# Groundwater Quality Management Plan

East San Joaquin Water Quality Coalition

February 23, 2015

**Irrigated Lands Regulatory Program**

**Central Valley Regional Water Quality Control Board**

# TABLE OF CONTENTS

# LIST OF TABLES

# LIST OF FIGURES

# LIST OF ACRONYMS

| | |
|---|---|
| AB | Assembly Bill |
| BOD | Board of Directors |
| CASGEM | California Statewide Groundwater Elevation Monitoring |
| CDPH | California Department of Public Health |
| COC | Constituent of Concern |
| CTR | California Toxics Rule |
| CURES | Coalition for Urban Rural Environmental Sterwardship |
| CVHM | Central Valley Hydrologic Model |
| CVRWQCB | Central Valley Regional Water Quality Control Board |
| CV-SALTS | Central Valley Salinity Alternatives for Long-Term Sustainability |
| DAC | Disadvantaged Community |
| DACT | Diaminochlorotriazine |
| DBCP | 1,2-dibromo-3-chloropropane |
| DEA | Diethyl-atrazine |
| DEM | Digital Elevation Model |
| DOI | United States Department of the Interior |
| DPR | California Department of Pesticide Regulation |
| DWR | California Department of Water Resources |
| EC | Electrical Conductivity |
| EPA | U.S. Environmental Protection Agency |
| ESJHVA | East San Joaquin Water Quality Coalition High Vulnerability Area |
| ESJWQC | East San Joaquin Water Quality Coalition |
| ESRI | Environmental Systems Research Institute |
| FEP | Farm Evaluation Plan |
| GAR | Groundwater Assessment Report |
| GAMA | Geotracker database |
| GIS | Geographic Information System |
| GQMP | Groundwater Quality Management Plan |
| HHVA | Hydrogeologic High Vulnerability Area |
| I | Irrigated |
| ILP | Irrigated Lands Program |
| ILRP | Irrigated Land and Regulatory Program |
| IPNI | International Plan Nutrition Institute |
| IRWM | Integrated Regional Water Management Plan |
| LSCE | Luhdorff and Scalmanini Consulting Engineers |
| MAGPI | Merced Area Groundwater Pool Interests |
| MCL | Maximum Contaminant Level |
| MID | Merced (or Modesto) Irrigation District |
| MLJ-LLC | Michael L. Johnson, LLC |
| MPEP | Management Practice Evaluation Program |

| | |
|---|---|
| NA | Not Applicable |
| NI | Non-irrigated |
| NOA | Notice of Applicability |
| NMP | Nitrogen Management Plan |
| NRCS | Natural Resource Conservation Service |
| NWIS | National Water Information System |
| OID | Oakdale Irrigation District |
| PAM | Polyacrylamide |
| PCA | Pesticide Control Adviser |
| pH | Power of Hydrogen |
| PLSS | Public Land Survey System |
| SC | Specific Conductance |
| SJR | San Joaquin River |
| SNMP | Salt and Nitrate Management Plan |
| SWRCB | State Water Resources Control Board |
| TAF | Thousand Acre Feet |
| TDS | Total Dissolved Solids |
| TID | Turlock Irrigation District |
| TRS | Township Range Section, Public Land Survey System |
| USDA | United States Department of Agriculture |
| USGS | United States Geological Survey |
| WDL | Water Data Library |
| WDR | Waste Discharge Requirements General Order r5-2012-0116-R2 |
| WQO | Water Quality Objective |
| WQTL | Water Quality Trigger Limit |

# LIST OF UNITS

| | |
|---|---|
| af | acre feet |
| °C | degrees Celcius |
| cm | centimeter |
| ft | foot |
| L | Liter |
| mg | milligram |
| µg | microgram |
| µmhos | microsiemens |

# INTRODUCTION AND BACKGROUND

The Comprehensive Groundwater Quality Management Plan (GQMP) outlined in this document, addresses the requirements of the Waste Discharge Requirements General Order for Growers within the Eastern San Joaquin River Watershed (No. R5-2012-0116-R2). The GQMP presents the Coalition's approach to eliminating/reducing impairments of beneficial uses of groundwater. The Management Plan approach involves three activities: 1) a broad spectrum method of identification of whether or not constituents of concern are related to agricultural practices, 2) outreach to all members whose parcels lay above groundwater identified as exceeding water quality parameters, providing recommendations of management practices with the potential to be effective in managing discharges, and 3) monitoring to evaluate the efficacy of those implemented management practices.

## BACKGROUND

The Central Valley Regional Water Quality Control Board (the Regional Board or CVRWQCB) initiated the Irrigated Lands Program (ILP) in 2003 (and renewed in 2006) with the adoption of a Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands. The ILP, later the Irrigated Lands Regulatory program (ILRP), was developed to regulate discharges from irrigated agriculture to surface waters. The Waste Discharge Requirements General Order for Growers within the Eastern San Joaquin River Watershed (WDR or the Order; No. R5-2012-0116-R2), along with other orders to be adopted for the irrigated lands within the Central Valley, constitute the long-term ILRP, an expansion of the initial ILRP.

The East San Joaquin Water Quality Coalition (ESJWQC or Coalition) has been selected as the third-party group representing Coalition Members in the East San Joaquin River Watershed. The ESJWQC is one of the 13 coalition groups in the Central Valley of California. Members of the ESJWQC are those landowners and/or operators of irrigated lands who have enrolled an irrigated land parcel(s) under the Order within the area represented by the ESJWQC. By enrolling an irrigated land parcel under the Order, members obtain regulatory coverage for operational discharges and agree to comply with the terms and conditions of the Order.

Following the Regional Board's adoption of the WDR on December 7, 2012 (revised October 3, 2013 and March 14, 2014), the Notice of Applicability (NOA) was approved on January 11, 2013 for ESJWQC. The approval date associated with the NOA started the timeline for several requirements, including submittal of an NOI from entities wishing to join the Coalition and for the Coalition to submit an outline of the Groundwater Assessment Report (GAR) (The Order, Section IV. A). The GAR provides the basis for the Groundwater Quality Management Plan, the Groundwater Quality Trend Monitoring Program and the Management Practices Evaluation Program.

The GAR outline was submitted April 11, 2013 (approved May 6, 2013) and the GAR was submitted January 13, 2014. The Coalition's GAR was 'conditionally' approved by the Regional Board on June 6, 2014, with a revised GAR to be submitted by August 11, 2014. A request from ESJWQC for an extension to the submittal date of the revised GAR was approved by the Regional Board's Executive Director on August 8, 2014. An ESJWQC GAR Addendum was submitted November 5, 2014. The CVRWQCB gave final approval of the GAR in combination with the GAR Addendum on December 23, 2014. The CVRWQCB's final approval established the Comprehensive GQMP's required submittal date to be February 23, 2015, 60 days after review and approval of the revised GAR and GAR Addendum.

The GQMP is developed following the requirements listed in the Order and using existing groundwater data and review of current regional management plans. The overarching goal of the GQMP is to improve the groundwater quality within the designated region of the Coalition in as timely a manner as possible and within the limitations set forth by the Order. Requirements of the Order and where they can be found within the GQMP are listed in Table 1.

**Table 1. WDR requirements for groundwater quality monitoring plans and their corresponding sections within the ESJWQC GQMP.**

| REQUIRED ELEMENT (APPENDIX MRP-1) | GROUNDWATER QUALITY MANAGEMENT PLAN SECTIONS |
|---|---|
| **A. Introduction and Background** | **Introduction and Background** |
| Previous work conducted to identify occurrence of COCs | |
| **B. Physical Setting and Information** | **Physical Setting and Geographical Characteristics** |
| B.1.a. Land use maps | Land Use |
| B.1.b. Identification of potential agricultural sources of COCs | Groundwater Constituents of Concern |
| B.1.c. Beneficial uses | Groundwater Beneficial Uses |
| B.1.d. Baseline of management practices | Existing Agricultural Management Practices |
| B.1.e. Summary, discussion, and compilation of surface water quality data | Previous Work to Identify Constituents of Concern in Groundwater |
| B.3. a. Soil information | Geology and Hydrology |
| B.3.b. Geology and hydrology | Geology and Hydrology |
| B.3.b.i. Regional geology | Geology and Hydrology |
| B.3.b.ii. Groundwater basins and sub-basins in area | Coalition Boundaries/Groundwater Hydrology |
| B.3.b.iii. Known water bearing zones | Groundwater Hydrology |
| B.3.b.iv. Identify water bearing zones used for domestic, irrigation, and municipal water | Geology and Hydrology |
| B.3.b.v. Aquifer characteristics | Geology and Hydrology |
| B.3.c. Identification of water chemistry | Geology and Hydrology |
| B.3.c. Identification of irrigation water sources | Irrigated Land |
| **C. Management Plan Strategy** | **Management Plan Strategy** |
| C.1. Description of approach | Description of Approach |
| C.2. Actions to meet goals and objectives | Actions to Meet Goals and Objectives |
| C.2.a. Compliance with receiving water limitations | Actions to Meet Goals and Objectives |
| C.2.b. Educate members | Outreach Methods |
| C.2.c. Identify, validate and implement management practices | Identify Management Practices that are Protective of Groundwater/Management Plan Effectiveness |
| C.3 Duties and responsibilities of individuals | Duties and Responsibilities |
| C.4. Strategies to implement the management plan tasks | Strategies to Implement Management Plan Tasks |
| C.4.a. ID entities or agencies | Agencies Contacted for Data and/or Assistance |
| C.4.b. ID management practices | Management Practices to Control COCs |
| C.4.c. ID outreach | Outreach Methods |
| C.4.d. Specific schedule and milestones | Specific Schedule and Milestones for Implementing Management Practices |
| C.4.e. Measurable performance goals with specific targets | Performance Goals and Performance Measures |
| **D. Monitoring Methods** | **Monitoring Methods** |
| D.3 Management Practice Evaluation Program and Groundwater Quality Trend Monitoring | Identify Management Practices that are Protective of Groundwater |
| **E. Data Evaluation** | **Data Evaluation** |
| **F. Records and Reporting** | **Records and Reporting** |
| **G. Source Identification Study Requirements** | **Strategies to Implement Management Plan Tasks** |

# COALITION BOUNDARIES

The East San Joaquin Water Quality Region encompasses an area of approximately 5.7 million acres (8,900 square miles), including approximately 1 million acres of irrigated land within the Eastern San Joaquin River Watershed. The Coalition region is bounded to the north by the Stanislaus River, to the south and west by the San Joaquin River, and to the east by the Sierra Nevada crest (Figure 1).

## Groundwater Basin(s) within Coalition Region

Groundwater within the ESJWQC region lies within the San Joaquin Valley Groundwater Basin of the San Joaquin River Hydrologic Region as defined in Bulletin 118 from the Department of Water Resources (DWR) (Figure 2). From north to south, all or portions of seven groundwater subbasins lie within the Coalition region: Eastern San Joaquin, Modesto, Turlock, Merced, Chowchilla, Delta-Mendota, and Madera. The Modesto, Turlock, Merced, Chowchilla, and Madera subbasins are entirely within the Coalition boundaries while portions of the Eastern San Joaquin and Delta-Mendota subbasins lie to the north and southwest of the Coalition boundary, respectively. The Stanislaus River serves as the northern boundary of the Coalition with the exception of a relatively small sliver of land along the northern border which includes a portion of the Eastern San Joaquin subbasin north of and roughly parallel to the Stanislaus River. The San Joaquin River serves as the western and southern boundaries of the Coalition. The San Joaquin River is also the western boundary to the Modesto, Turlock, Merced, and Chowchilla subbasins. A portion of the Delta-Mendota subbasin extends from west to east across the San Joaquin River, bordering the Madera subbasin. The eastern portion of the San Joaquin Valley watershed and the Coalition is bounded by the crest of the Sierra Nevada. The groundwater subbasins within the Coalition, as defined by Bulletin 118, only reach the base of the foothills to the Sierra Nevada Mountains.

**Figure 1. East San Joaquin Water Quality Coalition location within California.**

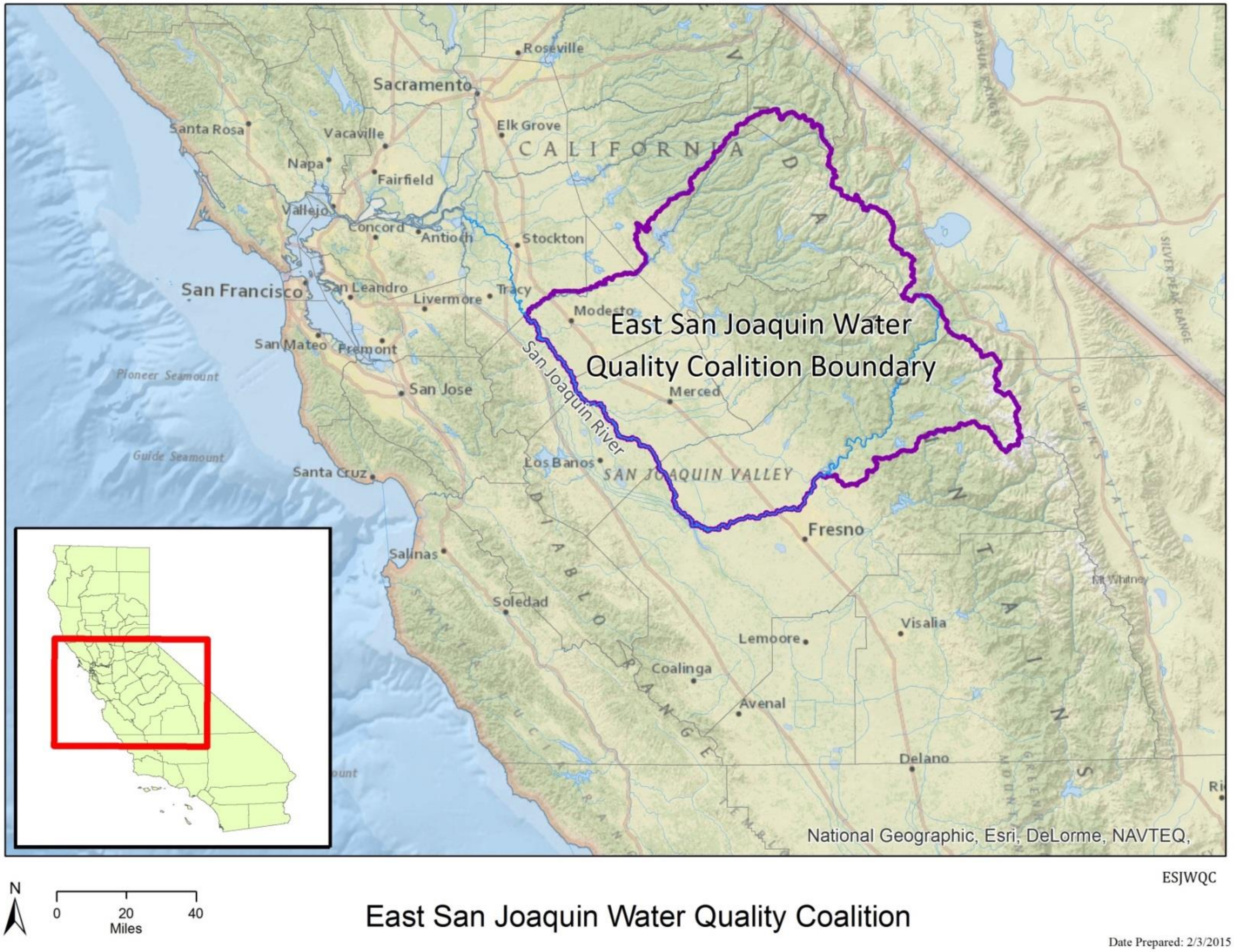
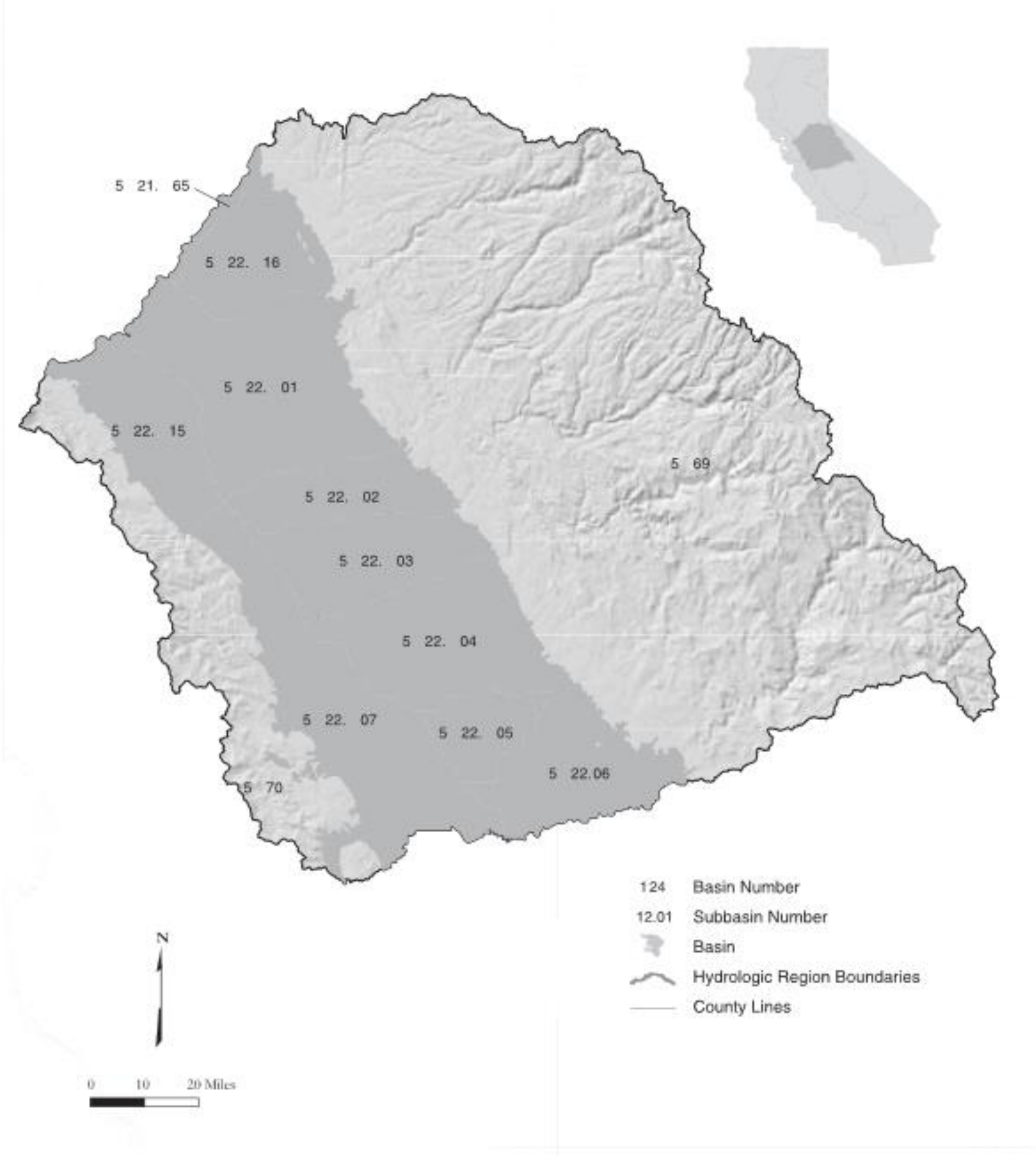


**Figure 2. DWR Designated Groundwater Basins and Subbasins within the Coalition region (reproduced from Figure 35 from Bulletin 118, DWR 2003).**



## Groundwater Quality Management Plan Area

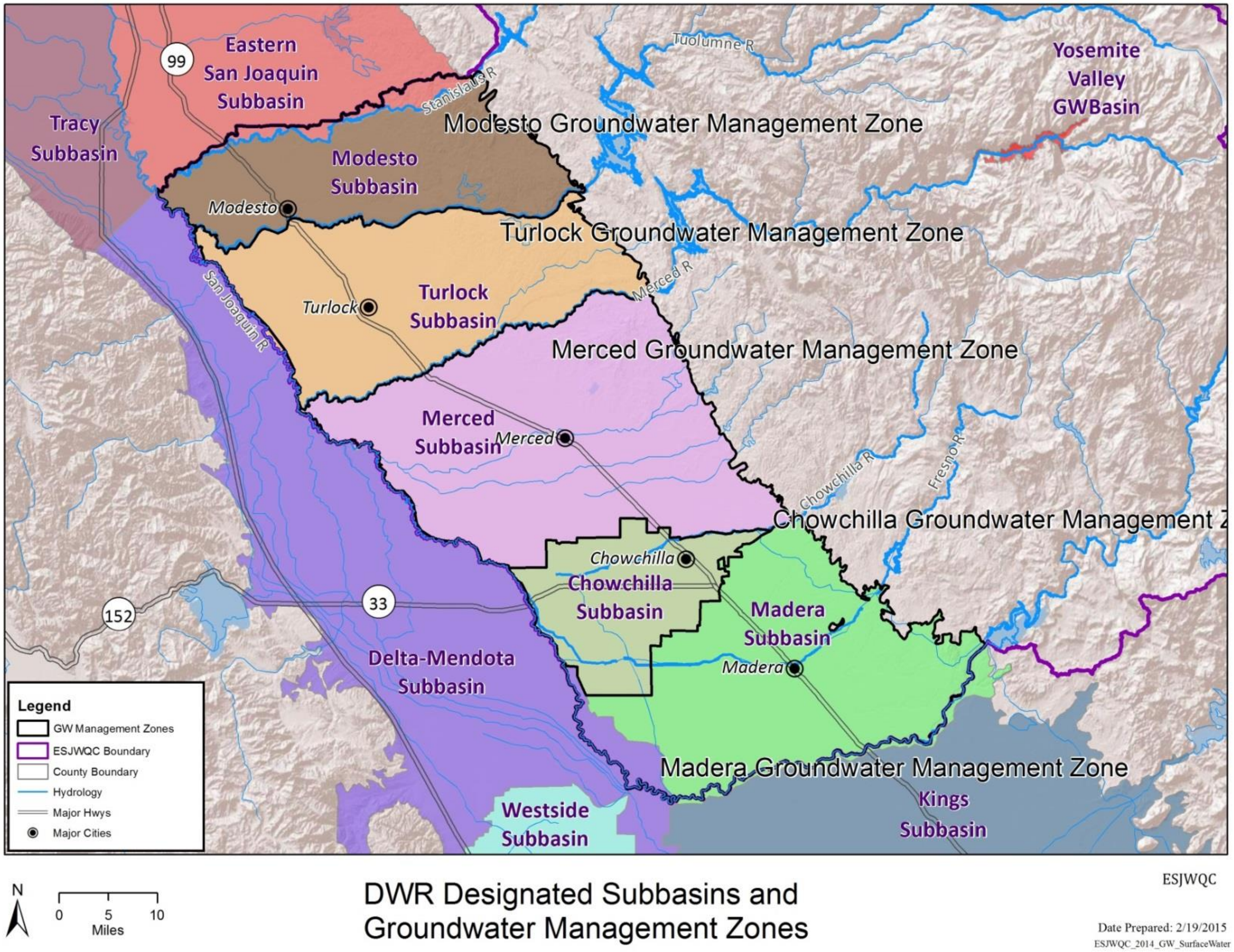
The Coalition area is divided into five groundwater management plan zones to facilitate the systematic monitoring of constituents of concern (COCs) and the implementation of an overall GQMP (Figure 3). The zone boundaries are based primarily on the underlying San Joaquin basin and subbasin boundaries within the San Joaquin River Hydrologic Region as estimated by Bulletin 118, page 168 (Figure 2). Zone names are based on the primary underlying subbasins from north to south: Modesto (including a portion of the Eastern San Joaquin subbasin), Turlock, Merced, Chowchilla, and Madera (including a portion of the Delta-Mendota subbasin; Table 2, Figure 3). The five zones overlay the western portion of the Coalition region, where the vast majority of agricultural land use occurs. Portions of the Delta-Mendota and Eastern San Joaquin subbasins are within the footprint of the Coalition boundaries and have been included within adjacent zones. The vast majority of agricultural activities (aside from ranching) occur within the Valley floor. Therefore, the GQMP Zones do not include the South American or Tracy subbasins of the San Joaquin Valley nor the Yosemite Valley or Los Banos Creek Valley basins (Table 2).

**Table 2. Basins and subbasins within the San Joaquin River Hydrologic Region located of the Coalition area.**

| Basin | Basin-Subbasin Number | Subbasin Name | GQMP Zone | Within Coalition Region |
|---|---|---|---|---|
| San Joaquin Valley | 5-21.65 | South American | NA | NA |
| San Joaquin Valley | 5-22.01 | Eastern San Joaquin | Modesto | Partial |
| San Joaquin Valley | 5-22.02 | Modesto | Modesto | Entire |
| San Joaquin Valley | 5-22.03 | Turlock | Turlock | Entire |
| San Joaquin Valley | 5-22.04 | Merced | Merced | Entire |
| San Joaquin Valley | 5-22.05 | Chowchilla | Chowchilla | Entire |
| San Joaquin Valley | 5-22.06 | Madera | Madera | Entire |
| San Joaquin Valley | 5-22.07 | Delta-Mendota | Madera | Partial |
| San Joaquin Valley | 5-22.15 | Tracy | NA | NA |
| Yosemite Valley | 5-69 | NA | NA | NA |
| Los Banos Creek Valley | 5-70 | NA | NA | NA |

NA – Not applicable

**Figure 3. GQMP Zones based on DWR Designated Groundwater Basins and Subbasins within the Central Valley portion of the Coalition.**



## Other Groundwater Management Plans within the ESJWQC Region

In 1992, the State Legislature provided structure for more formal groundwater management with the passage of Assembly Bill (AB) 3030, the Groundwater Management Act (Water Code §10750 et seq.). Groundwater management, as defined in DWR's Bulletin 118 Update 2003, is the planned and coordinated monitoring, operation, and administration of a groundwater basin, or portion of a basin, with the goal of long-term groundwater resource sustainability. Under AB 359, introduced in 2011, local agencies are required to provide a copy of their groundwater management plan to DWR and for DWR to provide public access to those plans.

Several entities (other than agricultural landowners/operators) whose management practices could affect groundwater quality are located within the Coalition area boundaries including portions of several irrigation districts, numerous federal and state water districts, municipal water companies, and sanitation districts. Oakdale, Modesto, Turlock, and Merced Irrigation Districts are now members of the ESJWQC. Table 3 lists the water agencies within the GQMP area, the subbasin(s) within which they fall and whether there is an existing groundwater management plan that is associated with the agency.

**Table 3. Water agencies and associated groundwater basin and subbasins (partial or entire) within the GQMP area.** Subbasins are listed as they appear from north to south according the DWR's Bulletin 118.

| Water Agencies | Eastern San Joaquin | Modesto | Turlock | Merced | Chowchilla | Madera | Delta-Mendota | Yosemite Valley[1] | Participating in an Existing Groundwater Management Plan[2] |
|---|---|---|---|---|---|---|---|---|---|
| River Junction Rec. Dist. #2064 | X | X | | | | | X | | |
| South Delta Water Agency | X | X | | | | | X | | |
| City of Riverbank W.S.A. | X | X | | | | | | | X |
| Oakdale Irrigation District | X | X | | | | | | | X |
| South San Joaquin Irrigation District | X | X | | | | | | | |
| Turlock Irrigation District | | X | X | X | | | X | | X |
| Modesto Irrigation District | | X | X | | | | | | X |
| City of Ceres W.S.A. | | X | X | | | | | | X |
| Eastside Water District | | X | X | | | | | | X |
| Calaveras County Water District | | X | | | | | | | X |
| City of Modesto | | X | | | | | | | |
| City of Oakdale | | X | | | | | | | |
| County of Stanislaus | | X | | | | | | | |
| Del Este Water Company (acquired by the City of Modesto) | | X | | | | | | | X |
| Stanislaus and Tuolumne Rivers' Groundwater Subbasin Association | | X | | | | | | | |
| Tuolumne Utilities District | | X | | | | | | | |
| Merced Irrigation District | | | X | X | | | | | |
| Ballico Community Service District | | | X | | | | | | X |
| Ballico-Cortez Water District (inactive) | | | X | | | | | | X |

| Water Agencies | Eastern San Joaquin | Modesto | Turlock | Merced | Chowchilla | Madera | Delta-Mendota | Yosemite Valley[1] | Participating in an Existing Groundwater Management Plan[2] |
|---|---|---|---|---|---|---|---|---|---|
| City of Turlock W.S.A. | | | X | | | | | | X |
| Delhi County Water District | | | X | | | | | | X |
| Denair Community Service District | | | X | | | | | | X |
| Hilmar County Water District | | | X | | | | | | X |
| Keyes Community Services District | | | X | | | | | | X |
| Merced Area Groundwater Pool Interests | | | | X | X | | X | | X |
| Sierra Water District (inactive) | | | | X | X | | X | | |
| Chowchilla Water District | | | | X | X | X | | | X |
| El Nido Irrigation District | | | | X | X | | | | X |
| Le Grand-Athlone Water District | | | | X | X | | | | X |
| San Luis Canal Co. | | | | X | | | X | | X |
| Mariposa County Water Agency | | | | X | | X | | | |
| Black Rascal Water Company | | | | X | | | | | X |
| City of Atwater W.S.A. | | | | X | | | | | X |
| City of Livingston | | | | X | | | | | X |
| City of Merced Water District | | | | X | | | | | X |
| County of Merced | | | | X | | | | | |
| Eagle Field Water District | | | | X | | | | | |
| East Merced Resource Conservtion District | | | | X | | | | | |
| Le Grand Community Service District | | | | X | | | | | X |
| Lone Tree Mutual Water Company | | | | X | | | | | |
| Merquin County Water District | | | | X | | | | | X |
| Plainsburg Irrigation District | | | | X | | | | | |
| Planada Community Services District | | | | X | | | | | X |
| Stevinson Irrigation Water District | | | | X | | | | | |
| Turner Island Water District | | | | X | | | | | X |
| Winton Water and Sanitation District | | | | X | | | | | X |
| Columbia Canal Company | | | | | X | X | X | | X |
| Central California Irrigation District | | | | | X | | X | | X |
| Clayton Water District | | | | | X | | X | | |
| Madera Irrigation District | | | | | X | X | | | X |
| California Water Service Company | | | | | X | | | | |
| New Stone Water District | | | | | X | | | | |
| Aliso Water District | | | | | | X | X | | X |
| Farmers Water District | | | | | | | X | | |
| Patterson Water District | | | | | | | X | | X |
| City of Fresno Service Area | | | | | | X | | | |
| Fresno Irrigation District | | | | | | X | | | X |
| Pinedale County Water District | | | | | | X | | | |
| City of Madera W.S.A. | | | | | | X | | | X[3] |
| County of Fresno Service Area | | | | | | X | | | X |
| Fresno Co. Waterworks #18 | | | | | | X | | | |

| **Water Agencies** | *Eastern San Joaquin* | *Modesto* | *Turlock* | *Merced* | *Chowchilla* | *Madera* | *Delta-Mendota* | *Yosemite Valley*[1] | **Participating in an Existing Groundwater Management Plan**[2] |
|---|---|---|---|---|---|---|---|---|---|
| Gravelly Ford Water District | | | | | | X | | | X |
| Madera Water District | | | | | | X | | | X |
| Mesa Water District | | | | | | X | | | |
| Root Creek Water District | | | | | | X | | | X |
| Bear Valley Community Services District | | | | | | | | | |
| Chowchilla-Red Top Resource Conservation District | | | | | | | | | X |
| City of Angels Camp W.S.A. | | | | | | | | | |
| City of Hughson | | | | | | | | | |
| Coulterville WTR & SWR-CSA 1-M | | | | | | | | | |
| Fish Camp Mutual Water Company | | | | | | | | X | |
| Groveland Community Service District | | | | | | | | X | |
| Hidden Lake Estates | | | | | | | | X | |
| Lake Don Pedro Community Services District | | | | | | | | X | |
| Leland Meadows Water District | | | | | | | | X | |
| Meadowbrook Water Company | | | | | | | | | X |
| Pacheco Water District | | | | | | | | | |
| Ponderosa Basin Mutual Water Company | | | | | | | | X | |
| San Luis Water District | | | | | | | | | |
| Sierra Cedars Community Services District | | | | | | | | X | |
| Tuolumne County Water District No. 1 | | | | | | | | X | |
| Yosemite Alpine Community Services District | | | | | | | | X | |

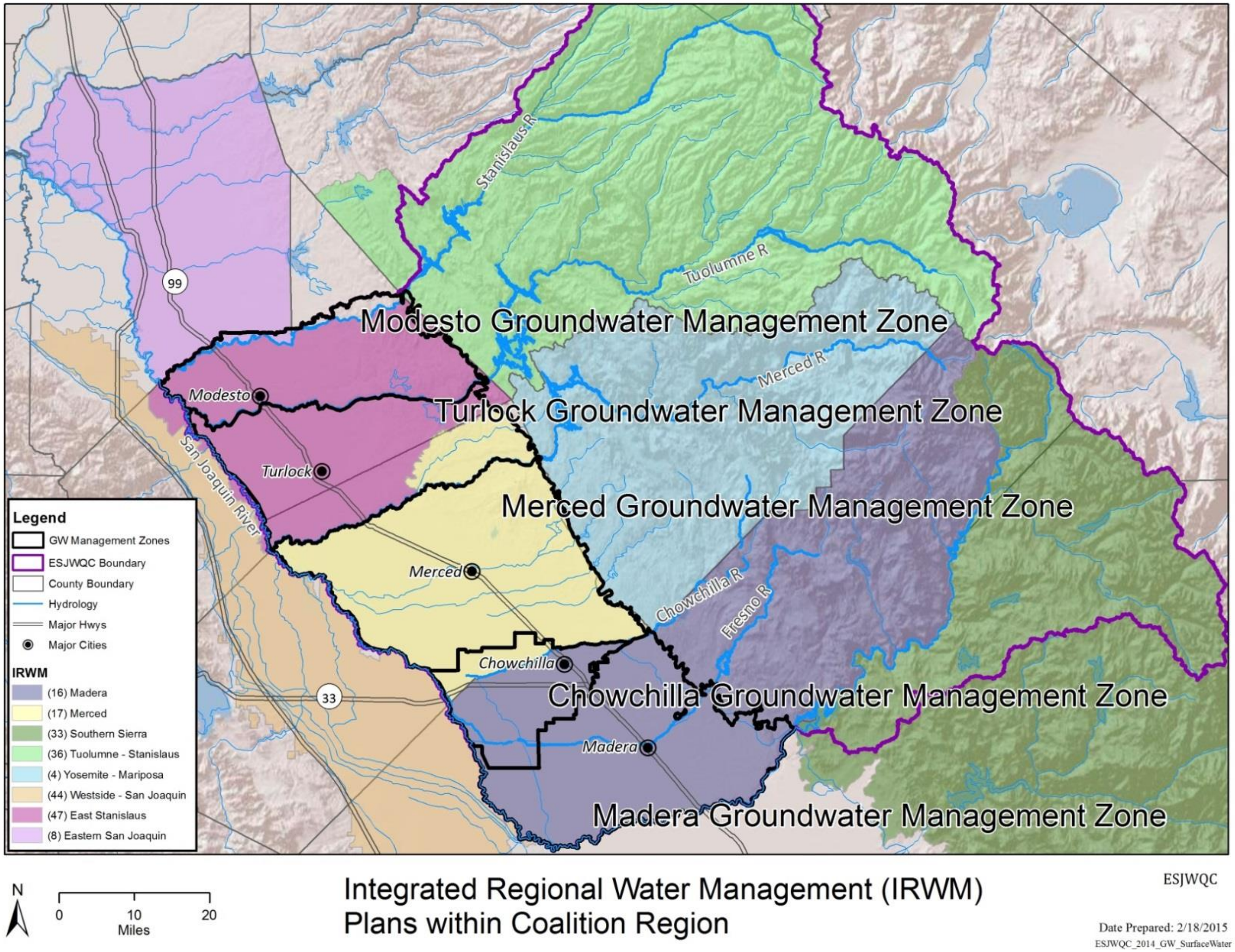
[1] Yosemite Valley groundwater basin is located east of and outside of the Central Valley and the Study area of this report.
[2] According to *California Water Plan Update 2013 (Draft)*, DWR; *Status of Groundwater Management in California, 2004*, DWR (http://www.water.ca.gov/pubs/groundwater/bulletin_118/california's_groundwater__bulletin_118_-_update_2003_/cagwmgmt10jan05-final.pdf); and DWR, *Bulletin 118*, updates.
[3] With the exclusion of 800 acres, the City is included in the Madera ID AB3030.

In 2002, the Integrated Regional Water Management Act was created when Senate Bill 1672 was passed. With the passing of Proposition 50 in 2002 (the Water Security, Clean Drinking Water, Coastal and Beach Protection Act), funding for the preparation of Integrated Regional Water Management Plans (IRWMPs) was in place. IRWMPs define planning regions and identify strategies that allow for the regional management of water resources (supply, quality, management, and ecosystem restoration). The IRWM program is currently administered by DWR. IRWMs in the GQMP area are Madera, Merced, and East Stanislaus (Table 4, Figure 4).

**Table 4. GQMP Zones, underlying subbasins (partial or entire), counties and Integrated Regional Water Management Plans (IRWMs) overlaying the Zone (partial or entire) within the irrigated land in ESJWQC.**

| GQMP Zones | Subbasins | Associated County(s) | Associated IRWM(s) |
|---|---|---|---|
| Modesto | Eastern San Joaquin | San Joaquin/Calaveras/Stanislaus | Eastern San Joaquin |
| | Modesto | Stanislaus | East Stanislaus |
| Turlock | Turlock | Merced/Stanislaus | East Stanislaus |
| Merced | Merced | Merced | Merced |
| Chowchilla | Chowchilla | Madera/Chowchilla | Madera |
| Madera | Madera | Madera | Madera |
| | Delta-Mendota | Fresno/Madera/Merced/Stanislaus | Madera |

**Figure 4. Integrated Regional Water Management regions overlaying the GQMP Zones of the Coalition region.**



# PHYSICAL SETTING AND GEOGRAPHICAL CHARACTERISTICS

The ESJWQC GQMP area includes the portions of Stanislaus and Merced counties east of the San Joaquin River, Madera County, the portion of Fresno County that drains directly into the San Joaquin River, and the portion of San Joaquin County that drains directly into the Stanislaus River (Table 5). The eastern counties within the boundary include Tuolumne, Mariposa, and the portions of Calaveras and Alpine Counties that drain into the Stanislaus River. Within the Coalition region, the major population centers include Madera, Merced, Modesto, and Turlock with smaller communities spread throughout the Central Valley Floor and in to the Sierra foothills. The ESJWQC consists of 3,971 Members who are landowners/growers of approximately 720,000 acres of land.

**Table 5. GQMP Zones, underlying subbasins (partial or entire), and counties overlaying the GQMP Monitoring Zones (partial or entire, in alphabetical order) within the irrigated land in ESJWQC.**

| GQMP Zones | Subbasins | Associated County(s) |
|---|---|---|
| Modesto | Eastern San Joaquin | Calaveras/San Joaquin/Stanislaus |
| | Modesto | Stanislaus |
| Turlock | Turlock | Merced/Stanislaus |
| Merced | Merced | Merced |
| Chowchilla | Chowchilla | Madera/Merced |
| Madera | Madera | Madera |
| | Delta-Mendota | Fresno/Madera/Merced/Stanislaus |

[1] Table contents from DWR's Bulletin 118

Elevations in the Coalition region range from less than 100 feet above mean sea level to over 10,000 feet along the Sierra crest as shown in Figure 5 in this document (Figure 2-1, GAR). The topography in the Coalition region ranges from flat to rolling land within the Central Valley Floor area to steep alpine terrain at higher elevations. Within the Central Valley Floor area, the topography flattens to the west with much of the area having a slope of less than 0.5 degrees (1 %). Topographic slope within the Central Valley Floor area of the Coalition region is shown in Figure 6 in this document (Figure 2-2, GAR).

The climate of the Coalition region ranges greatly from the Central Valley Floor to the higher elevations. Annual precipitation ranges from less than 10 inches in areas of the Central Valley Floor to more than 60 inches at high elevations. A map showing the spatial distribution of average annual precipitation in the Coalition area is included as Figure 7 (Figure 2-3, GAR). Most of the Central Valley Floor area receives less than 14 inches of annual precipitation with many areas having less than 12 inches of annual precipitation. Figure 8 (Figure 2-4, GAR) shows average monthly precipitation at Modesto, Merced, and Madera within the Central Valley Floor. Precipitation in the Central Valley Floor occurs mainly during winter months with almost 90 percent of precipitation occurring between November and April (GAR, page 5).

**Figure 5. Elevation map within the Coalition region (Figure 2-1, GAR).**

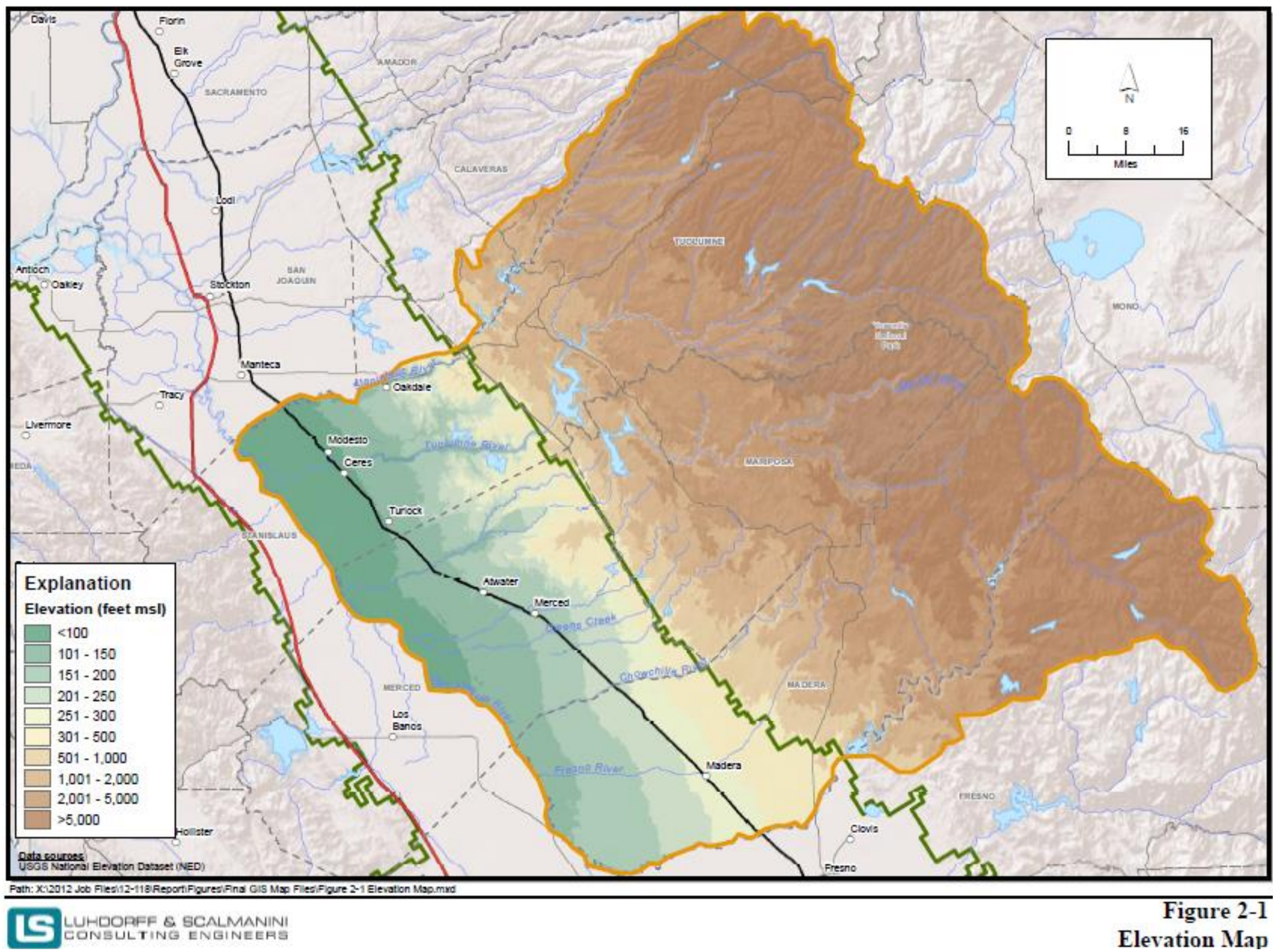


**Figure 6. Slope map of the irrigated lands within the Coalition region (Figure 2-2, GAR).**

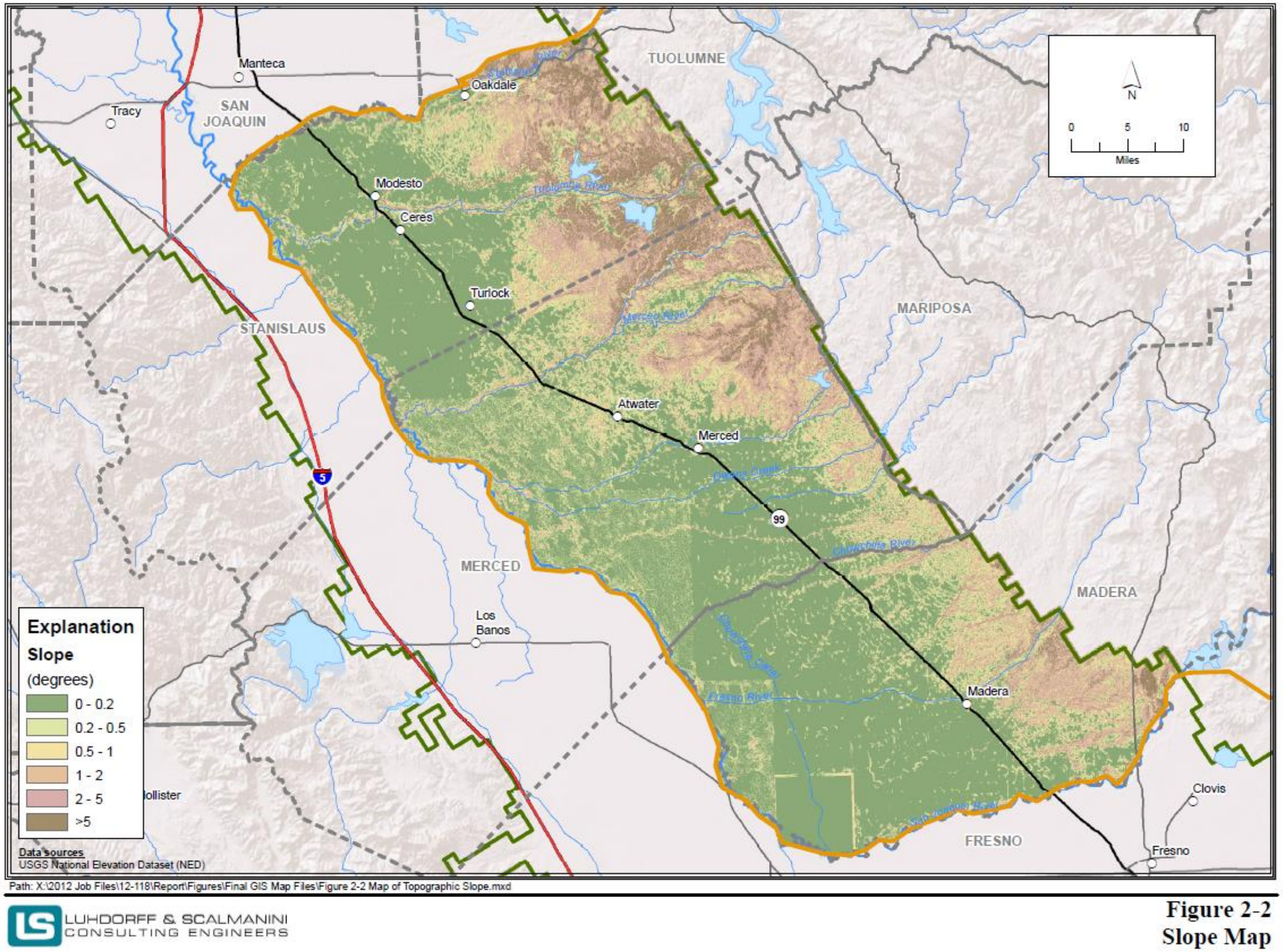


**Figure 7. Annual average precipitation within the Coalition region (Figure 2-3, GAR).**

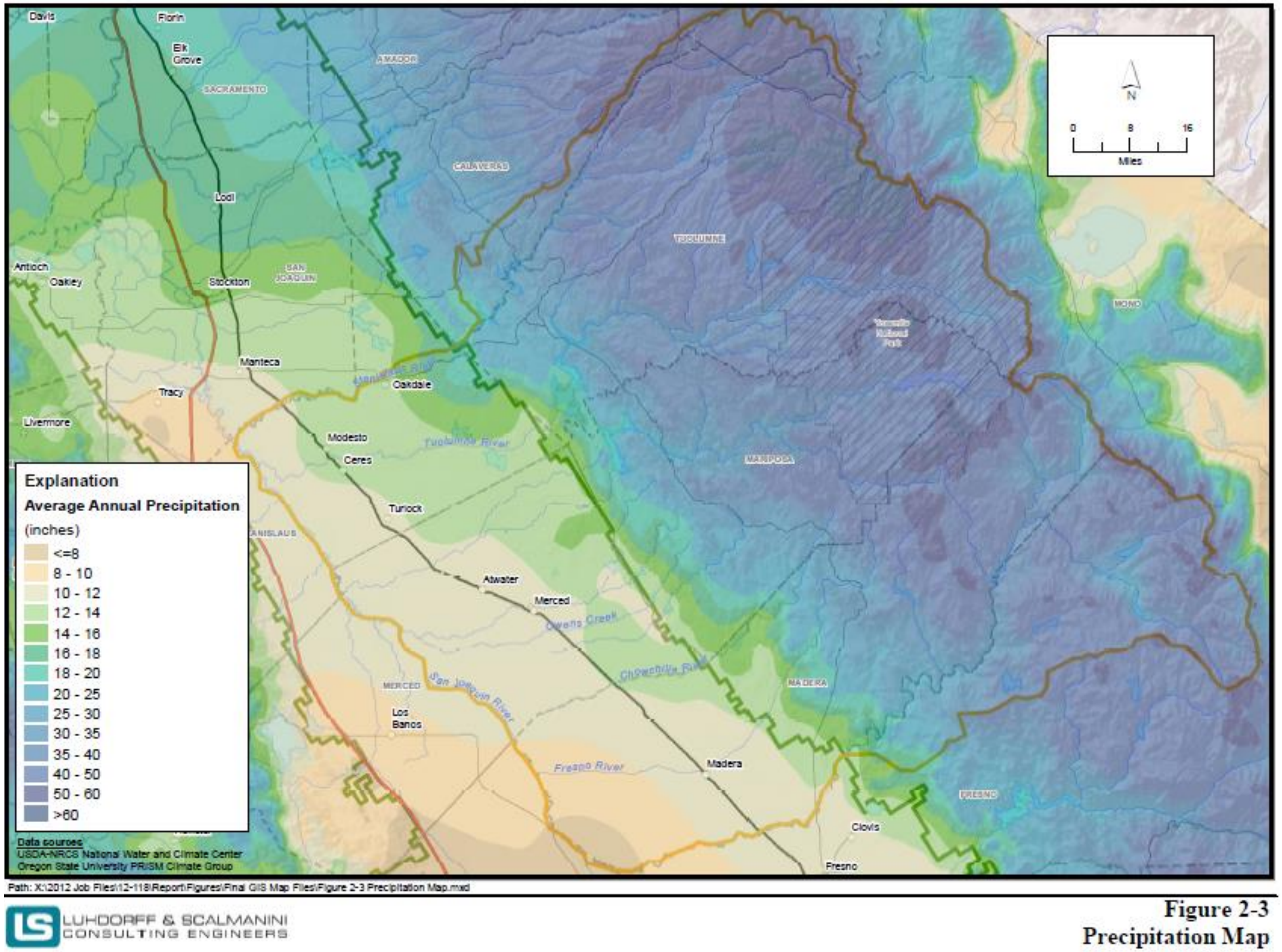
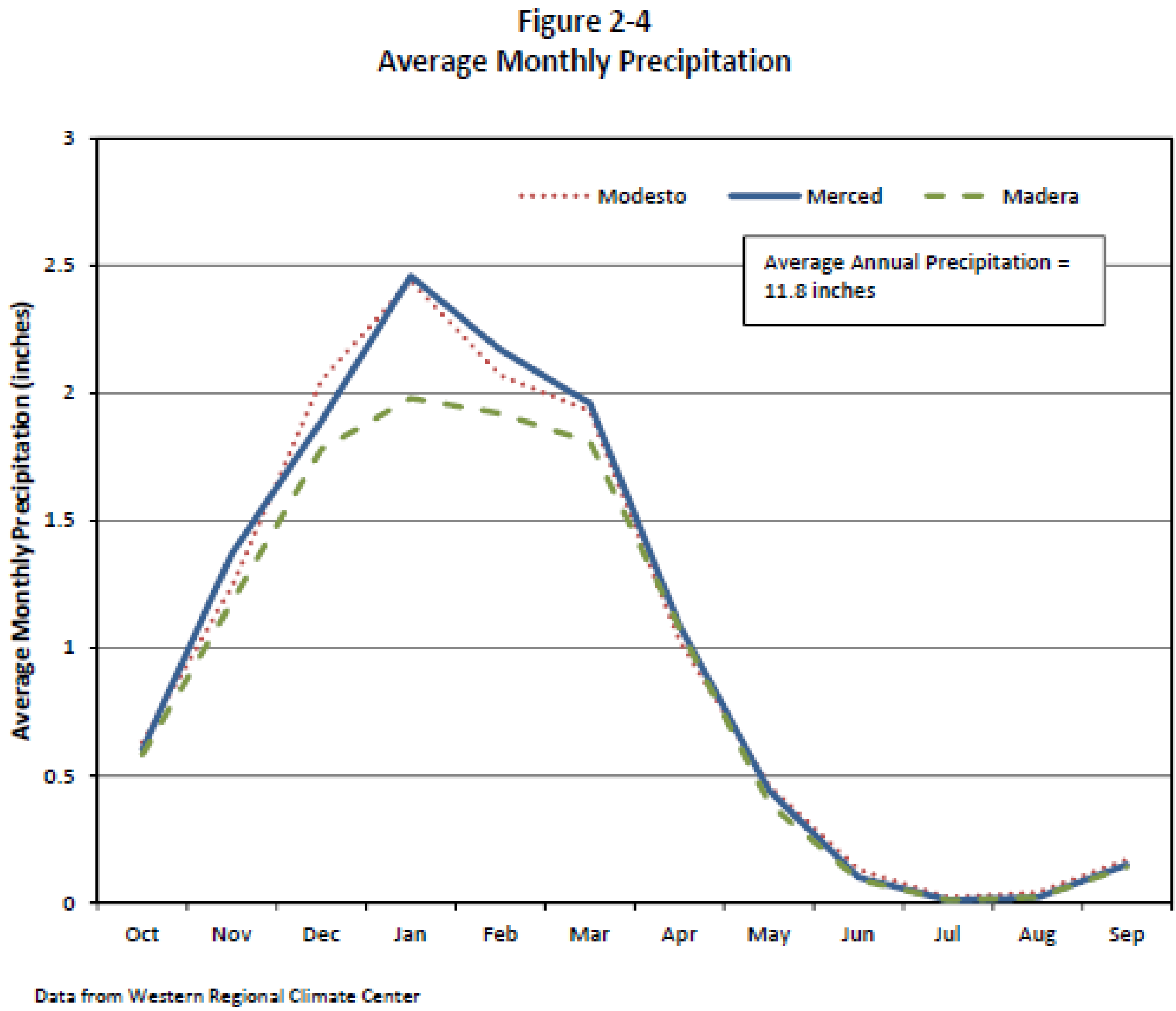


**Figure 8. Average monthly precipitation values in the cities of Modesto, Merced, and Madera, CA (Figure 2-4, GAR).**



# GEOLOGY AND HYDROGEOLOGY

Descriptions of GQMP Zone-specific soil characteristics, hydrology, and land use are included within the individual GQMP Zone sections. The general description of the geology, hydrogeology, and soils of the Central Valley Floor within the Coalition region is provided in the GAR (page 7 - 18) and summarized here.

