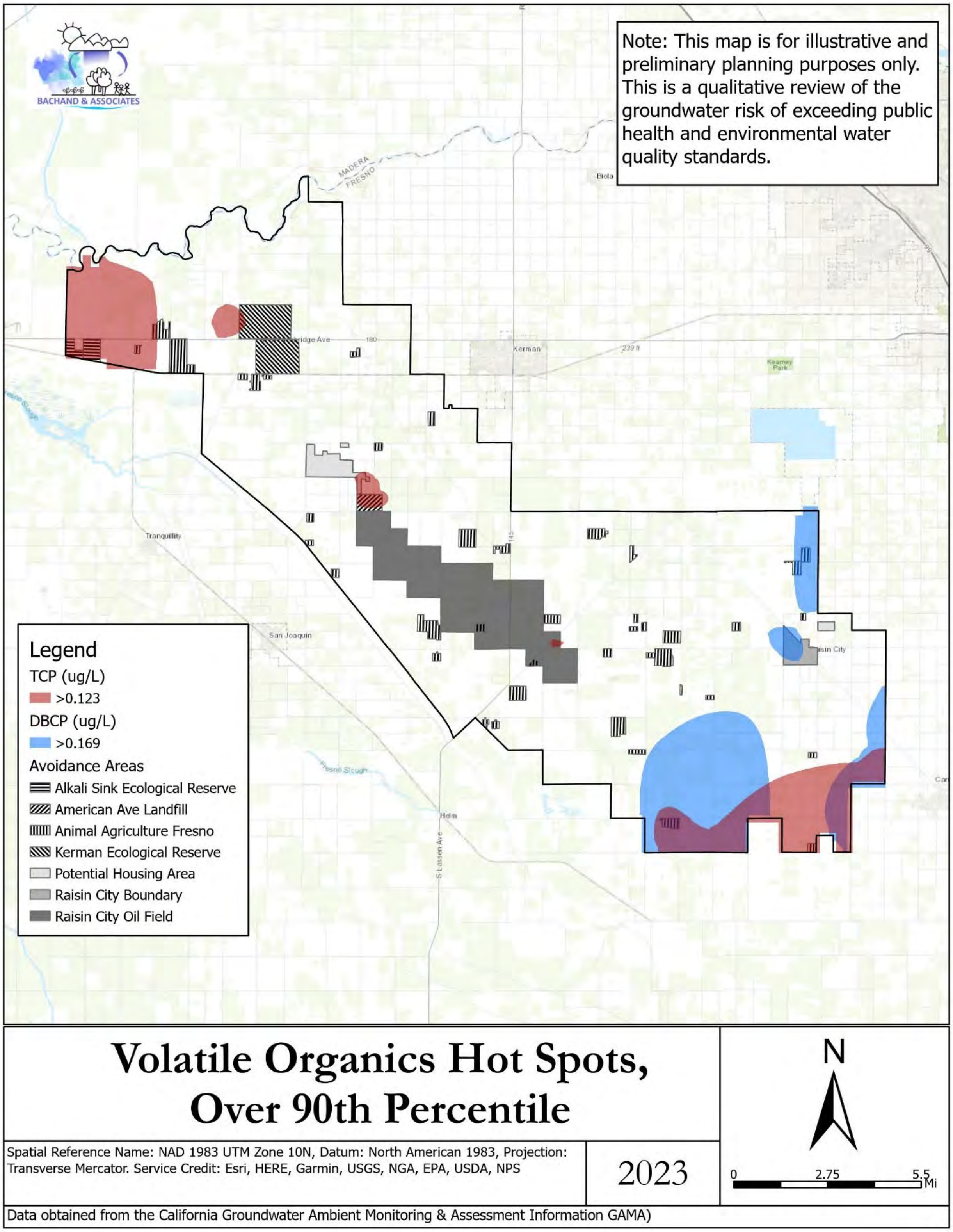


Figure 35. Volatile organic "hotspots."

6.5.5 Radionuclides

Uranium occurs naturally in groundwater in parts of the MAGSA area, derived from Sierra Nevada granitics and preferentially adhering to clays. Uranium has not been identified in GAMA data, 2015 through 2018 (MAGSA 2020).

Gross alpha radioactivity can be used as a surrogate for uranium and radon as discussed earlier. Ninety-four (94) groundwater quality samples have been collected for this analyte. The spatial median value for GAR is 35 cPi/l with a 25th – 75th quartile range of 8 – 90 cPi/l (Table 11).

Gross alpha sampling is more spatially limited and distributed than samples for other constituents (Figure 36). This figure visually shows many samples exceeding the standard. The estimated spatial extent of these exceedances are shown in Figure 37. Approximately 60 percent of MAGSA is estimated to have groundwater concentrations exceeding the gross alpha drinking water standard (Table 25). The spatial model estimates that these exceedances are generally distributed across MAGA and generally lower in the southeastern edges of MAGSA.

Spatial Model Estimates: Gross Alpha Radioactivity

Gross alpha is used here as a surrogate for uranium and other nucleotides. Uranium is derived from Sierra Nevade granitics. Spatial estimates suggest over 60% of MAGSA has groundwater exceeding the drinking water standard of 15 pCi/l. The hotspot is estimated near the Raisin City Oil Field.

Figure 38 presents "hotspots" based upon the 90th percentile calculated from the raster file. That file represents a geospatial dataset. The 90th percentile value is calculated at 121 pCi/l which is nearly an order of magnitude greater than the expected pump-in standard (Table 15). This high gross alpha level centers over the center of MAGSA (Figure 38).

Table 25. Estimated acreage below and above water quality thresholds and standards

GAR Range	Acres	%
< 15	45,220	38%
> 15	74,911	62%
Total	**120,131**	

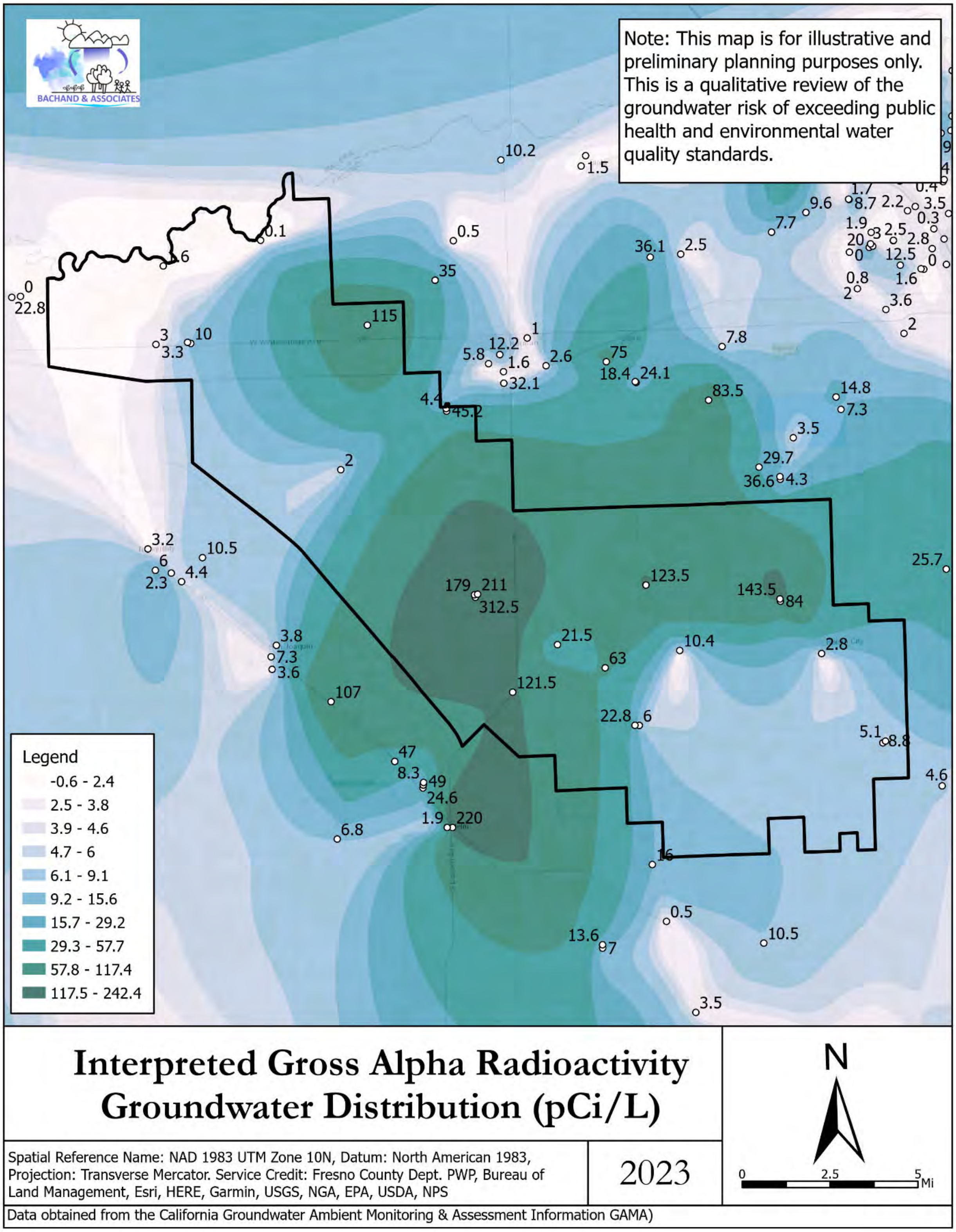


Figure 36. Spatial interpolation of GAR using data from 2000 onward.

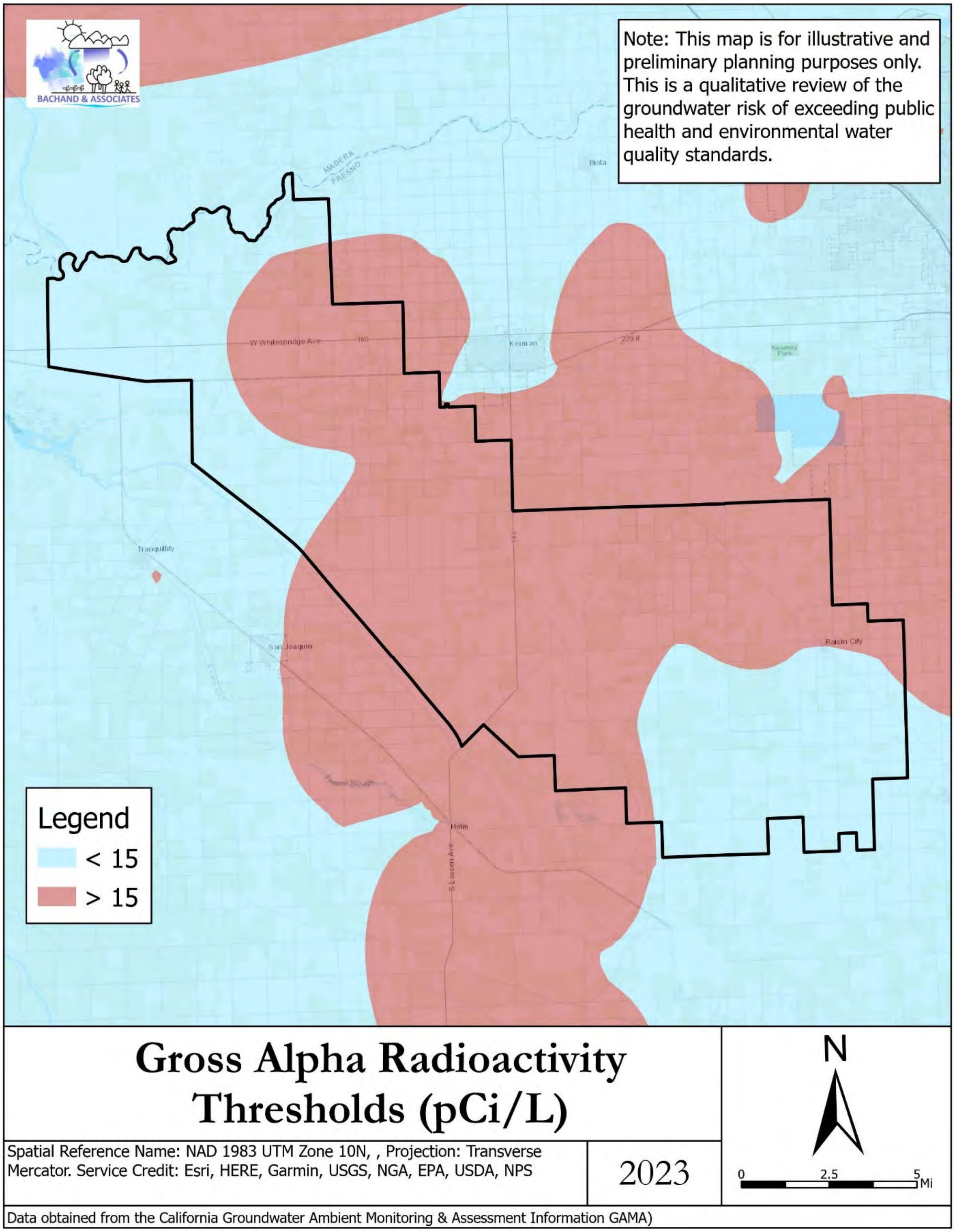


Figure 37. Areas below environmental, public health and Pump-in thresholds for GAR.

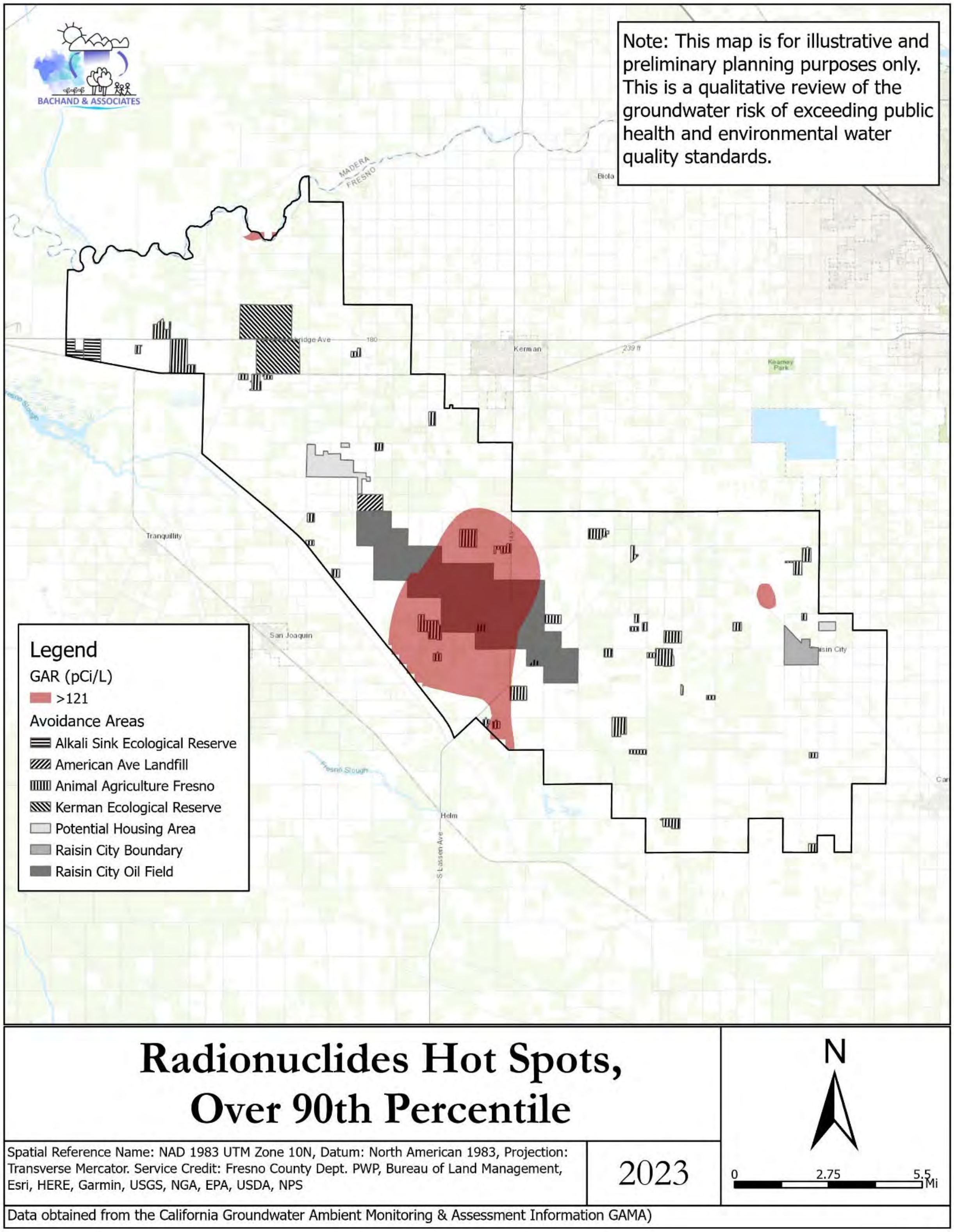


Figure 38. Radionuclide "hotspots."

6.6 Spatial Analysis Summary

A summary of the constituents above and below their corresponding monitoring thresholds is shown in Table 26. We estimate several constituents may be found to exceed monitoring thresholds across more than 60% of MAGSA: TDS, sodium, selenium, molybdenum, TCP, GAR.

Table 26. Summary of constituents above potential threshold

7 Potential Nitrate and TDS Mobilization under Recharge

Helpful in understanding the potential for transport of water quality constituents is putting data and numbers to the analyses. Recharge fields used for water banking will have been in agricultural production for decades and will have nitrates, salts, and other constituents resulting from fertilizer and soil amendment farming applications. As has been discussed, recharge will mobilize *dissolved constituents* to different degrees. *Negatively charged ions such as nitrate, chloride, and sulfate are negatively charged and less likely to attach to soils*. Within this category are other nitrogen species such of dissolved N and TDS, an aggregate measure of salts.

First Flush of Legacy Nitrate and Salts

Legacy nitrate and salts loads will be flushed from the vadose zone into MAGSA's groundwater when recharge basins are initially employed for use in the Bank. First flush is expected to occur through recharge of the first 15 – 30 feet of water.

7.1 Nitrate and Salt Loading to Groundwater, First Flush

Recharge will mobilize both salts and nitrate within the vadose zone, with constituents associated with more loosely bound pore water being flushed primarily through advection, and constituents associated with more tightly bound pore water becoming first limited by diffusion.

7.1.1 Quantify vadose zone loads and groundwater storage of salts and nitrate

A first step in understanding the potential impacts from flushing salts and nitrate from the vadose zone to groundwater is understanding the mass of these constituents in both the vadose zone and in groundwater. Deep soil cores collected across agricultural fields in and near MAGSA suggests TDS loads within pore waters throughout the vadose zone to groundwater average 166,000 lbs per acre (83 tons per acre), and nitrate loads average over 3,000 lbs per acre (1.5 tons per acre) (Table 27). Both show great variability loads, approximately an order of magnitude between low and high estimates for both TDS and nitrate. In comparison, we also estimated the mass in groundwater above the Corcoran Clay. This groundwater is the layer that will most interact with water introduced through surface recharge. Based upon average groundwater concentrations in groundwater throughout MAGSA, the volume of groundwater above the Corcoran clay and a porosity of 35 percent, an estimated 250,000 lbs per acre of TDS and 1,500 lb-N/ac of nitrate are in groundwater above the Corcoran Clay (Table 27).

7.1.2 Estimating vadose zone mass flushed to groundwater

The next step in understanding potential impacts is quantifying the potentially loading to groundwater during the "first" flush period during which nitrate and TDS are mobilized to groundwater.

Figure 39 uses data from On-Farm Recharge field studies conducted through the San Joaquin Valley which suggests more than 95 percent of legacy nitrate loads removed from soils in the upper thirty feet will typically occur by the time 15 feet of water has been applied for recharge. Deeper in the vadose zone, less may be removed because water may spread, and soils become less saturated. First flush of TDS from the vadose zone would be expected to behave similarly, both salts and nitrate are very soluble and mobilized with recharge water.

Importantly, the total mass stored in the vadose zone throughout MAGSA will not be flushed to groundwater. The hydrologic model analyses performed for this environmental analysis suggests the subsurface flushing will occur primarily under the recharge fields and in their vicinity. Here, we assume for each 80-acres of recharge an equivalent of twice that area is in the area affected by recharge, whether from backing up through the soil profile or moving laterally from mounding. This assumption seems reasonable given the modeling results from the hydrologic report and the groundwater model developed for that effort (Bachand et al., 2023). Thus, for each 80-acres we have assumed a 160-acre affected area.

Based on the above assumptions, we estimate recharge across a single 80-acre field would initially increase average TDS concentrations by an estimated 347 mg/l and NO3-N concentrations by 7 mg/l across a square mile region during a period of first flush (Table 28). Importantly, these results are estimates with uncertainty due to the limits of the data and assumptions. We contend these are reasonable estimates.

Table 27. Some typical nitrogen and TDS loading found in the San Joaquin Basin (0- 30 ft depths)
The data is from field studies in the Kings Basin near and within MAGSA. These field studies used soil cores to 30-ft to determine the mass storage of salts and nitrate in typical agricultural fields

Statistic	TDS		NO3-N	
	kg/ha	lb/ac	kg/ha	lb/ac
Estimated Vadose Zone Storage above Aquifer (2)				
Mean	168,875	165,865	3,174	3,118
Low	49,375	48,495	257	252
High	535,512	525,969	7,944	7,803
Estimated Groundwater Storage above Corcorran Clay Elevation				
Mean (1)	254,117	249,588	1,556	1,529

Notes
1. Based on mean calculations of concentration, depth to corcorran clay, aquifer elevation and porosity
2. Estimated from deep soil core data collected thoughout MAGSA and nearby regions and analyzed for salts and nitrate

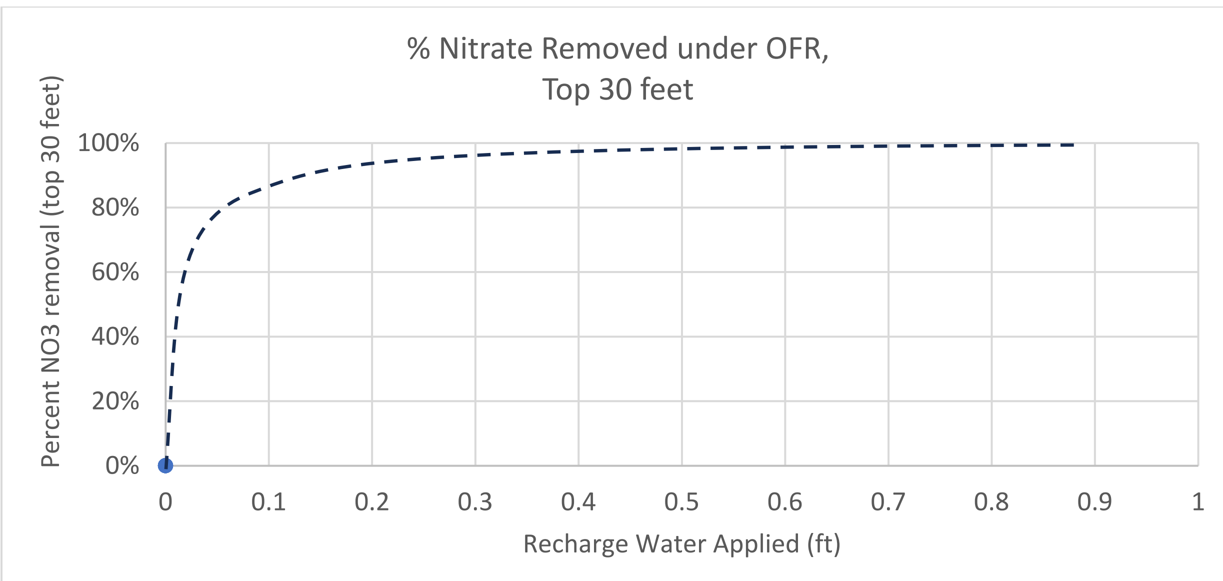


Figure 39. Estimated Percent Removal From Vadose Zone under OFR
Calculated nitrate flushing from recharge from field studies conducted in the San Joaquin Valley.

7.1.3 Estimating the scale of the affected groundwater area to consider first flush effects on underlying groundwater

Finally, we estimate the transport of the nitrate and TDS loads on groundwater concentrations in the underlying groundwater area that is locally affected by recharge.

For each 80-acre field, we also assume one square mile of the aquifer will initially be affected from flushing (Bachand et al. 2023). Modeling data from the hydrologic model shows that one quarter to one half miles from the recharge basins appears to be outside the area immediately affected by groundwater mounding during recharge (Bachand et al., 2023). The Bank design includes five recharge zones overlaid by around 3000 acres of recharge basins, the basins occupying approximately 10 percent of the acreage.

From that estimate we have calculated the resident TDS and nitrate mass in the underlying groundwater and the associated water volume. From that information, we estimate an average of 17 percent (+/`-) of the mass of TDS found in resident groundwater is in the overlying vadose zone, and an estimated 51 percent of nitrate (Table 28). With the addition of that TDS and nitrate to the local groundwater, resident groundwater concentrations are calculated to increase by an average of 347 mg/l for TDS and 7 mg-N/L for nitrate.

Table 28. Mass Balance estimates of typical mass loading to aquifers in recharge zones from first flush of nitrate and salts.

The below calculation estimates the change in groundwater TDS and nitrate concentrations after flushing of both from the above vadose zone during first flush. It assumes the affected area is one square mile.

Mass Budget Calculation (5)	**TDS**	**NO3-N**	**units**
Estimated Average Vadose Zone Loading From 80-acre recharge field (1)	13,269	249	tons
Estimated mass in groundwater within the affected area (1 sq mile)(2) (3)	79,868	489	tons
Vadose zone load as a % of resident groundwater load	17%	51%	%
Estimated groundwater volume above the Corcoran Clay	63,145	63,145	AF
Average change in groundwater concentration in affected area	*347*	*7*	*mg/l*
Notes			
1. Assume avg. vadose zone load across 160 Acre area for an 80-acre field under recharge, assuming mounding and			
2. Recharge fields in recharge zones occupy typically occupy about 10% of the total acres within the Bank recharge			
3. Affected area is assumed as 640 acres			
4. Assumes recharge volume needed for first flush of vadose zone is relatively neglible to total groundwater			
5. Calculations are simple water and mass balances / budgets for scenario described and assumptions stated			

7.2 Period and Extent of Impact

Roy et al. (2017) (Attachment B) modeled changes in water as it passed through the root zone and the vadose zone and then entering groundwater. They modeled two bookend crop scenarios representing higher and lower vadose zone loading from legacy nitrate accumulation under similar conditions as being discussed for the Bank for fields operated under On-Farm Recharge.[6] The model demonstrated the initial flushing of legacy nitrogen and salts as has been previously presented. It also considered changes in the shallow domestic well zone and the greater production well zone.

Concentration Pulses

Simple mass balance model calculations predict groundwater underlying recharge basins will initially increase by an estimated 350 mg/l for TDS and by 7 mg-N/l for nitrate. The latter is consistent with a subsurface flow model.

Figure 40 presents the instantaneous and cumulative loading of the two crop scenarios, low loading (grapes) (Figure 40A) and high loading (tomatoes) (Figure 40B). The figure shows for both crop scenarios the first nitrate flush discussed in the previous section. This flush occurs from the application of 30-feet of recharge water in line with data previously presented in Figure 39 Subsequent flushing of nitrate occurs, flushing nitrates in the vadose zone from current crop practices for fields under On-Farm Recharge. Those secondary nitrate loads which are initiated during subsequent periods of recharge are much less than from the first flush of legacy nitrate loads.

Figure 41 shows predicted changes in groundwater in response to the loads shown in Figure 40 for the higher loading scenario. The figure shows effects in the domestic well zone, defined as the upper 75 feet of the aquifer, presenting changes underneath the recharge zone and downstream of it in 500 meter intervals, occurring over a 42-year period.[7] Greatest effects on nitrate concentrations are shown both initially during the first flush and directly underneath the recharge basin. Initial flushing shows in NO_3-N concentrations increasing by 7 mg/l across the domestic well zone, in line with estimate from the simpler mass budget calculations shown in Table 28. Figure 42 shows a similar effect and magnitude under the recharge basins in the deeper production zone, the next 325 feet below the domestic zone.

Diminishing with Time and Distance

Nitrate pulses from flushing legacy nitrate are greatest underlying the recharge basins and diminish in the vadose zone with time and distance. The model estimated groundwater pulses to become negligible after 10 years or further than 500 meters away.

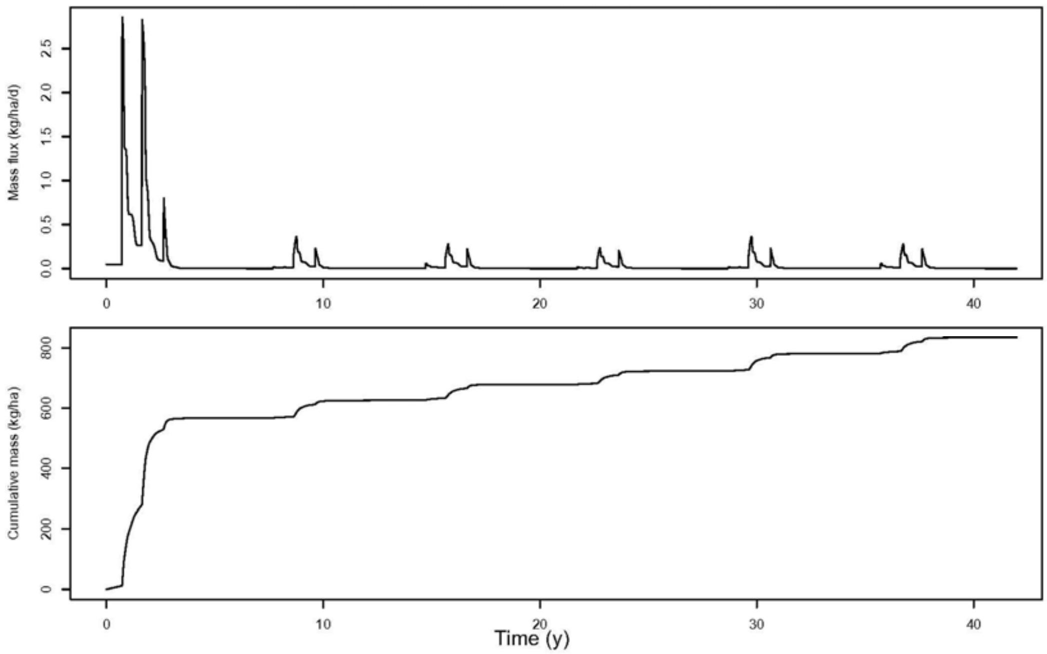
N trends are similar though all responses less extreme: e.g., initial N concentrations from the first flush, lower subsequent N spikes, less noticeable at 500 m.

[6] Two 80-acre fields under recharge. A seven-year cycle with three wet years that consisted of three successive years of recharge at 10 ft per year followed by 4 dry years. That seven-year cycle was repeated six times to model a 42-year period. The model included legacy nitrogen and annual applications for farming.

[7] 1500 meter is nearly 1 mile.

The spike in nitrate levels is greatly decreased but still noticeable 500 m downstream in both groundwater zones. At that distance from recharge, those effects are expected to begin about 5 years after recharge in the scenario modeled and continue for about five additional years. Effects on nitrate levels shown in the model are relatively negligible further away.

A. Low nitrate loading crop scenario (grapes)



B. High nitrate loading crop scenario (tomatoes)

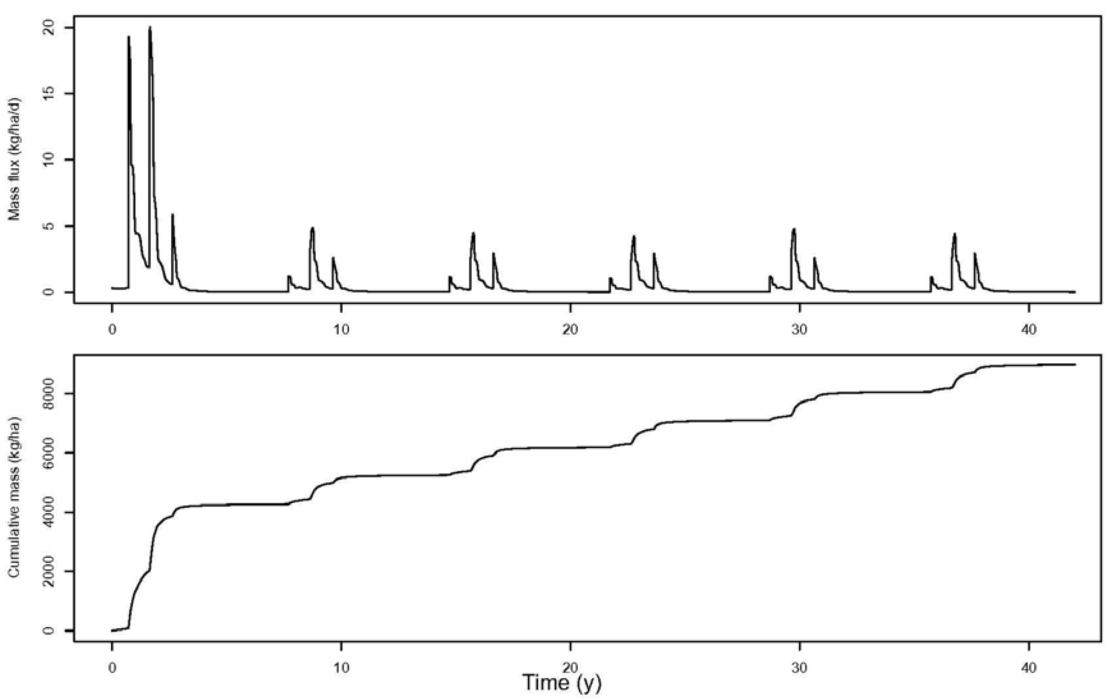


Figure 40. Daily and cumulative mass fluxes for tomatoes and grapes.

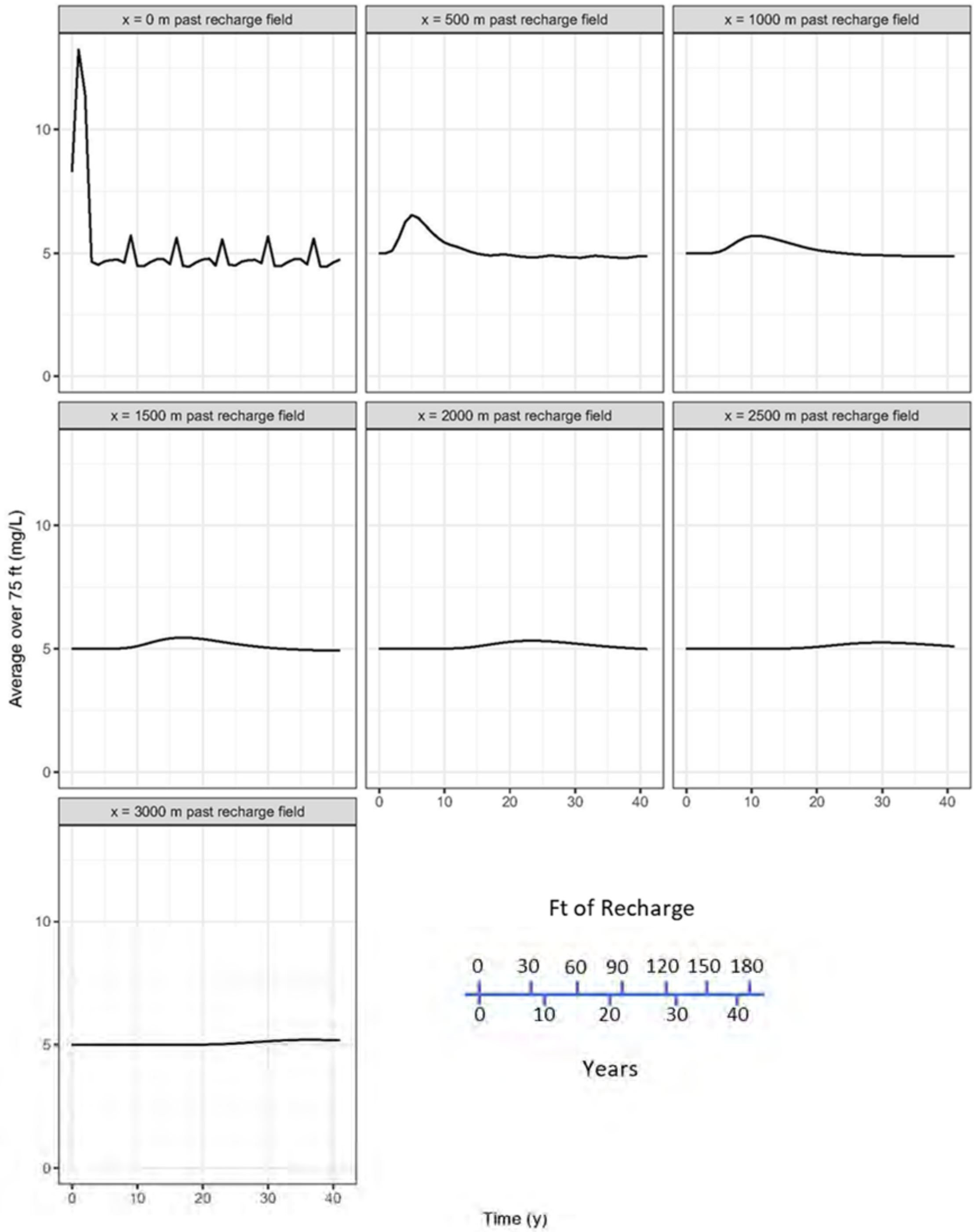


Figure 41. Nitrate concentrations (mg-N/L) in domestic wells and downstream.
Downstream locations include 500, 1000, 1500, 2000, 2500 and 3000 meters. One mile is about 1600 meters. Data is over a 42-year period

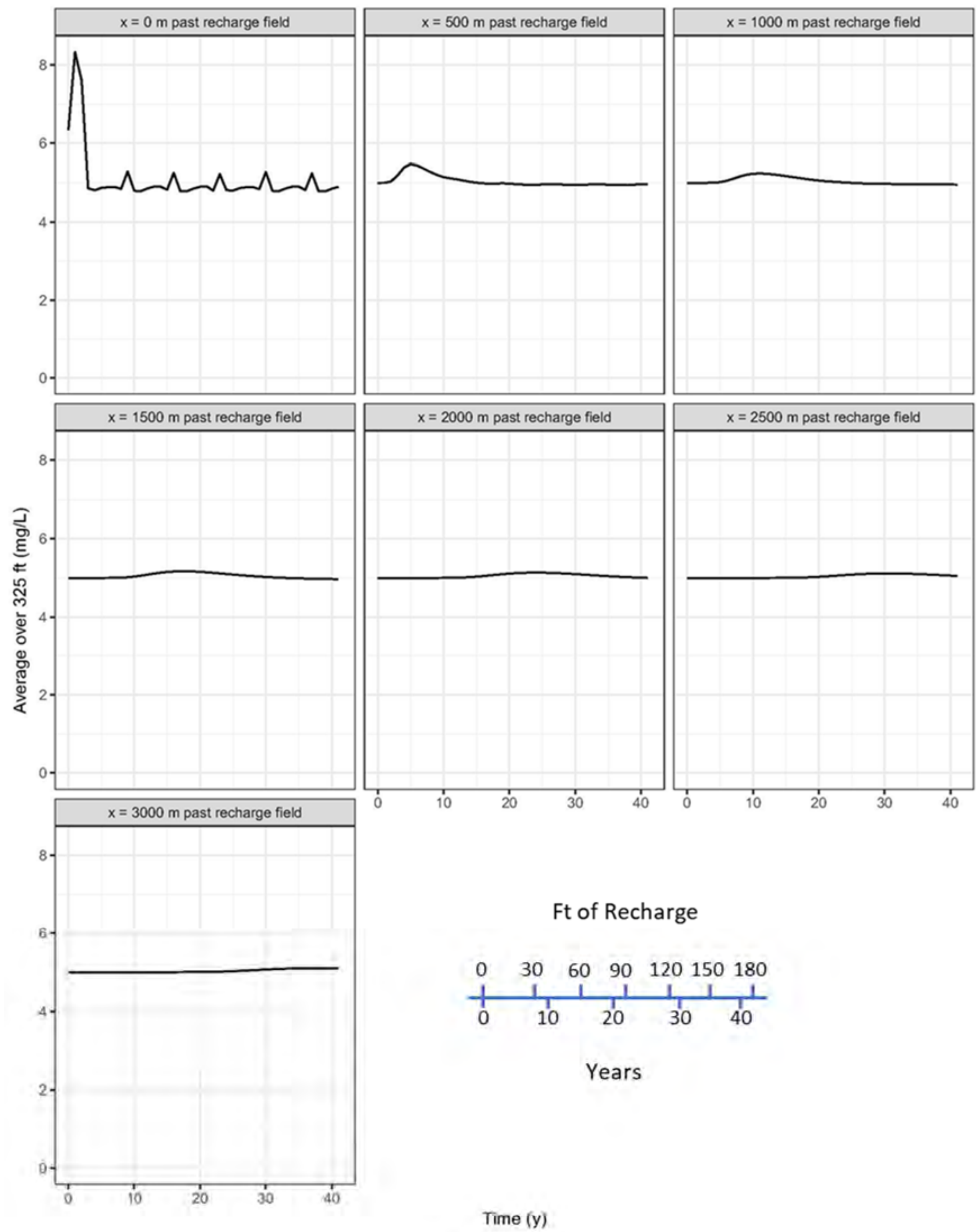


Figure 42. Nitrate concentrations (mg-N/L) in production well zone and downstream.
Downstream locations include 500, 1000, 1500, 2000, 2500 and 3000 meters. One mile is about 1600 meters. Data is over a 42-year period

7.3 Long-term Legacy Loading Effects

Long-term, 1) the legacy loading of nitrate and salts associated with the recharge fields and the underlying vadose zone will be flushed to groundwater and 2) groundwater will move to a quasi-equilibrium condition. This long-term scenario results in the vadose zone contributing an equivalent TDS load of about 3 percent of that found in the groundwater underlying MAGSA and above the Corcoran Clay, and about 10 percent the nitrate. The flushing is predicted to increase background TDS and nitrate concentrations across all of MAGSA by about 70 mg/l for TDS and 1 mg-n/l for nitrate (Table 29).

