D R A F T

Comprehensive Groundwater Quality Management Plan

Prepared for

Central Valley Regional Water Quality Control Board

On Behalf of

Northern California Water Association
Sacramento Valley Water Quality Coalition

November 22, 2016

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Executive Summary

This Comprehensive Groundwater Quality Management Plan (GQMP) was prepared on behalf of the Northern California Water Association, which is the third-party representing owners and operators of irrigated lands in the Sacramento Valley Water Quality Coalition (Coalition) under the Central Valley Regional Water Quality Control Board (CVRWQCB) Long-term Irrigated Lands Regulatory Program. The GQMP addresses the requirements of the Waste Discharge Requirements General Order for Growers within the Sacramento River Watershed (Sacramento River WDR) (R5-2014-0030-R1).

The first groundwater quality technical report for the Coalition was the Groundwater Quality Assessment Report (GAR). The GAR reviewed available groundwater quality data, hydrogeology and soil characteristics, agronomic information, and groundwater quality monitoring program information relevant to the Sacramento River Watershed to identify High Vulnerability Areas (HVAs). HVAs include regions that have surface or groundwater quality impairments or those determined susceptible to groundwater contamination. The GAR established that the Sacramento River Watershed has generally high-quality groundwater with a few areas of concern related to nitrate within the Sacramento Valley floor.

The final GAR was conditionally approved by CVRWQCB on September 16, 2016, which triggered a 60-day timeframe to submit the Comprehensive GQMP for all HVAs within the Coalition area. The Coalition is submitting this Comprehensive GQMP to address HVAs within the Coalition's boundaries.

The goal of the GQMP is to outline a process to assist Coalition members in adopting effective management practices that are protective of groundwater quality. The following GQMP objectives were developed to meet this goal:

1. Document information regarding sources of nitrate contamination in groundwater and collect current management practices for members in HVAs.
2. Study effectiveness of various management practices protective of groundwater quality.
3. Conduct outreach to members via Subwatershed Action Plans.
4. Evaluate effectiveness and adaptive management.
5. Prioritize HVAs in regions where disadvantaged communities' drinking water sources could be affected.

Five performance goals were developed to meet the objectives of the GQMP and ensure the continued protection of groundwater quality in HVAs throughout the Sacramento Valley floor. Performance measures are associated with each performance goal to outline specific actions that can be used to meet the goal. In addition, subwatershed-specific actions are outlined for identified HVAs in the Subwatershed Action Plans. These actions differ based on HVA priority rankings in order to strategically implement the GQMP and comply with the Sacramento River WDR.

This GQMP follows the requirements and plan sections outlined in the Sacramento River WDR. The GQMP action plan is closely linked to other related Irrigated Lands Regulatory Programs, including the Management Practices Evaluation Program and the Groundwater Quality Trend Monitoring Program, as well as the Central Valley Salinity Alternatives for Long-term Sustainability initiative. Consequently, the milestone schedule presented for the GQMP is contingent upon the milestone completions from those other related programs and initiative.

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Acronyms and Abbreviations

AMR	annual monitoring report
BMP	best management practice
CASGEM	California Statewide Groundwater Elevation Monitoring
CDFA	California Department of Food and Agriculture
Coalition	Sacramento Valley Water Quality Coalition
COC	constituent of concern
CVRWQCB	Central Valley Regional Water Quality Control Board
CV-SALTS	Central Valley Salinity Alternatives for Long-term Sustainability
DAC	disadvantaged community
DPR	Department of Pesticide Regulation
DWR	Department of Water Resources
GAMA	Groundwater Ambient Monitoring and Assessment
GAR	Groundwater Quality Assessment Report
GPA	Groundwater Protection Area
GQMP	Groundwater Quality Management Plan
GRMP	Groundwater Regional Monitoring Program
HVA	high vulnerability area
IAZ	initial analysis zone
ILRP	Irrigated Lands Regulatory Program
IRWM	Integrated Regional Water Management
LTILRP	Long-Term Irrigated Lands Regulatory Program
MCL	maximum contaminant level
MHI	median household income
MPEP	Management Practices Evaluation Program
MRP	Monitoring and Reporting Program
NA	not available
NCWA	Northern California Water Association
NMP	nitrogen management plan
NWIS	National Water Information System
SGMA	Sustainable Groundwater Management Act
SNMP	salt and nitrate management plan
SVWQC	Sacramento Valley Water Quality Coalition
SWRCB	State Water Resources Control Board

TAWG	Technical Advisory Work Group
UCCE	UC Davis Cooperative Extension
USGS	United States Geological Survey
WDR	waste discharge requirement
YCFCWCD	Yolo County Flood Control and Water Conservation District

A. Introduction and Background

This Comprehensive Groundwater Quality Management Plan (GQMP) addresses the requirements of the Waste Discharge Requirements General Order for Growers within the Sacramento River Watershed (Sacramento River WDR) (R5-2014-0030-R1). This GQMP has been prepared on behalf of the Northern California Water Association (NCWA) which is the third-party representing owners and operators of irrigated lands in the Sacramento Valley Water Quality Coalition (Coalition).