The Coalition region is located within the San Joaquin Valley, near the southern end of the Central Valley of California in the Great Valley Geomorphic Province. The trough-shaped Central Valley has been filled with interlayered sediments of sand, gravel, silt, and clay derived from erosion of the Sierra Nevada and Coast Range mountains. Figure 9 (Figure 3-1, GAR) shows the geology within the Coalition region as generalized from Jennings (1977). Figures 10 and 11 (Figure 3-2, GAR) show more detailed geologic mapping focusing on the Central Valley Floor area of the Coalition region. The fill deposits mapped throughout much of the valley extend vertically for thousands of feet and the texture of sediments varies in the east-west direction across the valley. Coalescing alluvial fans have formed along the sides of the valley, primarily from the Sierra Nevada with a lesser extent coming from the Coastal Range. Alluvial fans with course textured material generally extend from the edges of the valley, gradually becoming finer towards the axis of the valley. Lacustrine and flood plain deposits also exist closer to the valley axis as thick silt and clay layers. Clay sediments referred to as the Corcoran Clay extend along parts of the San Joaquin Valley floor and generally are located along the western portion of the Coalition region. Resistant sedimentary, metamorphic, volcanic, and crystalline rocks define the foothills and mountains that border the eastern edge of the Central Valley Floor. The regional dip of strata is generally to the southwest.

**Figure 9. Generalized geologic map of the Coalition region (Figure 3-1, GAR).**

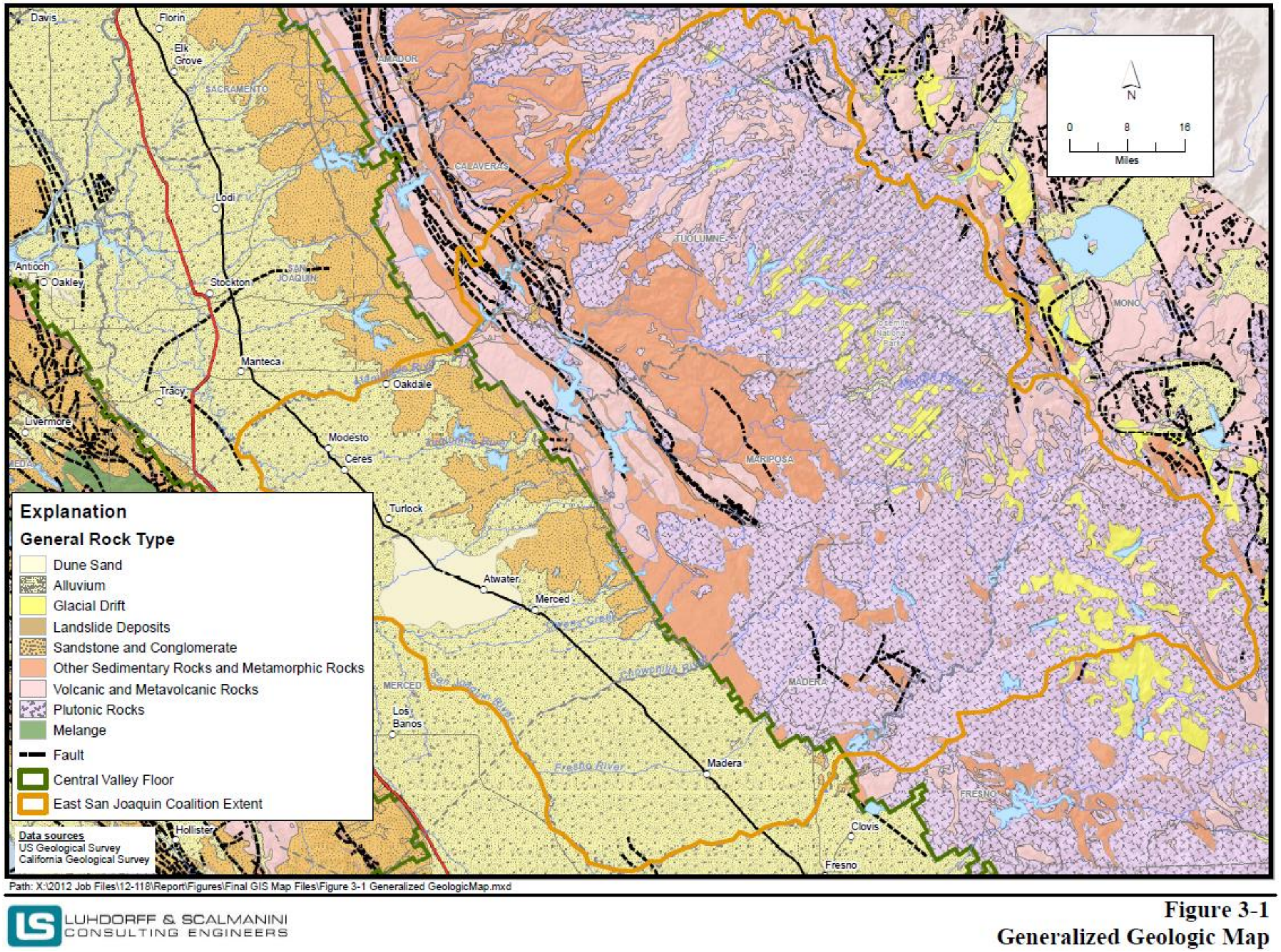


**Figure 10. Geologic Map of the Central Valley floor area (Figure 3-2, GAR).**

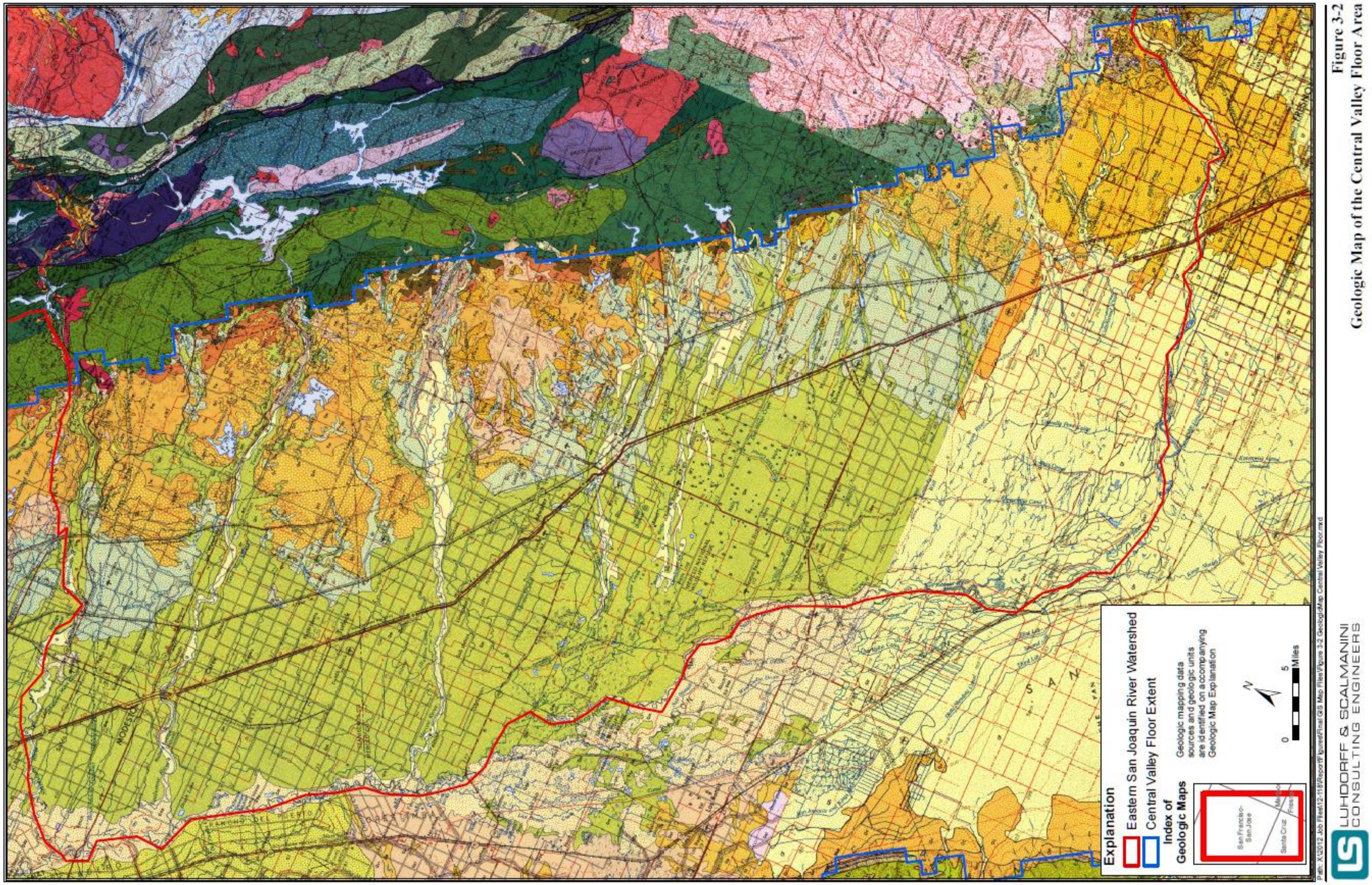
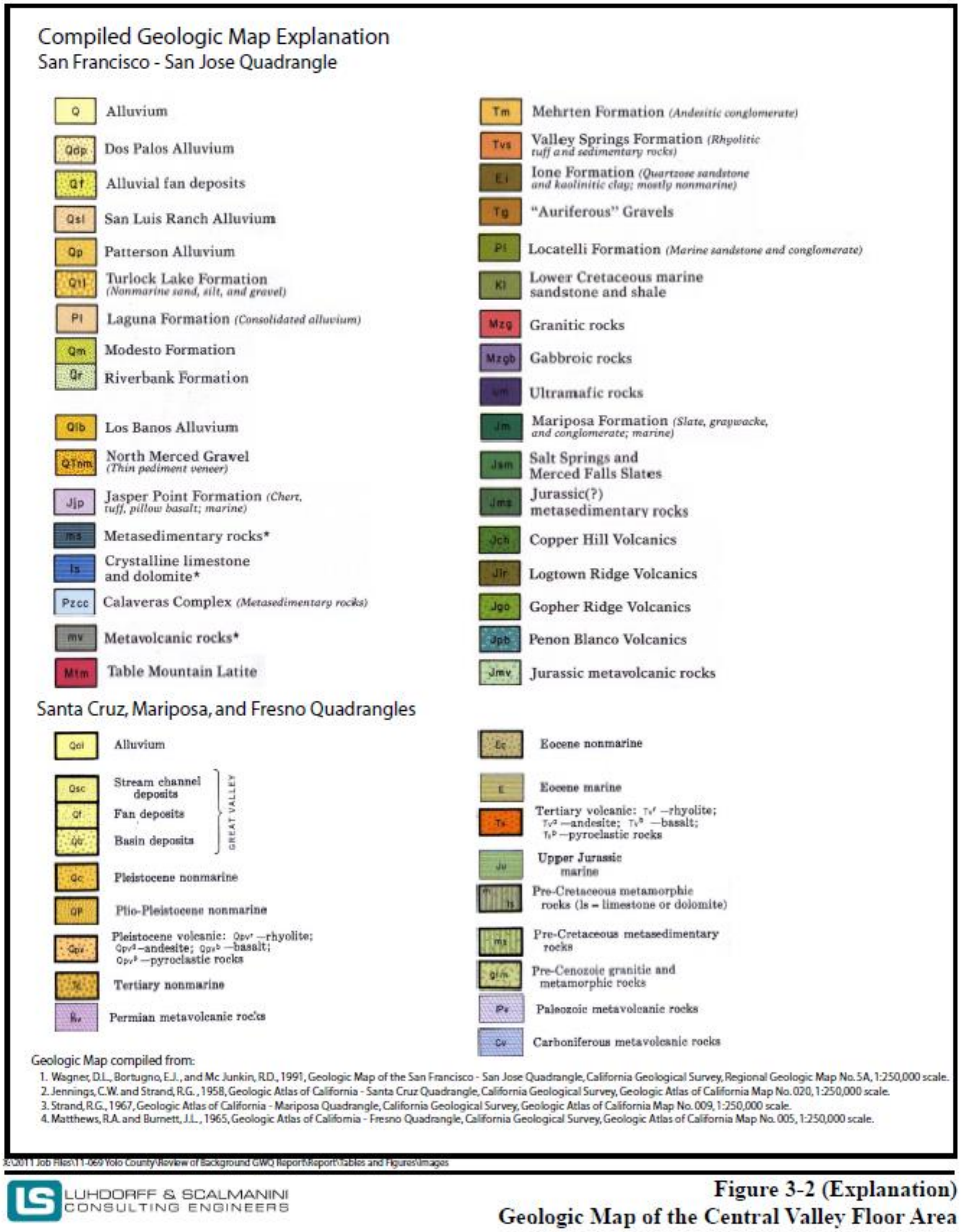


**Figure 11. Geologic Map of the Central Valley floor area (Figure 3-2 [Explanation], GAR).**



## General Hydrogeological Setting

Within the Central Valley Floor, the primary units consist of Quaternary-aged unconsolidated continental deposits and older alluvium that are present across most of the western portion of the Coalition region. The continental and older alluvial deposits consist of layers of sand, gravel, silt, and clay that increase in thickness away from the margins of the valley. The continental deposits are generally mapped as the Turlock Lake Formation, North Merced Gravel, and Pleistocene non-marine sedimentary units which occur along the eastern edge of the Central Valley Floor as shown in Figure 9 (Figure 3-1, GAR). The extent of the older alluvium is generally represented by geologic units mapped as alluvium, Riverbank Formation, Modesto Formation, and Great Valley deposits (Figures 9-11).

The Corcoran Clay is an extensive clay unit and prominent stratigraphic layer in parts of the Central Valley and is believed to separate shallow and deep groundwater systems where it is present. The Corcoran Clay is generally present only in the western portion of the Central Valley Floor area. Depth to the top of the Corcoran Clay generally increases towards the center of the valley.

Groundwater in the area generally occurs under confined, semi-confined, and unconfined conditions within primary water-yielding zones. Consolidated sedimentary rocks of lower water-bearing capacity include the Mehrten Formation, Valley Springs Formation, and Ione Formation which occur along the eastern edge of the Central Valley Floor and have lesser importance as a groundwater resource, although the Mehrten Formation, which consists primarily of sandstone, breccia, and conglomerate, is an important aquifer in the area (DWR, 2003).

## Surface and Shallow Subsurface Sediments Characterization

For the purposes of completing the GAR, sources of data used to characterize the surface and subsurface sediments in the Coalition area consisted primarily of county soil surveys completed by the Natural Resource Conservation Service (NRCS), subsurface sediment texture model data from the USGS Central Valley Hydrologic Model (CVHM), and thickness and depth characteristics of the Corcoran Clay as represented in the CVHM (Faunt et al., 2009). The texture data of the CVHM was estimated using 50-foot-thick vertical increments. The model layers (1-10) range from 50-400 feet thick with the thickness of each layer 50 feet thicker than the layer above (Figure 12, Table 6).

Figure 13 depicts the groupings of basins and subbasins with the Central Valley used for the textural soils analysis in the CVHM. Modesto, Turlock, and Merced GQMP Zones are located in the southern half of the Northern San Joaquin spatial province and domain (22) of Figure 13. The Chowchilla and Madera GQMP Zones are located in Chowchilla-Madera spatial province and domain (23) of Figure 13. Layers 1-3 of the texture model are provided below (Figures 14-15) to represent the texture of soils surrounding wells typically defined as shallow (less than 200 feet deep) in the GAR.

**Table 6. Central Valley, California groundwater flow model layer thicknesses and depths listed by layers (Table. A3, Faunt, et. al., 2009).**

Layers 4 and 5 represent Corcoran Clay where it exists; elsewhere a 1 foot thick phantom layer; they are kept only to keep track of layer numbers.

| LAYER | THICKNESS (FEET) | DEPTH TO BASE OUTSIDE CORCORAN CLAY (FEET) | TEXTURE FIGURE |
|---|---|---|---|
| 1 | 50 | 50 | A9(a) |
| 2 | 100 | 150 | - |
| 3 | 150 | 300 | A9(b) |
| 4 | Variable | 301 | A9(c) |
| 5 | Variable | 302 | A9(c) |
| 6 | 198 | 500 | A9(d) |
| 7 | 250 | 750 | - |
| 8 | 300 | 1050 | - |
| 9 | 350 | 1400 | **A9(c)** |
| 10 | 400 | 1800 | - |

**Figure 12. Generalized hydrogeologic section of the Central Valley according the CVHM. Layers 1-10 indicate the discreet vertical layers described in the CVHM (Fig. A11, Faunt, et. al., 2009).**

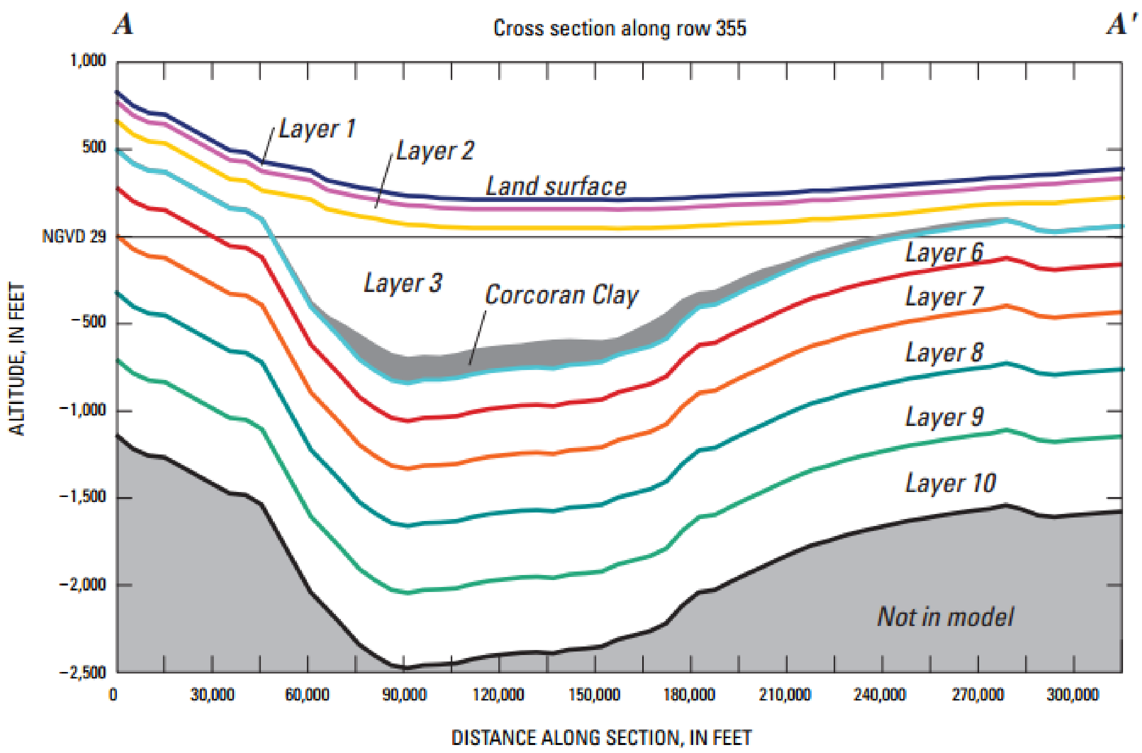



**Figure A11.** Generalized hydrogeologic section (*A–A'*) indicating the vertical discretization of the numerical model of the groundwater-flow system in the Central Valley, California. Line of section shown on *figure A1* (altitudes are along row 355; layer numbers indicate model layer).

**Figure 13. Groupings of basins and subbasins within the Central Valley used for textural soils analysis in the CVHM (Figure A10, Faunt, et. al., 2009).**

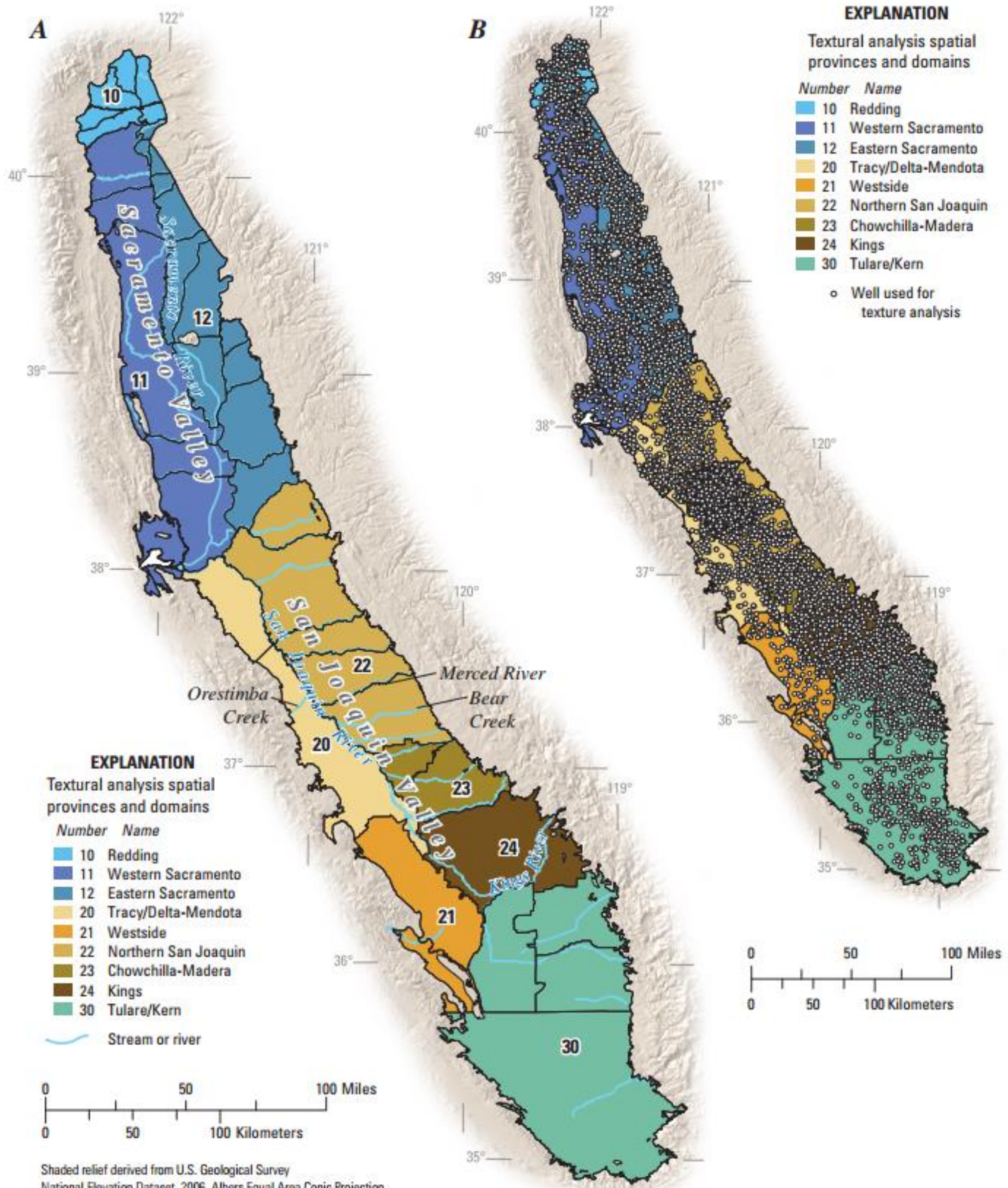



**Figure A10.** *A*, Central Valley showing groundwater basins and subbasins, groupings of basins and subbasins into spatial provinces and domains for textural analysis. *B*, Distribution of wells used for mapping texture. *C*, Count of wells for each depth increment by domains through 1,200 feet. Because less than 1 percent of the logs extend past 1,200 feet, increments below 1,200 feet were not shown. Detailed description of the spatial provinces and domains are in *table A2*.

**Figure 14. Layer 1 of the CVHM depicting the percentage of coarse-grained material within the top 50 feet of the Central Valley.**

Modesto, Turlock, and Merced GQMP Zones are located in the southern half of the Northern San Joaquin spatial province and domain (22). The Chowchilla and Madera GQMP Zones are located in Chowchilla-Madera spatial province and domain (23). (Fig. A12, Faunt, et. al., 2009).

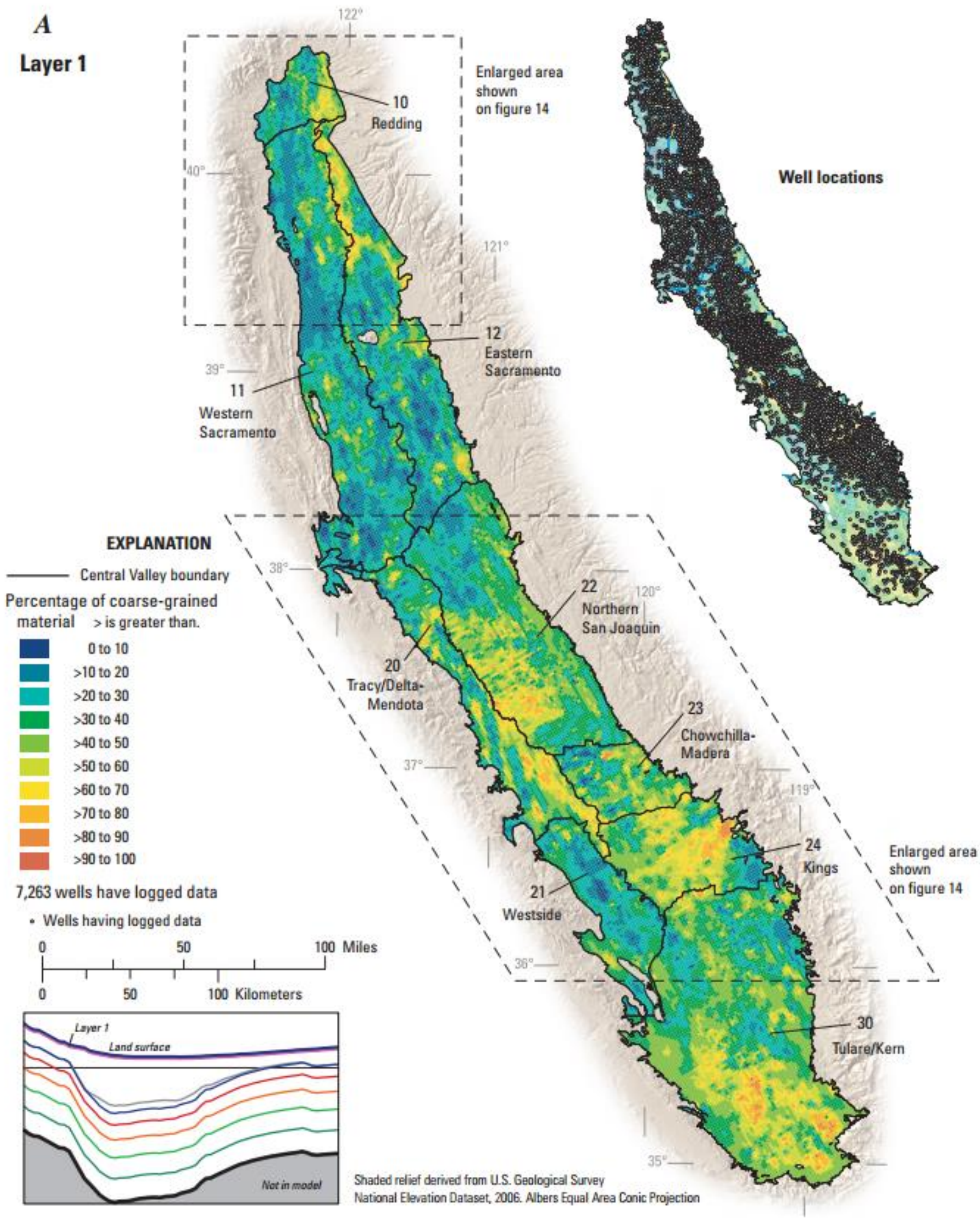
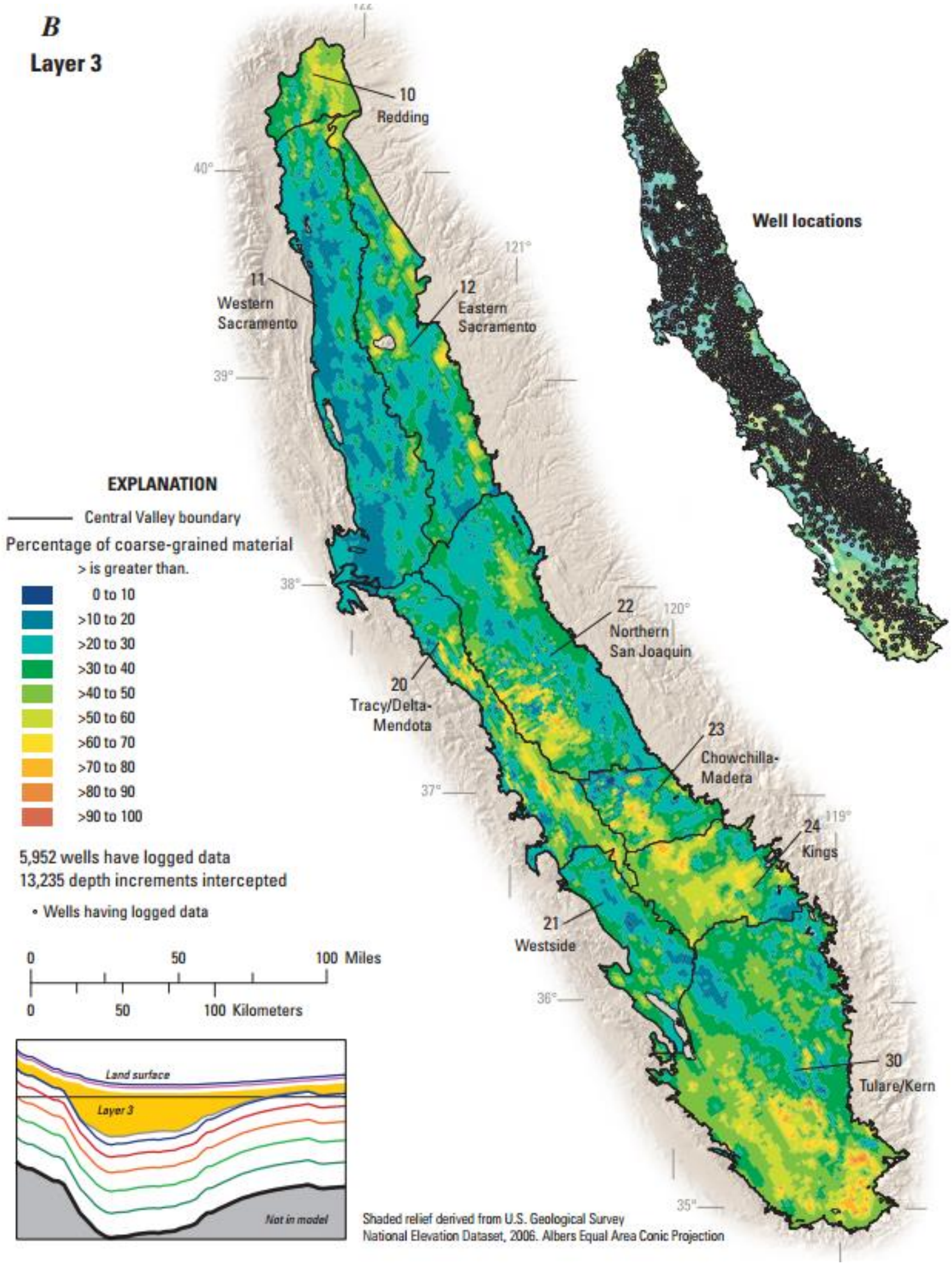


**Figure 15. Layer 3 of the CVHM depicting the percentage of coarse-grained material within the top 150 feet of the Central Valley.**

Modesto, Turlock, and Merced GQMP Zones are located in the southern half of the Northern San Joaquin spatial province and domain (22). The Chowchilla and Madera GQMP Zones are located in Chowchilla-Madera spatial province and domain (23). (Fig. A12 continued, Faunt, et. al., 2009).



### Soil Hydraulic Conductivity

Hydraulic conductivity is a measure of the ability of a material to transmit water; the greater a material's hydraulic conductivity, the faster water moves through the matrix of the material. Figure 16 (Figure 3-3, GAR) shows the hydraulic conductivity of soils as derived from NRCS soil surveys within the Central Valley Floor area of the Coalition region. Notably, the NRCS soil survey data presented in Figure 16 show the presence of numerous long and narrow coarser-textured deposits of higher conductivity and the presence of alluvial channels which have formed large fans of high conductivity soils, particularly in those areas adjacent to the Merced, Tuolumne, Stanislaus, Chowchilla, and Fresno Rivers. Similar patterns of coarser textured material can also been seen within the Northern San Joaquin spatial province and domain (22) and Chowchilla-Madera spatial province and domain (23) in Layer 1 of the CVHM (Figure 14).

### Soil Chemistry

The soil chemistry description below is taken almost exclusively from the GAR. Figure 17 (Figure 3-4, GAR) shows the spatial distribution of soil salinity within the Central Valley Floor area of the Coalition region, as derived from NRCS soil surveys. The GAR evaluates high salinity as electrical conductivity (EC) greater than 4 dS/m which may lead to an impact on crop productivity. Areas of soil salinity above 4 dS/m are largely limited to the western portion of the Central Valley Floor area of the Coalition region, and particularly in the southwest. Large areas of high salinity soils are also located south of Atwater and Merced, and to the west of Madera, while a smaller area of soils with high salinity is present west of Turlock.

The spatial distribution of soil pH, as derived from NRCS soil surveys, is shown in Figure 18 (Figure 3-5, GAR) for the Central Valley Floor area of the Coalition region. Highly alkaline soils ($pH > 7.8$) can affect plan health and appear to follow a similar spatial pattern as soils with high salinity. The western portion of the Central Valley Floor contains a majority of the alkaline soils, particularly to the south of Atwater and Merced and to the west of Madera. Throughout a large part of the Central Valley Floor of the Coalition region, soils are generally in the neutral pH range from 6.6 to 7.5. Crops vary in their ability to tolerate levels of soil pH; however, most crops grow best when the soil pH is slightly acidic at a value between 6 and 7. More acidic soils (lower pH) are generally located in the northern and eastern portions of the Central Valley Floor area of the Coalition region. Areas of greatest soil acidity exist to the northeast of Merced and along the eastern margins of the Central Valley Floor within the Coalition region.

**Figure 16. Soil hydraulic conductivity in the Central Valley portion of the Coalition (Figure 3-3, GAR).**

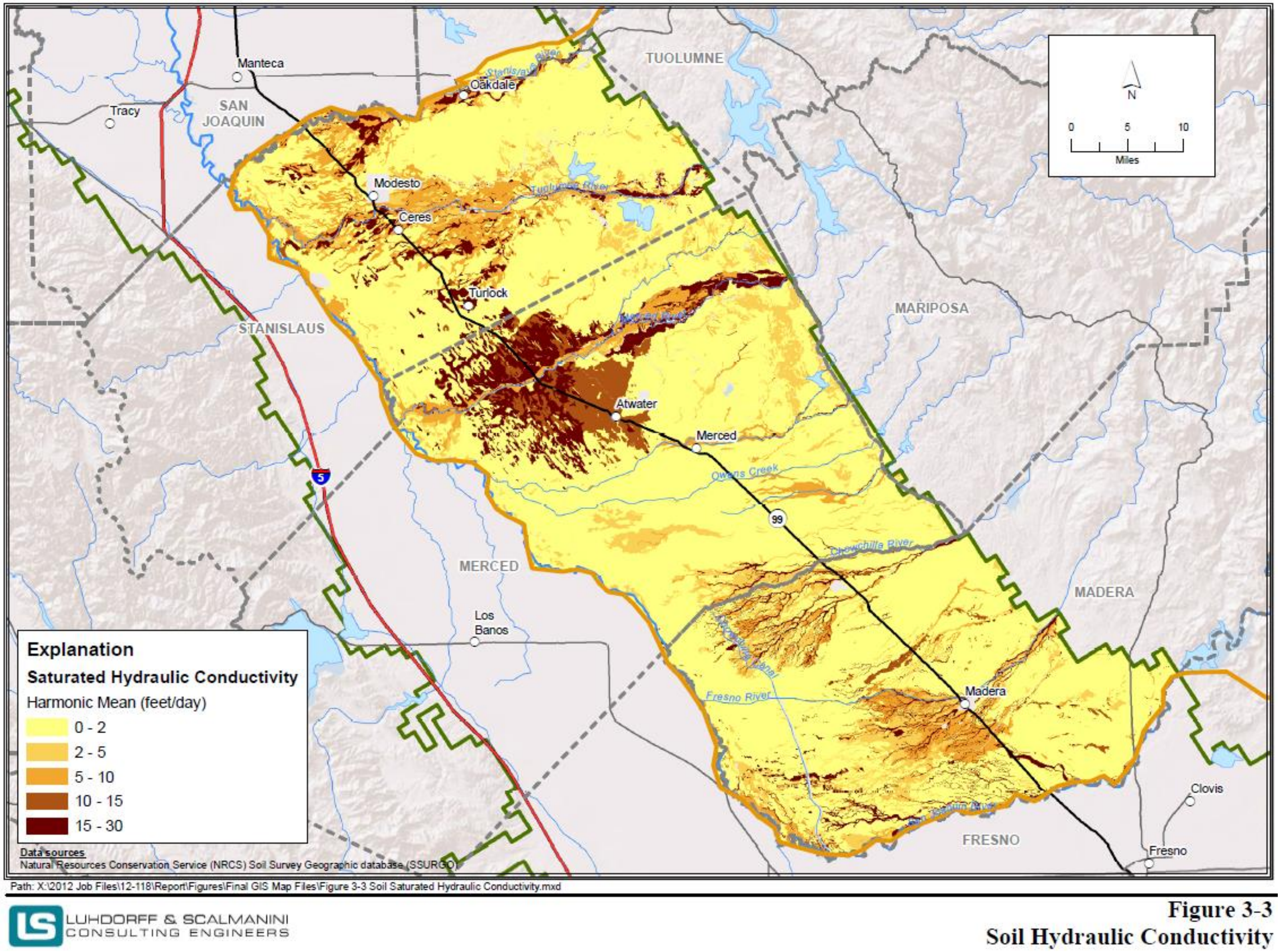


**Figure 17. Soil salinity in the Central Valley portion of the Coalition (Figure 3-4, GAR).**

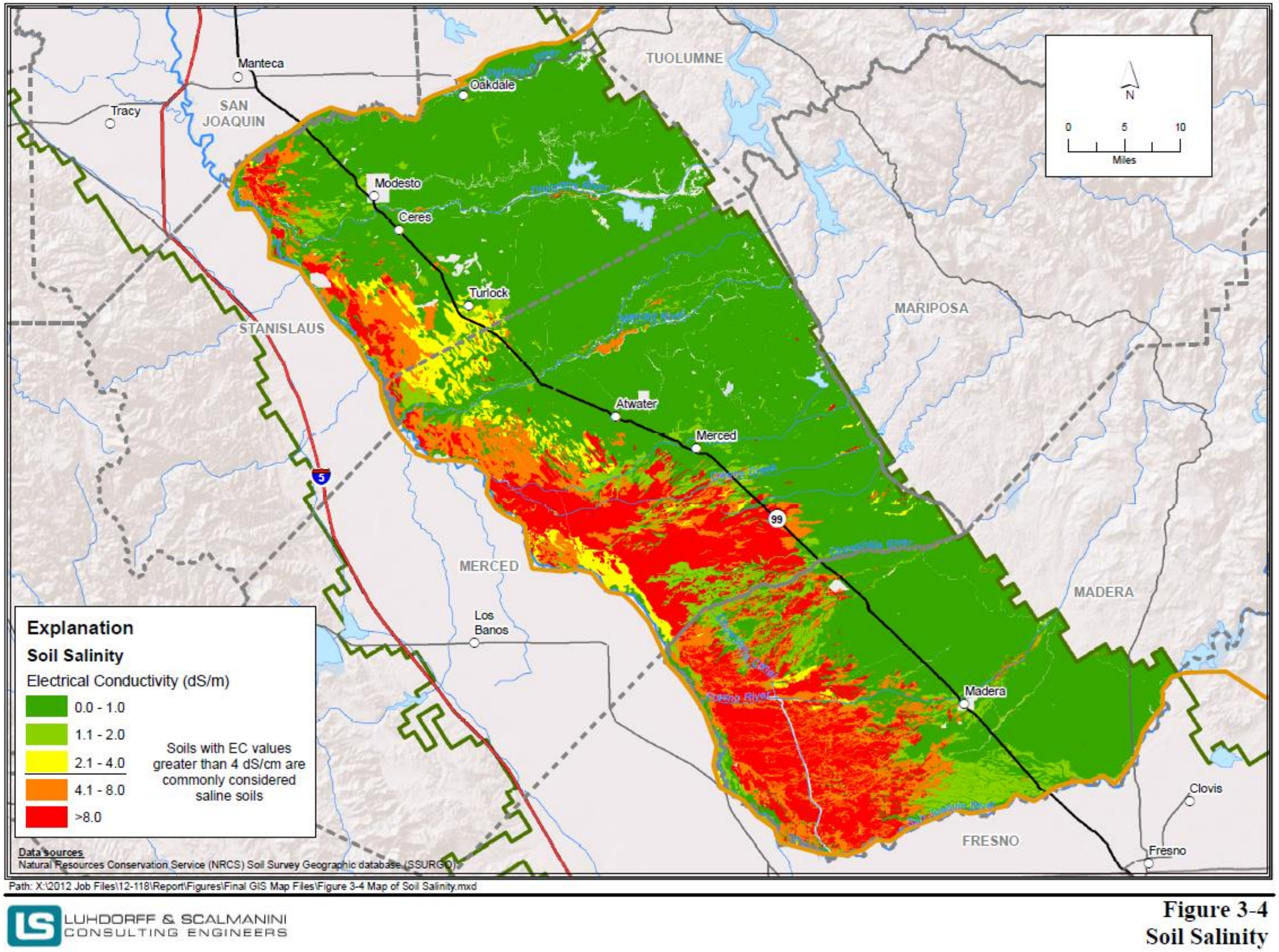
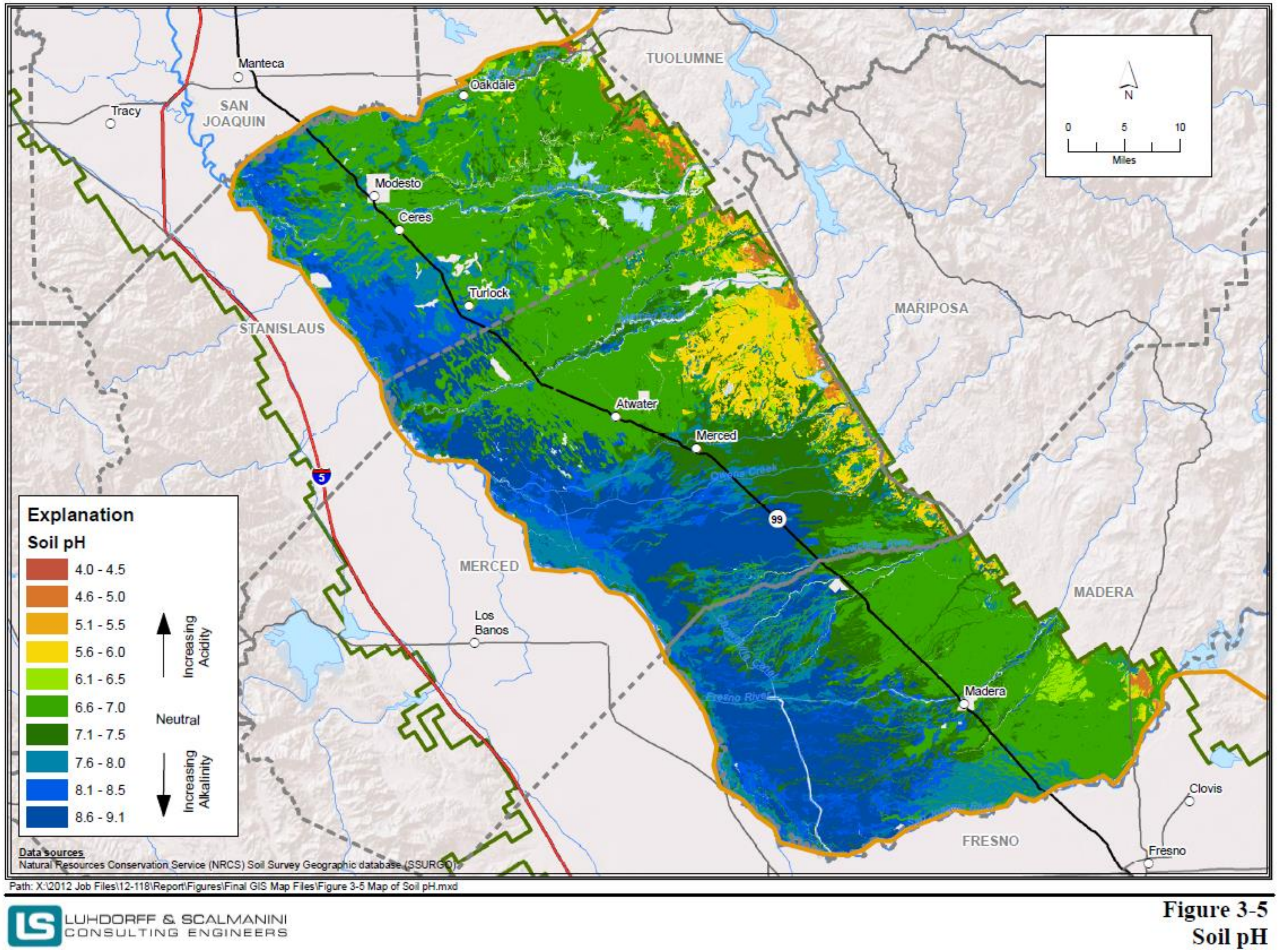


**Figure 18. Soil pH in the Central Valley portion of the Coalition (Figure 3-5, GAR).**



## *Subsurface Sediments*

The subsurface sediment description below is taken directly from the GAR. Reproductions of the figures presented in the GAR are included here for ease of reference.

### CVHM Hydraulic Conductivity

The CVHM (Faunt et al., 2009) (Figures 14-15) incorporates available lithologic data from numerous well drillers' logs and other available data in a three-dimensional sediment texture model characterizing the valley-fill deposits within the Central Valley Floor area. The CVHM presents a layered spatial representation of subsurface hydraulic conductivity and texture at a horizontal grid scale of one-square mile and approximately 50-foot thickness intervals. For the purposes of understanding the relationship between irrigated agriculture management practices and groundwater quality, particularly in regards to the hydrogeologic vulnerability, the characteristics of the uppermost layer of the CVHM are of greatest interest (Figure 14). In the Coalition region, Layer 1 of the CVHM generally extends to a depth of 50 feet, and Figure 19 (Figure 3-6, GAR) shows the vertical hydraulic conductivity as represented in Layer 1 of the CVHM.

### Corcoran Clay

The spatial extent, thickness, and depth to the top of the Corcoran Clay in the Coalition region, as depicted in the CVHM, are shown in Figures 20 and 21 (Figures 3-7a and 3-7b,GAR) and is generally present only in the western portion of the Central Valley Floor area, approximately west of Highway 99 as shown. Depth to the top of the Corcoran Clay generally increases towards the center of the valley and ranges from less than 50 feet along parts of its eastern extent to more than 300 feet below ground in the southwest portion of the Central Valley Floor area as illustrated in Figure 20 (Figure 3-7a, GAR). The thickness of the Corcoran Clay also increases towards the axis of the valley as shown in Figure 21 (Figure 3-7b, GAR). Two areas where the Corcoran Clay is thickest are located generally to the west of Turlock and also to the south of Turlock where the thickness is generally greater than 60 feet with some thicker areas of 100 feet or more. Although the lateral extent of the Corcoran Clay is generally greater farther south, the unit tends to thin with many areas of less than 40 feet thickness, particularly across most of the eastern part of its southern extent.

### Known Tile Drains

The presence of shallow or perched groundwater in parts of the San Joaquin Valley has led to the installation of tile drains in some areas. In preparation of the GAR, readily available data sources were researched in an attempt to identify locations of known tile drains within the Coalition region. Figure 22 (Figure 3-8, GAR) shows the locations of identified tile drains based on DWR water quality sampling points. This map shows the presence of tile drains throughout much of the Sacramento Delta area and in areas west of the San Joaquin River. However, these data do not show the existence of any tile drains within the Coalition region, although the presence of shallow groundwater conditions and shallow wells used by irrigation districts to drain the shallow groundwater is discussed below as it relates to groundwater level data. Tile drains apparently exist along the western edge of the Coalition region, although specific locations for these features are not known.