This increase would be offset by high quality source water over time. As discussed previously, median TDS concentrations measured at the O'Neill Forebay is 310 mg/l (Figure 4), below groundwater concentrations found in throughout MAGSA (Figure 10). The spatially rectified median for TDS within MAGSA is estimated at 671 mg/l (Table 10). Over time, source water concentrations in line with concentrations found at the O'Neill Forebay will dilute increases from the legacy loads. As this is true for TDS, it is true for nitrate as well in which the spatially rectified median for nitrate is less than 5 mg-N/l throughout MAGSA (Table 10).

Long-term Salts and Nitrate Improvements in Groundwater through Dilution.

Implementation of recharge basins is estimated to provide a legacy TDS load from the vadose zone equivalent to 70 mg/l averaged across all groundwater in MAGSA, and 1 mg-N/l of nitrate. Offsetting those loads will be high quality contract water with average nitrate and TDS concentrations much below those found in MAGSA. Together, these high quality recharge waters should offset legacy loads and improve groundwater quality related to salts and nitrate through dilution.

Table 29. Mass Balance estimates of long-term increases in salts and nitrate in the aquifer under Bank operations.

Mass Budget Calculation	TDS	NO3-N	units
Estimated Loading From 3000 acres of recharge field	497,596	9,353	tons
Reference mass within groundwater above Corcoran Clay	14,975,302	91,713	tons
Vadose zone load as a % of mass in groundwater	*3%*	*10%*	%
Estimated longterm groundwater concentration change under basin wide equilibrium	*69*	*1*	mg/l

7.4 Expectations Regarding Loading of Other Constituents

Loading, mobilization, and transport of different water quality constituents is a complex process described in Figure 2 and described in detail in Chapter 3.

This chapter so far has focused on salts and nitrate. Table 30 summarizes the factors driving constituent cycling and mobilization for all the constituents analyzed here. Salts and nitrate are highly soluble. Trace elements can present themselves as different species, and speciation affects their solubility, adsorption, precipitation and other processes affecting whether the elements are mobile or not. Arsenic and selenium are redox sensitive and can be immobilized or re-mobilized through redox changes. The volatile organics here are slightly soluble to water. These VOCs when solubilized in water are relatively mobile. Gross Alpha Radioactivity mobilization is affected by the various soil processes discussed in Section 3 which may retard mobilization by water flow.

Previous discussion in this chapter has quantified the potential loading of salts and nitrate from the vadose zone for the short- and long- terms. In Chapter 6.6 we summarize the spatial analyses conducted in Chapter 6.5, identifying salts, nitrate, selenium, TCP and gross alpha as the constituents most likely to need consideration during Bank operations based on the percent of estimated acreage in MAGSA with high constituent concentrations in relation to the different water quality standards discussed in this document. Aside from salts and nitrate, the qualified ranking for net mobilization in Table 30 suggests selenium and TCP are constituents that may provide sufficient loading during recharge to increase underlying groundwater concentrations. Gross alpha is considered less mobile and less of a concern.

Initial planning should consider the findings and recommendations from this report as a starting point. Ongoing monitoring and utilization of the operational model could enable refinements in Bank operations moving forward.

Qualifying Net Mobilization Rates of different constituents

Salts and nitrate are highly soluble and mobile. Trace elements form different species that have differing levels of mobilization. Arsenic and selenium are redox sensitive and can be immobilized or re-mobilized through redox changes. TCP and DBCP are slightly soluble in water with the water solubilized forms mobile. Gross Alpha Radioactivity mobilization is less mobile due to various soil processes.

Focus first on salts, nitrate, TCP and selenium; Utilize monitoring and Operation Model for Bank Management moving forward

Net mobilization expectations and spatial analyses suggests salts, nitrate, TCP and selenium are key constituents to consider in initial planning and management of the Bank. Implementation of ongoing monitoring and utilization of the operational model can help further refine Bank operations.

Table 30. Summary of Loading and Mobilization

Analyte	Primary Constituent Associated with Fertilizers and Amendments (4)	Primary Processes Affecting Recharge, Cycling and Mobilization (1) (2) (5)			Summary		
		Adsorp-tive	Precipita-tion	Remobiliza-tion from Redox	Description	Net Mobilization Rate (7)	Transform-ation to more mobile forms(6)
Salts and Major Ions (2)							
TDS	x				Remains in dissolved form and highly soluble and mobile across all conditions	1	
Sodium	x					1	
Chloride	x					1	
Sulfate	x					1	
Nutrients							
Nitrate (2) and TDN (8)	x				Remains in dissolved form and highly soluble and mobile across all conditions. Subject to microbial processes but generally conservative below root zone	1	
Trace elements							
Arsenic		y	y	y	Mobile with water but slowed through adsorption and precipitation. Changes in redox can remobilize species formerly precipitated species.	2	1
Selenium		y	y	y		2	1
Boron		y	y		Mobile with water but can be slowed through adsorption and precipitation. Less affected by redox than arsenic and selenium regarding remobilization.	2	
Manganese		y	y			2	
Volatile Organics							
DBCP (3)	Banned in most the US in 1979.				Slightly soluble in water and able to leach to groundwater.Low soil adsorption allows migration with water. Longlasting.	1	
TCP (3)	x					1	
Radionuclides							
Gross Alpha (1)		y	y	y	Can move with water flow but many processes can retard mobility	3	

Notes
1 Processes vary with soils, constituent, soil organic content, etc…
2 Salts and nitrate are highly mobile with water, independent of soils and other conditions
3 Both TCP and DBCP have low sorption coefficients and a high mobility in soils, co-migrating with water.
4 "x" = present
5 "y" = yes
6 Expected transformations under environmental conditions commonly found in soils, the vadose zone and groundwater,
7 Based on soil processes including those that can retard or slow mobility. 1 = most mobile. 3 = least mobile.
8 Total dissolved N is another form of nitrogen. We assume similar mobility similar to nitrate .

III. Management and Monitoring

8 Water Quality Management and Monitoring Strategies

Management strategies and actions will be required to protect and eventually improve groundwater quality within MAGSA, as well as to ensure adequate water quality of exported water returned to partners under Bank operations.

Water quality goals drawn from this analysis in the context of Bank operations fall under both surface water and groundwater goals. Surface water goals relate to protecting surface waters in relation to Pump-In and drinking water standards through either direct or indirect effects. Groundwater goals are associated with both managing the aquifer and the export of constituents from the vadose zone.

The following chapters discuss both envisioned management and monitoring strategies for the Bank and its operations.

9 Water Quality Management Practices

The Bank will be implemented and managed. Management practices will be refined during the operations and progression of the Bank. Presented below are practices currently planned for meeting water quality goals. These practices relate to imported water, the recovery and export program, recharge basins and the operational model (Table 31). Practices will be refined with the further development and then implementation of the Bank. This effort will be conducted in collaboration with Project partners.

Water Quality Management Practices

To manage water quality, management practices are expected to be required for import of water from contractors to the Bank, for the recovery and export program, for screening and operations of recharge basins, and for development and implementation of the Operational Model.

9.1 For Managing Imported Water

To manage imported water to the Bank, two practices are planned:

1. Developing and implementing a water quality standard for water being imported to the Bank, and
2. Implementing those standards through a surface water quality and flow monitoring program.

Managing Import Water Expectations and Opportunities

Key tools for managing import water will be determining a water quality standard, and then monitoring for compliance with that standard. Contract water pump-in standards as defined by the Mendota Pool Group EIS/EIR requires water meet drinking water standards as well as tighter standards as related to TDS and selenium. Those standards require higher quality water as related to salts, nitrate and selenium than typically found in the groundwater under MAGSA. That requirement would improve groundwater quality within MAGSA over time. Water found in the San Luis Reservoir exceeds the Pump-in standards. If import water met the current water quality found in the San Luis Reservoir, MAGSA groundwater quality would improve more quickly. More rapid improvement of MAGSA groundwater would help in operational flexibility of the Bank in returning water from the Bank back to contractors.

9.1.1 Import water quality standard

The Bank will need to set an import water quality standard. A default standard could be similar to the Pump-In standard developed for Non-Project water (Reclamation 2019). Use of this standard would result in higher quality import water diluting and improving the resident groundwater underlying MAGSA. Groundwater quality improvement would occur is because the non-Project Pump-In standard is higher quality than the resident groundwater, as estimated through the spatial analyses conducted in Chapter 6.5.

Water quality from sampling at the O'Neill Forebay (Chapter 4.1) suggest contract water is higher quality water as compared to resident groundwater. Thus, a potentially more stringent water quality standard could be set depending upon other factors that might hamper meeting a more stringent standard.

9.1.2 Implementing surface water quality and flow monitoring program

Implementing the above standard would provide a high quality source water that over time will dilute groundwater and would likely improve the water quality of groundwater in the long-term for some key constituents (e.g., salts, nitrate, selenium, TCP).

9.2 For Managing the Recovery and Export Program

Four practices are currently provided here to improve both surface water and groundwater.

9.2.1 Prioritize Recovery Well Locations

Recovery Well locations should be prioritized to help improve groundwater. Based upon our vadose zone and groundwater analysis (Chapter 7), groundwater *recovery wells should be a minimum of 500 meters downstream of the basin in which recharge is being conducted*. The first flush of recharge water (e.g., 15 – 30 ft) is expected to mobilize salts, nitrate and other mobile water quality constituents. In this latter category, one might expect mobilization of the trace element selenium.

Our analysis suggests the first flush could increase nitrate levels in underlying groundwater by 7 mg-N/l (Table 28). Such an increase would raise much of the groundwater above the drinking water standard. The analysis suggests the first flush could similarly increase TDS levels by 350 mg/l (Table 28), also driving groundwater concentrations below recharge basins above the drinking water standard and above Pump-In projects standards. However, these are expected to be localized and short-term. The model used here to describe effects on groundwater suggests these effects would diminish greatly spatially within a half mile of recharge, and temporally over a decade (Figure 41, Figure 42). Locating recovery wells 500 m or more downstream of a recharge basin is expected to ensure stable groundwater quality during this first flush period at the given recharge basin.

Recovery well should also be placed to target and develop subsurface flow paths. This goal relates to managing first flush vadose loads exported to groundwater, limiting groundwater mixing and export from concerning areas such

Recovery and Export Program

Management of the Recovery and Export program will benefit water quality of both surface water and groundwater. Four sets of practices are defined for this program: 1) Prioritizing the locations of recovery wells, 2) groundwater monitoring, 3) surface water monitoring, and 4) water quality management. These efforts focus on minimizing and managing the first flush effects on groundwater quality, and ensuring exported water will meet Pump-In standards. Within this program is establishment of a dense groundwater monitoring program that accurately captures groundwater changes during Bank operations, the difference is deeper and shallower groundwater, and capturing first flush events with data.

as the Raisin City Oil Field, and minimizing potential redox-driven impacts on groundwater quality and the quality of groundwater pumped for export.

Existing groundwater flow paths are identifiable from existing groundwater contours. Expected flow paths will be better predicted through the operational model and validated through groundwater monitoring.

Finally, recovery wells should be located to draw initially from regions with higher quality groundwater. The eastern region of MAGSA is such a region with salt and nitrate concentrations (Figure 11, Figure 13, Figure 18) below the Pump-In standards (Reclamation 2019). This region, about a quarter to one third of MAGSA, will ensure groundwater below the Pump-in standard can be returned to contractors, even during the early first flush period during which recharge basins are coming into operation.

9.2.2 Groundwater Monitoring

Groundwater monitoring will be needed to support real-time management and decision making: e.g.,

- *Ensure recovery zones have groundwater that will meet pump-in standards* set for the project;
- *Identify periods of first flush* during the initial recharge period at a recharge basin;
- Identify differences in *water quality of groundwater with depth*.

Groundwater quality monitoring will also be needed during the early development and calibration of the Operational Banking Model as well as for subsequent refinement.

This groundwater monitoring program will need –

- *A grid of monitoring wells*, approximately 1 – 2 miles apart to accurately map changes in groundwater as related to different water quality constituents, and for providing Operational Banking Model data;

- A subset of *nested wells* for understand difference in water quality constituent concentration with depth such that recovery well can access higher quality groundwater, as well as for understanding potential impacts on domestic wells from recharge;

- *Wells underlying and downstream of recharge basins along a flow gradien*t in order to plan for recovery of recharge water in consideration of the first flush of TDS, nitrates and other water quality constituents.

Groundwater monitoring wells will be critical in achieving all water quality goals (e.g., Table 31)(.

9.2.3 Surface Water Quality Monitoring

Surface water quality monitoring will be needed to ensure recovered water meets necessary pump-in and drinking water standards, and inform on water quality management decisions.

9.2.4 Water Quality Management

Water quality management actions will be needed as related pumping groundwater for export through the conveyance system to partners and contractors: e.g.,

- *Distribution and location of recovery wells* pumping groundwater into the conveyance system for return to the contractors and partners;
- *Mixing and blending decisions*; and
- *Well shutdown decisions*.

9.3 For Managing Recharge Basins

Actions will be needed regarding the implementation of the recharge basins. These actions are associated with both locating recharge basins and with their operations.

9.3.1 Recharge Basin Location Screening

Our analysis suggests the first flush could increase nitrate levels in groundwater underlying recharge basins by 7 mg-N/l (Table 28). Such an increase would raise the groundwater above the drinking water standard. The analysis suggests the first flush could similarly increase TDS levels by 350 mg/l (Table 28), also driving groundwater above the drinking water standard as well as above Pump-In projects standards.

Recharge Basin Screening to Limit First Flush of Legacy Loads (e.g., salts, nitrate)

The first flush of nitrate, salts and other constituents will create local water quality challenges for the Bank and limit its flexibility. Selecting basin with lower expected legacy loading will help mitigate those challenges. A two-step screening program based first on public crop and nutrient datasets and second validated with deep field cores will allow selection of basins with lower legacy loads. This consideration is important as local soil core data shows TDS and nitrate legacy loads in the vadose zone can vary by an order of magnitude.

These increases are expected to be localized and short-term. The model used here to describe effects on groundwater suggests these effects would expect to spatial diminish greatly within a half mile of recharge, and temporally the same over a decade (Figure 41, Figure 42) with a half mile of recharge, expected to have effects decrease a half mile away, and also within a decade.

Though the localized, short-term effects on groundwater are expected to be noticeable under and in the near vicinity of a recharge basin, the effects will be much less across MAGSA long-term. Mass balance calculations estimate that Implementation of recharge throughout MAGSA would export TDS loads equivalent to a 70 mg/L increase in TDS and nitrate loads equivalent to a 1 mg/L increase in NO3-N (Table 29). These loads would be offset in the longer term from aforementioned dilution from high quality source water (meeting an import water quality standard).

Other sources of dilution are also expected, such as from flood flow capture that was initiated within MAGSA in 2023, recharging an estimated 16,000 – 18,000 AF of high quality flood flows. SGMA and the ILRP have been implemented throughout the San Joaquin Valley as discussed in Chapter 6.4 in relation to suggested temporal improvements that have occurred in groundwater quality over the last two decades. These other factors could offset the one-time legacy loads from recharge basins.

The numbers discussed represent expectation and estimates of average conditions. However, the legacy loading of salts and nitrate likely vary by an order of magnitude as previously discussed (Table 27). To best manage these loads, recharge basins will be initially screened to identify basins expected to have lower constituent loads in the ground below. Lower loads will help lower first flush impacts on groundwater.

The proposed screening here is two-step. MAGSA and others have developed landowner tools that rank the potential of nitrate loading of fields across MAGSA based on crop nutrient cycling and leaching data provided by the Central Valley Water Board from the IRLP, and on the past fifteen years of crop data for each field within MAGSA. These two datasets have been integrated to estimate and rank potential nitrate loads from fields within MAGSA (Figure 43). This assessment can provide an initial screening for fields planned for recharge.

Secondary screening through deep soil cores (approximately 30 ft) could validate the initial ranking. Such cores have been used for characterizing cores within MAGSA (e.g., Table 27) and for transport model calibration and validation (e.g., Roy et al. 2017; Attachment A). These types of core at sufficient numbers (e.g., estimated 6 – 9 per field initially) are planned for subsequent secondary screening for recharge basin selection.

Other requirements are planned for locating recharge basins. Recharge basins will not be implemented in areas defined by MAGSA as areas requiring avoidance. The Raisin City Oil Field has been associated with water quality plumes that are remnants of oil pumping in that region. That region appears to be a hotspot for salts (Figure 16) and nitrate (Figure 19) based on estimates from the spatial analysis conducted here. This region should initially be avoided for recharge basin until further data collection can show otherwise.

Avoiding Recharge Basins in some locations

This effort supports regional though that the Raisin City Oil Field compromises groundwater quality. Our analysis shows the Raisin City Oil Field a hotspot for TDS and nitrate. Recharge should not be implemented there unless further and more robust water quality data shows otherwise. Other areas in MAGSA may also be deemed places to avoid locating recharge basins. in the Raisin City Oil Field unless additional data suggests.

Finally, recharge basins in which secondary screening shows the likelihood of low legacy loading of nitrate, salts and other water quality constituents could be placed upstream of domestic well locations, particularly for disadvantaged areas. Our spatial analysis shows much of MAGSA's groundwater has challenges with regard to meeting groundwater standards. Recharge of high quality water could help improve groundwater local to those regions through dilution.

Benefitting Drinking Water Quality

Recharge basins would be expected to benefit domestic wells through diluting groundwater as related to water quality constituents such as TDS, nitrate and selenium. This expectation would depend upon high quality import water for recharge and on managing the basins establishment and operations to minimize legacy loads. Locating recharge basins on lands that are determined to have relatively lower legacy loads would be a good first step.

9.3.2 Recharge Basin Operations

Recharge basin operations will be conducted to manage the impacts of the first flush and subsequent flushes of nitrate, salts and other constituents, as well as to maintain high quality input water to the basins.

Input water will be required to meet drinking water standards as well as project import standards. This requirement has been previously discussed in Chapter 9.1

The flow of water to a recharge basin for distribution and infiltration will also be measured. The flow rate and resulting infiltration rates will affect the period to recharge sufficient water (e.g., 15 – 30 ft) for first flush of nitrate, salts and other constituents to occur. This variable is critical for water quality management.

Stepwise Implementation of Recharge Basins

Stepwise and incremental introduction of recharge basins will reduce vadose zone first flush impacts by lessening the impact at any one time and spreading it over time.

Some recharge basins may be used for multiple uses, specifically farming and recharge. All farm fields in the Central Valley are regulated with regard to farming cultural practices through the Central Valley IRLP. Basins participating in the recharge program will also need to implement On-Farm Recharge practices that have been designed to integrate farming and recharge programs together as possible (Bachand et al. 2022). Early testing of that program occurred in 2023 with the implementation of recharge within MAGSA that resulted in infiltration of between 16,000 – 18,000 AF.

Groundwater quality management is expected to benefit from a stepwise approach of introducing recharge basins into the Bank program. A stepwise approach will allow for distributing first flush from recharge basins over a longer period of time. This strategy is comparison to recharge basins implemented all together. Under this latter approach, a global first-flush from many recharge basins would more greatly affect global groundwater quality. A stepwise approach will avoid that issue with the incremental introduction of recharge basins, so that as a first flush completes and flush water becomes clean, another starts infiltrating. This will average out first flush over a longer period of time, minimizing disruptions from the first flush phenomenon to the quality of groundwater.

9.4 For Planning through the Operational Model

The Operational Model will be an important tool in managing the Bank. The hydrologic and water quality model will allow for testing management scenarios and help in decision making. This document provides our current expectations using the tools and information currently available. The Operational Model will be developed using currently available information and data, and then subsequently be refined and evolve as water quality, hydrology and other needed data is collected.

Thus, the Operational Model can be used currently in planning and design, and for developing initial operations and management plans. As the Operational Model is refined, it will allow for more precise predictive model that will further support decision making.

Operational Model

A refined model of groundwater hydrology and water quality will help management of the Bank by allowing testing of different implementation and management scenarios.

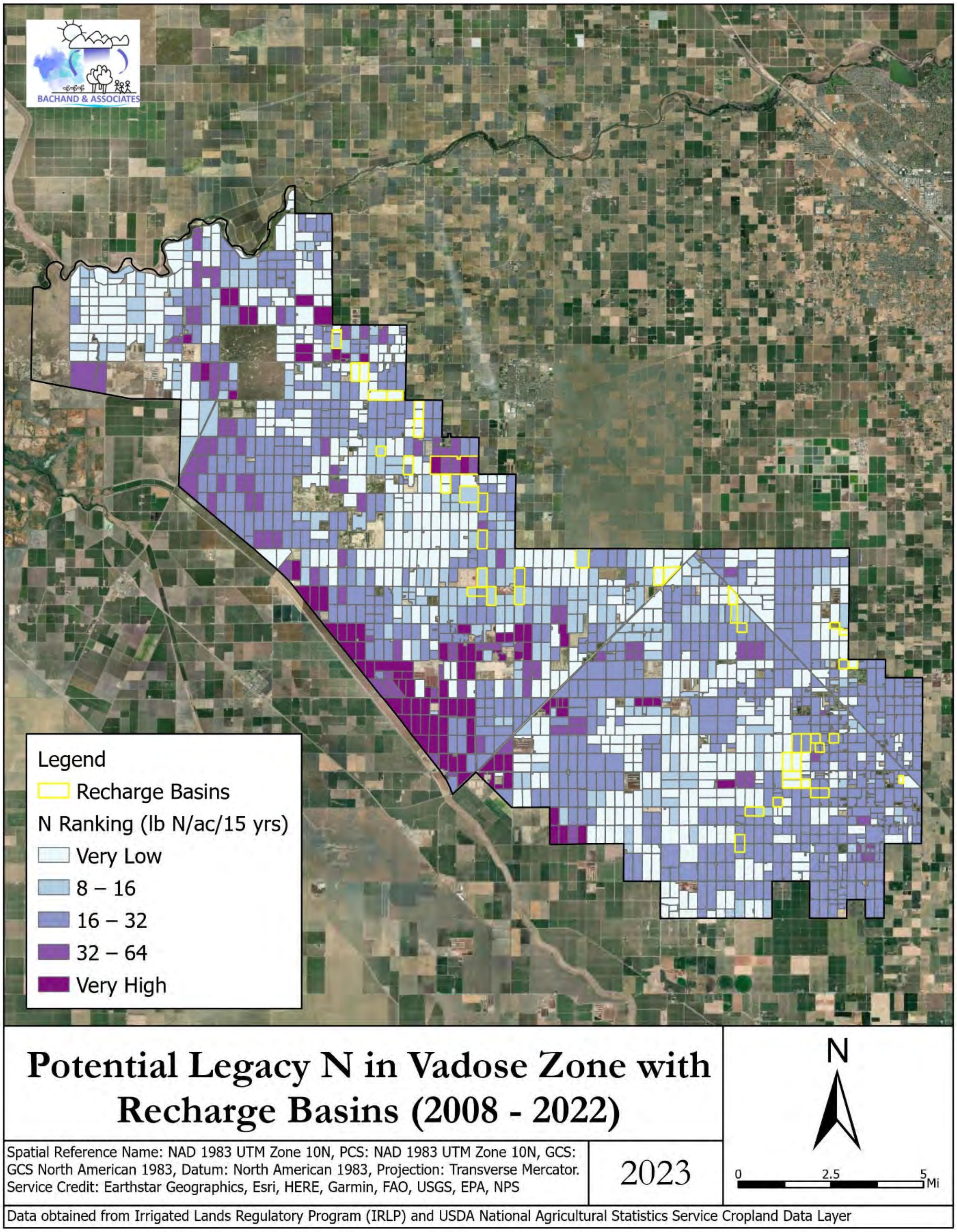


Figure 43. Ranking fields within MAGSA based on recharge potential loading of nitrogen.
N loads have been estimated utilizing 15-year crop history and Central Valley Regional Board data on N loading by crops within the San Joaquin Valley.

Table 31. Managing the Bank

Practice				Water Quality Goals							
				Surface Water Mgmt		Vadose Zone and Aquifer Mgmt					
				Pump-In Std	Drinking Water Std.	Legacy Loads	Loads from Ag practices	Redox Driven Mobilizaton	Avoid Hotspots	Drinking Water Stds	Op. Model Data
Import (IM)											
1			Water Quality Std. for water imported to Bank	x	x						
2			Surface water and flow monitoring	x	x						
Recovery and Export Program (R&E)											
1	Prioritize Recovery Well Locations										
	a		> 500 m downstream during first flush	x	x	x					
	b		along target subsurface flow paths and recovery targets	x	x	x	x	x	x		
	c		from high water quality zones (eastern MAGSA)	x	x	x					
2	Export water monitoring for mgmt			x	x						
3	Export water mgmt to meet stds										
	a		Recovery water blending	x	x						
	b		Temporary or permanent recovery well shutdown if unable to meet water quality stds	x	x	x	x	x	x		
4	Groundwater Monitoring Program										
	a	a	1 - 2 wells per sq. mile			x	x	x	x	x	x
	b	b	subset with nested wells for depth data			x	x	x		x	x
	c	c	Below and downstream of recharge basins			x	x	x		x	x
Recharge Basins (ReB)											
1	Recharge basin location screening										
	a		Initial using Crop and IRLM Program Data			x	x		x		
	b		Final screening under "deep" coring and sampling (e.g., TDS, NO3, Se)			x		x	x		
	c		Restrict Recharge from Identified Avoidance Areas						x		
	d		Low legacy load recharge basins sited upstream of potable water wells							x	
2	Recharge Basin operations										
	a		Input water meets California Drinking Water Standards	x	x						
	b		Stepwise introduction of recharge basin	x	x	x		x		x	
	c		Multi-Use Basins implement OFR / IRLM Management Practices				x			x	
	d		Flow monitoring to recharge basins			x	x			x	x
Operational Model (OpM)											
1	Recharge & recovery scenario testing			x	x	x	x	x	x	x	x

10 Monitoring Blueprint

The Aquaterra Monitoring program will need to focus on a few different areas of screening, operations and regulatory. Each of these is briefly discussed below. *The blueprint presented below represents an initial starting point. The program is expected to evolve over the design, planning and implementation process.*

Monitoring Blueprint

The Bank has a current blueprint for monitoring at key locations (e.g., import, export, recovery wells, recharge basins) for a variety of data (e.g., salts, nitrate, key constituents, EC, flow) at various frequencies (e.g., realtime, weekly, monthly) using a variety of methods for supporting planning, operations, strategized planning and regulatory. The Monitoring Plan and associated QAQC will develop as the Bank develops. The two key goals will be for real-time management decisions and for developing and refining the Operational Model to help test and refine different operational scenarios with regard to meeting Bank goals.

10.1 Basin Screening

To manage *loading from the vadose zone* and their associated water quality considerations, initial shallow coring and secondary deeper cores will enable quantifying *salt, nitrate, selenium and other potential water quality constituent loads* at the location and serve to guide decisions with regard to implementing recharge at a given site. These samples would be collected at one time. *Replicate cores* will provide characterizing conditions across the site. Appropriate QAQC will be implemented during sampling. Key constituents that relate to first flush are salts and nitrate. Secondary constituents could include selenium, TCP and gross alpha radioactivity.

10.2 Operations

Operations monitoring will be used for both real-time and current needs, as well as for planning.

10.2.1 Real time, current needs

Operations during Bank operations will need to include *groundwater monitoring* from recovery wells and *surface water monitoring* at key conveyance locations (e.g., import, export, operational nodes) and recharge basin locations. Both groundwater and surface water monitoring will benefit *from real-time, telemetric monitoring* of EC for tracking salts, and flow and pressure transducers for monitoring hydrology (i.e., flow, water level). These data will be used to manage the operations in real-time. The exact monitoring plan and schedule will reflect the two modes of operation for the bank: periods of recovery and periods of recharge.

Key constituents are currently planned to be collected weekly. For the Bank, these constituents will be used to manage the system with regard to meeting specific water quality goals. Salts, nitrate and selenium are initially expected to be sampled the most regularly, currently planned as weekly. These constituents are planned for sampling at both groundwater and surface water locations and be used for managing the conveyance, recharge and recovery systems and components, including decisions to change locations for recharge and recovery.

The *real-time monitoring will support compliance* with regard to the *Pump-in and delivery* requirement developed for the Bank.

10.2.2 Operational Model

A key for managing the system will be development and refinement of the operational model. Water quality sampling will support developing the model as pertains to water quality effects through vadose zone flushing during recharge, aquifer transport, and recovery. Salts and nitrate are expected to be transported relatively conservatively, with only minor losses. Sampling of salts and nitrate will help in development and refinement of the Operational Model.

10.3 Regulatory

Monitoring and sampling is expected to have similar requirements as for the Water Projects. Those requirements include drinking water standards with a short list of drinking water constituents sampled monthly and a long list of drinking water constituents sample every three years. These requirements are conducted at the O'Neill Forebay as well as key operational locations (e.g., Lateral 7) (Reclamation 2017). Similar requirements are expected for the Bank.

Additionally imposed regarding the Water Projects is a pump-in standard which in addition needs to regulate for drinking water standards, also regulates for salts, nitrate and some trace elements as discussed in Chapter 0. Similar standards are expected with regard to delivery and export from the Bank. These standards are expected to be developed in collaboration with the Bank partners.

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IV. Attachments

A. Water Quality Cycling, Redox Considerations and Mobilization under Banking

B. Modeling presentation 2016, Roy et al. 2017.

C. Bureau of Reclamation Water Quality Pump-In Program

A. Salt and Nitrate Transport Under On-Farm Recharge

Roy, S., J. Rath, M. Ungs, P. Bachand, S. Bachand, B. Dalgish, V. Kretsinger. 2017. Modeling Groundwater Quality Impacts of On-Farm Flood Capture and Recharge (OFFRC). Nitrate Management for Farmland Recharge Meeting. California Regional Water Quality Control Board. Rancho Cordova, CA 95670. September 20, 2017.

B. Non-Project Water Pump-In Program

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C. Ranking Nitrogen Loading Potential with MAGSA

The attached memorandum draft summarizes the methodologies and data used in ranking N loading by field within MAGSA.

Appendix 4

Air Quality and Greenhouse Gas Technical Study

Air Quality and Greenhouse Gas Technical Study

1. Introduction

Emissions of key air pollutants and greenhouse gas (GHG) were estimated for the Aquaterra Project based on the use of California Emissions Estimator Model (CalEEMod version 2022.1; California Air Pollution Control Officers Association 2023). The Aquaterra Project proposes to construct and operate a groundwater banking program and consists of a total of 65 miles of canals and approximately four thousand acres of farmland as the recharge basin. The scope of this project includes the construction or upgrades of canal levees, pump stations, and roadway crossings for the main canal, and levees, berms, and recovery wells for the recharge basins. The Aquaterra Project has a total duration of 42 months for construction, starting from September 2024 to the end of February 2028.

The modeling of air pollutant and GHG emissions using the CalEEMod mainly includes two components: (1) a construction phase for construction and upgrades of the main conveyance and recharge basin elements; and (2) an operation phase mainly involving the operation of various pump stations to carry out seasonal groundwater recharge. The emissions from the construction generally include the emissions from the equipment used primarily for grading, excavation, and hauling, and from daily trips of workforce and equipment. The emissions from the operation phase are primarily caused by the pumps used for groundwater recharge and daily trips for inspection.

Key modeling information including detailed project information and other modeling assumptions made are discussed in Section 2, whereas a summary of the modeling results is provided and described in Section 3.

2. Modeling Information

Corresponding to the project construction and operation, the CalEEMod was implemented combining two land use types: a linear land use type to consider and model construction activities involved (primarily related to main conveyance elements and as well as other activities related to recharge basins) and a city park land use type to incorporate and model the operation of recharge basin (primarily, operation of pump stations).

The first step of calculating emissions for construction activities involves the estimation of different equipment that will be utilized and the time they will be operated. The types of equipment that will be deployed for construction of different elements of this project are provided in Table 1. Additionally, the estimated numbers of equipment that will be operated in parallel for construction of different elements are also presented in Table 1.

Table 1. Schedule of the equipment used for the different project elements.

Project Elements		Equipment utilized													# of equipment operated in parallel
		Crane	Drill Rig	Backhoe	Excavator	Grader	Water truck	Boring	Concrete	Scraper	Compactor	Dump truck	Loader	Bulldozer	
Main Conveyance Elements															
1	Pump Stations	x		x	x				x		x				2
2	Paved Road Crossings (box culverts)	x			x						x	x	x	x	2
3	Railroad crossings	x			x						x	x	x	x	2
4	Paved Road Crossings (Jack and Bore)	x			x						x	x	x	x	2
5	Farm Road pipe culverts	x			x						x	x	x	x	2
6	Main Conveyance Canals				x	x	x			x	x				5
Recharge Elements															
1	Recharge Basin Field Complexes (80 Acres each)			x		x				x	x	x	x	x	1
Recovery Well Elements															
1	Recovery Wells	x	x						x						1

The types and numbers of equipment operated in parallel for construction of different elements in Table 1 were subsequently used to estimate the average operation hours during the entire construction period (i.e., 2024 to mid-2017). For construction of each element in this project, the number of pieces of equipment operated in parallel was used to calculate the average number of hours per day each individual piece of equipment. The hours were then summed over all the elements for each individual piece of equipment.

The numbers and estimated operation hours per day for each type of equipment are provided in Table 2. This equipment information was then incorporated into the CalEEMod.

Table 2. Types, numbers, and operation hours for the equipment scheduled and modeled in CalEEMod over the duration of project construction activities.

Type	Number	Hours per day	Engine Tier
Bore/Drill Rigs	1	2.26	Tier 3
Excavators	2	7.39	Tier 3
Graders	3	5.79	Tier 3
Off-Highway Trucks	2	4.89	Tier 3
Plate Compactors	3	6.39	Tier 3
Rubber Tired Dozers	2	4.89	Tier 3
Scrapers	2	7.56	Tier 3
Tractors/Loaders/Backhoes	2	7.56	Tier 3

An additional estimation of daily travels for material hauling, workers, and equipment was conducted and implemented to the CalEEMod. An average daily vehicle mile traveled (VMT) for material hauling was estimated based on the delivery of different materials and the capacity of trucks for these materials. The detailed breakdowns of VMT for hauling of different materials are presented in Table 3.

Table 3. Estimated distances traveled for material hauling for different project elements.

Element Summary by Unit					Project Total by Element	
	Element Name	**# of Units**	**Truckloads per Element Unit**	**1-way Distance per Unit**	**Total Truck Loads**	**Total Mileage**
Main Conveyance Elements						
1	Pump Stations	18	63	1,890	1,134	34,020
2	Typical Paved Road Crossings. Box Culverts	17	8	480	136	8,160
3	Major Crossings: State, county and RR crossings, J&B (1)	8	10	300	80	2,400
4	Farm road crossings along main canal and key laterals. Box Culverts	56	8	480	448	26,880
5	Farm Road crossing of laterals. Pipe culverts.	20	2	60	40	1,200
Recharge Elements						
1	Recharge Basin Field Complexes (80 Acres each)	50	8	240	400	12,000
Recovery Well Elements						
1	Recovery Wells	90	6	180	540	16,200
Total					2,778	100,860
Contingency		5%			139	5,043
Total w/Contingency					**2,917**	**105,903**
Average Distance per truck load						**36.3**

As shown in Table 3, the daily hauling distance was estimated as 36.3 miles per one-way trip and with 8 daily one-way trips (over the entire construction period of Sep-2024 to Feb-2028) or 72.6 mile per round trip and with 4 daily round trips. Additionally, the daily VMT for workers and for on-site trucks is assumed to be a round trip with a total of 40 miles per day.

The VMT information was subsequently implemented to the CalEEMod to provide estimates of emissions from construction activities of this project; the results of estimated emissions from construction are described in Section 3.

The emissions from the project operation are primarily caused by the operation of pump stations as previously described; additional emissions from daily travels for inspection of recharge basin operation are also modeled in CalEEMod. The numbers, types, and operation hours of the pumps included for the operation are presented in Table 4.

Table 4. Types, numbers, and operation hours of the pumps used for the operation of the proposed recharge basin and modeled in CalEEMod.

	Number	Operation days per year	Hours per day
Pump (electric) - 200 hp	84	151	24
Pump (natural gas) - 195 hp	18	151	24
Pump (propane) - 145 hp	12	151	24

The CalEEMod does not provide default emission data for the pumps using natural gas and propane as fuels; additional calculation procedures were carried out to obtain and estimate the emission factors for these two types of pumps. Specifically, the default data for diesel pumps in the CalEEMod, the emission factors for alternative fuels from the California Climate Investments Quantification Methodology Emission Factor Database (CARB 2020), and the GHG emission factors used in EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks (USEPA 2023) were used to obtain estimates of the required emission factors. The comparison results of different emission factors are presented in Table 5. Specifically, all factors for diesel pumps are default values provided by CalEEMod; the factors for ROG, NO_X, PM10, PM2.5 of natural gas and propane are based on the California Air Resources Board Emission Factor Database (CARB 2020); the factors for TOG, CO, and SO_X of natural gas and propane were similarly scaled based on the ROG and NO_X emissions; and the GHG emission factors of natural gas and propane are based on the values used in the EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks (USEPA 2023).

Table 5. Comparison of emission factors (grams per brake horsepower-hour) for the pumps using diesel (default data provided by CalEEMod), natural gas, and propane (estimated). Emission factors for pumps using natural gas and propane were subsequently used in CalEEMod.

Fuel	TOG	ROG	NO_x	CO	SO_x	PM10	PM2.5	CO_2	CH_4	N_2O
Diesel	0.391	0.323	3.24	3.86	0.007	0.057	0.052	568	0.023	0.005
Nature Gas	0.0391	0.03	0.31	0.386	0.0007	0.06	0.0552	403	0.0108	0.00075
Propane	0.0391	0.03	0.31	0.386	0.0007	0.06	0.0552	483	0.023	0.005

Additionally, given the uncertainty of the estimated emission factors presented in Table 5, the operation hours and days in a year for these pumps (as presented in Table 4) are more conservatively estimated and are expected to be greater than the actual operation time in a year.

3. Modeling Results

The CalEEMod modeling results of annual emissions of criterial air pollutants and GHG from the construction activities during the 42 months of project duration (Sep-2024 to Feb-2028) and during annual operation (after completion of construction) are presented in Tables 6 and 7. The emission thresholds of criteria pollutants associated with the construction and operation of a proposed project (SJVAPCD 2015) and compliance with these thresholds are also presented in Tables 6 and 7.

Table 6. Estimated emissions and compliance of criterial pollutants (short tons per year; tpy) and GHG (metric tons per year; MT/year) during construction of the proposed project (Sep-2024 to Feb-2028).

Year	TOG (tpy)	ROG (tpy)	NOx (tpy)	CO (tpy)	SO_x (tpy)	PM10 (tpy)	PM2.5 (tpy)	CO_2e (MT per year)
2024	0.072	0.071	1.85	2.147	0.004	2.694	0.387	411.4
2025	0.214	0.21	5.528	6.421	0.012	8.059	1.159	1228
2026	0.214	0.21	5.522	6.418	0.012	8.059	1.159	1226
2027	0.213	0.21	5.517	6.416	0.012	8.059	1.159	1222
2028	0.035	0.035	0.906	1.055	0.002	1.325	0.191	200.4
Annual threshold	-	10	10	100	27	15	15	-
Above threshold	-	No	No	No	No	No	No	-
Construction total	0.748	0.736	19.323	22.457	0.042	28.196	4.055	4287.8

Table 7. Estimated emissions (tons per year) and compliance of criterial pollutants (short tons per year; tpy) and GHG (metric tons per year; MT/year) during annual operation after project completion.

	TOG (tpy)	ROG (tpy)	NOx (tpy)	CO (tpy)	SO_x (tpy)	PM10 (tpy)	PM2.5 (tpy)	CO_2e (MT per year)
Annual emissions	0.606	0.467	4.812	5.997	0.016	0.933	0.854	9311
Annual threshold	-	10	10	100	27	15	15	-
Above threshold	-	No	No	No	No	No	No	-

As shown in Tables 6 and 7, six air pollutants have corresponding thresholds established by the San Joaquin Valley Unified Air Pollution Control District (SJVAPCD 2015): ROG, NO_X, CO, SO_X, PM10, and PM2.5. The results of CalEEMod suggests that during both construction and operation phases of this project, annual emissions of all six pollutants are below the given annual emission thresholds.