The Coalition, managed by the NCWA, is an approved third-party group under the Central Valley Regional Water Quality Control Board (CVRWQCB) Long-term Irrigated Lands Regulatory Program (LTILRP). The Sacramento River WDR, or Order, was adopted by CVRWQCB in March 2014, revised in June 2015 and further revised in February 2016. The Sacramento River WDR specifies the requirements for compliance by growers and the Coalition, including the preparation of technical reports.

The first groundwater quality technical report for the Coalition was the Groundwater Quality Assessment Report (GAR), initially drafted in June 2014, with comments received by CVRWQCB staff in October 2015. The final GAR was submitted to CVRWQCB in January 2016 (NCWA, 2016). The final GAR was conditionally approved by CVRWQCB on September 16, 2016, which triggered a 60-day timeframe to submit the Comprehensive GQMP for all high vulnerability areas (HVAs) within the Coalition area. This report satisfies the Sacramento River WDR's requirement that a Comprehensive GQMP be prepared and submitted by the NCWA and the Coalition.

The GAR is an initial study of Sacramento River Watershed groundwater quality conditions and assesses areas that have been affected by constituents of concern (COCs), particularly nitrate and salt indicators, that could be linked to agricultural practices and areas that may be vulnerable to future impacts from agricultural discharges.

A1. Background

Water resources managers in the Sacramento River Watershed view water resources sustainability as an overarching goal to help guide surface and groundwater management. The Coalition recognizes the importance of high-quality water in supporting and sustaining the local economy, community, and environment.

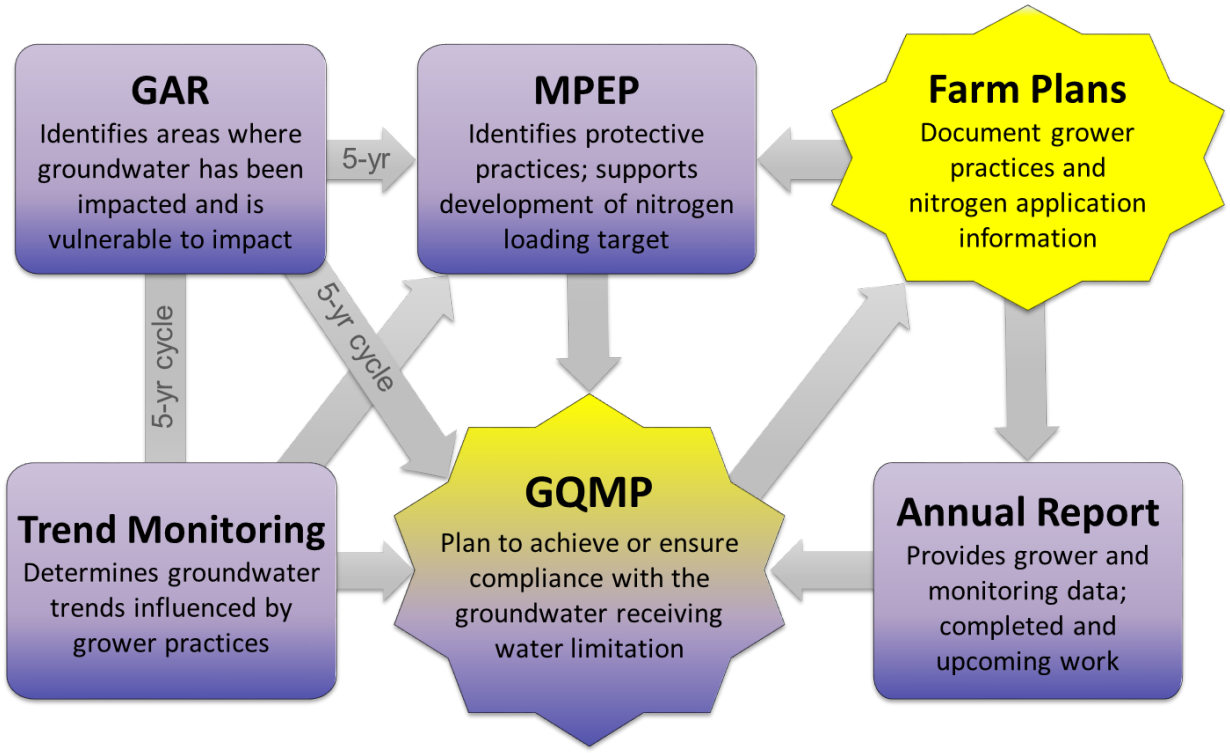
Groundwater aquifers within the Sacramento River Watershed are generally considered to have high groundwater quality, with the exception of a few localized areas of concern (Department of Water Resources [DWR], 2003). Areas susceptible to groundwater contamination because of nitrate are largely concentrated in the Sacramento Valley floor. Several conditions led to the high vulnerability of groundwater, including agricultural irrigation practices, legacy issues related to past agricultural practices, nutrients from dairy operations, municipal wastewater operations, concentrated septic systems, and hydrogeological conditions.