**Figure 19. Vertical hydraulic conductivity of the CVHM Layer 1within in the Central Valley portion of the Coalition (Figure 3-6, GAR).**

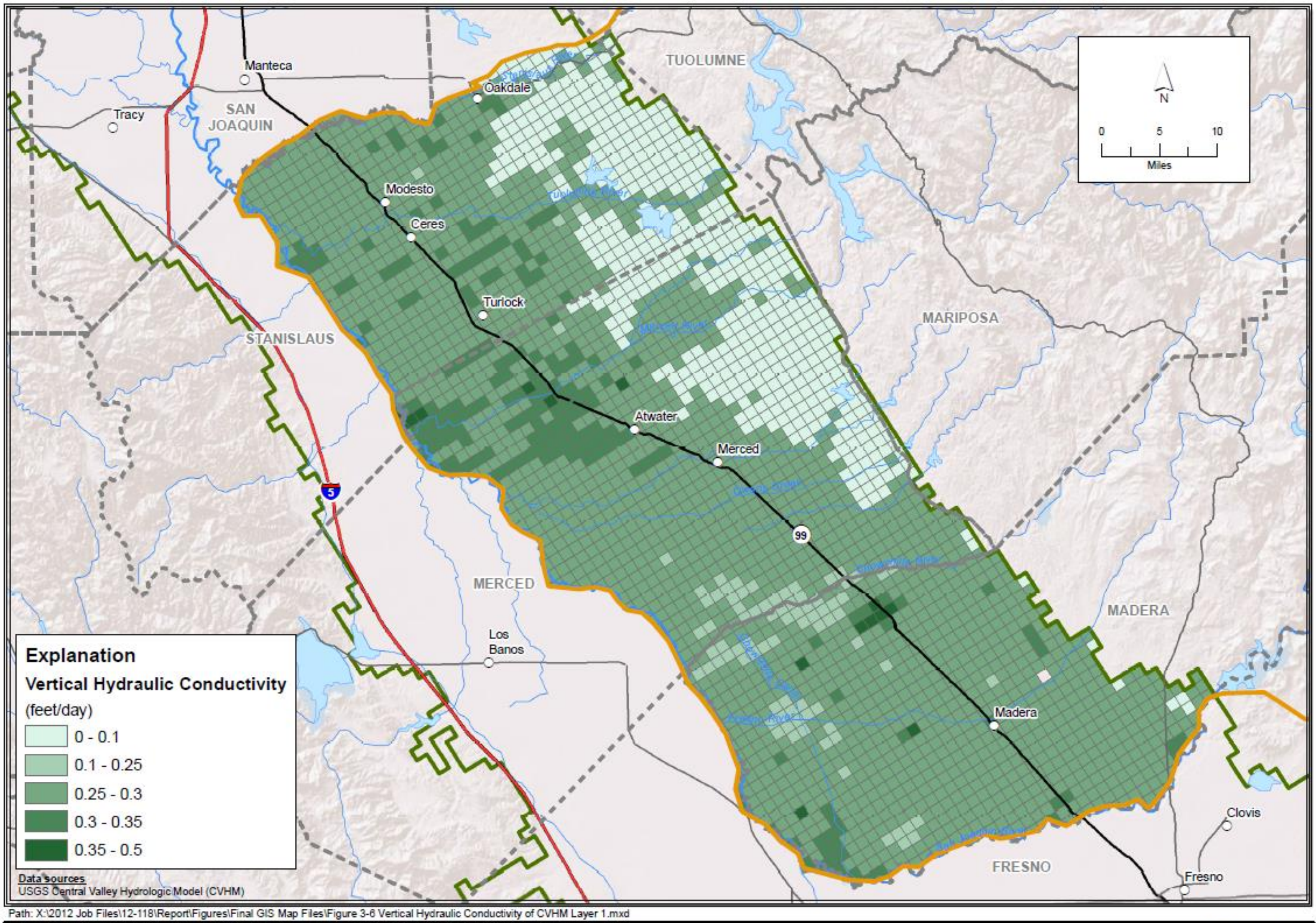



Figure 3-6
Vertical Hydraulic Conductivity of CVHM Layer 1

**Figure 20. Corcoran Clay characteristics (extent and depth) in the Central Valley portion of the Coalition (Figure 3-7a, GAR).**

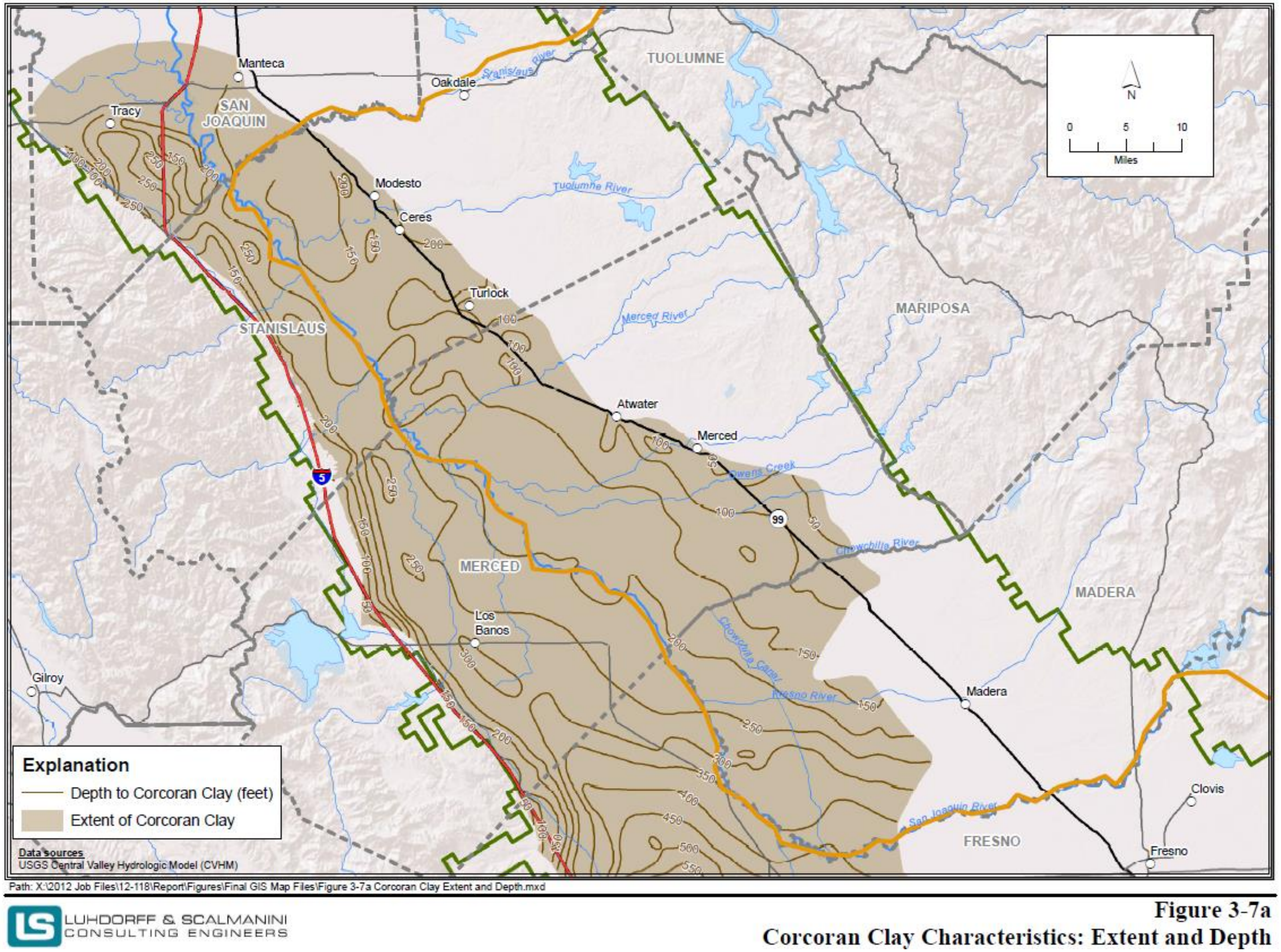
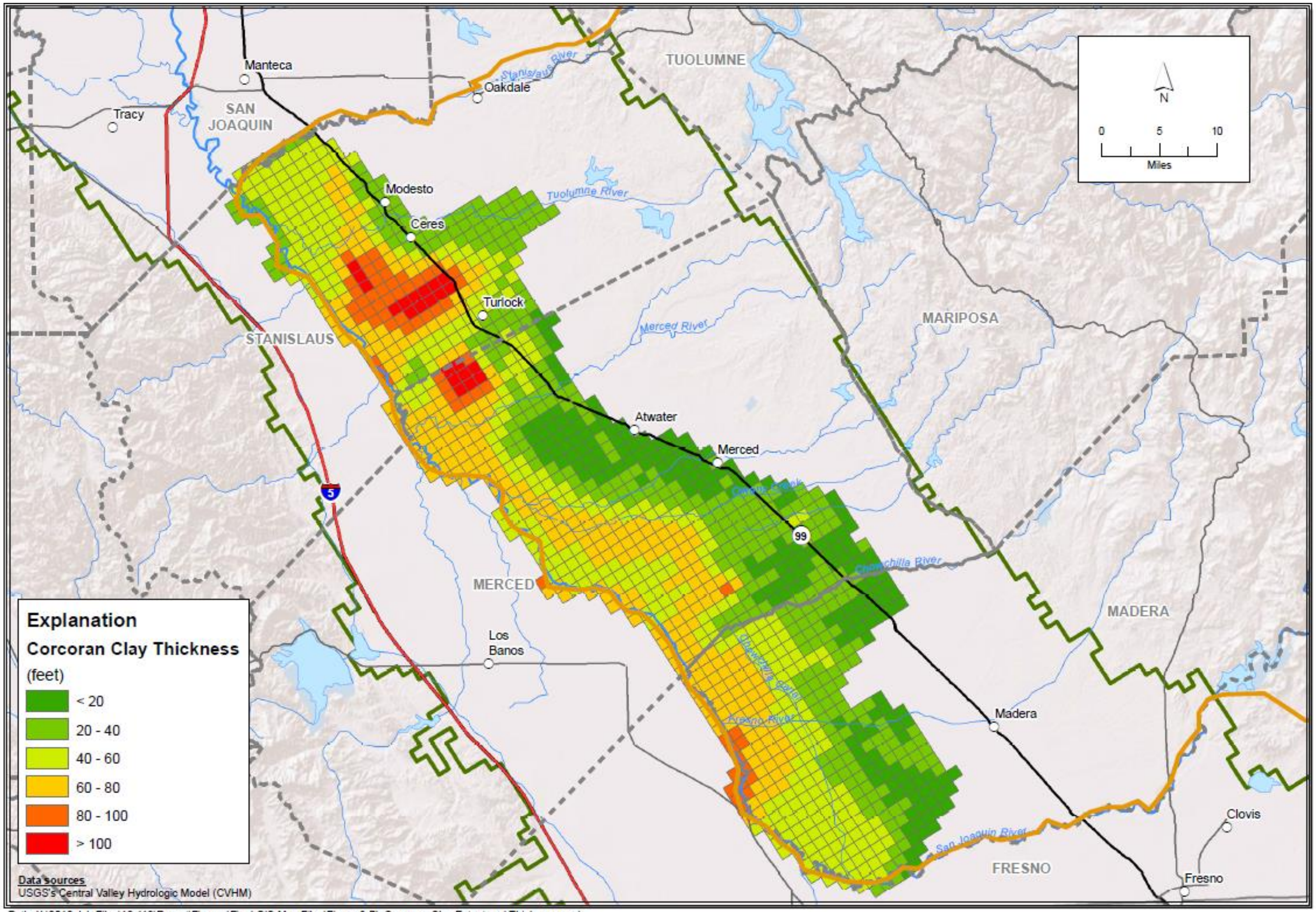



Figure 3-7a
Corcoran Clay Characteristics: Extent and Depth

**Figure 21. Corcoran Clay characteristics (thickness) in the Central Valley portion of the Coalition (Figure 3-7b, GAR).**

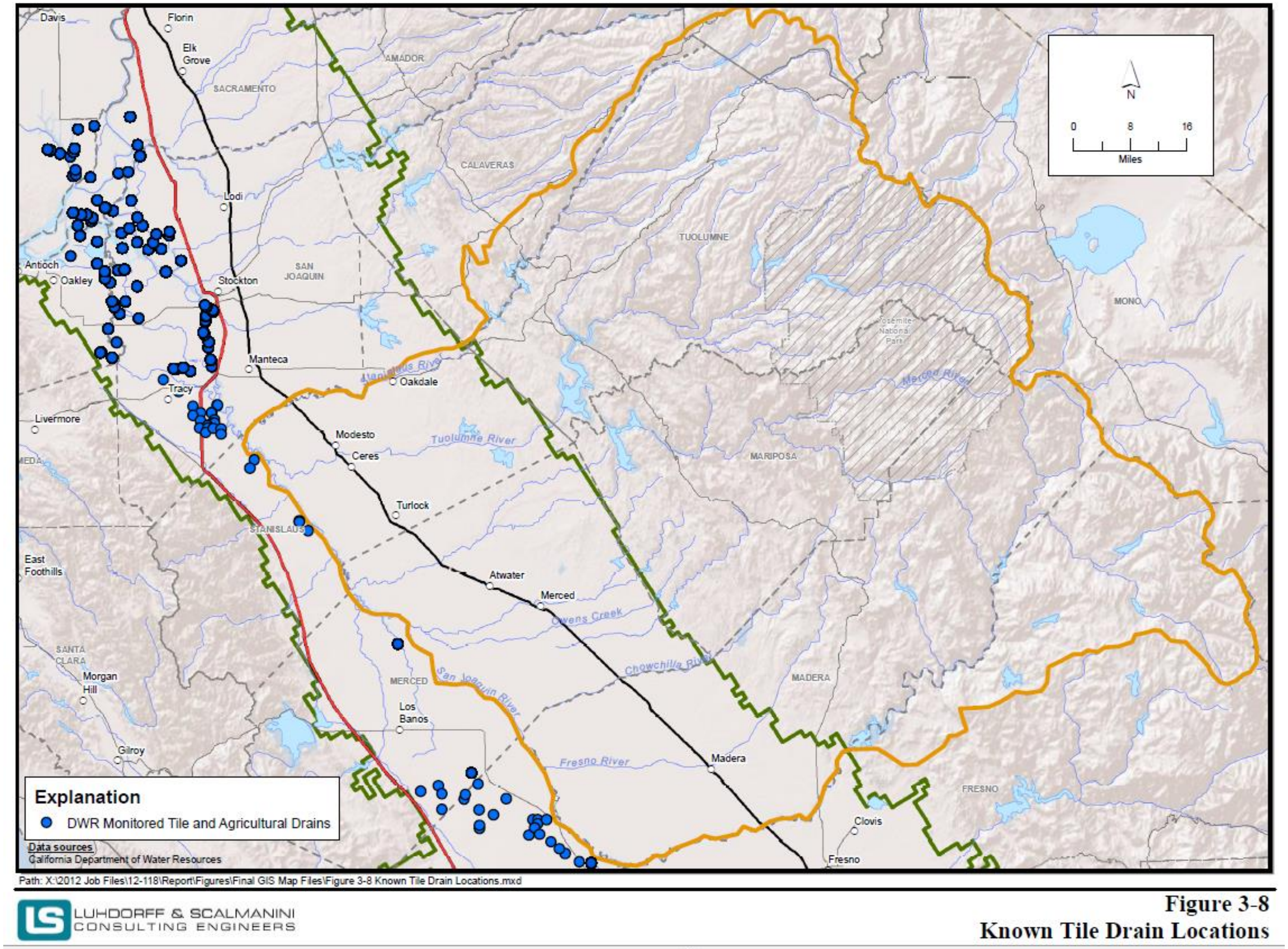



Path: X:\2012 Job Files\12-118\Report\Figures\Final GIS Map Files\Figure 3-7b Corcoran Clay Extent and Thickness.mxd

LUHDORFF & SCALMANINI CONSULTING ENGINEERS

**Figure 3-7b**
**Corcoran Clay Characteristics: Thickness**

**Figure 22. Known tile drain locations in the Central Valley portion of the Coalition (Figure 3-8, GAR).**



# GROUNDWATER HYDROLOGY

The groundwater hydrology description below is taken exclusively from the GAR. Reproduction of the figures presented in the GAR are included here for ease of reference. A discussion of the extent and various restrictions of the well data are presented at length in the GAR in Section 3.3.1.1.

## Groundwater Levels

In order to characterize historical and present groundwater conditions for the GAR, groundwater level data for the Coalition region were gathered from available data sources including DWR's Water Data Library (WDL), California Statewide Groundwater Elevation Monitoring (CASGEM), United States Geological Survey (USGS's) National Water Information System (NWIS), the State Water Resources Control Board's (SWRCB) Geotracker database (GAMA), Merced Irrigation District and Turlock Irrigation District.

In addition to water level measurement data, spatial datasets representing groundwater levels as developed by the California Department of Pesticide Regulation (DPR), and DWR were also reviewed and evaluated. These included interpolated groundwater level data from the DPR Environmental Hazards Assessment Program, Depth to Groundwater Database (DPR, 2000) and from DWR contour maps for select areas of available data, primarily in the western part of the Central Valley Floor area within the Coalition region.

In the GAR, wells were grouped into three general well depth categories: shallow, deep, and unknown. Shallow wells were defined to be wells with known depths less than 200 feet and also included well use categories of domestic wells, monitoring wells, and Turlock Irrigation District (TID) drainage wells (because of anecdotally provided information about general well depth) when well depth was not provided. Deep wells included wells with depths greater than 200 feet and also municipal wells, irrigation wells, or other well uses indicating a greater likelihood of a well that is deeper than 200 feet. Wells without any further information with which to assign them into either the shallow or deep category were designated unknown.

### *Spatial Patterns in Depth to Groundwater*

#### Central Valley Floor

The spring depth to groundwater contours in Figure 23 (Figure 3-11, GAR) show extensive shallow groundwater levels (<20 feet below ground surface [bgs]) in the northwestern part of the Coalition region near Turlock and westwards toward the San Joaquin River. Another area of considerable shallow groundwater exists in the general vicinity of Merced and along Owens Creek and its tributaries. Figure 23 also highlights other more localized areas of shallow groundwater evident along waterways, most notably along the Stanislaus River, Merced River, and San Joaquin River. Depth to groundwater tends to be deeper to the east and away from San Joaquin River. Two notable pockets of deeper groundwater are apparent to the east of Turlock, in the vicinity of Chowchilla, and between Merced and Madera in the more southerly portion of the area. Similar spatial patterns are evident in the contours of fall depth to groundwater as shown in Figure 24 (Figure 3-12, GAR). However, as expected, the depth to groundwater is generally greater in the fall than in the spring indicating seasonal lowering of groundwater levels. The depth to groundwater contour maps developed in the GAR show similar spatial patterns to those developed by DPR shown in Figure 25 (Figure 3-13, GAR).

Figure 26 (Figure 3-14, GAR) shows areas of potential groundwater discharge where the current depth to groundwater contours indicate shallow groundwater conditions (<10 feet bgs). Particularly notable areas where groundwater is within 10 feet of the ground surface are evident from Figure 26 in the vicinity of Turlock and along lower reach sections of many tributary rivers to the San Joaquin River, including the Stanislaus, Tuolumne, Merced, and Fresno Rivers. As a result, some of these tributary reaches may experience gaining conditions during some times. A number of sections of the San Joaquin River also have shallow groundwater conditions which may result in groundwater discharge areas along or near the river. These general patterns are similar to those depicted by DWR groundwater level contour maps (2010a; 2010b).

#### Peripheral Area

Because of the relatively sparse spatial distribution of available water level data, and the different hydrogeologic environment of the Peripheral Area in which groundwater commonly occurs in and moves through networks of fractures, interpreting spatial patterns can be challenging and misleading since groundwater conditions can be highly localized. Therefore, groundwater levels outside of the Central Valley Floor were not contoured. However, available recent water level data points in the Peripheral Area are shown in Figure 27 (Figure 3-15, GAR) to illustrate some of the general groundwater level conditions in the area. Because of the hydrogeologic environment of the Peripheral Area, differentiation of groundwater resources into shallow and deep zones is also not as meaningful. Figure 27 shows the average depth to groundwater value within the Peripheral Area for wells of all depth, regardless of time of year. This map shows a wide range of average depth to groundwater values ranging from shallow to greater than 700 feet below ground surface. The shallowest groundwater levels generally occur in valleys and deeper water levels are generally in upland areas away from waterways.

### *Groundwater Flow Directions*

The continuous depth to groundwater spatial dataset and associated contours generated in the GAR were used to calculate groundwater elevations across the Central Valley Floor area and for estimating groundwater flow direction.

Figures 28 and 29 (Figures 3-16 and 3-17, GAR) show a steeper groundwater surface with greater hydraulic gradients in the eastern part of the Central Valley Floor area with the presence of some notable local groundwater depressions, particularly in the vicinity of Chowchilla, between Merced and Madera, and east of Turlock. The hydraulic gradient of the groundwater surface generally flattens to the west, particularly in the northern and western part of the Coalition region. Arrows on Figures 28 and 29 show the interpreted directions of groundwater flow under spring and fall conditions based off of the contour maps. Both spring and fall groundwater elevation contours indicate that groundwater generally flows in a southwestern direction away from the hills and mountains to the northeast.

**Figure 23. Spring depth to groundwater contours: Central Valley portion of the Coalition (Figure 3-11, GAR).**

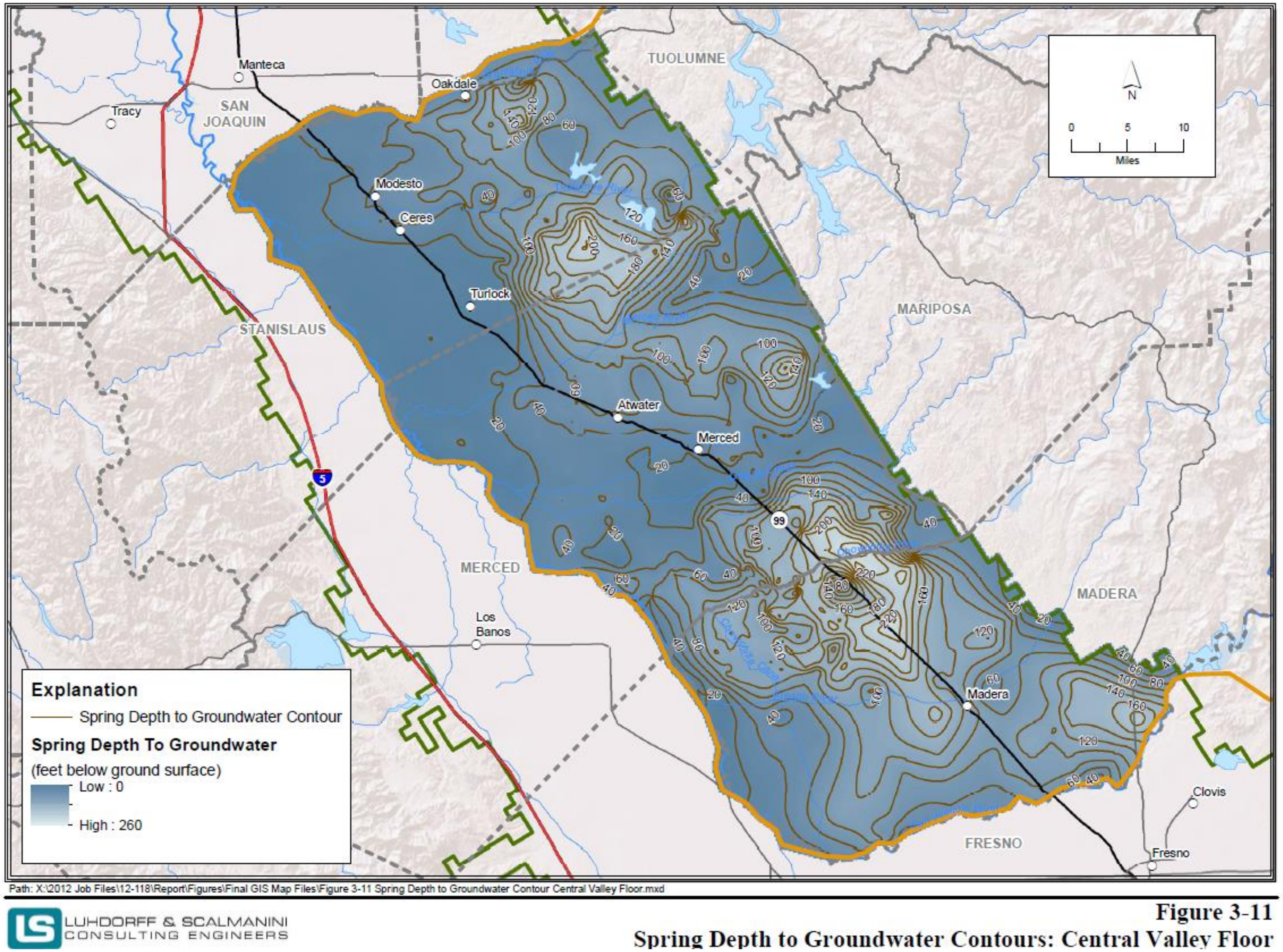


**Figure 24. Fall depth to groundwater contours: Central Valley portion of the Coalition (Figure 3-12, GAR).**

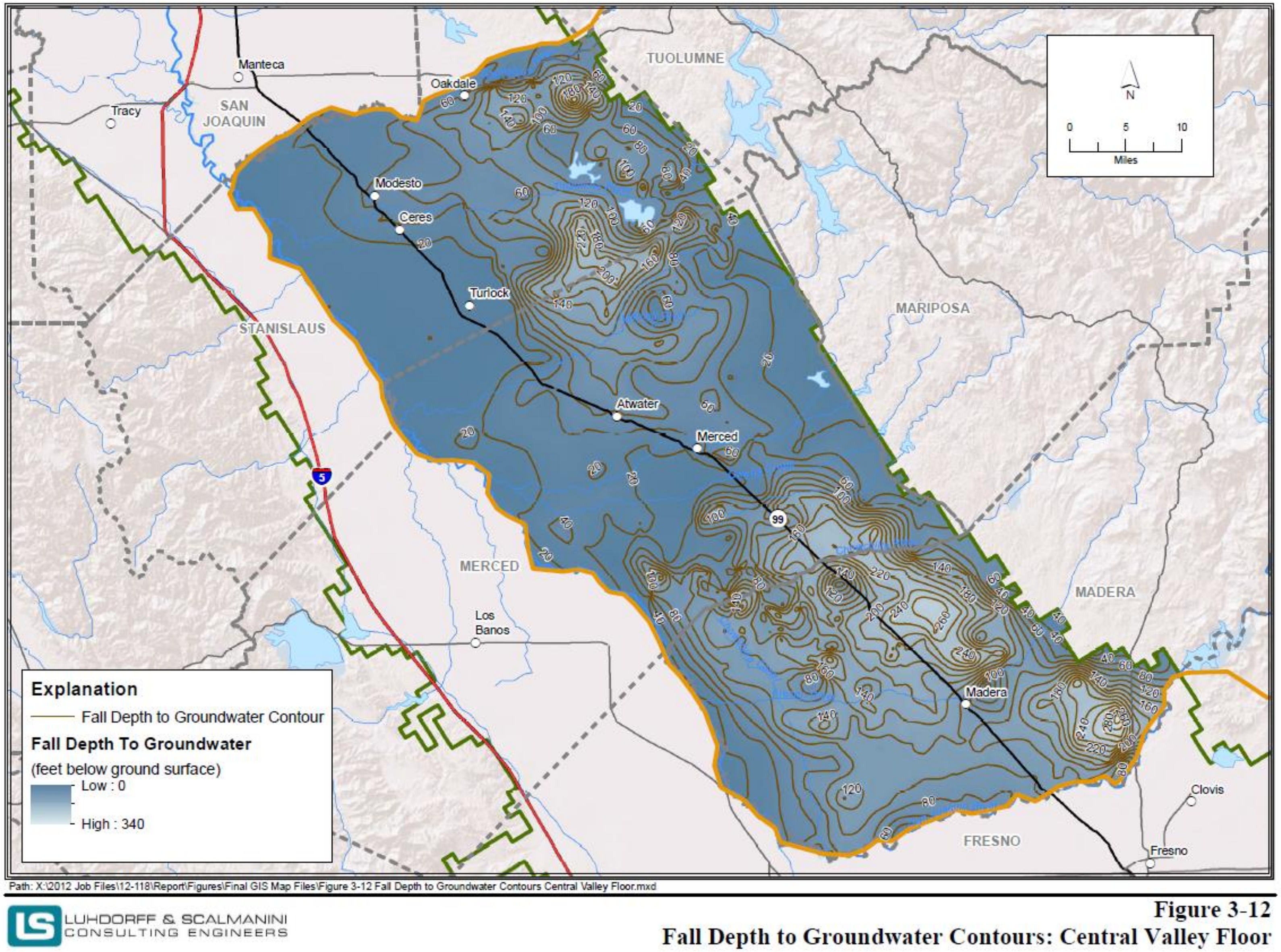


Figure 3-12
Fall Depth to Groundwater Contours: Central Valley Floor

**Figure 25. DWR depth to groundwater contours of the Central Valley portion of the Coalition (Figure 3-13, GAR).**

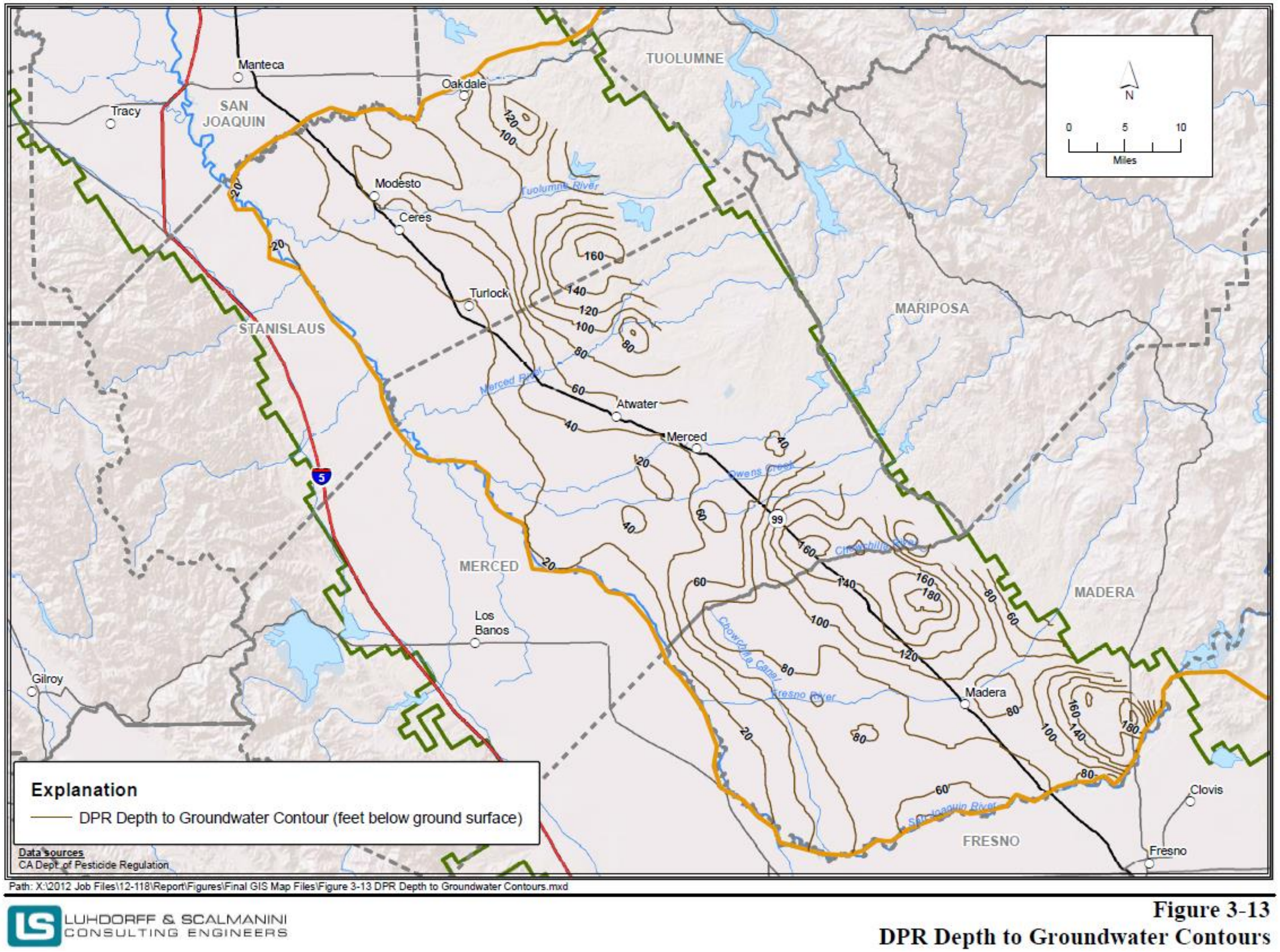


**Figure 26. Potential groundwater discharge areas of the Central Valley portion of the Coalition (Figure 3-14, GAR).**

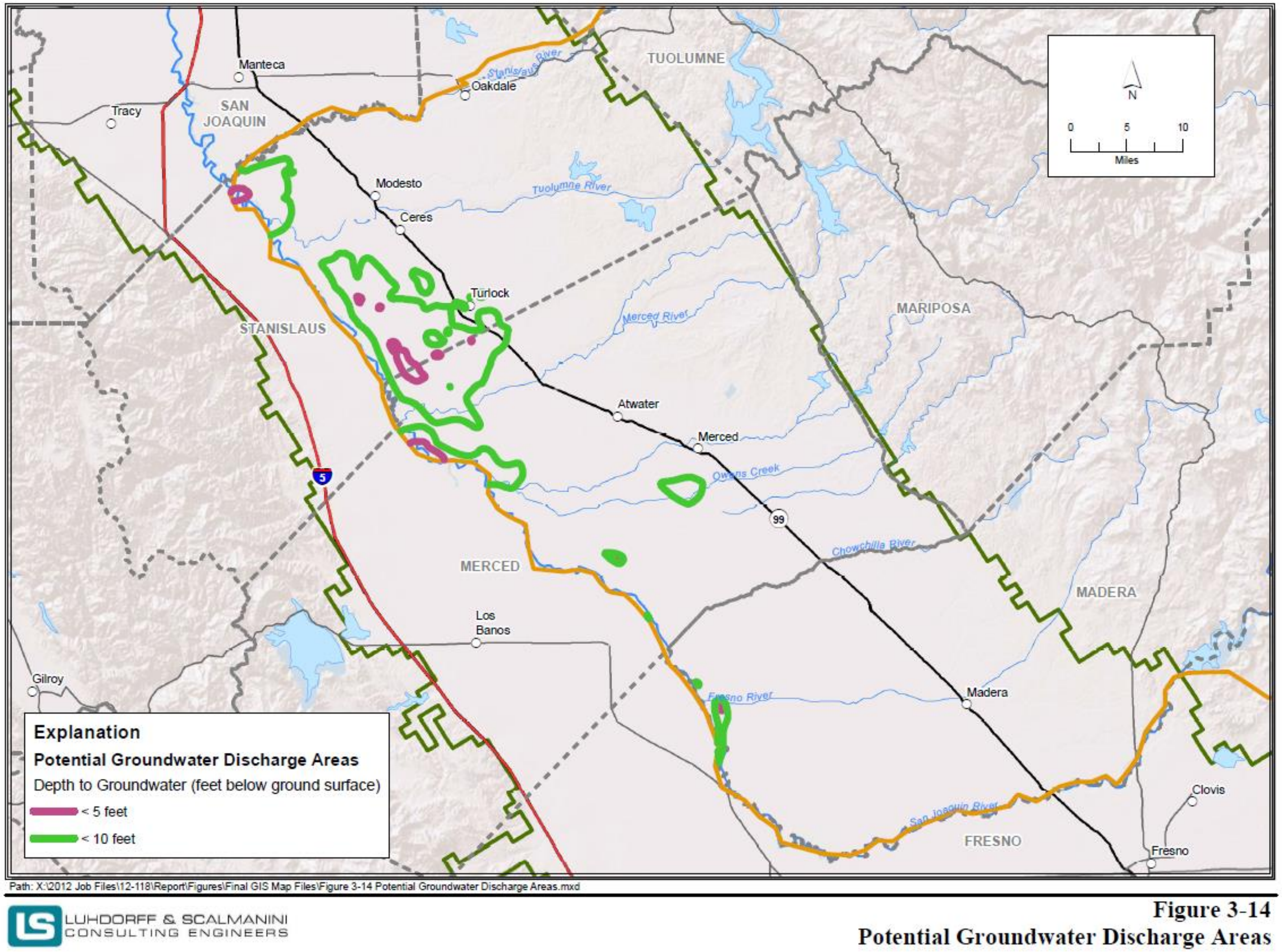


**Figure 27. Depth to groundwater measurements: Peripheral portion of the Coalition (Figure 3-15, GAR).**

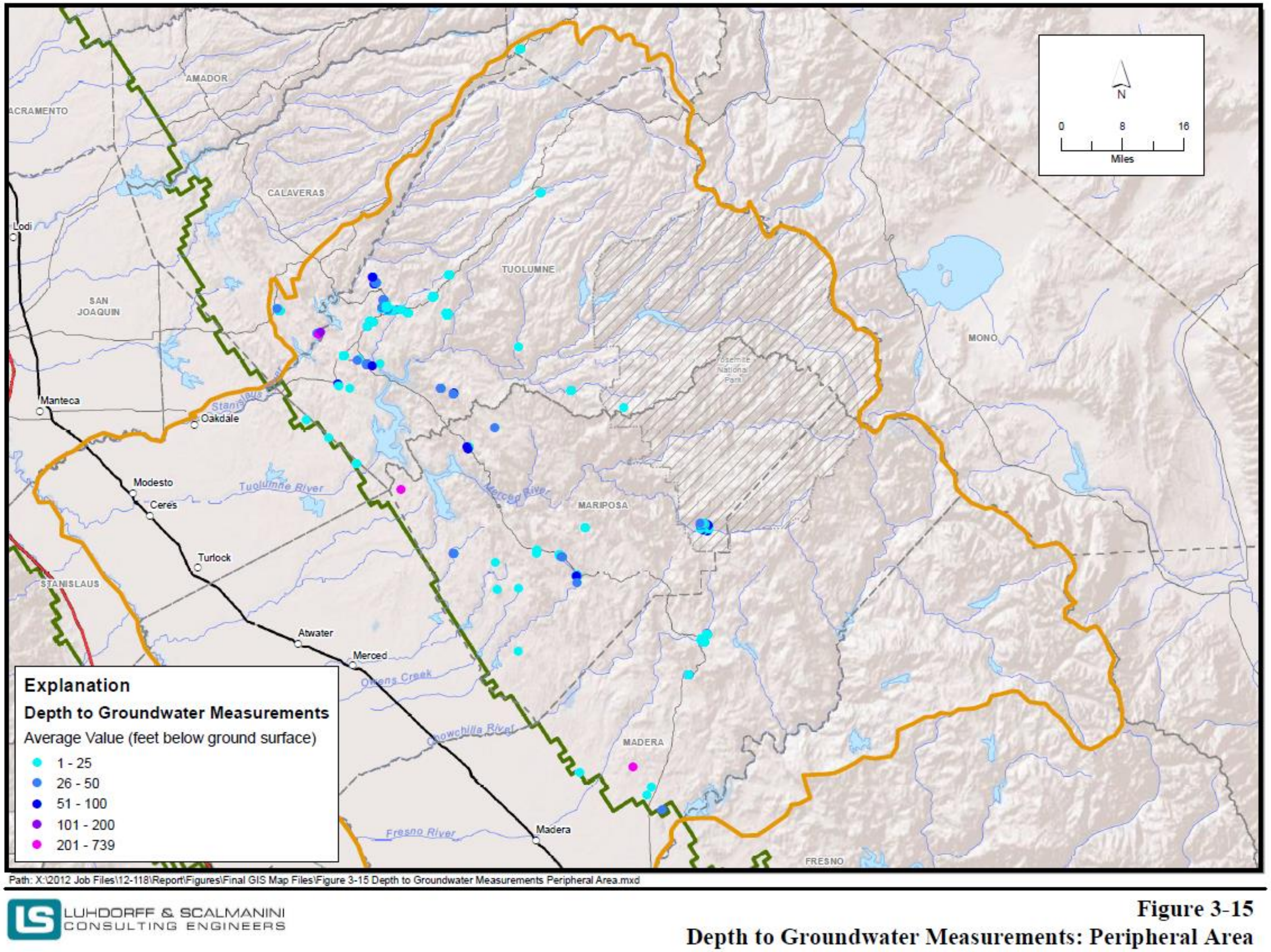


**Figure 28. Spring groundwater elevation contours: Central Valley portion of the Coalition (Figure 3-16, GAR).**

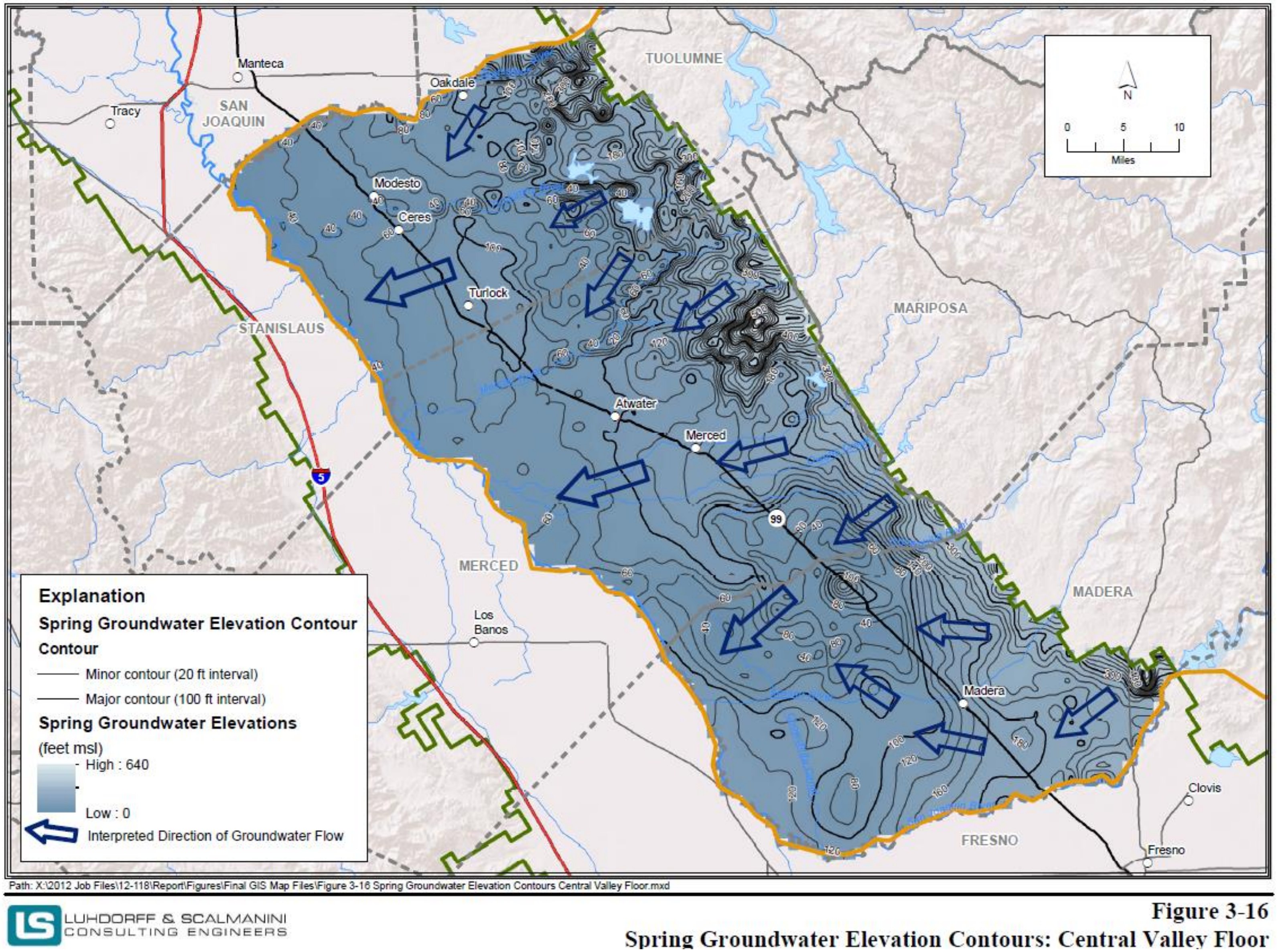
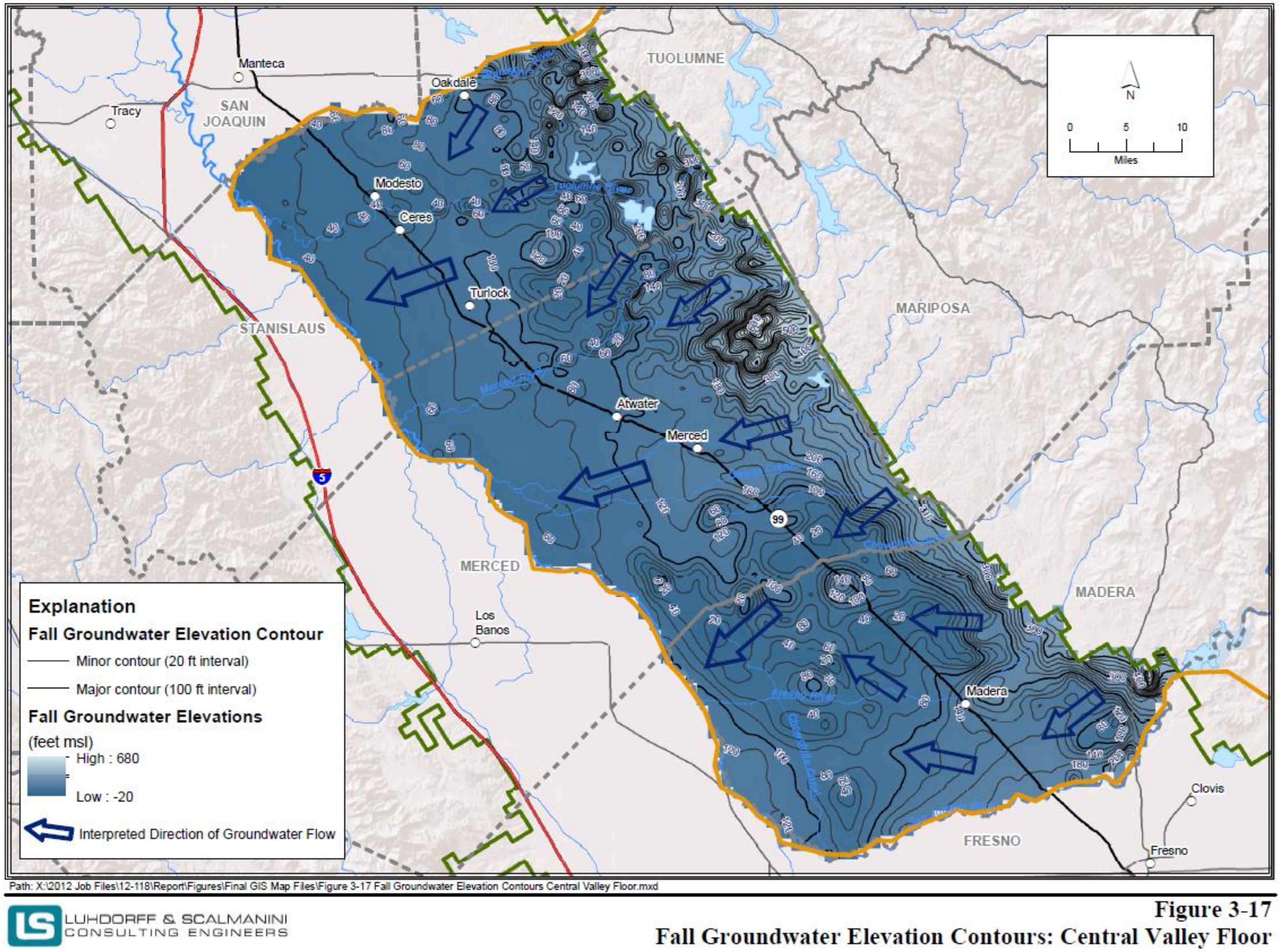


**Figure 29. Fall groundwater elevation contours: Central Valley portion of the Coalition (Figure 3-16, GAR).**



## *Recharge to Groundwater*

The primary process for groundwater recharge within the Central Valley Floor area is from percolation of applied irrigation water. Groundwater recharge estimates made by DWR (2003) for each of the five main groundwater subbasins within the Coalition region indicate that natural groundwater recharge represents a relatively small fraction of total recharge when compared with estimates of recharge from applied water. Annual natural recharge estimates made by DWR for the five main groundwater subbasins within the Coalition region total 274,000 acre-feet (af) (Modesto: 86,000 af, Turlock: 33,000 af, Merced: 47,000 af, Chowchilla: 87,000 af, Madera: 21,000 af). In contrast, estimates of average annual recharge from applied water for these subbasins totals 1,231,000 af (Modesto: 92,000 af, Turlock: 313,000 af, Merced: 243,000 af, Chowchilla: 179,000 af, Madera: 404,000 af).

The modeled net recharge within the Central Valley Floor area from the CVHM output is shown in Figure 30 (Figure 3-20, GAR). This map depicts model-simulated annual net recharge in units of inches at a one square mile grid scale with values ranging from below negative 20 inches per year to greater than 20 inches per year. The areas of highest net recharge correspond with areas of high vertical hydraulic conductivity in CVHM model layers (as shown for CVHM Layer 1 on Figure 14) and also areas where depth to groundwater is generally deeper (as shown in Figures 23 and 24). Conversely, negative net recharge values are generally in areas where groundwater is shallow resulting in greater evapotranspiration of water within the root zone and potential discharging of groundwater.

Areas with high potential for groundwater recharge within the Central Valley Floor area of the Coalition region are shown in Figure 31 (Figure 3-21, GAR). The areas of potential groundwater recharge are based on mapped areas of high soil hydraulic conductivity (harmonic mean of saturated soil vertical hydraulic conductivity >2 feet/day) which overlie mapped unconsolidated geologic units, mainly alluvium. High conductivity soils are shown in blue in Figure 31 and occur along many of the main tributary river channels and as the result of distributary channel and fan deposition. The areas where the greatest potential for groundwater recharge exists are areas where these high conductivity soils overlie unconsolidated alluvium which functions as the primary aquifer system in the area. Where the Corcoran Clay exists, groundwater recharge is more likely to be limited to shallow groundwater zones (Figure 31). As a result, the areas with potential for deep groundwater recharge are more likely to be located in the eastern part of the Central Valley Floor where the Corcoran Clay is not present.

**Figure 30. Groundwater recharge as simulated by the CVHM (Figure 3-20, GAR).**

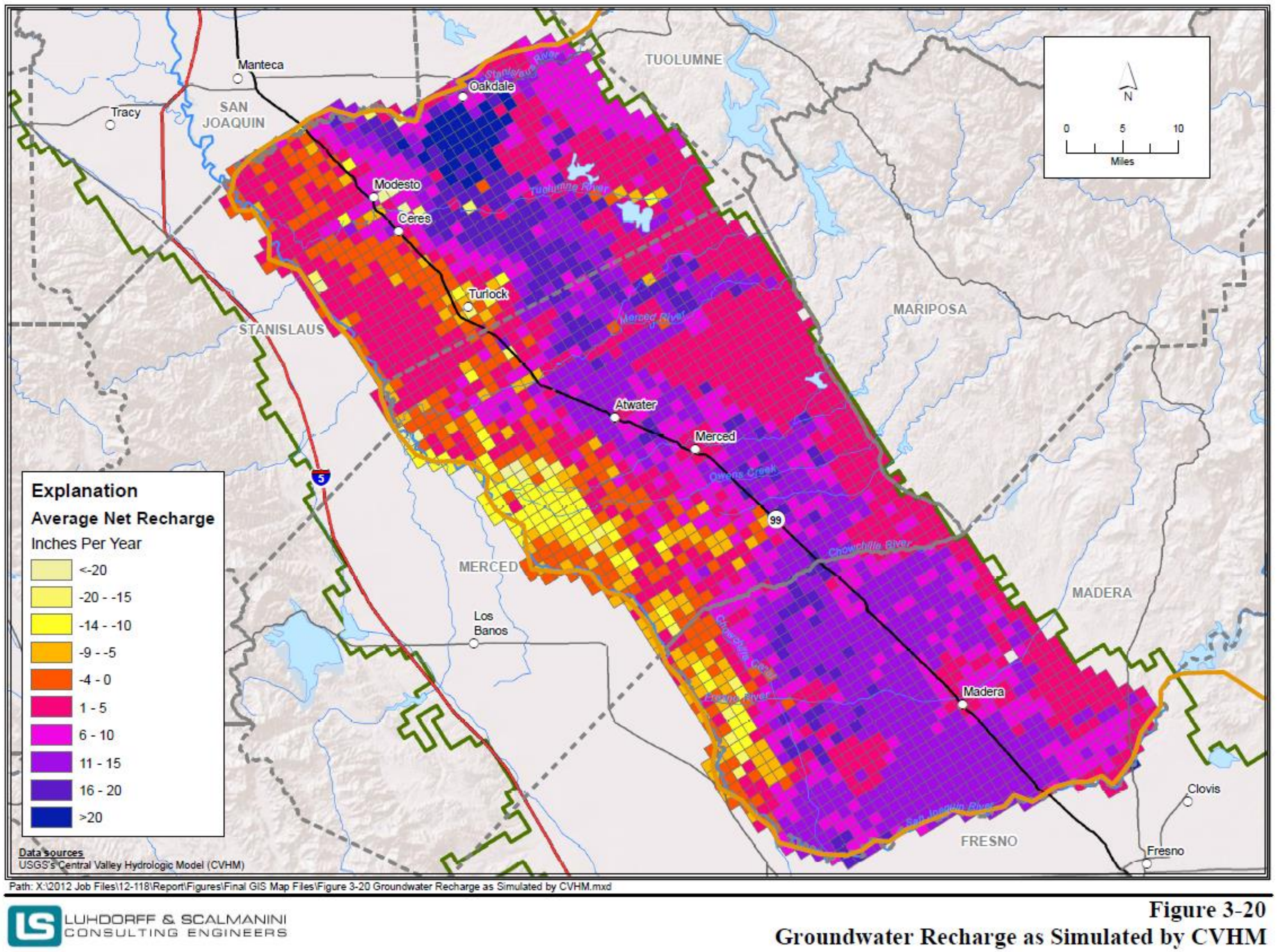


**Figure 31. Areas with higher potential for groundwater recharge (Figure 3-21, GAR).**

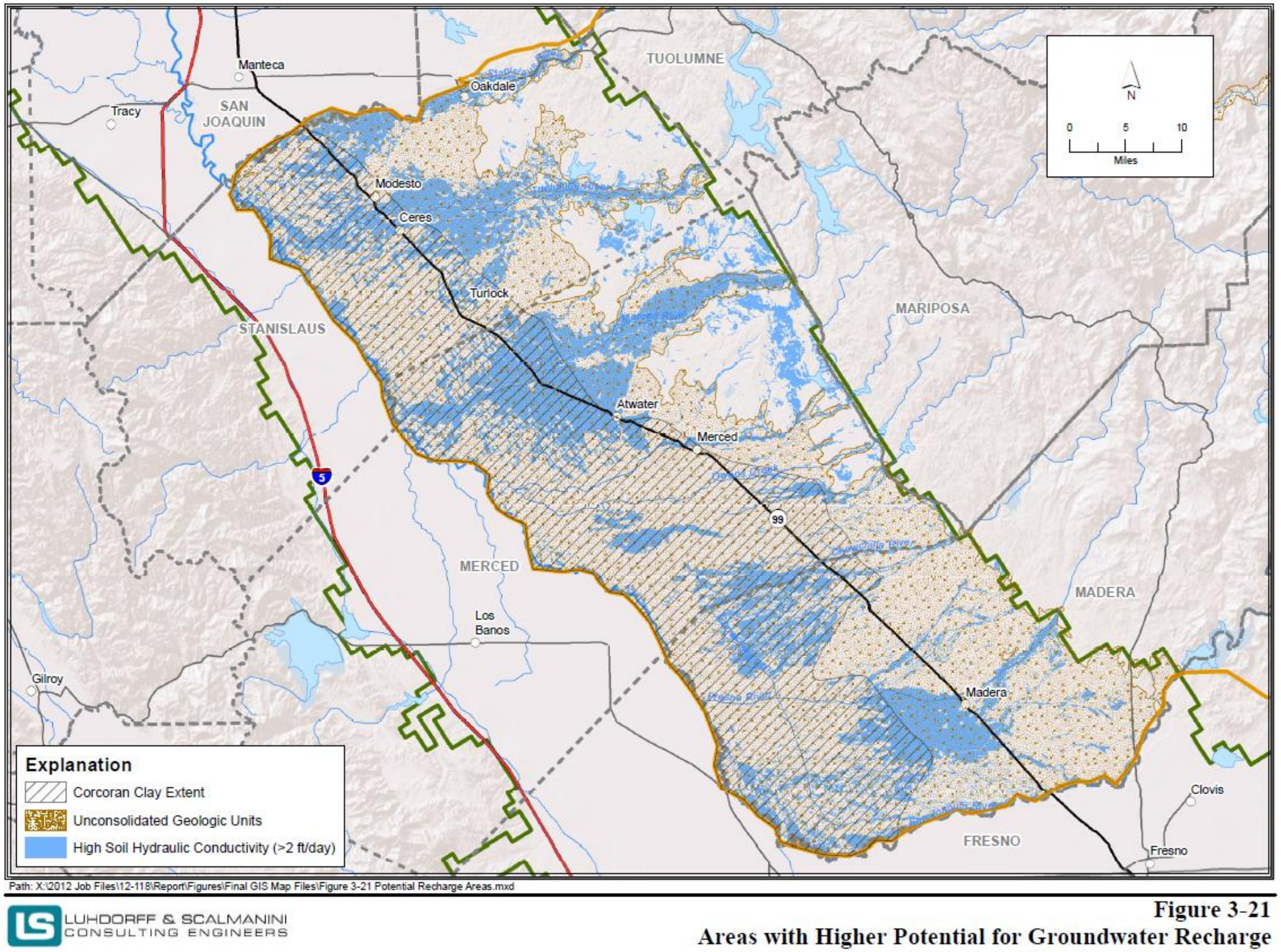



Figure 3-21
Areas with Higher Potential for Groundwater Recharge

## General Groundwater Chemistry

The cation-anion balance of groundwater monitored in USGS' Central–Eastside San Joaquin Basin Study Unit is depicted in a Piper Diagram below (Figure 32). California Department of Public Health (CDPH) data used in the Piper diagram describes a charge imbalance of less than 10 percent. USGS' Central–Eastside San Joaquin Basin Study Unit is bounded by the San Joaquin River to the west, the Sierra Nevada Mountains to the east, the Stanislaus River to the north, and the Chowchilla groundwater subbasin to the south (USGS, *Status and Understanding of Groundwater Quality, Central–Eastside San Joaquin Basin, 2006: GAMA Priority Basin Project, Scientific Investigations Report 2009-5266*, page 5). For the purposes of the management units laid out in this GQMP, the USGS' Central–Eastside San Joaquin Basin Study Unit includes most of the Modesto GQMP Zone (excluding the northern most sliver along the Stanislaus River), part of the Eastern San Joaquin subbasin, and the entire Turlock and Merced GQMP Zones (Figure 33).