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MAGSA2 Detailed Report

Table of Contents

1. Basic Project Information

1.1. Basic Project Information

1.2. Land Use Types

1.3. User-Selected Emission Reduction Measures by Emissions Sector

2. Emissions Summary

2.1. Construction Emissions Compared Against Thresholds

2.2. Construction Emissions by Year, Unmitigated

2.4. Operations Emissions Compared Against Thresholds

2.5. Operations Emissions by Sector, Unmitigated

3. Construction Emissions Details

3.1. Linear, Grading & Excavation (2024) - Unmitigated

3.3. Linear, Grading & Excavation (2025) - Unmitigated

3.5. Linear, Grading & Excavation (2026) - Unmitigated

3.7. Linear, Grading & Excavation (2027) - Unmitigated

3.9. Linear, Grading & Excavation (2028) - Unmitigated

4. Operations Emissions Details

4.1. Mobile Emissions by Land Use

4.1.1. Unmitigated

4.2. Energy

4.2.1. Electricity Emissions By Land Use - Unmitigated

4.2.3. Natural Gas Emissions By Land Use - Unmitigated

4.3. Area Emissions by Source

4.3.1. Unmitigated

4.4. Water Emissions by Land Use

4.4.1. Unmitigated

4.5. Waste Emissions by Land Use

4.5.1. Unmitigated

4.6. Refrigerant Emissions by Land Use

4.6.1. Unmitigated

4.7. Offroad Emissions By Equipment Type

4.7.1. Unmitigated

4.8. Stationary Emissions By Equipment Type

4.8.1. Unmitigated

4.9. User Defined Emissions By Equipment Type

4.9.1. Unmitigated

4.10. Soil Carbon Accumulation By Vegetation Type

4.10.1. Soil Carbon Accumulation By Vegetation Type - Unmitigated

4.10.2. Above and Belowground Carbon Accumulation by Land Use Type - Unmitigated

4.10.3. Avoided and Sequestered Emissions by Species - Unmitigated

5. Activity Data

5.1. Construction Schedule

5.2. Off-Road Equipment

5.2.1. Unmitigated

5.3. Construction Vehicles

5.3.1. Unmitigated

5.4. Vehicles

5.4.1. Construction Vehicle Control Strategies

5.5. Architectural Coatings

5.6. Dust Mitigation

5.6.1. Construction Earthmoving Activities

5.6.2. Construction Earthmoving Control Strategies

5.7. Construction Paving

5.8. Construction Electricity Consumption and Emissions Factors

5.9. Operational Mobile Sources

5.9.1. Unmitigated

5.10. Operational Area Sources

5.10.1. Hearths

5.10.1.1. Unmitigated

5.10.2. Architectural Coatings

5.10.3. Landscape Equipment

5.11. Operational Energy Consumption

5.11.1. Unmitigated

5.12. Operational Water and Wastewater Consumption

5.12.1. Unmitigated

5.13. Operational Waste Generation

5.13.1. Unmitigated

5.14. Operational Refrigeration and Air Conditioning Equipment

5.14.1. Unmitigated

5.15. Operational Off-Road Equipment

5.15.1. Unmitigated

5.16. Stationary Sources

5.16.1. Emergency Generators and Fire Pumps

5.16.2. Process Boilers

5.17. User Defined

5.18. Vegetation

5.18.1. Land Use Change

5.18.1.1. Unmitigated

5.18.1. Biomass Cover Type

5.18.1.1. Unmitigated

5.18.2. Sequestration

5.18.2.1. Unmitigated

6. Climate Risk Detailed Report

6.1. Climate Risk Summary

6.2. Initial Climate Risk Scores

6.3. Adjusted Climate Risk Scores

6.4. Climate Risk Reduction Measures

7. Health and Equity Details

7.1. CalEnviroScreen 4.0 Scores

7.2. Healthy Places Index Scores

7.3. Overall Health & Equity Scores

7.4. Health & Equity Measures

7.5. Evaluation Scorecard

7.6. Health & Equity Custom Measures

8. User Changes to Default Data

1. Basic Project Information

1.1. Basic Project Information

Data Field	Value
Project Name	MAGSA2
Construction Start Date	9/1/2024
Operational Year	2029
Lead Agency	—
Land Use Scale	Project/site
Analysis Level for Defaults	County
Windspeed (m/s)	2.90
Precipitation (days)	21.2
Location	36.759707, -120.313457
County	Fresno
City	Unincorporated
Air District	San Joaquin Valley APCD
Air Basin	San Joaquin Valley
TAZ	2526
EDFZ	5
Electric Utility	Pacific Gas & Electric Company
Gas Utility	Pacific Gas & Electric
App Version	2022.1.1.21

1.2. Land Use Types

Land Use Subtype	Size	Unit	Lot Acreage	Building Area (sq ft)	Landscape Area (sq ft)	Special Landscape Area (sq ft)	Population	Description

User Defined Linear	65.0	Mile	1,580	0.00	—	—	—	—
City Park	4,000	Acre	4,000	0.00	4,000	3,480	—	—

1.3. User-Selected Emission Reduction Measures by Emissions Sector

No measures selected

2. Emissions Summary

2.1. Construction Emissions Compared Against Thresholds

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Un/Mit.	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Unmit.	1.65	1.62	42.4	49.3	0.09	1.71	63.5	65.2	1.54	7.70	9.23	—	10,321	10,321	0.40	0.26	2.96	10,412
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Unmit.	1.65	1.62	42.5	49.3	0.09	1.71	63.5	65.2	1.54	7.70	9.23	—	10,318	10,318	0.39	0.26	0.08	10,406
Average Daily (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Unmit.	1.17	1.15	30.3	35.2	0.07	1.22	42.9	44.2	1.10	5.25	6.35	—	7,358	7,358	0.28	0.18	0.90	7,419
Annual (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Unmit.	0.21	0.21	5.53	6.42	0.01	0.22	7.84	8.06	0.20	0.96	1.16	—	1,218	1,218	0.05	0.03	0.15	1,228
Exceeds (Annual)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Threshold	—	10.0	10.0	100	27.0	—	—	15.0	—	—	15.0	—	—	—	—	—	—	—
Unmit.	—	No	No	No	No	Yes	—	No	Yes	—	No	—	—	—	—	—	—	—

2.2. Construction Emissions by Year, Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Year	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Daily - Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2024	1.65	1.62	42.4	49.3	0.09	1.71	63.5	65.2	1.54	7.70	9.23	—	10,321	10,321	0.40	0.26	2.96	10,412
2025	1.64	1.62	42.3	49.3	0.09	1.71	63.5	65.2	1.54	7.70	9.23	—	10,303	10,303	0.39	0.25	2.92	10,391
2026	1.64	1.61	42.3	49.3	0.09	1.71	63.5	65.2	1.54	7.70	9.23	—	10,281	10,281	0.39	0.25	2.75	10,369
2027	1.64	1.61	42.3	49.3	0.09	1.71	63.5	65.2	1.54	7.70	9.23	—	10,253	10,253	0.39	0.25	2.53	10,339
Daily - Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2024	1.65	1.62	42.5	49.3	0.09	1.71	63.5	65.2	1.54	7.70	9.23	—	10,318	10,318	0.39	0.26	0.08	10,406
2025	1.64	1.61	42.4	49.2	0.09	1.71	63.5	65.2	1.54	7.70	9.23	—	10,300	10,300	0.39	0.25	0.08	10,385
2026	1.64	1.61	42.4	49.2	0.09	1.71	63.5	65.2	1.54	7.70	9.23	—	10,278	10,278	0.39	0.25	0.07	10,363
2027	1.64	1.61	42.4	49.2	0.09	1.71	63.5	65.2	1.54	7.70	9.23	—	10,250	10,250	0.39	0.25	0.07	10,333
2028	1.64	1.61	42.3	49.2	0.09	1.71	63.5	65.2	1.54	7.70	9.23	—	10,223	10,223	0.39	0.25	0.06	10,306
Average Daily	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2024	0.39	0.39	10.1	11.8	0.02	0.41	14.4	14.8	0.37	1.76	2.12	—	2,464	2,464	0.09	0.06	0.30	2,485
2025	1.17	1.15	30.3	35.2	0.07	1.22	42.9	44.2	1.10	5.25	6.35	—	7,358	7,358	0.28	0.18	0.90	7,419
2026	1.17	1.15	30.3	35.2	0.07	1.22	42.9	44.2	1.10	5.25	6.35	—	7,342	7,342	0.28	0.18	0.85	7,403
2027	1.17	1.15	30.2	35.2	0.07	1.22	42.9	44.2	1.10	5.25	6.35	—	7,322	7,322	0.28	0.18	0.78	7,382
2028	0.19	0.19	4.96	5.78	0.01	0.20	7.06	7.26	0.18	0.86	1.04	—	1,200	1,200	0.05	0.03	0.12	1,210
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2024	0.07	0.07	1.85	2.15	< 0.005	0.07	2.62	2.69	0.07	0.32	0.39	—	408	408	0.02	0.01	0.05	411
2025	0.21	0.21	5.53	6.42	0.01	0.22	7.84	8.06	0.20	0.96	1.16	—	1,218	1,218	0.05	0.03	0.15	1,228
2026	0.21	0.21	5.52	6.42	0.01	0.22	7.84	8.06	0.20	0.96	1.16	—	1,215	1,215	0.05	0.03	0.14	1,226

2027	0.21	0.21	5.52	6.42	0.01	0.22	7.84	8.06	0.20	0.96	1.16	—	1,212	1,212	0.05	0.03	0.13	1,222
2028	0.04	0.03	0.91	1.05	< 0.005	0.04	1.29	1.32	0.03	0.16	0.19	—	199	199	0.01	< 0.005	0.02	200

2.4. Operations Emissions Compared Against Thresholds

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Un/Mit.	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Unmit.	8.04	6.18	63.7	79.4	0.21	12.3	0.01	12.3	11.3	< 0.005	11.3	185	133,692	133,877	29.0	1.37	0.04	135,009
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Unmit.	8.04	6.18	63.7	79.4	0.21	12.3	0.01	12.3	11.3	< 0.005	11.3	185	133,690	133,876	29.0	1.37	< 0.005	135,007
Average Daily (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Unmit.	3.33	2.56	26.4	32.9	0.09	5.10	0.01	5.11	4.69	< 0.005	4.69	185	55,312	55,498	22.8	0.57	0.01	56,238
Annual (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Unmit.	0.61	0.47	4.81	6.00	0.02	0.93	< 0.005	0.93	0.86	< 0.005	0.86	30.7	9,158	9,188	3.78	0.09	< 0.005	9,311
Exceeds (Annual)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Threshold	—	10.0	10.0	100	27.0	—	—	15.0	—	—	15.0	—	—	—	—	—	—	—
Unmit.	—	No	No	No	No	—	—	No	—	—	No	—	—	—	—	—	—	—

2.5. Operations Emissions by Sector, Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Sector	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e

Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mobile	0.01	0.01	0.01	0.06	< 0.005	< 0.005	0.01	0.01	< 0.005	< 0.005	< 0.005	—	16.5	16.5	< 0.005	< 0.005	0.04	16.7
Area	—	< 0.005	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Energy	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	—	0.00	—	45,385	45,385	7.34	0.89	—	45,834
Waste	—	—	—	—	—	—	—	—	—	—	—	185	0.00	185	18.5	0.00	—	649
Off-Road	16.1	12.3	127	159	0.35	24.7	—	24.7	22.7	—	22.7	—	176,581	176,581	6.13	0.92	—	177,009
Total	16.1	12.3	127	159	0.35	24.7	0.01	24.7	22.7	< 0.005	22.7	185	221,982	222,168	32.0	1.81	0.04	223,508
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mobile	0.01	0.01	0.01	0.05	< 0.005	< 0.005	0.01	0.01	< 0.005	< 0.005	< 0.005	—	15.1	15.1	< 0.005	< 0.005	< 0.005	15.3
Area	—	< 0.005	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Energy	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	—	0.00	—	45,385	45,385	7.34	0.89	—	45,834
Waste	—	—	—	—	—	—	—	—	—	—	—	185	0.00	185	18.5	0.00	—	649
Off-Road	16.1	12.3	127	159	0.35	24.7	—	24.7	22.7	—	22.7	—	176,581	176,581	6.13	0.92	—	177,009
Total	16.1	12.3	127	159	0.35	24.7	0.01	24.7	22.7	< 0.005	22.7	185	221,981	222,166	32.0	1.81	< 0.005	223,507
Average Daily	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mobile	< 0.005	< 0.005	0.01	0.04	< 0.005	< 0.005	0.01	0.01	< 0.005	< 0.005	< 0.005	—	11.0	11.0	< 0.005	< 0.005	0.01	11.2
Area	—	< 0.005	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Energy	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	—	0.00	—	18,776	18,776	3.04	0.37	—	18,961
Waste	—	—	—	—	—	—	—	—	—	—	—	185	0.00	185	18.5	0.00	—	649
Off-Road	6.64	5.10	52.7	65.7	0.14	10.2	—	10.2	9.37	—	9.37	—	73,051	73,051	2.54	0.38	—	73,228
Total	6.65	5.11	52.7	65.7	0.14	10.2	0.01	10.2	9.37	< 0.005	9.37	185	91,838	92,023	24.1	0.75	0.01	92,850
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mobile	< 0.005	< 0.005	< 0.005	0.01	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	—	1.83	1.83	< 0.005	< 0.005	< 0.005	1.86
Area	—	< 0.005	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Energy	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	—	0.00	—	3,109	3,109	0.50	0.06	—	3,139
Waste	—	—	—	—	—	—	—	—	—	—	—	30.7	0.00	30.7	3.07	0.00	—	107
Off-Road	1.21	0.93	9.62	12.0	0.03	1.86	—	1.86	1.71	—	1.71	—	12,094	12,094	0.42	0.06	—	12,124
Total	1.21	0.93	9.62	12.0	0.03	1.86	< 0.005	1.86	1.71	< 0.005	1.71	30.7	15,205	15,236	3.99	0.12	< 0.005	15,372

3. Construction Emissions Details

3.1. Linear, Grading & Excavation (2024) - Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Location	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Onsite	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Off-Road Equipment	1.59	1.59	41.1	48.9	0.08	1.69	—	1.69	1.51	—	1.51	—	9,124	9,124	0.37	0.07	—	9,155
Dust From Material Movement	—	—	—	—	—	—	4.35	4.35	—	1.74	1.74	—	—	—	—	—	—	—
Onsite truck	0.01	< 0.005	0.17	0.04	< 0.005	< 0.005	58.9	58.9	< 0.005	5.88	5.88	—	143	143	< 0.005	0.02	0.34	150
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Off-Road Equipment	1.59	1.59	41.1	48.9	0.08	1.69	—	1.69	1.51	—	1.51	—	9,124	9,124	0.37	0.07	—	9,155
Dust From Material Movement	—	—	—	—	—	—	4.35	4.35	—	1.74	1.74	—	—	—	—	—	—	—

Onsite truck	0.01	< 0.005	0.18	0.04	< 0.005	< 0.005	58.9	58.9	< 0.005	5.88	5.88	—	143	143	< 0.005	0.02	0.01	150
Average Daily	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Off-Road Equipment	0.38	0.38	9.80	11.7	0.02	0.40	—	0.40	0.36	—	0.36	—	2,178	2,178	0.09	0.02	—	2,186
Dust From Material Movement	—	—	—	—	—	—	1.04	1.04	—	0.42	0.42	—	—	—	—	—	—	—
Onsite truck	< 0.005	< 0.005	0.04	0.01	< 0.005	< 0.005	13.2	13.2	< 0.005	1.32	1.32	—	34.1	34.1	< 0.005	0.01	0.04	35.7
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Off-Road Equipment	0.07	0.07	1.79	2.13	< 0.005	0.07	—	0.07	0.07	—	0.07	—	361	361	0.01	< 0.005	—	362
Dust From Material Movement	—	—	—	—	—	—	0.19	0.19	—	0.08	0.08	—	—	—	—	—	—	—
Onsite truck	< 0.005	< 0.005	0.01	< 0.005	< 0.005	< 0.005	2.42	2.42	< 0.005	0.24	0.24	—	5.64	5.64	< 0.005	< 0.005	0.01	5.91
Offsite	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worker	0.01	0.01	0.01	0.18	0.00	0.00	0.03	0.03	0.00	0.01	0.01	—	31.6	31.6	< 0.005	< 0.005	0.13	32.1
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	0.04	0.02	1.15	0.22	0.01	0.02	0.27	0.29	0.02	0.07	0.09	—	1,024	1,024	0.02	0.16	2.49	1,075
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worker	0.01	0.01	0.01	0.13	0.00	0.00	0.03	0.03	0.00	0.01	0.01	—	27.9	27.9	< 0.005	< 0.005	< 0.005	28.3
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00

Hauling	0.04	0.02	1.23	0.23	0.01	0.02	0.27	0.29	0.02	0.07	0.09	—	1,024	1,024	0.02	0.16	0.06	1,073
Average Daily	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worker	< 0.005	< 0.005	< 0.005	0.03	0.00	0.00	0.01	0.01	0.00	< 0.005	< 0.005	—	6.92	6.92	< 0.005	< 0.005	0.01	7.02
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	0.01	< 0.005	0.29	0.05	< 0.005	< 0.005	0.06	0.07	< 0.005	0.02	0.02	—	244	244	0.01	0.04	0.26	256
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worker	< 0.005	< 0.005	< 0.005	0.01	0.00	0.00	< 0.005	< 0.005	0.00	< 0.005	< 0.005	—	1.15	1.15	< 0.005	< 0.005	< 0.005	1.16
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	< 0.005	< 0.005	0.05	0.01	< 0.005	< 0.005	0.01	0.01	< 0.005	< 0.005	< 0.005	—	40.5	40.5	< 0.005	0.01	0.04	42.4

3.3. Linear, Grading & Excavation (2025) - Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Location	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Onsite	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Off-Road Equipment	1.59	1.59	41.1	48.9	0.08	1.69	—	1.69	1.51	—	1.51	—	9,128	9,128	0.37	0.07	—	9,160
Dust From Material Movement	—	—	—	—	—	—	4.35	4.35	—	1.74	1.74	—	—	—	—	—	—	—
Onsite truck	0.01	< 0.005	0.17	0.04	< 0.005	< 0.005	58.9	58.9	< 0.005	5.88	5.88	—	140	140	< 0.005	0.02	0.34	147
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Off-Road Equipment	1.59	1.59	41.1	48.9	0.08	1.69	—	1.69	1.51	—	1.51	—	9,128	9,128	0.37	0.07	—	9,160

Dust From Material Movement	—	—	—	—	—	—	4.35	4.35	—	1.74	1.74	—	—	—	—	—	—	—
Onsite truck	0.01	< 0.005	0.18	0.04	< 0.005	< 0.005	58.9	58.9	< 0.005	5.88	5.88	—	140	140	< 0.005	0.02	0.01	147
Average Daily	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Off-Road Equipment	1.14	1.14	29.3	34.9	0.06	1.21	—	1.21	1.08	—	1.08	—	6,520	6,520	0.26	0.05	—	6,543
Dust From Material Movement	—	—	—	—	—	—	3.11	3.11	—	1.24	1.24	—	—	—	—	—	—	—
Onsite truck	< 0.005	< 0.005	0.13	0.03	< 0.005	< 0.005	39.6	39.6	< 0.005	3.95	3.96	—	99.9	99.9	< 0.005	0.02	0.10	105
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Off-Road Equipment	0.21	0.21	5.35	6.37	0.01	0.22	—	0.22	0.20	—	0.20	—	1,080	1,080	0.04	0.01	—	1,083
Dust From Material Movement	—	—	—	—	—	—	0.57	0.57	—	0.23	0.23	—	—	—	—	—	—	—
Onsite truck	< 0.005	< 0.005	0.02	0.01	< 0.005	< 0.005	7.23	7.23	< 0.005	0.72	0.72	—	16.5	16.5	< 0.005	< 0.005	0.02	17.3
Offsite	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worker	0.01	0.01	0.01	0.17	0.00	0.00	0.03	0.03	0.00	0.01	0.01	—	30.9	30.9	< 0.005	< 0.005	0.12	31.4
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	0.03	0.01	1.11	0.22	0.01	0.02	0.27	0.29	0.02	0.07	0.09	—	1,004	1,004	0.02	0.16	2.46	1,053
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Worker	0.01	0.01	0.01	0.12	0.00	0.00	0.03	0.03	0.00	0.01	0.01	—	27.4	27.4	< 0.005	< 0.005	< 0.005	27.7
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	0.03	0.01	1.19	0.23	0.01	0.02	0.27	0.29	0.02	0.07	0.09	—	1,004	1,004	0.02	0.16	0.06	1,051
Average Daily	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worker	0.01	0.01	0.01	0.09	0.00	0.00	0.02	0.02	0.00	< 0.005	< 0.005	—	20.3	20.3	< 0.005	< 0.005	0.04	20.5
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	0.02	0.01	0.84	0.16	< 0.005	0.01	0.19	0.20	0.01	0.05	0.07	—	717	717	0.01	0.11	0.76	751
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worker	< 0.005	< 0.005	< 0.005	0.02	0.00	0.00	< 0.005	< 0.005	0.00	< 0.005	< 0.005	—	3.36	3.36	< 0.005	< 0.005	0.01	3.40
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	< 0.005	< 0.005	0.15	0.03	< 0.005	< 0.005	0.03	0.04	< 0.005	0.01	0.01	—	119	119	< 0.005	0.02	0.13	124

3.5. Linear, Grading & Excavation (2026) - Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Location	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Onsite	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Off-Road Equipment	1.59	1.59	41.1	48.9	0.08	1.69	—	1.69	1.51	—	1.51	—	9,130	9,130	0.37	0.07	—	9,162
Dust From Material Movement	—	—	—	—	—	—	4.35	4.35	—	1.74	1.74	—	—	—	—	—	—	—
Onsite truck	0.01	< 0.005	0.16	0.04	< 0.005	< 0.005	58.9	58.9	< 0.005	5.88	5.88	—	137	137	< 0.005	0.02	0.32	144
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Off-Road Equipment	1.59	1.59	41.1	48.9	0.08	1.69	—	1.69	1.51	—	1.51	—	9,130	9,130	0.37	0.07	—	9,162
Dust From Material Movement	—	—	—	—	—	—	4.35	4.35	—	1.74	1.74	—	—	—	—	—	—	—
Onsite truck	0.01	< 0.005	0.17	0.04	< 0.005	< 0.005	58.9	58.9	< 0.005	5.88	5.88	—	137	137	< 0.005	0.02	0.01	144
Average Daily	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Off-Road Equipment	1.14	1.14	29.3	34.9	0.06	1.21	—	1.21	1.08	—	1.08	—	6,522	6,522	0.26	0.05	—	6,544
Dust From Material Movement	—	—	—	—	—	—	3.11	3.11	—	1.24	1.24	—	—	—	—	—	—	—
Onsite truck	< 0.005	< 0.005	0.12	0.03	< 0.005	< 0.005	39.6	39.6	< 0.005	3.95	3.96	—	97.9	97.9	< 0.005	0.02	0.10	103
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Off-Road Equipment	0.21	0.21	5.35	6.37	0.01	0.22	—	0.22	0.20	—	0.20	—	1,080	1,080	0.04	0.01	—	1,083
Dust From Material Movement	—	—	—	—	—	—	0.57	0.57	—	0.23	0.23	—	—	—	—	—	—	—
Onsite truck	< 0.005	< 0.005	0.02	0.01	< 0.005	< 0.005	7.23	7.23	< 0.005	0.72	0.72	—	16.2	16.2	< 0.005	< 0.005	0.02	17.0
Offsite	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worker	0.01	0.01	0.01	0.15	0.00	0.00	0.03	0.03	0.00	0.01	0.01	—	30.3	30.3	< 0.005	< 0.005	0.11	30.7
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	0.03	0.01	1.08	0.22	0.01	0.02	0.27	0.29	0.02	0.07	0.09	—	983	983	0.02	0.16	2.33	1,032

Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worker	0.01	0.01	0.01	0.11	0.00	0.00	0.03	0.03	0.00	0.01	0.01	—	26.8	26.8	< 0.005	< 0.005	< 0.005	27.1
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	0.03	0.01	1.15	0.22	0.01	0.02	0.27	0.29	0.02	0.07	0.09	—	983	983	0.02	0.16	0.06	1,030
Average Daily	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worker	0.01	0.01	0.01	0.08	0.00	0.00	0.02	0.02	0.00	< 0.005	< 0.005	—	19.9	19.9	< 0.005	< 0.005	0.03	20.1
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	0.02	0.01	0.81	0.16	< 0.005	0.01	0.19	0.20	0.01	0.05	0.07	—	702	702	0.01	0.11	0.72	737
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worker	< 0.005	< 0.005	< 0.005	0.02	0.00	0.00	< 0.005	< 0.005	0.00	< 0.005	< 0.005	—	3.29	3.29	< 0.005	< 0.005	0.01	3.33
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	< 0.005	< 0.005	0.15	0.03	< 0.005	< 0.005	0.03	0.04	< 0.005	0.01	0.01	—	116	116	< 0.005	0.02	0.12	122

3.7. Linear, Grading & Excavation (2027) - Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Location	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Onsite	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Off-Road Equipment	1.59	1.59	41.1	48.9	0.08	1.69	—	1.69	1.51	—	1.51	—	9,130	9,130	0.37	0.07	—	9,161
Dust From Material Movement	—	—	—	—	—	—	4.35	4.35	—	1.74	1.74	—	—	—	—	—	—	—
Onsite truck	0.01	< 0.005	0.16	0.04	< 0.005	< 0.005	58.9	58.9	< 0.005	5.88	5.88	—	134	134	< 0.005	0.02	0.30	140

Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Off-Road Equipment	1.59	1.59	41.1	48.9	0.08	1.69	—	1.69	1.51	—	1.51	—	9,130	9,130	0.37	0.07	—	9,161
Dust From Material Movement	—	—	—	—	—	—	4.35	4.35	—	1.74	1.74	—	—	—	—	—	—	—
Onsite truck	0.01	< 0.005	0.17	0.04	< 0.005	< 0.005	58.9	58.9	< 0.005	5.88	5.88	—	134	134	< 0.005	0.02	0.01	140
Average Daily	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Off-Road Equipment	1.14	1.14	29.3	34.9	0.06	1.21	—	1.21	1.08	—	1.08	—	6,521	6,521	0.26	0.05	—	6,544
Dust From Material Movement	—	—	—	—	—	—	3.11	3.11	—	1.24	1.24	—	—	—	—	—	—	—
Onsite truck	< 0.005	< 0.005	0.12	0.03	< 0.005	< 0.005	39.6	39.6	< 0.005	3.95	3.96	—	95.6	95.6	< 0.005	0.01	0.09	100
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Off-Road Equipment	0.21	0.21	5.35	6.37	0.01	0.22	—	0.22	0.20	—	0.20	—	1,080	1,080	0.04	0.01	—	1,083
Dust From Material Movement	—	—	—	—	—	—	0.57	0.57	—	0.23	0.23	—	—	—	—	—	—	—
Onsite truck	< 0.005	< 0.005	0.02	0.01	< 0.005	< 0.005	7.23	7.23	< 0.005	0.72	0.72	—	15.8	15.8	< 0.005	< 0.005	0.02	16.6
Offsite	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worker	0.01	0.01	0.01	0.14	0.00	0.00	0.03	0.03	0.00	0.01	0.01	—	29.7	29.7	< 0.005	< 0.005	0.10	30.1

Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	0.03	0.01	1.05	0.21	0.01	0.02	0.27	0.29	0.02	0.07	0.09	—	960	960	0.01	0.15	2.14	1,007
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worker	0.01	0.01	0.01	0.10	0.00	0.00	0.03	0.03	0.00	0.01	0.01	—	26.3	26.3	< 0.005	< 0.005	< 0.005	26.6
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	0.03	0.01	1.12	0.21	0.01	0.02	0.27	0.29	0.02	0.07	0.09	—	961	961	0.01	0.15	0.06	1,006
Average Daily	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worker	0.01	0.01	0.01	0.08	0.00	0.00	0.02	0.02	0.00	< 0.005	< 0.005	—	19.4	19.4	< 0.005	< 0.005	0.03	19.7
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	0.02	0.01	0.78	0.15	< 0.005	0.01	0.19	0.20	0.01	0.05	0.07	—	686	686	0.01	0.11	0.66	719
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worker	< 0.005	< 0.005	< 0.005	0.01	0.00	0.00	< 0.005	< 0.005	0.00	< 0.005	< 0.005	—	3.22	3.22	< 0.005	< 0.005	< 0.005	3.26
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	< 0.005	< 0.005	0.14	0.03	< 0.005	< 0.005	0.03	0.04	< 0.005	0.01	0.01	—	114	114	< 0.005	0.02	0.11	119

3.9. Linear, Grading & Excavation (2028) - Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Location	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Onsite	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Off-Road Equipment	1.59	1.59	41.1	48.9	0.08	1.69	—	1.69	1.51	—	1.51	—	9,131	9,131	0.37	0.07	—	9,162

Dust From Material Movement	—	—	—	—	—	—	4.35	4.35	—	1.74	1.74	—	—	—	—	—	—	—
Onsite truck	0.01	< 0.005	0.16	0.04	< 0.005	< 0.005	58.9	58.9	< 0.005	5.88	5.88	—	130	130	< 0.005	0.02	0.01	137
Average Daily	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Off-Road Equipment	0.19	0.19	4.82	5.74	0.01	0.20	—	0.20	0.18	—	0.18	—	1,072	1,072	0.04	0.01	—	1,076
Dust From Material Movement	—	—	—	—	—	—	0.51	0.51	—	0.20	0.20	—	—	—	—	—	—	—
Onsite truck	< 0.005	< 0.005	0.02	< 0.005	< 0.005	< 0.005	6.51	6.51	< 0.005	0.65	0.65	—	15.3	15.3	< 0.005	< 0.005	0.01	16.1
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Off-Road Equipment	0.03	0.03	0.88	1.05	< 0.005	0.04	—	0.04	0.03	—	0.03	—	178	178	0.01	< 0.005	—	178
Dust From Material Movement	—	—	—	—	—	—	0.09	0.09	—	0.04	0.04	—	—	—	—	—	—	—
Onsite truck	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	1.19	1.19	< 0.005	0.12	0.12	—	2.54	2.54	< 0.005	< 0.005	< 0.005	2.66
Offsite	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worker	0.01	0.01	0.01	0.09	0.00	0.00	0.03	0.03	0.00	0.01	0.01	—	25.8	25.8	< 0.005	< 0.005	< 0.005	26.1
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	0.03	0.01	1.09	0.21	0.01	0.02	0.27	0.29	0.02	0.07	0.09	—	936	936	0.01	0.15	0.05	981

Average Daily	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worker	< 0.005	< 0.005	< 0.005	0.01	0.00	0.00	< 0.005	< 0.005	0.00	< 0.005	< 0.005	—	3.13	3.13	< 0.005	< 0.005	< 0.005	3.18
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	< 0.005	< 0.005	0.12	0.02	< 0.005	< 0.005	0.03	0.03	< 0.005	0.01	0.01	—	110	110	< 0.005	0.02	0.10	115
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Worker	< 0.005	< 0.005	< 0.005	< 0.005	0.00	0.00	< 0.005	< 0.005	0.00	< 0.005	< 0.005	—	0.52	0.52	< 0.005	< 0.005	< 0.005	0.53
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	0.00	0.00	0.00	0.00
Hauling	< 0.005	< 0.005	0.02	< 0.005	< 0.005	< 0.005	0.01	0.01	< 0.005	< 0.005	< 0.005	—	18.2	18.2	< 0.005	< 0.005	0.02	19.1

4. Operations Emissions Details

4.1. Mobile Emissions by Land Use

4.1.1. Unmitigated

Mobile source emissions results are presented in Sections 2.6. No further detailed breakdown of emissions is available.

4.2. Energy

4.2.1. Electricity Emissions By Land Use - Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Land Use	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
City Park	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00	0.00	0.00	—	0.00
undefined	—	—	—	—	—	—	—	—	—	—	—	—	45,385	45,385	7.34	0.89	—	45,834
Total	—	—	—	—	—	—	—	—	—	—	—	—	45,385	45,385	7.34	0.89	—	45,834

Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
City Park	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00	0.00	0.00	—	0.00
undefined	—	—	—	—	—	—	—	—	—	—	—	—	45,385	45,385	7.34	0.89	—	45,834
Total	—	—	—	—	—	—	—	—	—	—	—	—	45,385	45,385	7.34	0.89	—	45,834
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
City Park	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00	0.00	0.00	—	0.00
undefined	—	—	—	—	—	—	—	—	—	—	—	—	3,109	3,109	0.50	0.06	—	3,139
Total	—	—	—	—	—	—	—	—	—	—	—	—	3,109	3,109	0.50	0.06	—	3,139

4.2.3. Natural Gas Emissions By Land Use - Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Land Use	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
City Park	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	—	0.00	—	0.00	0.00	0.00	0.00	—	0.00
Total	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	—	0.00	—	0.00	0.00	0.00	0.00	—	0.00
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
City Park	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	—	0.00	—	0.00	0.00	0.00	0.00	—	0.00
Total	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	—	0.00	—	0.00	0.00	0.00	0.00	—	0.00
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
City Park	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	—	0.00	—	0.00	0.00	0.00	0.00	—	0.00
Total	0.00	0.00	0.00	0.00	0.00	0.00	—	0.00	0.00	—	0.00	—	0.00	0.00	0.00	0.00	—	0.00

4.3. Area Emissions by Source

4.3.1. Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Source	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Consumer Products	—	< 0.005	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Architectural Coatings	—	0.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	< 0.005	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Consumer Products	—	< 0.005	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Architectural Coatings	—	0.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	< 0.005	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Consumer Products	—	< 0.005	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Architectural Coatings	—	0.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	< 0.005	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

4.4. Water Emissions by Land Use

4.4.1. Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Land Use	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

4.5. Waste Emissions by Land Use

4.5.1. Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Land Use	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
City Park	—	—	—	—	—	—	—	—	—	—	—	185	0.00	185	18.5	0.00	—	649
Total	—	—	—	—	—	—	—	—	—	—	—	185	0.00	185	18.5	0.00	—	649
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

City Park	—	—	—	—	—	—	—	—	—	—	—	185	0.00	185	18.5	0.00	—	649
Total	—	—	—	—	—	—	—	—	—	—	—	185	0.00	185	18.5	0.00	—	649
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
City Park	—	—	—	—	—	—	—	—	—	—	—	30.7	0.00	30.7	3.07	0.00	—	107
Total	—	—	—	—	—	—	—	—	—	—	—	30.7	0.00	30.7	3.07	0.00	—	107

4.6. Refrigerant Emissions by Land Use

4.6.1. Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Land Use	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

4.7. Offroad Emissions By Equipment Type

4.7.1. Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Equipment Type	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e

Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pumps	16.1	12.3	127	159	0.35	24.7	—	24.7	22.7	—	22.7	—	176,581	176,581	6.13	0.92	—	177,009
Total	16.1	12.3	127	159	0.35	24.7	—	24.7	22.7	—	22.7	—	176,581	176,581	6.13	0.92	—	177,009
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pumps	16.1	12.3	127	159	0.35	24.7	—	24.7	22.7	—	22.7	—	176,581	176,581	6.13	0.92	—	177,009
Total	16.1	12.3	127	159	0.35	24.7	—	24.7	22.7	—	22.7	—	176,581	176,581	6.13	0.92	—	177,009
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pumps	1.21	0.93	9.62	12.0	0.03	1.86	—	1.86	1.71	—	1.71	—	12,094	12,094	0.42	0.06	—	12,124
Total	1.21	0.93	9.62	12.0	0.03	1.86	—	1.86	1.71	—	1.71	—	12,094	12,094	0.42	0.06	—	12,124

4.8. Stationary Emissions By Equipment Type

4.8.1. Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Equipment Type	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

4.9. User Defined Emissions By Equipment Type

4.9.1. Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Equipment Type	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

4.10. Soil Carbon Accumulation By Vegetation Type

4.10.1. Soil Carbon Accumulation By Vegetation Type - Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Vegetation	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

4.10.2. Above and Belowground Carbon Accumulation by Land Use Type - Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Land Use	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

4.10.3. Avoided and Sequestered Emissions by Species - Unmitigated

Criteria Pollutants (lb/day for daily, ton/yr for annual) and GHGs (lb/day for daily, MT/yr for annual)

Species	TOG	ROG	NOx	CO	SO2	PM10E	PM10D	PM10T	PM2.5E	PM2.5D	PM2.5T	BCO2	NBCO2	CO2T	CH4	N2O	R	CO2e
Daily, Summer (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Avoided	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Subtotal	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sequestered	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Subtotal	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Remove	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Subtotal	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daily, Winter (Max)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Avoided	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Subtotal	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sequestered	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Subtotal	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Removed	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Subtotal	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Annual	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Avoided	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Subtotal	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sequestered	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Subtotal	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Removed	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Subtotal	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

5. Activity Data

5.1. Construction Schedule

Phase Name	Phase Type	Start Date	End Date	Days Per Week	Work Days per Phase	Phase Description
Linear, Grading & Excavation	Linear, Grading & Excavation	9/1/2024	2/29/2028	5.00	912	—

5.2. Off-Road Equipment

5.2.1. Unmitigated

Phase Name	Equipment Type	Fuel Type	Engine Tier	Number per Day	Hours Per Day	Horsepower	Load Factor
Linear, Grading & Excavation	Bore/Drill Rigs	Diesel	Tier 3	1.00	2.26	83.0	0.50
Linear, Grading & Excavation	Excavators	Diesel	Tier 3	2.00	7.39	36.0	0.38
Linear, Grading & Excavation	Graders	Diesel	Tier 3	3.00	5.79	148	0.41
Linear, Grading & Excavation	Off-Highway Trucks	Diesel	Tier 3	2.00	4.89	376	0.38
Linear, Grading & Excavation	Plate Compactors	Diesel	Tier 3	3.00	6.39	8.00	0.43
Linear, Grading & Excavation	Rubber Tired Dozers	Diesel	Tier 3	2.00	4.89	367	0.40
Linear, Grading & Excavation	Scrapers	Diesel	Tier 3	2.00	7.56	423	0.48
Linear, Grading & Excavation	Tractors/Loaders/Backhoes	Diesel	Tier 3	2.00	7.56	84.0	0.37

5.3. Construction Vehicles

5.3.1. Unmitigated

Phase Name	Trip Type	One-Way Trips per Day	Miles per Trip	Vehicle Mix
Linear, Grading & Excavation	—	—	—	—

Linear, Grading & Excavation	Worker	2.00	20.0	LDA,LDT1,LDT2
Linear, Grading & Excavation	Vendor	0.00	0.00	HHDT,MHDT
Linear, Grading & Excavation	Hauling	8.00	36.3	HHDT
Linear, Grading & Excavation	Onsite truck	2.00	20.0	HHDT

5.4. Vehicles

5.4.1. Construction Vehicle Control Strategies

Non-applicable. No control strategies activated by user.

5.5. Architectural Coatings

Phase Name	Residential Interior Area Coated (sq ft)	Residential Exterior Area Coated (sq ft)	Non-Residential Interior Area Coated (sq ft)	Non-Residential Exterior Area Coated (sq ft)	Parking Area Coated (sq ft)

5.6. Dust Mitigation

5.6.1. Construction Earthmoving Activities

Phase Name	Material Imported (Cubic Yards)	Material Exported (Cubic Yards)	Acres Graded (acres)	Material Demolished (sq. ft.)	Acres Paved (acres)
Linear, Grading & Excavation	0.00	0.00	1,580	0.00	—

5.6.2. Construction Earthmoving Control Strategies

Control Strategies Applied	Frequency (per day)	PM10 Reduction	PM2.5 Reduction
Water Exposed Area	2	61%	61%

5.7. Construction Paving

Land Use	Area Paved (acres)	% Asphalt
User Defined Linear	1,580	100%

City Park	0.00	0%

5.8. Construction Electricity Consumption and Emissions Factors

kWh per Year and Emission Factor (lb/MWh)

Year	kWh per Year	CO2	CH4	N2O
2024	0.00	204	0.03	< 0.005
2025	0.00	204	0.03	< 0.005
2026	0.00	204	0.03	< 0.005
2027	0.00	204	0.03	< 0.005
2028	0.00	204	0.03	< 0.005

5.9. Operational Mobile Sources

5.9.1. Unmitigated

Land Use Type	Trips/Weekday	Trips/Saturday	Trips/Sunday	Trips/Year	VMT/Weekday	VMT/Saturday	VMT/Sunday	VMT/Year
Total all Land Uses	2.00	0.00	0.00	521	20.0	0.00	0.00	5,214

5.10. Operational Area Sources

5.10.1. Hearths

5.10.1.1. Unmitigated

5.10.2. Architectural Coatings

Residential Interior Area Coated (sq ft)	Residential Exterior Area Coated (sq ft)	Non-Residential Interior Area Coated (sq ft)	Non-Residential Exterior Area Coated (sq ft)	Parking Area Coated (sq ft)
0	0.00	0.00	0.00	—

5.10.3. Landscape Equipment

Equipment Type	Fuel Type	Number Per Day	Hours per Day	Hours per Year	Horsepower	Load Factor

5.11. Operational Energy Consumption

5.11.1. Unmitigated

Electricity (kWh/yr) and CO2 and CH4 and N2O and Natural Gas (kBTU/yr)

Land Use	Electricity (kWh/yr)	CO2	CH4	N2O	Natural Gas (kBTU/yr)
City Park	0.00	204	0.0330	0.0040	0.00

5.12. Operational Water and Wastewater Consumption

5.12.1. Unmitigated

Land Use	Indoor Water (gal/year)	Outdoor Water (gal/year)

5.13. Operational Waste Generation

5.13.1. Unmitigated

Land Use	Waste (ton/year)	Cogeneration (kWh/year)
City Park	344	—

5.14. Operational Refrigeration and Air Conditioning Equipment

5.14.1. Unmitigated

Land Use Type	Equipment Type	Refrigerant	GWP	Quantity (kg)	Operations Leak Rate	Service Leak Rate	Times Serviced

5.15. Operational Off-Road Equipment

5.15.1. Unmitigated

Equipment Type	Fuel Type	Engine Tier	Number per Day	Hours Per Day	Horsepower	Load Factor
Pumps	Electric	Average	84.0	24.0	200	0.74
Pumps	Diesel	Average	18.0	24.0	195	0.74
Pumps	Gasoline	Average	12.0	24.0	145	0.74

5.16. Stationary Sources

5.16.1. Emergency Generators and Fire Pumps

Equipment Type	Fuel Type	Number per Day	Hours per Day	Hours per Year	Horsepower	Load Factor

5.16.2. Process Boilers

Equipment Type	Fuel Type	Number	Boiler Rating (MMBtu/hr)	Daily Heat Input (MMBtu/day)	Annual Heat Input (MMBtu/yr)

5.17. User Defined

Equipment Type	Fuel Type

5.18. Vegetation

5.18.1. Land Use Change

5.18.1.1. Unmitigated

Vegetation Land Use Type	Vegetation Soil Type	Initial Acres	Final Acres

5.18.1. Biomass Cover Type

5.18.1.1. Unmitigated

Biomass Cover Type	Initial Acres	Final Acres

5.18.2. Sequestration

5.18.2.1. Unmitigated

Tree Type	Number	Electricity Saved (kWh/year)	Natural Gas Saved (btu/year)

6. Climate Risk Detailed Report

6.1. Climate Risk Summary

Cal-Adapt midcentury 2040–2059 average projections for four hazards are reported below for your project location. These are under Representation Concentration Pathway (RCP) 8.5 which assumes GHG emissions will continue to rise strongly through 2050 and then plateau around 2100.