The Sacramento River WDR outlines the various reports required under the LTILRP for this region. The purpose of the GAR) is to provide the technical basis informing the scope and level of effort for implementation of the Order's groundwater monitoring and implementation provisions. The GAR assesses all available, applicable and relevant data and information to determine the high and low vulnerability areas where discharges from irrigated lands may result in groundwater quality degradation. The Coalition must review and confirm, or modify the GAR vulnerability designations every 5 years.

The GAR triggers subsequent technical reports that evaluate and implement practices to ensure the protection of groundwater quality and its beneficial uses. As shown on the figure below, the Management Practices Evaluation Program (MPEP) and associated reports help to determine the effects, if any, irrigated agricultural practices have on groundwater quality.

The GQMP addresses known areas of high vulnerability by outlining a plan to achieve compliance with the receiving water limitations. Finally, the Groundwater Quality Trend Monitoring Work Plan establishes a monitoring network to determine current groundwater quality conditions underlying irrigated agriculture and develop long-term groundwater quality information that can be used to evaluate the regional effects of irrigated agricultural practices.

The timeline of completion for the groundwater quality elements under the Order is shown in Table 1.



Source: CVRWQCB, 2016

Table 1. Summary of Coalition Deliverables and Approximate Submittal Dates

Report	Submittal Date
MPEP Work Plan	July 29, 2016
GAR	Initial draft June 2014; final draft January 2016 Conditionally approved September 16, 2016
Comprehensive GQMP	November 16, 2016
Groundwater Trend Monitoring Work Plan	September 16, 2017
GAR 5-Year Update	September 14, 2021
MPEP Report	May 1, 2023
Annual Monitoring Reports	May 1, annually

The LTILRP triggers the rigorous collection of data related to irrigated agricultural practices and groundwater quality. The Coalition's Order includes provisions to promote coordination with the Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) and to support the development of information needed for the CV-SALTS process. The data related to groundwater quality will also inform Groundwater Sustainability Plans developed by Groundwater Sustainability Agencies under the

Sustainable Groundwater Management Act (SGMA). The SGMA identifies six undesirable results that groundwater sustainability agencies overlying groundwater basins need to identify and manage. The significant and unreasonable degradation of groundwater quality is one of these undesirable results. Data collected under this Irrigated Lands Regulatory Program (ILRP) Order will help Groundwater Sustainability Agencies comply with the groundwater quality sustainability indicator.

A1.a Sacramento Valley Water Quality Coalition

Coordinated by NCWA, the Coalition was formed in 2003 as a partnership among 13 local subwatershed groups to improve water quality in the Sacramento River Basin and effectively implement the LTILRP requirements (Sacramento Valley Water Quality Coalition [SVWQC], 2016a). The Coalition consists of more than 8,600 farmers and wetland managers who work on more than 1.3 million irrigated acres. The 13 subwatershed groups are organized by local resource conservation districts, farm bureaus, or other non-governmental organizations. The subwatershed groups' primary responsibilities include, outreach and education to facilitate increased public awareness of water quality issues, documentation of cultural and management practices where required by management plans and augment the third-party's scientific and technical understanding of agricultural water quality conditions with local knowledge and expertise.

The Coalition is managed by NCWA, who is the lead regional representative. NCWA coordinates program implementation, oversees reporting requirements, surface water quality monitoring, and groundwater quality monitoring, and assists the subwatershed groups in implementing management plans.

The Coalition's area overlies the Sacramento Valley Groundwater Basin as well as other smaller alluvial basins, as shown on Figure A1.