The Merced Area Groundwater Pool Interests (MAGPI) published a map of groundwater types (cation/anion) within the Merced groundwater subbasin in the Merced Groundwater Basin Groundwater Management Plan Update Merced County, CA, 2008 (Figure 34). "Groundwater with high concentrations of total dissolved solids is present beneath the entire Merced groundwater basin at depths from about 400 feet in the west to over 800 feet in the west. The shallowest high Total Dissolved Solids (TDS) groundwater occurs in zones five to six miles wide adjacent and parallel to the San Joaquin River and the lower part of the Merced River west of Hilmar, where high TDS groundwater is upwelling. The chemistry of groundwater in the Merced groundwater basin indicates that mixing is occurring between the shallow fresh groundwater and the brines, which produces the high TDS groundwater observed" (Merced Groundwater Basin Groundwater Management Plan Update Merced County, CA, 2008, page 15).

The cation-anion balance of groundwater monitored in USGS' Madera- Chowchilla Study Unit is depicted in a Piper Diagram below (Figure 35). USGS' Madera- Chowchilla Study Unit is bounded partially on the north by the Chowchilla River, approximately on the west and south by the San Joaquin River, and on the east by foothills of the Sierra Nevada (USGS, Status and Understanding of Groundwater Quality in the Madera-Chowchilla Study Unit, 2008: California GAMA Priority Basin Project*, Scientific Investigations Report 2012–5094*, page 5). For the purposes of the monitoring units laid out in this GQMP, the USGS' Madera- Chowchilla Study Unit includes the entire Chowchilla groundwater monitoring zone and most of the Madera groundwater monitoring zone, only excluding the eastern sliver of the Delta-Mendota subbasin as it follows the San Joaquin.

Madera County overlies most of the Madera subbasin and parts of the Chowchilla and Delta-Mendota subbasins. Madera County published a Stiff diagram in Figure 2-12 of their AB3030 Groundwater Management Plan Madera County Final Draft produced in January 2002 (Madera County, 2002). The Stiff diagram is reproduced in Figure 36. The Stiff diagram is a geochemical plot which allows for a visual comparison between water quality types based on concentrations of specific cations and anions in the water. The Madera County Stiff diagram indicates that the East and Central Basin are shallow with smaller concentrations of TDS. The Eastern Basin is considered deep with higher TDS concentrations and the presence of detectable metals and the Western Basin is shallow with a wide diagram dominated by sodium and chloride. According to the

Madera County Groundwater Management Plan, “the geochemical plot graphically illustrates the changes in water quality with depth and in particular the poorer water quality in the west” (Madera County, 2002).

**Figure 32. Piper diagram of ion balance for USGS grid and understanding wells and all wells in the CDPH database that have a charge imbalance of less than 10 percent, Central Eastside, California, USGS study unit.**

USGS, Status and Understanding of Groundwater Quality, Central–Eastside San Joaquin Basin, 2006: GAMA Priority Basin Project, Scientific Investigations Report 2009-5266, Figure B2, page 96.

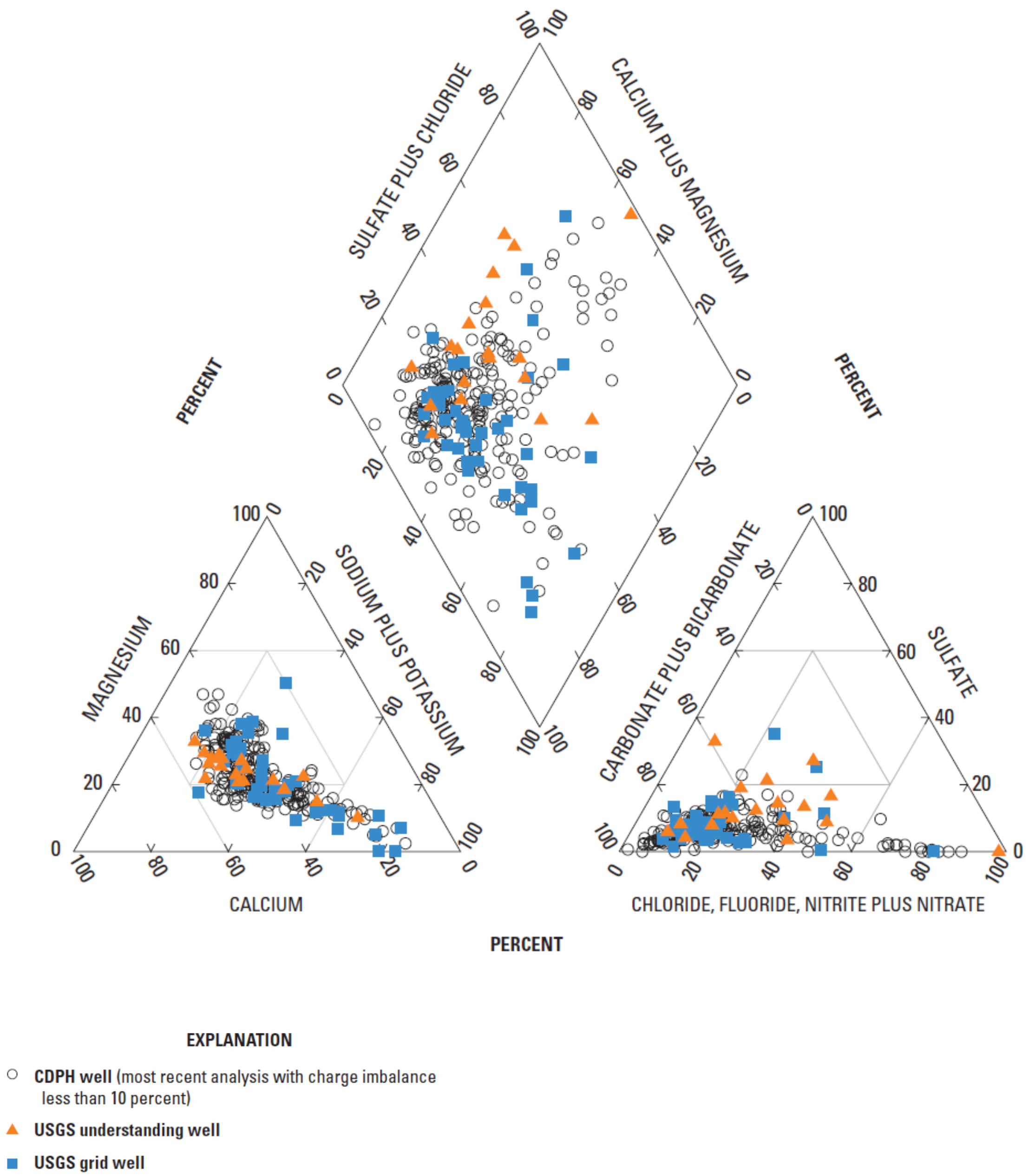


**Figure 33. USGS' Central–Eastside San Joaquin Basin Study Unit.**

USGS, Status and Understanding of Groundwater Quality, Central–Eastside San Joaquin Basin, 2006: GAMA Priority Basin Project, Scientific Investigations Report 2009-5266, page 5.

6 **Status and Understanding of Groundwater Quality, Central–Eastside San Joaquin Basin, 2006: GAMA Priority Basin Project**

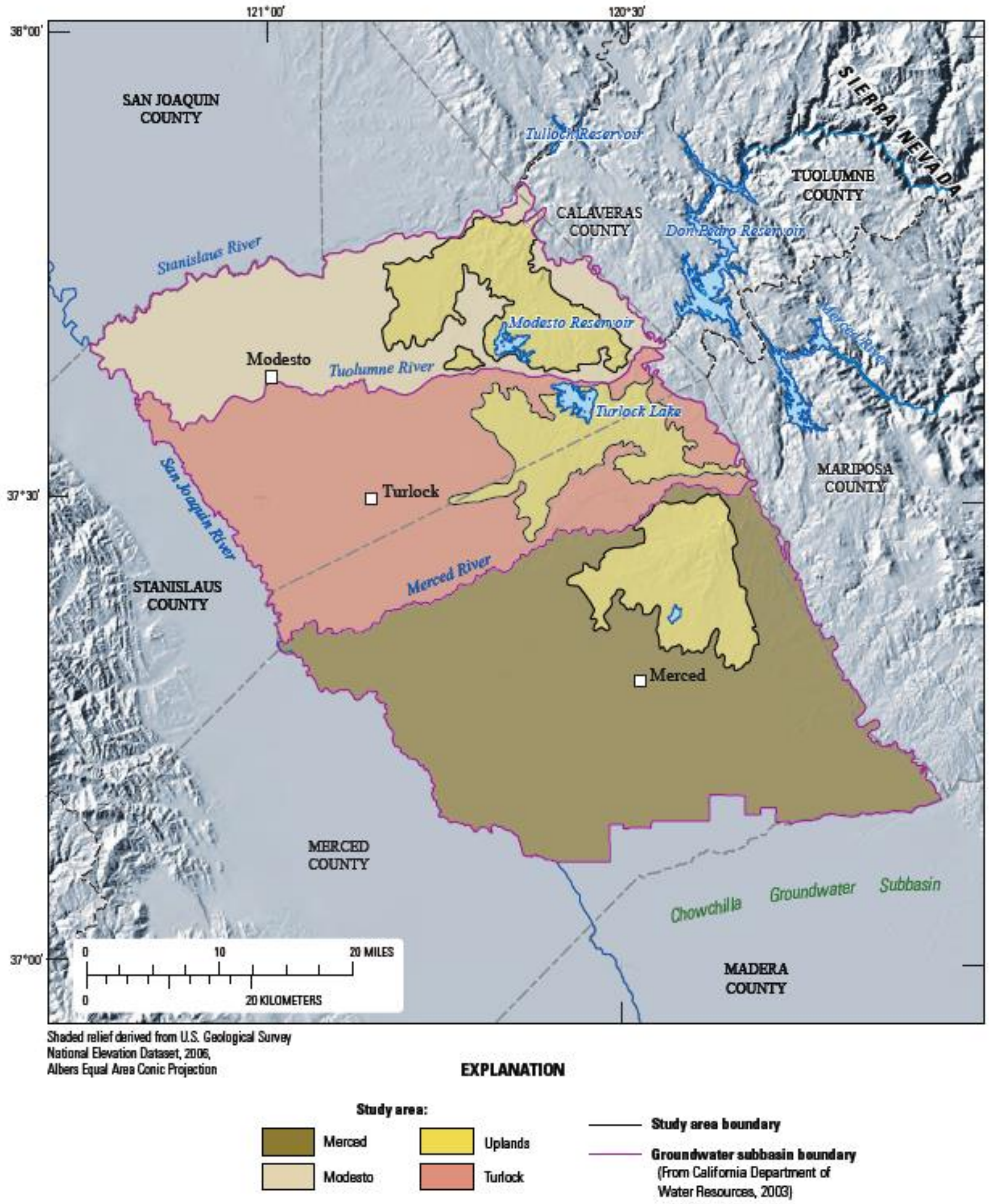



**Figure 2.** Geographic features of the Central Eastside, California, Groundwater Ambient Monitoring and Assessment (GAMA) study unit.

**Figure 34. Distribution of groundwater types within the Merced groundwater basin (Geomatrix, Merced Groundwater Basin Groundwater Management Plan Update Merced County, CA, Figure 19, 2008).**

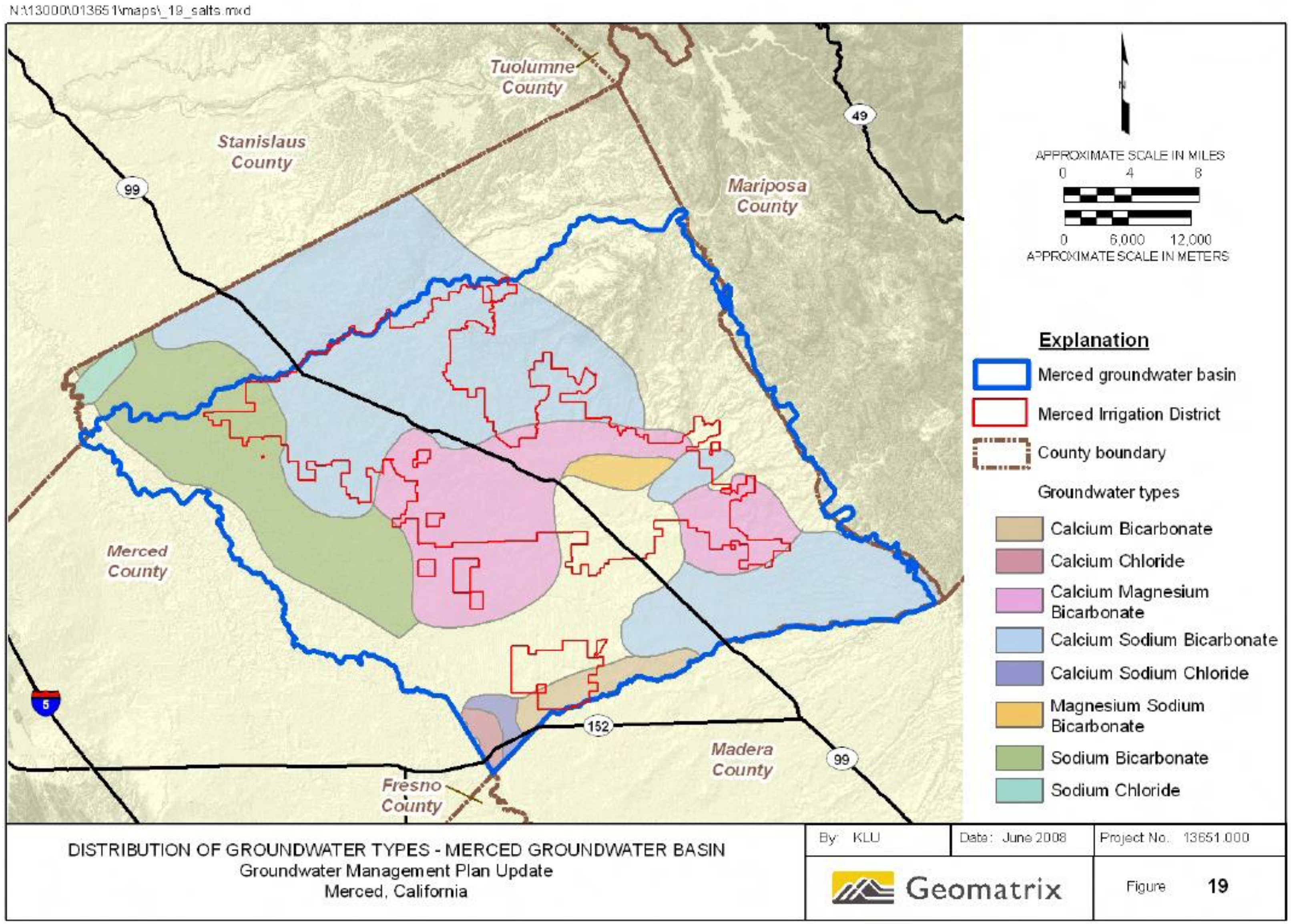


**Figure 35. Reproduced piper diagram for the Madera-Chowchilla study unit (USGS 2008). Well data are from the CDPH database using data from February 12, 2005 – February 12, 2008.**

USGS, Status and Understanding of Groundwater Quality in the Madera- Chowchilla Study Unit, 2008: California GAMA Priority Basin Project, Scientific Investigations Report 2012–5094, Figure B2, Appendix B, page 83.

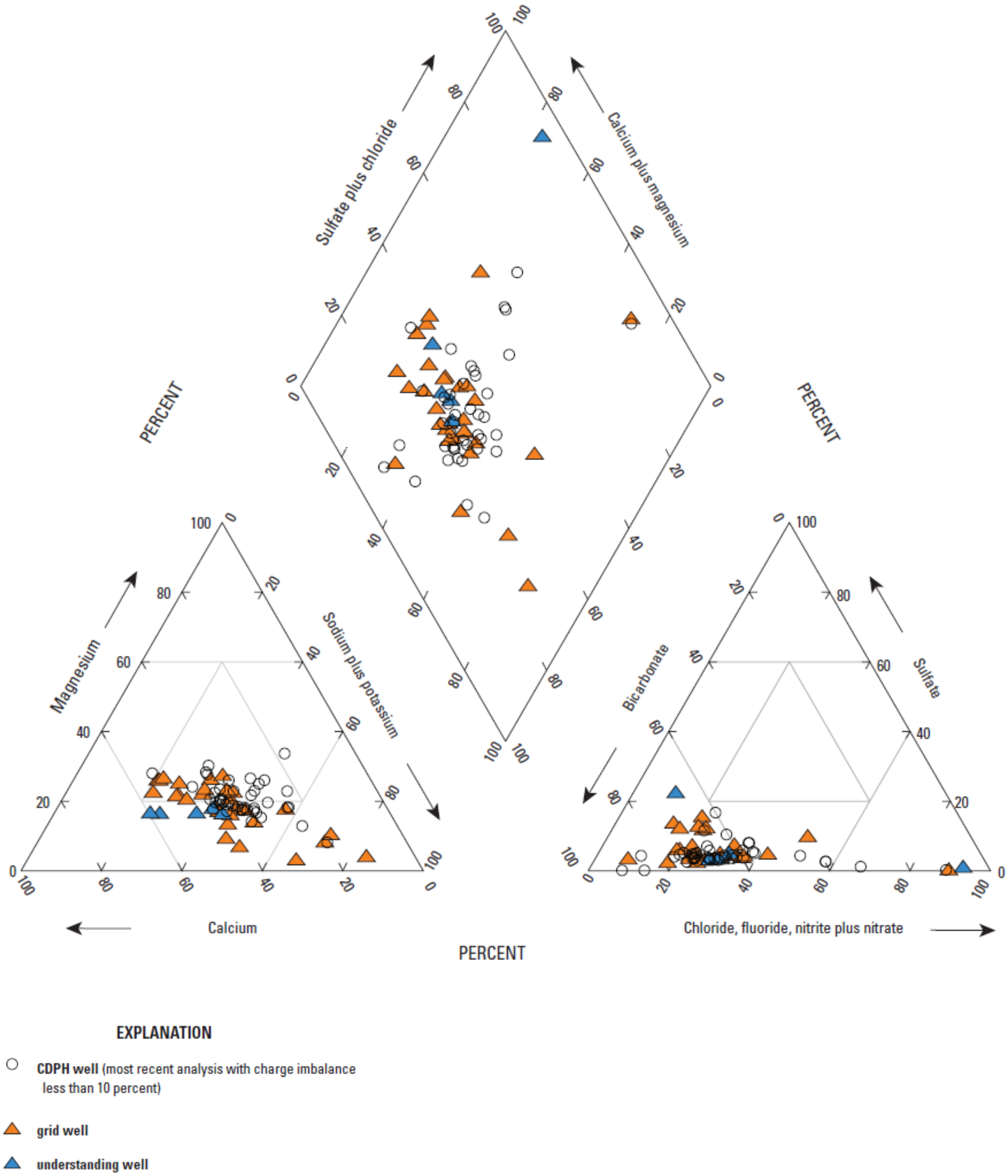
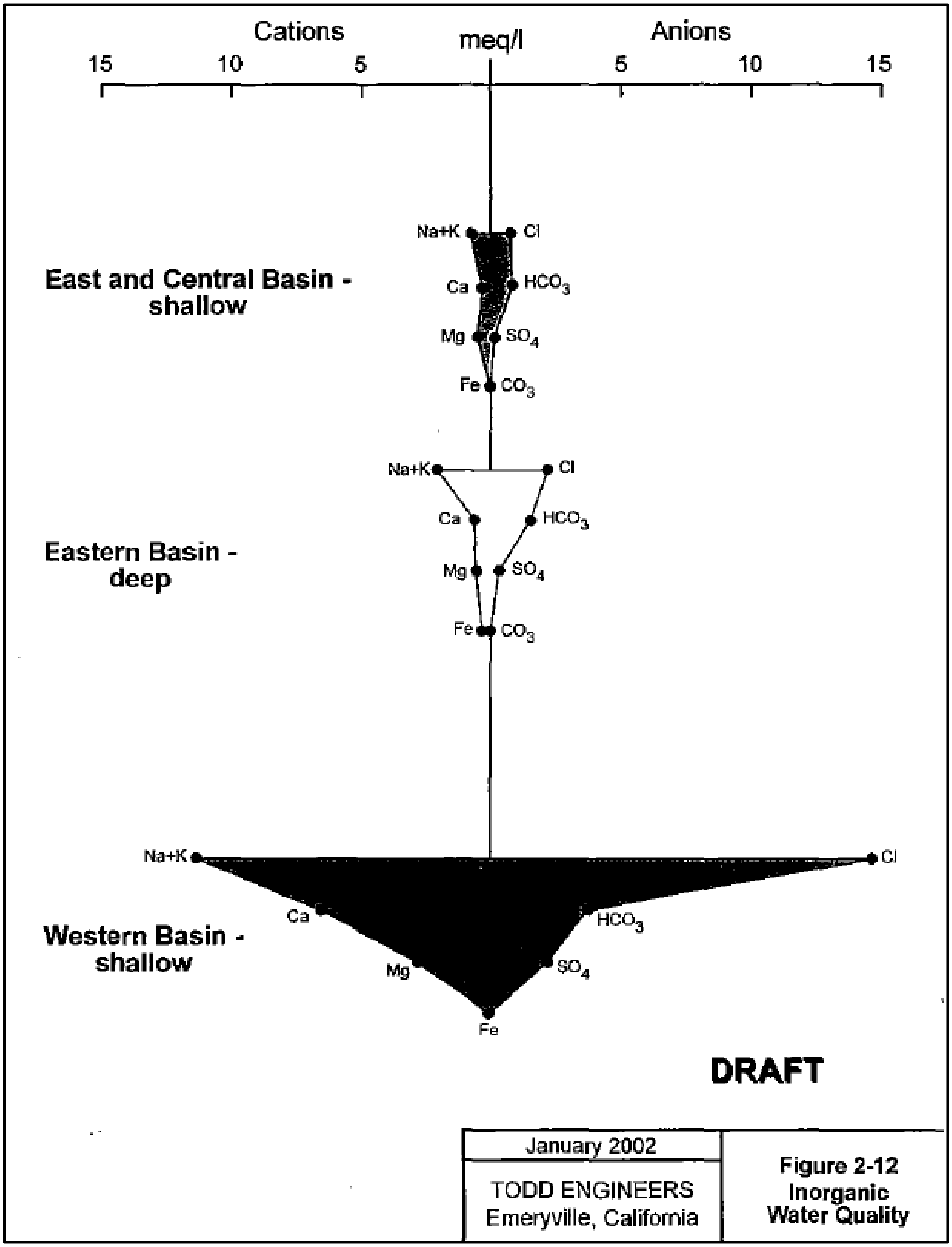


**Figure 36. Stiff Diagram representing geochemical properties of both deep and shallow groundwater aquifers within Madera County (AB3030 Groundwater Management Plan, Madera County, 2002).**



## LAND USE

Irrigated agriculture is the predominant land use in the Coalition area although the growing urban areas in the Central Valley are also a significant land use. Other non-irrigated land uses include dairies with some acreage in feedlots. Land use analyses in the GAR reported the temporal change of crop and land use in the area using DWR land used data, from the mid-1990s to the early 2000s, and the United States Department of Agriculture (USDA) cropland data from 2012, to present the most recent data available. Based on the DWR land use data up until the early 2000s, the largest agricultural crop was nut trees. Based on the USDA data from 2012, the top agricultural crop categories within the GQMP area of the Coalition are almonds, alfalfa, winter wheat, grapes, and corn totaling over 75% of cropland according to the 2012 USDA data, when including values for double crops with corn (Table 7).

**Table 7. Land use acreage within the entire GQMP area.**

Land use information obtained from data provided by USDA, 2012 California Cropland Data Layer: http://www.nass.usda.gov/research/Cropland/SARS1a.htm. Land use in some areas of the ESJWQC may have changed since that time.

| Crop Type | Acreage | Percent acreage of total GQMP* |
|---:|:---:|:---:|
| Almonds | 344690 | 36.18% |
| Alfalfa | 120899 | 12.69% |
| Grapes | 118449 | 12.43% |
| Winter Wheat | 47705 | 5.01% |
| Double Crop Oats/Corn | 42882 | 4.50% |
| Oats | 42037 | 4.41% |
| Other Hay/Non Alfalfa | 39727 | 4.17% |
| Fallow/Idle Cropland | 30244 | 3.17% |
| Pistachios | 28387 | 2.98% |
| Double Crop Winter Wheat/Corn | 24990 | 2.62% |
| Corn | 21796 | 2.29% |
| Walnuts | 21168 | 2.22% |
| Cotton | 16024 | 1.68% |
| Tomatoes | 12245 | 1.29% |
| Sweet Potatoes | 11506 | 1.21% |
| Grand Total for Agricultural Crops | 922747 | 96.85% |

*Percent of cropped area includes all agricultural fields, whether fallow or active. Land use categories such as barren, developed, and native or wetland vegetation were not included in acreage totals. Crops contributing 1% or more of the overall land use within the GQMP area were included.

## Irrigated Land

Although exact acreage is difficult to estimate due to rapidly changing land use, the Coalition area contains approximately 5,743,147 acres. The acreage within the GQMP area is approximately 1,711,555 with a total irrigated acreage of 983,470 acres (57%), as provided by DWR (Table 8). To obtain irrigated acreages, the Coalition uses information from two DWR data sources: 1) DWR Agricultural Land and Water Use data, and 2) DWR Land Use Survey (Figure 37).

Agricultural Land and Water Use data (DWR, http://www.water.ca.gov/landwateruse/anaglwu.cfm) estimates the acreage of irrigated crops for the entirety of each county. Land Use Survey data (http://www.water.ca.gov/landwateruse/lusrvymain.cfm) includes more detailed information regarding specific crop uses (both irrigated and non-irrigated) than the Agricultural Land and Water Use data but is updated less often. Because Land Use Survey data are available in Geographic Information System (GIS) shape files, the information was mapped to the Coalition area and used for estimates of irrigated crop acreage. The data source used depends on: 1) whether or not the entire county is within the Coalition boundary, and 2) which data were developed most recently.

For San Joaquin, Stanislaus, Merced, Madera, Fresno, Alpine and Calaveras Counties, the Coalition utilized DWR Land Use Survey data to determine irrigated land area as only portions of these counties are included in the Coalition boundary or the data were more current. For Tuolumne and Mariposa Counties, data from Agricultural Land and Water Use were used since these counties are included in their entirety within the Coalition boundary. Although the entire county of Madera is represented by the Coalition, the DWR Land Use Survey is more current. For calculations of total acreage, measurements were made using ArcGIS.

As described in the GAR Addendum, the top acreage crops within the Coalition are almonds (362,302 acres), grapes (136,409 acres), and corn (94,095 acres). The GAR analysis of crop type for the ESJHVA prioritization is based on USDA 2012 cropland data (Table 7). The USDA data does not indicate if the land use is irrigated or not and therefore the DWR land use data (which includes irrigated vs. non-irrigated data) is evaluated in Table 9. DWR data was used for the purposes of the GQMP analysis because of the availability of irrigated versus non-irrigated land use information. There are over 200 land use categories assigned to DWR data, therefore, land use groupings were assigned based on generalized crop categories and urban versus agricultural land use. The DWR data reflect a similar pattern as the USDA data, with deciduous nut and fruit (including almond), field crop (including corn), and vineyard (including all grapes) as the top three agricultural categories. Based on DWR data, the top irrigated crops within the ESJHVA Priority 1 Areas are deciduous nut and fruit and field crops as the two largest irrigated crops, followed by truck, nursery, berry crops third. Agricultural water use met by groundwater for various counties in the GQMP area is listed in Table 10. Thousand acre foot (TAF) values are given by county and therefore are presented simply as an approximate reference to percentage of irrigation needs that are met by groundwater within any given Zone. GQMP Zones may or may not be included entirely within any given county. Table 3 lists the Zones in reference to the underlying subbasins and associated counties.

**Table 8. Approximate total acreages of GQMP Zones for the Coalition area.**

| GQMP Zones | Total Acres[1] (from ArcGIS) |
|---|---|
| Modesto | 273,477 |
| Turlock | 362,267 |
| Merced | 499,225 |
| Chowchilla | 160,963 |
| Madera | 415,623 |
| **Total** | **1,711,555** |

[1]Total zone acreages calculated using ArcGIS.

**Table 9. ESJWQC land use acreage[1] of ESJHVA Priority 1-3 areas across the GQMP area.**
**Land uses designated as irrigated/non-irrigated (I/NI); numbers are rounded to nearest whole number.**

| Land Use | I/NI | Priority 1 | Priority 2 | Priority 3 | Not in ESJHVA | Total |
|---|---|---|---|---|---|---|
| Citrus | I | 37 | 216 | 877 | 6,220 | 7,350 |
| Citrus | NI | 3 | 1 | 11 | 29 | 44 |
| Deciduous nut and fruit | I | 16,011 | 75,771 | 103,749 | 150,527 | 346,058 |
| Deciduous nut and fruit | NI | 7 | - | - | 95 | 102 |
| Field crop | I | 5,614 | 60,613 | 86,825 | 79,404 | 232,456 |
| Field crop | NI | - | - | 4 | 449 | 454 |
| Grain and hay | I | 1,105 | 5,597 | 12,774 | 16,741 | 36,218 |
| Grain and hay | NI | 100 | 682 | 2,695 | 12,938 | 16,414 |
| Idle | I | 247 | 1,646 | 4,414 | 6122 | 12,428 |
| Idle | NI | - | - | 154 | 495 | 648 |
| Riparian Vegetation | NI | 44 | 524 | 6,338 | 6219 | 13,124 |
| Wild vegetation | NI | 747 | 8,084 | 70,056 | 303,6925 | 3,115,811 |
| Water surface | NI | 225 | 1,612 | 6,091 | 61,601 | 69,529 |
| Pasture | I | 1,529 | 18,160 | 90,504 | 89,992 | 200,185 |
| Pasture | NI | 47 | 238 | 1,945 | 6,080 | 8,310 |
| Rice | I | 211 | 2,293 | 724 | 2,227 | 5,455 |
| Feedlot, dairy, farmstead | NI | 1,017 | 9,079 | 15,910 | 11,629 | 37,635 |
| Truck, nursery, berry | I | 1,758 | 9,162 | 10,185 | 18,172 | 39,277 |
| Urban Landscape[1] | I/NI | 155 | 3,651 | 4,723 | 5,339 | 13,867 |
| Vineyard | I | 932 | 7,666 | 54,865 | 67,656 | 131,118 |

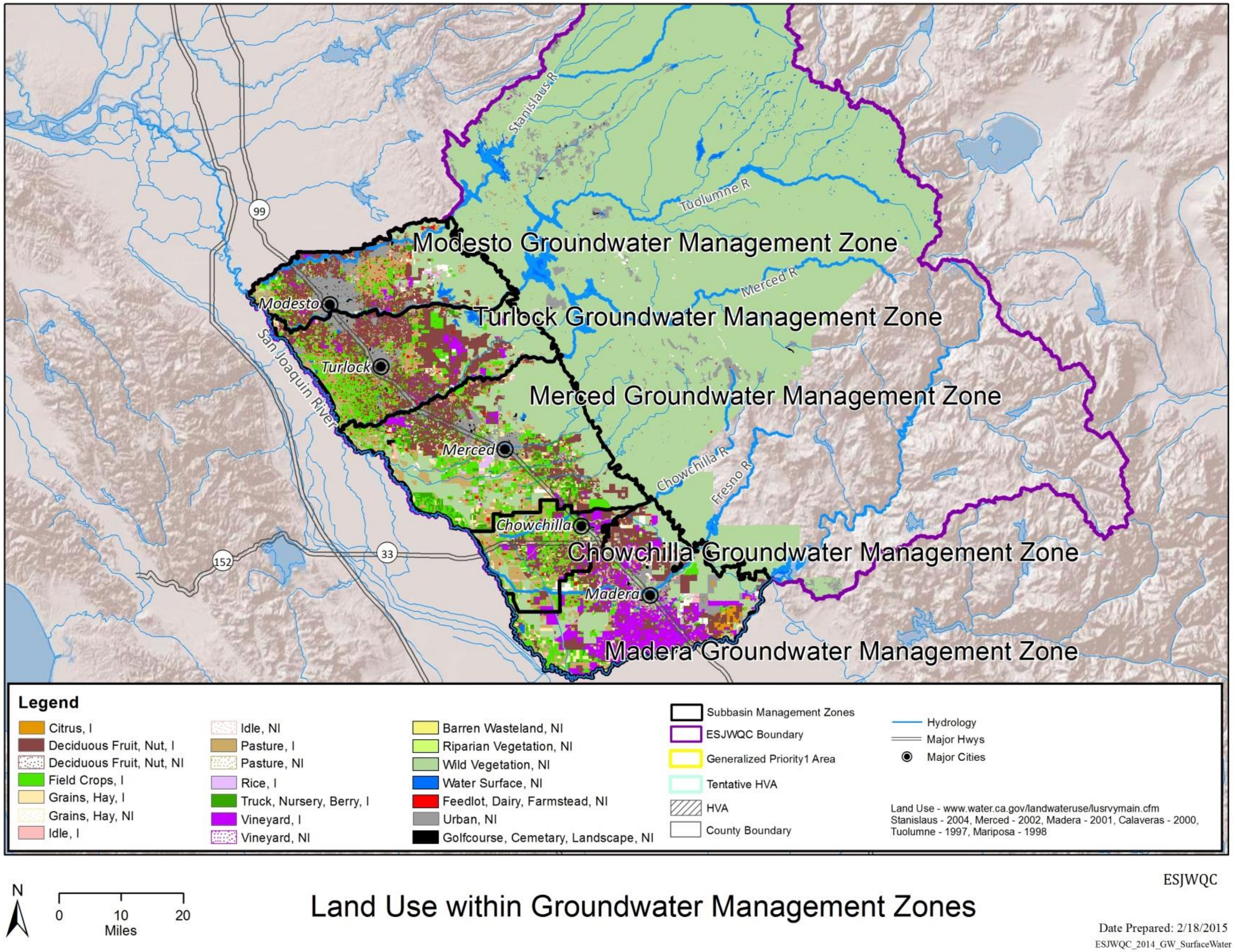
[1] Land use data obtained from data provided by DWR, http://www.water.ca.gov/landwateruse/anaglwu.cfm. Data compiled in 2001, land use in some areas of the ESJWQC may have changed since that time.
[1]Urban Landscape irrigation versus non-irrigation data from DWR Land Use by county included irrigated labeled data within its non-irrigated category. Therefore, the values within the urban landscape category were assumed to be all "irrigated."

**Table 10. San Joaquin River Hydrologic Region (and Tulare Lake Hydrologic Region [Fresno County]) Average Annual Groundwater Supply by County and by Type of Use (2005-2010).[1]**

| County | Water Use Type Met by Groundwater | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Agriculture | | Urban | | Managed Wetlands | | Total Water | |
| | TAF | % | TAF | % | TAF | % | TAF | % |
| Amador | 3.0 | 20% | 1.8 | 17% | 0.0 | 0% | 4.8 | 19% |
| Calaveras | 1.3 | 16% | 1.6 | 13% | 0.0 | 0% | 2.8 | 14% |
| Contra Costa | 0.8 | 1% | 25.0 | 9% | 0.0 | 0% | 25.8 | 6% |
| Fresno[2] | 1,705.2 | 46% | 272.4 | 80% | 1.1 | 4% | 1,978.6 | 48% |
| Madera[2] | 673.1 | 66% | 40.7 | 100% | 0.0 | 0% | 713.7 | 68% |
| Mariposa | 3.1 | 0% | 4.6 | 1% | 0.0 | 0% | 7.7 | 0% |
| Merced[2] | 764.6 | 38% | 84.6 | 97% | 189.2 | 40% | 1,038.3 | 40% |
| San Joaquin[2] | 354.1 | 22% | 79.9 | 42% | 0.0 | 0% | 434.0 | 24% |
| Stanislaus[2] | 512.4 | 30% | 162.8 | 85% | 1.4 | 13% | 676.6 | 36% |
| Tuolumne | 0.4 | 7% | 1.3 | 10% | 0.0 | 0% | 1.7 | 9% |
| **2005-2010 Annual Average Total** | **2,312.8** | **36%** | **402.1** | **48%** | **190.6** | **39%** | **2,905.5** | **37%** |

[1] Table contents from DWR's Draft Water Plan, 2013 (Tables SJR-17 and Table TL-19)
[2] Counties in the GQMP area (partial or entire county)
Percent (%) use is the percentage of the total water supply (for the county) that is met by groundwater, by type of use.

**Figure 37. Land use by GQMP Zone within the Coalition based on DWR data.**



# EXISTING AGRICULTURAL MANAGEMENT PRACTICES

Since 2007 the Coalition has surveyed its member grower/operators regarding their management practices. From 2008 to 2013 surveys were sent to landowners who were identified as having fields directly adjacent to or near any waterbody in a surface water management plan; the Coalition developed an inventory of surface water management practices of growers from these surveys including an assessment of irrigation management, pesticide application management and sediment management. Detailed results of the 2007 surveys can be found in the December 31, 2007 Semi Annual Monitoring Report. An inventory of management practices of growers with direct discharge to a management plan waterbody can be found in the Management Plan Update Reports submitted by the Coalition for each year between 2008 and 2013.

Starting in 2014, the Coalition has obtained additional management practice information from members within high vulnerability areas (surface or groundwater) based on the Farm Evaluation Plan surveys.

Farm Evaluations Plans are designed to collect the following information from each grower:

1. Crops grown and acreage of each crop,
2. Location of the member's farm,
3. Identification of on-farm management practices implemented to achieve the WDR farm management performance standards,
4. Potential for erosion during storm events and/or during irrigation (sediment and erosion risk areas) and a description of where within the property this occurs,
5. Identification of whether water leaves the property and is conveyed downstream and a description of where within the property this occurs,
6. Location of active wells and abandoned wells, and
7. Identification of whether wellhead protection and installation of backflow prevention devices have been implemented.

The Coalition includes an assessment of member management practices from the previous year in its Annual Report (submitted May 1 of each year). Table 11 and Figures 38-42 summarize the management practices implemented by members in 2013 to protect surface and groundwater quality.

**Table 11. ESJWQC member management practices implemented in 2013; listed by Management Practice Category.**

<table>
<tr><th colspan="2">MANAGEMENT PRACTICE CATEGORY</th><th>MANAGEMENT PRACTICES</th></tr>
<tr><td rowspan="8">Irrigation Management Practices</td><td rowspan="6">Irrigation Efficiency Practices</td><td>Laser Leveling</td></tr>
<tr><td>Pressure Bomb</td></tr>
<tr><td>Soil Moisture Neutron Probe</td></tr>
<tr><td>Use of ET in scheduling irrigations</td></tr>
<tr><td>Use of moisture probe</td></tr>
<tr><td>Water application scheduled to need</td></tr>
<tr><td rowspan="2">Primary (and/or secondary) Irrigation Practices</td><td>Border Strip</td></tr>
<tr><td>Drip</td></tr>
</table>

| Management Practice Category | | Management Practices |
| --- | --- | --- |
| | | Flood |
| | | Furrow |
| | | Sprinkler |
| | | Micro Sprinkler |
| Sediment Management Practices | Cultural Practices to Manage Sediment and Erosion | Berms are constructed at low ends of fields to capture runoff and trap sediment. |
| | | Cover crops or native vegetation are used to reduce erosion. |
| | | Creek banks and stream banks have been stabilized. |
| | | Crop rows are graded, directed and at a length that will optimize the use of rain and irrigation water. |
| | | Field is lower than surrounding terrain. |
| | | Hedgerows or trees are used to help stabilize soils and trap sediment movement. |
| | | Minimum tillage incorporated to minimize erosion. |
| | | Sediment basins / holding ponds are used to settle out sediment and hydrophobic pesticides such as pyrethroids from irrigation and storm runoff. |
| | | Soil water penetration has been increased through the use of amendments, deep ripping and/or aeration. |
| | | Storm water is captured using field borders. |
| | | Subsurface pipelines are used to channel runoff water. |
| | | Vegetated ditches are used to remove sediment as well as water soluble pesticides, phosphate fertilizers and some forms of nitrogen. |
| | | Vegetative filter strips and buffers are used to capture flows. |
| | Irrigation Practices for Managing Sediment and Erosion | In-furrow dams are used to increase infiltration and settling out of sediment prior to entering the tail ditch. |
| | | PAM (polyacrylamide) used in furrow and flood irrigated fields to help bind sediment and increase infiltration. |
| | | Shorter irrigation runs are used with checks to manage and capture flows. |
| | | Tailwater Return System. |
| | | The time between pesticide applications and the next irrigation is lengthened as much as possible to mitigate runoff of pesticide residue. |
| | | Use drip or micro-irrigation to eliminate irrigation drainage. |
| | | Use of flow dissipaters to minimize erosion at discharge point. |
| Pesticide & Nutrient Management | Pesticide Application Practices | Avoid Surface Water When Spraying |
| | | Chemigation |
| | | End of Row Shutoff When Spraying |
| | | Follow County Permit |
| | | Follow Label Restrictions |
| | | Monitor Rain Forecasts |
| | | Monitor Wind Conditions |
| | | Reapply Rinsate to Treated Field |
| | | Sensitive Areas Mapped |
| | | Target Sensing Sprayer used |
| | | Use Appropriate Buffer Zones |
| | | Use Drift Control Agents |
| | | Use PCA Recommendations |
| | | Use Vegetated Drain Ditches |
| | Nitrogen Management Methods to Minimize Leaching Past the Root Zone | Cover Crops |
| | | Fertigation |
| | | Foliar N Application |
| | | Irrigation Water N Testing |
| | | Soil Testing |
| | | Split Fertilizer Applications |
| | | Tissue/Petiole Testing |

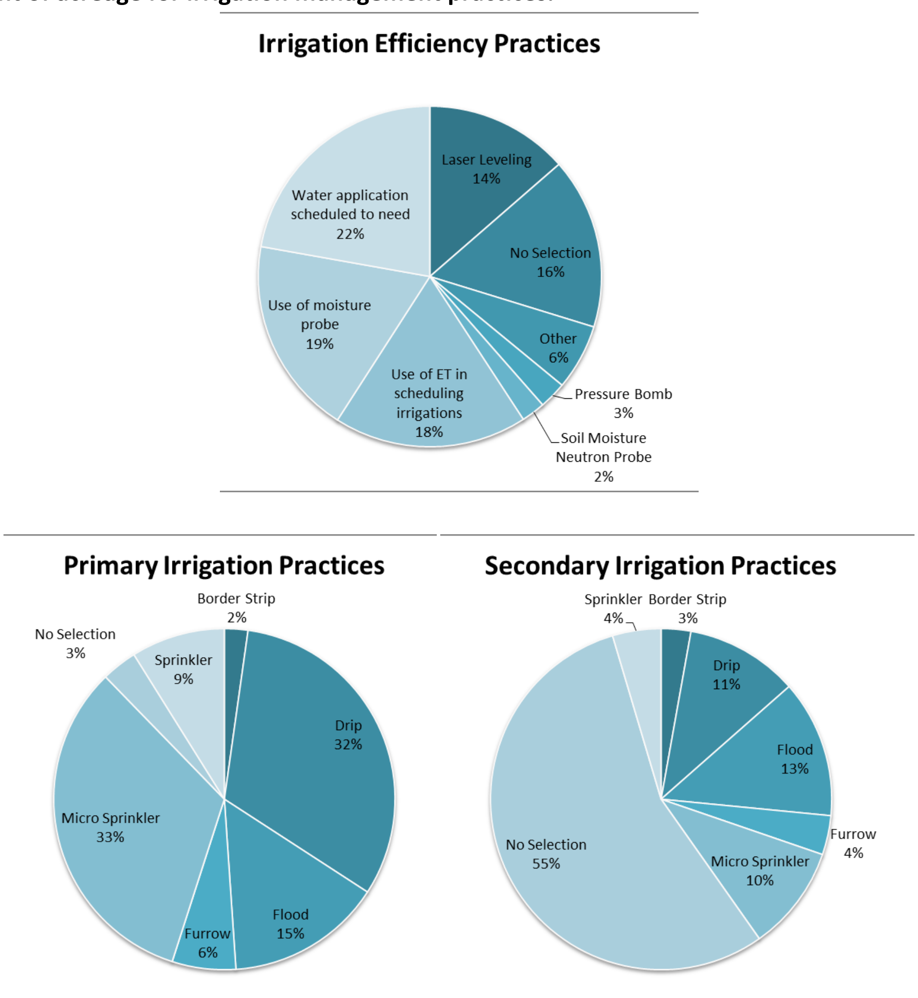
| Management Practice Category | | Management Practices |
|---|---|---|
| | | Variable Rate Applications using GPS |
| Well Management Practices | Wellhead Protection Practices | Air Gap (for non-pressurized systems |
| | | Backflow Preventive / Check Valve |
| | | Good "Housekeeping" Practices* |
| | | Ground Sloped Away from Wellhead |
| | | Standing water avoided around wellhead |
| | Abandoned Wells Practices (if abandoned well is known to be present on site) | Destroyed – certified by county |
| | | Destroyed - Unknown method |
| | | Destroyed by licensed professional |

*Good housekeeping practices include keeping the area surrounding the wellhead clean of trash, debris and any empty containers

## IRRIGATION MANAGEMENT PRACTICES

A large portion of the Coalition region has parcels with implemented practices associated with the management of irrigation. The largest acreages were associated with pressurized irrigation. A combination of flood, furrow, and sprinkler irrigation was used on fewer acres than drip irrigation alone. Most members utilize only one irrigation method (Figure 38).

**Figure 38. Percent of acreage for irrigation management practices.**



Several management practices are associated with pesticide and nutrient management in order to reduce the movement of pesticides and nutrients to surface waters. Nutrient management practices target measures designed to achieve the desired crop yield, but prevent excess nutrients from passing through the root zone and enter groundwater. Pesticide management practices apply to groundwater by targeting the minimum amount of pesticide required to achieve the desired crop yield, preventing overspray from entering recharge areas, and by timing the application of the pesticide far enough in advance of irrigation to prevent pesticides from travelling beyond the targeted area through irrigation waters to recharge areas and entering the groundwater (Figures 39 and 40).

**Figure 39. Acreage associated with pesticide application practices.**

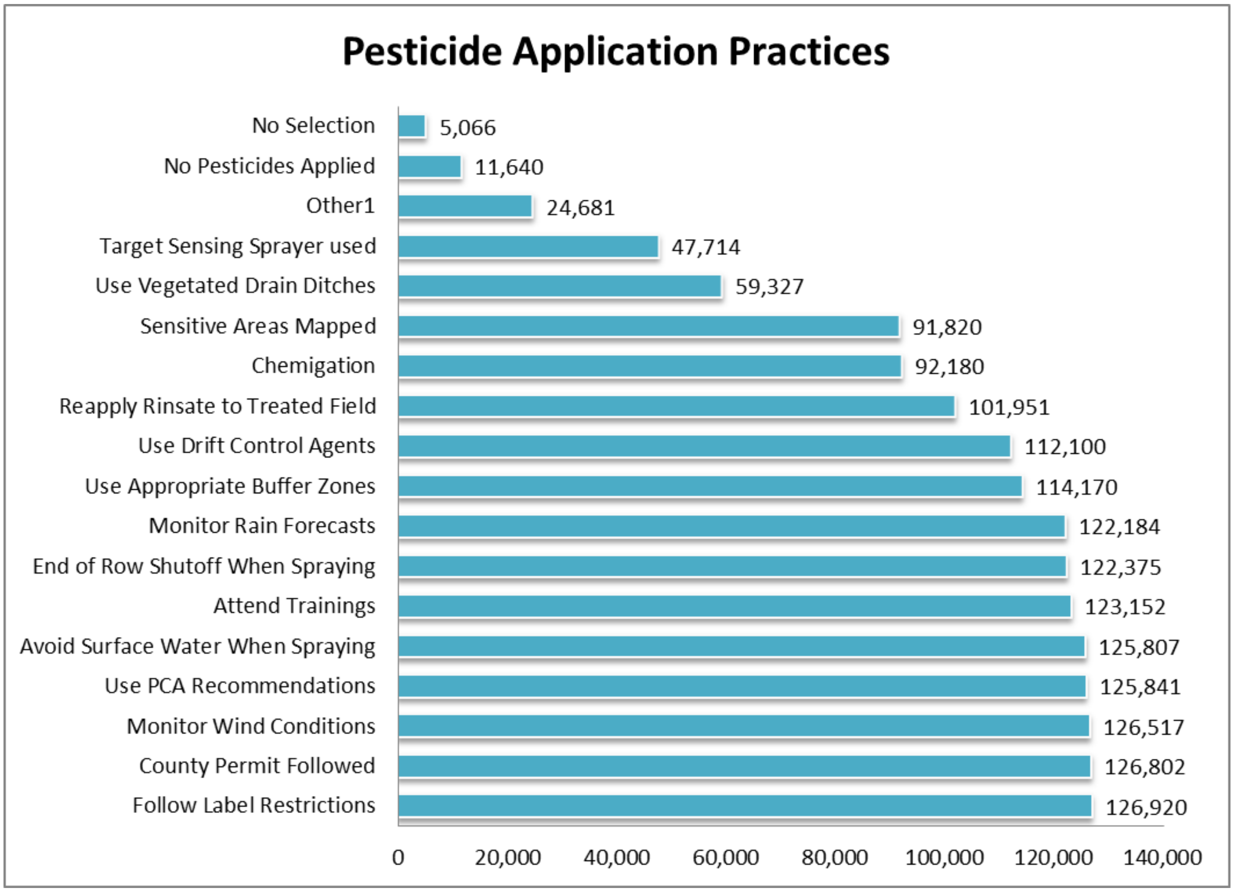
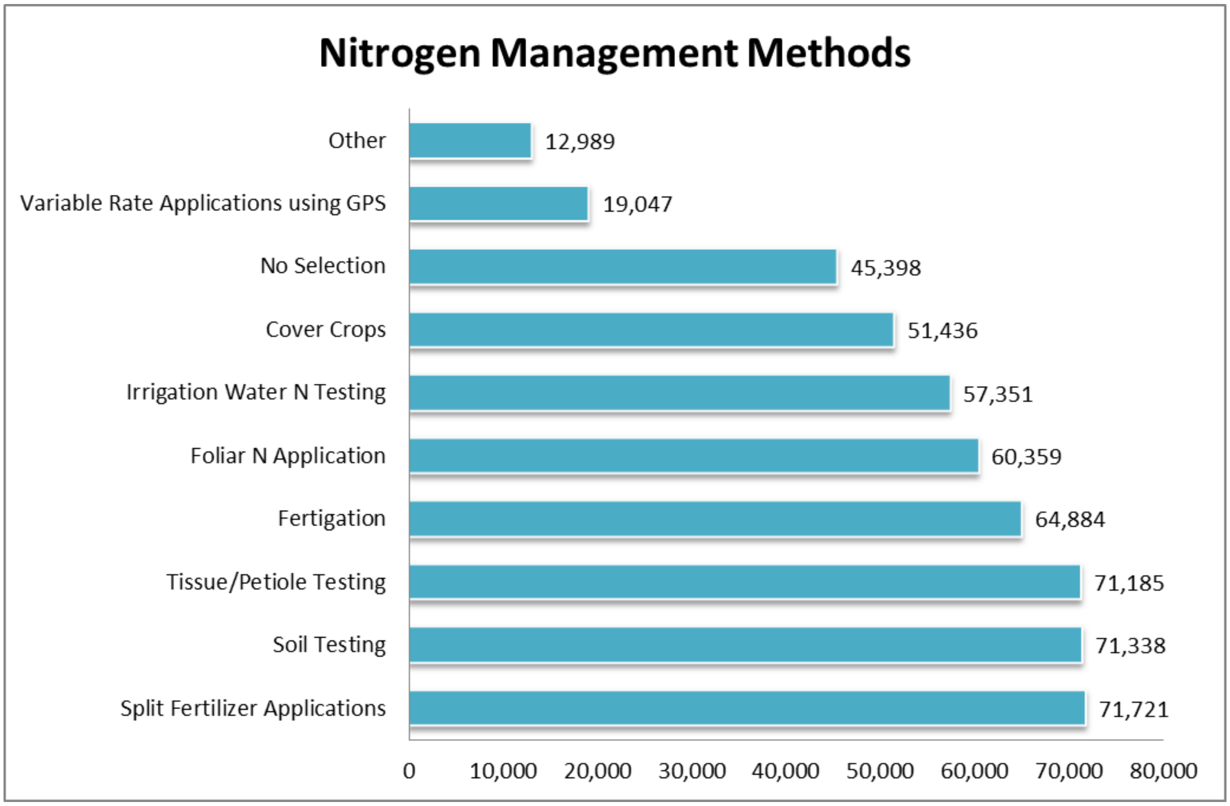


**Figure 40. Acreage associated with nitrogen management methods.**

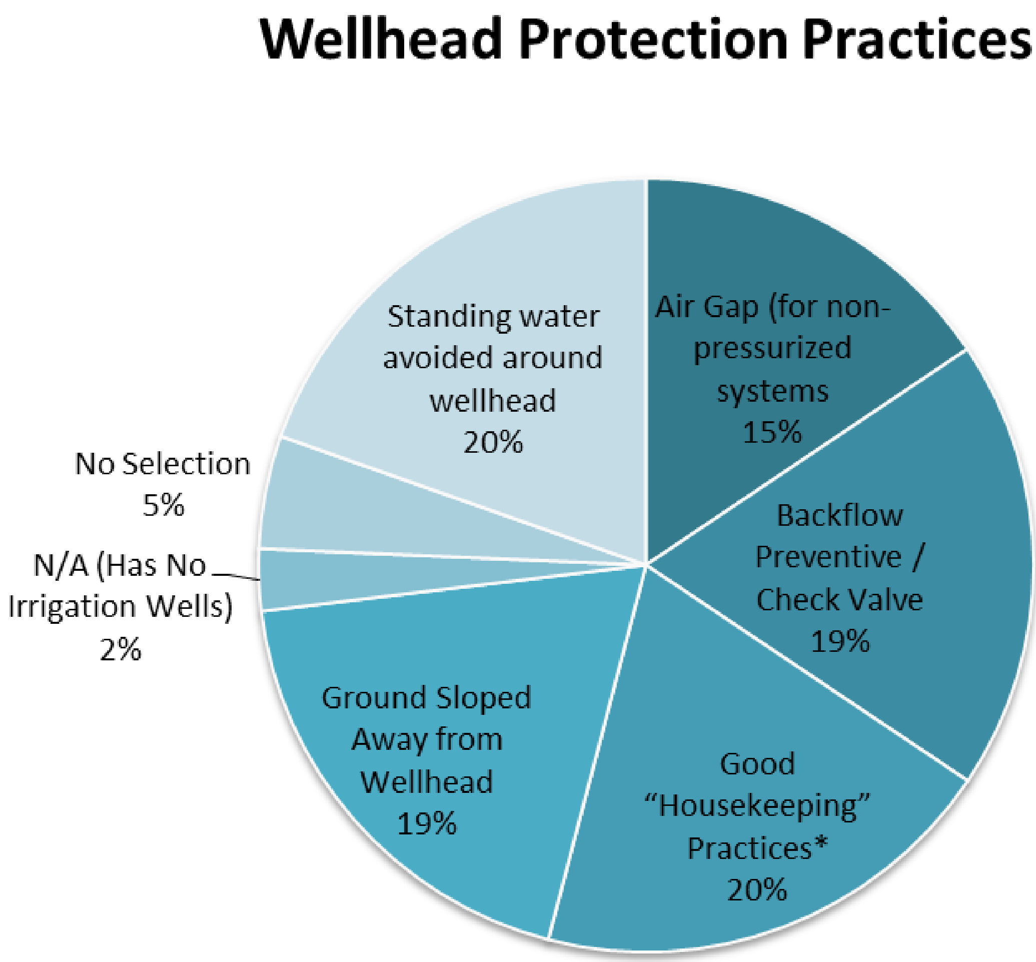



# WELL MANAGEMENT PRACTICES

## Irrigation Wells

Seventy eight percent of those owners/operators who returned a Farm Evaluation Survey indicated there was an irrigation well on the agricultural parcel(s). Of those owners/operators utilizing the irrigation well, various wellhead protection practices were employed (Figure 41).