Climate Hazard	Result for Project Location	Unit
Temperature and Extreme Heat	29.7	annual days of extreme heat
Extreme Precipitation	0.15	annual days with precipitation above 20 mm
Sea Level Rise	—	meters of inundation depth
Wildfire	0.00	annual hectares burned

Temperature and Extreme Heat data are for grid cell in which your project are located. The projection is based on the 98th historical percentile of daily maximum/minimum temperatures from observed historical data (32 climate model ensemble from Cal-Adapt, 2040–2059 average under RCP 8.5). Each grid cell is 6 kilometers (km) by 6 km, or 3.7 miles (mi) by 3.7 mi.
Extreme Precipitation data are for the grid cell in which your project are located. The threshold of 20 mm is equivalent to about ¾ an inch of rain, which would be light to moderate rainfall if received over a full day or heavy rain if received over a period of 2 to 4 hours. Each grid cell is 6 kilometers (km) by 6 km, or 3.7 miles (mi) by 3.7 mi.
Sea Level Rise data are for the grid cell in which your project are located. The projections are from Radke et al. (2017), as reported in Cal-Adapt (Radke et al., 2017, CEC-500-2017-008), and consider inundation location and depth for the San Francisco Bay, the Sacramento-San Joaquin River Delta and California coast resulting different increments of sea level rise coupled with extreme storm events. Users may select from four scenarios to view the range in potential inundation depth for the grid cell. The four scenarios are: No rise, 0.5 meter, 1.0 meter, 1.41 meters
Wildfire data are for the grid cell in which your project are located. The projections are from UC Davis, as reported in Cal-Adapt (2040–2059 average under RCP 8.5), and consider historical data of climate, vegetation, population density, and large (> 400 ha) fire history. Users may select from four model simulations to view the range in potential wildfire probabilities for the grid cell. The four simulations make different assumptions about expected rainfall and temperature are: Warmer/drier (HadGEM2-ES), Cooler/wetter (CNRM-CM5), Average conditions (CanESM2), Range of different rainfall and temperature possibilities (MIROC5). Each grid cell is 6 kilometers (km) by 6 km, or 3.7 miles (mi) by 3.7 mi.

6.2. Initial Climate Risk Scores

Climate Hazard	Exposure Score	Sensitivity Score	Adaptive Capacity Score	Vulnerability Score
Temperature and Extreme Heat	3	0	0	N/A
Extreme Precipitation	N/A	N/A	N/A	N/A
Sea Level Rise	N/A	N/A	N/A	N/A
Wildfire	N/A	N/A	N/A	N/A
Flooding	0	0	0	N/A
Drought	0	0	0	N/A
Snowpack Reduction	N/A	N/A	N/A	N/A
Air Quality Degradation	0	0	0	N/A

The sensitivity score reflects the extent to which a project would be adversely affected by exposure to a climate hazard. Exposure is rated on a scale of 1 to 5, with a score of 5 representing the greatest exposure.
The adaptive capacity of a project refers to its ability to manage and reduce vulnerabilities from projected climate hazards. Adaptive capacity is rated on a scale of 1 to 5, with a score of 5 representing the greatest ability to adapt.
The overall vulnerability scores are calculated based on the potential impacts and adaptive capacity assessments for each hazard. Scores do not include implementation of climate risk reduction measures.

6.3. Adjusted Climate Risk Scores

Climate Hazard	Exposure Score	Sensitivity Score	Adaptive Capacity Score	Vulnerability Score
Temperature and Extreme Heat	3	1	1	3
Extreme Precipitation	N/A	N/A	N/A	N/A
Sea Level Rise	N/A	N/A	N/A	N/A
Wildfire	N/A	N/A	N/A	N/A
Flooding	1	1	1	2
Drought	1	1	1	2
Snowpack Reduction	N/A	N/A	N/A	N/A
Air Quality Degradation	1	1	1	2

The sensitivity score reflects the extent to which a project would be adversely affected by exposure to a climate hazard. Exposure is rated on a scale of 1 to 5, with a score of 5 representing the greatest exposure.

The adaptive capacity of a project refers to its ability to manage and reduce vulnerabilities from projected climate hazards. Adaptive capacity is rated on a scale of 1 to 5, with a score of 5 representing the greatest ability to adapt.
The overall vulnerability scores are calculated based on the potential impacts and adaptive capacity assessments for each hazard. Scores include implementation of climate risk reduction measures.

6.4. Climate Risk Reduction Measures

7. Health and Equity Details

7.1. CalEnviroScreen 4.0 Scores

The maximum CalEnviroScreen score is 100. A high score (i.e., greater than 50) reflects a higher pollution burden compared to other census tracts in the state.

Indicator	Result for Project Census Tract
Exposure Indicators	—
AQ-Ozone	71.8
AQ-PM	66.9
AQ-DPM	22.5
Drinking Water	100.0
Lead Risk Housing	70.8
Pesticides	94.9
Toxic Releases	49.7
Traffic	4.03
Effect Indicators	—
CleanUp Sites	0.00
Groundwater	94.3
Haz Waste Facilities/Generators	16.6
Impaired Water Bodies	58.7
Solid Waste	98.3
Sensitive Population	—
Asthma	68.8
Cardio-vascular	62.2

Low Birth Weights	13.7
Socioeconomic Factor Indicators	—
Education	90.7
Housing	12.0
Linguistic	71.9
Poverty	74.2
Unemployment	28.2

7.2. Healthy Places Index Scores

The maximum Health Places Index score is 100. A high score (i.e., greater than 50) reflects healthier community conditions compared to other census tracts in the state.

Indicator	Result for Project Census Tract
Economic	—
Above Poverty	17.22058257
Employed	7.4554087
Median HI	12.17759528
Education	—
Bachelor's or higher	13.1271654
High school enrollment	100
Preschool enrollment	44.69395611
Transportation	—
Auto Access	27.10124471
Active commuting	30.51456435
Social	—
2-parent households	82.56127294
Voting	32.46503272
Neighborhood	—
Alcohol availability	93.26318491

Park access	2.194276915
Retail density	1.552675478
Supermarket access	2.399589375
Tree canopy	2.566405749
Housing	—
Homeownership	32.88848967
Housing habitability	55.80649301
Low-inc homeowner severe housing cost burden	57.11535994
Low-inc renter severe housing cost burden	77.46695753
Uncrowded housing	28.08931092
Health Outcomes	—
Insured adults	14.70550494
Arthritis	0.0
Asthma ER Admissions	33.9
High Blood Pressure	0.0
Cancer (excluding skin)	0.0
Asthma	0.0
Coronary Heart Disease	0.0
Chronic Obstructive Pulmonary Disease	0.0
Diagnosed Diabetes	0.0
Life Expectancy at Birth	52.3
Cognitively Disabled	4.0
Physically Disabled	8.1
Heart Attack ER Admissions	18.2
Mental Health Not Good	0.0
Chronic Kidney Disease	0.0
Obesity	0.0

Pedestrian Injuries	70.5
Physical Health Not Good	0.0
Stroke	0.0
Health Risk Behaviors	—
Binge Drinking	0.0
Current Smoker	0.0
No Leisure Time for Physical Activity	0.0
Climate Change Exposures	—
Wildfire Risk	0.0
SLR Inundation Area	0.0
Children	43.1
Elderly	48.0
English Speaking	22.3
Foreign-born	51.2
Outdoor Workers	0.9
Climate Change Adaptive Capacity	—
Impervious Surface Cover	98.5
Traffic Density	3.1
Traffic Access	0.0
Other Indices	—
Hardship	82.3
Other Decision Support	—
2016 Voting	33.3

7.3. Overall Health & Equity Scores

Metric	Result for Project Census Tract
CalEnviroScreen 4.0 Score for Project Location (a)	72.0

Healthy Places Index Score for Project Location (b)	15.0
Project Located in a Designated Disadvantaged Community (Senate Bill 535)	Yes
Project Located in a Low-Income Community (Assembly Bill 1550)	Yes
Project Located in a Community Air Protection Program Community (Assembly Bill 617)	No

a: The maximum CalEnviroScreen score is 100. A high score (i.e., greater than 50) reflects a higher pollution burden compared to other census tracts in the state.
b: The maximum Health Places Index score is 100. A high score (i.e., greater than 50) reflects healthier community conditions compared to other census tracts in the state.

7.4. Health & Equity Measures

No Health & Equity Measures selected.

7.5. Evaluation Scorecard

Health & Equity Evaluation Scorecard not completed.

7.6. Health & Equity Custom Measures

No Health & Equity Custom Measures created.

8. User Changes to Default Data

Screen	Justification
Construction: Construction Phases	42 month for the duration of construction
Construction: Off-Road Equipment	Aligning with estimated equipment needed; changed the engine tier based on the equipment information
Construction: Trips and VMT	Based on the total travel estimated using total material delivery and capacity of trucks.
Construction: Dust From Material Movement	All soils excavation will be done with a balanced design, such that excavated soils equal needed fill.
Operations: Water and Waste Water	No water and wastewater treatment processes
Operations: Refrigerants	Remove default data for city parks
Land Use	Adjusting area data based on project information
Operations: Off-Road Equipment	Added pumps for operation of groundwater recharge basin. Although diesel and gasoline pumps were selected, the emission factors were modified in the next page to reflect the use of natural gas and propane pumps.
Operations: Off-Road Equipment EF	Modify emission factors to reflect the use of natural gas and propane (factors cannot be changed when CNG is selected as fuel in the previous page).

Appendix 5

MAGSA Aquaterra Groundwater Banking Project Reconnaissance Level Biological Survey Report, January 2022

MAGSA Aquaterra Groundwater Banking Project

Reconnaissance Level Biological Survey Report

January 2022

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CONTENTS

1.0 INTRODUCTION 1
1.1 Purpose of the Survey and Report 1
1.2 Project Location and Environmental Setting 1
1.3 Project Description 3
2.0 REGULATORY BACKGROUND 3
2.1 Federal 3
2.2 State of California 6
2.3 Fresno County 8
3.0 METHODS 3
3.1 Desktop Review 3
3.2 Field Survey 4
3.3 Occurrence Evaluation 5
4.0 RESULTS 8
4.1 Physical Conditions 8
4.2 Vegetation 9
4.3 Wildlife 10
4.4 Special Status Plants, Wildlife, and Natural Communities 10
4.5 Potentially Jurisdictional Wetlands, Other Waters, and Groundwater Dependent Ecosystems 12
5.0 POTENTIAL IMPACTS AND RECOMMENDATIONS 13
6.0 SUMMARY 15
7.0 REFERENCES 16

LIST OF APPENDICES

Appendix A. Special Status Plant and Wildlife Evaluation 17
Appendix B. Database Query Results 1
Appendix C. Survey Data Forms and Photographs 1

LIST OF TABLES

Table 4-1. Listed or Otherwise Special-status Wildlife Species Potentially Occurring in the Project Area 11

LIST OF FIGURES

Figure 1-1. McMullin Expansion Project Area and Vicinity 2

1.0 INTRODUCTION

1.1 PURPOSE OF THE SURVEY AND REPORT

A reconnaissance level biological survey (survey) was conducted November 9-11, 2021 by a Tetra Tech biologist within the boundary of the McMullin Area Groundwater Sustainability Agency (MAGSA). The objective of the survey was to capture sufficient information about the existing habitat conditions within the areas of the MAGSA boundary which may be affected by the proposed Aquaterra Groundwater Banking Project (Project). The biologist's observations inform the habitat evaluations to determine the likelihood of sensitive plant and animal species occurring within the Project area.

The purpose of this report is to document the biological resources identified through the literature review and survey, evaluate the potential for special status or sensitive species and habitats to occur and thus potentially be affected by Project implementation, and recommend mitigation measures for Project implementation. Due the Project's location coinciding with the ranges of several federal and state listed and special status plant and wildlife species, an evaluation is incorporated into this report of the potential for such species to occur based on the observed habitat conditions. This report will be used to support the Project's California Environmental Quality Act (CEQA) review evaluated against the CEQA thresholds for biological resources.

1.2 PROJECT LOCATION AND ENVIRONMENTAL SETTING

The large Project area includes all lands within the approximately 123,000-acre MAGSA boundary located in rural Fresno County, approximately 16 miles southwest of Fresno, California (Figure 1-1). The MAGSA boundary lies within the Kings River Basin of the San Joaquin Valley and in portions of the following U.S. Geological Survey (USGS) 7.5-by 7.5-minute quadrangles: Mendota Dam, Gravelly Ford, Tranquility, Jamesan, Kerman, Kearney Park, San Joaquin, Helm, Raisin, and Caruthers. Lands within the Project area are relatively flat to gently sloping and dominantly cropped lands with row crops, orchards, vineyards, and few poultry, dairy cattle, and agricultural processing and packing facilities of relatively low habitat value. Some lands are fallowed, disked, and/or generally vacant plots. Settlements with home sites and associated outbuildings and storage areas occur interspersed throughout the agricultural lands within the Project area. In addition, the County of Fresno operates a regional landfill on American Avenue that lies within the MAGSA boundary.

Just beyond and west of the Project area, the James Bypass borders a western portion of MAGSA boundary, the Mendota Wildlife Area (bisected by the Fresno Slough) is just to the west of the boundary, west-northwest of the James Bypass, and the Alkali Sink Ecological Reserve lies just northeast of the Mendota Wildlife Area. These natural areas, owned and managed by California Department of Fish and Wildlife (CDFW), provide floodplain, riparian, wetland including vernal pool, alkali sink scrub, and annual forb and grassland habitat (CDFW, 2021a). CDFW's Kerman Ecological Reserve occupies approximately 1,800 acres of principally annual grassland habitat and limited northern claypan vernal pool and alkali desert scrub habitats within the northern portion of the MAGSA boundary on two parcels north and south of State Route (SR) 180 (Figure 1). The San Joaquin River and associated grassland and valley foothill riparian habitats adjacent to cropped lands lie along the northern MAGSA boundary.

The Project area climate is characterized by semi-arid (Mediterranean) conditions typical of the central California San Joaquin Valley, including hot, dry summers and cool, moist winters. Average daily mean air temperature is 65.0 degrees Fahrenheit and average annual precipitation is 11.0 inches based on recorded data at Fresno Yosemite International Airport for the 1991-2020 averaging period (AgACIS 2021).

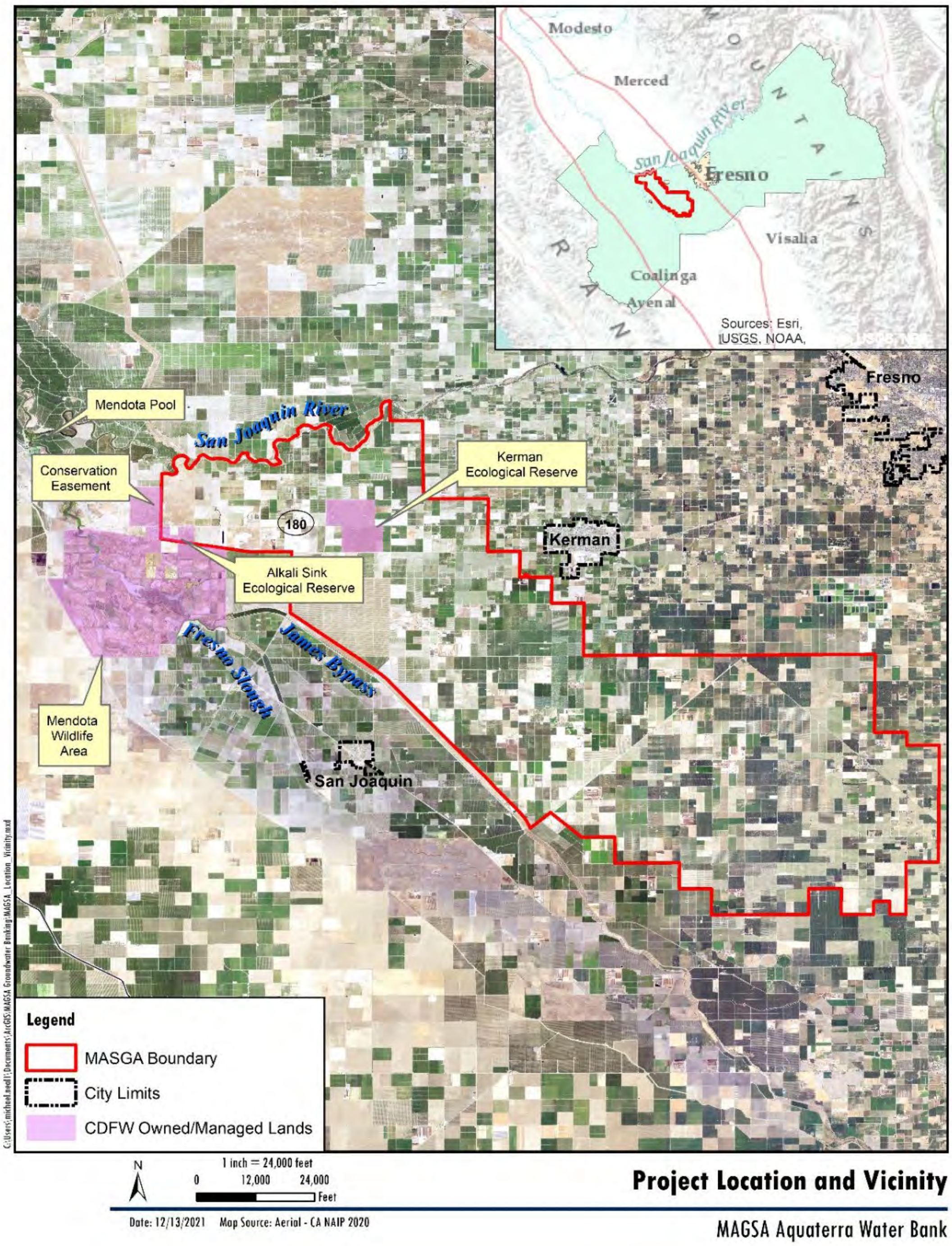

Figure 1. MAGSA Boundary Project Area and Vicinity

1.3 PROJECT DESCRIPTION

The McMullin Area Groundwater Sustainability Agency (MAGSA) is proposing to develop and operate the Aquaterra Groundwater Bank Project (Project) within its jurisdictional boundaries, located approximately 20 miles southwest of Fresno (Figure 1). The Project will establish the 800k AF-capacity Bank underlying the MAGSA area, which is adjacent to, and will accept water from, the Fresno Slough and the Mendota Pool (Figure 1-4, Figure 1-5). The Project will be designed to divert and recharge up to 208,000 acre-feet per year (AFY) of contract water into the Bank over a 5-month period, and subsequently recover up to 148,000 AFY of contract water from the Bank over a 5-month period for use by SWP and CVP contractors (MAGSA 2022).

The Project is intended to meet two primary objectives:

1. Establish the Aquaterra Water Bank (Bank) for use by local, regional, and statewide entities to improve their use of available surface water supplies; and,
2. Help MAGSA in achieving sustainable groundwater management for local water and agricultural sustainability, in compliance with SGMA.

2.0 REGULATORY BACKGROUND

Development of vast, intensively managed agriculture has transformed the natural vegetation communities and associated wildlife habitats of the southern San Joaquin Valley. Most native plant communities and sensitive habitats, such as isolated or riverine wetlands, once present in the Project area have been converted to mostly agricultural uses mentioned above or otherwise impacted from road construction and flood control and dam construction projects.

The regulatory framework is used in determining whether a project will have a significant impact on species or other biological resources. Applicable federal, state, and local regulations that govern biological resources within the Project area are summarized below. Even when species are not afforded formal legal protection through Federal and/or California Endangered Species Acts or other protective acts listed below, they may still warrant an evaluation and potentially mitigation measures under CEQA.

3.0 METHODS

3.1 DESKTOP REVIEW

Prior to the Tetra Tech biologist conducting an on-the-ground reconnaissance survey, a desktop review of available data pertinent to the proposed project area and vicinity was completed. These data were reviewed to assess the potential for special status species to occur within the Project area specifically, based on the regional setting, known land uses in the Project area and vicinity, and the species' habitats and/or life histories. Informational sources included:

- USFWS Information for Planning and Consultation (IPaC) for the Project area boundary and immediate vicinity to obtain a list of federal ESA-listed species, species of concern, and the presence of critical habitats (USFWS, 2021; Appendix B)

- CDFW Lands Viewer (CDFW, 2021a)
- California Natural Diversity Database (CNDDB) query of biological records for the following USGS 7.5-minute topographic quadrangles (quads) within the Project area: Mendota Dam, Gravelly Ford, Tranquility, Jamesan, Kerman, Kearney Park, San Joaquin, Helm, Raisin, and Caruthers. (CDFW, 2021b; Appendix B)
- California Native Plant Society (CNPS) Electronic Inventory for further ecological and distributional information on plant species of concern which *may potentially occur* within the Project area based on CNDDB query results (CNPS, 2021)
- USFWS National Wetlands Inventory (NWI) to identify *potential* areas with wetlands and/or other waters (USFWS, 1987; Figure 2, Appendix B)
- California Department of Water Resources (DWR) Natural Communities Commonly Associated with Groundwater dataset (Natural Communities dataset) for vegetation and wetland types commonly associated with the expression of groundwater *under natural, unmodified conditions* (Klausmeyer et al, 2018)
- NRCS Web Soil Survey for general characteristics of soils and areas with mapped soils containing hydric soil components (Soil Survey Staff, 2021)

Listings in the CNDDB are records of species detections submitted voluntarily, and if a species occurrence is not listed in the CNDDB, then it does not mean the species is not present where there is suitable habitat for a particular species. When suitable habitat for a species is known to occur within an area impacted by a Project action, it's necessary for a qualified biologist to survey areas impacted by the Project at times appropriate to determine whether or not a species are present.

A query of the NWI and Wetlands Mapper, which produces *reconnaissance level information* for the location, type, and size of potential wetlands and deepwater habitats based on vegetation, visible hydrology, and geography, depicts areas of riverine wetland, freshwater forested/shrub wetland, freshwater emergent wetland, and freshwater pond wetland within the proposed Project area (Appendix B). Imagery used for the photo interpretation analysis in the project area (and most of Fresno County, CA) is from the 1980s (USFWS 1987). Thus, field verification is necessary to verify or rule out actual wetland conditions.

California DWR's Natural Communities dataset does not represent the agency's determination of a groundwater dependent ecosystem (GDE) but is intended for use by GSAs or others as an aid in identifying GDEs in California and includes two habitat classes associated with groundwater: (1) wetland features commonly associated with the surface expression of groundwater under natural, unmodified conditions; and (2) vegetation types commonly associated with the sub-surface presence of groundwater. The wetland features identified in this dataset most often align with a subset of the NWI dataset, and the vegetation features include large trees such as sequoia (*Sequoia sempervirens*), Douglas-fir (*Pseudotsuga menziesii*), and Goodding's black willow (*Salix gooddingii*), and vegetation communities, such as riparian mixed hardwoods, willows, alkaline mixed grasses, and wet meadows. The dataset is limited, and a thorough understanding of geology, groundwater elevations, hydrology, and land use of a certain area is necessary for positive identification of groundwater dependent ecosystems (Klausmeyer et al., 2018).

3.2 FIELD SURVEY

The biologist conducted the survey during the daylight hours (generally between 8 a.m. and 5 p.m.)

over approximately two days between November 9th and 11th, 2021. The survey consisted of driving a vehicle along accessible paved and dirt roadways throughout the Project area and stopping at points of interest gleaned from the desktop review such as locations of proposed project elements like pump stations and road crossings; potential areas of wetland or groundwater dependent habitats and associated vegetation; and locations and points where representative biological features, suitable habitat for sensitive species, or evidence of wildlife use were observed from the vehicle. Since the survey was reconnaissance level, no wetland investigations or delineations were performed.

At each observation point (data points 1-35), a biologist recorded a GPS location using an EOS Arrow 100 GNSS receiver connected to an iPad running ESRI Collector software to record the observation locations to submeter accuracy (Figures 3 and 4, Appendix B). Next, the biologist walked the roadway and/or right-of-way within approximately 100 feet of the recorded location investigating the site noting the dominant vegetation type(s) or potential nesting trees, habitat conditions, wildlife or wildlife burrows, nests, tracks, or other evidence of wildlife presence observed, and surface water or potential wetland conditions. This information was recorded in an electronic field data form. Since most of the Project area is used and managed for agricultural purposes, interiors of fields and orchards away from the roads were observed to the extent possible from accessible rights-of-way. Binoculars were used to view areas or wildlife of interest distant from the observation locations, and one or more photographs were taken at each data point to document the observed conditions (Appendix C – Survey Data Forms with Photographs). No CDFW lands were accessed, but the Mendota Wildlife Area and Kerman Ecological Reserve were observed and photographed from a few points approximately near their boundaries.

3.3 OCCURRENCE EVALUATION

Special status plant and wildlife species were evaluated based on known regional site characteristics and field observations to assess their potential to occur or for habitats meeting their life history requirements to occur within the Project area (Appendix A). Observed site conditions combined with the habitat requirements and known ranges of these species were evaluated to determine potential for occurrence of these species within the Project area boundaries.

3.4 FEDERAL

Endangered Species Act

The U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) have jurisdiction over species listed as threatened or endangered under the federal Endangered Species Act (ESA) of 1973, as amended, and candidate species proposed for listing. The ESA protects listed species from harm, or "take," which is broadly defined as "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct." For any project with a federal nexus (funding, permitting, or other approvals) that affects a listed species, the federal agency must consult with the USFWS and/or NMFS Fisheries under Section 7 of the ESA. Under the ESA, critical habitat may be formally designated by the USFWS or NMFS for survival and recovery of listed species. Critical habitat designations are specific areas within a geographic region that are occupied by a species and determined to be critical to its survival in accordance with the ESA.

Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA) prohibits the destruction of nests, eggs, and/or young of all designated migratory bird species. With very limited exceptions, including non-native, human-introduced birds, all birds are included in this prohibition (85 FR 21262). This prohibition includes both direct and indirect acts, although harassment and habitat modification are not included unless they result in direct loss of birds, nests, or eggs. Permits for take of non-game migratory birds can be issued only for specific activities, such as scientific collecting, rehabilitation, propagation, education, taxidermy, and protection of human health, safety, and personal property.

Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act (16 USC 668-668c) prohibits anyone, without a permit issued by the Secretary of the Interior, from "taking" bald or golden eagles, including their parts, nests, or eggs. The Act provides criminal penalties for persons who "take, possess, sell, purchase, barter, offer to sell, purchase or barter, transport, export or import, at any time or any manner, any bald eagle ... [or any golden eagle], alive or dead, or any part, nest, or egg thereof." The act defines "take" as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb."

Clean Water Act

The Clean Water Act (CWA) sections 404 and 401 have provisions for protecting biological resources within the aquatic environment through identification of beneficial uses and prohibitions on fill of wetlands or other Waters of the U.S. The primary functions of the CWA in protecting biological resources, in this instance, are to ensure that any impacts to wetlands or other waters are compensated for and to provide a framework for ensuring that water quality is maintained or improved.

3.5 STATE OF CALIFORNIA

California Environmental Quality Act

CEQA Guidelines §15380 define special status plant and animal species as those species that are:

- Listed as endangered, threatened, or candidate species under the federal ESA
- Listed as endangered, threatened, or candidate species under the California Endangered Species Act (CESA)
- Listed by the California Department of Fish and Wildlife or the Department of Forestry as a species of special concern
- Listed (List 1 or 2) plant species on the California Native Plant Society's (CNPS) List 1 or 2
- Otherwise considered rare, threatened, or endangered under CEQA guidelines when the species' survival is in jeopardy due to loss or change in habitat.

In addition, plant and animal species protected by other specific federal and/or California state statutes are considered special status species.

California Endangered Species Act

Pursuant to the California Endangered Species Act (CESA), a permit from California Department of Fish and Wildlife (CDFW) is required for projects that could result in the "take" of a plant or animal species that is State-listed as threatened or endangered. Under CESA, "take" is defined as an activity that would directly or indirectly kill an individual of a species. The CESA definition of take does not include "harming" or "harassing," as the Federal ESA definition does. Therefore, the threshold for take is higher under CESA than under ESA. A State or local public agency reviewing a proposed project within its jurisdiction must determine whether any State-listed endangered or threatened species may be present in the program area and determine whether the project would have a potentially significant impact on such species. In addition, CDFW encourages informal consultation on any proposed project that could affect a candidate species. For the potential taking of individual animals listed under CESA Fish and Game Code Sections 2080.1 and 2081 provide for issuance of an incidental take permit. CDFW will issue an incidental take permit only if: (1) the authorized take is incidental to an otherwise lawful activity; (2) the impacts of the authorized take are minimized and fully mitigated; and (3) adequate funding is provided to implement the minimization and mitigation measures.

California Fish and Game Code

Several sections of the California Fish and Game Code (CFGC) are applicable to determination of the biological resource impacts that may be associated with the Project.

Section 1580. This section declares it is the policy of the state to protect threatened or endangered native plants; wildlife; aquatic organisms or specialized habitat types; both terrestrial and non-marine aquatic, or large, heterogeneous natural gene pools for the future use of mankind through the establishment of ecological reserves.

Sections 1600-1616. Under Sections 1600-1616, CDFW regulates all diversions, obstructions, or changes to the natural flow or bed, channel, or bank of any river, stream, or lake, which support fish or wildlife (i.e., bed to bank). The CDFW defines a “stream” (including creeks and rivers) as “a body of water that flows at least periodically or intermittently through a bed or channel having banks and supports fish or other aquatic life. This includes watercourses having surface or subsurface flow that supports or has supported riparian vegetation.” The CDFW has interpreted the term “streambed” to encompass all portions of the bed, banks, and channel of any stream, including intermittent and ephemeral streams, extending laterally to the upland edge of riparian vegetation. Construction and maintenance actions that may affect the streambed would be subject to creation of a Streambed Alteration Agreement under Section 1602. This agreement would include measures to protect fish, wildlife, and vegetation that may be affected during construction in the streambed.

Section 1900, et seq. The purpose of this chapter, known as the *California Native Plant Protection Act of 1977*, is to preserve, protect, and enhance endangered or rare native plants of California. Many species and subspecies of native plants are endangered because their habitats are threatened with destruction, drastic modification, or severe curtailment. Commercial exploitation, disease, and other factors also represent threats to species and subspecies of native plants. This portion of the code designates rare, threatened, and endangered plant taxa of California.

Sections 3503 and 3503.5*.* Section 3503 of the CFGC states that it is unlawful to take, possess, or needlessly destroy the nest or eggs of any bird. Section 3503.5 specifically states that it is unlawful to take, possess, or destroy any raptors (i.e., species in the orders falconiformes and strigiformes), including their nests or eggs. Typical violations of these codes include destruction of active nests resulting from removal of vegetation in which the nests are located. Violation of Section 3503.5 could also include failure of active raptor nests resulting from disturbance of nesting pairs by nearby project construction. This statute does not provide for the issuance of any type of incidental take permit.

Section 3513. This section prohibits taking, possessing, or needlessly destroying the nest or eggs or any bird. Birds of prey are included in Section 3503.5.

Sections 3511, 4700, 5050, and 5515. These statutes prohibit take or possession of fully protected species and do not provide for authorization of incidental take of fully protected species.

Porter-Cologne Water Quality Control Act

Under the Porter-Cologne Water Quality Control Act, all waters of the U.S. that are within the borders of California are also waters of the state. The State Water Resources Control Board delegates authority to the Regional Water Quality Control Board (RWQCB), which take Section 401 water quality certification actions for activities subject to any permit issued by the USACE pursuant to Section 404 of the CWA. Under Section 401 of the CWA and the Porter-Cologne Water Quality Act, the RWQCB exercises jurisdiction over discharges that may affect jurisdictional wetlands and those non-isolated waters associated with Traditional Navigable Waters.

3.6 FRESNO COUNTY

Fresno County General Plan

The following elements of the Fresno County General Plan apply to biological resources within the Project area (Fresno County, 2000).

- The Open Space and Conservation Element addresses preservation and protection of natural resources, open spaces preservation, commodity resources production management, cultural resources protection and enhancement, and availability of recreational opportunities
- In addition to describing land use designations, the Agriculture and Land Use Element establishes the goals, policies, and implementation procedures for Resource Lands, including Agriculture and River Influence areas. Policies are aimed at avoiding adverse impacts from development and encouraging environmentally acceptable agricultural activities

4.0 RESULTS

4.1 PHYSICAL CONDITIONS

The Project area is relatively level, situated in the San Joaquin Valley between the San Joaquin River to the north, the Kings River on the south, and the Fresno Slough and James Bypass on the west. Since agriculture assumed the primary land use, natural depressions in the area's land, which were once present and supported seasonal wetlands, have been mostly removed through grading and disking to support agricultural uses. Tile drains and ditches have been used to manipulate area hydrology to suit the desired agricultural uses as necessary. Irrigation water supply and drain conveyances as well as lift pump stations used for transferring irrigation water into irrigation distribution systems are abundant throughout these agricultural lands.

Roads driven throughout the project area were paved, dirt, and gravel surfaces. The Project area consists of actively managed orchards, vineyards, row crops, scattered poultry and dairy product agricultural uses, and a few agricultural product processing facilities (tree nut hulling, raisin, and citrus processors/packers). Additionally, some lands are fallowed, disked, and/or being prepared for new agriculture production. Crops observed included primarily tree nuts, including mostly almonds, pistachios, and walnuts; grapes; and alfalfa. Most of the observed agriculture appeared to be either flood or drip irrigated.

Dozens of soil series are mapped within the large overall Project area and consist of loamy sand, sandy loam, clay loam, silt loam, and loam textures (Soil Survey Staff 2021). Animal burrows and burrow tailings observed were consistently sandy, sandy loam, and loam soil textures. The majority of mapped soils or inclusions within the project area are non-hydric, or soils that under natural conditions are not saturated or inundated long enough during the growing season to support growth and reproduction of hydrophytic vegetation. Areas with soils containing hydric components would not likely exhibit characteristics of hydric soils due to the conversion of most of those areas to intensively managed agricultural uses. Elevations within the project area generally range from approximately 160 feet above sea level in west-northwest Project area increasing up to approximately 235 feet above sea level towards the eastern side of the Project area. Some western and northern portions of the Project area adjacent to the James Bypass and San Joaquin River are within Federal Emergency Management Agency (FEMA) Special Flood Hazard Areas subject to inundation by the one percent annual chance flood, but the majority of the project area is not in the regulatory floodplain (FEMA, 2021).

Precipitation for the month prior to the survey (October) was above normal (1.27 inches recorded at Fresno Yosemite International Airport), and 0.26-inch of rainfall occurred on the morning of November 9th. Some dirt roads were ponded and muddy during the survey. Most of the native or ruderal annual and deciduous vegetation was senesced, but cool-season perennial grasses remained where established.

4.2 VEGETATION

The following generalized vegetation communities were observed during the reconnaissance survey:

- Flood or drip irrigated deciduous orchard (pistachio, almond, walnut, and cherry)
- Flood or drip irrigated row and field crops (seasonally mostly alfalfa)
- Barren or fallow land
- Ruderal grassland
- Native-dominant annual and perennial grassland
- Riparian woody plant – willow dominant
- Emergent wetland – hardstem bulrush (*Schoenoplectus acutus*)

Annual/biennial broadleaf ruderal weed species, where they occurred, were dominant along the roadsides adjacent to and between crop/orchard/vineyard rows. Few species were observed including hairy fleabane (*Conyza = Erigeron bonariensis*), tumble pigweed (*Amaranthus albus*), Russian thistle (*Salsola kali*), and jimson weed (*Datura stramonium*). Narrow-leaf milkweed (*Asclepias fascicularis* - native) and goldenrod (*Solidago* spp.) were observed adjacent to or within the riparian zone in the James Bypass area.

Though less abundant than the broadleaf weeds listed above, ruderal annual and perennial grasses also occur and were observed at some roadside areas adjacent to and between crop/orchard/vineyard rows and in and adjacent to the James Bypass. Recognizable species included bermudagrass (*Cynodon dactylon*), Johnsongrass (*Sorghum halepense*), crabgrass (*Digitaria* spp.), and ryegrass (*Lolium* spp). In general, the roadsides were maintained to be mostly free of vegetation.

The only shrub species observed other than ornamental species planted or established in settlement areas was narrowleaf willow (*Salix exigua*) which were located in a willow scrub gallery established adjacent to an impoundment in the northeastern portion of the Project area (Figure 3, Appendix B; Data Point 10, Appendix C). Tree species, other than orchard trees, were scattered and few throughout the project area and mostly concentrated where settlements were established. Most were smaller ornamental trees adapted to the dry valley climate and planted for landscapes or windbreaks on private property. A few larger, mature deciduous and evergreen trees such as eucalyptus were also observed in settlement areas. Goodding's black willow were observed as single scattered trees adjacent to ditches within the Project area and as many established riparian trees west beyond the Project area near the Mendota Wildlife Area and James Bypass (Figure 3, Appendix B; Data Point 2, Appendix C). Emergent habitat composed of hardstem bullrush was well established around the shallow fringe areas of an impounded drainage north of SR 180 (Figure 3, Appendix B; Data Point 34, Appendix C).

4.3 WILDLIFE

Few wildlife, mostly avian species, were observed during the survey. Within the Project area, observations included red-tailed hawk (*Buteo jamaicensis*), red-winged blackbird (*Agelaius phoeniceus*), American crow (*Corvus brachyrhynchos*), American robin (*Turdus migratorius*), mourning dove (*Zenaida macroura*), western scrub jay (*Aphelocoma californica*), killdeer (*Charadrius vociferus*), barn owl (*Tyto alba*), great egret (*Ardea alba*), great blue heron (*Ardea herodias*), American coot (*Fulica americana),* and coyote (*Canis latrans*).

Other wildlife species typical of the southern San Joaquin Valley and tolerant of agricultural areas with frequent disturbances would occur throughout the Project area at different times of the year. Such a low diversity of wildlife species likely using the Project area is due to the large-scale conversion to agriculture, development, and continual human presence in an area that once supported native riparian habitats, marshes, seasonal wetlands, and perennial grasslands. Row crops, orchards, and vineyards are intensively managed and frequently disturbed, and available habitats are highly fragmented and therefore of limited value. Agricultural fields that are fallowed and rights-of-way within the Project area may serve as wildlife corridors for some adaptable species but are sparse and highly fragmented. Functioning wildlife corridors are primarily beyond the Project area in the James Bypass, San Joaquin River corridor and the CDFW reserves and easements to the west.

4.4 SPECIAL STATUS PLANTS, WILDLIFE, AND NATURAL COMMUNITIES

Based on the desktop literature review of the USFWS information and CNDDB database queries for the 10 USGS 7.5-minute topographic quads for the Project area, 16 listed or otherwise special status plant and 32 listed or otherwise special status wildlife species have potential to occur (CDFW, 2021b; USFWS, 2021) (Appendix B). Federally designated critical habitat for the Fresno kangaroo rat is present within the CDFW Alkali Sink Ecological Reserve which overlaps with the Project area.

Four special status or sensitive natural communities, or communities which are considered rare within the region and may provide habitat conditions for special status wildlife species, were identified as potentially occurring in the CNDDB query within the Project area's quads. These sensitive natural communities are northern claypan vernal pool, valley sacaton grassland, coastal and valley freshwater marsh, and valley sink scrub. No special status natural communities having potential to support special status wildlife species were observed within the Project area outside of the CDFW reserves during the survey.

The initial evaluation of special-status plant and wildlife species reported to the CNDDB with a potential to occur are included in Appendix A. Two plant species evaluated for the Project area and vicinity have federal ESA and/or state ESA listing status (Appendix A). These species would not be expected to occur, have not been recorded as occurring within the Project area, and no suitable habitat for these species occurs within the Project area outside of the CDFW reserves. No listed or otherwise special status plant species were observed within the Project area during the survey. Though some special status plant species have historically been recorded as occurring within the Project area and vicinity, no further discussion on these species is provided beyond the initial evaluation presented in Appendix A because the Project area does not provide suitable habitats outside of the CDFW lands for these plant species and their occurrence is not expected due to the large-scale conversion of the area's natural habitats to agricultural uses and development.

Sixteen of the wildlife species evaluated for the Project area and vicinity have federal ESA or state ESA listing or candidate status. Of these, eight have the potential to be impacted by the proposed Project due to presence of potential habitat for these species (Table 4-1, Appendix A). In addition, six special-status species have the potential to be impacted by the proposed Project due to presence of potential habitat for these species (Table 4-1, Appendix A). In the species occurrence evaluation, Appendix A, these species' evaluation is listed as "possible". No listed or otherwise special status wildlife species were observed within the Project area during the survey.

Table 4-1. Listed or Otherwise Special-status Wildlife Species Potentially Occurring in the Project Area

Scientific Name	Common Name	[1]Status Fed/State
Invertebrates		
Linderiella occidentalis	California linderiella	-/-
Amphibians		
Ambystoma californiense	California tiger salamander	T/T
Rana draytonii	California red-legged frog	T/SSC
Reptiles		
Emys marmorata	Western pond turtle	-/SSC
Thamnophis gigas	Giant garter snake	T/T
Birds		
Agelaius tricolor	Tricolored blackbird	-/T, SSC
Athene cunicularia	Burrowing owl	-/SSC
Buteo swainsoni	Swainson's hawk	-/T
Charadrius montanus	Mountain plover	-/SSC
Plegadis chihi	White-faced ibis	-/-
Riparia riparia	Bank swallow	-/T
Mammals		
Dipodomys nitratoides exilis	Fresno kangaroo rat	E/E
Taxidea taxus	American badger	-/SSC
Vulpes macrotis mutica	San Joaquin kit fox	E/T

Scientific Name	Common Name	[1]Status Fed/State
[1]Status: Federal and State Listing Codes: E = Federal or State-listed Endangered T = Federal or State-listed Threatened SSC = California Department of Fish and Wildlife Designated Species of Special Concern - = No Listing Status		

4.5 POTENTIALLY JURISDICTIONAL WETLANDS, OTHER WATERS, AND GROUNDWATER DEPENDENT ECOSYSTEMS

Though recent aerial photography (California NAIP, 2020) reviewed for the Project area depicts mostly active agricultural uses outside of the CDFW lands, areas with wetland polygons mapped in the NWI were checked during the survey to observe the conditions in areas currently depicted as row and field crops, orchards, vineyards, or another agricultural use.