A1.b. Trigger for the Preparation of the GQMP

The Sacramento River WDR requires the development of a GQMP in the following cases: (1) There is a confirmed exceedance of a water quality objective or applicable water quality trigger limit in a groundwater well and irrigated agriculture may cause or contribute to the exceedance; (2) HVAs were identified by the GAR; (3) A GQMP is required by the Basin Plan for a COC discharged by irrigated agriculture; or (4) the Executive Officer determines that irrigated agriculture is degrading groundwater to an extent that may threaten applicable Basin Plan beneficial uses. The identification of HVAs by the GAR triggered the preparation of this Comprehensive GQMP within 60 days of GAR approval. A Comprehensive GQMP allows for the preparation of a plan that addresses all HVAs identified in the GAR, instead of submitting individual plans for each identified HVA. The Coalition is submitting this Comprehensive GQMP, which addresses COCs and HVAs within the Coalition's boundaries.

The GAR reviewed available groundwater quality data, hydrogeology and soil characteristics, agronomic information, and groundwater quality monitoring program information relevant to the Sacramento River Watershed to identify HVAs, areas of low vulnerability, and areas lacking sufficient data within the Coalition's boundaries (categorized as data gaps). The CVRWQCB recognized that due to geologic factors and less intensive farming operations, further upper watershed vulnerability analysis is a lower priority than that of the Sacramento Valley floor. The conclusions of the upper watershed vulnerability analysis and any new information on the upper watersheds must be described and added to the HVA map in the 5-year GAR update (CVRWQCB, 2015a). Therefore, this Comprehensive GQMP focuses on the Sacramento Valley floor. Figure A2 shows the vulnerability designation for sections that include irrigated agricultural lands. Further description of the HVA designations is provided in Section A5.

A2. Purpose of the GQMP

The purpose of the GQMP is to assist Coalition members in adopting effective management practices that are protective of groundwater quality. The GQMP specifically focuses on areas designated as HVAs,

located on the Sacramento Valley floor. Low vulnerability areas are not discussed in this GQMP. Areas with data gaps are briefly addressed in the GQMP but will be reviewed in more detail in the 5-year GAR update.

This Comprehensive GQMP is based on the GAR results, identifies the next steps and implementation requirements, focuses on HVAs, prioritizes data gap areas, and incorporates recent CV-SALTS analysis and results, where appropriate. This Comprehensive GQMP, in addition to the GAR, establishes the framework for the Groundwater Quality Trend Monitoring Work Plan. The GQMP's work plans describe how the third-party will assist their Members in addressing the identified water quality problem(s); the types of actions Members will take to address the identified water quality problem(s); how the third-party will conduct evaluations of effectiveness of implemented practices; and document consistency with Time Schedule for Compliance (Section XII of the Order).

This GQMP summarizes land use and groundwater quality within the Sacramento Valley and outlines the Coalition's plan of action to manage and monitor efforts to address groundwater quality impacts as identified in the GAR through the development and implementation of Subwatershed Action Plans. The comprehensive technical evaluation of groundwater quality data from the California Department of Pesticide Regulation (DPR), the United States Geological Survey (USGS), the State Water Resources Control Board (SWRCB) Groundwater Ambient Monitoring and Assessment (GAMA) and other sources, conducted as part of the GAR found anthropogenic constituents generally linked to farming practices, such as pesticides and nutrients (e.g., nitrates found in fertilizers) are generally not identified as a threat to drinking water supplies of the Sacramento Valley. The results of the GAR evaluation are consistent with the CVRWQCB's findings in Attachment A (Information Sheet) to R5-2014-0030-R1 (CVRWQCB, 2015b). Thus the GQMP focuses on contributions of nitrate from irrigated agriculture to potential degradation of groundwater quality.

This GQMP follows the requirements and plan sections outlined in the Order. Section A presents an introduction and background of the report. Section B highlights general information pertaining to the physical setting of the Sacramento Valley. Section C highlights the GQMP management plan strategy, including performance goals and milestones. Section D outlines the GQMP monitoring design, and Section E highlights the methods used to track, evaluate, and report data. Appendix A includes a table that cross references the requirements from the Order with the relevant GQMP section, GAR section, and future documents. Appendix B includes the Subwatershed Action Plans for the six subwatersheds that include HVAs as identified in the revised GAR (according to conditional approval requirements).

A3. Sacramento Valley Water Quality Coalition Boundaries

The Coalition's boundaries (Figure A1) are defined by the Sacramento River Watershed in Northern California. The watershed is bounded on the east by the Sierra Nevada and Cascade Ranges and on the west by the North Coast Range and Klamath Mountains. The Sacramento River Watershed encompasses approximately 17 percent of the land area in California, or about 22.2 million acres (NCWA, 2016).