**Figure 41. Percent acreage associated with members who have irrigation wells and members implementing wellhead protection practices.**

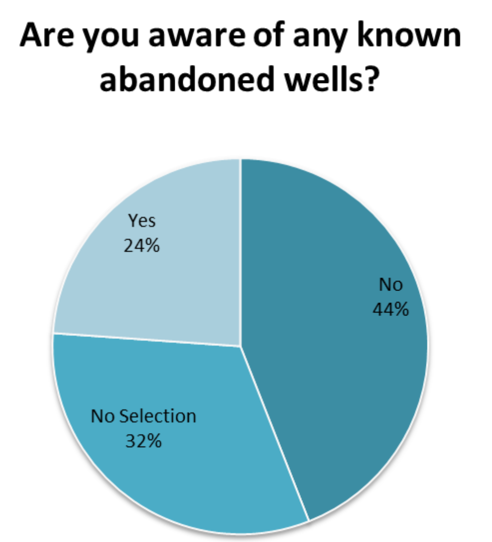


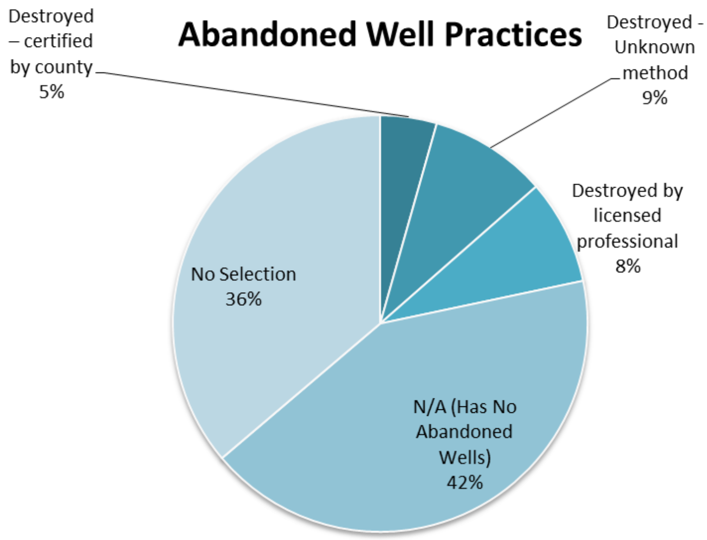

*Good housekeeping practices include keeping the area surrounding the wellhead clean of trash, debris and any empty containers

## Abandoned Wells

The Coalition region contains abandoned wells, a large portion of these abandoned wells have been properly destroyed (Figures 42). The number of wells abandoned over the years has fluctuated and appears to bear no relationship to any environmental variable although a thorough analysis was not conducted.

**Figure 42. Percentage of acreage with abandoned wells and practices associated with those wells.**



# GROUNDWATER CONSTITUENTS OF CONCERN

"…potential constituents of concern (in shallow groundwater) include any material applied as part of the agricultural operation, including constituents in irrigation supply water (e.g., pesticides, fertilizers, soil amendments, etc.) that could impact beneficial uses or cause degradation" (WDR, Attachment B, pg. 13).

Constituents of concern in groundwater are those materials that could impact beneficial uses and that have been applied during agricultural operations (including constituents in irrigation supply water (e.g., pesticides, fertilizers, soil amendments, etc.). Typically, shallow groundwater is that water most recently entering the groundwater recharge cycle and is representative of more recent overlaying land use activities. Due to the extended transport time of downward-moving irrigation return water (years) to even shallow groundwater aquifers, any management practice applied to land use during a given year could take years to result in improvements in groundwater quality. Because groundwater samples taken currently will in most cases include constituents applied several years in the past, identifying the source of a constituent in groundwater is impractical. Agricultural management practices recommended by this GQMP are designed to prevent future degradation of groundwater quality by agricultural operations.

The Groundwater Monitoring Advisory Workgroup for the Regional Board determined "that the most important constituents of concern related to agriculture's impacts to the beneficial uses of groundwater are nitrate ($NO_3$-N) and salinity" (WDR, Attachment A, page 16).

According to Bulletin 118 (DWR 2003), in general, the primary constituents present in the San Joaquin River Hydrologic Region with the potential to impact or cause degradation state waters are salts (TDS), nitrate, boron, chloride and organic compounds such as pesticides. High salts can be attributed to marine sediments in the Coast Range in the west side of the San Joaquin Valley and a culmination of evaporation and poor drainage resulting in increased salt concentrations within the Valley floor. Nitrates may occur naturally or as a result of anthropogenic sources such as human/animal waste or fertilizers, and boron/chloride are likely to be a result of evaporation leading to increased concentrations. As described in Bulletin 118, agricultural pesticides and herbicides have been detected in groundwater throughout the San Joaquin River Hydrologic Region especially where soil permeability is higher and depth to groundwater is shallower.

In the identification of constituents of concern (COCs) for the GQMP area, the Coalition relied on the findings of the GAR and GAR Addendum which presented previous work, studies, and monitoring programs conducted throughout GQMP area. Several sources were cited in the GAR for water quality data and COCs including: California Department of Public Health's (CDPH) Water Quality Analyses Database Files, DWR's Water Data Library (WDL), USGS's National Water Information System (NWIS), SWRCB's Geotracker database (GAMA), data from wells on dairy permitted lands acquired from the CVRWQCB, and the DPR pesticide sampling database. The following constituents are identified in the GAR as having exceeded a threshold for the Drinking Water Standards Maximum Contaminant Levels (MCLs): nitrate, TDS, and the pesticides aldicarb sulfone, DBCP (dibromochloropropane), diazinon, ethylene dibromide, ethylene dichloride, naphthalene, simazine, and tetrachloroethane (Table 14). Per the GAR, selection of the threshold value to indicate an exceedance is based on a hierarchy consisting of the following order of preference: California Primary MCL, United States Environmental Protection Agency (EPA's) Federal Primary MCL, and California Notification Level (Tables 12-14). One notable exception is for TDS; in this document the threshold used to indicate an exceedance is based on the 450 mg/L limit for Agricultural Water Quality Goals (Food & Agriculture Organization of United Nations) versus the 500 mg/L threshold of the CDPH and EPA's Secondary MCLs. Only those constituents with concentrations above the MCLs or notification level or concentration of TDS above 450 mg/L were retained as potential COCs.

## PREVIOUS WORK TO IDENTIFY CONSTITUENTS OF CONCERN IN GROUNDWATER

The Coalition's GAR summarizes current and historic groundwater quality data (dating back to 1910) in the Eastern San Joaquin River Watershed area using data from local, state, and federal agencies (CDPH Water Quality Analyses Database Files, DWR Water Data Library, USGS National Water Information System, GAMA, data acquired from the Regional Water Control Board from wells on dairy permitted lands, the DPR pesticide sampling database, MID, and TID). The GAR lists groundwater quality data relevant to irrigated agricultural practices (Tables 12-14), provides a spatial and temporal assessment of constituents in the groundwater, and serves as the survey of current, available groundwater quality data necessary to develop effective GQMPs for the Coalition region. According to groundwater quality data compiled from a variety of well depths throughout the Central Valley Coalition region, nitrogen concentrations were reported to be above both the 5 and 10 mg/L levels (Figure 43) and TDS concentrations exceeded the 450, 500 and 1,000 mg/L levels (Figure 44).

### Nitrate and TDS – Spatial Distribution

According to the GAR, high concentrations of nitrate are found in shallow groundwater throughout much of the western part of the Central Valley Floor, with a large area of very high in nitrate levels in the northwestern part of the Coalition region, particularly in the vicinity and to the west of Turlock (Figure 43). Several shallow wells in the area west of Turlock exhibit nitrate concentrations above the drinking water MCL of 10 mg/L (nitrate as nitrogen). Nitrate concentrations in shallow groundwater within the southwestern portion of the Coalition region appear to be generally lower, however, much of the available data for this area date back to the 1970s and earlier.

Recent nitrate concentrations in deep wells show a somewhat similar spatial pattern as seen in shallow wells with higher nitrate concentrations occurring in the western part of the Central Valley Floor, again with a clustering of high nitrate concentrations around the Turlock area. Overall, nitrate concentrations in deep wells appear to be lower than those exhibited in the shallow wells and do not exhibit the same lateral spread as in shallow wells.

According to the GAR, some areas of locally high TDS concentrations exist in shallow wells, particularly in the vicinity of Modesto and also in some general locations west of Turlock. However, the most recent data indicate TDS concentrations in many shallow wells are below 500 mg/L, which represents the recommended MCL for Secondary Drinking Water Standards; agricultural beneficial use MCL is set at 450 mg/L. Figure 44 illustrates the distribution of wells exhibiting TDS concentrations above 450 mg/L in the Coalition region. The pattern of distribution appears to be similar to that of nitrates in Figure 43, with a cluster of wells with TDS concentrations above 450 mg/L between Turlock and the San Joaquin River. A number of wells with higher TDS concentrations are apparent in close proximity to the San Joaquin River along the western edge of the Coalition region where groundwater is generally very shallow. According to the GAR, the available data from deep wells show most TDS concentrations are below 500 mg/L although some deep wells with high concentrations are scattered throughout the Central Valley Floor area. Most the wells with the highest TDS concentrations (above 1,000 or 1,500 mg/L) are in the western part of the Coalition region.

## Pesticides – Spatial Distribution

According to the GAR, data assembled to evaluate the distribution of pesticide detections in the Coalition region were from DPR. Corresponding well sampling location data are only available at the spatial resolution of the Public Land Survey System (PLSS) section in which the well is located. Overall, out of 2,732 unique wells sampled for pesticides, 872 had detectable concentrations of a pesticide and 369 wells had pesticide concentration exceedances of a water quality objective (Table 14, Figure 45). Of a total of 997 sections within which pesticide data archived by DPR are available, 375 sections have pesticide detections and 167 sections have exceedances. A total of 48 different pesticides have been detected within the Coalition region with exceedances reported for 8 different pesticides. The pesticides most often tested for were DBCP, atrazine, simazine, and 1,2-dichloropropane, and the most commonly detected pesticides were DBCP, simazine, DEA (diethyl-atrazine), and atrazine. Of those pesticides with reported exceedances, only diazinon, atrazine, and simazine are currently registered with DPR and/or are the only chemicals used in agricultural practice. Therefore, for the purposes of management of current agricultural practices in order to protect groundwater quality, only simazine and diazinon will be described in the GQMP Zone sections. Diazinon was detected in two wells within 442 sections, both wells had concentrations above the primary MCL of 1.2 µg/L. Simazine was detected in 75 wells within 62 sections, but only one well had a concentration above the primary MCL of 4 µg/L.

**Table 12. Summary of Assembled Groundwater Quality Data for nitrate as N (all data since 1940; Table 5-1, GAR).**

| Nitrate Data | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monitoring Entity | Number of wells | Number of samples | Number with known depth | Irrigation Wells | Monitoring Wells | Residential Wells | Public Supply Wells | Other Well Types | Unknown Well Type | Shallow Zone | Deep Zone | Unknown Depth Zone | Wells with results over 5 mg/L (as N) | Wells with results over 10 mg/L (as N) | Wells with results over 20 mg/L (as N) | Samples Pre-1970s | Samples in 1970s | Samples in 1980s | Samples in 1990s | Samples in 2000s | Samples in 2010s |
| Dairy | 1,775 | 2,236 | 0 | 441 | 35 | 1,299 | 0 | 0 | 0 | 1,334 | 441 | 0 | 1,107 | 845 | 513 | 0 | 0 | 0 | 0 | 2,236 | 0 |
| CDPH | 1,235 | 27,404 | 0 | 0 | 0 | 0 | 1,235 | 0 | 0 | 0 | 1,235 | 0 | 438 | 146 | 21 | 0 | 0 | 754 | 3,388 | 16,910 | 6,352 |
| DWR | 836 | 1,651 | 0 | 0 | 0 | 0 | 29 | 11 | 796 | 0 | 29 | 807 | 240 | 56 | 5 | 1,246 | 278 | 127 | 0 | 0 | 0 |
| GAMA | 2,049 | 17,475 | 0 | 0 | 483 | 0 | 1,566 | 0 | 0 | 483 | 1,566 | 0 | 615 | 260 | 83 | 611 | 70 | 399 | 1,159 | 10,463 | 4,773 |
| MID | 29 | 32 | 0 | 0 | 0 | 0 | 0 | 0 | 29 | 0 | 0 | 29 | 16 | 9 | 2 | 0 | 0 | 0 | 0 | 32 | 0 |
| TID | 108 | 323 | 0 | 0 | 0 | 0 | 0 | 108 | 0 | 108 | 0 | 0 | 106 | 105 | 68 | 0 | 0 | 0 | 55 | 268 | 0 |
| USGS | 540 | 1,574 | 521 | 0 | 0 | 0 | 0 | 0 | 540 | 320 | 201 | 19 | 166 | 58 | 19 | 631 | 72 | 88 | 73 | 701 | 9 |
| **Total** | **6,572** | **50,695** | **521** | **441** | **518** | **1,299** | **2,830** | **119** | **1,365** | **2,245** | **3,472** | **855** | **2,688** | **1,479** | **711** | **2,488** | **420** | **1,368** | **4,675** | **30,610** | **11,134** |

**Table 13. Summary of Assembled Groundwater Quality Data for TDS (all data since 1940; Table 5-1, GAR).**

| Total Dissolved Solids Data | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monitoring Entity | Number of wells | Number of samples | Number with known depth | Irrigation Wells | Monitoring Wells | Residential Wells | Public Supply Wells | Other Well Types | Unknown Well Type | Shallow Zone | Deep Zone | Unknown Depth Zone | Wells with results over 500 mg/L | Wells with results over 1,000 mg/L | Wells with results over 1,500 mg/L | Samples Pre-1970s | Samples in 1970s | Samples in 1980s | Samples in 1990s | Samples in 2000s | Samples in 2010s |
| Dairy | 34 | 156 | 0 | 0 | 34 | 0 | 0 | 0 | 0 | 34 | 0 | 0 | 25 | 8 | 0 | 0 | 0 | 0 | 0 | 156 | 0 |
| CDPH | 915 | 7,175 | 0 | 0 | 0 | 0 | 915 | 0 | 0 | 0 | 915 | 0 | 130 | 35 | 16 | 0 | 0 | 437 | 920 | 4,537 | 1,281 |
| DWR | 1,054 | 2,466 | 0 | 0 | 0 | 0 | 29 | 0 | 1,025 | 0 | 0 | 1,054 | 213 | 76 | 51 | 2,046 | 289 | 131 | 0 | 0 | 0 |
| GAMA | 1,654 | 6,555 | 0 | 0 | 254 | 0 | 1,400 | 0 | 0 | 254 | 0 | 1,400 | 466 | 183 | 122 | 1,400 | 124 | 262 | 406 | 3,467 | 896 |
| MID | 29 | 32 | 0 | 0 | 0 | 0 | 0 | 0 | 29 | 0 | 0 | 29 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 32 | 0 |
| TID | 108 | 323 | 0 | 0 | 0 | 0 | 0 | 108 | 0 | 108 | 0 | 0 | 102 | 18 | 1 | 0 | 0 | 0 | 55 | 268 | 0 |
| USGS | 722 | 3,215 | 696 | 0 | 0 | 0 | 0 | 0 | 722 | 429 | 267 | 26 | 167 | 61 | 43 | 842 | 74 | 454 | 364 | 1,464 | 17 |
| **Total** | **4,516** | **19,922** | **696** | **0** | **288** | **0** | **2,344** | **108** | **1,776** | **825** | **1,182** | **2,509** | **1,108** | **381** | **233** | **4,288** | **487** | **1,284** | **1,745** | **9,924** | **2,194** |

**Table 14. Summary of pesticide detections (Table 5-2, GAR).**

| Pesticide | Wells Sampled | Wells with Detection | Wells with Exceedance | Sections Sampled | Sections with Detection | Sections with Exceedance | Concentration in Samples with Detections (µg/L) | | | Exceedance Threshold Used (µg/L) | Basis for Exceedance Threshold |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Average | Minimum | Maximum | | |
| 1,2-Dichloropropane (Propylene Dichloride) | 1107 | 13 | 0 | 567 | 12 | 0 | 0.4 | 0.03 | 1.4 | 5 | CA Primary MCL |
| 2,4-DP (Isooctyl Ester) | 40 | 2 | 0 | 31 | 2 | 0 | 0.01 | 0 | 0.01 | - | Chemical not |
| 3,4-Dichloro Aniline | 160 | 12 | 0 | 146 | 12 | 0 | 0.005 | 0.004 | 0.01 | - | Chemical not |
| ACET (Deisopropylatrazine) | 233 | 41 | 0 | 185 | 37 | 0 | 0.14 | 0 | 0.53 | - | Chemical not |
| Alachlor | 832 | 1 | 0 | 488 | 1 | 0 | 0.1 | 0.1 | 0.1 | 2 | CA Primary |
| Alachlor ESA | 18 | 2 | 0 | 11 | 2 | 0 | 0.494 | 0.077 | 0.91 | - | Chemical not |
| Aldicarb Sulfone | 414 | 23 | 21 | 250 | 2 | 2 | 46 | 1 | 1281 | 3 | EPA Primary |
| Aldicarb Sulfoxide | 366 | 4 | 0 | 249 | 2 | 0 | 2.9 | 2.9 | 2.9 | 4 | EPA Primary |
| Atrazine | 1292 | 49 | 0 | 712 | 47 | 0 | 0.077 | 0.004 | 0.599 | 1 | CA Primary |
| Bentazon, Sodium Salt | 369 | 4 | 0 | 220 | 4 | 0 | 1.72 | 0.26 | 3.74 | 18 | CA Primary |
| Bromacil | 941 | 9 | 0 | 531 | 9 | 0 | 0.096 | 0.01 | 0.303 | - | No value in |
| Carbon Disulfide | 226 | 4 | 0 | 183 | 4 | 0 | 0.05 | 0.03 | 0.07 | 160 | CA Notification |
| Chlorothalonil | 348 | 1 | 0 | 239 | 1 | 0 | 0.02 | 0.02 | 0.02 | - | No value in |
| Chlorthal-Dimethyl | 241 | 2 | 0 | 205 | 1 | 0 | 0.46 | 0.37 | 0.54 | - | No value in |
| Coumaphos | 2 | 1 | 0 | 2 | 1 | 0 | 1 | 1 | 1 | - | Chemical not |
| DBCP (Dibromochloropropane) | 1786 | 632 | 331 | 675 | 250 | 154 | 0.831 | 0.001 | 166 | 0.2 | CA Primary |
| Deethyl-Atrazine (DEA) | 346 | 58 | 0 | 280 | 56 | 0 | 0.028 | 0.004 | 0.429 | - | No value in |
| Demeton | 128 | 1 | 0 | 89 | 1 | 0 | 1 | 1 | 1 | - | No value in |
| Desmethylnorflurazon | 79 | 15 | 0 | 65 | 13 | 0 | 0.36 | 0.066 | 1.86 | - | Chemical not |
| Desulfinyl Fipronil | 160 | 1 | 0 | 146 | 1 | 0 | 0.005 | 0.005 | 0.005 | - | Chemical not |
| Diaminochlorotriazine (DACT) | 126 | 46 | 0 | 93 | 38 | 0 | 0.243 | 0.051 | 1.23 | - | Chemical not |
| Diazinon | 732 | 2 | 2 | 442 | 2 | 2 | 127.5 | 0.1 | 507 | 1.2 | CA Notification |
| Dicamba | 331 | 1 | 0 | 228 | 1 | 0 | 0.01 | 0.01 | 0.01 | - | No value in |
| Dinoseb | 388 | 1 | 0 | 243 | 1 | 0 | 0.04 | 0.04 | 0.04 | 7 | CA Primary |
| Diuron | 618 | 32 | 0 | 394 | 29 | 0 | 0.16 | 0.01 | 1 | - | No value in |
| Ethylene Dibromide | 590 | 21 | 14 | 330 | 16 | 12 | 0.24 | 0.01 | 1 | 0.05 | CA Primary |
| Ethylene Dichloride | 29 | 1 | 1 | 29 | 1 | 1 | 2.9 | 2.9 | 2.9 | 0.5 | CA Primary |
| Fipronil | 160 | 1 | 0 | 146 | 1 | 0 | 0.011 | 0.011 | 0.011 | - | Chemical not |
| Fipronil Sulfone | 160 | 1 | 0 | 146 | 1 | 0 | 0.008 | 0.008 | 0.008 | - | Chemical not |
| Hexazinone | 429 | 12 | 0 | 328 | 10 | 0 | 0.078 | 0.008 | 0.27 | - | No exceedance |

| Pesticide | Wells Sampled | Wells with Detection | Wells with Exceedance | Sections Sampled | Sections with Detection | Sections with Exceedance | Concentration in Samples with Detections (µg/L) | | | Exceedance Threshold Used (µg/L) | Basis for Exceedance Threshold |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Average | Minimum | Maximum | | |
| Imazethapyr | 47 | 1 | 0 | 45 | 1 | 0 | 0.01 | 0.01 | 0.01 | - | Chemical not |
| Merphos | 45 | 1 | 0 | 36 | 1 | 0 | 1 | 1 | 1 | - | No value in |
| Methyl Bromide | 1047 | 6 | 0 | 538 | 5 | 0 | 2.37 | 0.54 | 7.7 | - | No value in |
| Metolachlor | 637 | 11 | 0 | 382 | 11 | 0 | 0.011 | 0.004 | 0.036 | - | No value in |
| Metolachlor ESA | 18 | 9 | 0 | 11 | 7 | 0 | 0.527 | 0.06 | 1.155 | - | Chemical not |
| Metolachlor OXA | 18 | 4 | 0 | 11 | 4 | 0 | 0.14 | 0.072 | 0.279 | - | Chemical not |
| Naled (Dibrom) | 33 | 1 | 0 | 28 | 1 | 0 | 5 | 5 | 5 | - | No value in |
| Naphthalene | 684 | 6 | 1 | 398 | 5 | 1 | 6.4 | 0.4 | 29 | 17 | CA Notification |
| Norflurazon | 217 | 9 | 0 | 175 | 8 | 0 | 0.152 | 0.01 | 0.468 | - | No value in |
| Ortho-Dichlorobenzene | 848 | 2 | 0 | 454 | 2 | 0 | 0.69 | 0.56 | 1 | - | No value in |
| Prometon | 732 | 6 | 0 | 484 | 6 | 0 | 0.432 | 0.005 | 1.7 | - | No value in |
| Propoxur | 156 | 1 | 0 | 127 | 1 | 0 | 5 | 5 | 5 | 30 | CA Notification |
| Simazine | 1288 | 75 | 1 | 711 | 62 | 1 | 0.335 | 0.003 | 6.6 | 4 | CA Primary |
| Tetrachloroethane | 590 | 2 | 1 | 339 | 2 | 1 | 26.12 | 0.84 | 51.4 | 1 | CA Primary |
| Tetrachloroethylene | 30 | 2 | 0 | 30 | 2 | 0 | 0.2 | 0.2 | 0.2 | 5 | CA Primary |
| Tetrachlorvinphos (Stirofos) | 24 | 1 | 0 | 16 | 1 | 0 | 1 | 1 | 1 | - | No value in |
| TPA (2,3,5,6-Tetrachloroterephthalic Acid) | 7 | 3 | 0 | 4 | 2 | 0 | 0.817 | 0.419 | 1.5 | 3500 | CA Notification |
| **TOTAL UNIQUE LOCATIONS** | **2732** | **872** | **369** | **997** | **375** | **167** | | | | | |

Pesticide data are for the period 1979-2011 provided by DPR.

*Exceedance thresholds used are based on values reported in the SWRCB Water Quality Goals Online Database (http://www.waterboards.ca.gov/water_issues/programs/water_quality_goals/search.shtml), when available. Selection of the threshold value for use to indicate an exceedance is based on a hierarchy consisting of the following order of preference: CA Primary MCL = California Primary MCL; EPA Primary MCL = EPA's Federal Primary MCL; CA Notification = California Notification Level. No value in database = Chemical is in the database but not possible threshold value reported, Chemical not in database = Chemical was not located in the SWRCB database.

**Figure 43. Distribution of nitrogen as nitrate at concentrations at or above 5 mg/L within the GQMP Zones of the Coalition region.**

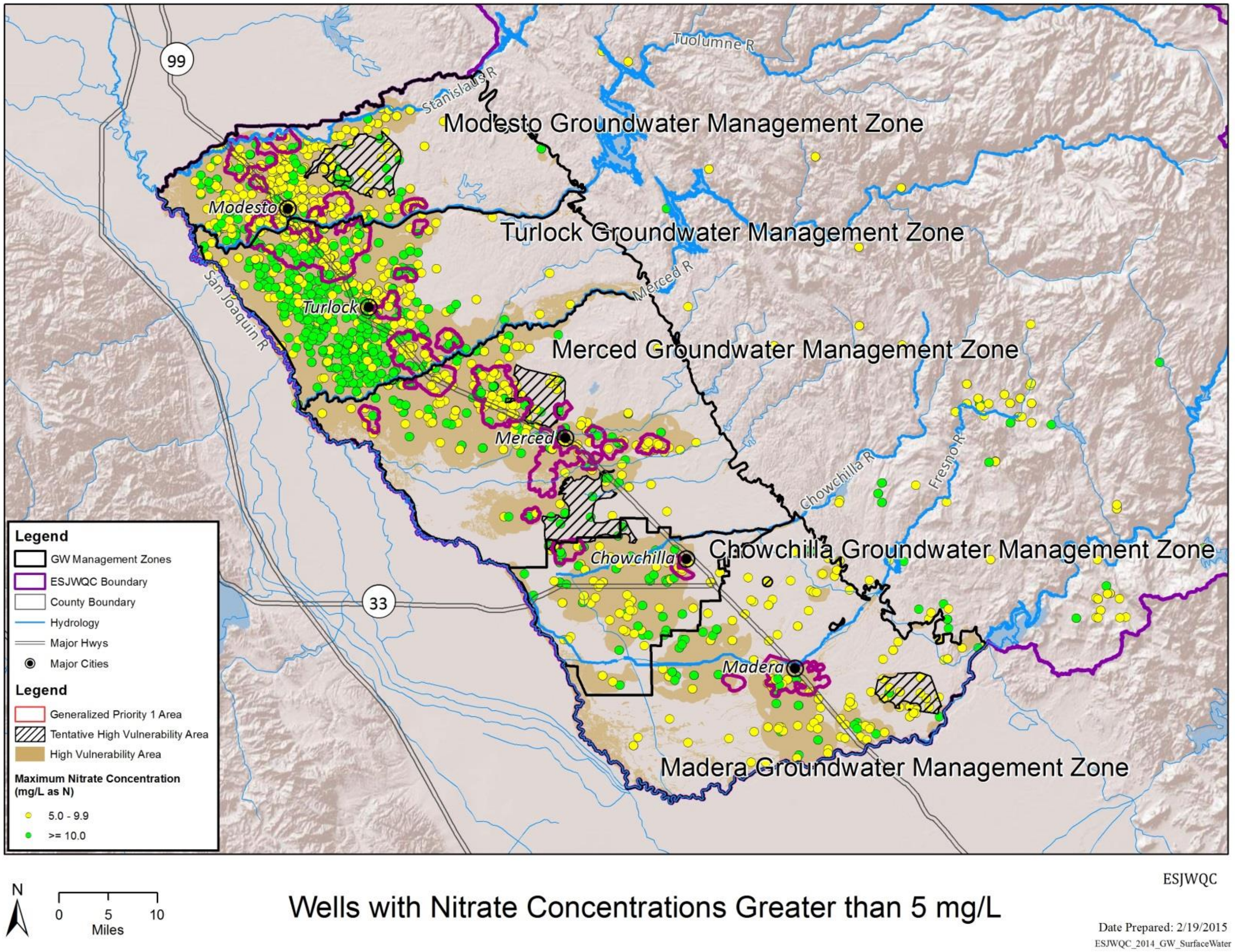


**Figure 44. Distribution of TDS at concentrations at or above 450 mg/L within the GQMP Zones of the Coalition region.**

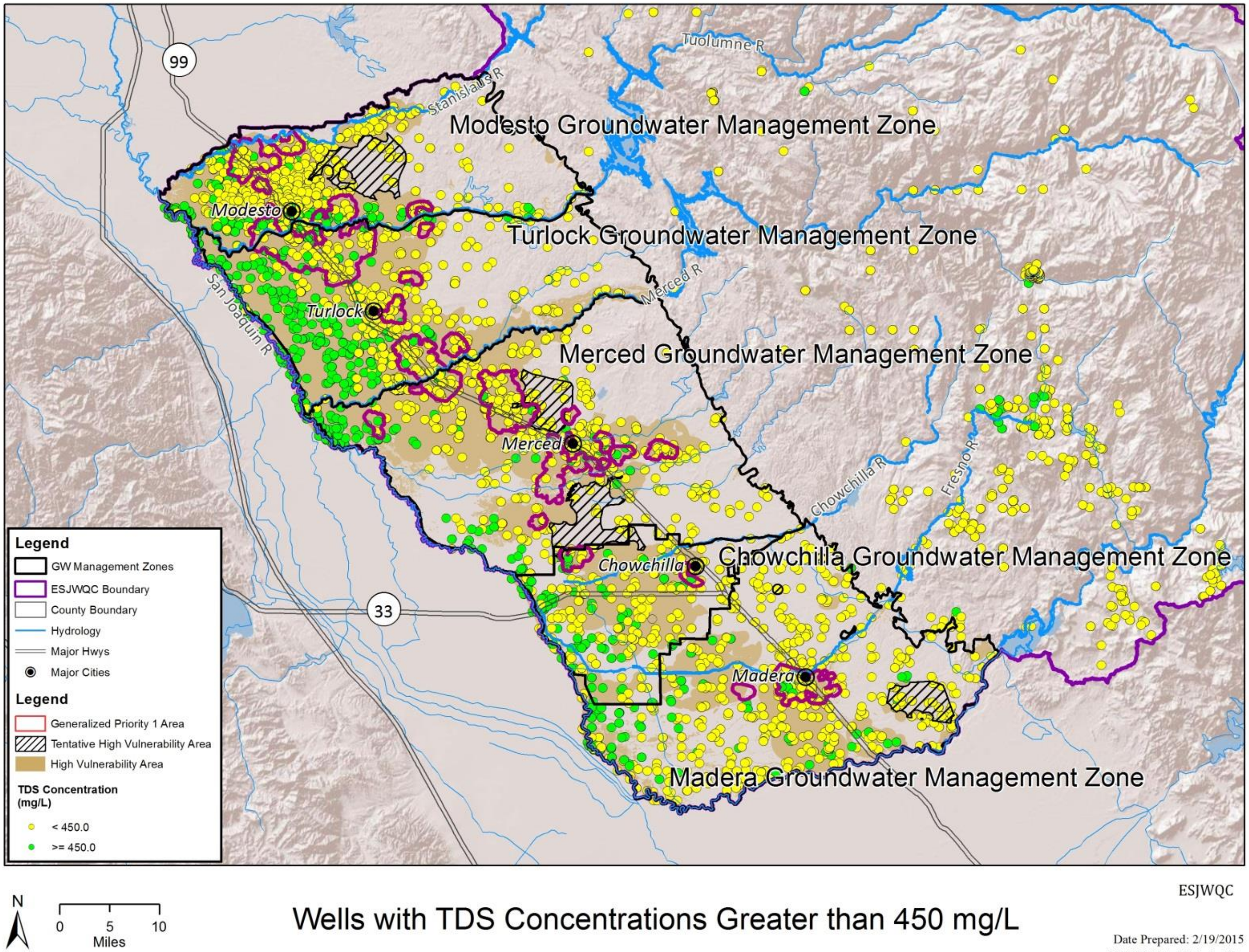
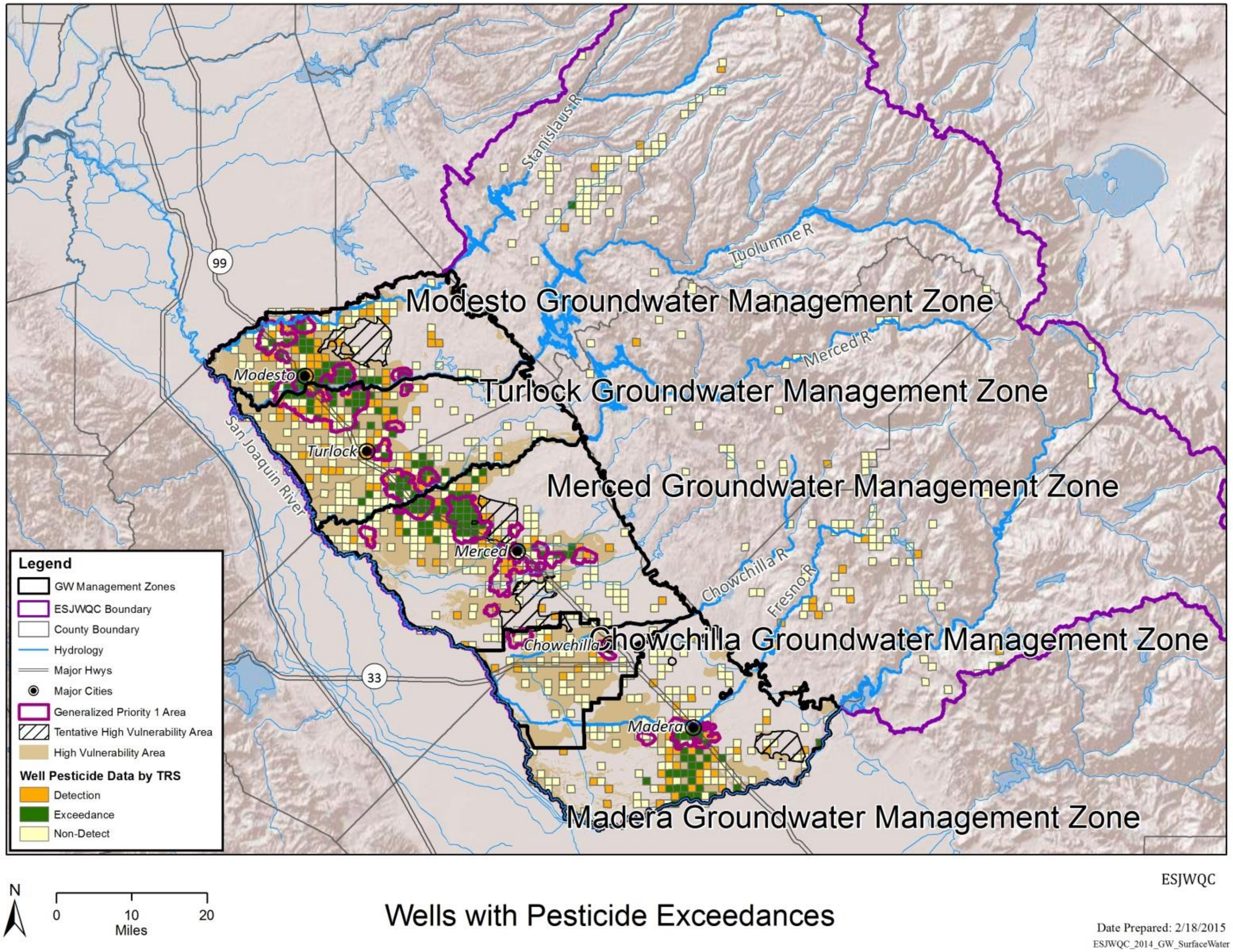


**Figure 45. Distribution of all pesticide concentrations (detection, exceedance, or non-detect) by TRS within the GQMP Zones of the Coalition region.**



## ESJWQC High Vulnerability Area

"The GAR shall designate high/low vulnerability areas for groundwater in consideration of high and low vulnerability definitions provided in Attachment E of the Order" (WDR, Attachment B, pg. 13).

One of the objectives of the GAR was to "provide a basis for establishing groundwater quality management plans in high vulnerability areas and priorities for implementation of those plans" (WDR, Attachment B, page 13). As part of the focus on protection of regional groundwater quality, the relative vulnerability of groundwater to irrigated land practices was assessed in the GAR based on hydrogeologic sensitivity, overlying land uses and practices and groundwater quality data, historic and recent (Figure 46).

### *Determination of High Vulnerability Area*

The Hydrogeologic High Vulnerability Area (HHVA) within the Coalition was determined utilizing a statistical model incorporating observed groundwater quality and hydrogeologic characteristics. The HHVA defines areas within the region where groundwater is most likely to be vulnerable to contamination based on current exceedances of the nitrate MCL, and select hydrogeologic characteristics identified in the groundwater vulnerability model laid out in the GAR. The HHVAs capture approximately 75 percent of the nitrate signals exceeding WQTLs observed across the Coalition region. A 0.5-mile buffer was added around the HHVA in the vicinity of wells where an observed nitrate exceedance occurred. With the addition of the 0.5 mile buffer around the HHVA, and a few additional, select areas (GAR, ES-15), 98 percent of the locations of nitrate exceedances observed in the surveyed well data are accounted for. The combined extents of the HHVA and buffer represent the East San Joaquin Water Quality Coalition High Vulnerability Area (ESJHVA) (Figure 46). The ESJHVA identified in the GAR covers approximately 55 percent of the area within the irrigated lands area and represents approximately 577,000 acres.

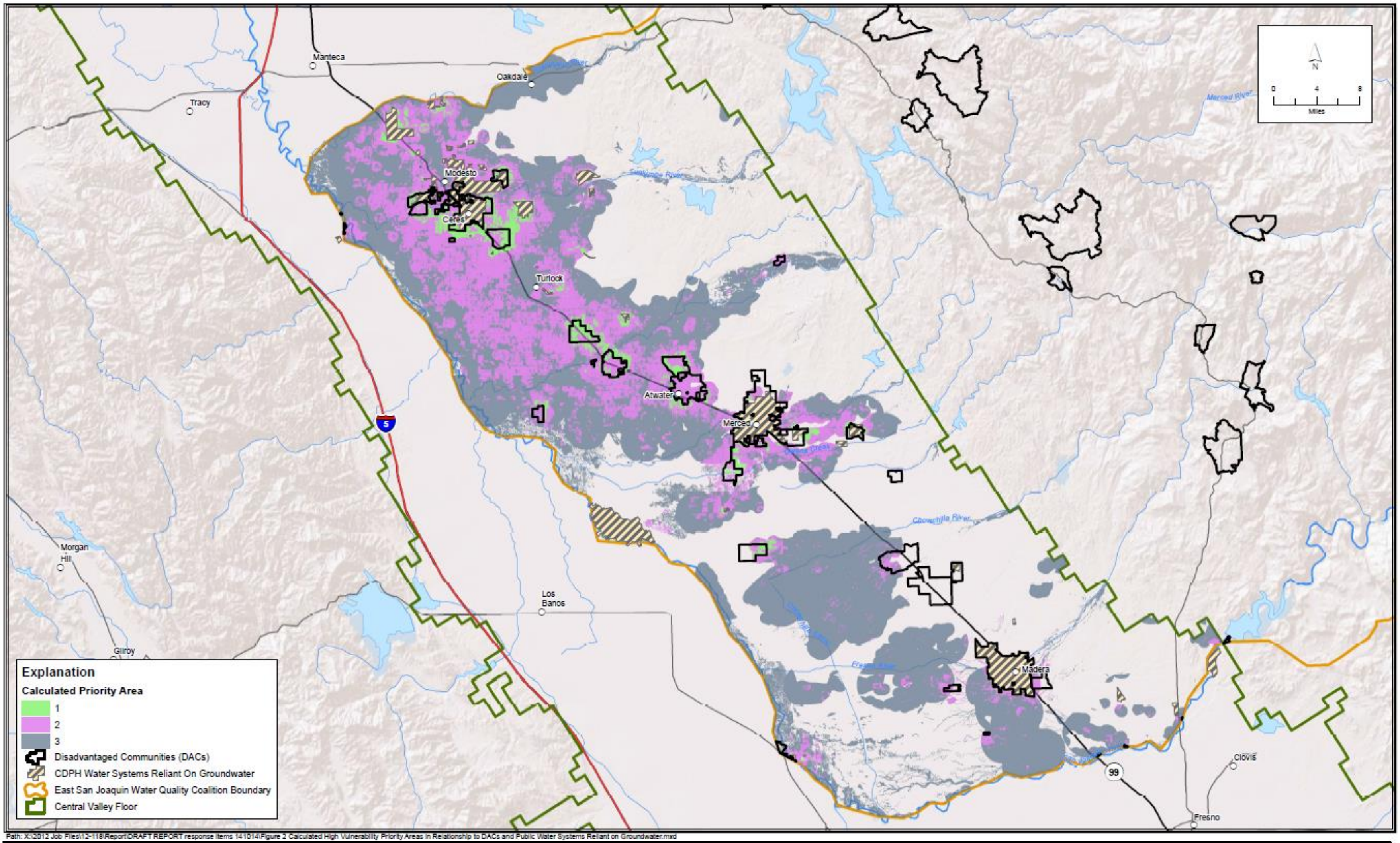
### *Determination of Prioritization of ESJHVAs*

The WDR required several factors to be considered when prioritizing the high vulnerability areas of the ESJHVA:

- Identified exceedances of water quality objectives
- Proximity to areas contributing recharge to urban and rural communities that rely on groundwater as a source of supply
- Existing field and operational practices identified to be associated with irrigated agricultural waste discharges that are the cause or source of groundwater quality degradation
- The largest acreage commodity types comprising up to at least 80 percent of irrigated agriculture in the high vulnerability areas
- Legacy or ambient groundwater conditions
- Groundwater basins currently proposed to be under review by Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS)
- Identified constituents of concern

In addition, Disadvantaged Communities (DACs) and corresponding recharge areas were incorporated in the prioritization matrix and priority ranking (1-3) of the ESJHVA (Figure 46). Figure 47 illustrates the ESJHVA Priority Areas relative to the GQMP Zones. The top Priority 1 Area are almonds (38, 660 acres), corn (6,804 acres), and grapes (4,901 acres) (GAR Addendum, 2014) (Figure 48).

**Figure 46. East San Joaquin Water Quality Coalition High Vulnerability Areas (ESJHVA) and Priority Areas (1-3) (GAR Addendum, 2014).**




LUHDORFF & SCALMANINI CONSULTING ENGINEERS

**Figure 2**
**Calculated High Vulnerability Priority Areas in Relationship to DACs and Public Water Systems Reliant on Groundwater**

**Figure 47. East San Joaquin Water Quality Coalition High Vulnerability Areas (ESJHVA) and Priority Areas (1-3) relative to GWMP Zones.**

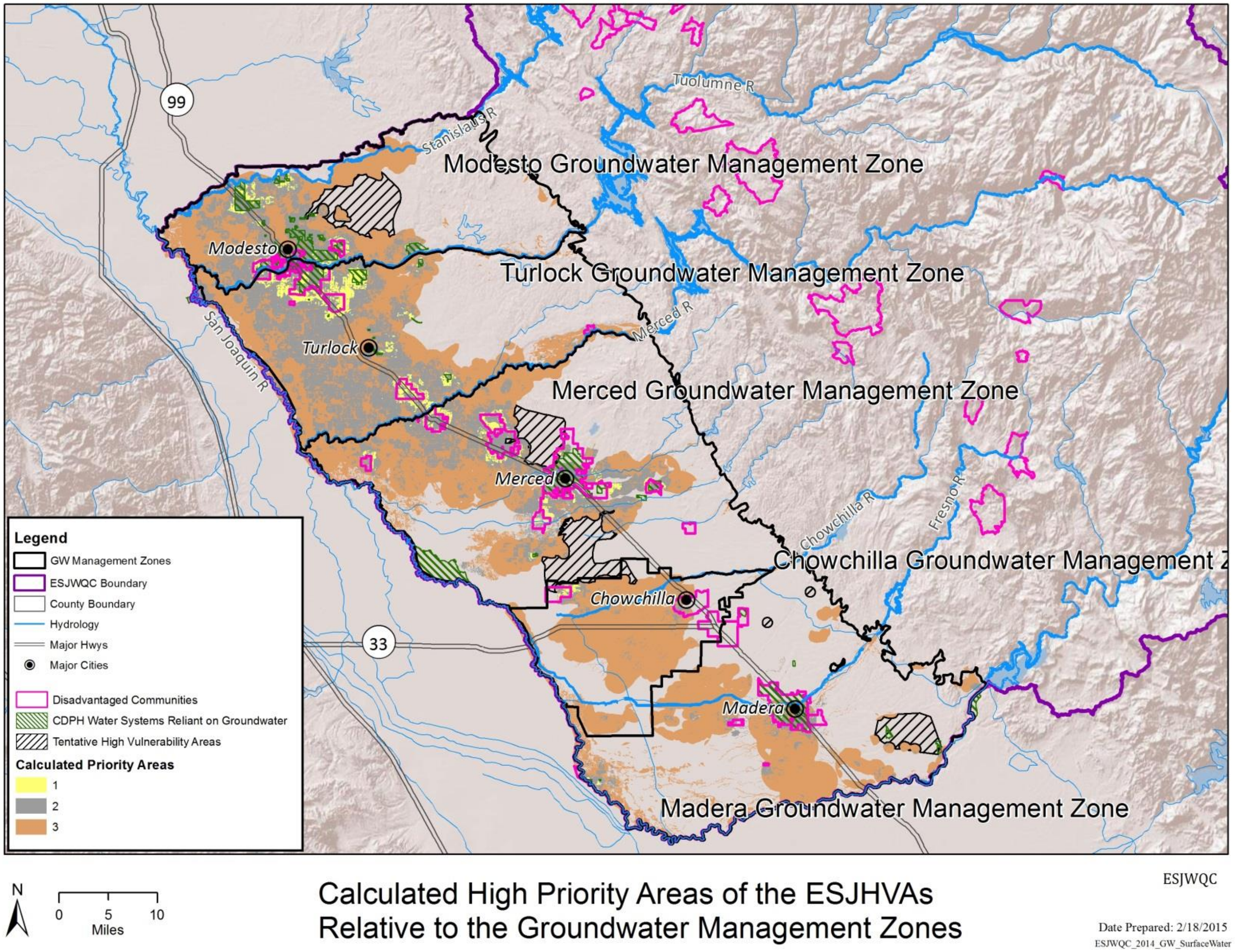
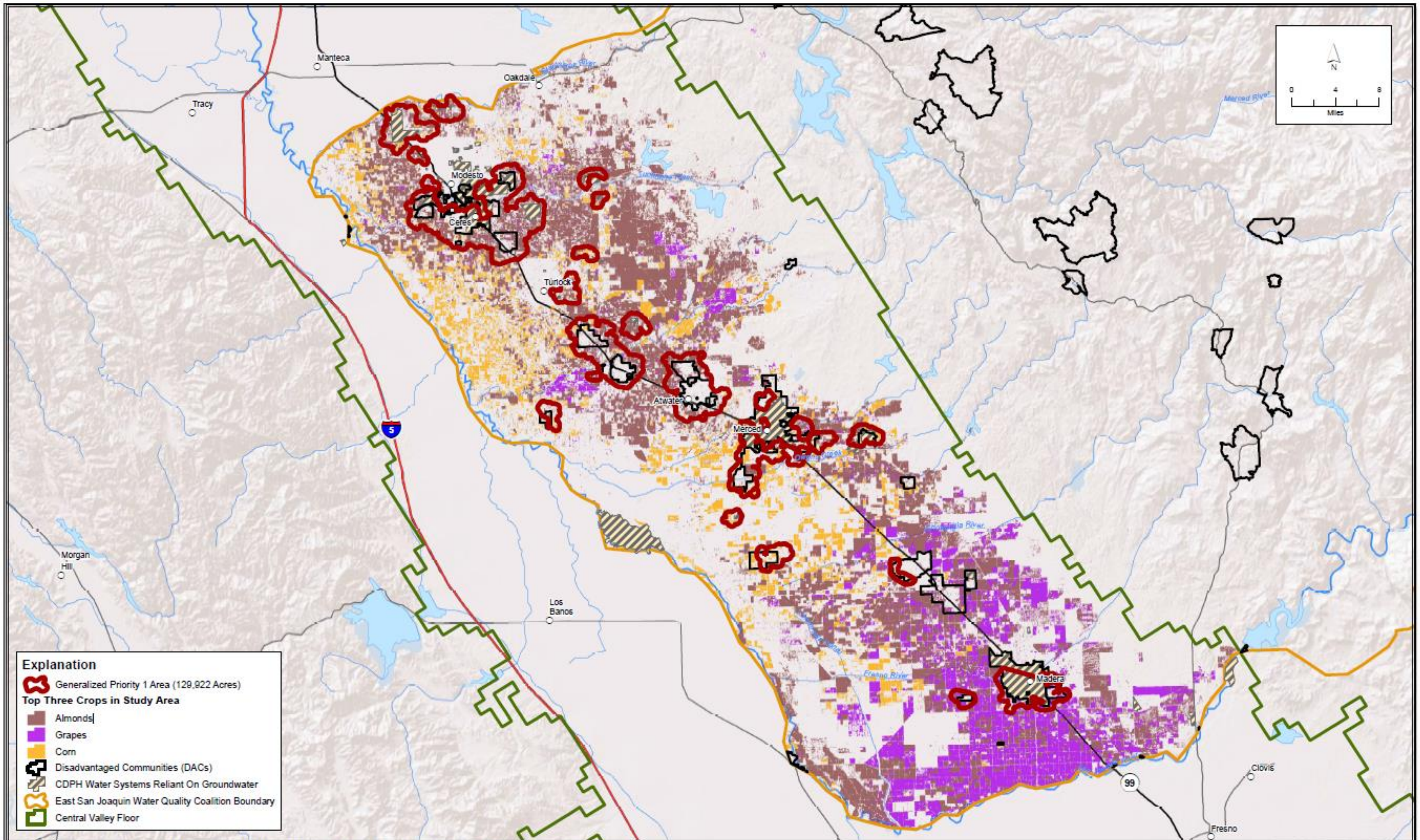


**Figure 48. East San Joaquin Water Quality Coalition High Vulnerability Areas (ESJHVA), top 3 crops, and the Generalized Priority 1 Area (GAR, Figure 8).**




Path: X:\2012 Job Files\12-118\Report\DRAFT REPORT response items 141014\Figure 8 Top Crops in Relation to Priority 2 Areas and Communities Reliant on Groundwater.mxd

LUHDORFF & SCALMANINI CONSULTING ENGINEERS

Figure 8
Top Crops in Relation to Priority 2 Areas and Communities Reliant on Groundwater

## SURFACE WATER DATA INDICATING CONSTITUENTS OF CONCERN IN GROUNDWATER

The ESJWQC began surface water quality monitoring as part of the ILRP in 2004 and currently submits Annual Monitoring Reports of surface water quality monitoring and management for its Members to the Regional Board. In general terms, data collected from surface water monitoring will be used to evaluate current constituent applications in agricultural operations and to better advise specific management practices to protect future groundwater quality. It is beyond the scope of the GQMP to identify surface water sources of constituents of concern identified in groundwater samples collected over previous decades.

## GROUNDWATER BENEFICIAL USES

The Water Quality Trigger Limits (WQTLs) in Table 12 are applied based on the protection of beneficial uses assigned to groundwater according to the Water Quality Control Plan for the Sacramento and San Joaquin River Basins (Basin Plan). According to the Basin Plan, "unless otherwise designated by the Regional Water Board, all ground waters in the Region are considered as suitable or potentially suitable, at a minimum, for municipal and domestic water supply, agricultural supply, industrial service supply, and industrial process supply" (Basin Plan, page II-3.00). These beneficial uses are described as:

- Municipal and Domestic Supply (MUN) – Uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply.
- Agricultural Supply (AGR) – Uses of water for farming, horticulture, or ranching including, but not limited to, irrigation, stock watering, or support of vegetation for range grazing.
- Industrial Service Supply (IND) – Uses of water for industrial activities that do not depend primarily on water quality including, but not limited to, mining cooling water supply, hydraulic conveyance, gravel washing, fire protection, and oil well repressurization.
- Industrial Process Supply (PRO) – Uses of water for industrial activities that depend primarily on water quality.