Three areas with wetland conditions were observed during the survey. The first area was the upper end of the James Bypass near its connection with the Fresno Slough (Figure 3, Appendix B; Data Point 2, Appendix C). This area consisted of open water, emergent, and palustrine scrub-shrub and forested riparian habitats. Much of this area and the Fresno Slough would satisfy the current (proposed "pre-2015 regulatory regime") definition for Waters of the United States (WOTUS). Other areas in the James Bypass may seasonally support conditions conducive to wetland development. The other two were associated with impoundments adjacent to agriculture with open water, emergent, and palustrine scrub-shrub habitats (Figure 3, Appendix B; Data points 10 and 34, Appendix C). These impoundments and any adjacent wetlands would be assessed as federally jurisdictional features on a case-by-case basis under the discretionary authority of the agencies.

In addition, areas with the potential to support wetland conditions and where wetlands may develop were observed during the survey. Excavated agricultural ditches, other than those lined with concrete, have the potential to develop conditions meeting the definition of a wetland if left unmaintained for vegetation to establish and supplied hydrology with the frequency and duration necessary to support wetland conditions and develop hydric soil indicators. Agricultural irrigation canals in the Project area likely having a relatively permanent surface water connection to CWA Traditional Navigable Waters were observed in the main, concrete-lined irrigation conveyances. Other ditches were isolated, meaning they had no surface connection to the aforementioned conveyances, and likely served as tailwater collection systems for crop irrigation systems, distribution ditches, or another agricultural drainage use. Isolated ditches were, for the most part, not lined with concrete. Many were dry and contained some to large amounts of debris and trash. Some had visible evidence of hydrology (pockets of standing water or filled with water throughout), and others were saturated or dry at the soil surface. Very little actively growing vegetation was observed in the isolated agricultural ditches, but these areas may support hydrophytic vegetation if left unmaintained. Irrigation canals are represented in the NWI as riverine, unknown perennial, unconsolidated bottom, semi-permanently flooded, excavated (R5UBFx) features (USFWS 1987).

Few agricultural facilities located within the Project area contained one or more excavated ponds, some with water and some without, that are presumably used for agricultural wastewater or process water treatment purposes. Little to no vegetation occurred on the pond banks. These ponds were mostly represented in the NWI as palustrine, unconsolidated shore, seasonally flooded, excavated (PUSCx) features (USFWS 1987).

A few vegetation communities which are likely indicative of potential GDEs, such as the Goodding's black willow found in the vicinity of the upper James Bypass and the narrowleaf willow gallery adjacent to the agricultural impoundment as discussed above, were observed within the Project area. Very few large trees were observed throughout the Project area. Some portions or all of the CDFW lands in and adjacent to the Project area would qualify as GDEs.

5.0 POTENTIAL IMPACTS AND RECOMMENDATIONS

This section provides an analysis of the potential impacts by applying CEQA significance criteria (CEQA Guidelines, Appendix G). These are the thresholds which trigger a determination of impact significance. Impact assessment takes into consideration construction and operational impacts.

The Project would create a significant impact to biological resources, based on the specifications in the biological resources section in Appendix G of the CEQA Guidelines, if the following were to occur:

1) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the CDFW or the USFWS

2) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, and regulations; or by the CDFW or the USFWS

3) Have a substantial adverse effect on state or federally protected wetlands (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means

4) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites

5) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance

6) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan

The following discusses potential impacts associated with implementation and operation of the Project:

1) Would the Project have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the CDFW or the USFWS?

The Project area offers potential habitat for special status species including the California linderiella, California tiger salamander, California red-legged frog, western pond turtle, giant garter snake, tricolored blackbird, burrowing owl, Swainson's hawk, mountain plover, white-faced ibis, bank swallow, Fresno kangaroo rat, American badger, and San Joaquin kit fox.

The Project has the potential to disturb nesting birds. Therefore, these species may potentially be impacted by the Project.

Mitigation: Preventative avoidance measures are recommended for California tiger salamander, California red-legged frog, western pond turtle, giant garter snake, burrowing owl, Swainson's hawk, San Joaquin kit fox, Fresno kangaroo rat and nesting birds and their nests to avoid potential impacts, including *incidental take* of a threatened, endangered, or otherwise protected species.

2) **Would the Project have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, and regulations; or by the CDFW or the USFWS?**

No riparian habitat or other sensitive natural communities occur within the Project area outside of CDFW reserves. No riparian habitat or other sensitive natural community identified in local or regional plans, policies, or regulations; or by the CDFW or the USFWS will be disturbed by the proposed Project. No impact is anticipated.

Mitigation: No mitigation measures should be recommended.

3) **Would the Project have a substantial adverse effect on state or federally protected wetlands (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?**

Minor impacts to other waters and potentially fringing wetland are anticipated from implementation of the proposed project. The majority of areas identified by the USFWS NWI as palustrine and riverine wetlands throughout the Project area were verified during the survey to be occupied with the agricultural uses identified in this report. This confirms that many of the palustrine wetland features identified in the NWI are relic features possibly present prior to agricultural uses, and the riverine features are associated with isolated agricultural ditches that are maintained to be mostly free of vegetation.

Mitigation: To protect and preserve waters of the U.S., and to meet CDFW, RWQCB, and USACE requirements, preventative measures are recommended to avoid and minimize potential impacts

4) **Would the Project interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?**

Wildlife corridors for terrestrial species are usually habitats such as riparian areas and vegetative buffers, washes, canyons, and other generally undisturbed habitats that differ from the surrounding areas and which wildlife species use to move between their suitable habitats. Though several areas likely functioning as wildlife corridors occur within and immediately adjacent to the Project area, no impacts are anticipated to these habitats from the proposed Project.

Mitigation: No mitigation measures should be recommended.

5) **Would the Project conflict with any local policies or ordinances protecting biological**

resources, such as a tree preservation policy or ordinance?

The Project is known not to conflict with any local policies or ordinances protecting biological resources. No impact is anticipated.

Mitigation: No mitigation measures should be recommended.

6) **Would the Project conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?**

The Project is known not to conflict with any Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan. No impact is anticipated.

Mitigation: No mitigation measures should be recommended.

6.0 SUMMARY

Upon review of the habitat requirements for the species that are threatened or endangered under the Federal and/or California ESA and other special status known in this area of the San Joaquin Valley, it's clear that the CDFW conservation lands in the Project area and vicinity are vitally important to the continued existence of many of these species. The decades of land conversion to agriculture and associated development and degradation over the vast majority of the Project area severely limits the habitat value throughout the converted lands. Though, some species such as the San Joaquin kit fox, burrowing owl, Swainson's hawk, tri-colored blackbird, and giant garter snakes have adapted their life histories to the lands' conversion and may be present as rare occurrences in these areas.

Few suitable habitats for listed or otherwise special-status plant species or natural communities were observed within the Project area outside of the CDFW reserves. Potential habitats observed within the Project area included limited area of manmade habitats such as impoundments with fringing emergent wetland habitat, drainage ditches, and irrigation canals which may substitute for natural habitat but are only marginally suitable habitats due to continual disturbance and human presence. Also, burrowing owl, Swainson's hawk, and San Joaquin kit fox have been documented nesting in or near rights-of-way. The Project area is characterized by intensively managed agriculture, ruderal roadside weedy species and bare soils or gravels, few isolated large trees, and a minimal amount of open water and associated emergent and/or scrub wetland or riparian vegetation.

No listed or otherwise special-status or sensitive wildlife species were observed within the Project area during the survey; however, low-to-moderate quality, fragmented habitat conditions including manmade habitats do occur and have the potential to support the following 14 listed or otherwise special-status species: California linderiella, California tiger salamander, California red-legged frog, western pond turtle, giant garter snake, tricolored blackbird, burrowing owl, Swainson's hawk, mountain plover, white-faced ibis, bank swallow, Fresno kangaroo rat, American badger, and San Joaquin kit fox.

Potential impacts to special-status species which have the potential to use the Project area would be reduced if mitigation measures directed towards those species are implemented. Therefore, the proposed Project would have a less than significant impact on special-status species and their habitat.

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APPENDIX A. SPECIAL STATUS PLANT AND WILDLIFE EVALUATION

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Table A-1. Special-Status Plants Having the Potential to Occur Within the Project Area and Vicinity

Scientific Name Common Name	[1]Status Fed/State/[2] CNPS	Habitat Description	Blooming Period	*Occurrence/Survey Results
Atriplex cordulata var. *cordulata* Heartscale	-/-/1B.2	Found in chenopod scrub, meadows and seeps, and valley and foothill grasslands in sandy, saline, or alkaline soils below ~1,800 feet in elevation.	April to October	**Absent.** No suitable habitat for heartscale was observed outside of CDFW lands during the survey. Suitable habitat may occur within CDFW lands within the Project area and vicinity since several CNDDB records name these locations. No significant impacts to this species are expected to occur as a result of this Project.
Atriplex cordulata var.*erecticaulis* Earlimart orache	-/-/1B.2	Found in valley and foothill grassland in southern San Joaquin valley; requires alkaline soils between ~130 and 330 feet in elevation.	August to September	**Absent.** No suitable habitat for Earlimart orache was observed outside of CDFW lands during the survey. Suitable habitat may occur within CDFW lands within the Project area and vicinity. CNDDB record is a single occurrence. No significant impacts to this species are expected to occur as a result of this Project.
Atriplex coronate var. vallicola Lost Hills crownscale	-/-/1B.2	Found in dried chenopod scrub, valley and foothill grassland, vernal pools; requires alkaline soils between 165 and 2,000 feet in elevation.	April to August	**Absent.** No suitable habitat for Lost Hills crownscale was observed outside of CDFW lands during the survey. Suitable habitat may occur within CDFW lands within the Project area and vicinity. CNDDB records are in Kerman ER and Mendota.

Scientific Name Common Name	[1]Status Fed/State/[2] CNPS	Habitat Description	Blooming Period	*Occurrence/Survey Results
				No significant impacts to this species are expected to occur as a result of this Project.
Atriplex depressa Brittlescale	-/-/1B.2	Found in chenopod scrub, meadows and seeps, playas, valley and foothill grassland, vernal pools, and alkaline or clay soils below ~1,000 feet in elevation.	May to October	**Absent.** No suitable habitat for brittlescale was observed outside of CDFW lands during the survey. Suitable habitat may occur within CDFW lands within the vicinity of the Project area. No significant impacts to this species are expected to occur as a result of this Project.
Atriplex minuscula Lesser saltscale	-/-/1B.1	Found in chenopod scrub, meadows and seeps, playas, valley and foothill grassland, vernal pools, and alkaline or clay soils between ~50 and 650 feet in elevation.	May to October	**Absent.** No suitable habitat for lesser saltscale was observed outside of CDFW lands during the survey. Suitable habitat may occur within CDFW lands within the vicinity of the Project area. No significant impacts to this species are expected to occur as a result of this Project.
Atriplex persistens Vernal pool smallscale	-/-/1B.2	Found in alkaline vernal pools between 30 and 380 feet in elevation.	July to October	**Absent.** No suitable habitat for vernal pool saltscale was observed outside of CDFW lands during the survey. Suitable habitat may occur within CDFW lands within the vicinity of the Project

Scientific Name Common Name	[1]Status Fed/State/[2] CNPS	Habitat Description	Blooming Period	*Occurrence/Survey Results
				area. Mapped as a single CNDDB occurrence north of the Project area. No significant impacts to this species are expected to occur as a result of this Project.
Atriplex subtilis Subtle orache	-/-/1B.2	Found in valley and foothill grasslands between ~130 and 330 feet in elevation.	August to October	**Absent.** No suitable habitat for subtle orache was observed outside of CDFW lands during the survey. Suitable habitat may occur within CDFW lands within the Project area and vicinity. No significant impacts to this species are expected to occur as a result of this Project.
Chloropyron palmatum Palmate-bracted bird's beak	E/E/1B.1	Found in chenopod scrub and valley and foothill grasslands; alkaline soils between ~15 and 510 feet in elevation.	May to October	**Absent.** No suitable habitat for palmate-bracted bird's beak was observed outside of CDFW lands during the survey. Suitable habitat may occur within CDFW lands within the Project area and vicinity. No significant impacts to this species are expected to occur as a result of this Project.
Delphinium recurvatum Recurved larkspur	-/-/1B.2	Found in chenopod scrub, cismontane woodland, and valley and foothill grasslands on alkaline soils between ~10 and 2,450 feet in elevation.	March to May	**Absent.** No suitable habitat for recurved larkspur was observed outside of CDFW lands during the survey. Suitable habitat may occur within CDFW lands within the Project area and vicinity.

Scientific Name Common Name	[1]Status Fed/State/[2] CNPS	Habitat Description	Blooming Period	*Occurrence/Survey Results
				This species has been mapped in Kerman ER in 2004. Other occurrences were prior to conversion to agriculture. No significant impacts to this species are expected to occur as a result of this Project.
Eriastrum hooveri Hoover's eriastrum	D/-/4.2	Found in chenopod scrub and valley and foothill grasslands on clayey soils between ~325 and 1,800 feet in elevation.	March to July	**Absent.** No suitable habitat for Hoover's eriastrum was observed outside of CDFW lands during the survey. Suitable habitat may occur within CDFW lands within the Project area and vicinity, but observations are only historical (>20 yrs). No occurrence is expected. No significant impacts to this species are expected to occur as a result of this Project.
Eryngium spinosepalum Spiny-sepaled button-celery	-/-/1B.2	Found in valley and foothill grassland and vernal pools between 260 and 3200 feet in elevation.	April to June	**Absent.** No suitable habitat for spiny-sepaled button-celery was observed outside of CDFW lands during the survey. Suitable habitat may occur within CDFW lands within the Project area and vicinity, but the only observation shown for the Project quads was in Madera County beyond the Project boundary. No occurrence is expected. No significant impacts to this species are expected to occur as a result of this Project.

Scientific Name Common Name	[1]Status Fed/State/[2] CNPS	Habitat Description	Blooming Period	*Occurrence/Survey Results
Lasthenia chrysantha Alkali-sink goldfields	-/-/1B.2	Found in vernal pools and wet alkali flats below 655 feet in elevation.	February to April	**Absent.** No suitable habitat for alkali-sink goldfields was observed outside of CDFW lands during the survey. Suitable habitat may occur within CDFW lands within the Project area and vicinity. This species has been mapped in Kerman ER and Alkali Sink ER in 2004. Other occurrences were prior to conversion to agriculture. No significant impacts to this species are expected to occur as a result of this Project.
Layia munzii Munz's tidy-tips	-/-/1B.2	Found in chenopod scrub, valley and foothill grasslands on alkaline, clayey soils between 490 and 2,300 feet in elevation.	March to April	**Absent.** No suitable habitat for Munz's tidy-tips was observed outside of CDFW lands during the survey. Suitable habitat may occur within CDFW lands within the Project area and vicinity. No occurrence is expected. No significant impacts to this species are expected to occur as a result of this project.
Monolopia congdonii San Joaquin woollythreads	E/-/1B.2	Found in grasslands, and in sandy soils between 300 and 2,300 feet in elevation.	February to May	**Absent.** No suitable habitat was observed outside of CDFW lands during the survey. Suitable habitat for San Joaquin woollythreads may occur in CDFW lands with grassland habitat such as Kerman ER. No impacts to this species are expected to

Scientific Name Common Name	[1]Status Fed/State/[2] CNPS	Habitat Description	Blooming Period	*Occurrence/Survey Results
				occur because no CDFW lands will be affected.
Puccinellia simplex California alkali grass	-/-/1B.2	Found in chenopod scrub, meadows and seeps, lake margins, valley and foothill grassland, vernal pools and alkaline soils below ~3,050 feet in elevation.	March to May	**Absent.** No suitable habitat was observed outside of CDFW lands during the survey. California alkali grass may occur in CDFW lands with alkali sink scrub and vernal pool habitats. CDFW lands were not accessed during the survey. No impacts to this species are expected to occur because CDFW lands occur mostly beyond the Project boundary and/or will not be affected.
Sagittaria sanfordii Sanford's arrowhead	-/-/1B.2	Found in ponds and along ditches, streams and lake margins below 1,000 feet in elevation.	May to October	**Unlikely.** Suitable habitat for Sanford's arrowhead may occur adjacent to or in perennially flooded habitats or habitats with high water tables year-round such as the Fresno Slough, Mendota Wildlife Area, James Bypass, or impoundments and ditches in the Project area.

[1]Status: Federal and State Listing Codes:

D = Delisted

E = Federal or State-listed Endangered

\- = No Listing Status

[2]CNPS:

1B.1 = Plants considered rare, threatened, or endangered in California and elsewhere; seriously threatened in California.

1B.2 = Plants considered rare, threatened, or endangered in California and elsewhere; moderately threatened in California.

2B.1 = Plants considered rare, threatened, or endangered in California, but more common elsewhere; seriously threatened in California.

Scientific Name Common Name	[1]Status Fed/State/[2] CNPS	Habitat Description	Blooming Period	*Occurrence/Survey Results

2B.2 = Plants considered rare, threatened, or endangered in California, but more common elsewhere; moderately threatened in California.
4.2 = Plants of limited distribution; moderately threatened in California (not considered rare).

*Occurrence within the project area:
Absent: No suitable habitat exists within the Project area and outside of CDFW lands.
Unlikely: No suitable natural habitat exists within the Project area but may exist in the vicinity outside of CDFW lands, or a less than suitable man-made environment may substitute for the natural habitat in the vicinity.
Possible: Less than suitable natural or man-made habitat may occur within the project area.

Source: CNPS 2021

Table A-2. Special-status Wildlife Having the Potential to Occur Within the Project Area and Vicinity

Scientific Name Common Name	[1]Status Fed/State	General Habitat Needs	*Occurrence/Survey Results and Evaluation
Invertebrates			
Branchinecta longiantenna Longhorn fairy shrimp	E/-	Found in clear to rather turbid vernal pools including clear-water depressions in sandstone outcroppings, grass-bottomed pools, and claypan pools. Longhorn fairy shrimp are endemic to California vernal pool habitat and restricted to the Central Valley.	**Absent.** Neither evidence nor presence of this species was observed. Natural habitat for this species does not exist within the Project area outside of CDFW lands. One known population of longhorn fairy shrimp was identified in the CDFW Alkali Sink ER (USFWS 2012).
Branchinecta lynchi Vernal pool fairy shrimp	T/-	Found in small vernal pools and grassy swales or other depressional pools characterized by clear to tea-colored waters.	**Unlikely.** Neither evidence nor presence of this species was observed. Natural habitat for this species does not exist within the Project area outside of CDFW lands. Manmade grassy swales may substitute for natural habitat, but no grassy swales were observed in the Project area during the survey.
Lepidurus packardi Vernal pool tadpole shrimp	E/-	Found in small vernal pools and grassy swales or other depressional pools characterized by clear to tea-colored waters.	**Unlikely.** Neither evidence nor presence of this species was observed. Natural habitat for this species exist within the Project area or immediate vicinity within CDFW Reserves with vernal pool habitat but not outside of CDFW lands within the Project area. Manmade grassy swales may substitute for natural habitat, but none were observed in the Project area during the survey.
Linderiella occidentalis California linderiella	-/-	Found in various ponded habitats including vernal pools, swales, ephemeral drainages, stock ponds, reservoirs, ditches, and backhoe pits.	**Possible.** Neither evidence nor presence of this species was observed. Natural habitat for this species does not exist within the Project area outside of CDFW lands. Manmade habitats such as stock ponds, impoundments, and ditches may substitute for natural habitat, and were observed in the Project area during the survey. Only one CNDDB

Scientific Name Common Name	[1]Status Fed/State	General Habitat Needs	*Occurrence/Survey Results and Evaluation
			occurrence was recorded within the Project area quads.
Fish			
Hypomesus transpacificus Delta smelt	T/T	Only found in the Sacramento-San Joaquin Estuary in the interface between salt and freshwater.	**Absent.** No suitable habitat for this species exists within the Project area or immediate vicinity.
Amphibians			
Ambystoma californiense California tiger salamander	T/T	Restricted to grasslands and low foothills with pools or ponds that are necessary for breeding. Spends most of its life on land underground, using burrows made by squirrels and other burrowing mammals. Vernal pools are the natural breeding areas, but stock ponds that are allowed to go dry help take the place of vernal pools for breeding.	**Possible.** Neither evidence nor presence of this species was observed. Natural habitat for this species exists within the Project area or immediate vicinity only within CDFW lands with vernal pool habitat (Kerman Ecological Reserve and Alkali Sink Ecological Reserve), and less than suitable manmade habitat (stock ponds) may occur in the Project area. However, no CNDDB occurrence records exist within the Project area quads.
Rana draytonii California red-legged frog	T/SSC	Found in dense, shrubby riparian vegetation associated with deep (~ 2 feet), still or slow-moving water; arroyo willow (*Salix lasiolepis*), cattail (*Typha* sp.) and bulrush (*Scirpus* sp.) habitats.	**Possible.** Neither evidence nor presence of this species was observed. Suitable habitat for this species likely exists within the CDFW Mendota Wildlife Area adjacent to and outside of the Project area. Moderately suitable habitat for this species exists within emergent bulrush habitat which occurs over a limited extent within the Project area. However, no CNDDB occurrence records exist within the Project area quads.

Scientific Name Common Name	[1]Status Fed/State	General Habitat Needs	*Occurrence/Survey Results and Evaluation
Spea hammondii Western spadefoot	-/SSC	In the California Central Valley, usually found in grasslands, but may be in chaparral, scrub, and oak woodlands where the soil is favorable for burrowing. Shallow ephemeral ponds, or vernal pools, are used for breeding and egg laying.	**Absent.** Neither evidence nor presence of this species was observed. Natural habitat for this species exists within the Project area or immediate vicinity only within CDFW lands with vernal pool habitat and grassland.
Reptiles			
Anniella pulchra Northern California legless lizard	-/SSC	May inhabit a range of habitats including coastal dune, valley foothill, chaparral and coastal scrub in friable soils. They require soil moisture to shed skin.	**Absent.** Neither evidence nor presence of this species was observed. No suitable habitat for this species exists within the Project area or immediate vicinity. Single CNDDB occurrence was listed in Madera County beyond the Project area.
Emys marmorata Western pond turtle	-/SSC	Inhabits aquatic habitats such as rivers, sloughs, lakes, reservoirs, ponds, and irrigation canals. Uses land for nesting, overwintering, basking and dispersal. Nesting typically occurs within 650 feet of aquatic habitat in areas with compact soil, sparse vegetation, and good solar exposure.	**Possible.** Neither evidence nor presence of this species was observed. Natural habitat for this species exists within the Project area or immediate vicinity only within CDFW lands. All CNDDB occurrences for the Project area quads are mapped within the CDFW Mendota Wildlife Area or the San Joaquin River. However, manmade habitats such as impoundments and irrigation canals may substitute for natural habitat and were observed in the Project area during the survey.
Gambelia sila Blunt-nosed leopard lizard	E/E, FP	Found only in the San Joaquin Valley inhabiting sparsely vegetated plains, lower canyon slopes, on valley floors, and washes; open grassland, saltbush scrub, and alkali sink are more common habitat types.	**Unlikely.** Neither evidence nor presence of this species was observed. Natural habitat for this species within the Project area or immediate vicinity is mostly confined to only within CDFW lands; however, sparsely vegetated plains, a less common habitat type, do occur within the Project area between the San Joaquin River and Mendota Wildlife Area. The only CNDDB occurrence with a specified location in the Project quads was from the CDFW Mendota

Scientific Name Common Name	[1]Status Fed/State	General Habitat Needs	*Occurrence/Survey Results and Evaluation
			Wildlife Area/Alkali Sink ER and most occurrences are historical (>20 yrs).
Masticophis flagellum ruddocki San Joaquin coachwhip	-/SSC	Found in open, dry, treeless areas including valley grasslands and saltbush scrub. Avoids dense vegetation.	**Absent.** Neither evidence nor presence of this species was observed. Natural habitat for this species exists within the Project area or immediate vicinity only within CDFW lands. The recent (< 20 yrs) CNDDB occurrences were located within the Alkali Sink ER and Kerman ER.
Phrynosoma blainvillii Coast horned lizard	-/SSC	Found in the south and central Coast Range, and inland to the Sierra foothills utilizing open areas with loose sandy soils and low vegetation, including grasslands, valley foothills, and riparian habitats. May use mammal burrows or crevices during inactivity and hibernation.	**Absent.** Neither evidence nor presence of this species was observed. Natural habitat for this species exists within the Project area or immediate vicinity only within CDFW lands. The recent (< 20 yrs) CNDDB occurrences were located within the Alkali Sink ER.
Thamnophis gigas Giant garter snake	T/T	Usually found in areas of freshwater marsh, low-gradient streams, but has adapted to drainage canals and irrigation ditches, especially those associated with rice farming; highly aquatic. Historically occurred in the San Joaquin Valley from the vicinity of Sacramento southward to Buena Vista and the Tulare Lake Basin; currently known from near Chico, Butte County, to the vicinity of Burrel, Fresno County. Active from early spring to mid-fall, and vegetative cover in ditches and ponds is necessary for cover and foraging habitat. Dormant in the winter inhabiting small mammal burrows above flood elevations.	**Possible.** Neither evidence nor presence of this species was observed. Natural habitat for this species exists within the Project area or immediate vicinity only within CDFW lands. All CNDDB occurrences for the Project area quads with a specified location are mapped within the CDFW Mendota Wildlife Area. However, manmade habitats such as impoundments with fringing emergent habitat, drainage ditches, and irrigation canals may substitute for natural habitat and were observed in the Project area during the survey.
Thamnophis hammondii Two-striped gartersnake	-/SSC	Found in or near permanent fresh water, along streams with rocky beds. Often associated with willows, coastal sage scrub, scrub oak, and brushland.	**Absent.** Neither evidence nor presence of this species was observed. Natural habitat for this species exists within the immediate vicinity only within CDFW lands. The single, historical (> 20 yrs) CNDDB occurrence was located within the Mendota Wildlife Area.
Birds			

Scientific Name Common Name	[1]Status Fed/State	General Habitat Needs	*Occurrence/Survey Results and Evaluation
Agelaius tricolor Tricolored blackbird	-/T, SSC	Found foraging in grasslands, wetlands, rice fields, wheat fields, and weedy uplands dominated by mustards and thistles, etc.; colonial breeder in marshes containing heavy growth of bulrushes, cattails, wild rose thickets, thistle, and blackberries; found throughout the Central Valley.	**Possible.** Suitable nesting/breeding habitat does occur within the Project area in marginal emergent habitat. Suitable foraging habitat also occurs seasonally within the Project area and year-round in the Project vicinity. This species was not observed, but red-winged blackbirds (*Agelaius phoeniceus),* which utilize the same habitat types, were observed within the Project area at emergent bulrush habitat. CNDDB occurrences suggest cattail habitats are preferred, colonies often coincided with duck brood ponds, and birds foraged heavily in wheat fields. Foraging near dairy crops (e.g., alfalfa) is also common. According to CDFW comments from the scoping meeting, tricolored blackbird are known to occur in the Project vicinity.
Athene cunicularia Burrowing owl	-/SSC	Burrowing sites occur in open, dry annual or perennial grasslands, scrub, desert, and areas with low-growing vegetation such as certain farmland. Species is dependent on mammal burrows such as those excavated by the California ground squirrel.	**Possible.** Neither evidence nor presence of this species was observed. Suitable nesting and foraging habitat may occur within the Project area and immediate vicinity. Most potential habitat is likely poor owing to continual agricultural uses and disturbance, but California ground squirrel burrows are abundant in some of the Project area. Many recent (<20 yrs) CNDDB occurrences within the Project area quads are from PGE, suggesting utility ROWs are utilized by this species. According to CDFW comments from the scoping meeting, burrowing owl is known to nest and winter within the vicinity of the Project, and the Project area contains suitable habitat for burrowing owl.
Buteo swainsoni Swainson's hawk	-/T	Found using riparian and sometimes large, isolated trees for nesting, and grasslands and agricultural lands are used for foraging. In California, breeds primarily in the Sacramento Valley, with occasional nesting to the south through Kern County. Central and San Joaquin Valleys are migration corridors to their wintering grounds in South America.	**Possible.** Neither evidence nor presence of this species was observed. Suitable riparian habitat is available for nesting in the CDFW Mendota Wildlife Area but not in Project area. Isolated large trees for use as potential nesting habitat is rare within the Project area, but abundant foraging areas are present, especially alfalfa in agricultural areas. According to

Scientific Name Common Name	[1]Status Fed/State	General Habitat Needs	*Occurrence/Survey Results and Evaluation
			CDFW comments from the scoping meeting, Swainson's hawk is documented within the McMullin GSA boundary and surrounding area and has the potential to nest in trees within the Project area.
Charadrius montanus Mountain plover	-/SSC	Found on short, grassy plains, rolling grassy hills, plowed agricultural fields, and germinating grain fields where the vegetation is short and there is plenty of bare soil areas.	**Possible.** Neither evidence nor presence of this species was observed. Potential nesting habitat is rare within the Project area due to continual ground disturbance from agriculture, but abundant foraging areas are present. Two of the three CNDDB occurrences for the Project area quads are historical (>20 yrs) and the third was in 2002 from the Tranquility quad.
Coccyzus americanus occidentalis Western yellow-billed cuckoo	T/E	Found in woodland habitats with dense cover and nearby water including low scrubby vegetation, overgrown orchards, abandoned farmland, and dense thickets along streams and marshes. Often nests in willows along streams and rivers with neighboring cottonwoods serving as foraging sites.	**Unlikely.** Neither evidence nor presence of this species was observed. No CNDDB listings occurred in the Project area quads. Suitable riparian habitat is available for nesting and foraging in the CDFW Mendota Wildlife Area but not in Project area which is generally disturbed too frequently to be suitable for this species.
Falco columbaris Merlin	-/-	Found in open conifer woodlands, prairie groves, foothills, marshes and open country. In winter months, found in open areas such as grasslands and coastal marshes.	**Absent.** Neither evidence nor presence of this species was observed. No suitable habitat for this species exists within the Project area or immediate vicinity outside of CDFW lands with grassland habitat, and occurrences in those areas would be rare.
Plegadis chihi White-faced ibis	-/-	Found in freshwater wetlands, marshes, flooded hay meadows, agricultural fields, and estuarine wetlands. Associated with *Typha* spp., bulrush, *Scirpus* spp.	**Possible.** Neither evidence nor presence of this species was observed. Suitable nesting/breeding habitat does occur within the Project area in marginal emergent habitat. Suitable foraging habitat also occurs seasonally within the Project area and year-round in the Project vicinity. The single CNDDB occurrence was located in the Mendota Wildlife

Scientific Name Common Name	[1]Status Fed/State	General Habitat Needs	*Occurrence/Survey Results and Evaluation
			Area but is a historical (>20 yrs) occurrence. An occurrence in the Project area would be rare.
Riparia riparia Bank swallow	-/T	Found in open habitat near rivers, streams, ocean coasts and reservoirs. Foraging habitat includes wetlands, grasslands, riparian woodland, orchards, agricultural fields, shrub lands, and upland woodlands. Nests in vertical sand, soil, or gravel banks and cliffs.	**Possible.** Neither evidence nor presence of this species was observed. CNDDB listing was a single historical (>20 yrs) occurrence. No nesting habitat is available within the Project area and natural foraging habitat within the Project area or immediate vicinity mostly occurs within CDFW lands. An occurrence in the Project area would be rare.
Mammals			
Ammospermophilus nelsoni Nelson's antelope squirrel	-/T	Found on dry, sparsely vegetated, sandy loam soils of the western San Joaquin Valley. Frequently found in areas with widely scattered shrubs, annual forbs and grasses, on terrain with small gullies and washes. Frequents areas with alkali scrub vegetation and dry washes. Nests in burrows associated with shrubs such as *Atriplex* and *Ephedra*.	**Absent.** No suitable habitat for this species exists within the Project area or immediate vicinity.
Dipodomys ingens Giant kangaroo rat	E/E	Prefer annual grassland with sparse vegetation on gentle slopes generally less than 10 degrees where they develop burrow systems in sandy loam soils.	**Unlikely.** Neither evidence nor presence of this species was observed. No CNDDB records occur within the Project area quads.
Dipodomys nitratoides exilis Fresno kangaroo rat	E/E	Found in alkali-sink, open grassland habitat in western Fresno County and on seasonally inundated, bare alkaline, clay-based soils also subject to seasonal inundation.	**Possible.** Neither evidence nor presence of this species was observed. Marginally suitable habitat for this species exists within the Project area at the CDFW Kerman Ecological Reserve (overgrazed alkali sink plant communities) and other CDFW lands, which according to CNDDB may be refuge for this species, but it has not been trapped in surveys for

Scientific Name Common Name	[1]Status Fed/State	General Habitat Needs	*Occurrence/Survey Results and Evaluation
			more than 30 years and an occurrence in the Project area would be rare.
Eumops perotis californicus Western mastiff bat	-/SSC	Usually found in desert scrub to woodland and foraging in open areas. Roost in exfoliating rock slabs of vertical cliffs and rugged canyons. Live deep inside narrow crevices. Sometimes may roost with other species.	**Absent.** Neither evidence nor presence of this species was observed. No suitable habitat for this species exists within the Project area or immediate vicinity.
Lasiurus blossevillii Western red bat	-/SSC	Found in riparian habitats, particularly riparian forests with mature cottonwood and sycamore near open fields, orchards, and sometimes urban areas. Often associated with vernal pools, vernal pool grasslands, seasonal wetlands, oak woodlands, and valley grasslands.	**Unlikely.** Neither evidence nor presence of this species was observed. No suitable habitat for this species exists within the Project area or immediate vicinity outside of CDFW reserves and the Fresno Slough, but foraging habitat in agricultural areas does occur adjacent to CDFW lands.
Myotis yumanensis Yuma myotis	-/-	Found in upland and lowland habitats including riparian, desert scrub, moist woodlands, and forests usually near open water. This species is strongly associated with water.	**Absent.** Neither evidence nor presence of this species was observed. No suitable habitat for this species exists within the Project area or immediate vicinity outside of CDFW reserves and the Fresno Slough.
Perognathus inornatus San Joaquin pocket mouse	-/-	Found in grasslands and oak savannahs at areas with friable soils.	**Absent.** Neither evidence nor presence of this species was observed. CNDDB occurrence records are more than 100 years old. No suitable habitat for this species exists within the Project area.
Taxidea taxus American badger	-/SSC	Found in dry, open grasslands, fields, pastures, and meadows. Open habitat with suitable burrowing conditions is necessary.	**Possible.** Neither evidence nor presence of this species was observed. Habitat such as fallow fields may occur, but agricultural uses limit suitable habitat for this species within the Project area and immediate vicinity. Suitable habitat does occur within CDFW reserves and one CNDDB record is from the Alkali

Scientific Name Common Name	[1]Status Fed/State	General Habitat Needs	*Occurrence/Survey Results and Evaluation
			Sink ER/Mendota Wildlife Area. An occurrence within the Project area would be rare.
Vulpes macrotis mutica San Joaquin kit fox	E/T	Found in level valley saltbush scrub, valley sink scrub, sagebrush scrub, and in Central Valley sacaton grasslands with friable soils. May den in rights-of-way, vacant lots, and other disturbed areas in addition to undisturbed habitats.	**Possible.** Neither evidence nor presence of this species was observed. Burrows likely excavated by ground squirrels may serve as potential dens. Use of the Project area is possible as the species may move through this large Project area. According to CDFW comments from the scoping meeting, San Joaquin kit fox have been documented in close proximity to the Project site. Agricultural uses and continual disturbance limit suitable habitat for this species within the Project area and immediate vicinity.

[1]Status: Federal and State Listing Codes:

E = Federal or State-listed Endangered

T = Federal or State-listed Threatened

CE = State Candidate Endangered

SSC = California Department of Fish and Wildlife Designated Species of Special Concern

FP = California Department of Fish and Wildlife Designated Fully Protected

- = No Listing Status

*Occurrence within the project area:

Absent: No suitable habitat exists within the Project area and outside of CDFW lands.

Unlikely: No suitable natural habitat exists within the Project area but may exist in the vicinity outside of CDFW lands, or a less than suitable man-made environment may substitute for the natural habitat in the vicinity.

Possible: Less than suitable natural or man-made habitat may occur within the Project area.