Groundwater provides almost the entire urban and rural water use and about 75 percent of the agricultural water use in the Central Valley Floor (Madera IRWMP 2008). Groundwater accounts for about 30 percent of the annual supply used for agricultural and urban purposes in the entire San Joaquin River Hydrologic Region (DWR YYYY). However, agricultural irrigation supplied by surface water and groundwater accounts for about 95 percent of the total water use in Modesto, Turlock and Merced subbasins (USGS 2006).

The irrigation demand in Madera County is unknown but estimated to be approximately 940,000 AFY. The average annual amount of surface water delivered in Madera County is approximately 300,000 AFY (1996-2006), leaving greater than a 600,000 AFY gap in water supply and irrigation demand (Madera IRWMP 2008).

# MANAGEMENT PLAN STRATEGY

## DESCRIPTION OF APPROACH

The goals of the ESJWQC GQMP process are to inform growers about management practices that are protective of groundwater quality, and have the growers implement those practices. To achieve those goals, the ESJWQC developed four objectives that will allow the Coalition to identify the specific constituents applied by agriculture that leach to groundwater and result in impaired water quality, identify management practices to prevent/reduce leaching, and identify a process for documenting the implementation of those practices and improvements in groundwater quality.

The objectives of the ESJWQC Groundwater Quality Management Plan Strategy are:

- Identify COCs in the GQMP Zones
- Identify management practices to be implemented that are protective groundwater quality
- Develop a management practice implementation evaluation process and schedule (based on priority)
- Develop management practice performance goals with a schedule (10 year compliance)

### Identify COCs in the GQMP Zones

The ESJWQC identified COCs based on analyses for constituents known to have the potential to be found in groundwater. As identified in the GAR there have been exceedances of water quality objectives for nitrate, TDS, pesticides (aldicarb sulfone, DBCP [dibromochloropropane], diazinon, ethylene dibromide, ethylene dichloride, and simazine), and additional compounds (naphthalene and tetrachloroethane) (Table 14). Naphthalene is the active ingredient in moth balls and is used for indoor storage, not irrigated agriculture, and tetrachloroethane is a degreasing agent, again not used for crop production by irrigated agriculture. Because naphthalene and tetrachloroethane are not used by irrigated agriculture, and aldicarb sulfone, DBCP, ethylene dibromide, and ethylene dichloride are not registered for use in California, these compounds are not included as constituents of concern. Constituents of concern for the ESJWQC region include nitrate, TDS, diazinon, and simazine. Table 15 lists the WQTLs for the GQMP COCs.

**Table 15. GQMP COC WQTLs.**

| Constituent | Water Quality Trigger Limit (WQTL) | Standard Type | Beneficial Use (BU) with most protective limit | Reference for the Trigger Limit | Category (see footnotes) |
|---|---|---|---|---|---|
| Total Dissolved Solids | 450 mg/L | Narrative | Agricultural Supply | Water Quality for Agriculture (Ayers & Westcott) | 3 |
| **Pesticides – Organophosphates** | | | | | |
| Diazinon | 0.1 µg/L | Numeric | Freshwater Habitat | Sacramento/San Joaquin Basin Plan: San Joaquin River & Delta numeric standard. Sacramento & Feather Rivers numeric standard | 1 |
| **Pesticides – Herbicides** | | | | | |
| Simazine | 4.0 µg/L | Numeric | Municipal and Domestic Supply | Sacramento/San Joaquin Basin Plan Chemical Constituents Objective: California Primary MCL (MUN, human health) | 1 |
| **Nutrients** | | | | | |
| Nitrate as NO3<br>Nitrate as N | 45 mg/L as NO3<br>10 mg/L as N | Numeric | Municipal and Domestic Supply | Sacramento/San Joaquin Basin Plan Chemical Constituents Objective: California Primary MCL | 1 |

**Category 1:** Constituents that have numeric water quality objectives in the Sac-SJR Basin Plan or other WQO listed by reference such as MCLs (Page III-3.0)* , CTRs (Page III-10.1)*,

**Category 3:** Constituent does not have numeric WQO, and does not have a primary MCL. WQTL exceedance is based on implementation of narrative objective. All detections should be tracked. None are default exceedances.

**MUN**-Municipal and Domestic Supply

**(*)**-Water Quality Control Plan for the Sacramento and San Joaquin River Basins. Revised on October 2007.

## Identify Management Practices that are Protective of Groundwater

The COCs are all soluble chemicals that are transported to groundwater with the downward movement of water. The sources of water resulting in leaching include: rainfall, irrigation, direct injection to operational wells lacking a proper backflow device, improperly abandoned or improperly cased wells, and surface water (rainfall and irrigation). Consequently the Coalition will focus on management practices that address all of these pathways to groundwater. Some of these transport pathways can be addressed immediately (transport through wells lacking backflow prevention, improperly abandoned wells); others will require additional research conducted through the MPEP to fully understand which management practices are most effective and under what conditions (movement to groundwater resulting from surface applications of nitrate).

The Coalition approach includes outreach about practices that can be implemented immediately and, through the MPEP, conducting studies that will provide crop-specific information on management practices. In the short term, the Coalition will initiate outreach on management practices that the Coalition knows can reduce the movement of nitrates and pesticides to groundwater through wells. In addition, there are numerous general management practices that can reduce leaching of nitrate from irrigated fields. The Coalition is currently communicating practices about wellhead protection and general practices to manage nitrogen applications to its members through outreach meetings. In the longer term, the emphasis in the Coalition's outreach will be expanded to include the outcome of the MPEP studies which will provide information that is specific to crops, soils, and climatic regions within the Coalition region.

Practices involving wellhead protection and prevention of contaminants moving down active or abandoned wells to groundwater include:

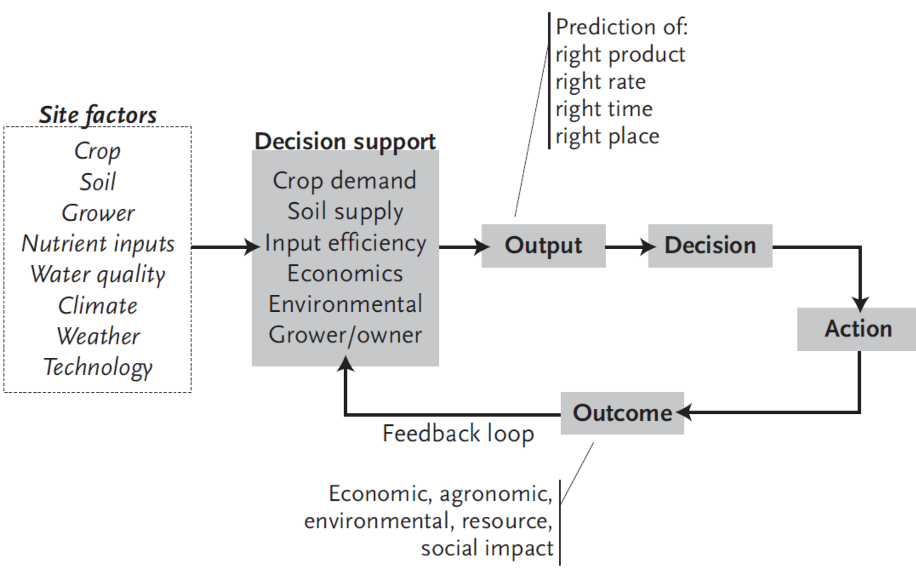
- Installation of proper backflow prevention devices

- Maintenance of area around wellhead including grading ground away from well
- Good housekeeping practices around wellhead
- Properly abandoning/destroying wells

The Coalition will utilize the 4Rs to guide its general approach for managing nutrients. The 4Rs (see below) were developed in the late 1980's at the Potash and Phosphate Institute, which is the predecessor of the International Plant Nutrition Institute. The original authors included a fertilizer industry agronomist and a university scientist who developed the concept to promote agricultural sustainability. Although developed specifically for fertilizers, these practices are also applicable to the management of other soluble constituents.

The International Plant Nutrition Institute (IPNI) is a leader in developing practices to optimize fertilizer applications and efficient use of nitrogen. The IPNI recognizes that there is not one set of universal fertilizer BMPs. By definition, BMPs are site and crop-specific and vary depending on soils, climate, cropping history, and management expertise. There are many uncontrollable factors such as light, temperature, moisture, soils, and cultivar. Controllable factors include fertilizer, soil amendments, pesticide applications, tillage, and other cultural practices. Uncontrollable factors introduce uncertainty into the system which can make management of nutrients difficult. Only when controllable factors are controlled and uncontrollable factors are measured can reliable information on the efficacy of management practices be generated. Once the information is developed, it can be used as part of a larger decision support system to guide the selection and implementation of appropriate management practices. An example of a DSS is provided in Figure 49 which is promoted by IPNI. The Coalition will use this general framework for communicating with growers about implementing fertilizer BMPs.

**Figure 49. Decision support system for managing nutrient inputs to irrigated crops. Taken from Fixen (2007).**



The 4Rs include right time, right place, right rate, and right source (product):

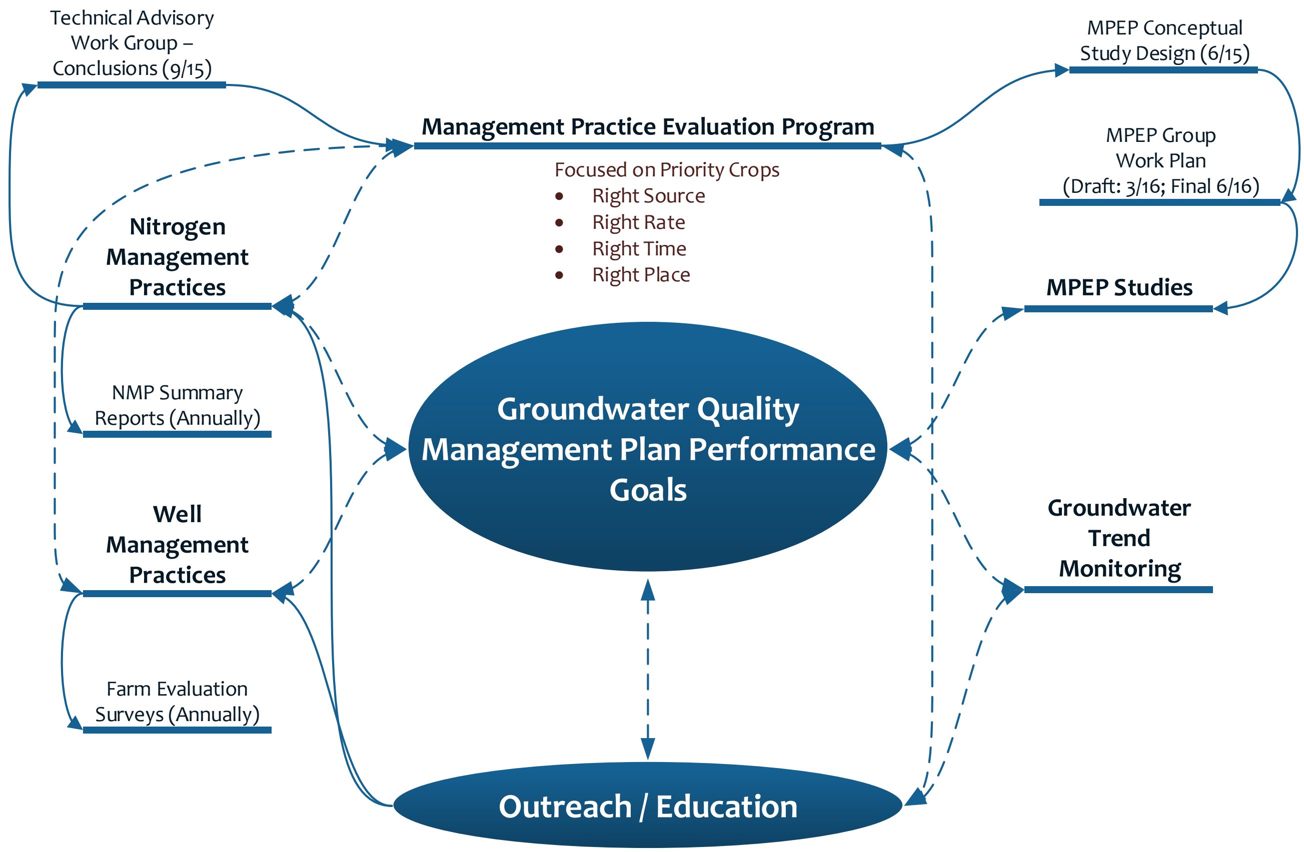
- Right time – nutrients are made available when the plant needs them, can be accomplished by providing when the plant needs them by synchronizing their application with crop demand, properly managing applications e.g. pre-plant or split applications, controlled release technologies, and product stabilizers
- Right rate – match the amount of fertilizer applied to the crop need to reduce losses to leaching or surface water runoff; BMPs include realistic yield goals, soil testing, crop nutrient budgets, tissue testing, plant analysis, applicator calibration, good record keeping and nutrient management plans
- Right place – keep nutrients where the crop can use them. Incorporation or fertigation are usually the best methods of doing this
- Right source (product) – match the fertilizer source and product to crop need and soil properties. Be aware of nutrient interactions and balance nitrogen, phosphorus, potassium, and other nutrients

Many of the basic properties of the 4Rs can be implemented without specific information about the individual crop including actions such as soil testing for residual N, tissue testing, testing of the concentration of nitrate in irrigation water, and developing a nitrogen management plan. However, for more specific management practices associated with the 4Rs, including the right timing of applications, right place (side dress), and right rate (100 lbs/acre vs. 200 lbs/acre), additional research needs to be conducted before the most efficient management practices, including the most optimal nitrogen fertilizer rate, are known for each crop. This research is the purpose of the MPEP.

## MANAGEMENT PLAN EFFECTIVENESS

The Coalition will evaluate the effectiveness of the GQMP strategy by 1) documenting nitrate and well head management practices by members and 2) assessing groundwater quality improvements using monitoring data (Figure 50).

**Figure 50. Conceptual diagram of the GQMP strategy to evaluation effectiveness.**




## Tracking of Management Practices

Farm Evaluation Plan surveys (FEPs) are required of members to report the management practices implemented on their farming operation. Completed yearly in HVAs, the FEPs address constituents of concern in both surface and groundwater. For groundwater, the FEPs provide information on wellhead protection, irrigation practices, and nitrogen applications. More specific information on nitrogen management is provided in the Nitrogen Management Plan (NMP) which will be completed yearly by members in HVAs starting in 2015. The NMP provides very specific information about the amount of nitrogen applied, the timing of the nitrogen additions, additional sources of nitrogen available (e.g. irrigation water) to the crop, and anticipated yield. Growers in HVAs will submit NMP summary reports annually starting in 2016 which will includes summary information based on the previous crop year's NMP. The Coalition will use a combination of the FEPs and NMP summary reports to track implementation of management practices in HVAs from year to year.

During 2015 the NMP Technical Advisory Work Group will convene to create a "Crop Nitrogen Knowledge Gap Study Plan" to determine the appropriate metric of nitrogen use to report to the CVRWQCB; it is anticipated that the metric will be some measure of nitrogen uptake and use by the crop. The recommended appropriate ratio of applied N to "consumed N" will be submitted to the Coalition by the members and these values will be tracked over time for each grower with the objective of reducing the potential for leaching nitrate to the groundwater. When the final reporting metric is developed, the Coalition will integrate the measure into the

MPEP studies to determine the appropriate range of target values for the major crops in the Coalition region starting with the priority crops identified in the GAR. Once these target values are known, members will be able to identify and implement practices that will allow them to evaluate their operation and practices (if needed) to minimize the potential for leaching of nitrate to groundwater.

### Tracking of Groundwater Quality

Changes in groundwater quality, even first encountered groundwater which may be shallow, are very difficult to document for several reasons including infiltration rate, depth to groundwater, seasonal variation in groundwater quality and depth, yearly variation due to changes in weather (drought years vs. above normal rainfall years), volume of the aquifer, flow rate and path, and the spatial and temporal sample sizes (potentially years) needed to demonstrate a trend. However, the Coalition's Trend Monitoring Program will generate groundwater quality data that can be used to evaluate groundwater quality for COCs as tracked over an extended period of time. Even in shallow groundwater, reductions in nitrate leaching to groundwater may not be identifiable for many years. The nitrate in the vadose zone may take several years to reach groundwater, and the volume of groundwater and concentration of nitrate in that groundwater may make detection of any changes difficult to document. The extended drought in the Central Valley is also greatly delaying any movement of nitrates through the soil profile. Consequently, the first few years of monitoring will establish a baseline from which future trends can be determined and linked to implementation of management practices as reported in the FEPs and NMPs. The time needed to demonstrate improvements in groundwater quality is expected to vary across the Coalition region and therefore it is not known how long it will take to detect trends in groundwater quality.

## ACTIONS TO MEET GOALS AND OBJECTIVES

The Coalition conducts outreach meetings regularly throughout the year at various locations in the Coalition region. At these meetings, Coalition monitoring results including exceedances of water quality objectives are discussed as well as management practices that can be implemented to reduce surface water runoff, sediment discharge, and leaching of COCs to groundwater. These practices include but are not limited to wellhead protection, irrigation system maintenance and calibration, and nitrogen management planning.

In addition to the outreach meetings, the Coalition presents information about management practices at individual meetings targeted to specific watersheds. The MPEP will provide substantial information about crop-specific management practices that can be provided to growers. The Coalition will provide information to growers of specific commodities at meetings in the Coalition region focused on conclusions from the MPEP studies. The Coalition will work with the MPEP Group to secure funding for studies on priority crops in HVAs as well as funds for creating additional outreach materials and tools that can be utilized by members to assist with nitrogen application planning relative to the 4Rs.

# DUTIES AND RESPONSIBILITIES

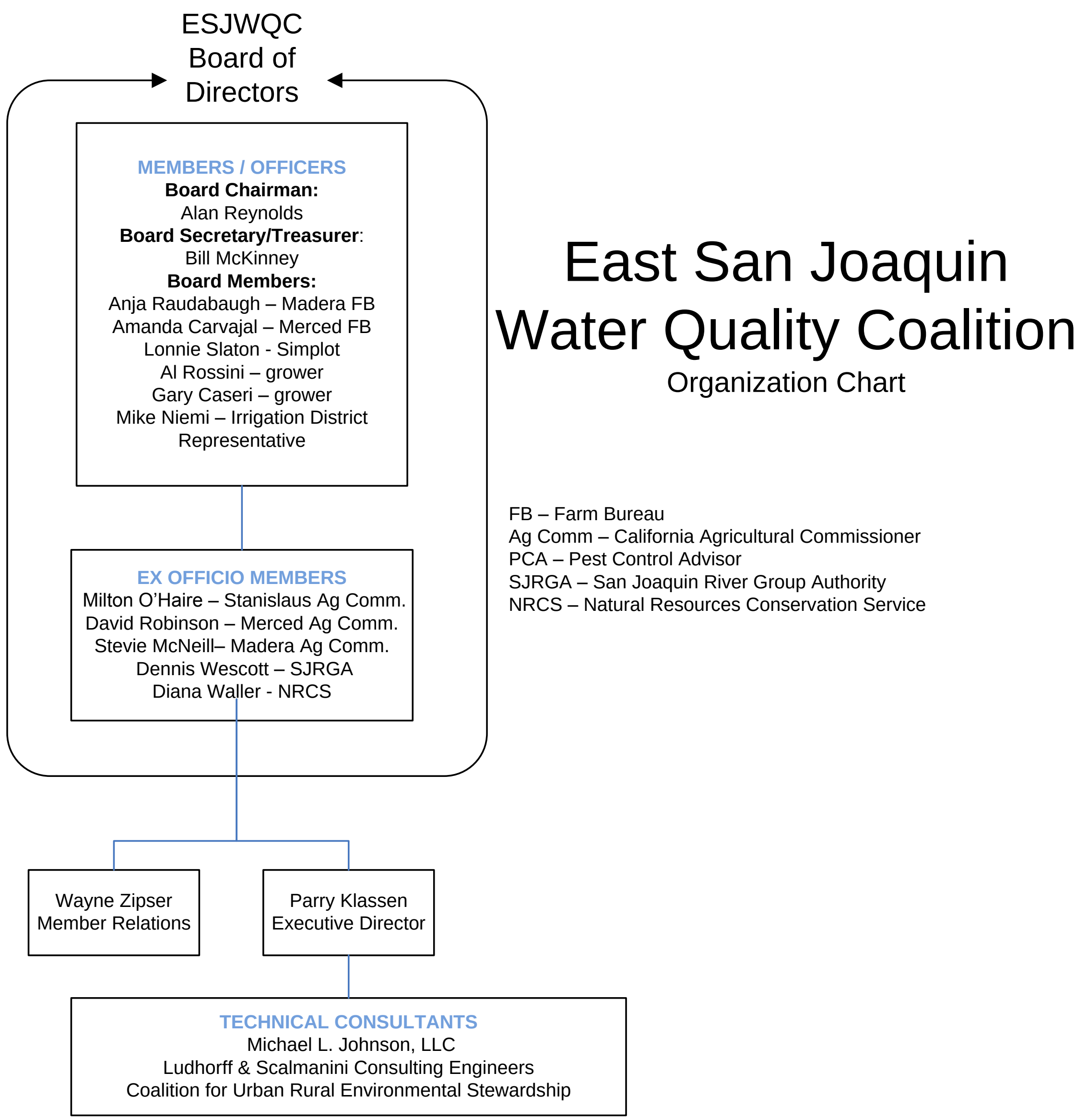
The responsible parties are provided in organizational chart provided below (Figure 51).

ESJWQC policy is determined by a Board of Directors. The ESJWQC Board of Directors (BOD) also oversees all Coalition business. The BOD works closely with the Executive Director to ensure effective management of Coalition activities. Parry Klassen is the Executive Director of the ESJWQC and the project lead for management plan activities. Mr. Klassen is responsible for implementing policy as directed by the Board of Directors including budgeting and financial management, management of the Coalition's membership, member outreach, oversight of consultant contracts, and management of consultant work products. Wayne Zipser is the Coalition Manager of Member Relations. Mr. Zipser is the lead for stakeholder involvement and is responsible for outreach to members, primarily in individual meetings with growers in management plan site subwatersheds. Technical consultants are contracted by the Coalition as needed to complete tasks and activities required by the Regional Water Board. Currently, the technical consultants to the ESJWQC are Michael L. Johnson, LLC; Luhdorff and Scalmanini Consulting Engineers (LSCE), and the Coalition for Urban Rural Environmental Stewardship (CURES). Michael L. Johnson, LLC (MLJ-LLC) will be responsible for conducting the groundwater monitoring and reporting program. LSCE is responsible for developing the Groundwater Trend Monitoring Report, updating the GAR every 5 years and providing technical support for groundwater issues. CURES assists in developing BMP literature and conducting member outreach events.

### Coalition Contact Information

Parry Klassen
Executive Director
East San Joaquin Water Quality Coalition
559-288-8125
pklassen@unwiredbb.com

**Figure 51. Identification key of responsible parties involved in major aspects of the GWMP.**



# STRATEGIES TO IMPLEMENT MANAGEMENT PLAN TASKS

## Agencies Contacted for Data and/or Assistance

The Coalition utilizes data from DPR to assist with sources of applied pesticides that occur due to applied pesticides. The Coalition works with the each County Agricultural Commissioner office to obtain preliminary data approximately every quarter. These data are reviewed, analyzed and summarized in the Annual Report which includes the Management Plan Progress Report.

The Coalition receives input from NRCS in Modesto regarding county wide NRCS assistance to growers to implement new management practices is summarized in the Management Plan Progress Report. The Coalition encourages members to apply for NRCS funds to implement structural BMPs.

The Coalition is participating in a joint effort to conduct MPEP studies. Other coalitions participating are the Sacramento Valley Water Quality Coalition, San Joaquin County and Delta Water Quality Coalition, and the Westside Water Quality Coalition. The Coalitions have met and developed an administrative structure to manage the MPEP studies, and have convened a technical advisory group consisting of several representatives from UC Cooperative Extension, the fertilizer industry, and commodity groups. The Coalitions selected CURES as the administrative contractor, and have started developing grant proposals to fund MPEP studies.

In addition, several Coalitions are working with the CDFA to develop a nitrogen management curriculum that will allow members who successfully complete the course and certify their Nitrogen Management Plans. The MPEP participants are submitting a grant proposal to CDFA to fund the development of the curriculum of the self-certification course.

The Central Valley Salinity Alternatives for Long Term Solutions (CV-SALTS) process and the Central Valley Salinity Coalition are in the process of developing a Basin Plan Amendment for salt and nitrate that will involve the development of a Salt and Nitrate Management Plan (SNMP). This SNMP will include implementation options that may result in the use of specific management practices in some or the entire Coalition region. The CV SALTS process is anticipated to be completed by 2017 and when that BPA is finalized, the Coalition will re-evaluate its GQMP to determine its compatibility with the requirements of the BPA and the SNMP(s) developed for the Coalition region.

## Management Practices to Control COCs

The Coalition uses the information provided by different state and federal agencies when making recommendations to growers about how to eliminate discharges from their farming operation. Recommended practices include a range of actions from reducing the amount of pesticide applied to installation of pressurized irrigation systems. Some of the management practices are not technically feasible on some crops. Some practices may be technically feasible but for some members, the practices may not be economically feasibility. For these members, the Coalition provides information about programs that provide a cost share of the purchase and installation improving the affordability of these systems.

## Outreach Methods

### Grower meetings

Meetings in each of the major counties (Stanislaus, Merced, and Madera Counties) in the Coalition region are typically the held three time each year. Additional meetings can be called at any time during the year if circumstances warrant. At these meetings, the Coalition discusses the water quality results for the year, new management plans that can improve water quality, and any changes in requirements due to updates of the WDR by the Regional Water Board.

Meetings within a smaller geographic area are held periodically. These meetings are arranged as needed and can involve the participation of individuals with specialized training, e.g. NRCS or UC Extension personnel. If the Coalition determines that meeting with a subgroup of members in the high priority areas within the HVAs will provide information that can lead to increased implementation of practices known to be protective of groundwater quality, the Coalition will organize a meeting with members who grow a specific crop such as almonds or operate of a groundwater basin of specific interest.

Other entities within the Coalition region hold meetings where water quality results and management practices are discussed. Meetings are conducted by the County Agricultural Commissioner to satisfy education requirements involved in receiving a pesticide application permit. Although not the focus of these meetings, presentations focusing on water quality and management practices are given specifically addressing pesticides and pesticide applications.

Outside of a formal meeting setting, the Coalition provides information to growers throughout the year through mailings, emails, newsletters and an annual member summary report. Through these media the Coalition presents information to members concerning the Coalition's progress in achieving water quality goals, monitoring results and management practices proven to be effective to reduce the discharge of nutrients and pesticides to groundwater. All outreach and education activities are reported in the ESJWQC Annual Report submitted by May 1 of each year.

The Coalition also hosts a website (http://www.esjcoalition.org/home.asp), which serves as a clearing house for Coalition activities and outreach on management practices. Information provided through the website is utilized as a supplement to regular grower contacts and meetings.

### Pest Control Advisors, Agricultural Commissioners, Registrants, and Fertilizer Manufacturers

Agricultural Commissioners from Stanislaus, Merced, and Madera Counties are active participants as non-voting members of the ESJWQC Board of Directors. The Coalition collaborates with County Agricultural Commissioners, Pest Control Advisors (PCAs), and pesticide registrants to provide information on effective management practices to growers within the ESJWQC region. As the focus or water quality expands to groundwater, the Coalition has enlisted assistance from fertilizer manufacturers and their CCAs to work with members to optimize their nitrogen applications to achieve the maximum yield and eliminate discharge to groundwater.

## *Performance Goals and Performance Measures*

The Coalition's Performance Goals are built on actions essential for successful completion of the Management Plan strategy. The Performance Goals reflect the steps necessary to guarantee that the objectives of the Management Plan program are met and that groundwater quality improves in the ESJWQC region.

The following section describes the Performance Measures associated with each Performance Goal (Table 16). These Performance Measures are the actions the Coalition will perform to meet the Performance Goals. Included in the table of Performance Goals and Performance Measures are the parties responsible for performing the actions described by the Performance Measures.

### Performance Goal 1. Identify member parcels in areas requiring a GQMP.

***Performance Measures***

1.1 Map parcels of members in each GQMP Zone.

The ESJWQC will review member parcels in relation to the most recent groundwater high vulnerability areas and trend monitoring results (if applicable). This information will be used to identify member acreage within the ESJWQC GQMP area and will be reported on in the annual Management Plan Progress Report.

### Performance Goal 2. Review the members' Farm Evaluation Plan survey (FEPs) to determine number/type of well management practices in place.

***Performance Measures***

2.1 Review FEP from 100% of member parcels in a GWMP for well management practices.
2.2 Identify members with abandoned wells where it is unknown how they were abandoned (e.g. unknown method, no selection on survey).
2.3 Identify well management practices not currently used by members that can be recommended to prevent discharges to groundwater.

The Farm Evaluation Plan survey (FEP) is completed by all members in high vulnerability regions annually. The Coalition will review these submissions to determine what practices are in place on member farming operations in regards to well management practices. The Coalition will conduct outreach to members who did not indicate a method for properly abandoning their wells on their Farm Evaluation. In addition, the Coalition will review well management practice responses and conduct outreach and education about additional practices that should be implemented to prevent discharges to groundwater. The Coalition will report on well management practices and additional recommended practices in the Management Plan Progress Report.

### Performance Goal 3. Review the members' Farm Evaluation Plan survey (FEPs) to determine number/type of irrigation, pesticide and nitrate management practices in place.

***Performance Measures***

3.1 Review FEP from 100% of member parcels in GWMP for irrigation, pesticide and nitrate management practices.
3.2 Identify management practices not currently used by members that can be recommended to prevent discharges to groundwater based on MPEP study results.

Irrigation, pesticide and nitrate management practices will be recorded in an Access database annually to track changes in member management practices over time. As the MPEP studies are conducted, the results will be communicated to members within the Coalition as effective management practices to reduce the potential for discharging nitrogen to the groundwater. The Management Plan Progress Report will identify management practices that have been identified by the Coalition (either through the MPEP or other resources) to be effective in reducing the potential for leaching of pesticides, nitrates and salts.

### Performance Goal 4. Conduct outreach to inform members of water quality problems and recommend additional practices.

***Performance Measures***

4.1 Provide groundwater monitoring results at meetings with members and discuss practices that can be used to reduce leaching of COCs to groundwater.
4.2 When available and appropriate, provide information to members on the results of the MPEP.
4.3 Track attendance at meetings attended by the targeted members.

The Coalition conducts a series of Annual Meetings in addition to various meetings throughout the year. Results of groundwater monitoring will be discussed with members at Coalition meetings as well as the various management practices that can be implemented to reduce the leaching of COCs to groundwater. As results of the MPEP studies are available, the Coalition will present this information to its members in addition to having information available on its website. Attendance will be tracked at meetings to ensure that members within groundwater high vulnerability zones attend these meetings and are informed of current groundwater quality conditions.

### Performance Goal 5. Improve understanding of effective management practices to reduce potential for leaching of COCs.

***Performance Measures***

5.1 Identify high priority crops and any data gaps through the NMP Technical Advisory Group.
5.2 Conduct studies through the MPEP to help fill data gaps regarding management practice effectiveness.
5.3 Create online resources regarding MPEP study results and information regarding the 4Rs.

The Coalition will work with the NMP Technical Advisory Group to identify high priority crops and data gaps that are necessary to resolve for better understanding the effectiveness of nitrogen application practices. The NMP Technical Advisory Group are expected to have conclusions regarding the data gaps and suggestions for what should be reported in the Nitrogen Summary Report. This information will be summarized in the Management Plan Progress Report and disseminated to members. The MPEP studies will assist with filling in data gaps identified through the NMP Technical Advisory Group as well as better understand the efficacy of many of the practices currently being implemented by ESJWQC members. The Coalition will participate in the MPEP planning process including study design implementation and working with participating members to conduct the studies as necessary. The Coalition anticipates that online resources will be necessary to disseminate the results of the NMP Technical Advisory Group, the MPEP studies, other nitrogen management studies, and various information regarding the 4Rs for specific crops. The ESJWQC will post resources on the ESJWQC website including links to existing webpages with pertinent information regarding nitrogen and irrigation management.

### Performance Goal 6. Improve understanding of effective management practices to reduce potential for leaching of COCs.

***Performance Measure***

6.1 Evaluate monitoring results from the Groundwater Trend Monitoring Program for COCs.

Once the Groundwater Trend Monitoring Program is initiated, the Coalition will review the results annually in its Management Plan Progress Report and adjust the COCs in each GQMP Zone as needed. The results will be reviewed in relation to changes in management practices as documented in the FEPs as well as changes in nitrogen applications as recorded in the NMP Summary Reports.

**Table 16. Performance Goals for the ESJWQC GQMP.**

| Performance Goal/Performance Measure | Outputs | Who |
|---|---|---|
| ***Performance Goal 1: Identify member parcels in areas requiring a GQMP.*** | | |
| Performance Measure 1.1. – Map parcels of members in each GQMP Zone. | Report in Management Plan Progress Report the acreage represented by members in a GQMP area. | MLJ-LLC |
| ***Performance Goal 2: Review the member's Farm Evaluation Plan (FEP) to determine number/type of well management practices in place.*** | | |
| Performance Measure 2.1 – Review FEP from 100% of member parcels in a GWMP for well management practices. | Completed individual management practice evaluations recorded in an Access database. | MLJ-LLC |
| Performance Measure 2.2 – Identify members with abandoned wells where it is unknown how they were abandoned (e.g. unknown method, no selection on survey). | Conduct outreach to members that have not properly abandoned a well or did not record an answer. | Parry Klassen/MLJ-LLC |
| Performance Measure 2.3 – Identify well management practices not currently used by members that can be recommended to prevent discharges to groundwater. | Summary in the Management Plan Progress Report of management practices recommended to members. | Parry Klassen |
| ***Performance Goal 3: Review the member's Farm Evaluation Plan (FEP) to determine number/type of irrigation, pesticide and nitrate management practices in place.*** | | |
| Performance Measure 3.1 – Review FEP from 100% of member parcels in a GWMP for irrigation, pesticide and nitrate management practices. | Completed individual management practice evaluations recorded in an Access database. | MLJ-LLC |
| Performance Measure 3.2 – Identify management practices not currently used by members that can be recommended to prevent discharges to groundwater based on MPEP study results. | Summary in the Management Plan Progress Report of management practices identified as reducing the potential for leaching pesticides, nitrates and salts. | Parry Klassen/MLJ-LLC |
| ***Performance Goal 4: Conduct outreach to inform members of water quality problems and recommend additional practices.*** | | |
| Performance Measure 4.1 – Provide groundwater monitoring results at meetings with members, and discuss practices that can be used to reduce leaching of COCs to groundwater. | Agendas and/or reports of all meetings with members. | Parry Klassen/MLJ-LLC |
| Performance Measure 4.2 – When available and appropriate, provide information to members on the results of the MPEP. | Provide reports from studies through meetings and the ESJWQC website. | Parry Klassen |
| Performance Measure 4.3 - Track attendance at meetings attended by the targeted members. | Report of members attending meetings provided in Management Plan Progress Report. | Parry Klassen/MLJ-LLC |
| ***Performance Goal 5: Improve understanding of effective management practices to reduce potential for leaching of COCs.*** | | |
| Performance Measure 5.1 – Identify high priority crops and any data gaps through the NMP Technical Advisory Group. | Include conclusions from NMP TAC in Management Plan Progress Report. | MLJ-LLC |
| Performance Measure 5.2 – Conduct studies through the MPEP to help fill data gaps regarding management practice effectiveness. | Participate in the MPEP including study design implementation. | MLJ-LLC |
| Performance Measure 5.3 – Create online resources regarding MPEP study results and information regarding the 4Rs. | Post resources on the ESJWQC website. | MLJ-LLC |
| ***Performance Goal 6: Evaluate effectiveness of new management practices.*** | | |
| Performance Measure 6.1 – Evaluate monitoring results from the Groundwater Trend Monitoring Program for COCs. | Assess results in Management Plan Progress Report. | MLJ-LLC |
| Performance Measure 6.2 – Compare annually changes in well, irrigation, pesticide and nitrate management practices recorded on FEPs. | Evaluate changes in Management Plan Progress Report. | MLJ-LLC |
| Performance Measure 6.3 – Evaluate trends in groundwater quality every 5 years in the GAR. | Trend analysis of COCs in GAR. | Luhdorff & Scalmanini |

### *Specific Schedule and Milestones for Implementing Management Practices*

Each year the Coalition will evaluate and report on the management practices implemented the previous year by members within GQMP Zones. During the year the Coalition will conduct outreach and education to members regarding effective management practices that can be implemented to reduce the transport of COCs to groundwater. As data gaps regarding the 4Rs for specific crops are decreased, this information will be included in the Coalition's outreach and education efforts. The following milestones were developed based on this strategy and supplemented with target dates based on the objectives of this GQMP.

**Milestone 1**: Within 2 years of the approved GQMP, additional management practices will be implemented by members in high vulnerability areas especially regarding well management and nitrogen management (Target Date – 2018).

**Milestone 2**: Within 3 years of the initiation of the MPEP studies, identify a schedule for implementation of practices identified as effective by the MPEP (Target Date – 2020).

**Milestone 3**: Within 10 years of approved GQMP, all known abandoned wells will be properly abandoned (Target Date – 2026).

**Milestone 4:** Within 10 years of conducting Groundwater Trend Monitoring, show a reduction of the amount of nitrate being discharged to groundwater by irrigation agriculture for the priority crops almonds, walnuts and tomatoes through a combination of implemented management practices and monitoring data.

# MONITORING METHODS

## MONITORING DESIGN

The Coalition's groundwater monitoring strategy is currently being developed through the Groundwater Trend Monitoring Program and the Management Practices Evaluation Program. The Groundwater Trend Monitoring Program Work Plan will be submitted in June 2015 that will include a comprehensive monitoring program for groundwater quality. In addition, the MPEP will develop several studies of management practices to determine if they are protective of groundwater. A conceptual work plan will be submitted by June 4, 2015 and the final work plan will be submitted by June 4, 2016.

### Minimum Groundwater Monitoring Requirements

According to the Order, "Trend monitoring wells will be sampled, at a minimum, annually at the same time of the year for the indicator parameters identified in Table 17 below."

**Table 17. Groundwater monitoring parameters (WDR, Attachment B, pg. 19).**

| CONSTITUENTS, PARAMETERS, AND TESTS | |
|---|---|
| **ANNUAL MONITORING** | |
| Dissolved Oxygen* (mg/L) | **Physical Parameters and General Chemistry** |
| Electrical Conductivity* (µmhos/cm) | |
| pH* (in pH units) | |
| Temperature* (˚C) | |
| Nitrate* as nitrogen (mg/L) | |
| **TREND MONITORING** | |
| Total Dissolved Solids (SC, field measure) | **Physical Parameters and General Chemistry** |
| Carbonate | Anions |
| Bicarbonate | |
| Chloride | |
| Sulfate | |
| Boron | Cations |
| Calcium | |
| Sodium | |
| Magnesium | |
| Potassium | |

*Field parameters

# GROUNDWATER MANAGEMENT PLAN ZONES

## MODESTO SUBBASIN MANAGEMENT ZONE

### Introduction and Background

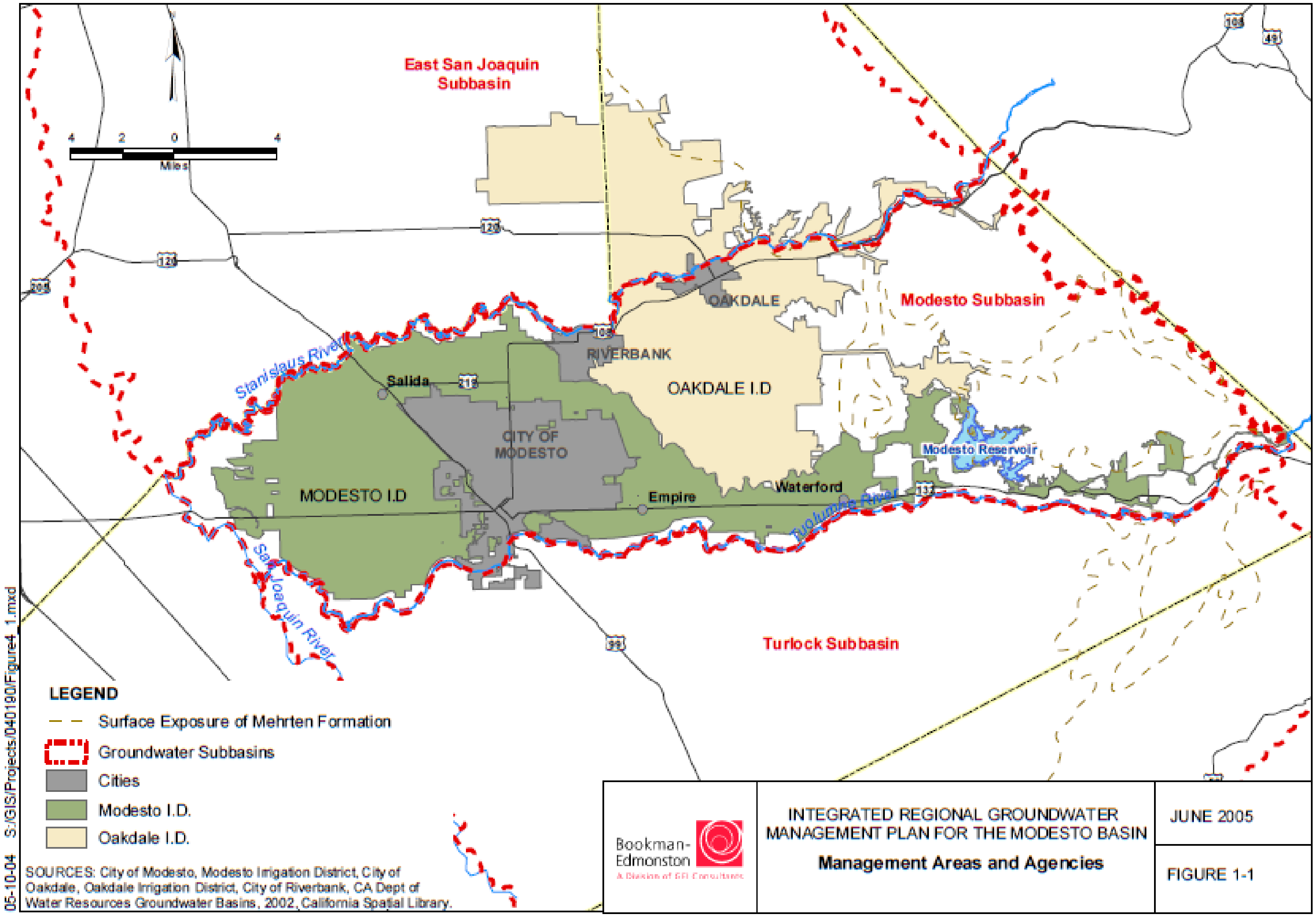
The Modesto GQMP Zone is the northern most zone within the Coalition including the entire Modesto Groundwater Subbasin and the southernmost border of the Eastern San Joaquin Groundwater Subbasin. The entire Modesto subbasin is within the Stanislaus County.

### Existing Groundwater Management Plans/Entities

Figure 52 illustrates the six agencies covering the Modesto Groundwater Subbasin. These six agencies formed the Stanislaus and Tuolumne Rivers Groundwater Basin Association in 1994 to provide a forum for coordinated planning and management of the Subbasin. These six agencies are: the City of Modesto, the Modesto Irrigation District (MID), the City of Oakdale, The Oakdale Irrigation District (OID), the City of Riverbank, and Stanislaus County" (Bookman-Edmonston, 2005). The Integrated Regional Groundwater Management Plan for the Modesto Subbasin includes a table of "Current Level of Monitoring Efforts". This table lists a number of member agencies, including MID, OID, a number of small communities and also DWR and CDPH. "Altogether, the table shows a total of 113 wells monitored for water levels and 104 wells monitored annually for water quality" (Luhdorff and Scalmanini, 2014).

**Figure 52. Integrated Regional Groundwater Management Plan Area for the Modesto Subbasin and participating agencies.**

(Bookman-Edmonston, Integrated Regional Groundwater Management Plan for the Modesto Subbasin, Stanislaus & Tuolumne Rivers Groundwater Basin Association, Figure 1-1, 2005).



## Basin Boundaries and Surface Hydrology

"The Modesto subbasin lies between the Stanislaus River to the north and Tuolumne River to the south and between the San Joaquin River on the west and crystalline basement rock of the Sierra Nevada foothills on the east. The northern, western, and southern boundaries are shared with the Eastern San Joaquin Valley, Delta-Mendota, and Turlock Groundwater Subbasins, respectively. The subbasin comprises land primarily in the Modesto Irrigation District (MID) and the southern two-thirds of the OID. The City of Modesto is in the southwestern portion of the subbasin. Average annual precipitation for this subbasin is 11 to 15 inches, increasing eastward" (DWR, Bulletin 118).

## Geology, Hydrogeology, and Groundwater Hydrology

The characteristics of the Modesto, Turlock, and Merced groundwater subbasins which underlay the Modesto, Turlock, and Merced GQMP Zones are described as study areas within the Central Eastside Study Unit in the USGS' Status and Understanding Groundwater Quality in the Central-Eastside San Joaquin Basin Study Unit, 2006: California GAMA Priority Basin Project (Figure 53). The main water-bearing units of the Modesto, Turlock, and Merced study areas include the unconsolidated alluvial-fan deposits of the Pleistocene-age Riverbank Formation, the deeper unconsolidated Pleistocene-age Turlock Lake and Pliocene-age Laguna Formations, and the semi-consolidated Miocene-Pliocene-age Mehrten Formation.

Groundwater conditions are unconfined, semi-confined, and confined in different zones of the groundwater system in the Central Eastside study unit. The base of freshwater, where estimated, generally is more than 700 feet (ft) below land surface, but may be as shallow as 300 ft in parts of the study unit. Unconfined conditions are present in unconsolidated deposits above and east of the Corcoran Clay Member of the Turlock Lake Formation, which underlies the southwestern half of the study unit at depths ranging from 50 to 250 ft. Confined conditions are present below the Corcoran Clay. Semi-confined conditions are present at depth east of the Corcoran Clay, because of many discontinuous clay lenses (Landon, et al., 2010).

**Figure 53. Geologic setting of the Central-Eastside San Joaquin Basin study unit.**

(US Department of the Interior and US Geologic Survey, Status and Understanding Groundwater Quality in the Central-Eastside San Joaquin Basin Study Unit, 2006: California GAMA Priority Basin Project, Figure 5, pg. 10, 2006).

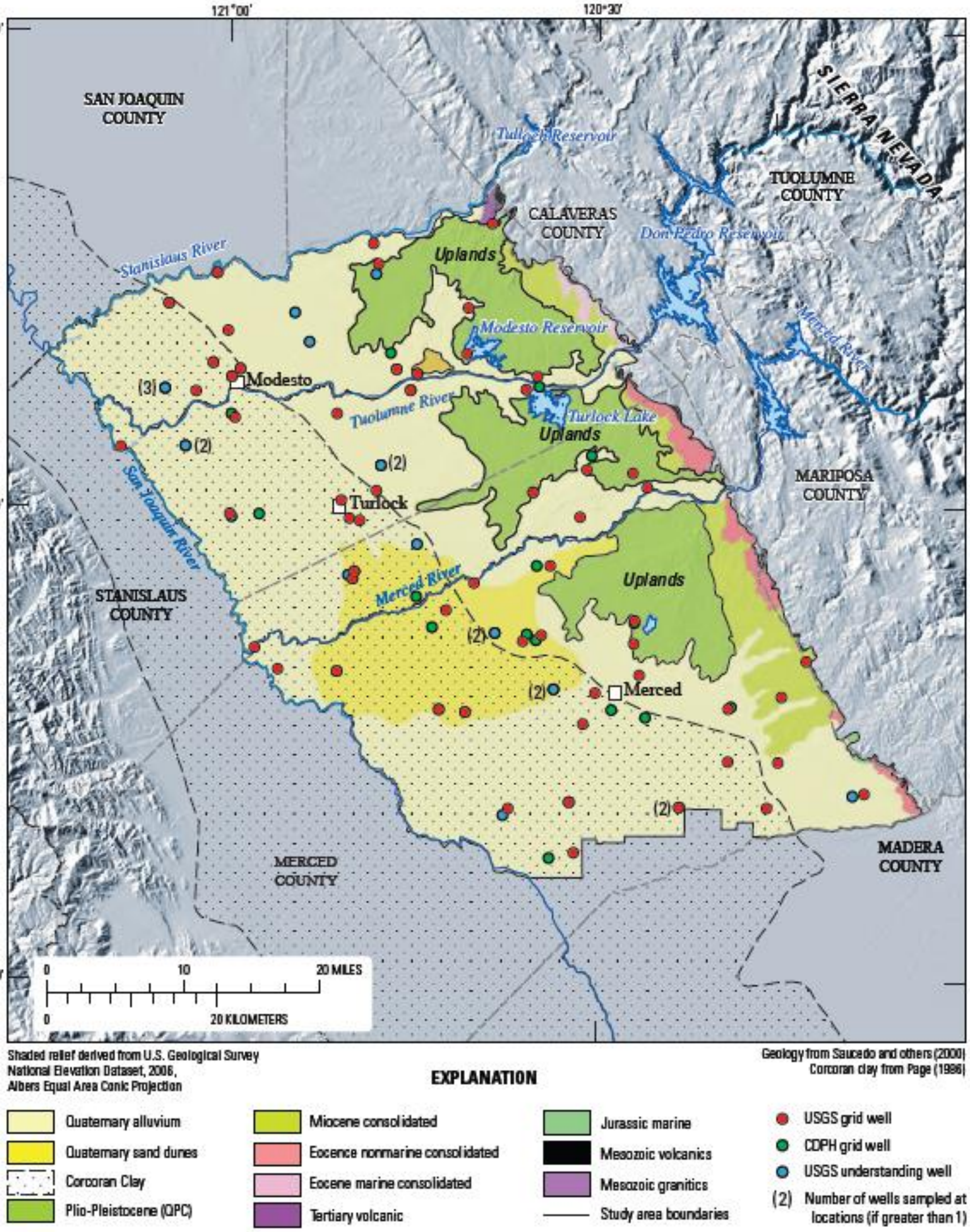



**Figure 5.** Geologic map of the Central Eastside, California, Groundwater Ambient Monitoring and Assessment (GAMA) study unit.

The geology, hydrogeology and groundwater hydrology description for the Modesto subbasin is taken almost exclusively from Bulletin 118 (DWR 2003).

### Water Bearing Formations

The primary hydrogeologic units in the Modesto Subbasin include both consolidated and unconsolidated sedimentary deposits. The consolidated deposits include the Ione Formation of Miocene age, the Valley Springs Formation of Eocene age, and the Mehrten Formation, which was deposited during the Miocene to Pliocene Epochs. The consolidated deposits lie in the eastern portion of the subbasin and generally yield small quantities of water to wells except for the Mehrten Formation, which is an important aquifer. In the Subbasin, the Mehrten Formation is composed of up to 300 feet of sandstone, breccia, conglomerate, tuff siltstone and claystone (Page 1973).

The unconsolidated deposits were laid down during the Pliocene to present and, from oldest to youngest, include continental deposits lacustrine and marsh deposits, older alluvium, younger alluvium, and flood-subbasin deposits. The continental deposits and older alluvium are the main water-yielding units in the unconsolidated deposits. The lacustrine and marsh deposits (which include the Corcoran, or “E-” Clay), and the flood-subbasin deposits yield little water to wells, and the younger alluvium in most places probably yields only moderate quantities of water to wells (page 1973).

The continental deposits consist of poorly sorted gravel, sand, silt and clay varying in thickness from 0 to 450 feet occurring at the surface on the eastern side of the subbasin to over 400 feet deep in the western portion. These deposits are the equivalent of the North Merced Gravels and the lower Turlock Lake Formation (Davis and others 1959). The older alluvium consists of intercalated beds of gravel sand, silt, and clay with some hardpan. This alluvium is up to 400 feet thick and is generally present near or at the surface of the western one-half of the subbasin. The older alluvium is largely equivalent to the Riverbank and Modesto Formations (Davis and others 1959).

Ground water occurs under unconfined, semi-confined, and confined conditions. The unconfined waterbody occurs in the unconsolidated deposits above and east of the Corcoran Clay, which underlies the southwestern portion of the subbasin at depths ranging from 150 to 250 feet (DWR 1981). Where clay lenses restrict the downward flow of groundwater, semi-confined conditions occur. The confined waterbody occurs in the unconsolidated deposits below the Corcoran Clay and extends downward to the base of fresh water.

The estimated average specific yield of this subbasin is 8.8 percent (based on DWR San Joaquin District internal data and Davis and others 1959).

### Restrictive Structures

Groundwater flow is primarily to the southwest, following the regional dip of basement rock and sedimentary units. The lower to middle reaches of the Stanislaus and Tuolumne Rivers in the Subbasin appear to be gaining streams with groundwater flow into both, especially the Tuolumne River (DWR 2000). No faults have been identified that affect the movement of fresh groundwater (Page and Balding 1973).

### Recharge Areas

Groundwater recharge is primarily from deep percolation of applied irrigation water and canal seepage from MID and OID facilities. Seepage from Modesto Reservoir is also significant (STRGBA 1995). Lesser recharge occurs as a result of subsurface flows originating in the mountains and foothills along the east side of the subbasin, losses from minor streams, and from percolation of direct precipitation.

'The irrigation supply is provided primarily by surface water draining from the Sierra Nevada, and stored in reservoirs. The surface-water supplies are managed by irrigation districts and delivered to agricultural users through hundreds of miles of lined canals. Primary sources of discharge are pumping withdrawals for irrigation and municipal water supply, evaporation from areas with a shallow depth to water, and discharge to streams. Agricultural irrigation supplied by surface water and groundwater accounts for about 95 percent of the total water use in the region' (Landon, et al., 2010).

### Groundwater Level Trends

Changes in groundwater levels are based on annual water level measurements by DWR and cooperators. Water level changes were evaluated by quarter township and computed through a custom DWR computer program using geostatistics (kriging). On average, the subbasin water level has declined nearly 15 feet from 1970 through 2000. The period from 1970 through 1978 showed steep declines totaling about 12 feet. The six-year period from 1978 to 1984 saw stabilization and rebound of about 7 feet. 1984 through 1995 again showed steep declines, bottoming out in 1995 at nearly 20 feet below the 1970 level. Water levels then rose about 5 feet from 1996 to 2000. Water level declines have been more severe in the eastern portion of the subbasin, but have risen faster in the eastern subbasin between 1996 and 2000 than in any other portion of the subbasin.

### Groundwater Storage

Estimations of the total storage capacity of the subbasin and the amount of water in storage as of 1995 were calculated using an estimated specific yield of 8.8 percent and water levels collected by DWR and cooperators. According to these calculations, the total storage capacity of this subbasin is estimated to be 6,500,000 af to a depth of 300 feet. According to published literature, the amount of stored groundwater in this subbasin as of 1961 is 14,000,000 af to a depth of < 1000 feet (Williamson 1989).

### Groundwater Budget (Type B)

Although a detailed budget was not available for this subbasin, an estimate of groundwater demand was calculated based on the 1990 normalized year and data on land and water use. A subsequent analysis was done by a DWR water budget spreadsheet to estimate overall applied water demands, agricultural groundwater pumpage, urban pumping demand and other extraction data.

Natural recharge into the subbasin is estimated to be 86,000 af. Artificial recharge and subsurface inflow values are not determined. There is approximately 92,000 af of applied water recharge. Annual urban and agricultural extractions are estimated to be 81,000 and 145,000 af, respectively. There are no other extractions, and values for subsurface outflow are not determined.

### Groundwater Quality Characterization

The groundwater in this basin is of a calcium bicarbonate type in the eastern subbasin to a calcium-magnesium bicarbonate or calcium-sodium bicarbonate type in the western portion. The TDS values range from 60 to 8,300 mg/L, with a typical range of 200 to 500 mg/L. The Department of Health Services, which monitors Title 22 water quality standards, reports TDS values in 88 wells ranging from 60 to 860 mg/L, with an average value of 295 mg/L.

### Groundwater Quality Impairments

There are areas of hard groundwater and localized areas of high chloride, boron, DBCP, nitrate, iron, and manganese. Some sodium chloride waters of high TDS values are found along the east side of the subbasin. There are also some areas of shallow groundwater in the subbasin that require dewatering wells.

## Land Use/Irrigated Land

### *Management Practices/Crops in Zone*

Tables 18 and 19 describe land uses within the Modesto GQMP Zone from two different data sets, USDA (2012) and DWR (early 2000s), respectively. Table 18 indicates almonds, other-hay/non-alfalfa, walnut, alfalfa, clover/wildflower, and oats as the crops capturing over 85% of the land use in the Modesto GQMP Zone, regardless of irrigated or non-irrigated status. DWR data indicates the top irrigated crop as deciduous fruits and nuts, which also include almonds.

**Table 18. Land use acreage within the entire Modesto GQMP Zone1.**

| Row Labels | Acreage | Percent acreage of Zone* |
|---:|:---:|:---:|
| Almonds | 40818 | 37.22% |
| Other Hay/Non Alfalfa | 16316 | 14.88% |
| Walnuts | 13391 | 12.21% |
| Alfalfa | 11714 | 10.68% |
| Clover/Wildflowers | 6115 | 5.58% |
| Oats | 5589 | 5.10% |
| Double Crop Oats/Corn | 3950 | 3.60% |
| Winter Wheat | 2447 | 2.23% |
| Grapes | 2184 | 1.99% |
| Double Crop Winter Wheat/Corn | 1537 | 1.40% |
| Fallow/Idle Cropland | 1229 | 1.12% |
| Grand Total for Agricultural Crops | 105290 | 96.01% |

[1]Land use information obtained from data provided by USDA, 2012 California Cropland Data Layer: http://www.nass.usda.gov/research/Cropland/SARS1a.htm. Land use in some areas of the ESJWQC may have changed since that time.

*Percent of cropped area includes all agricultural fields, whether fallow or active. Land use categories such as barren, developed, and native or wetland vegetation were not included in acreage totals. Crops contributing 1% or more of the overall land use within the GQMP area were included.

**Table 19. Land use acreage as associated with irrigation data within the Modesto GQMP Zone by ESJHVA Priority 1-3 areas.**

**Land uses derived from DWR data in order to incorporate irrigation data designated as irrigated/non-irrigated (I/NI); numbers are rounded to nearest whole number.**

| Land Use | I/NI | Priority 1 | Priority 2 | Priority 3 | Outside ESJHVA |
|---|---|---|---|---|---|
| Citrus & Sub-Tropical | I | 0 | 5 | 33 | 0 |
| Citrus & Sub-Tropical | N | 0 | 0 | 1 | 29 |
| Deciduous Fruits & Nuts | I | 2898 | 16084 | 18416 | 16706 |
| Field Crops | I | 641 | 5944 | 6556 | 7245 |
| Grain & Hay | I | 161 | 368 | 501 | 186 |
| Grain & Hay | N | 2 | 23 | 76 | 2171 |
| Idle | I | 12 | 369 | 419 | 457 |
| Native Riparian | N | 36 | 288 | 4170 | 3135 |
| Native Vegetation | N | 103 | 801 | 4724 | 78791 |
| Open Water | N | 35 | 591 | 1650 | 2773 |
| Pasture | I | 264 | 1521 | 12806 | 19397 |
| Pasture | N | 17 | 63 | 147 | 1898 |
| Rice | I | 0 | 127 | 93 | 1465 |
| Semi-agricultural | N | 123 | 1375 | 2421 | 3759 |
| Truck, Nursery, Berry | I | 211 | 717 | 1104 | 268 |
| Urban | N | 528 | 19841 | 17996 | 3142 |
| Vineyard | I | 66 | 945 | 2458 | 1119 |

* Land use information obtained from data provided by DWR, http://www.water.ca.gov/landwateruse/anaglwu.cfm. Data compiled in 2001, land use in some areas of the ESJWQC may have changed since that time.

## Constituents of Concern in Zone

### *Nitrates*

Tables 20 and 21 describe nitrogen as nitrate within the Modesto GQMP Zone. Table 18 indicates that of those wells sampled in the Modesto GQMP Zone, approximately 24% exceeded the MCL of 10mg/L. Table 21 indicates that of those wells with nitrate exceedances from 2005-2013, the majority (107) are located in the Priority 3 area of the ESJHVA.

**Table 20. Count of nitrate (NO3) detections from 5-10mg/L and exceedances >10mg/L by well from 2005-2013 for the Modesto GQMP Zone.**

| | Count of Wells | | | Percent of Wells | | |
|---|---|---|---|---|---|---|
| | $NO_3$ <5 mg/L | $NO_3$ 5-10 mg/L | $NO_3$ > =10 mg/L | $NO_3$ <5 mg/L | $NO_3$ 5-10 mg/L | $NO_3$ > =10 mg/L |
| Modesto GQMP Zone | 391 | 234 | 199 | 47% | 28% | 24% |

**Table 21. Number of individual wells with nitrate exceedances (greater than 10 mg/L) by well from 2005-2013 for the Modesto Groundwater Management Zone relative to ESJHVA Priority Areas 1, 2, or 3.**

Well, nitrate, and ESJHVA priority designation data used here are the same as those data compiled in the GAR.

| ZONE | ESJHVA PRIORITY AREAS | | | |
|---|---|---|---|---|
| | Priority 1 | Priority 2 | Priority 3 | Outside ESJHVA |
| Modesto GQMP Zone | 4 | 81 | 107 | 7 |

## *TDS*

Tables 22 and 23 describe TDS levels within the Modesto GQMP Zone. Table 22 indicates that of those wells sampled in the Modesto GQMP Zone, approximately 43% exceeded the agricultural MCL of 450 mg/L. Table 23 indicates that of those wells with TDS exceedances from 2005-2013, the majority (28) are located in the Priority 3 area of the ESJHVA.

**Table 22. Count of wells with detections of TDS (less than 450 mg/L) and exceedances of TDS (equal to or greater than 450 mg/L) by well from 2005-2013 within the Modesto GQMP Zone.**

Well and TDS data used here are the same as those data compiled in the GAR.

| ZONE | COUNT OF WELLS | | | % WELLS TDS>450 |
|---|---|---|---|---|
| | TDS<450 | TDS>=450 | Total wells | |
| Modesto GQMP Zone | 273 | 208 | 481 | 43% |

**Table 23. Number of individual wells with TDS exceedances (greater than 450 mg/L) by well from 2005-2013 for the Modesto GQMP Zone relative to ESJHVA Priority Areas 1, 2, or 3.**

Well, TDS, and ESJHVA priority designation data used here are the same as those data compiled in the GAR.

| ZONE | ESJHVA PRIORITY AREAS | | | |
|---|---|---|---|---|
| | Priority 1 | Priority 2 | Priority 3 | Outside ESJHVA |
| Modesto GQMP Zone | 10 | 24 | 28 | 6 |

### *Pesticides*

As stated in previous sections, of the eight pesticides recorded as having exceeded WQTLs in the GAR, only diazinon and simazine are currently registered for application and use with the DPR. Only diazinon and simazine are to be considered COCs for current groundwater quality management purposes. No exceedances of pesticide COCs occurred in the Modesto GQMP Zone. The below data (Tables 24 and 25) indicate detections only.

**Table 24. Summary of pesticide detections (below MCL threshold) and exceedances (at or above MCL threshold) for the Modesto GQMP Zone by individual well and TRS. COCs in this GQMP are bolded.**

Well and pesticide data used below are those data compiled in the GAR.

| Pesticide | Individual Wells with Detections | Individual Wells with Exceedances | Individual TRS with Detections | Individual TRS with Exceedances | Concentration in Samples with Detections (μg/L) | | Exceedance Threshold Used (μg/L) | Basis for Exceedance Threshold |
|---|---|---|---|---|---|---|---|---|
| | | | | | Minimum | Maximum | | |
| DBCP | 107 | 73 | 55 | 37 | 0.002 | 166.000 | 0.2 | CA Primary MCL |
| Ethylene Dibromide | 7 | 5 | 4 | 4 | 0.010 | 0.210 | 0.05 | CA Primary MCL |
| Naphthalene | 1 | 0 | 1 | 0 | 0.700 | 0.700 | 17 | CA Notification |
| **Simazine** | **9** | **0** | **9** | **0** | **0.004** | **0.120** | **4** | **CA Primary MCL** |
| Tetrachloroethane | 1 | 0 | 1 | 0 | 0.840 | 0.840 | 1 | CA Primary MCL |

Pesticide data are for the period 1979-2011 provided by the California Department of Pesticide Regulation (DPR)
TRS-Township Range Section
*Exceedance thresholds used are based on values reported in the SWRCB Water Quality Goals Online Database (http://www.waterboards.ca.gov/water_issues/programs/water_quality_goals/search.shtml), when available. Selection of the threshold value for use to indicate an exceedance is based on a hierarchy consisting of the following order of preference: CA Primary MCL = California Primary MCL; EPA Primary MCL = EPA's Federal Primary MCL; CA Notification = California Notification Level. No value in database = Chemical is in the database but not possible threshold value reported, Chemical not in database = Chemical was not located in the SWRCB database

**Table 25. Number of individual wells and TRS sections with pesticide exceedances for the Modesto GQMP Zone relative to ESJHVA Priority Areas 1, 2, or 3.**

Well, TRS, pesticide, and ESJHVA priority designation data used here are the same as those data compiled in the GAR.

| Pesticide | ESJHVA Priority Areas | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Priority 1 | | Priority 2 | | Priority 3 | | Outside ESJHVA | |
| | Individual | Individual | Individual | Individual | Individual | Individual | Individual | Individual |
| DBCP | 1 | 1 | 56 | 27 | 12 | 7 | 4 | 2 |
| Ethylene Dibromide | 0 | 0 | 4 | 3 | 1 | 1 | 0 | 0 |

# TURLOCK GROUNDWATER MANAGEMENT ZONE

## Introduction and Background

The Turlock GQMP Zone is south of the Modesto GQMP Zone and north of the Merced GQMP Zone within the Coalition. The Turlock GQMP Zone includes the entire Turlock Groundwater Subbasin. The Turlock subbasin is within the eastern portion of Stanislaus and Merced counties.

## Existing Groundwater Management Plans/Entities

Figure 54 depicts the various water agencies within the footprint of the Turlock groundwater subbasin. Agencies eligible to participate in the Turlock Groundwater Basin Groundwater Management Plan for the include: the Turlock and Merced irrigation districts; the cities of Ceres, Turlock, Modesto and Hughson; the Hilmar and Delhi county water districts; the Keyes, Denair and Ballico community services districts; the Eastside and Ballico-Cortez water districts; as well as Stanislaus and Merced counties (Turlock Groundwater Basin Association, 2008).

The 2008 Turlock Groundwater Subbasin Groundwater Management Plan for the Turlock Subbasin includes a table of "Current Level of Monitoring Efforts". "The table shows a total of 68 wells monitored monthly for water levels (and also an additional 307 wells monitored for levels by DWR) and 69 wells sampled from monthly to triennially for water quality (and an additional 163 wells sampled to meet CDPH requirements for water quality)" (Luhdorff and Scalmanini, 2014).

**Figure 54. Locations of the various local water agencies and their respective political boundaries for the Turlock Subbasin. (Turlock Groundwater Basin Association, Turlock Groundwater basin, Groundwater Management Plan, Figure 2, 2008).**

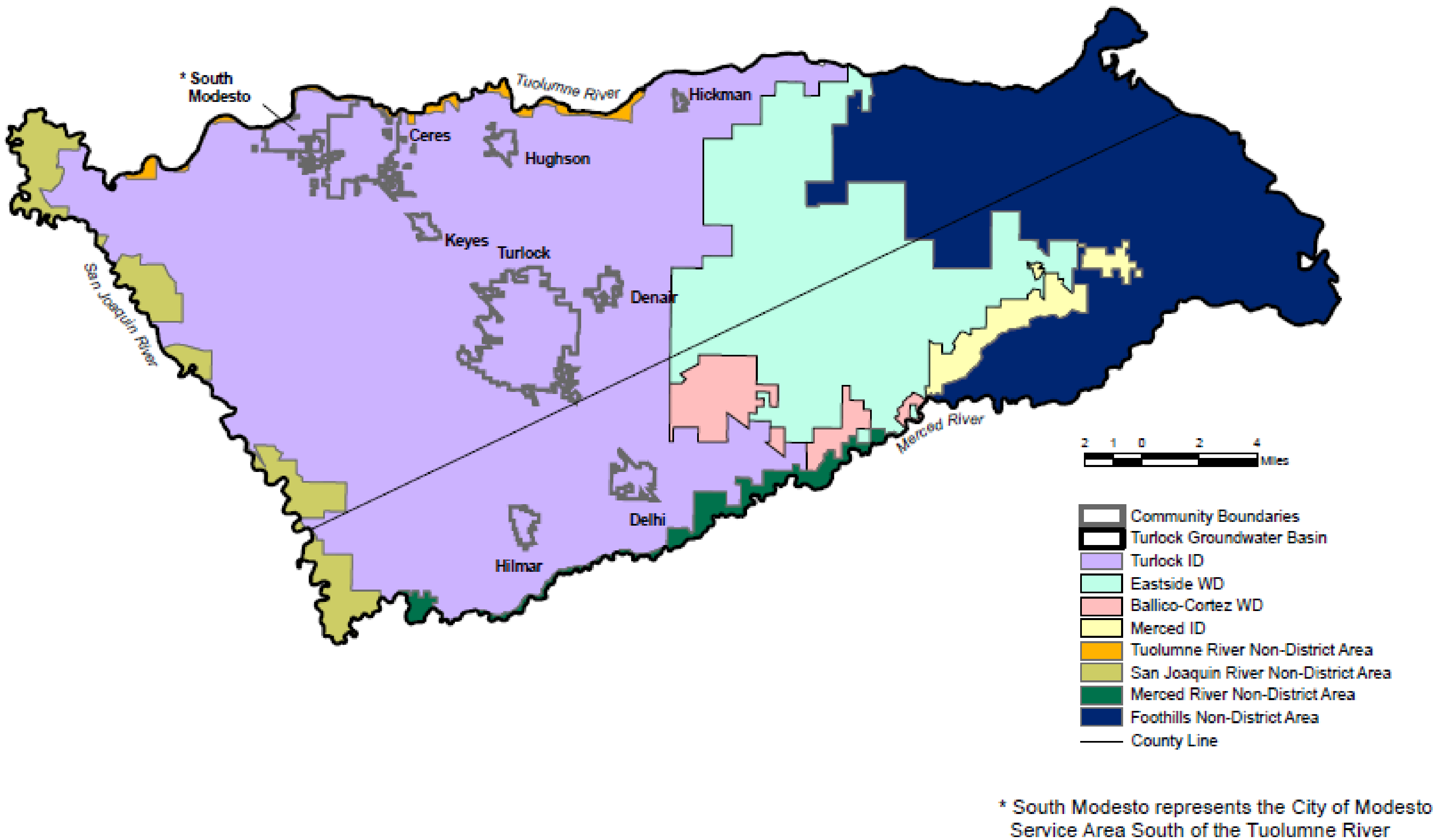



Figure 2. Urban Areas, Irrigation Districts, and Non-District Areas within the Turlock Groundwater Basin

## Basin Boundaries and Surface Water Hydrology

"The Turlock Subbasin lies between the Tuolumne and Merced Rivers and is bounded on the west by the San Joaquin River and on the east by crystalline basement rock of the Sierra Nevada foothills. The northern, western, and southern boundaries are shared with the Modesto, Delta-Mendota, and Merced Groundwater Subbasins, respectively. The subbasin includes lands in the Turlock Irrigation District, the Ballico-Cortez Water District, the Eastside Water District, and a small portion of Merced I.D. Average annual precipitation is estimated as 11 to 13 inches, increasing eastward, with 15 inches in the Sierra foothills" (Bulletin 118).

## Geology, Hydrogeology, and Groundwater Hydrology

As mentioned above, the characteristics of the Turlock groundwater subbasin is described as one of the study areas within the Central Eastside Study Unit in the USGS' Status and Understanding Groundwater Quality in the Central-Eastside San Joaquin Basin Study Unit, 2006: California GAMA Priority Basin Project (Figure 53). The main water-bearing units of the Modesto, Turlock, and Merced study areas include the unconsolidated alluvial-fan deposits of the Pleistocene-age Riverbank Formation, the deeper unconsolidated Pleistocene-age Turlock Lake and Pliocene-age Laguna Formations, and the semi-consolidated Miocene-Pliocene-age Mehrten Formation.

Groundwater conditions are unconfined, semi-confined, and confined in different zones of the groundwater system in the Central Eastside study unit. The base of freshwater, where estimated, generally is more than 700 ft below land surface, but may be as shallow as 300 ft in parts of the study unit. Unconfined conditions are present in unconsolidated deposits above and east of the Corcoran Clay Member of the Turlock Lake Formation, which underlies the southwestern half of the study unit at depths ranging from 50 to 250 ft. Confined conditions are present below the Corcoran Clay. Semi-confined conditions are present at depth east of the Corcoran Clay, because of many discontinuous clay lenses (Landon, et al., 2010).

The geology, hydrogeology and groundwater hydrology description for the Turlock subbasin is taken almost exclusively from Bulletin 118 (DWR 2003).

### Water Bearing Formations

The primary hydrogeologic units in the Turlock Subbasin include both consolidated and unconsolidated sedimentary deposits. The consolidated deposits include the Ione Formation of Miocene age, the Valley Springs Formation of Eocene age, and the Mehrten Formation, which was deposited during the Miocene to Pliocene Epochs. The consolidated deposits lie in the eastern portion of the subbasin and generally yield small quantities of water to wells except for the Mehrten Formation, which is an important aquifer. The Mehrten Formation is composed of up to 800 feet of sandstone, breccia, conglomerate, tuff siltstone and claystone (Page 1973). Unconsolidated deposits include continental deposits, older alluvium, younger alluvium, and flood-basin deposits. Lacustrine and marsh deposits, which constitute the Corcoran or E-clay aquitard, underlie the western half of the subbasin at depths ranging between about 50 and 200 feet (DWR 1981). The continental deposits and older alluvium are the main water-yielding units in the unconsolidated deposits. The lacustrine and marsh deposits and the flood-subbasin deposits yield little water to wells. The younger alluvium, in most places, probably yields only moderate quantities of water. There are three groundwater bodies in the Turlock Subbasin: the unconfined waterbody; the semi-confined and confined waterbody in the consolidated rocks; and the confined waterbody beneath the E-clay in the western Subbasin. The estimated average specific yield of the subbasin is 10.1 percent (based on DWR San Joaquin District internal data and Davis 1959).

### Restrictive Structures

Groundwater flow is primarily to the southwest, following the regional dip of basement rock and sedimentary units. Based on recent groundwater measurements (DWR 2000), a paired groundwater mound and depression appear beneath the city of Turlock and to its east, respectively. The lower to middle reaches of the Tuolumne River and the reach of the San Joaquin River in the subbasin appear to be gaining streams during this period also. No faults have been identified that affect the movement of fresh groundwater (Page 1973).

### Groundwater Level Trends

Changes in groundwater levels are based on annual water level measurements by DWR and cooperators. Water level changes were evaluated by quarter township and computed through a custom DWR computer program using geostatistics (kriging). On average the subbasin water level has declined nearly 7 feet from 1970 through 2000. The period from 1970 through 1992 showed a generally steep decline totaling about 15 feet. Between 1992 and 1994, water levels stayed near this low level. From 1994 to 2000, the water levels rebounded about 8 feet, bringing them to approximately 7 feet below the 1970 levels. Water level declines have been more severe in the eastern portion of the subbasin after 1982. From 1970 to 1982, water level declines were more severe in the western portion of the subbasin.

### Groundwater Storage

Estimations of the total storage capacity of the subbasin and the amount of water in storage as of 1995 were calculated using an estimated specific yield of 10.1 percent and water levels collected by DWR and cooperators. According to these calculations, the total storage capacity of this subbasin is estimated to be 15,800,000 af to a depth of 300 feet and 30,000,000 af to the base of fresh groundwater. These same calculations give an estimate of 12,800,000 af of groundwater to a depth of 300 feet stored in this subbasin as of 1995 (DWR 1995). According to published literature, the amount of stored groundwater in this subbasin as of 1961 is 23,000,000 af to a depth of < 1000 feet (Williamson 1989).

### Groundwater Budget (Type B)

Although a detailed budget was not available for this subbasin, an estimate of groundwater demand was calculated based on the 1990 normalized year and data on land and water use. A subsequent analysis was done by a DWR water budget spreadsheet to estimate overall applied water demands, agricultural groundwater pumpage, urban pumping demand and other extraction data. Natural recharge of the subbasin was estimated to be 33,000 af. Artificial recharge and subsurface inflow were not determined. Applied water recharge was calculated to be 313,000 af. Annual urban extraction and annual agricultural extraction were calculated at 65,000 and 387,000 af, respectively. Other extractions and subsurface inflow were not determined.

### Groundwater Quality Characterization

The groundwater in this subbasin is predominately of the sodium-calcium bicarbonate type, with sodium bicarbonate and sodium chloride types at the western margin and a small area in the north-central portion. TDS values range from 100 to 8,300 mg/L, with a typical range of 200 to 500 mg/L. The Department of Health Services, which monitors Title 22 water quality standards, reports TDS values in 71 wells ranging from 100 to 930 mg/L, with an average value of 335 mg/L. EC values range from 168 to 1,000 µmhos/cm, with a typical range of 244 to 707 µmhos/cm.

### Groundwater Quality Impairments

There are localized areas of hard groundwater, nitrate, chloride, boron, and DBCP. Some sodium chloride type water of high TDS is found along the west side of the subbasin. Two wells in the city of Turlock have been closed, one for nitrate and one for carbon tetrachloride (Dan Wilde 2001).

## Land Use/Irrigated Land

### *Management Practices/Crops in Zone*

Tables 26 and 27 describe land uses within the Turlock GQMP Zone from two different data sets, USDA (2012) and DWR (early 2000s), respectively. Table 26 indicates almonds, double crop oats/corn, alfalfa, oats, other hay/non alfalfa, and grapes as the crops capturing over 85% of the land use in the Modesto GQMP Zone, regardless of irrigated or non-irrigated status. DWR data indicates the top irrigated crop as deciduous fruits and nuts, which also include almonds.

**Table 26. Land use acreage within the entire Turlock GQMP Zone1.**

| Row Labels | Acreage | Percent acreage of Zone |
|---|---|---|
| Almonds | 78305 | 40.49% |
| Double Crop Oats/Corn | 24289 | 12.56% |
| Alfalfa | 21442 | 11.09% |
| Oats | 15261 | 7.89% |
| Other Hay/Non Alfalfa | 13949 | 7.21% |
| Grapes | 8710 | 4.50% |
| Walnuts | 6245 | 3.23% |
| Double Crop Winter Wheat/Corn | 5996 | 3.10% |
| Corn | 5095 | 2.63% |
| Winter Wheat | 2408 | 1.24% |
| Fallow/Idle Cropland | 1954 | 1.01% |
| **Grand Total for Agricultural Crops** | 183654 | 95% |

[1]Land use information obtained from data provided by USDA, 2012 California Cropland Data Layer: http://www.nass.usda.gov/research/Cropland/SARS1a.htm. Land use in some areas of the ESJWQC may have changed since that time.
*Percent of cropped area includes all agricultural fields, whether fallow or active. Land use categories such as barren, developed, and native or wetland vegetation were not included in acreage totals. Crops contributing 1% or more of the overall land use within the GQMP area were included.

**Table 27. Land use acreage associated with irrigation data within the Turlock GQMP Zone by ESJHVA Priority 1-3 areas.** Land uses derived from DWR data in order to incorporate irrigation data designated as irrigated/non-irrigated (I/NI); numbers are rounded to nearest whole number.

| Land Use | I/NI | Priority 1 | Priority 2 | Priority 3 | Not in ESJHVA |
|---|---|---|---|---|---|
| Citrus & Sub-Tropical | I | 5 | 28 | 61 | 133 |
| Citrus & Sub-Tropical | NI | 0 | 1 | 10 | 0 |
| Deciduous Fruits & Nuts | I | 9558 | 36758 | 25499 | 41346 |
| Deciduous Fruits & Nuts | NI | 7 | 0 | 0 | 0 |
| Field Crops | I | 2105 | 34386 | 19235 | 10694 |
| Field Crops | NI | 0 | 0 | 0 | 139 |
| Grain & Hay | I | 42 | 818 | 1963 | 327 |
| Grain & Hay | NI | 14 | 97 | 252 | 808 |
| Idle | I | 80 | 632 | 895 | 138 |
| Idle | NI | 0 | 0 | 0 | 4 |
| Native Riparian | NI | 2 | 108 | 815 | 250 |
| Native Vegetation | NI | 176 | 1714 | 14766 | 52055 |
| Open Water | NI | 140 | 322 | 1806 | 3814 |
| Pasture | I | 666 | 9189 | 23871 | 5433 |
| Pasture | NI | 8 | 42 | 368 | 187 |
| Semiagricultural | NI | 732 | 5535 | 5515 | 1796 |
| Truck, Nursery, Berry | I | 310 | 1984 | 1378 | 688 |
| Urban | NI | 3824 | 13,553 | 12,081 | 79 |
| Vineyard | I | 622 | 2221 | 3184 | 5840 |

* Land use information obtained from data provided by DWR, http://www.water.ca.gov/landwateruse/anaglwu.cfm. Data compiled in 2001, land use in some areas of the ESJWQC may have changed since that time

## Constituents of Concern in Zone

### *Nitrates*

Tables 28 and 29 describe nitrogen as nitrate within the Turlock GQMP Zone. Table 28 indicates that of those wells sampled in the Turlock GQMP Zone, approximately 51% exceeded the MCL of 10mg/L. Table 29 indicates that of those wells with nitrate exceedances from 2005-2013, the majority of wells (428) are located in the Priority 2 area of the ESJHVA.

**Table 28. Count of nitrate (NO3) detections from 5-10mg/L and exceedances >10mg/L by well from 2005-2013 for the Turlock GQMP Zone.**

| Zone | Count of Wells | | | Percent of Wells | | |
|---|---|---|---|---|---|---|
| | $NO_3$ <5 mg/L | $NO_3$ 5-10 mg/L | $NO_3$ > =10 mg/L | $NO_3$ <5 mg/L | $NO_3$ 5-10 mg/L | $NO_3$ > =10 mg/L |
| Turlock GQMP Zone | 475 | 220 | 712 | 34% | 16% | 51% |

**Table 29. Number of individual wells with nitrate exceedances (greater than 10 mg/L) for the Turlock GQMP Zone relative to ESJHVA Priority Areas 1, 2, or 3.**

Well, nitrate, and ESJHVA priority designation data used here are the same as those data compiled in the GAR.

| Zone | ESJHVA Priority Areas | | | |
|---|---|---|---|---|
| | Priority 1 | Priority 2 | Priority 3 | Outside ESJHVA |
| Turlock GQMP Zone | 27 | 428 | 257 | 0 |

### *TDS*

Tables 30 and 31 describe TDS levels within the Turlock GQMP Zone. Table 30 indicates that of those wells sampled in the Turlock GQMP Zone, approximately 62% exceeded the agricultural MCL of 450 mg/L. Table 31 indicates that of those wells with TDS exceedances from 2005-2013, the majority of wells (107) are located in the Priority 3 area of the ESJHVA.

**Table 30. Count of wells with detections of TDS (less than 450 mg/L) and exceedances of TDS (equal to or greater than 450 mg/L) within the Turlock GQMP Zone.**

Well and TDS data used here are the same as those data compiled in the GAR.

| Zone | COUNT OF WELLS | | | % wells TDS>450 |
|---|---|---|---|---|
| | TDS<450 | TDS>=450 | Total wells | |
| Turlock GQMP Zone | 158 | 255 | 413 | 62% |

**Table 31. Number of individual wells with TDS exceedances (greater than 450 mg/L) by well from 2005-2013 for the Turlock GQMP Zone relative to ESJHVA Priority Areas 1, 2, or 3.**

Well, TDS, and ESJHVA priority designation data used here are the same as those data compiled in the GAR.

| Zone | ESJHVA Priority Areas | | | |
|---|---|---|---|---|
| | Priority 1 | Priority 2 | Priority 3 | Outside ESJHVA |
| Turlock GQMP Zone | 3 | 88 | 107 | 10 |

### *Pesticides*

As stated in previous sections, of the eight pesticides recorded as having exceeded WQTLs in the GAR, only diazinon and simazine are currently registered for application and use with the DPR. Only diazinon and simazine are to be considered COCs for current groundwater quality management purposes. The below data (Tables 32 and 33) indicate exceedances of diazinon and simazine in one individual well each in the Turlock GQMP Zone.

**Table 32. Summary of pesticide detections (below MCL threshold) and exceedances (at or above MCL threshold) for the Turlock GQMP Zone. COCs in this GQMP Zone are bolded.**

Well and pesticide data used below are those data compiled in the GAR.

| Pesticide | Individual Wells with Detections | Individual Wells with Exceedances | Individual TRS with Detections | Individual TRS with Exceedances | Concentration in Samples with Detections (µg/L) | | Exceedance Threshold Used (µg/L) | Basis for Exceedance Threshold |
|---|---|---|---|---|---|---|---|---|
| | | | | | Minimum | Maximum | | |
| Aldicarb Sulfone | 3 | 9 | 1 | 1 | 1.000 | 1281.000 | 3 | EPA Primary MCL |
| DBCP | 86 | 79 | 46 | 42 | 0.001 | 31.900 | 0.2 | CA Primary MCL |
| **Diazinon** | **1** | **1** | **1** | **1** | **0.100** | **2.600** | **1.2** | **CA Notification** |
| Ethylene Dibromide | 2 | 3 | 2 | 1 | 0.020 | 0.070 | 0.05 | CA Primary MCL |
| Ethylene Dichloride | 0 | 1 | 0 | 1 | 2.900 | 2.900 | 0.5 | CA Primary MCL |
| Naphthalene | 1 | 0 | 1 | 0 | 0.400 | 0.400 | 17 | CA Notification |
| **Simazine** | **26** | **1** | **19** | **1** | **0.004** | **6.600** | **4** | **CA Primary MCL** |

Pesticide data are for the period 1979-2011 provided by the California Department of Pesticide Regulation (DPR)

*Exceedance thresholds used are based on values reported in the SWRCB Water Quality Goals Online Database (http://www.waterboards.ca.gov/water_issues/programs/water_quality_goals/search.shtml), when available. Selection of the threshold value for use to indicate an exceedance is based on a hierarchy consisting of the following order of preference: CA Primary MCL = California Primary MCL; EPA Primary MCL = EPA's Federal Primary MCL; CA Notification = California Notification Level. No value in database = Chemical is in the database but not possible threshold value reported, Chemical not in database = Chemical was not located in the SWRCB database

**Table 33. Number of individual wells and TRS sections with pesticide exceedances for the Turlock GQMP Zone relative to ESJHVA Priority Areas 1, 2, or 3. Well, TRS, pesticide, and ESJHVA priority designation data used here are the same as those data compiled in the GAR.**

| Pesticide | ESJHVA Priority Areas | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Priority 1 | | Priority 2 | | Priority 3 | | Not in ESJHVA | |
| | Individual | TRS | Individual | TRS | Individual | TRS | Individual | TRS |
| Aldicarb Sulfone | 0 | 0 | 0 | 0 | 9 | 1 | 0 | 0 |
| DBCP | 10 | 7 | 51 | 27 | 18 | 8 | 0 | 0 |
| **Diazinon** | **0** | **0** | **0** | **0** | **1** | **1** | **0** | **0** |
| Ethylene Dibromide | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| Ethylene Dichloride | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| **Simazine** | **1** | **1** | **0** | **0** | **0** | **0** | **0** | **0** |

# MERCED GROUNDWATER MANAGEMENT ZONE

## Introduction and Background

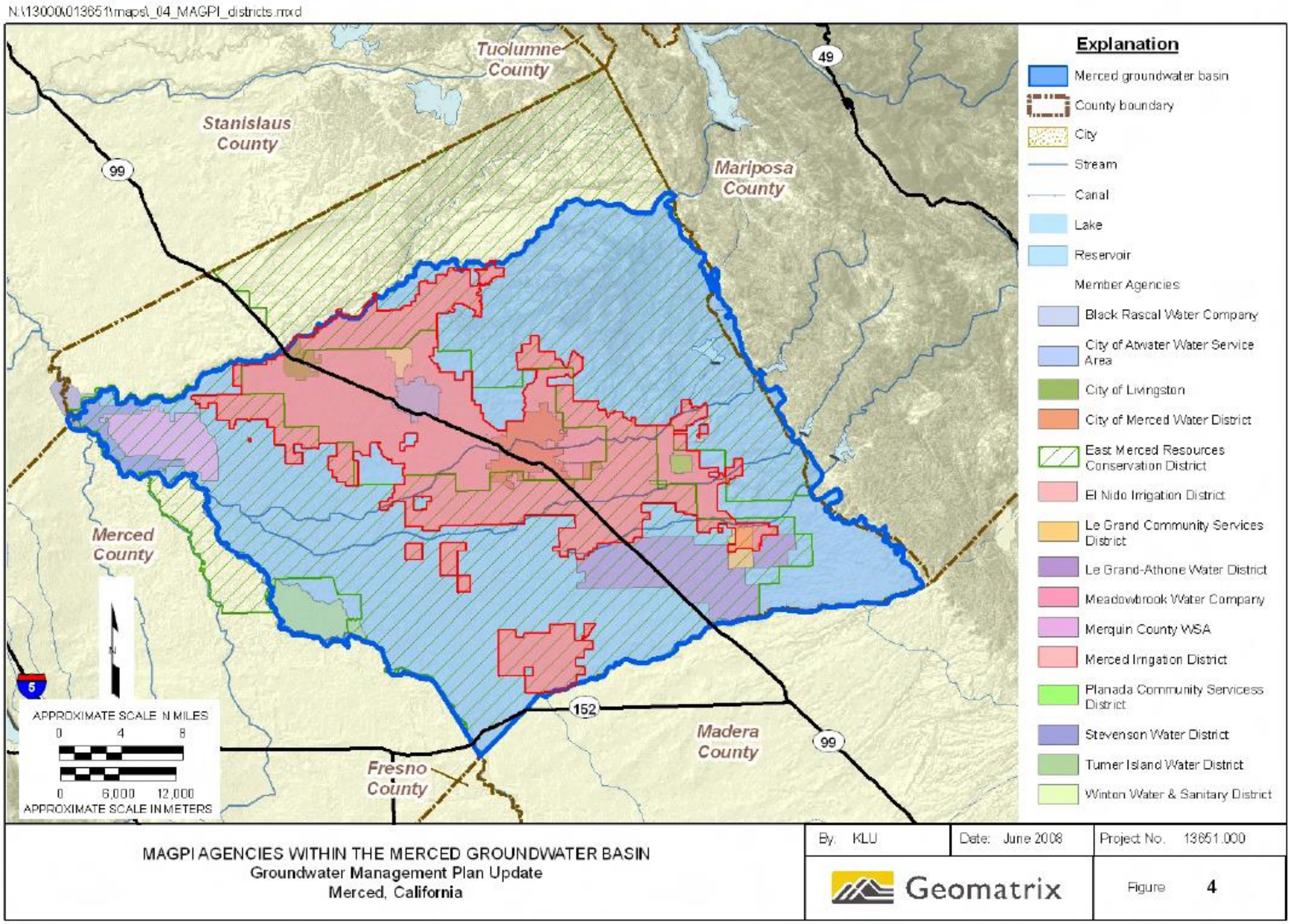
The Merced GQMP Zone is south of the Turlock GQMP Zone and north of the Chowchilla GQMP Zone within the Coalition. The Merced GQMP Zone includes the entire Merced Groundwater subbasin. The Merced subbasin is entirely within the Merced County.

## Existing Groundwater Management Plans/Entities

Figure 26 depicts the various water agencies within the footprint of the Merced groundwater subbasin. Agencies eligible to participate in the Merced Groundwater Basin Groundwater Management Plan include: the City of Atwater, Black Rascal Water District, East Side Water District, Le Grand Community Service District, Le Grand-Athlone Water District, City of Livingston, Lone Tree Mutual Water Company, Meadowbrook Water Company, City of Merced, Merced County Environmental Health Department, Merced Irrigation District, Merquin County Water District, Planada Community Service District, Stevinson Water District, Turner Island Water District, Winton Water and Sanitary District (AMEC Geomatrix, 2008).

The 2008 Merced Groundwater Basin Groundwater Management Plan Update, Merced County, CA (AMEC Geomatrix, 2008) mentions other entities that monitor in the basin and the plan includes a figure (Figure 55) with a “Proposed Groundwater Monitoring Well Network, Merced Groundwater Basin”; there are 27 wells shown on the map with state well numbers (GAR, 2014).

**Figure 55. Locations of Merced Area Groundwater Pool Interests (MAGPI) agencies and their respective political boundaries for the Merced Subbasin (Geomatrix, Merced Groundwater Basin Groundwater Management Plan Update Merced County, CA, Figure 4, 2008).**



## Basin Boundaries and Surface Water Hydrology

The Merced subbasin includes lands south of the Merced River between the San Joaquin River on the west and the crystalline basement rock of the Sierra Nevada foothills on the east. The subbasin boundary on the south stretches westerly along the Madera-Merced County line (Chowchilla River) and then between the boundary of the Le Grand-Athlone Water District and the Chowchilla Water District. The boundary continues west along the northern boundaries of Chowchilla Water District and El Nido Irrigation District. The southern boundary then follows the western boundary of El Nido I.D. south to the northern boundary of the Sierra Water District, which is followed westerly to the San Joaquin River. Average annual precipitation is 11 to 13 inches, increasing eastward (Bulletin 118).

## Geology, Hydrogeology, and Groundwater Hydrology

As mentioned above, the characteristics of the Merced groundwater subbasin is described as one of the study areas within the Central Eastside Study Unit in the USGS' Status and Understanding Groundwater Quality in the Central-Eastside San Joaquin Basin Study Unit, 2006: California GAMA Priority Basin Project (Figure 53). The main water-bearing units of the Modesto, Turlock, and Merced study areas include the unconsolidated alluvial-fan deposits of the Pleistocene-age Riverbank Formation, the deeper unconsolidated Pleistocene-age Turlock Lake and Pliocene-age Laguna Formations, and the semi-consolidated Miocene-Pliocene-age Mehrten Formation.

Groundwater conditions are unconfined, semi-confined, and confined in different zones of the groundwater system in the Central Eastside study unit. The base of freshwater, where estimated, generally is more than 700 ft below land surface, but may be as shallow as 300 ft in parts of the study unit. Unconfined conditions are present in unconsolidated deposits above and east of the Corcoran Clay Member of the Turlock Lake Formation, which underlies the southwestern half of the study unit at depths ranging from 50 to 250 ft. Confined conditions are present below the Corcoran Clay. Semi-confined conditions are present at depth east of the Corcoran Clay, because of many discontinuous clay lenses (Landon, et al., 2010).

The geology, hydrogeology, and groundwater hydrology description for the Modesto subbasin is taken almost exclusively from Bulletin 118 (DWR 2003).

### Water Bearing Formations

Geologic units in the Merced Subbasin consist of consolidated rocks and unconsolidated deposits. The consolidated rocks include the Ione Formation, the Valley Springs Formation, and the Mehrten Formation. In the eastern part of the area, the consolidated rocks generally yield small quantities of water to wells except for the Mehrten Formation, which is an important aquifer.

The unconsolidated deposits were laid down during the Pliocene to present. From oldest to youngest, these deposits include continental deposits, lacustrine and marsh deposits, older alluvium, younger alluvium, and flood basin deposits. The continental deposits and older alluvium are the main water-yielding units in the unconsolidated deposits. The lacustrine and marsh deposits (which include the Corcoran, or "E-" Clay), and the flood basin deposits yield little water to wells, and the younger alluvium in most places probably yields only moderate quantities of water to wells (page 1973.)

There are three groundwater bodies in the area: an unconfined waterbody, a confined waterbody, and the waterbody in consolidated rocks. The unconfined waterbody occurs in the unconsolidated deposits above and east of the Corcoran Clay, which underlies the western half of the subbasin at depths ranging between about 50 and 200 feet (DWR 1981), except in the western and southern parts of the area where clay lenses occur and semi-confined conditions exist. The confined waterbody occurs in the unconsolidated deposits below the Corcoran Clay and extends downward to the base of fresh water. The waterbody in consolidated rocks occurs under both unconfined and confined conditions. The estimated average specific yield of this subbasin is 9.0 percent (based on DWR, San Joaquin District internal data and that of Davis 1959).

### Restrictive Structures

Groundwater flow is primarily to the southwest, following the regional dip of basement rock and sedimentary units. DWR (2000) data show two groundwater depressions south and southeast of the city of Merced during 1999.

### Groundwater Level Trends

Changes in groundwater levels are based on annual water level measurements by DWR and cooperators. Water level changes were evaluated by quarter township and computed through a custom DWR computer program using geostatistics (kriging). On average, the subbasin water level has declined nearly 30 feet from 1970 through 2000. The period from 1970 through 1978 showed steep declines totaling about 15 feet. The ten-year period from 1978 to 1988 saw stabilization and a rebound of about 10 feet. 1988 through 1995 again showed steep declines, bottoming out in 1996 with water levels rising from 1996 to 2000. Water level declines have been more severe in the eastern portion of the subbasin.

### Groundwater Storage

Estimations of the total storage capacity of the subbasin and the amount of water in storage as of 1995 were calculated using an estimated specific yield of 9.0 percent and water levels collected by DWR and cooperators. According to these calculations, the total storage capacity of this subbasin is estimated to be 21,100,000 af to a depth of 300 feet and 47,600,000 af to the base of fresh groundwater. These same calculations give an estimate of 15,700,000 af of groundwater to a depth of 300 feet stored in this subbasin as of 1995 (DWR 1995). According to published literature, the amount of stored groundwater in this subbasin as of 1961 is 37,000,000 af to a depth of < 1000 feet (Williamson 1989).

### Groundwater Budget (Type B)

Although a detailed budget was not available for this subbasin, an estimate of groundwater demand was calculated based on the 1990 normalized year and data on land and water use. A subsequent analysis was done by a DWR water budget spreadsheet to estimate overall applied water demands, agricultural groundwater pumpage, urban pumping demand and other extraction data. Natural recharge into the subbasin is estimated to be 47,000 af. Values for artificial recharge and subsurface inflow are not determined. There is approximately 243,000 af of applied water recharge into the subbasin. Annual urban and agricultural extractions are 54,000 af and 492,000 af, respectively. Other extractions equal approximately 9,000 af. Subsurface inflow values are not determined.

### Groundwater Quality Characterization

The groundwater in this subbasin is characterized by calcium-magnesium bicarbonate at the basin interior, sodium bicarbonate to the west, and calcium-sodium bicarbonate to the south. Small areas of sodium chloride and calcium-sodium chloride waters exist at the southwest corner of the basin (Page 1973). TDS values range from 100 to 3,600 mg/L, with a typical range of 200 to 400 mg/L.  The Department of Health Services, which monitors Title 22 water quality standards, reports TDS values in 46 wells ranging from 150 to 424 mg/L, with an average value of 231 mg/L. For 10 wells, EC values range from 260 to 410 µmhos/cm, with an average value of 291 µmhos/cm.

### Groundwater Quality Impairments

There are localized areas of high hardness, iron, nitrate, and chloride in this subbasin.

## Land Use/Irrigated Land

### *Management Practices/Crops in Zone*

Tables 34 and 35 describe land uses within the Merced GQMP Zone from two different data sets, USDA (2012) and DWR (early 2000s), respectively.  USDA data in Table 34 indicate almonds, alfalfa, winter wheat, grapes, corn, cotton, double crop oats/corn, oats, sweet potatoes, and double crop winter wheat/corn as the crops capturing over 85% of the land use in the Merced GQMP Zone, regardless of irrigated or non-irrigated status. DWR data in Table 35 indicate the top irrigated crop as field crops, followed  by deciduous fruits and nuts.

**Table 34. Land use acreage within the entire Merced GQMP Zone1.**

| Row Labels | Percent acreage of Zone | Acreage |
|---:|:---:|:---:|
| Almonds | 66544 | 26.96% |
| Alfalfa | 45711 | 18.52% |
| Winter Wheat | 18341 | 7.43% |
| Grapes | 14051 | 5.69% |
| Corn | 12843 | 5.20% |
| Cotton | 12702 | 5.15% |
| Double Crop Oats/Corn | 12023 | 4.87% |
| Oats | 11612 | 4.70% |
| Sweet Potatoes | 9748 | 3.95% |
| Double Crop Winter Wheat/Corn | 8649 | 3.50% |
| Fallow/Idle Cropland | 8341 | 3.38% |
| Tomatoes | 6873 | 2.78% |
| Pistachios | 5777 | 2.34% |
| Other Hay/Non Alfalfa | 4978 | 2.02% |
| Barley | 2470 | 1.00% |
| **Grand Total for Agricultural Crops** | 240663 | 97.5% |

[1]Land use information obtained from data provided by USDA, 2012 California Cropland Data Layer: http://www.nass.usda.gov/research/Cropland/SARS1a.htm. Land use in some areas of the ESJWQC may have changed since that time.

*Percent of cropped area includes all agricultural fields, whether fallow or active. Land use categories such as barren, developed, and native or wetland vegetation were not included in acreage totals. Crops contributing 1% or more of the overall land use within the GQMP area were included.

**Table 35. Land use acreage within the Merced GQMP Zone by ESJHVA Priority 1-3 areas.**

Land uses derived from DWR data in order to incorporate irrigation data designated as irrigated/non-irrigated (I/NI); numbers are rounded to nearest whole number.

| Land Use | I/NI | Priority 1 | Priority 2 | Priority 3 | Not in ESJHVA |
|---|---|---|---|---|---|
| Citrus & Sub-Tropical | I | 6 | 29 | 19 | 79 |
| Citrus & Sub-Tropical | NI | 3 | 1 | 0 | 0 |
| Deciduous Fruits & Nuts | I | 3457 | 19538 | 20533 | 23934 |
| Field Crops | I | 1994 | 14465 | 19917 | 29628 |
| Grain & Hay | I | 641 | 3084 | 3102 | 6594 |
| Grain & Hay | NI | 73 | 404 | 898 | 2000 |
| Idle | I | 154 | 573 | 1866 | 1719 |
| Idle | NI | | 0 | 152 | 490 |
| Native Riparian | NI | 5 | 32 | 43 | 363 |
| Native Vegetation | NI | 438 | 4391 | 30271 | 168241 |
| Open Water | NI | 17 | 290 | 627 | 962 |
| Pasture | I | 440 | 5137 | 23725 | 31987 |
| Pasture | NI | 21 | 130 | 1429 | 680 |
| Rice | I | 209 | 2051 | 629 | 750 |
| Semi-agricultural | NI | 115 | 1545 | 3658 | 2333 |
| Truck, Nursery, Berry | I | 1231 | 6189 | 5753 | 14806 |
| Urban | NI | 993 | 14728 | 4178 | 8181 |
| Vineyard | I | 30 | 881 | 4203 | 2522 |

* Land use information obtained from data provided by DWR, http://www.water.ca.gov/landwateruse/anaglwu.cfm. Data compiled in 2001, land use in some areas of the ESJWQC may have changed since that time.

## Constituents of Concern in Zone

### *Nitrates*

Tables 36 and 37 describe nitrogen as nitrate within the Merced GQMP Zone. Table 36 indicates that of those wells sampled in the Merced GQMP Zone, approximately 26% exceeded the MCL of 10mg/L. Table 37 indicates that of those wells with nitrate exceedances from 2005-2013, the highest number of wells with nitrate exceedances greater than 10 mg/L are located in the Priority 2 and 3 areas (both with 68 wells) of the ESJHVA.

**Table 36. Count of nitrate ($NO_3$) detections from 5-10mg/L and exceedances >10mg/L by well from 2005-2013 for the Merced GQMP Zone.**

| | Count of Wells | | | Percent of Wells | | |
|---|---|---|---|---|---|---|
| | $NO_3$ <5 mg/L | $NO_3$ 5-10 mg/L | $NO_3$ > =10 mg/L | $NO_3$ <5 mg/L | $NO_3$ 5-10 mg/L | $NO_3$ > =10 mg/L |
| Merced GQMP Zone | 366 | 137 | 178 | 54% | 20% | 26% |

**Table 37. Number of individual wells with nitrate exceedances (greater than 10 mg/L) for the Merced GQMP Zone relative to ESJHVA Priority Areas 1, 2, or 3.**

Well, nitrate, and ESJHVA priority designation data used here are the same as those data compiled in the GAR.

| Zone | ESJHVA Priority Areas | | | |
|---|---|---|---|---|
| | Priority 1 | Priority 2 | Priority 3 | Outside ESJHVA |
| Merced GQMP Zone | 27 | 68 | 68 | 15 |

### *TDS*

Tables 38 and 39 describe TDS levels within the Merced GQMP Zone. Table 38 indicates that of those wells sampled in the Merced GQMP Zone, approximately 31% exceeded the agricultural MCL of 450 mg/L. Table 39 indicates that of those wells with TDS exceedances from 2005-2013, the majority of wells (13) are located in the Priority 3 area of the ESJHVA.

**Table 38. Count of wells with detections of TDS (less than 450 mg/L) and exceedances of TDS (equal to or greater than 450 mg/L) within the Merced GQMP Zone.**

Well and TDS data used here are the same as those data compiled in the GAR.

| Zone | Count of Wells | | | % Wells TDS>450 |
|---|---|---|---|---|
| | TDS<450 | TDS>=450 | Total wells | |
| Merced GQMP Zone | 153 | 68 | 221 | 31% |

**Table 39. Number of individual wells with TDS exceedances (greater than 450 mg/L) by well from 2005-2013 for the Merced GQMP Zone relative to ESJHVA Priority Areas 1, 2, or 3.**

Well, TDS, and ESJHVA priority designation data used here are the same as those data compiled in the GAR.

| Zone | ESJHVA Priority Areas | | | |
|---|---|---|---|---|
| | Priority 1 | Priority 2 | Priority 3 | Outside ESJHVA |
| Merced GQMP Zone | 0 | 10 | 13 | 9 |

### *Pesticides*

As stated in previous sections, of the eight pesticides recorded as having exceeded WQTLs in the GAR, only diazinon and simazine are currently registered for application and use with the DPR. Only diazinon and simazine are to be considered COCs for current groundwater quality management purposes. No exceedances of pesticide COC occurred in the Merced GQMP Zone; Tables 40 and 41 indicate detections only.

**Table 40. Summary of pesticide detections (below MCL threshold) and exceedances (at or above MCL threshold) for the Merced GQMP Zone. COCs in this GQMP Zone are bolded.**

Well and pesticide data used below are those data compiled in the GAR.

| Pesticide | Individual Wells with Detections | Individual Wells with Exceedances | TRS Sections with Detections | TRS Sections with Exceedances | Concentration in Samples with Detections (µg/L) | | Exceedance Threshold Used (µg/L) | Basis for Exceedance Threshold |
|---|---|---|---|---|---|---|---|---|
| | | | | | Minimum | Maximum | | |
| Aldicarb Sulfone | 7 | 12 | 1 | 1 | 1.000 | 78.000 | 3 | EPA Primary MCL |
| DBCP | 136 | 143 | 53 | 51 | 0.001 | 32.000 | 0.2 | CA Primary MCL |
| Ethylene Dibromide | 4 | 7 | 3 | 6 | 0.020 | 0.320 | 0.05 | CA Primary MCL |
| Naphthalene | 3 | 1 | 3 | 1 | 2.000 | 29.000 | 17 | CA Notification |
| **Simazine** | **22** | **0** | **19** | **0** | **0.003** | **1.140** | **4** | **CA Primary MCL** |

Pesticide data are for the period 1979-2011 provided by the California Department of Pesticide Regulation (DPR)

*Exceedance thresholds used are based on values reported in the SWRCB Water Quality Goals Online Database (http://www.waterboards.ca.gov/water_issues/programs/water_quality_goals/search.shtml), when available. Selection of the threshold value for use to indicate an exceedance is based on a hierarchy consisting of the following order of preference: CA Primary MCL = California Primary MCL; EPA Primary MCL = EPA's Federal Primary MCL; CA Notification = California Notification Level. No value in database = Chemical is in the database but not possible threshold value reported, Chemical not in database = Chemical was not located in the SWRCB database

**Table 41. Number of individual wells and TRS sections with pesticide exceedances for the Merced GQMP Zone relative to ESJHVA Priority Areas 1, 2, or 3.**

Well, TRS, pesticide, and ESJHVA priority designation data used here are the same as those data compiled in the GAR.

| Pesticide | ESJHVA Priority Areas | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Priority 1 | | Priority 2 | | Priority 3 | | Not in ESJHVA | |
| | Individual | TRS | Individual | TRS | Individual | TRS | Individual | TRS |
| Aldicarb Sulfone | 0 | 0 | 12 | 1 | 0 | 0 | 0 | 0 |
| DBCP | 21 | 5 | 110 | 37 | 12 | 0 | 0 | 0 |
| Ethylene Dibromide | 1 | 1 | 5 | 4 | 1 | 1 | 0 | 0 |
| Naphthalene | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |

# CHOWCHILLA GROUNDWATER MANAGEMENT ZONE

## Introduction and Background

The Chowchilla GQMP Zone is the south of the Merced GQMP Zone and northwest of the Madera GQMP Zone within the Coalition. The entire Chowchilla Groundwater subbasin is included within the Chowchilla GQMP Zone. The Chowchilla subbasin is underlays portions of both the Madera and Merced Counties.