APPENDIX B. DATABASE QUERY RESULTS AND FIGURES

Summary Table Report

California Department of Fish and Wildlife

California Natural Diversity Database

Query Criteria: Quad IS (Mendota Dam (3612073) OR Gravelly Ford (3612072) OR Tranquillity (3612063) OR Jamesan (3612062) OR Kerman (3612061) OR Kearney Park (3611968) OR San Joaquin (3612052) OR Helm (3612051) OR Raisin (3611958))

Name (Scientific/Common)	CNDDB Ranks	Listing Status (Fed/State)	Other Lists	Elev. Range (ft.)	Total EO's	Element Occ. Ranks						Population Status		Presence		
						A	B	C	D	X	U	Historic > 20 yr	Recent <= 20 yr	Extant	Poss. Extirp.	Extirp.
Agelaius tricolor tricolored blackbird	G1G2 S1S2	None Threatened	BLM_S-Sensitive CDFW_SSC-Species of Special Concern IUCN_EN-Endangered NABCI_RWL-Red Watch List USFWS_BCC-Birds of Conservation Concern	160 235	955 S:10	0	0	0	0	0	10	9	1	10	0	0
Ammospermophilus nelsoni Nelson's antelope squirrel	G2G3 S2S3	None Threatened	BLM_S-Sensitive IUCN_EN-Endangered	176 176	287 S:1	0	0	0	0	0	1	1	0	1	0	0
Anniella pulchra Northern California legless lizard	G3 S3	None None	CDFW_SSC-Species of Special Concern USFS_S-Sensitive	175 175	378 S:1	0	0	0	1	0	0	1	0	1	0	0
Athene cunicularia burrowing owl	G4 S3	None None	BLM_S-Sensitive CDFW_SSC-Species of Special Concern IUCN_LC-Least Concern USFWS_BCC-Birds of Conservation Concern	150 230	2011 S:16	1	5	4	2	1	3	6	10	15	1	0
Atriplex cordulata var. cordulata heartscale	G3T2 S2	None None	Rare Plant Rank - 1B.2 BLM_S-Sensitive	50 200	66 S:9	2	2	1	0	2	2	8	1	7	0	2
Atriplex cordulata var. erecticaulis Earlimart orache	G3T1 S1	None None	Rare Plant Rank - 1B.2	175 175	23 S:1	0	0	0	0	1	0	1	0	0	0	1
Atriplex coronata var. vallicola Lost Hills crownscale	G4T3 S3	None None	Rare Plant Rank - 1B.2 BLM_S-Sensitive	160 190	76 S:3	0	1	0	0	0	2	2	1	3	0	0
Atriplex depressa brittlescale	G2 S2	None None	Rare Plant Rank - 1B.2	160 190	60 S:6	0	4	0	0	0	2	4	2	6	0	0
Atriplex minuscula lesser saltscale	G2 S2	None None	Rare Plant Rank - 1B.1	163 200	52 S:10	2	4	1	0	0	3	9	1	10	0	0
Atriplex persistens vernal pool smallscale	G2 S2	None None	Rare Plant Rank - 1B.2	182 182	41 S:1	0	1	0	0	0	0	1	0	1	0	0

Summary Table Report

California Department of Fish and Wildlife

California Natural Diversity Database

Name (Scientific/Common)	CNDDB Ranks	Listing Status (Fed/State)	Other Lists	Elev. Range (ft.)	Total EO's	Element Occ. Ranks A	B	C	D	X	U	Population Status Historic > 20 yr	Recent <= 20 yr	Presence Extant	Poss. Extirp.	Extirp.
Atriplex subtilis subtle orache	G1 S1	None None	Rare Plant Rank - 1B.2	185 190	24 S:5	2	0	0	0	1	2	5	0	4	1	0
Branchinecta longiantenna longhorn fairy shrimp	G1 S1S2	Endangered None	IUCN_EN-Endangered	165 165	23 S:2	2	0	0	0	0	0	0	2	2	0	0
Branchinecta lynchi vernal pool fairy shrimp	G3 S3	Threatened None	IUCN_VU-Vulnerable	165 165	795 S:1	0	0	0	0	0	1	0	1	1	0	0
Buteo swainsoni Swainson's hawk	G5 S3	None Threatened	BLM_S-Sensitive IUCN_LC-Least Concern USFWS_BCC-Birds of Conservation Concern	155 199	2541 S:22	0	9	9	0	0	4	11	11	22	0	0
Charadrius montanus mountain plover	G3 S2S3	None None	BLM_S-Sensitive CDFW_SSC-Species of Special Concern IUCN_NT-Near Threatened NABCI_RWL-Red Watch List USFWS_BCC-Birds of Conservation Concern	140 175	90 S:3	0	1	1	0	0	1	1	2	3	0	0
Chloropyron palmatum palmate-bracted bird's-beak	G1 S1	Endangered Endangered	Rare Plant Rank - 1B.1 SB_CalBG/RSABG-California/Rancho Santa Ana Botanic Garden	160 195	25 S:4	0	1	1	0	2	0	3	1	2	0	2
Coastal and Valley Freshwater Marsh Coastal and Valley Freshwater Marsh	G3 S2.1	None None		155 155	60 S:1	0	0	0	0	0	1	1	0	1	0	0
Coccyzus americanus occidentalis western yellow-billed cuckoo	G5T2T3 S1	Threatened Endangered	BLM_S-Sensitive NABCI_RWL-Red Watch List USFS_S-Sensitive USFWS_BCC-Birds of Conservation Concern	160 160	165 S:1	0	0	0	0	1	0	1	0	0	1	0
Delphinium recurvatum recurved larkspur	G2? S2?	None None	Rare Plant Rank - 1B.2 BLM_S-Sensitive SB_SBBG-Santa Barbara Botanic Garden	180 195	119 S:4	0	0	1	0	2	1	3	1	2	0	2
Dipodomys nitratoides exilis Fresno kangaroo rat	G3TH SH	Endangered Endangered	IUCN_VU-Vulnerable	156 225	12 S:9	0	0	2	0	5	2	9	0	4	3	2

Summary Table Report

California Department of Fish and Wildlife

California Natural Diversity Database

Name (Scientific/Common)	CNDDB Ranks	Listing Status (Fed/State)	Other Lists	Elev. Range (ft.)	Total EO's	Element Occ. Ranks A	B	C	D	X	U	Population Status Historic > 20 yr	Recent <= 20 yr	Presence Extant	Poss. Extirp.	Extirp.
Emys marmorata western pond turtle	G3G4 S3	None None	BLM_S-Sensitive CDFW_SSC-Species of Special Concern IUCN_VU-Vulnerable USFS_S-Sensitive	150 160	1398 S:5	1	3	0	0	0	1	5	0	5	0	0
Eriastrum hooveri Hoover's eriastrum	G3 S3	Delisted None	Rare Plant Rank - 4.2 SB_CalBG/RSABG-California/Rancho Santa Ana Botanic Garden	160 235	47 S:8	0	1	2	0	5	0	8	0	3	0	5
Eryngium spinosepalum spiny-sepaled button-celery	G2 S2	None None	Rare Plant Rank - 1B.2 BLM_S-Sensitive	183 183	108 S:1	0	0	0	0	0	1	1	0	1	0	0
Eumops perotis californicus western mastiff bat	G4G5T4 S3S4	None None	BLM_S-Sensitive CDFW_SSC-Species of Special Concern WBWG_H-High Priority	160 175	296 S:2	0	0	0	0	0	2	2	0	2	0	0
Falco columbarius merlin	G5 S3S4	None None	CDFW_WL-Watch List IUCN_LC-Least Concern	165 165	37 S:1	0	1	0	0	0	0	0	1	1	0	0
Gambelia sila blunt-nosed leopard lizard	G1 S1	Endangered Endangered	CDFW_FP-Fully Protected IUCN_EN-Endangered	150 1,302	416 S:10	0	0	0	0	0	10	10	0	10	0	0
Lasiurus blossevillii western red bat	G4 S3	None None	CDFW_SSC-Species of Special Concern IUCN_LC-Least Concern WBWG_H-High Priority	160 160	128 S:1	0	0	0	0	0	1	1	0	1	0	0
Lasthenia chrysantha alkali-sink goldfields	G2 S2	None None	Rare Plant Rank - 1B.1	165 220	55 S:11	0	0	0	0	4	7	4	7	7	4	0
Layia munzii Munz's tidy-tips	G2 S2	None None	Rare Plant Rank - 1B.2 BLM_S-Sensitive	160 190	68 S:3	0	0	1	0	0	2	2	1	3	0	0
Linderiella occidentalis California linderiella	G2G3 S2S3	None None	IUCN_NT-Near Threatened	164 164	508 S:1	0	0	0	0	0	1	0	1	1	0	0
Masticophis flagellum ruddocki San Joaquin coachwhip	G5T2T3 S2?	None None	CDFW_SSC-Species of Special Concern	160 180	96 S:2	0	2	0	0	0	0	0	2	2	0	0

Name (Scientific/Common)	CNDDB Ranks	Listing Status (Fed/State)	Other Lists	Elev. Range (ft.)	Total EO's	Element Occ. Ranks A	B	C	D	X	U	Population Status Historic > 20 yr	Recent <= 20 yr	Presence Extant	Poss. Extirp.	Extirp.
Monolopia congdonii San Joaquin woollythreads	G2 S2	Endangered None	Rare Plant Rank - 1B.2 SB_UCBG-UC Botanical Garden at Berkeley	190 190	111 S:1	0	0	0	0	1	0	1	0	0	1	0
Myotis yumanensis Yuma myotis	G5 S4	None None	BLM_S-Sensitive IUCN_LC-Least Concern WBWG_LM-Low-Medium Priority	160 160	265 S:1	0	0	0	0	0	1	1	0	1	0	0
Northern Claypan Vernal Pool Northern Claypan Vernal Pool	G1 S1.1	None None		175 175	21 S:1	0	0	0	0	0	1	1	0	1	0	0
Perognathus inornatus San Joaquin pocket mouse	G2G3 S2S3	None None	BLM_S-Sensitive IUCN_LC-Least Concern		140 S:2	0	0	0	0	0	2	2	0	2	0	0
Phrynosoma blainvillii coast horned lizard	G3G4 S3S4	None None	BLM_S-Sensitive CDFW_SSC-Species of Special Concern IUCN_LC-Least Concern	165 170	784 S:2	1	1	0	0	0	0	0	2	2	0	0
Plegadis chihi white-faced ibis	G5 S3S4	None None	CDFW_WL-Watch List IUCN_LC-Least Concern	150 150	20 S:1	0	0	0	0	0	1	1	0	1	0	0
Puccinellia simplex California alkali grass	G3 S2	None None	Rare Plant Rank - 1B.2 BLM_S-Sensitive	180 220	80 S:6	0	0	0	0	3	3	4	2	3	1	2
Riparia riparia bank swallow	G5 S2	None Threatened	BLM_S-Sensitive IUCN_LC-Least Concern	155 155	298 S:1	0	0	0	0	0	1	1	0	1	0	0
Sagittaria sanfordii Sanford's arrowhead	G3 S3	None None	Rare Plant Rank - 1B.2 BLM_S-Sensitive	160 185	126 S:2	0	0	0	0	0	2	2	0	2	0	0
Spea hammondii western spadefoot	G2G3 S3	None None	BLM_S-Sensitive CDFW_SSC-Species of Special Concern IUCN_NT-Near Threatened	157 202	1422 S:10	2	2	2	1	0	3	4	6	10	0	0
Taxidea taxus American badger	G5 S3	None None	CDFW_SSC-Species of Special Concern IUCN_LC-Least Concern	160 182	594 S:3	1	1	0	0	0	1	1	2	3	0	0
Thamnophis gigas giant gartersnake	G2 S2	Threatened Threatened	IUCN_VU-Vulnerable	150 195	366 S:6	1	0	1	0	1	3	5	1	5	1	0

Name (Scientific/Common)	CNDDB Ranks	Listing Status (Fed/State)	Other Lists	Elev. Range (ft.)	Total EO's	Element Occ. Ranks A	B	C	D	X	U	Population Status Historic > 20 yr	Recent <= 20 yr	Presence Extant	Poss. Extirp.	Extirp.
Thamnophis hammondii two-striped gartersnake	G4 S3S4	None None	BLM_S-Sensitive CDFW_SSC-Species of Special Concern IUCN_LC-Least Concern USFS_S-Sensitive	160 160	184 S:1	0	0	0	0	0	1	1	0	1	0	0
Valley Sacaton Grassland Valley Sacaton Grassland	G1 S1.1	None None		160 175	9 S:2	0	0	2	0	0	0	2	0	2	0	0
Valley Sink Scrub Valley Sink Scrub	G1 S1.1	None None		160 160	29 S:1	1	0	0	0	0	0	1	0	1	0	0
Vulpes macrotis mutica San Joaquin kit fox	G4T2 S2	Endangered Threatened		175 200	1020 S:4	0	0	0	0	0	4	4	0	4	0	0

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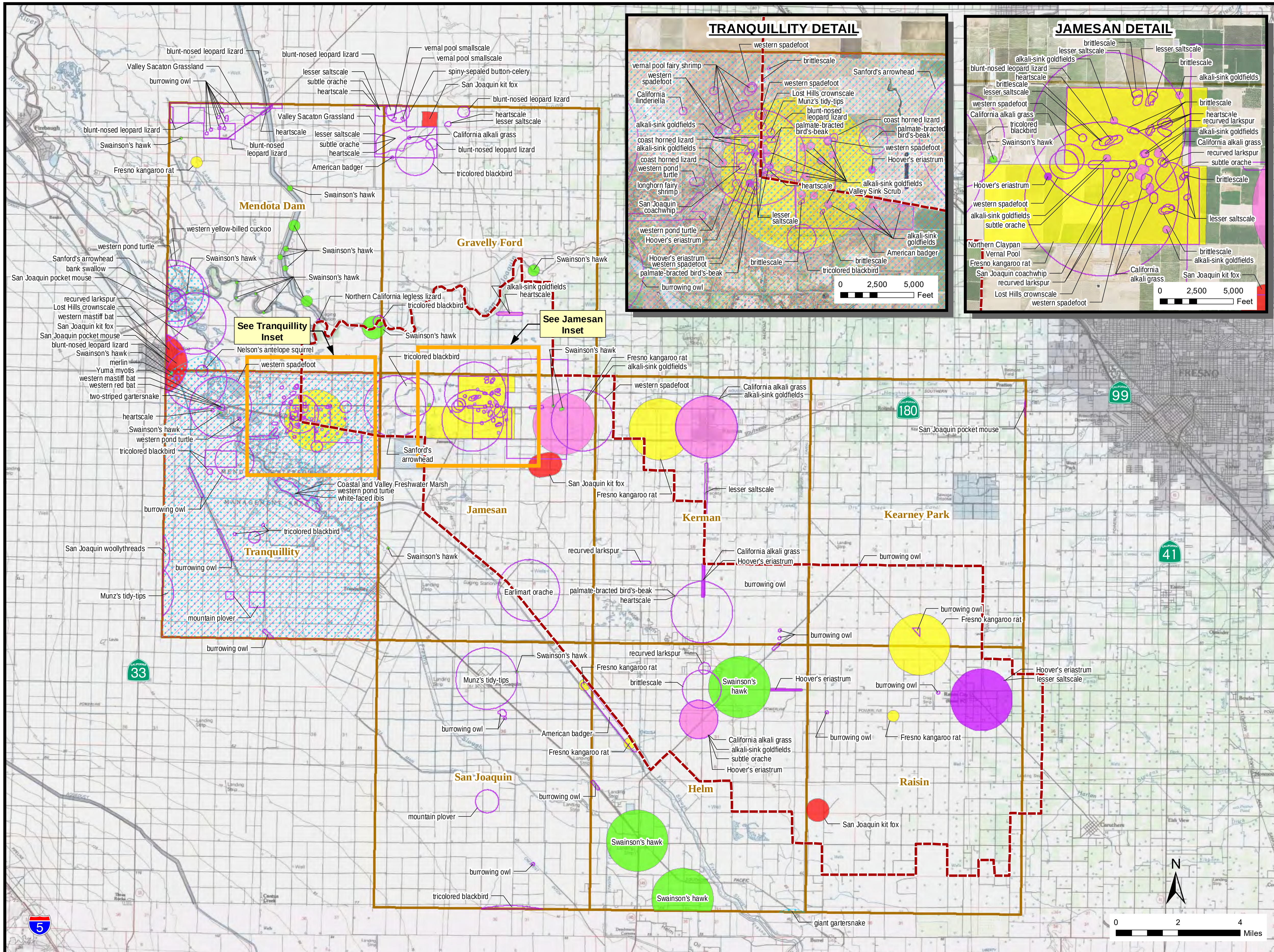


MAGSA Boundary

USGS 7.5' Topographic Quadrangle Boundary

CNDDB Occurrences

- Fresno Kangaroo Rat
- Hoover's Eriastrum
- San Joaquin Kit Fox
- Swainson's Hawk
- Alkali-sink Goldfields
- Giant Gartersnake
- Longhorn Fairy Shrimp
- Other CNDDB Occurrence (label indicates species)

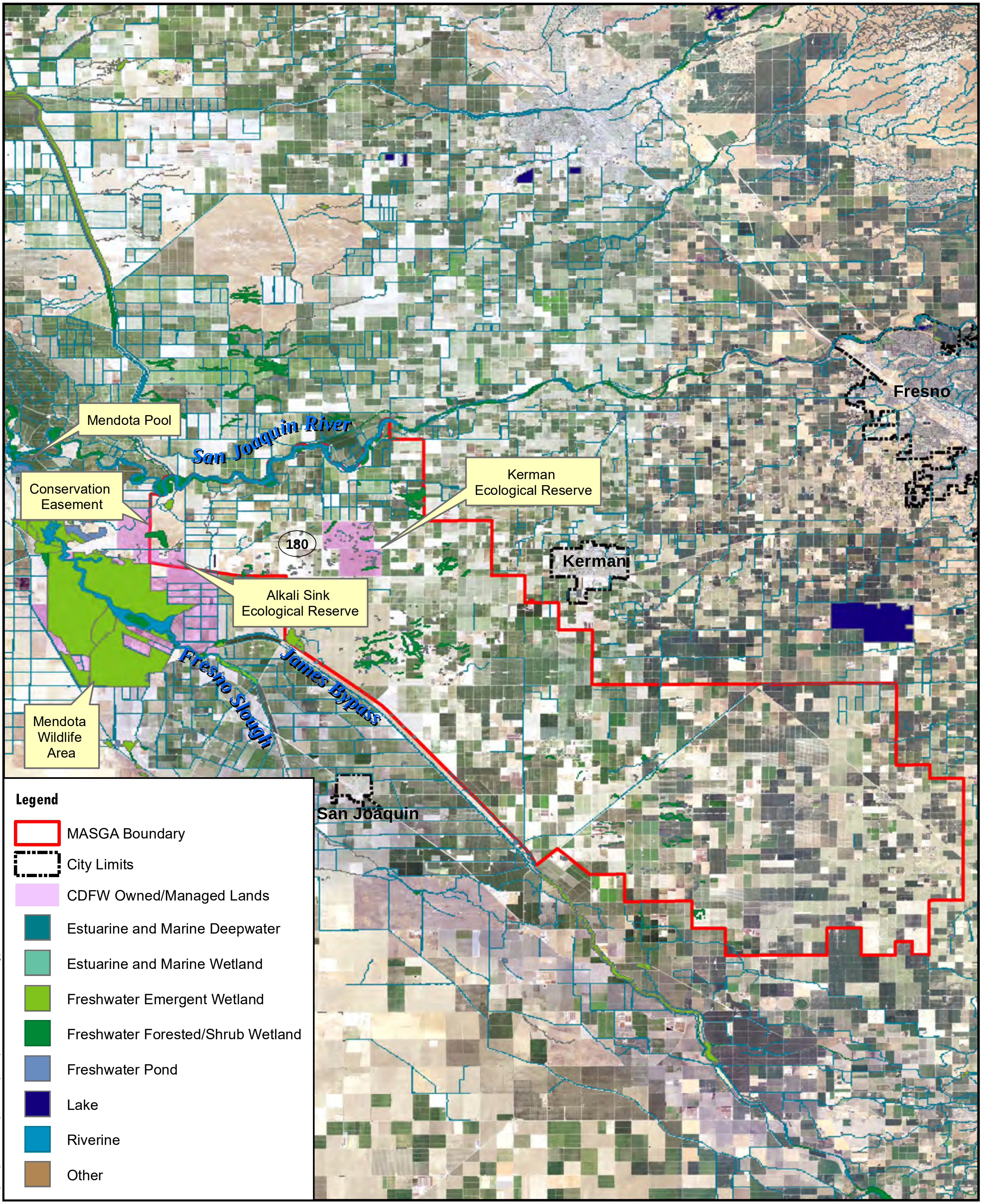
Sources:
CNDDB, October 2021.
ESRI, National Geographic Society, I-cubed, 2013.
NAIP, 2020.

MAGSA AQUATERRA WATER BANK

Figure 1

CNDDB Occurrences

TETRA TECH



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N

1 inch = 24,000 feet

0 12,000 24,000 Feet

Figure 2. NWI - USFWS

Date: 12/29/2021 Map Source: Aerial - CA NAIP 2020

MAGSA Aquaterra Water Bank

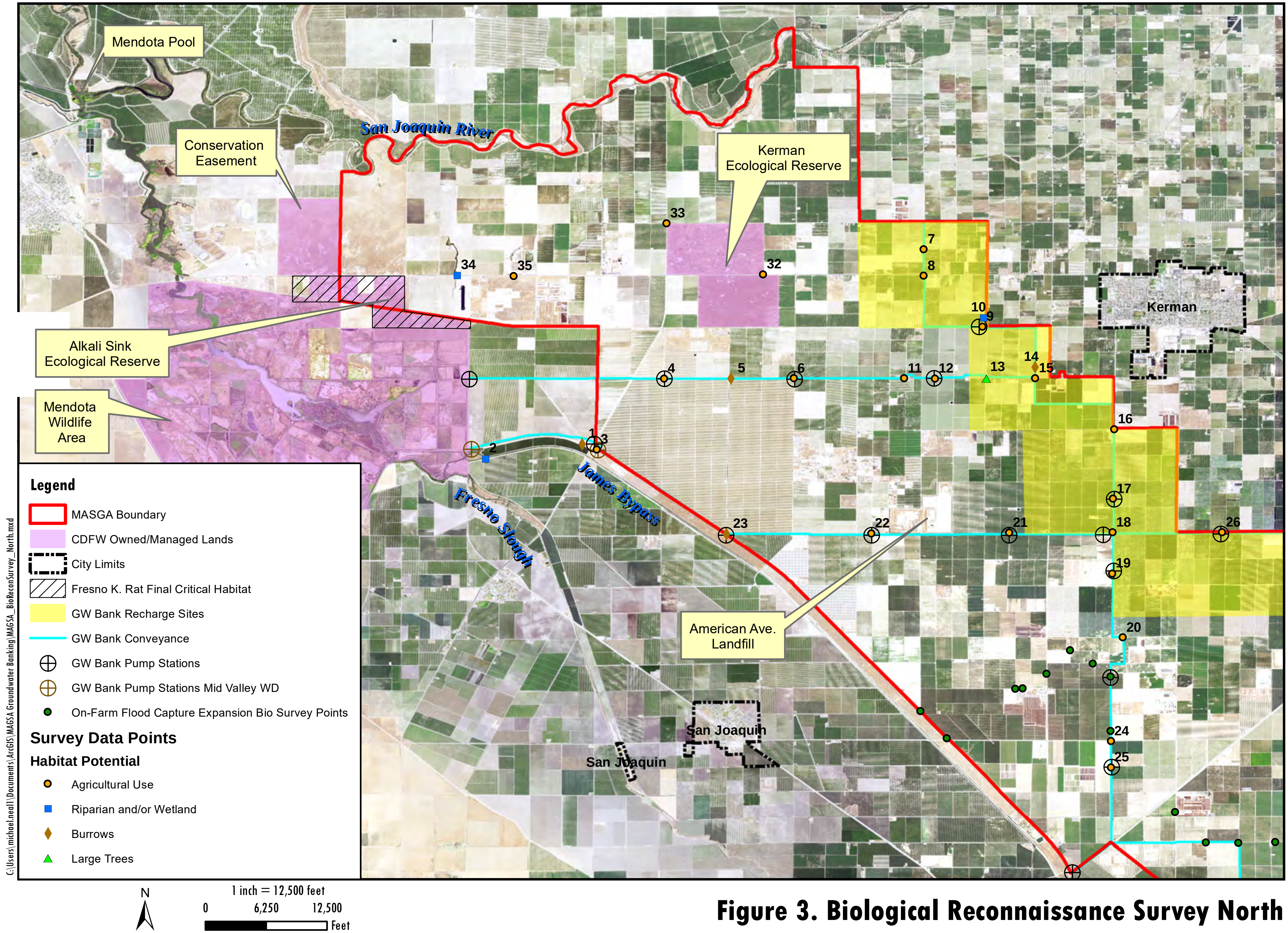

Figure 3. Biological Reconnaissance Survey North

Date: 12/29/2021

MAGSA Aquaterra Water Bank

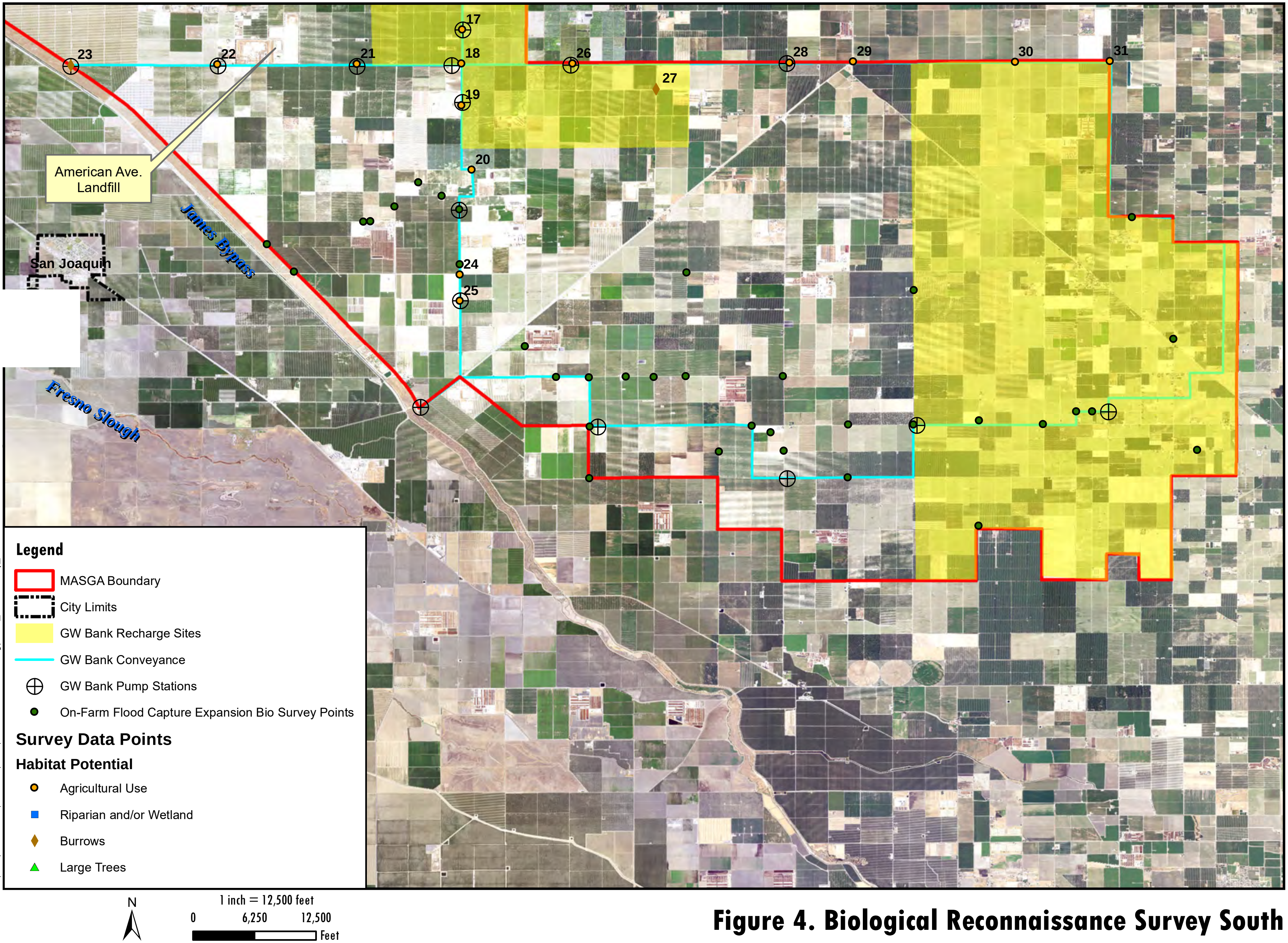

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Figure 4. Biological Reconnaissance Survey South

Date: 12/29/2021

MAGSA Aquaterra Water Bank

IPaC **U.S. Fish & Wildlife Service**

IPaC resource list

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

NOT FOR CONSULTATION

Location

Fresno and Madera counties, California

Local office

Sacramento Fish And Wildlife Office

(916) 414-6600
(916) 414-6713

Federal Building
2800 Cottage Way, Room W-2605
Sacramento, CA 95825-1846

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species[1] and their critical habitats are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service (USFWS) and the fisheries division of the National Oceanic and Atmospheric Administration (NOAA Fisheries[2]).

Species and critical habitats under the sole responsibility of NOAA Fisheries are **not** shown on this list. Please contact NOAA Fisheries for species under their jurisdiction.

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1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information. IPaC only shows species that are regulated by USFWS (see FAQ).
2. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following species are potentially affected by activities in this location:

Mammals

NAME	STATUS

NOT FOR CONSULTATION

Fresno Kangaroo Rat Dipodomys nitratoides exilis | Endangered
Wherever found
There is **final** critical habitat for this species. Your location overlaps the critical habitat.
http://ecos.fws.gov/ecp/species/5150

Giant Kangaroo Rat Dipodomys ingens | Endangered
Wherever found
No critical habitat has been designated for this species.
http://ecos.fws.gov/ecp/species/6051

San Joaquin Kit Fox Vulpes macrotis mutica | Endangered
Wherever found
No critical habitat has been designated for this species.
http://ecos.fws.gov/ecp/species/2873

Birds

NAME	STATUS
Yellow-billed Cuckoo Coccyzus americanus There is **final** critical habitat for this species. The location of the critical habitat is not available. http://ecos.fws.gov/ecp/species/3911	Threatened

Reptiles

NAME	STATUS
Blunt-nosed Leopard Lizard Gambelia silus Wherever found No critical habitat has been designated for this species. http://ecos.fws.gov/ecp/species/625	Endangered
Giant Garter Snake Thamnophis gigas Wherever found No critical habitat has been designated for this species. http://ecos.fws.gov/ecp/species/4482	Threatened

Amphibians

NAME	STATUS
California Red-legged Frog Rana draytonii Wherever found There is **final** critical habitat for this species. The location of the critical habitat is not available. http://ecos.fws.gov/ecp/species/2891	Threatened

NOT FOR CONSULTATION

NAME	STATUS
California Tiger Salamander Ambystoma californiense There is **final** critical habitat for this species. The location of the critical habitat is not available. http://ecos.fws.gov/ecp/species/2076	Threatened

Fishes

NAME	STATUS
Delta Smelt Hypomesus transpacificus Wherever found There is **final** critical habitat for this species. The location of the critical habitat is not available. http://ecos.fws.gov/ecp/species/321	Threatened

Insects

NAME	STATUS
Monarch Butterfly Danaus plexippus Wherever found No critical habitat has been designated for this species. http://ecos.fws.gov/ecp/species/9743	Candidate

Crustaceans

NAME	STATUS
Vernal Pool Fairy Shrimp Branchinecta lynchi Wherever found There is **final** critical habitat for this species. The location of the critical habitat is not available. http://ecos.fws.gov/ecp/species/498	Threatened
Vernal Pool Tadpole Shrimp Lepidurus packardi Wherever found There is **final** critical habitat for this species. The location of the critical habitat is not available. http://ecos.fws.gov/ecp/species/2246	Endangered

NOT FOR CONSULTATION

Flowering Plants

NAME	STATUS
Palmate-bracted Bird's Beak Cordylanthus palmatus Wherever found No critical habitat has been designated for this species. http://ecos.fws.gov/ecp/species/1616	Endangered

San Joaquin Wooly-threads Monolopia (=Lembertia) congdonii — Endangered
Wherever found
No critical habitat has been designated for this species.
http://ecos.fws.gov/ecp/species/3746

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

This location overlaps the critical habitat for the following species:

NAME	TYPE
Fresno Kangaroo Rat Dipodomys nitratoides exilis http://ecos.fws.gov/ecp/species/5150#crithab	Final

NOT FOR CONSULTATION

Migratory birds

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats should follow appropriate regulations and consider implementing appropriate conservation measures, as described below.

1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.

Additional information can be found using the following links:

- Birds of Conservation Concern http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php
- Measures for avoiding and minimizing impacts to birds http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php
- Nationwide conservation measures for birds http://www.fws.gov/migratorybirds/pdf/management/nationwidestandardconservationmeasures.pdf

The birds listed below are birds of particular concern either because they occur on the USFWS Birds of Conservation Concern (BCC) list or warrant special attention in your project location. To learn more about the levels of concern for birds on your list and how this list is generated, see the FAQ below. This is not a list of every bird you may find in this location, nor a guarantee that every bird on this list will be found in your project area. To see exact locations of where birders and the general public have sighted birds in and around your project area, visit the E-bird data mapping tool (Tip: enter your location, desired date range and a species on your list). For projects that occur off the Atlantic Coast, additional maps and models detailing the relative occurrence and abundance of bird species on your list are available. Links to additional information about Atlantic Coast birds, and other important information about your migratory bird list, including how to properly interpret and use your migratory bird report, can be found below.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, click on the PROBABILITY OF PRESENCE SUMMARY at the top of your list to see when these birds are most likely to be present and breeding in your project area.

NAME	BREEDING SEASON (IF A BREEDING SEASON IS INDICATED FOR A BIRD ON YOUR LIST, THE BIRD MAY BREED IN YOUR PROJECT AREA SOMETIME WITHIN THE TIMEFRAME SPECIFIED, WHICH IS A VERY LIBERAL ESTIMATE OF THE DATES INSIDE WHICH THE BIRD BREEDS ACROSS ITS ENTIRE RANGE. "BREEDS ELSEWHERE" INDICATES THAT THE BIRD DOES NOT LIKELY BREED IN YOUR PROJECT AREA.)
Bald Eagle Haliaeetus leucocephalus This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. http://ecos.fws.gov/ecp/species/1626	Breeds Jan 1 to Aug 31
Black Tern Chlidonias niger This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. http://ecos.fws.gov/ecp/species/3093	Breeds May 15 to Aug 20
California Thrasher Toxostoma redivivum This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds Jan 1 to Jul 31
Clark's Grebe Aechmophorus clarkii This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds Jun 1 to Aug 31
Common Yellowthroat Geothlypis trichas sinuosa This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA http://ecos.fws.gov/ecp/species/2084	Breeds May 20 to Jul 31

NOT FOR CONSULTATION

Golden Eagle Aquila chrysaetos — Breeds Jan 1 to Aug 31

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.
http://ecos.fws.gov/ecp/species/1680

Lawrence's Goldfinch Carduelis lawrencei — Breeds Mar 20 to Sep 20

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
http://ecos.fws.gov/ecp/species/9464

Marbled Godwit Limosa fedoa — Breeds elsewhere

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
http://ecos.fws.gov/ecp/species/9481

Nuttall's Woodpecker Picoides nuttallii — Breeds Apr 1 to Jul 20

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA
http://ecos.fws.gov/ecp/species/9410

Short-billed Dowitcher Limnodromus griseus — Breeds elsewhere

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
http://ecos.fws.gov/ecp/species/9480

Tricolored Blackbird Agelaius tricolor — Breeds Mar 15 to Aug 10

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
http://ecos.fws.gov/ecp/species/3910

Willet Tringa semipalmata — Breeds elsewhere

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Yellow-billed Magpie Pica nuttalli — Breeds Apr 1 to Jul 31

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
http://ecos.fws.gov/ecp/species/9726

NOT FOR CONSULTATION

Probability of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read and understand the FAQ

"Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence (■)

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

To see a bar's probability of presence score, simply hover your mouse cursor over the bar.

Breeding Season (■)

Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort (|)

Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

To see a bar's survey effort range, simply hover your mouse cursor over the bar.

No Data (–)

A week is marked as having no data if there were no survey events for that week.

Survey Timeframe

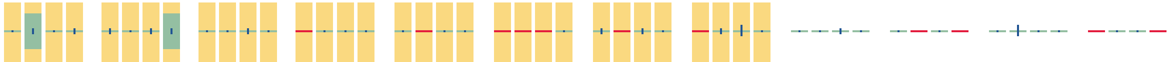
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.

■ probability of presence ■ breeding season | survey effort – no data

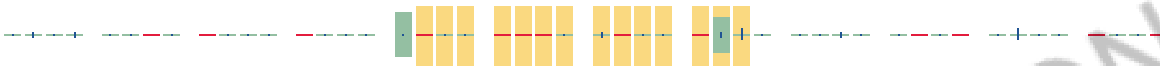
SPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC

NOT FOR CONSULTATION

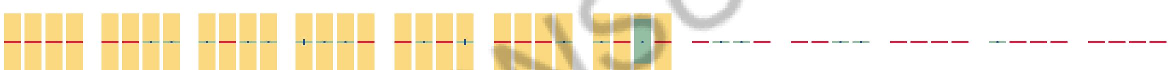
Bald Eagle
Non-BCC Vulnerable (This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.)



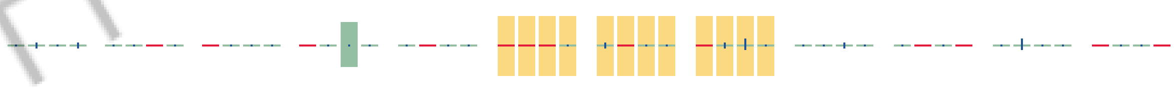
Black Tern
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



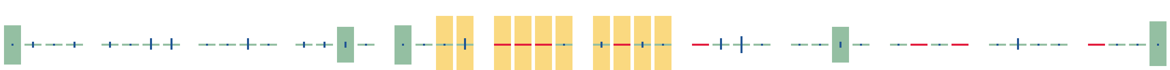
California Thrasher
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



Clark's Grebe
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

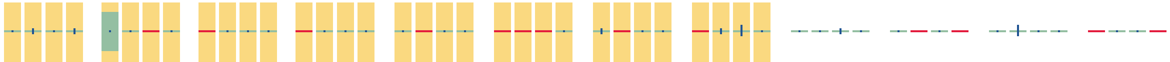


Common Yellowthroat
BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)

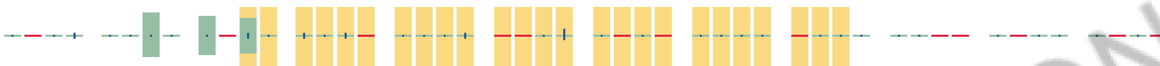


NOT FOR CONSULTATION

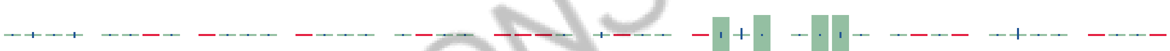
Golden Eagle
Non-BCC Vulnerable (This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.)



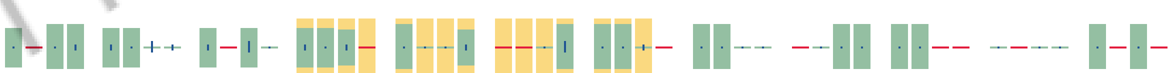
Lawrence's Goldfinch
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



Marbled Godwit
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

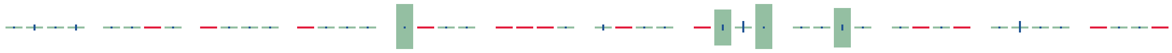


Nuttall's Woodpecker
BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)



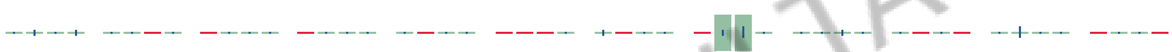
NOT FOR CONSULTATION

Short-billed Dowitcher
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



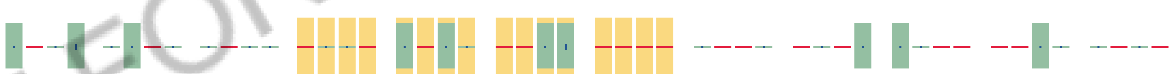
Tricolored Blackbird
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Willet
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



SPECIES JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

Yellow-billed Magpie
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



NOT FOR CONSULTATION

Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Conservation Measures describes measures that can help avoid and minimize impacts to all birds at any location year round. Implementation of these measures is particularly important when birds are most likely to occur in the project area. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is a very helpful impact minimization measure. To see when birds are most likely to occur and be breeding in your project area, view the Probability of Presence Summary. Additional measures or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the migratory birds potentially occurring in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the AKN Phenology Tool.

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets .

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering, migrating or present year-round in my project area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may refer to the following resources: The Cornell Lab of Ornithology All About Birds Bird Guide, or (if you are unsuccessful in locating the bird of interest there), the Cornell Lab of Ornithology Neotropical Birds guide. If a bird on your migratory bird species list has a breeding season associated with it, if that bird does occur in your project area, there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?

Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Eagle Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to try to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially eagles and BCC species of rangewide concern. For more information on conservation measures you can implement to help avoid and minimize migratory bird impacts and requirements for eagles, please see the FAQs for these topics.

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review.

NOT FOR CONSULTATION

Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Bird tracking data can also provide additional details about occurrence and habitat use throughout the year, including migration. Models relying on survey data may not include this information. For additional information on marine bird tracking data, see the Diving Bird Study and the nanotag studies or contact Caleb Spiegel or Pam Loring.

What if I have eagles on my list?

If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the Eagle Act should such impacts occur.

Proper Interpretation and Use of Your Migratory Bird Report

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated, and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please also look carefully at the survey effort (indicated by the black vertical bar) and for the existence of the "no data" indicator (a red horizontal bar). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list helps you know what to look for to confirm presence, and helps guide you in knowing when to implement conservation measures to avoid or minimize potential impacts from your project activities, should presence be confirmed. To learn more about conservation measures, visit the FAQ "Tell me about conservation measures I can implement to avoid or minimize impacts to migratory birds" at the bottom of your migratory bird trust resources page.

NOT FOR CONSULTATION

Facilities

National Wildlife Refuge lands

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

THERE ARE NO REFUGE LANDS AT THIS LOCATION.

Fish hatcheries

THERE ARE NO FISH HATCHERIES AT THIS LOCATION.

Wetlands in the National Wetlands Inventory

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

WETLAND INFORMATION IS NOT AVAILABLE AT THIS TIME

This can happen when the National Wetlands Inventory (NWI) map service is unavailable, or for very large projects that intersect many wetland areas. Try again, or visit the NWI map to view wetlands at this location.