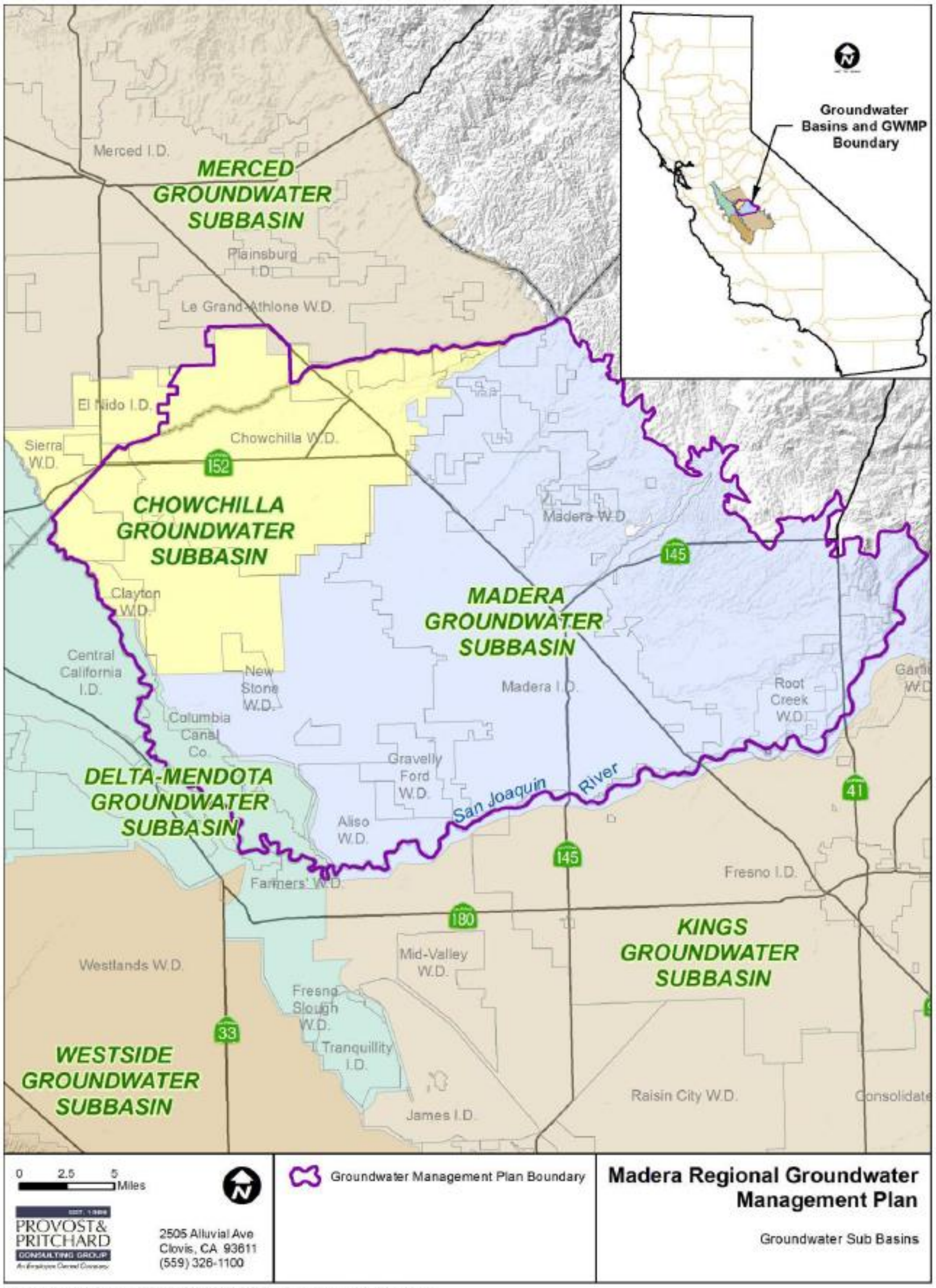
## Existing Groundwater Management Plans/Entities

The Chowchilla groundwater subbasin is largely, although not entirely, located within Madera County (Figure 56). Those agencies located within Madera County are eligible to participate in the Madera Regional Groundwater Management Plan. The Madera Regional Groundwater Management Plan (Provost and Pritchard, 2014) lists several entities within the plan's boundaries which perform mostly groundwater level monitoring (Figure 57). These groundwater entities include the City of Chowchilla, City of Madera, Chowchilla Water District, Gravelly Ford Water District (not as a participant of the Madera Regional Groundwater Management Plan but as a member of the California State Groundwater Elevation Monitoring Program), Madera Irrigation District, and Madera County. The total number of wells monitored for groundwater elevation listed within the Madera Regional Groundwater Management Plan approximately 415. The Madera Regional Groundwater Management Plan mentions the water quality data collected by DWR and the CDPH, and local city and county water agencies were used to analyze water quality trends for the Madera 2008 Integrated Regional Water Management Plan but the Madera Regional Groundwater Management Plan does not list other local monitoring agencies or any monitoring schedule.

In 2010, DWR approved the Madera-Chowchilla Basin Groundwater Monitoring Group as the local monitoring entity including: Madera Irrigation District, Chowchilla Water District, Gravelly Ford Water District, and Madera County, Madera Water District, and Root Creek Water District. The total monitoring area covers 789 square miles and includes all of the Madera sub-basin and most of the Chowchilla sub-basin. The Group submits groundwater level data each spring and fall to the DWR describes a variety of groundwater monitoring programs that exist throughout the county and suggests a meeting of all parties currently collecting groundwater data (Provost and Pritchard, 2014).

**Figure 56. Water agencies and groundwater subbasins (partial and entire) located within the Draft Madera Regional Groundwater Management Plan area.**

Provost & Pritchard, Draft Madera Regional Groundwater Management Plan, Figure 2.1, 2014.




W:\Clients\Madera County-2227\222713C1-GWMP\GIS\Map\Groundwater_Sub_Basins.mxd

**Figure 2.1 – Groundwater Sub-basins**

-29-

\\PINEFLAT\dwg_dgn\Clients\Madera County of - 2227\222713C1 - GWMP_DOCUMENTS\Reports\Madera Regional GMP-4th Revised Draft.2014.11.06.doc

**Figure 57. Section of Madera County (that area within the Central Valley) covered in the Draft Madera Regional Groundwater Management Plan, the locations of participating agencies, and their respective political boundaries for the Chowchilla/Madera Subbasins.**

The Draft Madera Regional Groundwater Management Plan area excludes those cities and irrigation/water districts with previously adopted groundwater management plans (Provost & Pritchard, Draft Madera Regional Groundwater Management Plan, Figure 1.1, 2014).

\\PINEFLAT\dwg_dgn\Clients\Madera County of - 2227\222713C1 - GWMP_DOCUMENTS\Reports\Madera Regional GMP-4th Revised Draft.2014.11.06.doc

-4-

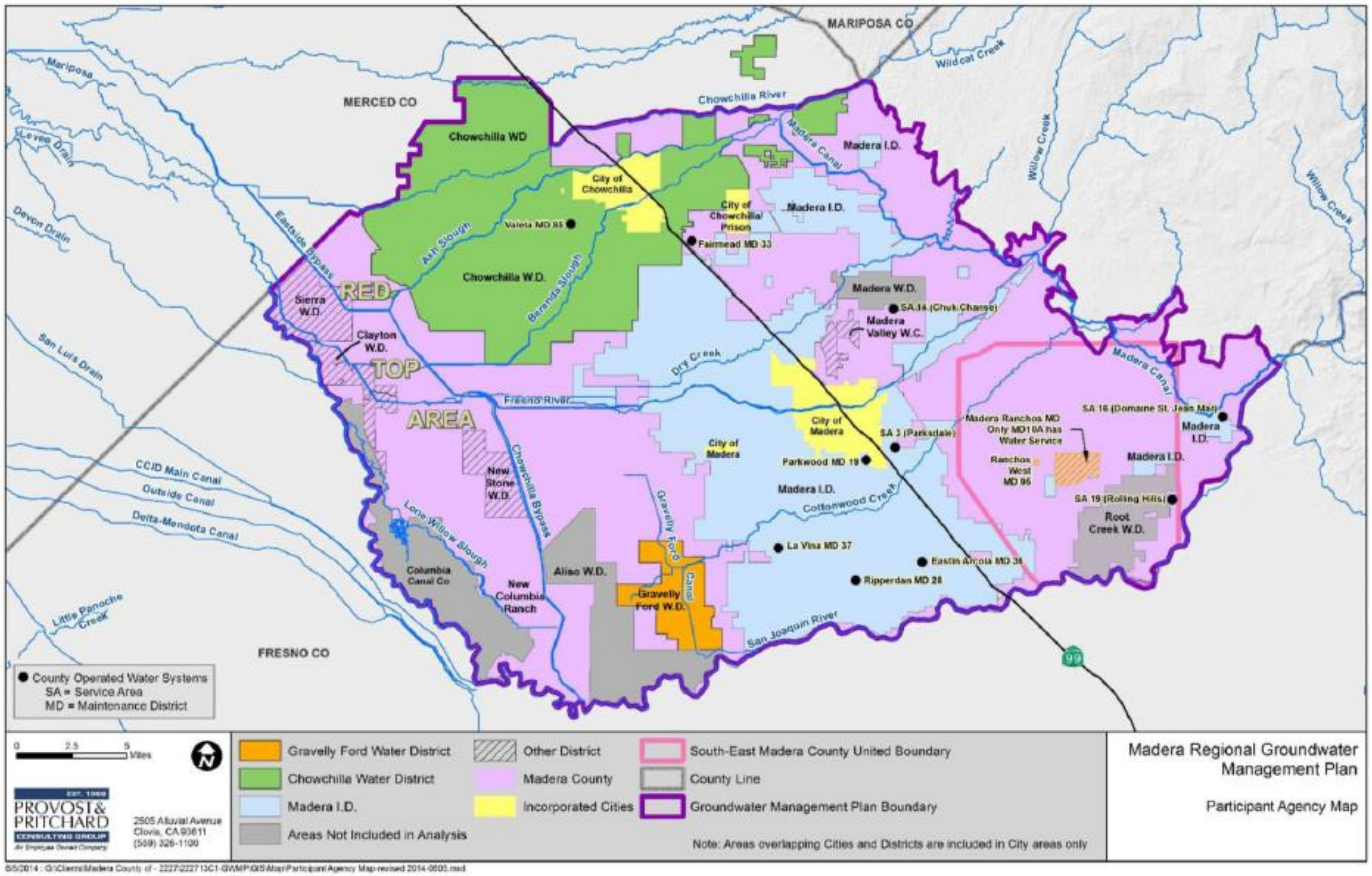



**Figure 1.1 – Participating Agency Map**

## Basin Boundaries and Surface Hydrology

The basin boundaries, surface hydrology, geology, hydrogeology, and groundwater hydrology description for the Chowchilla subbasin is taken almost exclusively from Bulletin 118 (DWR 2003).

The Chowchilla subbasin includes lands in Madera and Merced Counties. The subbasin is bounded on the west by the San Joaquin River and the eastern boundary of the Columbia Canal Company Service Area and on the north by the southern boundary of the Merced Subbasin. The southern boundary from the west to its connection with the northern boundary runs along the southern boundary of Township 11 South, Ranges 14 East and 15 East, northerly along the eastern boundaries of sections 9, 20, 27, and 33 of Township 11S, Range 15 East, and northeasterly along the southern and eastern boundaries of Chowchilla Water District, then northeasterly following Berenda Slough and Ash Slough to the Chowchilla River. Major rivers in the subbasin are the Fresno and Chowchilla Rivers. Average annual precipitation is estimated to be 11 inches.

## Geology, Hydrogeology, and Groundwater Hydrology

The characteristics of the Chowchilla and Madera groundwater subbasins which underlay the Chowchilla and Madera GQMP Zones are described as study areas within the Madera- Chowchilla Study Unit in the USGS' Status and Understanding of Groundwater Quality in the Madera- Chowchilla Study Unit, 2008: California GAMA Priority Basin Project. The study unit is bounded partially on the north by the Chowchilla River, approximately on the west and south by the San Joaquin River, and on the east by foothills of the Sierra Nevada (Figure 58; Shelton, et. al., 2008). In general, the Late Tertiary and Quaternary continental deposits increase in thickness from north to south and are up to 3,000 ft thick in the Madera-Chowchilla study unit. The Madera-Chowchilla study unit includes eastern alluvial fan, with derivatives from the Sierra Nevada, and basin areas. The Corcoran Clay Member of the Tulare Formation, underlies large parts of the basin and the distal end of parts of the eastern alluvial fans at depths dipping from 50 ft on the eastern edge of the Clay to 300 ft along the margin of the Coast Ranges and divides the San Joaquin Valley freshwater aquifer systems into an unconfined to semi-confined upper system and a largely confined lower system.

**Figure 58. Geologic setting of the Madera-Chowchilla study unit (DOI and USGS, Status and Understanding Groundwater Quality in the Madera-Chowchilla Study Unit, 2008: California GAMA Priority Basin Project, Fig. 3, pg. 7, 2008).**

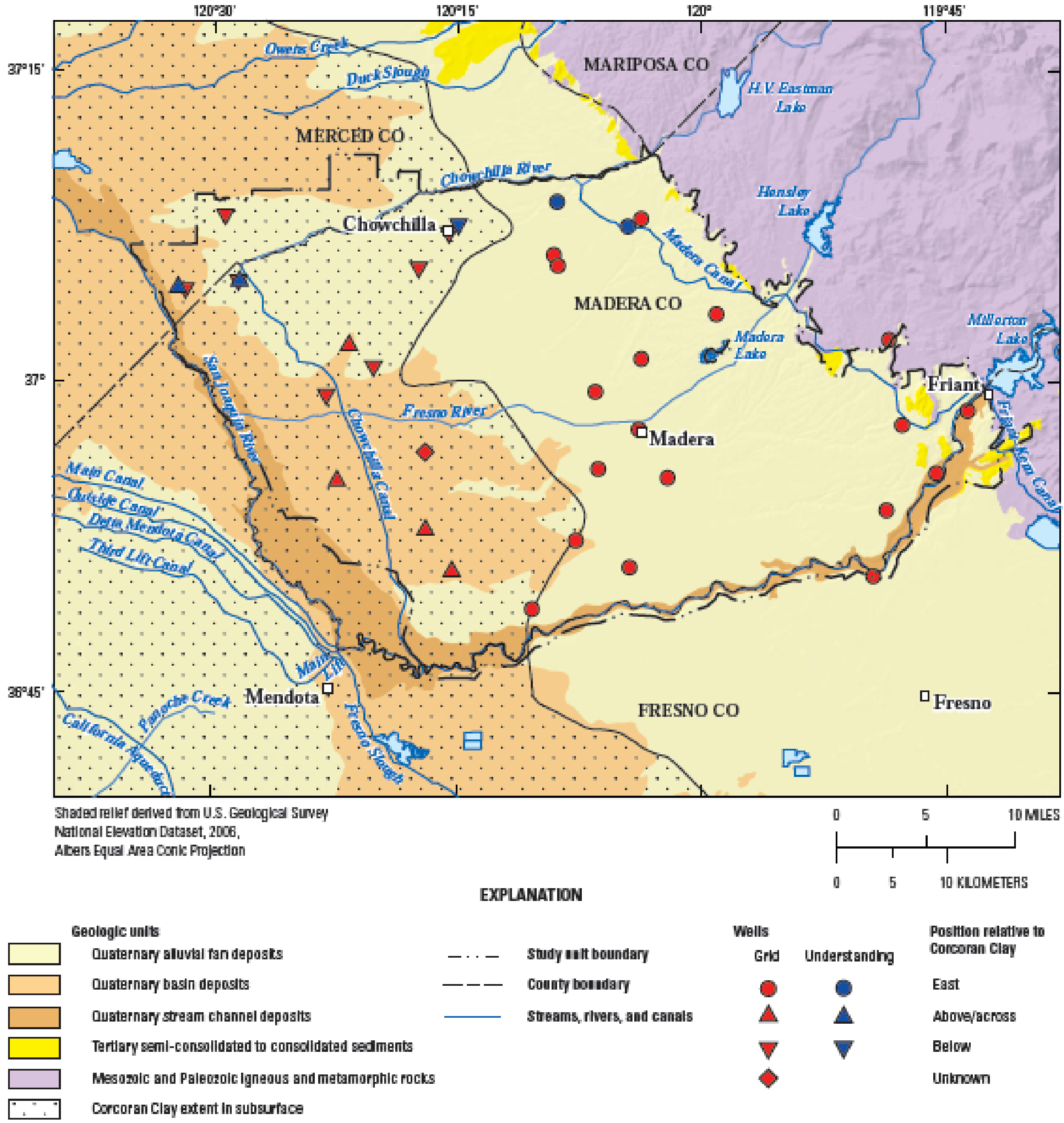



**Figure 3.** Madera-Chowchilla study unit, California GAMA Priority Basin Project.

### Water Bearing Formations

Hydrogeologic units in the Chowchilla Subbasin consist of unconsolidated deposits of Pleistocene and Holocene age. These deposits are divided into continental deposit of Tertiary and Quaternary age, and continental deposits of Quaternary age. Continental deposits of Quaternary age include older alluvium, lacustrine and marsh deposits and younger alluvium. The continental deposits of Quaternary age crop out over most of the area and yield probably more than 95 percent of the water pumped from wells. Although younger alluvium and flood-basin deposits yield small quantities of water to wells, the most important aquifer in the area is the older alluvium. It consists mostly of intercalated lenses of clay, silt, sand, and some gravel. The Corcoran Clay or E-Clay (a lacustrine and marsh deposit), which underlies most of the subbasin at depths ranging between 50 and 250 feet (DWR 1981), restricts the vertical movement of groundwater and divides the water bearing deposits into confined and unconfined aquifers. The estimated average specific yield of this subbasin is 8.6 percent (based on DWR San Joaquin District internal data and that of Davis 1959).

### Restrictive Structures

Groundwater flow is generally southwestward but with groundwater mounds occurring at the subbasin center and pumping depressions in the western portion during 1999 (DWR 2000). Based on current and historical groundwater elevation maps, groundwater barriers do not appear to exist in the subbasin.

### Recharge Areas

Groundwater recharge is primarily from deep percolation of applied irrigation water (DWR 1995).

### Groundwater Level Trends

Changes in groundwater levels are based on annual water level measurements by DWR and cooperators. Water level changes were evaluated by quarter township and computed through a custom DWR computer program using geostatistics (kriging). On average, the subbasin water level has declined nearly 40 feet from 1970 through 2000. The period from 1970 through 1978 showed steep declines totaling about 30 feet. The nine-year period from 1978 to 1987 saw stabilization and rebound of about 25 feet, taking the water levels close to where they were in 1970. 1987 through 1996 again showed steep declines, bottoming out in 1996 at about 45 feet below 1970 levels. Water levels rose about 8 feet from 1996 to 2000. Water level declines have been more severe in the eastern portion of the subbasin from 1980 to the present, but the western basin showed the strongest declines before this time period.

### Groundwater Storage

Estimations of the total storage capacity of the subbasin and the amount of water in storage as of 1995 were calculated using an estimated specific yield of 8.6 percent and water levels collected by DWR and cooperators. According to these calculations, the total storage capacity of this subbasin is estimated to be 8,000,000 af to a depth of 300 feet and 13,900,000 af to the base of fresh groundwater. These same calculations give an estimate of 5,500,000 af of groundwater to a depth of 300 feet stored in this subbasin as of 1995 (DWR 1995). According to published literature, the amount of stored groundwater in this subbasin as of 1961 is 15,000,000 af to a depth of < 1000 feet (Williamson 1989).

### Groundwater Budget (Type B)

Although a detailed budget was not available for this subbasin, an estimate of groundwater demand was calculated based on the 1990 normalized year and data on land and water use. A subsequent analysis was done by a DWR water budget spreadsheet to estimate overall applied water demands, agricultural groundwater pumpage, urban pumping demand and other extraction data. Natural recharge of the subbasin is estimated to be 87,000 af. Artificial recharge and subsurface inflow are not determined. There is approximately 179,000 af of applied water recharge. Annual urban and agricultural extractions are 6,000 af and 249,000 af, respectively. There are no other extractions, and subsurface outflow has not been determined.

### Groundwater Quality Characterization

The water in this subbasin is of a calcium-sodium bicarbonate type in the eastern part of the subbasin. This turns into calcium bicarbonate, sodium-calcium bicarbonate, and sodium chloride water types towards the western part of the subbasin (Mitten 1970). TDS values range from 120 to 6,400 mg/L, with a typical range of 200 to 500 mg/L. The Department of Health Services, which monitors Title 22 water quality standards, reports TDS values in eight wells ranging from 120 to 390 mg/L, with an average value of 228 mg/L. EC values range from 150 to 3,380 µmhos/cm, with an average value of 508 µmhos/cm.

### Groundwater Quality Impairments

There are local areas of high nitrate, hardness, iron, and chloride in the subbasin.

## Land Use/Irrigated Land

### *Management Practices/Crops in Zone*

Tables 42 and 43 describe land uses within the Chowchilla GQMP Zone from two different data sets, USDA (2012) and DWR (early 2000s), respectively. USDA data in Table 18 indicate almonds, alfalfa, winter wheat, grapes, double crop winter wheat/corn, fallow/Idle cropland, and pistachios as the crops capturing over 85% of the land use in the Chowchilla GQMP Zone, regardless of irrigated or non-irrigated status. DWR data (Table 43) indicate the top irrigated crop as field crops followed by deciduous fruits and nuts.

**Table 42. Land use acreage within the entire Chowchilla GQMP Zone1.**

| Row Labels | Acreages | Percent of acreage in Zone |
|---|---|---|
| Almonds | 46814 | 34.10% |
| Alfalfa | 30472 | 22.19% |
| Winter Wheat | 15032 | 10.95% |
| Grapes | 10015 | 7.29% |
| Double Crop Winter Wheat/Corn | 8173 | 5.95% |
| Fallow/Idle Cropland | 6143 | 4.47% |
| Pistachios | 4824 | 3.51% |
| Other Hay/Non Alfalfa | 3705 | 2.70% |
| Cotton | 2671 | 1.95% |
| Double Crop Oats/Corn | 2152 | 1.57% |
| Oats | 1760 | 1.28% |
| Tomatoes | 1695 | 1.23% |
| Corn | 1654 | 1.20% |
| Barley | 1382 | 1.01% |
| **Grand Total for Agricultural Crops** | 136493 | 99.4% |

[1]Land use information obtained from data provided by USDA, 2012 California Cropland Data Layer: http://www.nass.usda.gov/research/Cropland/SARS1a.htm. Land use in some areas of the ESJWQC may have changed since that time.
*Percent of cropped area includes all agricultural fields, whether fallow or active. Land use categories such as barren, developed, and native or wetland vegetation were not included in acreage totals. Crops contributing 1% or more of the overall land use within the GQMP area were included.

**Table 43. Land use acreage within the Chowchilla GQMP Zone by ESJHVA Priority 1-3 areas.**
Land uses derived from DWR data in order to incorporate irrigation data designated as irrigated/non-irrigated (I/NI); numbers are rounded to nearest whole number.

| Land Use | I/NI | Priority 1 | Priority 2 | Priority 3 | Not in ESJHVA |
|---|---|---|---|---|---|
| Citrus & Sub-Tropical | I | 0 | 4 | 3 | 12 |
| Deciduous Fruits & Nuts | I | 31 | 600 | 18230 | 9825 |
| Field Crops | I | 698 | 2608 | 26492 | 11187 |
| Grain & Hay | I | 215 | 271 | 2992 | 2618 |
| Grain & Hay | NI | 11 | 109 | 424 | 1110 |
| Idle | I | 1 | 64 | 319 | 522 |
| Native Riparian | NI | 0 | 0 | 255 | 176 |
| Native Vegetation | NI | 7 | 293 | 7271 | 12691 |
| Open Water | NI | 4 | 2 | 403 | 279 |

| LAND USE | I/NI | PRIORITY 1 | PRIORITY 2 | PRIORITY 3 | NOT IN ESJHVA |
|---|---|---|---|---|---|
| Pasture | I | 70 | 1067 | 20754 | 17344 |
| Pasture | NI | 0 | 4 | 1 | 0 |
| Semi-agricultural | NI | 40 | 326 | 2514 | 989 |
| Truck, Nursery, Berry | I | 0 | 44 | 900 | 105 |
| Urban | NI | 39 | 801 | 1274 | 1949 |
| Vineyard | I | 0 | 85 | 5213 | 6827 |

* Land use information obtained from data provided by DWR, http://www.water.ca.gov/landwateruse/anaglwu.cfm. Data compiled in 2001, land use in some areas of the ESJWQC may have changed since that time.

## Constituents of Concern in Zone

### *Nitrates*

Tables 44 and 45 describe nitrogen as nitrate within the Chowchilla GQMP Zone. Table 44 indicates that of those wells sampled in the Chowchilla GQMP Zone, approximately 36% exceeded the MCL of 10mg/L. Table 45 indicates that of those wells with nitrate exceedances from 2005-2013, the highest number of wells with nitrate exceedances greater than 10 mg/L are located in the Priority 3 area (69 wells) of the ESJHVA.

**Table 44. Count of nitrate (NO3) detections from 5-10mg/L and exceedances >10mg/L by well from 2005-2013 for the Chowchilla GQMP Zone.**

| | COUNT OF WELLS | | | PERCENT OF WELLS | | |
|---|---|---|---|---|---|---|
| | $NO_3$ <5 mg/L | $NO_3$ 5-10 mg/L | $NO_3$ > =10 mg/L | $NO_3$ <5 mg/L | $NO_3$ 5-10 mg/L | $NO_3$ > =10 mg/L |
| Chowchilla GQMP Zone | 108 | 55 | 92 | 42% | 22% | 36% |

**Table 45. Number of individual wells with nitrate exceedances (greater than 10 mg/L) for the Chowchilla GQMP Zone relative to ESJHVA Priority Areas 1, 2, or 3.**

Well, nitrate, and ESJHVA priority designation data used here are the same as those data compiled in the GAR.

| ZONE | ESJHVA PRIORITY AREAS | | | |
|---|---|---|---|---|
| | Priority 1 | Priority 2 | Priority 3 | Outside ESJHVA |
| Chowchilla GQMP Zone | 0 | 19 | 69 | 4 |

### *TDS*

Tables 46 and 47 describe TDS levels within the Chowchilla GQMP Zone. Table 46 indicates that of those wells sampled in the Chowchilla GQMP Zone, approximately 34% exceeded the agricultural MCL of 450 mg/L. Table 47 indicates that of those wells with TDS exceedances from 2005-2013, the majority of wells (17) are located in the Priority 3 area of the ESJHVA.

**Table 46. Count of wells with detections of TDS (less than 450 mg/L) and exceedances of TDS (equal to or greater than 450 mg/L) within the Chowchilla GQMP Zone.**

Well and TDS data used here are the same as those data compiled in the GAR.

| Zone | Count of Wells | | | % wells TDS>450 |
|---|---|---|---|---|
| | TDS<450 | TDS>=450 | Total wells | |
| Chowchilla GQMP Zone | 35 | 18 | 53 | 34% |

**Table 47. Number of individual wells with TDS exceedances (greater than 450 mg/L) by well from 2005-2013 for the Chowchilla GQMP Zone relative to ESJHVA Priority Areas 1, 2, or 3. Well, TDS, and ESJHVA priority designation data used here are the same as those data compiled in the GAR.**

| Zone | ESJHVA Priority Areas | | | |
|---|---|---|---|---|
| | Priority 1 | Priority 2 | Priority 3 | Outside ESJHVA |
| Chowchilla GQMP Zone | 0 | 1 | 17 | 0 |

## *Pesticides*

As stated in previous sections, of the eight pesticides recorded as having exceeded WQTLs in the GAR, only diazinon and simazine are currently registered for application and use with the DPR. Only diazinon and simazine are to be considered COCs for current groundwater quality management purposes. No exceedances of pesticide COCs occurred in the Chowchilla GQMP Zone. The below data (Tables 48 and 49) indicate detections only.

**Table 48. Summary of pesticide detections (below MCL threshold) and exceedances (at or above MCL threshold) for the Chowchilla GQMP Zone.**

The TRS, well, and pesticide data used below are those data compiled in the GAR.

| Pesticide | Individual Wells with Detections | Individual Wells with Exceedances | TRS Sections with Detections | TRS Sections with Exceedances | Concentration in Samples with Detections (µg/L) | | Exceedance Threshold Used (µg/L) | Basis for Exceedance Threshold |
|---|---|---|---|---|---|---|---|---|
| | | | | | Minimum | Maximum | | |
| DBCP | 2 | 0 | 2 | 0 | 0.003 | 0.003 | 0.2 | CA Primary MCL |
| Simazine | 2 | 0 | 2 | 0 | 0.006 | 0.062 | 4 | CA Primary MCL |

Pesticide data are for the period 1979-2011 provided by the California Department of Pesticide Regulation (DPR)

*Exceedance thresholds used are based on values reported in the SWRCB Water Quality Goals Online Database (http://www.waterboards.ca.gov/water_issues/programs/water_quality_goals/search.shtml), when available. Selection of the threshold value for use to indicate an exceedance is based on a hierarchy consisting of the following order of preference: CA Primary MCL = California Primary MCL; EPA Primary MCL = EPA's Federal Primary MCL; CA Notification = California Notification Level. No value in database = Chemical is in the database but not possible threshold value reported, Chemical not in database = Chemical was not located in the SWRCB database

**Table 49. Number of individual wells and TRS sections with pesticide exceedances for the Chowchilla GQMP Zone relative to ESJHVA Priority Areas 1, 2, or 3.**

Well, TRS, pesticide, and ESJHVA priority designation data used here are the same as those data compiled in the GAR.

| Pesticide | ESJHVA Priority Areas | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Priority 1 | | Priority 2 | | Priority 3 | | Not in ESJHVA | |
| | Individual | TRS | Individual | TRS | Individual | TRS | Individual | TRS |
| DBCP | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Simazine | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# MADERA GROUNDWATER MANAGEMENT ZONE

## Introduction and Background

The Madera GQMP Zone is the southernmost GQMP Zone, south of the Chowchilla GQMP Zone. The entire Madera Groundwater subbasin and a portion of the Delta-Mendota groundwater subbasin are included within the Madera GQMP Zone. The Madera subbasin in entire included within Madera County. The eastern portion of the Delta-Mendota subbasin within the Madera GQMP Zone is located within Madera County.

## Existing Groundwater Management Plans/Entities

As stated previously, the Madera Regional Groundwater Management Plan (Provost and Pritchard, 2014) lists several entities within the plan's boundaries (Figure 31) which perform mostly groundwater level monitoring. These groundwater entities include the City of Chowchilla, City of Madera, Chowchilla Water District, Gravelly Ford Water District (not as a participant of the Madera Regional Groundwater Management Plan but as a member of the California State Groundwater Elevation Monitoring Program), Madera Irrigation District, and Madera County. The total number of wells monitored for groundwater elevation listed within the Madera Regional Groundwater Management Plan approximately 415. The Madera Regional Groundwater Management Plan mentions the water quality data collected by DWR and the CDPH, and local City and County water agencies were used to analyze water quality trends for the Madera 2008 Integrated Regional Water Management Plan but the Madera Regional Groundwater Management Plan does not list other local monitoring agencies or any monitoring schedule.

In 2010, DWR approved the Madera-Chowchilla Basin Groundwater Monitoring Group as the local monitoring entity including: Madera Irrigation District, Chowchilla Water District, Gravelly Ford Water District, and Madera County, Madera Water District, and Root Creek Water District. The total monitoring area covers 789 square miles and includes all of the Madera sub-basin and most of the Chowchilla sub-basin. The Group submits groundwater level data each spring and fall to the DWR describes a variety of groundwater monitoring programs that exist throughout the county and suggests a meeting of all parties currently collecting groundwater data. (Provost and Pritchard, 2014)

## Basin Boundaries and Surface Water Hydrology

"The Madera subbasin consists of lands overlying the alluvium in Madera County. The subbasin is bounded on the south by the San Joaquin River, on the west by the eastern boundary of the Columbia Canal Service area, on the north by the south boundary of the Chowchilla Subbasin, and on the east by the crystalline bedrock of the Sierra Nevada foothills. Major streams in the area include the San Joaquin and Fresno Rivers. Average annual precipitation is 11 inches throughout the majority of the subbasin and 15 inches in the Sierra foothills" (DWR, Bulletin 118).

## Geology, Hydrogeology, and Groundwater Hydrology

As stated previously, the characteristics of the Chowchilla and Madera groundwater subbasins which underlay the Chowchilla and Madera GQMP Zones are described as study areas within the Madera-Chowchilla Study Unit in the USGS' Status and Understanding of Groundwater Quality in the Madera-Chowchilla Study Unit, 2008: California GAMA Priority Basin Project. The study unit is bounded partially on the north by the Chowchilla River, approximately on the west and south by the San Joaquin River, and on the east by foothills of the Sierra Nevada (Figure 58; Shelton, et. al., 2008). In general, the Late Tertiary and Quaternary continental deposits increase in thickness from north to south and are up to 3,000 ft thick in the Madera-Chowchilla study unit. The Madera-Chowchilla study unit includes eastern alluvial fan, with derivatives from the Sierra Nevada, and basin areas. The Corcoran Clay Member of the Tulare Formation, underlies large parts of the basin and the distal end of parts of the eastern alluvial fans at depths dipping from 50 ft on the eastern edge of the Clay to 300 ft along the margin of the Coast Ranges and divides the San Joaquin Valley freshwater aquifer systems into an unconfined to semi-confined upper system and a largely confined lower system.

The geology, hydrogeology and groundwater hydrology description for the Madera subbasin is taken almost exclusively from Bulletin 118 (DWR 2003).

### Water Bearing Formations

Hydrogeologic units in the Madera Subbasin consist of unconsolidated deposits of Pleistocene and Holocene age. These deposits are divided into continental deposit of Tertiary and Quaternary age, and continental deposits of Quaternary age. Continental deposits of Quaternary age include older alluvium, lacustrine and marsh deposits and younger alluvium. The continental deposits of Quaternary age crop out over most of the area and yield probably more than 95 percent of the water pumped from wells. Although younger alluvium and flood-basin deposits yield small quantities of water to wells, the most important aquifer in the area is the older alluvium. It consists mostly of intercalated lenses of clay, silt, sand, and some gravel. The lacustrine and marsh deposits (which contain the E-clay) do not crop out in the area but occur within the older alluvium and underlie the western portion of the subbasin at depths ranging between 150 and 300 feet (DWR 1981). These deposits restrict the vertical movement of groundwater and divide the water-bearing deposits into confined and unconfined aquifers. Continental deposits of Tertiary and Quaternary age include the Ione Formation which outcrops on the Subbasin's eastern margin. This unit may yield small quantities of water to wells but is not an important aquifer. The estimated average specific yield of this groundwater subbasin is 10.4 percent (based on DWR San Joaquin District internal data and that of Davis 1959).

### Restrictive Structures

Groundwater flow is generally southwestward in the eastern part of the subbasin and to the northwest in the southern portion, away from the recharge area along the San Joaquin River. During 1999, a groundwater mound occurred in the northwest portion of the subbasin with accompanying depressions to the north and south, and a large depression in the subbasin's southeast corner (DWR 2000). Based on current and historical groundwater elevation maps, groundwater barriers do not appear to exist in the subbasin.

### Groundwater Level Trends

Changes in groundwater levels are based on annual water level measurements by DWR and cooperators. Water level changes were evaluated by quarter township and computed through a custom DWR computer program using geostatistics (kriging). On average, the subbasin water level has declined nearly 40 feet from 1970 through 2000. The period from 1970 through 1978 showed steep declines totaling about 30 feet. The nine-year period from 1978 to 1987 saw stabilization and rebound of about 25 feet, taking the water levels close to where they were in 1970. 1987 through 1996 again showed steep declines, bottoming out in 1996 at about 45 feet below 1970 levels. Water levels rose about 8 feet from 1996 to 2000. Water levels declines have been more severe in the eastern portion of the subbasin from 1980 to the present, but the western subbasin showed the strongest declines before this time period.

### Groundwater Storage

Estimations of the total storage capacity of the subbasin and the amount of water in storage as of 1995 were calculated using an estimated specific yield of 10.4 percent and water levels collected by DWR and cooperators. According to these calculations, the total storage capacity of this subbasin is estimated to be 18,500,000 af to a depth of 300 feet and 40,900,000 af to the base of fresh groundwater. These same calculations give an estimate of 12,600,000 af of groundwater to a depth of 300 feet stored in this subbasin as of 1995 (DWR 1995). According to published literature, the amount of stored groundwater in this subbasin as of 1961 is 24,000,000 af to a depth of < 1000 feet (Williamson 1989).

### Groundwater Budget (Type B)

Although a detailed budget was not available for this subbasin, an estimate of groundwater demand was calculated based on the 1990 normalized year and data on land and water use. A subsequent analysis was done by a DWR water budget spreadsheet to estimate overall applied water demands, agricultural groundwater pumpage, urban pumping demand and other extraction data. Natural recharge was estimated to be 21,000 af. Artificial recharge and subsurface inflow were not determined. Applied water recharge was calculated to be 404,000 af. Annual urban extraction and annual agricultural extraction were estimated as 15,000 af and 551,000 af, respectively. There were no other extractions, and subsurface outflow was not determined.

### Groundwater Quality Characterization

The majority of this subbasin is generally a calcium sodium bicarbonate type, with sodium bicarbonate and sodium chloride at the western margin of the subbasin along the San Joaquin River (Mitten 1970). TDS values range from 100 to 6,400 mg/L, with a typical range of 200 to 400 mg/L. The Department of Health Services, which monitors Title 22 water quality standards, reports TDS values in 40 wells ranging from 100 to 400 mg/L, with an average value of 215 mg/L. EC values range from 180 to 600 µmhos/cm, with an average value of 251 µmhos/cm (based on 15 wells).

### Groundwater Quality Impairments

There are localized areas of high hardness, iron, nitrate, and chloride. One well is currently undergoing GAC filtration for the removal of EDB/DBCP (Glos 2001).

## Land Use/Irrigated Land

Tables 50 and 51 describe land uses within the Madera GQMP Zone from two different data sets, USDA (2012) and DWR (early 2000s), respectively. USDA data in Table 50 indicate almonds, grapes, pistachios, and fallow/idle cropland as the crops capturing over 85% of the land use in the Madera GQMP Zone, regardless of irrigated or non-irrigated status. DWR data in Table 51 indicate the top irrigated crop as deciduous fruits and nuts followed closely by vineyards.

**Table 50. Land use acreage within the entire Madera GQMP Zone1.**

| Row Labels | Acreage | Percent acreage of Zone |
|---|---|---|
| Almonds | 112208 | 42.27% |
| Grapes | 83488 | 31.45% |
| Pistachios | 17638 | 6.64% |
| Fallow/Idle Cropland | 12576 | 4.74% |
| Alfalfa | 11560 | 4.35% |
| Winter Wheat | 9477 | 3.57% |
| Oats | 7814 | 2.94% |
| **Grand Total for Agricultural Crops** | 254763 | 96% |

[1]Land use information obtained from data provided by USDA, 2012 California Cropland Data Layer: http://www.nass.usda.gov/research/Cropland/SARS1a.htm. Land use in some areas of the ESJWQC may have changed since that time.
*Percent of cropped area includes all agricultural fields, whether fallow or active. Land use categories such as barren, developed, and native or wetland vegetation were not included in acreage totals. Crops contributing 1% or more of the overall land use within the GQMP area were included.

**Table 51. Land use acreage within the Madera GQMP Zone by ESJHVA Priority 1-3 areas.**

Land uses derived from DWR data in order to incorporate irrigation data designated as irrigated/non-irrigated (I/NI); numbers are rounded to nearest whole number.

| Land Use | I/NI | Priority 1 | Priority 2 | Priority 3 | Not in ESJHVA |
|---|---|---|---|---|---|
| Citrus & Sub-Tropical | I | 26 | 151 | 761 | 5979 |
| Deciduous Fruits & Nuts | I | 67 | 2791 | 21070 | 58409 |
| Field Crops | I | 176 | 3209 | 14625 | 20649 |
| Field Crops | NI | 0 | 0 | 4 | 311 |
| Grain & Hay | I | 45 | 1056 | 4216 | 7017 |
| Grain & Hay | NI | 0 | 49 | 1045 | 6812 |
| Idle | I | 0 | 8 | 915 | 3238 |
| Idle | NI | 0 | 0 | 1 | 0 |
| Native Riparian | NI | 1 | 96 | 1055 | 972 |
| Native Vegetation | NI | 23 | 885 | 12612 | 88805 |
| Pasture | I | 88 | 1245 | 9348 | 14204 |
| Pasture | NI | 0 | 0 | 0 | 28 |
| Rice | I | 1 | 115 | 2 | 12 |
| Semi-agricultural | NI | 7 | 299 | 1800 | 1897 |
| Truck, Nursery, Berry | I | 6 | 228 | 1051 | 2280 |
| Urban | NI | 160 | 3619 | 4331 | 18629 |
| Vineyard | I | 214 | 3534 | 39807 | 50762 |

* Land use information obtained from data provided by DWR, http://www.water.ca.gov/landwateruse/anaglwu.cfm. Data compiled in 2001, land use in some areas of the ESJWQC may have changed since that time.

## Constituents of Concern in Zone

### *Nitrates*

Tables 52 and 53 describe nitrogen as nitrate within the Madera GQMP Zone. Table 52 indicates that of those wells sampled in the Madera GQMP Zone, approximately 13% exceeded the MCL of 10mg/L. Table 53 indicates that of those wells with nitrate exceedances from 2005-2013, the highest number of wells with nitrate exceedances greater than 10 mg/L are located in the Priority 3 area (21 wells) of the ESJHVA.

**Table 52. Count of nitrate (NO3) detections from 5-10mg/L and exceedances >10mg/L by well from 2005-2013 for the Madera GQMP Zone.**

| | COUNT OF WELLS | | | PERCENT OF WELLS | | |
|---|---|---|---|---|---|---|
| | $NO_3$ <5 mg/L | $NO_3$ 5-10 mg/L | $NO_3$ > =10 mg/L | $NO_3$ <5 mg/L | $NO_3$ 5-10 mg/L | $NO_3$ > =10 mg/L |
| Madera GQMP Zone | 174 | 49 | 32 | 68% | 19% | 13% |

**Table 53. Number of individual wells with nitrate exceedances (greater than 10 mg/L) for the Madera GQMP Zone relative to ESJHVA Priority Areas 1, 2, or 3.**

Well, nitrate, and ESJHVA priority designation data used here are the same as those data compiled in the GAR.

| ZONE | ESJHVA PRIORITY AREAS | | | |
|---|---|---|---|---|
| | **Priority 1** | **Priority 2** | **Priority 3** | **Outside ESJHVA** |
| Madera GQMP Zone | 0 | 7 | 21 | 4 |

### *TDS*

Tables 54 and 55 describe TDS levels within the Madera GQMP Zone. Table 54 indicates that of those wells sampled in the Madera GQMP Zone, approximately 19% exceeded the agricultural MCL of 450 mg/L. Table 55 indicates that of those wells with TDS exceedances from 2005-2013, the majority (17) are located in the Priority 3 area of the ESJHVA.

**Table 54. Count of wells with detections of TDS (less than 450 mg/L) and exceedances of TDS (equal to or greater than 450 mg/L) within the Madera Groundwater Management Zone.**

Well and TDS data used here are the same as those data compiled in the GAR.

| ZONE | COUNT OF WELLS | | | % WELLS TDS>450 |
|---|---|---|---|---|
| | **TDS<450** | **TDS>=450** | **Total wells** | |
| Madera GQMP Zone | 136 | 32 | 168 | 19% |

**Table 55. Number of individual wells with TDS exceedances (greater than 450 mg/L) by well from 2005-2013 for the Madera Groundwater Management Zone relative to ESJHVA Priority Areas 1, 2, or 3.**

Well, TDS, and ESJHVA priority designation data used here are the same as those data compiled in the GAR.

| ZONE | ESJHVA PRIORITY AREAS | | | |
|---|---|---|---|---|
| | **Priority 1** | **Priority 2** | **Priority 3** | **Outside ESJHVA** |
| Madera GQMP Zone | 0 | 1 | 17 | 0 |

## *Pesticides*

As stated in previous sections, of the eight pesticides recorded as having exceeded WQTLs in the GAR, only diazinon and simazine are currently registered for application and use with the DPR. Only diazinon and simazine are to be considered COCs for current groundwater quality management purposes. No exceedances of pesticide COCs occurred in the Madera GQMP Zone. The below data (Tables 56 and 57) indicate detections only.

**Table 56. Summary of pesticide detections (below MCL threshold) and exceedances (at or above MCL threshold) for the Madera GQMP Zone.**

COCs in this GQMP Zone are bolded. Well and pesticide data used below are those data compiled in the GAR.

| Pesticide | Individual Wells with Detections | Individual Wells with Exceedances | TRS Sections with Detections | TRS Sections with Exceedances | Concentration in Samples with Detections (µG/L) | | Exceedance Threshold Used (µG/L) | Basis for Exceedance Threshold |
|---|---|---|---|---|---|---|---|---|
| | | | | | Minimum | Maximum | | |
| DBCP | 57 | 49 | 40 | 32 | 0.003 | 60.000 | 0.2 | CA Primary MCL |
| Ethylene Dibromide | 1 | 1 | 1 | 1 | 0.010 | 1.000 | 0.05 | CA Primary MCL |
| **Simazine** | **5** | **0** | **5** | **0** | **0.006** | **0.200** | **4** | **CA Primary MCL** |

Pesticide data are for the period 1979-2011 provided by the California Department of Pesticide Regulation (DPR)

*Exceedance thresholds used are based on values reported in the SWRCB Water Quality Goals Online Database (http://www.waterboards.ca.gov/water_issues/programs/water_quality_goals/search.shtml), when available. Selection of the threshold value for use to indicate an exceedance is based on a hierarchy consisting of the following order of preference: CA Primary MCL = California Primary MCL; EPA Primary MCL = EPA's Federal Primary MCL; CA Notification = California Notification Level. No value in database = Chemical is in the database but not possible threshold value reported, Chemical not in database = Chemical was not located in the SWRCB database

**Table 57. Number of individual wells and TRS sections with pesticide exceedances for the Madera GQMP Zone relative to ESJHVA Priority Areas 1, 2, or 3.**

Well, TRS, pesticide, and ESJHVA priority designation data used here are the same as those data compiled in the GAR.

| Pesticide | ESJHVA Priority Areas | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Priority 1 | | Priority 2 | | Priority 3 | | Not in ESJHVA | |
| | Individual | TRS | Individual | TRS | Individual | TRS | Individual | TRS |
| DBCP | 0 | 0 | 9 | 7 | 32 | 20 | 8 | 5 |
| Ethylene Dibromide | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |

# DATA EVALUATION

## INFORMATION NEEDED TO QUANTIFY PROGRAM EFFECTIVENESS

To quantify management plan program effectiveness, there are several types of data that will be collected by the Coalition over the next year including:

- Management practices used by members in high vulnerability regions,
- Management practices recommended to growers for implementation in the future, and
- Recommended management practices actually implemented by members.

The Coalition currently maintains independent relational databases for water quality monitoring data, management practices reported in the Farm Evaluation Reports, practices recommended by Coalition representatives, and pesticide use information received from the office of the County Agricultural Commissioners. In addition, the Coalition maintains a database of pesticides applied in the Coalition region including physical, chemical, and toxicological information that is used to identify applications that have the potential to cause toxicity.

# RECORDS AND REPORTING

The Coalition will submit each year by May 1 in a Management Practice Progress Report as part of the Annual Monitoring Report, also submitted by May 1. The report will contain the 13 components listed in Appendix MRP-1 of the WDR. All reports are submitted electronically and shapefiles are either submitted with the reports, or available upon request.

# REFERENCES


AMEC Geomatrix. (2008). *Merced Groundwater Basin Groundwater Management Plan Update, Merced County, CA*. Available at: http://www.water.ca.gov/groundwater/docs/GWMP/SJ-8_MAGPI_GWMP_2008.pdf.

Bookman-Edmonston. (2005). *Integrated Regional Groundwater Management Plan for the Modesto Subbasin*. Available at: http://www.water.ca.gov/urbanwatermanagement/2005uwmps/Modesto/GWMP/app-h.pdf.

Boyle Engineering Corporation. (2008). *Integrated Regional Water Management Plan, Volume 1, Madera County*.

Burow, K.R., Shelton, J.L., Hevesi, J.A., and Weissmann, G.S. (2004). *Hydrogeologic Characterization of the Modesto Area, San Joaquin Valley, California: U.S. Geological Survey Scientific Investigations Report 2004-5232*. Available at: http://pubs.usgs.gov/sir/2004/5232/.

California Department of Water Resources, County Land Use Survey Data by Individual County, http://www.water.ca.gov/landwateruse/lusrvymain.cfm.

California Department of Water Resources. (1997). *Groundwater Management in California, A Report to the Legislature Pursuant to Senate Bill 1245 (1997)*.

California Department of Water Resources. (2003). *Bulletin 118*. Available at: http://www.water.ca.gov/groundwater/bulletin118/index.cfm.

California Department of Water Resources. (2005). Irrigated Crop Acres and Water Use. Currently using 2005 Data. Available at: http://www.water.ca.gov/landwateruse/anaglwu.cf

California Department of Water Resources. (2013). *California Water Plan, Investing in Innovation and Infrastructure, San Joaquin River Hydrologic Region, Volume 2, Regional Reports*. Available at: http://www.waterplan.water.ca.gov/docs/cwpu2013/Final/Vol2_SanJoaquinRiverRR.pdf.

California Regional Water Quality Control Board Central Valley Region. (2006). *Irrigated Lands Discharge Program Draft Existing Conditions Report.* Available at: http://www.waterboards.ca.gov/centralvalley/water_issues/irrigated_lands/new_waste_discharge_requirements/exist_cond_rpt/draft_existing_conditions_rpt/ch04_pt3.pdf.

California Regional Water Quality Control Board Central Valley Region. (2012). *California Regional Water Quality Control Board Central Valley Region Order R5-2012-0116, Revision 2, Waste Discharge Requirements General Order for Growers within the Eastern San Joaquin River Watershed that are Members of the Third-Party Group*. Available at: http://www.waterboards.ca.gov/centralvalley/board_decisions/adopted_orders/general_orders/r5-2012-0116-r2.pdf.

California State Water Resources Control Board. (2013a). Water Quality Goals Online Database. Available at: http://www.waterboards.ca.gov/water_issues/programs/water_quality_goals/search.shtml.

CWD-Red Top RCD Joint Powers Authority. (1997). *Groundwater Management Plan in Accordance with AB3030*. Available at: http://www.water.ca.gov/groundwater/docs/GWMP/SJ-2_ChowchillaWD-RedTopRCD_GWMP_1997.pdf.

East San Joaquin Water Quality Coalition. (2014). *East San Joaquin Water Quality Coalition Groundwater Quality Assessment Report*.

East Stanislaus Regional Water Management Partnership. (2013). *East Stanislaus Region Integrated Regional Water Management Plan*.

Faunt, C., R.T. Hanson, K. Belitz, W. Schmid, S. Predmore, D. L. Rewis, and K. McPherson. (2009) *Groundwater Availability of the Central Valley Aquifer, California. USGS Professional Paper 1766*. Available at: http://pubs.usgs.gov/pp/1766/.

GEI Consultants, Inc. (2014). *Draft 2014 Eastern San Joaquin Integrated Regional Water Management Plan*. Available at: http://www.water.ca.gov/irwm/grants/docs/PlanReviewProcess/Eastern_San_Joaquin_IRWMP/Eastern%20San%20Joaquin%202014%20IRWMP%20Update%20140605%20rev21%20%28FINAL%29.pdf.

Landon, M.K., Belitz, Kenneth, Jurgens, B.C., Kulongoski, J.T., and Johnson, T.D. (2010). *Status and Understanding of Groundwater Quality in the Central-Eastside San Joaquin Basin, 2006: California GAMA Program Priority Basin Project: U.S. Geological Survey Scientific Investigations Report 2009-5266*.

Provost and Pritchard Consulting Group. (2014). *Draft Madera Regional Groundwater Management Plan*, http://co.madera.ca.gov/index.php/county-forms/category/633-groundwater-management-plan.

RMC. (2013). *Merced Integrated Regional Water Management Plan*. Available at: http://www.mercedirwmp.org/files/MIRWMP%20Revised%20Final.pdf.

Shelton, J.L., Fram, M.S., Belitz, K., and Jurgens, B.C. (2012). *Status and Understanding of Groundwater Quality in the Madera-Chowchilla study unit, 2008: U.S. Geological Survey Scientific Investigations Report 2012-5094*.

Roberts, T. L. (2007). Right product, right rate, tight time and right place… the foundation of best management practices for fertilizer. Fertilizer Best Management Practices. First Edition, IFA, Paris, France. p. 1-32. Available at: (http://www.ipni.net/ipniweb/portal.nsf/0/55C6FA392D96B89885257A8C0057EDAA/$FILE/Fixen_2007_Global_BMP_Framework.pdf).

Madera County. (2002). *AB3030 Groundwater Management Plan Madera County (Final Draft)*.

Turlock Groundwater Basin Association. (2008). *Turlock Groundwater Basin, Draft Groundwater Management Plan*. Available at: http://www.water.ca.gov/urbanwatermanagement/2010uwmps/Turlock,%20City%20of/Turlock_Groundwater_Management_Plan+Appendices.pdf.

U.S. Department of Agriculture. (2012) USDA, National Agricultural Statistics Service, 2012 California Cropland Data Layer. 2007-2012. Available at: http://www.nass.usda.gov/research/Cropland/SARS1a.htm