NOT FOR CONSULTATION

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

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APPENDIX C. SURVEY DATA FORMS WITH PHOTOGRAPHS

MAGSA Biological Resources Assessment v2

Project	MAGSA Groundwater Banking Project
ID	193562
Survey Date	11/09/2021
User	Michael Neal
Survey Participants	M. Neal
Time In	02:39 PM
Data Point	1
Location	36.68703867,-120.22878700
Latitude	36.68703867
Longitude	-120.228787
Datum	NAD83/2011
Accuracy	0.0 m
Weather	Mostly clear; 65; winds SE 10
Habitat Type	Irrigation Canal
Plants	*Datura stramonium* / Jimson weed *Salsola kali* / Russian thistle
Other Plants	
Wildlife	
Other Wildlife	Burrows
Settlement Area	false
Industrial/Commercial Facility	true
Direct Impact	false
Comments	Adjacent to James Bypass area

Photos

view west in canal

view east towards S. James Rd and pump station locations from top of canal

burrow

bank burrow

Time Out 02:49 PM

MAGSA Biological Resources Assessment v2

Project	MAGSA Groundwater Banking Project
ID	193544
Survey Date	11/09/2021
User	Michael Neal
Survey Participants	M. Neal
Time In	03:33 PM
Data Point	2
Location	36.68290433,-120.25597667
Latitude	36.68290433
Longitude	-120.25597667
Datum	NAD83/2011
Accuracy	0.0 m
Weather	Mostly sunny; 65; SE wind 5-10
Habitat Type	Riparian, Riverine
Plants	*Asclepias fascicularis* / Milkweed, Narrow-leaf milkweed *Salix gooddingii* / Gooding's willow, Goodding's black willow *Solidago* / Goldenrod
Other Plants	Willow riparian
Wildlife	*Buteo jamaicensis* / Red-tailed hawk
Other Wildlife	
Settlement Area	false
Industrial/Commercial Facility	false
Direct Impact	false
Comments	Accessible point to observe riparian habitat

Photos

view NW towards pump pump station location and typical riparian zone for James Bypass

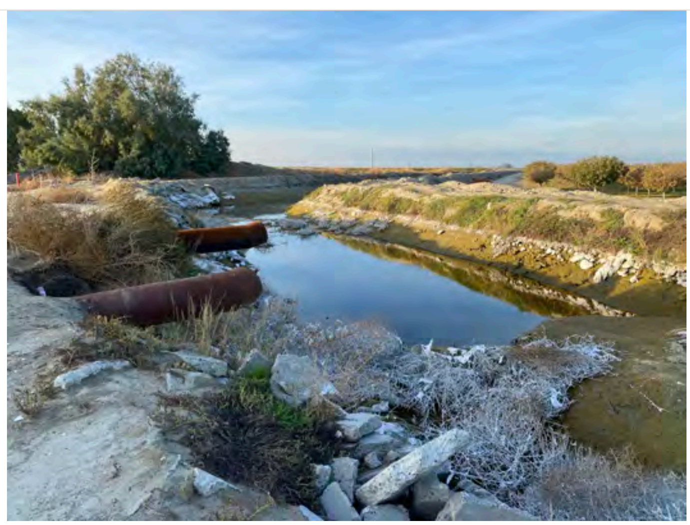
Time Out	03:35 PM

MAGSA Biological Resources Assessment v2

Project	MAGSA Groundwater Banking Project
ID	193556
Survey Date	11/09/2021
User	Michael Neal
Survey Participants	M. Neal
Time In	04:01 PM
Data Point	3
Location	36.68544567,-120.22447717
Latitude	36.68544567
Longitude	-120.22447717
Datum	NAD83/2011
Accuracy	0.0 m
Weather	Mostly sunny; 65; SE 5-10
Habitat Type	Irrigation Canal, Orchard, Riparian, Riverine
Plants	
Other Plants	Single large willow
Wildlife	
Other Wildlife	Songbirds
Settlement Area	false
Industrial/Commercial Facility	false
Direct Impact	true
Comments	Diversion canal and pump station location James Bypass; clam shell on banks

Photos


View east at pump station location


View NW

Time Out	04:01 PM

MAGSA Biological Resources Assessment v2

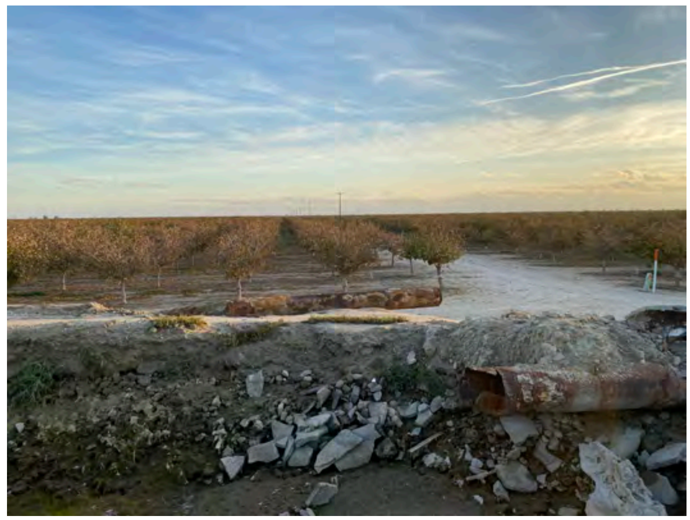
Project	MAGSA Groundwater Banking Project
ID	193570
Survey Date	11/09/2021
User	Michael Neal
Survey Participants	M. Neal
Time In	04:30 PM
Data Point	4
Location	36.70544183,-120.20557883
Latitude	36.70544183
Longitude	-120.20557883
Datum	NAD83/2011
Accuracy	0.0 m
Weather	Mostly sunny; 64; SE 5
Habitat Type	Irrigation Canal, Orchard
Plants	
Other Plants	
Wildlife	*Ardea alba* / Great egret *Ardea herodias* / Great blue heron
Other Wildlife	
Settlement Area	false
Industrial/Commercial Facility	false
Direct Impact	true
Comments	Proposed alignment and pump station

Photos

view east egrets and herons in canal

view west canal and pump infrastructure

canal bank view



view south pistachio orchard

Time Out 04:33 PM

MAGSA Biological Resources Assessment v2

Project	MAGSA Groundwater Banking Project
ID	193558
Survey Date	11/09/2021
User	Michael Neal
Survey Participants	M. Neal
Time In	04:47 PM
Data Point	5
Location	36.70552583,-120.18678067
Latitude	36.70552583
Longitude	-120.18678067
Datum	NAD83/2011
Accuracy	0.0 m
Weather	Mostly sunny; near dusk; 63; calm
Habitat Type	Irrigation Canal, Orchard
Plants	
Other Plants	
Wildlife	
Other Wildlife	Extensive burrows in canal bank
Settlement Area	false
Industrial/Commercial Facility	false
Direct Impact	false
Comments	Along Jensen Canal

Photos

burrow with tailings

active burrow

extensive burrows in banks

Time Out 04:52 PM

MAGSA Biological Resources Assessment v2

Project	MAGSA Groundwater Banking Project
ID	193555
Survey Date	11/09/2021
User	Michael Neal
Survey Participants	M. Neal
Time In	05:03 PM
Data Point	6
Location	36.70549117,-120.16912733
Latitude	36.70549117
Longitude	-120.16912733
Datum	NAD83/2011
Accuracy	0.49 m
Weather	Near dusk; 62; calm
Habitat Type	Irrigation Canal, Orchard
Plants	
Other Plants	
Wildlife	*Buteo jamaicensis* / Red-tailed hawk
Other Wildlife	
Settlement Area	false
Industrial/Commercial Facility	false
Direct Impact	true
Comments	

Photos

hawk on power pole along Jensen Canal and pump station location

Large amount of debris in canal

Intersection at Jensen/Yuba

Time Out 05:06 PM

Project	MAGSA Groundwater Banking Project
ID	193545
Survey Date	11/10/2021
User	Michael Neal
Survey Participants	M. Neal
Time In	08:24 AM
Data Point	7
Location	36.74186800,-120.13243733
Latitude	36.741868
Longitude	-120.13243733
Datum	NAD83/2011
Accuracy	0.0 m
Weather	Fog; 58
Habitat Type	Orchard, Ruderal Roadside, Vinyard
Plants	
Other Plants	Tree nuts and vineyard
Wildlife	
Other Wildlife	
Settlement Area	false
Industrial/Commercial Facility	false
Direct Impact	true
Comments	East canal alignment

Photos

N Lake Ave and Nielsen view east

view north on N. Lake Ave

Time Out	08:28 AM

MAGSA Biological Resources Assessment v2

Project	MAGSA Groundwater Banking Project
ID	193536
Survey Date	11/10/2021
User	Michael Neal
Survey Participants	M. Neal
Time In	08:34 AM
Data Point	8
Location	36.73441767,-120.13244533
Latitude	36.73441767
Longitude	-120.13244533
Datum	NAD83/2011
Accuracy	0.0 m
Weather	Fog; 58; W 5mph
Habitat Type	Orchard, Vinyard
Plants	
Other Plants	
Wildlife	
Other Wildlife	
Settlement Area	false
Industrial/Commercial Facility	false
Direct Impact	true
Comments	East side canal crossing at CA 180

Photos

view north S Lake Ave

Time Out	08:37 AM

MAGSA Biological Resources Assessment v2

Project	MAGSA Groundwater Banking Project
ID	193546
Survey Date	11/10/2021
User	Michael Neal
Survey Participants	M. Neal
Time In	08:55 AM
Data Point	9
Location	36.72003500,-120.11586350
Latitude	36.720035
Longitude	-120.1158635
Datum	NAD83/2011
Accuracy	0.0 m
Weather	Fog; 58; W 5mph
Habitat Type	Orchard, Vinyard
Plants	
Other Plants	
Wildlife	
Other Wildlife	
Settlement Area	false
Industrial/Commercial Facility	false
Direct Impact	true
Comments	RR crossing for east side canal and pump station location

Photos

view west at California Ave

view SE across tracks

Time Out	08:57 AM

MAGSA Biological Resources Assessment v2

Project	MAGSA Groundwater Banking Project
ID	193557
Survey Date	11/10/2021
User	Michael Neal
Survey Participants	M. Neal
Time In	09:08 AM
Data Point	10
Location	36.72227367,-120.11574667
Latitude	36.72227367
Longitude	-120.11574667
Datum	NAD83/2011
Accuracy	0.0 m
Weather	Fog; 59; W 5mph
Habitat Type	Orchard, Ruderal Roadside, Wetland
Plants	*Salix* / Willow
Other Plants	
Wildlife	*Aphelocoma californica* / Western scrub-jay *Ardea alba* / Great egret *Fulica americana* / American coot
Other Wildlife	
Settlement Area	false
Industrial/Commercial Facility	false
Direct Impact	false
Comments	

Photos

view east; impoundment left; Willow scrub habitat right

view north; impoundment right; almond orchard left

view SE; bird nesting habitat at Willow scrub

Time Out 09:17 AM

MAGSA Biological Resources Assessment v2

Project	MAGSA Groundwater Banking Project
ID	193537
Survey Date	11/10/2021
User	Michael Neal
Survey Participants	M. Neal
Time In	10:00 AM
Data Point	11
Location	36.70549117,-120.13789883
Latitude	36.70549117
Longitude	-120.13789883
Datum	NAD83/2011
Accuracy	0.0 m
Weather	Fog; SE wind 5mph; 57
Habitat Type	Orchard
Plants	
Other Plants	
Wildlife	
Other Wildlife	
Settlement Area	true
Industrial/Commercial Facility	true
Direct Impact	true
Comments	Jensen canal around warehouse/yard facilities

Photos

view NE from Jensen

Time Out	10:03 AM

MAGSA Biological Resources Assessment v2

Project	MAGSA Groundwater Banking Project
ID	193547
Survey Date	11/10/2021
User	Michael Neal
Survey Participants	M. Neal
Time In	10:07 AM
Data Point	12
Location	36.70543433,-120.12927950
Latitude	36.70543433
Longitude	-120.1292795
Datum	NAD83/2011
Accuracy	0.58 m
Weather	Light fog; 57; SE wind 5
Habitat Type	Ruderal Roadside, Vinyard
Plants	
Other Plants	
Wildlife	
Other Wildlife	
Settlement Area	false
Industrial/Commercial Facility	false
Direct Impact	true
Comments	Jensen canal pump station location

Photos

view NE

view W at Jensen Ave

Time Out	10:12 AM

MAGSA Biological Resources Assessment v2

Project	MAGSA Groundwater Banking Project
ID	193538
Survey Date	11/10/2021
User	Michael Neal
Survey Participants	M. Neal
Time In	10:19 AM
Data Point	13
Location	36.70551600,-120.11491833
Latitude	36.705516
Longitude	-120.11491833
Datum	NAD83/2011
Accuracy	0.63 m
Weather	Light fog; 57; SE 5 mph
Habitat Type	Orchard, Vinyard
Plants	
Other Plants	
Wildlife	*Corvus brachyrhynchos* / American crow
Other Wildlife	
Settlement Area	true
Industrial/Commercial Facility	false
Direct Impact	false
Comments	Settlement area with mature, large eucalyptus; Jensen canal alignment shifts north of settlements

Photos

view west to alignment shift to avoid settlement

Time Out	10:22 AM

MAGSA Biological Resources Assessment v2

Project	MAGSA Groundwater Banking Project
ID	193568
Survey Date	11/10/2021
User	Michael Neal
Survey Participants	M. Neal
Time In	10:39 AM
Data Point	14
Location	36.70875133,-120.10121733
Latitude	36.70875133
Longitude	-120.10121733
Datum	NAD83/2011
Accuracy	0.43 m
Weather	Overcast; 57; SE 5-10
Habitat Type	Barren/Fallow, Vinyard
Plants	*Amaranthus albus* / Tumbleweed *Datura stramonium* / Jimson weed
Other Plants	
Wildlife	
Other Wildlife	Burrows and coyote tracks in mud
Settlement Area	false
Industrial/Commercial Facility	false
Direct Impact	true
Comments	Along east side canal alignment

Photos

~ 2 in burrow with tailings in fallow area with fill; area has been disturbed with 20x40 excavation approximately 8' deep; burrows everywhere in fallow area

view south; fallow area left; vineyard right

view north; excavated area

view east at elevated fallow field area

height of elevated fallow area

Time Out	10:43 AM

MAGSA Biological Resources Assessment v2

Project	MAGSA Groundwater Banking Project
ID	193548
Survey Date	11/10/2021
User	Michael Neal
Survey Participants	M. Neal
Time In	10:55 AM
Data Point	15
Location	36.70553117,-120.10102550
Latitude	36.70553117
Longitude	-120.1010255
Datum	NAD83/2011
Accuracy	0.33 m
Weather	Overcast; 58; SE winds 10
Habitat Type	Barren/Fallow, Ruderal Roadside
Plants	
Other Plants	
Wildlife	*Corvus brachyrhynchos* / American crow
Other Wildlife	
Settlement Area	false
Industrial/Commercial Facility	true
Direct Impact	true
Comments	East side canal crossing at Jensen and alignment adjacent to AG facility

Photos

view south down east side canal alignment; fallow field left; facilities right

view west; Jensen crossing for east side canal

Time Out	11:00 AM

MAGSA Biological Resources Assessment v2

Project	MAGSA Groundwater Banking Project
ID	193563
Survey Date	11/10/2021
User	Michael Neal
Survey Participants	M. Neal
Time In	11:15 AM
Data Point	16
Location	36.69116450,-120.07881650
Latitude	36.6911645
Longitude	-120.0788165
Datum	NAD83/2011
Accuracy	0.0 m
Weather	Overcast; Winds NW 10
Habitat Type	Barren/Fallow, Orchard
Plants	
Other Plants	
Wildlife	
Other Wildlife	
Settlement Area	true
Industrial/Commercial Facility	false
Direct Impact	true
Comments	East side canal crossing at Madoc/Siskiyou and North Ave


view south towards settlement area


view west at disked field


view east orchards


view north

Time Out 11:18 AM

MAGSA Biological Resources Assessment v2

Project	MAGSA Groundwater Banking Project
ID	193539
Survey Date	11/10/2021
User	Michael Neal
Survey Participants	M. Neal
Time In	11:28 AM
Data Point	17
Location	36.67154250,-120.07907767
Latitude	36.6715425
Longitude	-120.07907767
Datum	NAD83/2011
Accuracy	0.0 m
Weather	Overcast; 57; NNW 10
Habitat Type	Orchard
Plants	
Other Plants	
Wildlife	
Other Wildlife	
Settlement Area	false
Industrial/Commercial Facility	false
Direct Impact	true
Comments	Pump station location for east side canal

Photos

view north at canal alignment and pump station location proposed

Time Out	11:30 AM

MAGSA Biological Resources Assessment v2

Project	MAGSA Groundwater Banking Project
ID	193560
Survey Date	11/10/2021
User	Michael Neal
Survey Participants	M. Neal
Time In	11:38 AM
Data Point	18
Location	36.66210983,-120.07922317
Latitude	36.66210983
Longitude	-120.07922317
Datum	NAD83/2011
Accuracy	0.0 m
Weather	Overcast; 59; NW 10mph
Habitat Type	Orchard, Ruderal Roadside
Plants	
Other Plants	
Wildlife	
Other Wildlife	
Settlement Area	false
Industrial/Commercial Facility	false
Direct Impact	true
Comments	Intersection of American Ave and Siskiyou Ave; Eastside canal; James Alignment, and Siskiyou Canal

Photos

view south down Siskiyou Canal

view west down James Alignment and at pump station location proposed

view north Eastside canal

view east Eastside canal

Time Out 11:43 AM

MAGSA Biological Resources Assessment v2

Project	MAGSA Groundwater Banking Project
ID	192511
Survey Date	11/10/2021
User	Michael Neal
Survey Participants	M. Neal
Time In	11:53 AM
Data Point	19
Location	36.65049067,-120.07930983
Latitude	36.65049067
Longitude	-120.07930983
Datum	NAD83/2011
Accuracy	0.43 m
Weather	Overcast; 59; NW 5-10
Habitat Type	Orchard
Plants	
Other Plants	
Wildlife	
Other Wildlife	
Settlement Area	false
Industrial/Commercial Facility	true
Direct Impact	true
Comments	Pump station location proposed for Siskiyou Canal

Photos

View north at proposed pump station location

Time Out 11:56 AM

MAGSA Biological Resources Assessment v2

Project	MAGSA Groundwater Banking Project
ID	193550
Survey Date	11/10/2021
User	Michael Neal
Survey Participants	M. Neal
Time In	12:06 PM
Data Point	20
Location	36.63252900,-120.07640700
Latitude	36.632529
Longitude	-120.076407
Datum	NAD83/2011
Accuracy	0.31 m
Weather	Overcast; 59; NNW 5-10
Habitat Type	Barren/Fallow, Orchard, Row Crop
Plants	
Other Plants	
Wildlife	
Other Wildlife	
Settlement Area	false
Industrial/Commercial Facility	false
Direct Impact	true
Comments	East to South for Siskiyou Canal

Photos

view south at proposed Siskiyou Canal alignment; fallow left; Alfalfa right

view west

Time Out	12:08 PM

MAGSA Biological Resources Assessment v2

Project	MAGSA Groundwater Banking Project
ID	193541
Survey Date	11/10/2021
User	Michael Neal
Survey Participants	M. Neal
Time In	12:58 PM
Data Point	21
Location	36.66194150,-120.10838733
Latitude	36.6619415
Longitude	-120.10838733
Datum	NAD83/2011
Accuracy	0.0 m
Weather	Overcast; 60; NW 5-10
Habitat Type	Orchard
Plants	
Other Plants	
Wildlife	
Other Wildlife	
Settlement Area	false
Industrial/Commercial Facility	false
Direct Impact	true
Comments	Location for James Alignment pump station at American and Noble

Photos

view of location proposed on south side of American Ave

Time Out	01:00 PM

MAGSA Biological Resources Assessment v2

Project	MAGSA Groundwater Banking Project
ID	193540
Survey Date	11/10/2021
User	Michael Neal
Survey Participants	M. Neal
Time In	01:11 PM
Data Point	22
Location	36.66179950,-120.14723500
Latitude	36.6617995
Longitude	-120.147235
Datum	NAD83/2011
Accuracy	0.81 m
Weather	Overcast; 62; NNW 5-10
Habitat Type	Orchard, Ruderal Roadside, Vinyard
Plants	
Other Plants	
Wildlife	
Other Wildlife	
Settlement Area	true
Industrial/Commercial Facility	false
Direct Impact	true
Comments	Pump station location proposed at American Ave and S Plumas.

Photos

view to south side of American Ave.

Time Out	01:13 PM

MAGSA Biological Resources Assessment v2

Project	MAGSA Groundwater Banking Project
ID	193566
Survey Date	11/10/2021
User	Michael Neal
Survey Participants	M. Neal
Time In	01:26 PM
Data Point	23
Location	36.66157183,-120.18805650
Latitude	36.66157183
Longitude	-120.1880565
Datum	NAD83/2011
Accuracy	0.0 m
Weather	Overcast; 62; NNW 5-10
Habitat Type	Annual Grassland, Orchard, Ruderal Roadside
Plants	
Other Plants	
Wildlife	*Tyto alba* / Barn owl
Other Wildlife	Songbird calls; barn owls in boxes along bypass; burrows
Settlement Area	false
Industrial/Commercial Facility	false
Direct Impact	true
Comments	Proposed pump station location for James Alignment next to James Bypass

Photos

view south at Bypass habitats

view west

view north; irrigation canal foreground; almond orchard background

view west

Time Out 01:30 PM

MAGSA Biological Resources Assessment v2

Project	MAGSA Groundwater Banking Project
ID	193543
Survey Date	11/10/2021
User	Michael Neal
Survey Participants	M. Neal
Time In	02:04 PM
Data Point	24
Location	36.60325033,-120.07973567
Latitude	36.60325033
Longitude	-120.07973567
Datum	NAD83/2011
Accuracy	0.0 m
Weather	Partly sunny; 64; NNW 5-10
Habitat Type	Orchard, Row Crop
Plants	
Other Plants	
Wildlife	
Other Wildlife	
Settlement Area	false
Industrial/Commercial Facility	false
Direct Impact	true
Comments	crossing for Siskiyou Canal at Manning avenue

Photos

view north at canal alignment crossing at Manning Avenue

Time Out	02:07 PM

MAGSA Biological Resources Assessment v2

Project	MAGSA Groundwater Banking Project
ID	193542
Survey Date	11/10/2021
User	Michael Neal
Survey Participants	M. Neal
Time In	02:15 PM
Data Point	25
Location	36.59591133,-120.07974200
Latitude	36.59591133
Longitude	-120.079742
Datum	NAD83/2011
Accuracy	0.27 m
Weather	Partly sunny; 64; NNW 5-10mph
Habitat Type	Row Crop
Plants	
Other Plants	
Wildlife	*Buteo jamaicensis* / Red-tailed hawk
Other Wildlife	
Settlement Area	false
Industrial/Commercial Facility	false
Direct Impact	true
Comments	End Siskiyou Canal and pump station location

Photos

view north

Time Out	02:16 PM

MAGSA Biological Resources Assessment v2

Project	MAGSA Groundwater Banking Project
ID	193549
Survey Date	11/10/2021
User	Michael Neal
Survey Participants	M. Neal
Time In	02:43 PM
Data Point	26
Location	36.66206650,-120.04832417
Latitude	36.6620665
Longitude	-120.04832417
Datum	NAD83/2011
Accuracy	0.56 m
Weather	Mostly cloudy; 65; NW 5 mph
Habitat Type	Orchard
Plants	
Other Plants	
Wildlife	
Other Wildlife	
Settlement Area	false
Industrial/Commercial Facility	false
Direct Impact	true
Comments	Pump station location for Eastside Canal

Photos

view towards proposed location and canal alignment west

Time Out	02:44 PM

MAGSA Biological Resources Assessment v2

Project	MAGSA Groundwater Banking Project
ID	193567
Survey Date	11/10/2021
User	Michael Neal
Survey Participants	M. Neal
Time In	02:58 PM
Data Point	27
Location	36.65498800,-120.02515433
Latitude	36.654988
Longitude	-120.02515433
Datum	NAD83/2011
Accuracy	0.44 m
Weather	Partly sunny; NW 5-10; 65
Habitat Type	Irrigation Canal, Row Crop
Plants	
Other Plants	Alfalfa
Wildlife	*Buteo jamaicensis* / Red-tailed hawk *Zenaida macroura* / Mourning dove
Other Wildlife	Burrows
Settlement Area	false
Industrial/Commercial Facility	false
Direct Impact	false
Comments	Alfalfa fields

Photos

view west

view south; canal; bank burrows

view east

view north

Time Out 03:02 PM

MAGSA Biological Resources Assessment v2

Project	MAGSA Groundwater Banking Project
ID	193561
Survey Date	11/10/2021
User	Michael Neal
Survey Participants	M. Neal
Time In	03:41 PM
Data Point	28
Location	36.66234633,-119.98790150
Latitude	36.66234633
Longitude	-119.9879015
Datum	NAD83/2011
Accuracy	0.0 m
Weather	Mostly sunny; 65; NNW 5
Habitat Type	Orchard, Row Crop
Plants	
Other Plants	
Wildlife	
Other Wildlife	Songbirds
Settlement Area	true
Industrial/Commercial Facility	false
Direct Impact	true
Comments	Relict settlement area; pump location for Eastside Canal

Photos

view west American Ave toward pump station location

view north relict settlement area

view east

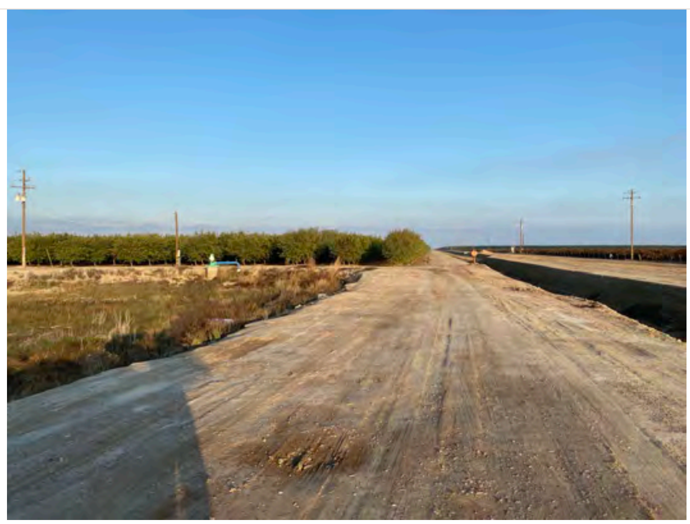
Time Out 03:47 PM

MAGSA Biological Resources Assessment v2

Project	MAGSA Groundwater Banking Project
ID	193551
Survey Date	11/10/2021
User	Michael Neal
Survey Participants	M. Neal
Time In	04:06 PM
Data Point	29
Location	36.66263600,-119.97020700
Latitude	36.662636
Longitude	-119.970207
Datum	NAD83/2011
Accuracy	0.0 m
Weather	Mostly sunny; NW 5mph; 63
Habitat Type	Irrigation Canal, Orchard, Vinyard
Plants	
Other Plants	
Wildlife	
Other Wildlife	
Settlement Area	false
Industrial/Commercial Facility	false
Direct Impact	true
Comments	Crossing at American Ave and Dickenson for Eastside Canal; detention facility- no habitat

Photos

view west to road crossing



view east; canal right; detention facility left

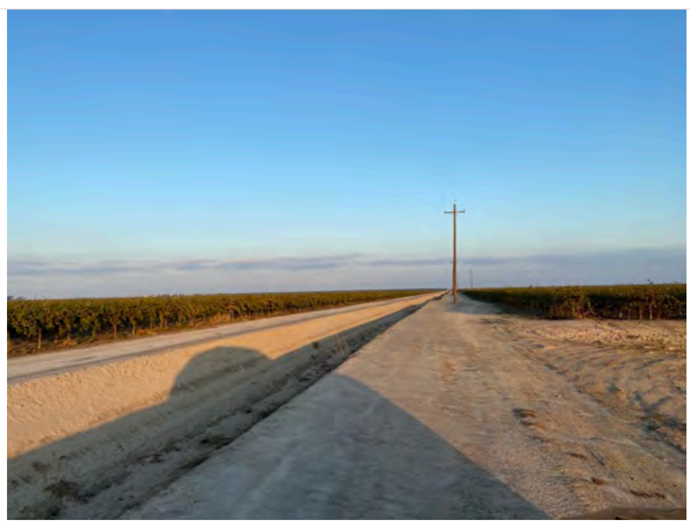
Time Out	04:08 PM

MAGSA Biological Resources Assessment v2

Project	MAGSA Groundwater Banking Project
ID	193553
Survey Date	11/10/2021
User	Michael Neal
Survey Participants	M. Neal
Time In	04:19 PM
Data Point	30
Location	36.66251717,-119.92516783
Latitude	36.66251717
Longitude	-119.92516783
Datum	NAD83/2011
Accuracy	0.26 m
Weather	
Habitat Type	Vinyard
Plants	
Other Plants	
Wildlife	*Charadrius vociferus* / Killdeer
Other Wildlife	
Settlement Area	false
Industrial/Commercial Facility	false
Direct Impact	false
Comments	AG waste area just south of Eastside Canal alignment

Photos

AG waste area killdeer; view south



view east along canal alignment

Time Out	04:21 PM

MAGSA Biological Resources Assessment v2

Project	MAGSA Groundwater Banking Project
ID	193552
Survey Date	11/10/2021
User	Michael Neal
Survey Participants	M. Neal
Time In	04:34 PM
Data Point	31
Location	36.66272783,-119.89868483
Latitude	36.66272783
Longitude	-119.89868483
Datum	NAD83/2011
Accuracy	0.0 m
Weather	Mostly sunny; 62; NW 5
Habitat Type	Irrigation Canal, Orchard
Plants	
Other Plants	
Wildlife	*Buteo jamaicensis* / Red-tailed hawk
Other Wildlife	
Settlement Area	false
Industrial/Commercial Facility	false
Direct Impact	true
Comments	East side canal turn south onto S Hayes from American

Photos

view south

view west

Time Out	04:36 PM

MAGSA Biological Resources Assessment v2

Project	MAGSA Groundwater Banking Project
ID	193554
Survey Date	11/11/2021
User	Michael Neal
Survey Participants	M. Neal
Time In	09:02 AM
Data Point	32
Location	36.73479117,-120.17764017
Latitude	36.73479117
Longitude	-120.17764017
Datum	NAD83/2011
Accuracy	0.0 m
Weather	Overcast; 70; calm
Habitat Type	Ruderal Roadside
Plants	
Other Plants	
Wildlife	
Other Wildlife	CDFW lands ecological reserve
Settlement Area	false
Industrial/Commercial Facility	false
Direct Impact	false
Comments	Fenced preserve areas

Photos

View NW to preserve area

view south from south side of CA 180

Time Out 09:07 AM

MAGSA Biological Resources Assessment v2

Project	MAGSA Groundwater Banking Project
ID	193565
Survey Date	11/11/2021
User	Michael Neal
Survey Participants	M. Neal
Time In	09:16 AM
Data Point	33
Location	36.74915817,-120.20485500
Latitude	36.74915817
Longitude	-120.204855
Datum	NAD83/2011
Accuracy	0.44 m
Weather	Overcast; 58; calm
Habitat Type	Orchard, Vinyard
Plants	
Other Plants	
Wildlife	
Other Wildlife	CDFW Ecological Preserve
Settlement Area	false
Industrial/Commercial Facility	false
Direct Impact	false
Comments	Preserve with adjacent agricultural

Photos

view SE from corner of preserve

view west

view east

view north orchard/vineyard

Time Out 09:20 AM

MAGSA Biological Resources Assessment v2

Project	MAGSA Groundwater Banking Project
ID	193569
Survey Date	11/11/2021
User	Michael Neal
Survey Participants	M. Neal
Time In	09:33 AM
Data Point	34
Location	36.73450450,-120.26413467
Latitude	36.7345045
Longitude	-120.26413467
Datum	NAD83/2011
Accuracy	0.41 m
Weather	Overcast; 60; calm
Habitat Type	Ruderal Roadside, Wetland
Plants	*Salix gooddingii* / Gooding's willow, Goodding's black willow *Schoenoplectus acutus* / Hardstem bulrush
Other Plants	
Wildlife	*Agelaius phoeniceus* / Red-winged blackbird
Other Wildlife	
Settlement Area	false
Industrial/Commercial Facility	false
Direct Impact	false
Comments	

Photos

red-winged blackbird in emergent bulrush (fill in habitat in foreground)

drainage under CA180; no culvert visible; debris dump off road fill

view north at emergent habitat

view south from south side of CA180

Time Out	09:45 AM

MAGSA Biological Resources Assessment v2

Project	MAGSA Groundwater Banking Project
ID	193564
Survey Date	11/11/2021
User	Michael Neal
Survey Participants	M. Neal
Time In	09:52 AM
Data Point	35
Location	36.73433183,-120.24790933
Latitude	36.73433183
Longitude	-120.24790933
Datum	NAD83/2011
Accuracy	0.0 m
Weather	Overcast; 60; calm
Habitat Type	Riverine
Plants	*Salsola kali* / Russian thistle
Other Plants	
Wildlife	
Other Wildlife	
Settlement Area	false
Industrial/Commercial Facility	false
Direct Impact	false
Comments	Drainage under CA 180

Photos


view NW culvert under CA 180


view south down drainage


view SE


view north

Time Out 09:57 AM

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Appendix 6

US Fish and Wildlife Service Endangered Species Act Consultation and Determination Letter

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, Suite W-2605
Sacramento, California 95825-1846
SFWO_mail@fws.gov

In Reply Refer to
2024-0048262

February 13, 2024
Sent Electronically

David E. Hyatt
Chief, Resource Management Division
Bureau of Reclamation
1243 N Street
Fresno, CA 93721
dhyatt@usbr.gov

Subject: Informal Consultation on the Aquaterra Groundwater Banking Project, Fresno County, California

Dear David Hyatt:

This letter is in response to the United States Department of the Interior, Bureau of Reclamation's (Reclamation) request for informal consultation with the U.S. Fish and Wildlife Service (Service) on the Aquaterra Groundwater Banking Project (Project) in Fresno County, California. The proposed Project includes the construction and operation of an 800,000-acre-foot water bank, recognized as a water bank by Reclamation, underlying the McMullin Area Groundwater Sustainability Agency (MAGSA) area that simultaneously provides flexibility to water contractors and contributes to aquifer recharge. The proposed action is needed to improve regional groundwater sustainability through the provision of additional water storage intended to maximize the capture and use of allocated waters.

Reclamation has made the determination that the Project may affect, but is not likely to adversely affect the giant garter snake (*Thamnophis gigas,* snake), and the San Joaquin kit fox (*Vulpes macrotis mutica*, kit fox. This response is provided under the authority of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq*.) (Act) and in accordance with the implementing regulations pertaining to interagency cooperation (50 CFR 402). The findings and recommendations presented in this document are based on: (1) Reclamation's letter requesting initiation of informal consultation; (2) a biological assessment dated December, 2022; (3) enclosures with additional information regarding the proposed Project including Project figures and photographs; (4) email and phone correspondence between the Service, Reclamation, and the Natural Resource Conservation Service (NRCS), and (5) other information available to the Service.

Reclamation's action associated with this project entails acknowledgement of the groundwater bank to allow banking of Central Valley Project (CVP) water as authorized by the Central Valley Project Improvement Act (CVPIA, Title XXXIV, Public Law 102-575, October 1992), and as authorized by certain federal contracts. At this time there are no CVP banking agreements for the proposed groundwater bank. These would be separate federal actions that would be considered in the future and consulted upon if applicable.

The action area includes portions of the lands within the approximately 123,000-acre MAGSA boundary located west of State Route (SR) 99 in rural Fresno County, approximately 16 miles southwest of Fresno, California.

Project implementation will include easement acquisition and project infrastructure construction. Construction elements will consist of staging areas and conveyance canals which will connect and form a network of alignments. The project will also include diversion points, lift pump stations, and recharge and recovery facilities.

The action area is characterized by intensively managed agriculture, ruderal roadside weedy species, bare soils or gravels, few isolated large trees, and a minimal amount of open water and associated emergent or scrub wetland or riparian vegetation. The action area is almost completely developed for agriculture, except for lands immediately adjacent to the MWA and Fresno Slough. Agricultural lands are comprised of row crops, orchards, and vineyards, and small areas are dedicated to poultry, dairy cattle, and agricultural processing and packing facilities. Some lands are fallow, disked, vacant, or ruderal plots. Fallowed fields and rights-of-way within the action area may serve as wildlife corridors for some adaptable species but are sparse and highly fragmented. Settlements with home sites and associated outbuildings and storage areas occur interspersed throughout the agricultural lands throughout the MAGSA area. Overall, these areas are of relatively low wildlife habitat value. Some portions of the action area have numerous burrows, likely made by California ground squirrels and valley pocket gophers as both of these species were observed in the action area.

The action area is within the current and historic range of this species, and four kit fox occurrences are shown within the greater MAGSA boundary in the California Natural Diversity Database (CNDDB). However, occurrences are historical, dating back more than 20 years. Intensively managed, frequently disturbed agricultural lands and development related to animal farming operations and crop production offer low-quality habitat for kit fox and their prey base. The habitat that surrounds the action area is similarly developed and of low quality. Kit fox may disperse into agricultural areas if adequate prey species are available, but they would be unlikely to use the project area for any purpose other than to commute between suitable habitat locations elsewhere in the region. Kit fox may use the adjacent MWA, James Bypass, or the San Joaquin River corridors for dispersal. Kit fox occurrences within the action area, should they occur, are therefore likely to be transient in nature.

The action area occurs within the historic range of the snake, although the species is scarce throughout its Central Valley range. Only one of the six CNDDB recorded occurrences from the project area quadrangles occurred within the last 20 years; The California Department of Fish and Wildlife (CDFW) recorded that occurrence in the MWA in 2008. The most likely location within the action area for the snake to occur is at the proposed diversion pump station location in the MWA. Habitats that are permanently or seasonally flooded and contain herbaceous wetland vegetation such as cattails and bulrushes do occur within and adjacent to the action area but are frequently disturbed or are immediately adjacent to frequently disturbed areas.

Suitable habitat for the snake within the action area likely occurs in some portions of the Fresno Slough, and the unmaintained irrigation canals and ditches can substitute as marginally suitable habitat within the action area. However, these features are almost entirely bordered by active agriculture and therefore generally lack the suitable upland habitat components necessary and/or are disturbed at least seasonally. The portion of the action area at the Fresno Slough is associated with a larger body of water, which likely has an abundance of non-native, introduced predatory fish, and would not likely be suitable habitat for the snake. No rice fields occur in the MAGSA boundary or the action area. Areas with excessive shade, lack of basking sites, and absence of prey are not considered suitable habitat. Additionally, anticipated disturbances in potentially suitable snake habitat would be expected to occur over an insignificant amount and be relatively minor by using modern construction techniques such as jack-and-bore systems.

Most areas affected by ground disturbance have no suitable habitat for the kit fox or snake. Even where potential habitat does occur, such as the Mendota Pool diversion locations or fallowed agricultural lands, the habitat is still less than suitable. Thus, an occurrence of either of these two species in the action area would be rare. Nonetheless, Reclamation has committed to conservation measures that will further avoid and minimize the potential for adverse effects to occur to the species, as outlined below.

1. The Service's *Standardized Recommendations for the Protection of the San Joaquin Kit Fox Prior to or During Ground Disturbance* (USFWS 2011), with the exception of the destruction of dens measure, will be incorporated into the project and shall be implemented to avoid potential impacts to kit fox. MAGSA's conservation measure to protect and preserve kit fox is den avoidance.

2. Identification and monitoring of potential kit fox dens (squirrel burrows) along the Main Canal alignments shall be conducted for three consecutive nights to evaluate kit fox use per USFWS 2011 guidelines (USFWS 2011). A report on the findings will be prepared. Vacant squirrel holes will be filled by hand after the survey by a qualified biologist to prevent future use by and future impacts to the kit fox.

3. A preconstruction (one-day) survey shall be conducted by a qualified biologist to examine potential dens (squirrel burrows) on and immediately adjacent to the project area for the existence of kit fox. The survey shall be conducted within 30 days prior to any construction activities. Results of the preconstruction survey shall be prepared in a letter and given to MAGSA prior to any construction activities.

4. If a kit fox den is discovered within the action area or within 200 feet of the action area, then the Service and CDFW shall be immediately consulted, and appropriate avoidance measures shall be developed in cooperation with the qualified project biologist and MAGSA.

5. A qualified biologist will flag and designate avoided snake habitat within or immediately adjacent to the project area as Environmentally Sensitive Areas to be avoided by all construction personnel and equipment.

6. Escape routes for snake should be determined in advance of construction and snakes will be allowed to leave on their own.

7. Construction activities within 200 feet from the banks of snake aquatic habitat will be avoided to the greatest extent possible.

8. Vegetation clearing will be confined to the minimal area necessary to facilitate construction activities.

9. Movement of heavy equipment will be confined to existing roadways to minimize habitat disturbance.

10. Construction-related holes will be covered to prevent entrapment of individuals.

11. If temporary giant garter snake habitat disturbance is necessary, then 24 hours prior to construction activities, the habitat will be surveyed for snake by a qualified biologist. The survey will be repeated if a lapse in construction activity of two weeks or greater has occurred.

12. Construction activity within snake habitat will be conducted between May 1 and October 1. This is the active period for the snake, and direct mortality is lessened, because snakes are expected to actively move and avoid danger.

13. Any dewatered habitat will be required to remain dry for at least 15 consecutive days after April 15, and prior to excavating or filling of the dewatered habitat. Sightings or incidental take will be reported to the Service and CDFW immediately.

14. During post-construction restoration, the MAGSA contractor will remove any temporary fill and construction debris and restore temporarily disturbed areas to pre-project conditions. If erosion control materials are needed in suitable habitat for the snake, only non-entangling erosion control materials (no monofilament) will be used to reduce the potential for entrapment. This limitation will be communicated to the contractor through use of special provisions included in the bid solicitation package.

The Service concurs with the determination that the proposed Project may affect, but is not likely to adversely affect San Joaquin kit fox and giant garter snake. The action area contains habitat that is likely only marginally suitable for either species, and the proposed activities are not expected to have a significant impact on individuals of the species even if they are present. Additionally, Reclamation has committed to conservation measures that will further avoid and minimize the potential for adverse effects to occur to both species.

This concludes the Service's review of the proposed Project. No further coordination with the Service under the Act is necessary at this time. Please note, however, this letter does not authorize take of listed species. As provided in 50 CFR §402.14, initiation of formal consultation is required where there is discretionary federal involvement or control over the action (or is authorized by law) and if: 1) new information reveals the effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this review; 2) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this review; or 3) a new species is listed or critical habitat designated that may be affected by the action.

If you have any questions, please contact Matthew Nelson, Fish and Wildlife Biologist (matthew_nelson@fws.gov) or me (patricia_cole@fws.gov), at the letterhead address or at (916) 414-6544.

Sincerely,

Patricia Cole
Supervisor, San Joaquin Valley Division

cc:
Jesse Bahm, USDA/Natural Resources Conservation Service, Fresno, CA
Craig Bailey, California Department of Fish and Wildlife, Fresno, CA
Shauna McDonald, Bureau of Reclamation, Fresno, CA

Appendix 7

MAGSA Tribal Coordination Letter

McMullin Area
Groundwater Sustainability Agency

275 S. Madera Avenue, Suite 301
Kerman, CA 93630
559-515-3339

January 22, 2024

RE: The Proposed Aquaterra Groundwater Bank Project, Fresno County, California

To Whom It May Concern,

The McMullin Area Groundwater Sustainability Agency (MAGSA) is proposing to develop infrastructure to capture excess water generated during flood flows and divert it to recharge basins as part of operations of the Aquaterra Groundwater Bank Project (Project). The proposed Project will be located in Fresno County and the Kings Subbasin, all within the +/- 120,000 acre MAGSA management area (Enclosure 1). For more information regarding MAGSA visit https://www.mcmullinarea.org/.

This letter provides information regarding the construction and operation of the Project and environmental review to date. Under the proposed Project, excess water that is spilled from San Luis Reservoir and flows into the Mendota Pool will be diverted by pipes that will export water from the edges of the Mendota Wildlife Area and the northern end of the James Bypass into recharge basins located on the eastern edge of the MAGSA management area. These diverted waters will be used for direct groundwater recharge and stored as deposits on behalf of contract water users until such time as they request that the water is withdrawn. Withdrawn water will be pumped back into the Mendota Pool during dry periods to help sustain fish and wildlife habitat and to provide water for downstream users. An Initial Study under the California Environmental Quality Act (CEQA) is being prepared for the Project.

Project Name: The Aquaterra Groundwater Bank Project, Fresno County, California

Location: The proposed Project is located within approximately 5,174 specific acres of agricultural land within the MAGSA management area boundary. The Project is west and southwest of the City of Fresno, east of the Fresno Slough, west of Kerman, and near Raisin City. All the land is within a primarily rural agricultural developed region. A large variety of crops are grown in the area including annual crops (e.g., peppers, onions, tomatoes, carrots), perennial crops (e.g., almonds, walnuts, pistachios, vineyards), and pasture and dairy land.

- The Project overlaps with several United States Geological Survey (USGS) 7.5 Minute Topographic Quadrangle maps, Townships, Ranges, and Sections (Enclosure 1).

BOARD OF DIRECTORS
Seat 1, Brian Pacheco • Seat 2, Don Cameron • Seat 3, Jonathon DeGroot • Seat 4, Ariel Namvar • Seat 5, Matt Abercrombie

OFFICERS
Don Cameron, Chair • Matthew Hurley, Secretary/Treasurer

Proposed Project: The proposed Project is currently under design. Land to be used for the groundwater bank will be a subset of the total acreage of the MAGSA management area. Farmers will voluntarily participate in this program and agricultural fields will also continue to remain active as the banking program is compatible with farming practices (e.g., planting, fallowing, harvesting). Three types of easements are planned for the proposed Project: permanent flood easements, permanent conveyance easements, and temporary construction easements. The easements are described below:

- **Conveyance Infrastructure and Temporary Construction Easements**: 63.5 linear miles by 200 feet horizontal width (approximately 1,804 acres total) and includes the main canals levees, lateral levees, pump stations along the main canals with pumps, recovery wells, staging areas, and road crossings The vertical APE varies depending on canal or well specifications. The vertical ground disturbance depth varies depending on canal or well specifications.

- **Recharge Basins:** would include approximately 3,294.8 acres of existing agricultural fields and includes various landowner parcels. A basin may be obtained from the landowners for farmland identified as recharge farmland. Farmers will be able to continue growing seasonal crops within the recharge basins. All recharge and berm project activity ground disturbance depth will be within the existing disturbed soils of the agricultural areas.

The proposed Project is within an agricultural environment (row crops, orchards, paved roadways, water conveyance systems) that has been historically disturbed (disced, tilled) and flooded for agricultural purposes.

Cultural Resource Review to Date: A California Historical Resources Information Center records search of the Project and surrounding 0.5 mile radius was conducted via the Southern San Joaquin Valley Information Center (SSJVIC), Division of Anthropology, California State University, Bakersfield, on June 1, 2021 (Records Search File No.: 21-189) and on February 20, 2023 (File no.: 23-042. The SSJVIC records search identified 14 previously conducted cultural resource studies that overlap with the Project and 5 previously recorded historic era-built environment cultural resources overlap with the Project. These cultural resources consist of two transmission lines, a railroad right of way, a farming community, and a water conveyance system. The built environment resources will be avoided by the Project.

A Native American Heritage Commission (NAHC) Sacred Lands File Search was requested on January 21, 2023. The NAHC responded on February 17, 2023, that the Sacred Lands File Search record search results were positive. The NAHC provided a list of tribal representatives and recommended contacting those listed for information regarding known tribal cultural resources within or near the Project (Enclosure 2).

An archaeological survey was conducted for the Project and the reporting is in process. The pedestrian field survey resulted in the identification of five (5) historic era archaeological sites, eight (8) historic era isolates (glass, metal, or ceramic fragments), and four (4) precontact isolated pieces of debitage (lithic flake). Geoarchaeological studies are forthcoming.

Conclusion: We respectfully request your participation in this local planning process, as tribal knowledge and participation regarding the proposed Project is important. If you possess any information or knowledge regarding tribal cultural resources or other resources of importance to the tribe in and around the proposed Project, please reply to me via email at mhurley@mcmullinarea.org. Also, if you have any questions or need additional information, please feel free to call (559) 515-3339 or email Cristel Tufenkjian at ctufenkjian@mcmullinarea.org or the cultural resources specialist for the consultant at Jennifer.farrell@tetratech.com.

Very truly yours,

Matthew H Hurley
General Manager
McMullin Area GSA

Enclosure:
1. Project Maps
2. Native American Heritage Commission Sacred Lands File Results

Other Tribal Governments being consulted:
Big Sandy Rancheria of Western Mono Indians
Chicken Ranch Rancheria of Me-Wuk Indians
Cold Springs Rancheria of Mono Indians
Dumna Band of Mono Indians
Dunlap Band of Mono Indians
Kings River Choinumni Farm Tribe
Nashville Enterprise Miwok-Maidu-Nishinam Tribe
North Fork Mono Tribe
North Fork Rancheria of Mono Indians
North Valley Yokuts Tribe
Picayune Rancheria of Chukchansi Indians
Salinan Tribe of Monterey, San Luis Obispo Counties
Santa Rosa Rancheria Tachi Yokut Tribe
Table Mountain Rancheria
Traditional Choinumni Tribe
Tule River Indian Tribe
Tuolumne Band of Me-Wuk Indians
Wuksache Indian Tribe/Eshom Valley Band
Xolon-Salinan Tribe

TETRA TECH

MAGSA

Appendix 8

Aquaterra Groundwater Bank Project: Mitigation Monitoring and Reporting Program

MCMULLIN AREA GROUNDWATER SUSTAINABILITY AGENCY

AQUATERRA GROUNDWATER BANK PROJECT

MITIGATION, MONITORING, AND REPORTING PROGRAM
FRESNO COUNTY, CALIFORNIA

PREPARED BY:

TETRA TECH

MARCH 2024

CONTENTS

1. Introduction 1

2. Purpose 1

3. Roles and Responsibilities 1

4. Future Changes to Mitigation Measures 1

5. Mitigation Measures 2

air-1) Prepare and Implement a Fugitive Dust Control Plan 2

AIR-2) Minimize Personnel and Public Exposure 3

AIR-3) Implement Vehicle Emissions Controls 3

BIO-1) General Measures 4

BIO-2) Protect and Preserve Giant Garter Snake 4

BIO-3) Protect and Preserve Tricolored Blackbird 5

BIO-4) Protect and Preserve Waters of the U.S. and Waters of the State 6

BIO-5) Protect and Preserve the Burrowing Owl 6

BIO-6) Protect and Preserve Swainson's Hawk 7

BIO-7) Protect and Preserve Nesting Birds 7

BIO-8) Protect and Preserve San Joaquin Kit Fox 8

CUL-1: Worker Environmental Training 8

CUL-2: Cultural Resource Monitoring and Inadvertent Discovery Plan 8

GEO-1: Certified Paleontologist 9

HAZ-1: Prepare and Implement a Spill Prevention and Response Plan (SPRP). 9

TRA-1: Prepare and Implement a Traffic Safety Plan. 10

WAT-1: Recharge Basin Screening 10

WAT-2: Manage Import Water to the bank 11

WAT-3: Recharge basin Employment and operations 11

WAT-4: Recovery Well Distribution and Design 11

WAT-5: Groundwater Monitoring And Export Water Standards 11

WAT-6. Compliance with Irrigated Lands Regulatory Program (ILRP) 11

WAT-7. Stormwater Pollution Prevention Plan (SWPPP) 12

WAT-8. Inspect Water Control Structures and Canals. 12

WAT-9. Develop and Implement Surface water Monitoring Plan 12

WAT-10. Develop and implement Facilities operation, Maintenance and Monitoring manual 12

WAT-11. Manage diversions and recovery Timing 13

WAT-12. Develop and Implement Operation Model 13

6. Mitigation Summary Table 13

LIST OF TABLES

Table A. Mitigation Monitoring and Reporting Program, Summary Table of Mitigation Measures 14

1. INTRODUCTION

This Mitigation, Monitoring and Reporting Program (MMRP) has been prepared pursuant to the California Environmental Quality Act (CEQA) and the State CEQA Guidelines. It provides for the monitoring of mitigation measures required of the McMullin Area Groundwater Sustainability Agency (MAGSA) in the Aquaterra Groundwater Bank Project (proposed project), as set forth in the Initial Study/Mitigated Negative Declaration (IS/MND).

Section 21081.6 of the California Public Resources Code and Sections 15091(d) and 15097 of the State CEQA Guidelines require public agencies "to adopt a reporting or monitoring program for changes to the project which it has adopted or made a condition of project approval in order to mitigate or avoid significant effects on the environment."

An MMRP is required for the proposed project because the IS/MND identified potentially significant adverse impacts and identified mitigation measures to reduce some of those impacts to less than significant levels. All measures are intended to offset, to the degree possible, potential adverse effects under CEQA.

2. PURPOSE

This MMRP has been prepared to ensure that all required mitigation measures are implemented and completed according to schedule and maintained in a satisfactory manner throughout implementation of the proposed project. The MMRP may be modified by MAGSA in response to changing conditions or circumstances.

Table A below provides a summary of the individual mitigation measures, and for each measure identifies the agency responsible for implementation, schedule timing, and verification of implementation. Specific impacts for which mitigation measures are proposed are provided in the IS/MND. The order in which mitigation measures are presented (by resource category) follows the sequence established in the IS/MND. MAGSA will either act as the project sponsor or will coordinate with the project sponsor to construct the proposed project.

3. ROLES AND RESPONSIBILITIES

Unless otherwise specified herein, MAGSA is responsible for taking all actions necessary to implement the mitigation measures according to the provided specifications and demonstrating that each action has been successfully completed. MAGSA, at its discretion, may assume responsibility for any of the measures described herein, or may delegate implementation responsibility or portions thereof to a licensed contractor or other responsible party.

4. FUTURE CHANGES TO MITIGATION MEASURES

Any substantive change to the MMRP shall be documented in writing. Modifications to mitigation measures may be made by MAGSA subject to one of the following findings:

1. The measure included in the IS/MND and the MMRP is no longer required because the significant environmental impact identified in the IS/MND has been found not to exist, or to

occur at a level which makes the impact less than significant as a result of changes in the project, changes in conditions of the environment, or other factors.

OR

2. A modified or substitute mitigation measure to be included in the MMRP provides a level of environmental protection equal to or greater than that afforded by the mitigation measure included in the IS/MND and the MMRP.

   AND

3. The modified or substitute mitigation measures do not have significant adverse effects on the environment in addition to or greater than those which were considered by MAGSA in its decisions regarding the IS/MND and the proposed project.

   AND

4. The modified or substitute mitigation measures are feasible, and MAGSA, through measures included in the MMRP or other established procedures, can assure their implementation.

Findings involving modifications to mitigation measures, and related documentation supporting the findings, shall be maintained in the project file with the MMRP and shall be made available to the public upon request.

5. MITIGATION MEASURES

A total of 28 mitigation measures have been identified as necessary for protection of environmental resources. These mitigation measures have been described within the proposed project's IS/MND and are reproduced here as a stand-alone MMRP document. A summary of mitigation is provided in Table A below.

In cases where resources will experience No Impact or Less Than Significant Impact, no mitigation measures were necessary. The resource areas for which no mitigation is required include Aesthetics, Agriculture and Forestry, Geology and Soils, Greenhouse Gas Emissions, Land Use and Planning, Mineral Resources, Noise, Population and Housing, Public Services, Recreation, and Utilities and Service Systems. In some cases, mitigation measures have been identified for one resource area, but may also apply to other resources as well.

AIR-1) PREPARE AND IMPLEMENT A FUGITIVE DUST CONTROL PLAN
MAGSA will prepare and implement a Fugitive Dust Control Plan (DCP) consistent with SJVAPCD's *Regulation VIII Fugitive Dust Prohibitions*. The DCP shall be submitted to and approved by the SJVAPCD prior to issuance of construction/grading permits. Fugitive dust control measures to be included in the DCP shall include, but are not limited to, the following:

a. All disturbed areas, including storage piles, which are not being actively utilized for construction purposes, shall be effectively stabilized of dust emissions using water, chemical stabilizer/suppressant, covered with a tarp or other suitable cover or vegetative ground cover.

b. All on-site unpaved roads and off-site unpaved access roads shall be effectively stabilized of dust emissions using water or chemical stabilizer/suppressant.
c. All land clearing, grubbing, scraping, excavation, land leveling, grading, cut & fill, and demolition activities shall be effectively controlled of fugitive dust emissions utilizing application of water or by presoaking.
d. When materials are transported off-site, all material shall be covered, or effectively wetted to limit visible dust emissions, and at least six inches of freeboard space from the top of the container shall be maintained.
e. All operations shall limit or expeditiously remove the accumulation of mud or dirt from adjacent public streets at the end of each workday. (The use of dry rotary brushes is expressly prohibited except where preceded or accompanied by sufficient wetting to limit the visible dust emissions.) (Use of blower devices is expressly forbidden.)
f. Following the addition of materials to, or the removal of materials from, the surface of outdoor storage piles, said piles shall be effectively stabilized of fugitive dust emissions
g. Utilizing sufficient water or chemical stabilizer/suppressant.
h. An owner/operator of any site with 150 or more vehicle trips per day, or 20 or more vehicle trips per day by vehicles with three or more axles shall implement measures to prevent carryout and trackout.

AIR-2) MINIMIZE PERSONNEL AND PUBLIC EXPOSURE

To minimize personnel and public exposure to potential Valley Fever–containing dust both on- and off-site, the following additional control measures shall be included in the DCP to be prepared for this project as required by Mitigation Measure AQ-1:

a. Equipment, vehicles, and other items shall be thoroughly cleaned of dust before they are moved offsite to other work locations.
b. Wherever possible, grading and trenching work shall be phased so that earth-moving equipment is working well ahead or down-wind of workers on the ground.
c. The area immediately behind grading or trenching equipment shall be sprayed with water before ground workers move into the area.
d. In the event that a water truck runs out of water before dust is sufficiently dampened, ground workers being exposed to dust are to leave the area until a full truck resumes water spraying.
e. All heavy-duty earth-moving vehicles shall be closed-cab and equipped with a HEP-filtered air system.
f. Workers shall receive training to recognize the symptoms of Valley Fever, and shall be instructed to promptly report suspected symptoms of work-related Valley Fever to a supervisor.
g. A Valley Fever informational handout shall be provided to all on-site construction personnel. The handout shall, at a minimum, provide information regarding the symptoms, health effects, preventative measures, and treatment.
h. Onsite personnel shall be trained on the proper use of personnel protective equipment, including respiratory equipment. National Institute for Occupational Safety and Health (NIOSH)-approved respirators shall be provided to onsite personal, upon request.

AIR-3) IMPLEMENT VEHICLE EMISSIONS CONTROLS

1. To the extent locally available, alternative fueled, electric, hybrid, or catalyst construction equipment will be used during construction.

2. On-site mobile equipment will be equipped with PM_{10} pollution control devices and/or newer, less polluting equipment will be required (either lower emissions diesel or alternative fuels engines).
3. Heavy-duty (50 hp, or greater) off-road construction equipment shall, at a minimum, meet U.S. EPA Tier 3 emission standards.
4. On-site equipment will utilize aqueous diesel fuel.
5. The construction contractor will comply with all current and future Regulation VIII rules.
6. Diesel engines will be shut off when not in use for more than 5 minutes to reduce emissions from idling.

BIO-1) GENERAL MEASURES

GM #1. A Worker Environmental Awareness Program (WEAP) will be incorporated into the Project to ensure that all construction personnel are informed about the special status and sensitive biological resources known to occur in and/or adjacent to the Project area. A qualified biologist shall conduct a WEAP training session for construction workers prior to any Project construction activities. Trainings will be documented and kept on file.

GM #2 Environmentally sensitive areas will be protected from encroachment by construction workers and heavy equipment by orange construction fencing and will be designated as such on the construction plans.

GM #3. Working hours will be confined to daylight hours (sunrise to sunset) unless otherwise necessary to assess or protect biological resources or remain in compliance with local ordinances.

GM #4. Construction workers must limit personal vehicle and construction heavy equipment speeds to 20 miles per hour in the Project area and immediate vicinity.

GM #5. No pets will be allowed in the Project area or immediate vicinity.

BIO-2) PROTECT AND PRESERVE GIANT GARTER SNAKE

Habitats that are permanently or seasonally flooded and contain herbaceous wetland vegetation such as cattails and bulrushes occur within and adjacent to the Project area. Even unmaintained irrigation canals can substitute as marginally suitable habitat for giant garter snake (GGS) and may occur within the Project area. Areas with excessive shade, lack of basking sites, and absence of GGS prey are not considered suitable habitat.

To protect and preserve the GGS, to avoid any impacts to it or its habitat, and to meet CDFW and USFWS requirements, the following preventative measures shall be incorporated into the Project.

GGS #1. A qualified biologist will flag and designate avoided GGS habitat within or immediately adjacent to the project area as Environmentally Sensitive Areas to be avoided by all construction personnel and equipment.

Escape routes for GGS should be determined in advance of construction and snakes will be allowed to leave on their own.

Construction activities within 200 feet from the banks of GGS aquatic habitat will be avoided to the greatest extent possible.

GGS #2. Clearing will be confined to the minimal area necessary to facilitate construction activities.

Movement of heavy equipment will be confined to existing roadways to minimize habitat disturbance.

Construction-related holes will be covered to prevent entrapment of individuals.

GGS #3. If temporary giant garter snake habitat disturbance is necessary, then 24-hours prior to construction activities, the project area will be surveyed for GGS by a qualified biologist. Survey of the project area will be repeated if a lapse in construction activity of two weeks or greater has occurred.

Construction activity within habitat will be conducted between May 1 and October 1. This is the active period for giant garter snakes and direct mortality is lessened, because snakes are expected to actively move and avoid danger.

Any dewatered habitat will be required to remain dry for at least 15 consecutive days after April 15 and prior to excavating or filling of the dewatered habitat. Sightings or incidental take will be reported to the USFWS and CDFW immediately.

GGS #4. During post-construction restoration, the MAGSA contractor will remove any temporary fill and construction debris and restore temporarily disturbed areas to pre-project conditions. If erosion control materials are installed in suitable habitat for GGS, then only non-entangling erosion control materials (no monofilament) will be used to reduce the potential for entrapment. This limitation will be communicated to the contractor through use of special provisions included in the bid solicitation package.

BIO-3) PROTECT AND PRESERVE TRICOLORED BLACKBIRD

Within the Project area, potential tricolored blackbird (TCB) nest sites are often associated with freshwater marsh or thistle thickets and other thorny vegetation, and TCBs may forage in agricultural fields (such as large tracts of alfalfa or dairies). To protect and preserve the TCB, to avoid any impacts to it or its habitat, and to meet CDFW requirements, the following preventive measures shall be incorporated into the Project during construction activities.

TCB #1. If a Project activity is anticipated to occur in potential TCB habitat or habitat is present within 500 feet of the Project footprint, then an approved biologist will conduct a field investigation to determine if existing or potential nesting or foraging sites are present within the project footprint and adjacent areas within 500 feet. Nesting sites shall be noted on plans.

TCB #2. Pre-construction surveys will be required to determine if active nests are present within a project footprint or within 500 feet of a project footprint if existing or potential nest sites were found during design surveys and construction activities will occur during the breeding season (March 1 through September 15). An approved biologist will conduct pre-construction surveys within 30 days and within 3 days of ground-disturbing activities, and within the proposed Project footprint and 500 feet of the proposed Project footprint to determine the presence of nesting tricolored blackbird. Pre-construction surveys will be conducted during the breeding season (March 1 through August 31).

TCB #3. a. If active nests are found within the Project construction footprint, the MAGSA contractor will establish a 500-foot temporary buffer around the active nest until the young have fledged.

b. An approved biologist experienced with TCB behavior will be retained by the MAGSA contractor to monitor the nest throughout the nesting season and to determine when the young have fledged. The approved biologist will be on site daily while construction-related activities are taking place near the disturbance buffer. Work within the nest disturbance buffer will not be permitted. If the approved biologist determines that tricolored blackbirds are exhibiting agitated behavior, construction will cease until the buffer size is increased to a distance necessary to result in no harm or harassment to the nesting tricolored blackbirds.

BIO-4) PROTECT AND PRESERVE WATERS OF THE U.S. AND WATERS OF THE STATE

To protect and preserve waters of the U.S. habitats, to avoid and lessen any potential impacts, and to meet CDFW, USACE, and RWQCB regulatory requirements, the following preventive measures shall be incorporated into the project.

WUS #1. As the design for conveyance system alignments and associated Project infrastructure continues to be developed, the project team including wetland and permitting specialists, will avoid direct impacts to wetlands to the extent possible. Where avoidance is not possible, impacts will be minimal and concentrated to previously impacted areas.

WUS #2. If additional construction is required in areas not within the 2022 ARD review area, then an additional ARD shall be conducted if necessary to evaluate and quantify wetlands and/or other waters of the State of California and/or U.S. which may be impacted by the additional construction. A resulting ARD report will quantify the acreage of wetlands or other waters which will be impacted and thus, the acreage to be permitted by the resource and regulatory agencies. The evaluation will also aid the consultants and USACE in determining the type of permit and the permitting process to follow if needed.

BIO-5) PROTECT AND PRESERVE THE BURROWING OWL

California ground squirrel burrows are dispersed throughout the Project area and may offer some suitable nesting/denning habitat for burrowing owls. Earthwork performed with heavy equipment during project construction has the potential to destroy this habitat type and/or harm retreating owls.

To protect and preserve the burrowing owl, to avoid any impacts to it or its habitat, and to meet CDFW requirements, the following preventive measures shall be incorporated into the Project.

BO #1. A protocol burrowing owl survey shall be conducted to ensure that no owls nest on or adjacent to the Main Canal alignment. The surveys shall be conducted four times in the winter and five times during the February through July period as per the guidelines (CBOC 1997).

BO #2. If an owl is found, the CDFW shall be consulted and MAGSA shall select one or more of the following possible measures for implementation by a qualified biologist.

- Redesign the Project temporarily or permanently to avoid occupied burrows or nest sites until after the nesting/fledgling season (February 1 through August 31).
- Delay the Project until after the nesting/fledgling season (March 1 through August 31).
- Install artificial burrows in open-space areas of or near the Project area and wait for passive relocation of the burrowing owl.

- Active relocation of burrowing owl with conditions. MAGSA shall fund the relocation of burrowing owls to unoccupied, suitable habitat which is permanently preserved (up to 6.5 acres per nesting pair). Details and requirements are specified in CDFW (2012).
- Though not endorsed by the CDFW, if other measures are possible and can be successful, ensure that potential burrows are vacant, and destroy vacant burrows prior to February 1 and/or after August 31.

BIO-6) PROTECT AND PRESERVE SWAINSON'S HAWK

To protect and preserve the Swainson's hawk, to avoid any impacts to it and its habitats, and to meet CDFW and USFWS requirements, the following measures shall be incorporated into the Project.

SH #1. a. Swainson's hawk nest trees should not be removed.

b. To the extent feasible, construction activities shall be started during the non-nesting season of September 1 through January 31 when Swainson's hawks are gone from California and have migrated to their wintering grounds in Mexico and South America. Thus, Swainson's hawk will not be in the project vicinity and thus will not be disturbed by the project.

SH #2. If construction must occur during the nesting season, a preconstruction survey shall be conducted by a qualified biologist for hawks and their nests within a one-half mile radius of the construction area prior to construction. Surveys should be performed within 30 days prior to the onset of construction.

SH #3. If an active Swainson's hawk nest is found within a one-half mile radius of the Project area, the biologist will establish a half-mile buffer around the nest, or as needed to adequately protect the nest in the context of the actions planned at that location. The buffer will be identified by placing flags and stakes around the perimeter and will remain in place until the biologist has determined that all young have fledged.

BIO-7) PROTECT AND PRESERVE NESTING BIRDS

Although no trees will be removed by the Project, potential nesting trees associated with the settlement areas occur scattered throughout the project area. Swallow nesting habitats and ground nesting shall also be considered.

To protect and preserve nesting birds and their nests, to avoid any impacts to them and their nests, and to meet CDFW and USFWS requirements, the following preventive measures shall be incorporated into the project.

NB #1. Prior to any construction activities on the project area during the nesting season (February 1 through August 31), a preconstruction (one-day) survey shall be conducted by a qualified biologist for nesting birds within a minimum of a 250-foot radius around project activities. Results of the preconstruction survey shall be prepared in a letter and given to MAGSA prior to any construction activities. If no nests are observed, project construction activities can proceed without additional nesting bird measures.

NB #2. If any active nests are observed, the nests shall be designated as an Environmentally Sensitive Area with buffer zones determined by a qualified biologist to be protected and avoided (while occupied) during the construction activities. CDFW shall be contacted, consulted, and avoidance measures, specific to each incident, shall be developed in cooperation with the project biologist.

BIO-8) PROTECT AND PRESERVE SAN JOAQUIN KIT FOX

To protect and preserve the SJKF, to avoid any impacts to it or its habitat, and to meet CDFW and USFWS requirements, the following preventive measures shall be incorporated into the Project during construction activities.

KF #1. The USFWS's Standardized Recommendations for the Protection of the San Joaquin Kit Fox Prior to or During Ground Disturbance (USFWS 2011) will be incorporated into the Project and shall be implemented to avoid potential impacts to SJKF.

KF #2. A check for and monitoring of potential kit fox dens (squirrel burrows) along the Main Canal alignment shall be conducted for three consecutive nights to evaluate SJKF use as per the USFWS 2011 guidelines (USFWS 2011). A report on the findings will be prepared. Vacant squirrel holes will be filled by hand after the survey by a qualified biologist to prevent future use by and future impacts to the SJKF.

KF #3. A preconstruction (one-day) survey shall be conducted by a qualified biologist to examine potential dens (squirrel burrows) on and immediately adjacent to the Project area for the existence of SJKF. The survey shall be conducted within 30 days prior to any construction activities. Results of the preconstruction survey shall be prepared in a letter and given to MAGSA prior to any construction activities.

KF #4. If a SJKF den is found, the CDFW and USFWS shall be immediately consulted, and appropriate avoidance measures shall be developed in cooperation with the qualified Project biologist and MAGSA.

CUL-1: WORKER ENVIRONMENTAL TRAINING

Prior to the initiation of construction of the project, a Secretary of Interior qualified archaeologist will be retained and will provide a cultural resource briefing to all construction workers. The briefing will include discussion of all applicable laws and penalties pertaining to disturbing cultural resources, a brief discussion of the prehistoric and historic regional context and archaeological sensitivity of the area, types of cultural resources found in the area, and instruction that project workers will halt construction if a cultural resource is inadvertently discovered during construction. The archaeologist will discuss procedures to follow in the event an inadvertent discovery is encountered, including appropriate treatment and respectful behavior of a discovery (e.g., no posting to social media or photographs). The consulting tribes will provide a representative to participate in the environmental training to discuss or provide input from a tribal cultural perspective regarding the potential cultural resources within the region (as applicable). After the training, all personnel will be given a worker education/training brochure regarding identification of cultural resources and protocols for reporting finds. Any employee beginning work following the initial worker education/training secession must also receive commensurate cultural, tribal, and archaeological resources sensitivity training (via a power point presentation or handout) and will be provided the brochure.

CUL-2: CULTURAL RESOURCE MONITORING AND INADVERTENT DISCOVERY PLAN

A Secretary of Interior qualified archaeologist shall be retained on-call and shall prepare a Monitoring and Inadvertent Discovery Plan for the project which includes appropriate Monitoring and Inadvertent Discovery Procedures. The Plan shall be prepared and approved prior to the initiation of construction.

The Plan shall include (but not limited to): monitoring schedule, project ground disturbing activities and areas that require a cultural resource monitor, monitoring procedures, stop work and notification procedures in the event of an inadvertent discovery, treatment for an inadvertent discovery, reporting, and final monitor reporting. During project-level construction, should subsurface archaeological resources be discovered, all activity in the vicinity of the find (and 100-foot buffer) shall stop. The qualified archaeologist shall be contacted to assess the significance of the find according to CEQA Guidelines Section 15064.5 and/or NRHP criteria (as applicable). In addition, the lead representative for the consulting tribes will be notified (as applicable). If any find is determined to be significant, the archaeologist shall determine, in consultation with the implementing agencies and consulting Native American group(s) expressing interest, appropriate avoidance measures or other appropriate mitigation. Under CEQA Guidelines Section 15126.4(b)(3), preservation in place shall be the preferred means to avoid impacts to significant tribal cultural resources (as defined by PRC 21074), and archaeological resources qualifying as historical resources. Methods of avoidance may include, but shall not be limited to, project reroute or re-design, project cancellation, or identification of protection measures such as capping or fencing, PRC 20184.3(b)(2) provides examples of mitigation measures that lead agencies may considered to avoid or minimize impacts to tribal cultural resources. Consistent with CEQA Guidelines Section 15126.4(b)(3)(C), if it is demonstrated that resources cannot be avoided, the qualified archaeologist shall develop additional treatment measures, such as data recovery or other appropriate measures, in consultation with the implementing agency and any local Native American representatives expressing interest in prehistoric or tribal resources. If an archaeological site does not qualify as an historical resource but meets the criteria for a unique archaeological resource as defined in Section 21083.2, then the site shall be treated in accordance with the provisions of Section 21083.2. Federal law and California state law requires that all project excavation activities halt if human remains are encountered and the County Coroner must be notified. Any discovery of human remains during project-related activities would be treated in accordance with federal laws and PRC Section 5097.98 and Section 7050.5 of the State Health and Safety Code.

GEO-1: CERTIFIED PALEONTOLOGIST

The project shall have a certified paleontologist, who meets the standards of SVP, on call to evaluate excavated material for paleontological significance. If the paleontologist makes a paleontologically significant discovery, all construction will stop within 50 feet of the find. The paleontologist will evaluate the significance and recommend any appropriate treatment of the site. At each location where a fossil was found, the paleontologist will maintain all appropriate data forms; record pertinent geologic and stratigraphic data; take notes and photographs and map the location; collect and submit for analysis any necessary sediment samples; and ensure all records and data of the find are curated at an accredited institution. The paleontologist will prepare a report for any significant finds and submit to the appropriate entities, including Fresno County records.

HAZ-1: PREPARE AND IMPLEMENT A SPILL PREVENTION AND RESPONSE PLAN (SPRP).

To help avoid and minimize potential accidental spills during construction, a project specific SPRP would be prepared by the construction contractor prior to construction that conforms to applicable local, state, and federal requirements. The SPRP would be on site during construction and distributed to all workers and managers prior to construction. The SPRP shall include measures that ensure the safe transport, storage, use, and disposal of hazardous materials used or encountered during construction. The construction contractors shall be required to comply with the SPRP and applicable federal, state, and local laws. The project sponsor would provide compliance oversight. The plan shall outline measures for specific handling and reporting procedures for hazardous materials and disposal of hazardous materials removed from the site at an appropriate offsite disposal facility.

The federal reportable spill quantity for petroleum products, as defined in EPA's CFR (40 CFR 110), is any oil spill that 1) violates applicable water quality standards, 2) causes a film or sheen upon or discoloration of the water surface or adjoining shoreline, or 3) causes a sludge or emulsion to be deposited beneath the surface of the water or adjoining shorelines. If a spill is reportable, the construction contractor shall notify the project proponent who shall inform the applicable county agency and arrange for the appropriate safety and cleanup crews to ensure the spill prevention plan is followed. A written description of reportable releases must be submitted to the RWQCB and the applicable county agencies. This submittal must include a description of the release, including the type of material and an estimate of the amount spilled, the date of the release, an explanation of why the spill occurred, and a description of the steps taken to prevent and control future releases. The releases would be documented on a spill report form. If a spill has occurred, the applicant shall coordinate with responsible regulatory agencies to implement measures to control and abate contamination.

TRA-1: PREPARE AND IMPLEMENT A TRAFFIC SAFETY PLAN.

The project proponent will require the construction contractor to prepare and implement a traffic safety plan before the onset of the construction phase. The traffic safety plan shall be reviewed and approved by the Fresno County Department of Public Works and Planning, Transportation Planning Division. The plan shall address:

- Appropriate vehicle size and speed,
- Travel routes,
- Detour or lane-closure plans,
- Flag person requirements,
- Locations of turnouts to be constructed,
- Coordination with law enforcement and fire control agencies,
- Coordination with California Department of Transportation personnel (for work affecting state road rights-of-way),
- Emergency access to ensure public safety, and
- Traffic and speed limit signs.

It shall also be specific in this plan that before beginning construction activities, the project proponent or the construction contractor shall contact local emergency-response agencies (Fresno County Sheriff and Fire Departments) to provide information on the timing and location of any traffic control measures required to complete the proposed project. Emergency response agencies will be notified of any change to traffic control measures as the construction phases proceed so that emergency-response providers can modify their response routes to ensure that response time would not be affected.

WAT-1: RECHARGE BASIN SCREENING

The first flush of nitrate, salts and other constituents from the vadose zone could create local water quality challenges for the Bank and limit its flexibility. Selecting basins with lower expected legacy loading will help mitigate those challenges. A three-step program will be used to screen sites through 1) avoiding areas of particular concern, such as the Raisin City Oil Field; 2) selecting preliminary locations with low loading based on public crop and nutrient datasets and; 3) validating preliminary locations with 30 foot deep field cores. Samples from these cores will be tested for nitrogen species and TDS. Results will be used to select basin locations with lowest legacy loads.

WAT-2: MANAGE IMPORT WATER TO THE BANK

Aquaterra will manage imported water quality by setting a water quality standard for imported water and monitoring imported water to assure it is meeting the standard. Use of a standard will result in higher quality import water diluting and improving the resident groundwater underlying MAGSA.

A default standard for Pump-in water will be equivalent to the Mendota Pool Group standard (Reclamation 2019). A more stringent water quality standard may be developed based on the current water quality at the O'Neil Forebay. Both standards will result in imported water with higher quality than existing groundwater. The more stringent standard will increase groundwater conditions more rapidly in MAGSA and allow more flexibility under future recovery pumping (Appendix 3, section 9.1.1) (Bachand et al., 2023b).

WAT-3: RECHARGE BASIN EMPLOYMENT AND OPERATIONS

Incremental introduction of recharge basins will reduce vadose zone first flush impacts by spreading it over time. A stepwise approach will avoid that issue with the incremental introduction of recharge basins, so that as a first flush completes and flush water becomes clean, another basin starts infiltrating. Continued use of recharge basins that have infiltrated more than 15-30 feet of water will be prioritized because it will result in improved groundwater quality. First flush will be tracked by measuring flow into the basins, and the groundwater quality underlying the basin or adjacent areas will be monitored to document completion of the first flush of constituents from the vadose zone.

WAT-4: RECOVERY WELL DISTRIBUTION AND DESIGN

The locations of recharge basins and extraction wells are designed to optimize the water quality of groundwater reaching potential users. Extraction wells will be located to limit groundwater flow into areas such as the oil fields, where it could hasten movement of existing plumes of degraded groundwater, potentially impacting other users. Extraction wells will be located a minimum of 500 meters downstream of basins to avoid first-flush impacts. The extraction wells will initially be situated in regions with higher quality groundwater, such as the eastern quarter of MAGSA, where groundwater meets Pump-in standards. This will allow high quality groundwater to be returned to contractors, even during the early first flush period.

WAT-5: GROUNDWATER MONITORING AND EXPORT WATER STANDARDS

MAGSA will implement a groundwater monitoring program that **will** include a grid of monitoring wells spaced approximately 1 – 2 miles apart to accurately map groundwater quality and levels and track lateral groundwater movement. A subset of nested wells will be used to track water quality constituent concentrations with depth to avoid any negative impacts to domestic wells and to ensure recovery wells can access higher quality groundwater. Wells underlying and downstream of recharge basins will be used to monitor first flush of constituents, characterize flow paths, and plan for future groundwater recovery.

Real-time groundwater monitoring at recovery wells will be used to ensure water returned to the contractors and partners meets DWR Non-Project pump-in standards (DWR 2012). MAGSA will develop and comply with export water quality standards equivalent to standards developed by the Mendota Pool Group (Reclamation 2019). These standards will drive recovery operations such as temporary recovery well shutdown, permanent recovery well abandonment, adjusted recharge strategies, and mixing of recovered waters.

WAT-6. COMPLIANCE WITH IRRIGATED LANDS REGULATORY PROGRAM (ILRP)

Some recharge basins may be used for multiple uses, specifically farming and recharge. All farms in the Central Valley are regulated through the Central Valley IRLP, limiting their use of pesticides, fertilizers and salts. Farms participating in the banking program will implement practices that have been designed to integrate farming and recharge programs together as possible.

WAT-7. STORMWATER POLLUTION PREVENTION PLAN (SWPPP)
Because soil surface disturbance for the proposed project would be greater than one acre, specific erosion control measures will be identified as part of the CGP and SWPPP required for construction. The construction contractor will prepare an SWPPP that details measures to control erosion, contain sediments, and prevent turbidity and leakage of vehicle and equipment fluids during construction. The SWPPP will be approved by the Bank sponsors and ensure compliance with the plan throughout the construction process. Measures from the SWPPP will be incorporated into the contractor's work plan and will be implemented prior to groundbreaking. The Bank sponsors will comply with requirements, including preparation and implementation of the SWPPP and the NPDES General Permit for Stormwater Discharges from Construction and Land Disturbing Activities issued by the SWRCB.

WAT-8. INSPECT WATER CONTROL STRUCTURES AND CANALS.
During initial operations each season, MAGSA will visually inspect all levees that protect infrastructure or surrounding buildings to ensure that there are no structural deficiencies that may lead to levee failure under normal operating conditions. The levees will be reinspected each year before flooding or after events which may damage levees, such as earthquakes. The inspectors will record the dates and locations of all levees inspected, any deficiencies identified, and remedial measures used to correct problems.

WAT-9. DEVELOP AND IMPLEMENT SURFACE WATER MONITORING PLAN
Surface water hydrology and water quality monitoring will be critical in real-time operational decisions and for regulatory requirements. Surface water monitoring will occur at key conveyance locations (e.g., import, export, operational nodes) and recharge basin locations. Monitoring will include real-time, telemetric monitoring of surface flows and levels to provide data for managing the distribution of surface waters through the Bank and alert water managers of potential levee or operational failures. The Water Quality Report, Section 10, provides an initial plan for monitoring during periods of recharge and recovery (Appendix 3).

WAT-10. DEVELOP AND IMPLEMENT FACILITIES OPERATION, MAINTENANCE AND MONITORING MANUAL
MAGSA will develop a comprehensive Facilities Operation, Maintenance and Monitoring Manual for the Bank. This manual will develop O&M protocols for conveyance canals, recovery wells and recharge basins and their associated turnouts, valves, pumping stations, security fencing and other equipment and instrumentation. Mechanical and electrical equipment such as pump stations, valves instrumentation, and telemetry systems will utilize manufacturer and installer recommendations, manuals, and standard practices for their O&M. The conveyance and distributions system will include protocols for routine maintenance and emergency actions including the following:

- Regular scheduled inspections, vegetation management, channel repair and stabilization of canals,
- Regular scheduled inspections, vegetation management, and repair of recharge basins,
- Implementation of real-time flow and level monitoring of the canal system at key nodes to track flows and deliveries, manage freeboard in the canal system, and to alert operators to canal levee failures,

- Emergency protocols for canal operations in case of levee failures (e.g., stopping pumping to canal sections, diverting from or draining canal sections, emergency repairs such as sandbags and earthwork), and
- Access road repairs and maintenance.

WAT-11. MANAGE DIVERSIONS AND RECOVERY TIMING

Bank management and scheduling of diversions to and recovery from will be developed in coordination with Bank partners and other local and potentially affected agencies and contractors to ensure Bank operations are not interfering with flow management and diversions from the Mendota Pool. Scheduling guidelines will be developed from this effort and updated on a regular schedule to accommodate changing conditions and needs in the region (e.g., 5 years).

WAT-12. DEVELOP AND IMPLEMENT OPERATION MODEL

MAGSA will develop an Operational Model (OM) to guide planning and design, and for developing initial operations and management plans. The OM will use currently available information and data and will be subsequently refined and evolve as water quality, hydrology and other needed data is collected. As the OM is refined, it will become a more precise predictive model that will further support decision making. Key goals and objectives of the OM include;

- Developing recharge and recovery strategies to ensure water quality requirements are being met for exported water returned to contractors,
- Supporting design and distribution of recharge basins and recovery wells to protect or enhance groundwater recovery and its quality,
- Recharge and recovery actions are not adversely affecting groundwater levels or quality outside of MAGSA,
- Recharge and recovery actions are not impeding use of groundwater within MAGSA for irrigation, drinking water or other uses,
- Recharge and recovery actions are enhancing groundwater sustainability throughout MAGSA with regard to groundwater supplies and quality.

6. MITIGATION SUMMARY TABLE

Table A will guide MAGSA in evaluating and documenting implementation of mitigation measures. For each mitigation measure the following have been identified:

- **Timing/Schedule.** Identifies the time frame or milestone at which the mitigation measure will be implemented.
- **Implementation Responsibility.** Identifies the entity responsible for complying with mitigation measure requirements.
- **Implementation and Verification.** These fields are to be completed as the MMRP is implemented. The “Status/Verification” column describes the type of action taken to verify implementation, and is to be filled out by MAGSA staff based on the documentation provided by qualified contractors, or through personal verification.

Table A. Mitigation Monitoring and Reporting Program, Summary Table of Mitigation Measures				
Mitigation Measures	**Responsibility for Implementation**	**Schedule**	**Monitoring/Report Responsibility**	**Status/ Verification**
AIR QUALITY				
AIR-1. Prepare and Implement a Fugitive Dust Control Plan AIR-2: Minimize Personnel and Public Exposure AIR-3. Implement Vehicle Emissions Controls	Project sponsors will prepare and incorporate specifications into the final construction design. Construction contractor will implement requirements during construction.	Prior to and throughout project construction	Project sponsor and construction contractor	Project sponsor PM to verify plan prior to construction and compliance during construction
BIOLOGICAL RESOURCES				
Pre-Construction and Construction BIO-1. General Measures BIO-2. Protect and Preserve Giant Garter Snake BIO-3. Protect and Preserve Tricolored Blackbird BIO-4. Protect and Preserve Waters of the State and Waters of the U.S. BIO-5. Protect and Preserve the Burrowing Owl BIO-6. Protect and Preserve Swainson's Hawk BIO-7. Protect and Preserve Nesting Birds BIO-8 Protect and Preserve San Joaquin Kit Fox	Project sponsors will ensure that qualified biologist is hired to conduct any needed surveys and work with CDFW and USFWS to ensure appropriate and adequate avoidance measures are used during construction.	Prior to and throughout project construction	Project sponsor and construction contractor	Project sponsor PM to verify proper implementation, enforcement and documenting compliance
CULTURAL RESOURCES				
CUL-1. Worker Education/Training CUL-2. Cultural Resource Monitoring and Inadvertent Discovery Plan	Project sponsors will hire a cultural resources professional who meets Professional Qualification Standards (36 CFR 61) to perform surveys and conduct construction monitoring.	Prior to and throughout construction	Project sponsor	Project sponsor PM to verify proper implementation, enforcement and documenting compliance

Table A. Mitigation Monitoring and Reporting Program, Summary Table of Mitigation Measures				
Mitigation Measures	**Responsibility for Implementation**	**Schedule**	**Monitoring/Report Responsibility**	**Status/ Verification**
HAZARDS AND HAZARDOUS MATERIALS				
HAZ-1. Prepare and Implement a Spill Prevention and Response Plan (SPRP)	Project sponsors will retain qualified professionals to prepare required documents and coordinate with construction contractor to implement requirements.	Prior to construction for implementation throughout construction	Project sponsor and construction contractor	Project sponsor PM to verify compliance with requirements prior to construction and during construction
TRAFFIC AND TRANSPORTATION				
TRA-1. Prepare and Implement a Traffic Safety Plan (TSP)	Project sponsors will incorporate measures into the construction contract specifications.	TSP to be approved by Caltrans and Fresno County prior to construction. TSP to be implemented during construction.	Construction contractor	Project sponsor PM to obtain Caltrans and Fresno County approval prior to construction and to verify compliance throughout construction
WATER RESOURCES				
WAT-1. Recharge Basin Screening WAT-2. Managing Import Water WAT-3. Recharge Basin Employment and Operations WAT-4. Recovery Well Distribution and Design WAT-5. Grndwtr. Monitoring and Export Water Standards WAT-6. Compliance with ILRP WAT-7. Prepare SWPPP WAT-8. Inspect Water Control Structures and Canals WAT-9. Surface Water Monitoring Plan WAT-10. Develop/Implement O&M Manual WAT-11. Manage Diversions and Recovery WAT-12: Develop Operational Model	Project sponsors will prepare or coordinate with qualified professionals to prepare the required plans and will incorporate measures into the construction contract specifications	Prepare prior to construction. Implement throughout construction	Project sponsor and construction contractor	Project sponsor PM to verify proper implementation, enforcement and documenting compliance