The Coalition consists of 13 subwatersheds. The subwatersheds were delineated based on a combination of political and physical features, including county boundaries, hydrology, and organizational structure. A summary of the subwatershed descriptions, including their boundaries, is available in Appendix A of the GAR.

The Sacramento Valley is drained by the Sacramento River, which extends more than 400 miles from Mount Shasta to the San Francisco Bay-Delta. The majority of agriculture within the Coalition's boundaries occurs near the Sacramento River on the Sacramento Valley floor. The Sacramento Valley floor overlies the northern portion of the Central Valley alluvial aquifer and consists of the Sacramento Valley Groundwater Basin and the Redding Area Groundwater Basin. The Sacramento Valley floor

contains the majority of groundwater within the Sacramento River Watershed and is the area of focus for this GQMP.

Six subwatersheds within the Sacramento Valley floor include areas designated as HVAs. These subwatersheds are Butte-Yuba-Sutter, Colusa-Glenn, Dixon-Solano, Sacramento-Amador, Shasta-Tehama, and Yolo. Table 2 summarizes the main areas identified on the Sacramento Valley floor that include HVAs and lists other potential influencers identified during the GAR study.

Table 2. Summary of Main Areas Having High Vulnerability to Nitrate Contamination

Subwatershed	Main Areas of High Vulnerability	Other Potential Influencers
Butte-Yuba-Sutter	Northeastern Butte County, Yuba City area, areas near the Feather River (DPR GPAs)	Chico area septic systems
Colusa-Glenn	Northern Glenn County	Glenn County dairies
Dixon-Solano	Northeastern Solano County	Dixon wastewater ponds
Sacramento-Amador	Delta area	Historical dairies in the Delta
Shasta-Tehama	Red-Bluff and Corning areas	Septic systems
Yolo	Davis-Woodland area	

Note:

GPA = Groundwater Protection Area

A4. Disadvantaged Communities

Disadvantaged communities (DACs) are defined by the DWR Division of Integrated Regional Water Management (IRWM) as communities with an annual median household income (MHI) that is less than 80 percent of the annual MHI for the State of California (California Public Resource Code §75005 (g)). The California statewide MHI is $61,094, according to the American Community Survey 2009-2013, and the 80 percent mark is $48,875 (DWR, 2015).

Many DACs located within the Sacramento River Watershed use groundwater as a source of drinking water through the use of domestic wells. DACs located on the Sacramento Valley floor are shown on Figure A3 along with the location of the HVAs identified in the GAR. The high concentration of agricultural lands on the Sacramento Valley floor may increase the susceptibility of these communities to groundwater contamination potentially caused by irrigated agriculture. These communities are concentrated near Chico, Oroville, Yuba City, and Sacramento, with a few smaller areas west of the Sacramento River (Figure A3).

Groundwater quality within the Sacramento Valley floor and where DACs are located is generally appropriate for municipal, agricultural, domestic, and industrial uses. However, several areas, including Red Bluff/Antelope, Gridley-Marysville, and Corning-Chico, experience high concentrations of nitrates in groundwater. The source of this nitrate is considered to be from agricultural fertilizer with significant contributions from septic systems (DWR, 2009).

A5. Constituents of Concern

The GAR reviewed previous studies on groundwater quality and analyzed well data pertaining to the COCs generally associated with irrigated agriculture—nitrate, salinity, and pesticides. The GAR established that the Sacramento River Watershed has generally high-quality groundwater with a few areas of concern related to nitrate. It found that the primary sources of salinity are not the result of agriculture, and that pesticides do not pose issues, based on the low levels of pesticides found in

groundwater. Nitrate, however, was detected in localized areas within the Sacramento Valley floor and is the primary COC addressed in this GQMP.

Both intrinsic and anthropogenic factors influence the vulnerability of groundwater to contamination from irrigated agriculture. Intrinsic factors include existing, physical factors such as hydrogeologic and soil conditions, the presence of naturally occurring contaminants, and geochemical characteristics. Anthropogenic factors include practices surrounding crop type, irrigation, and nutrient and pesticide management. In addition, the DPR identified areas that may be vulnerable to pesticide contamination because of the presence of coarser soil and geologic materials. These areas, known as DPR GPAs, were included in the GAR vulnerability analysis and are identified as HVAs.

The final HVAs are shown on Figure A2. These areas are concentrated on the Sacramento Valley floor, where the majority of groundwater and irrigated agriculture exists. Because of this, the Sacramento Valley floor is the focus of this GQMP.

Source: Subwatersheds, Watershed (SVWQC 2013); Basemap, County, City, Highway, River (ESRI 2011). Datum is NAD83.

LEGEND

- Cities

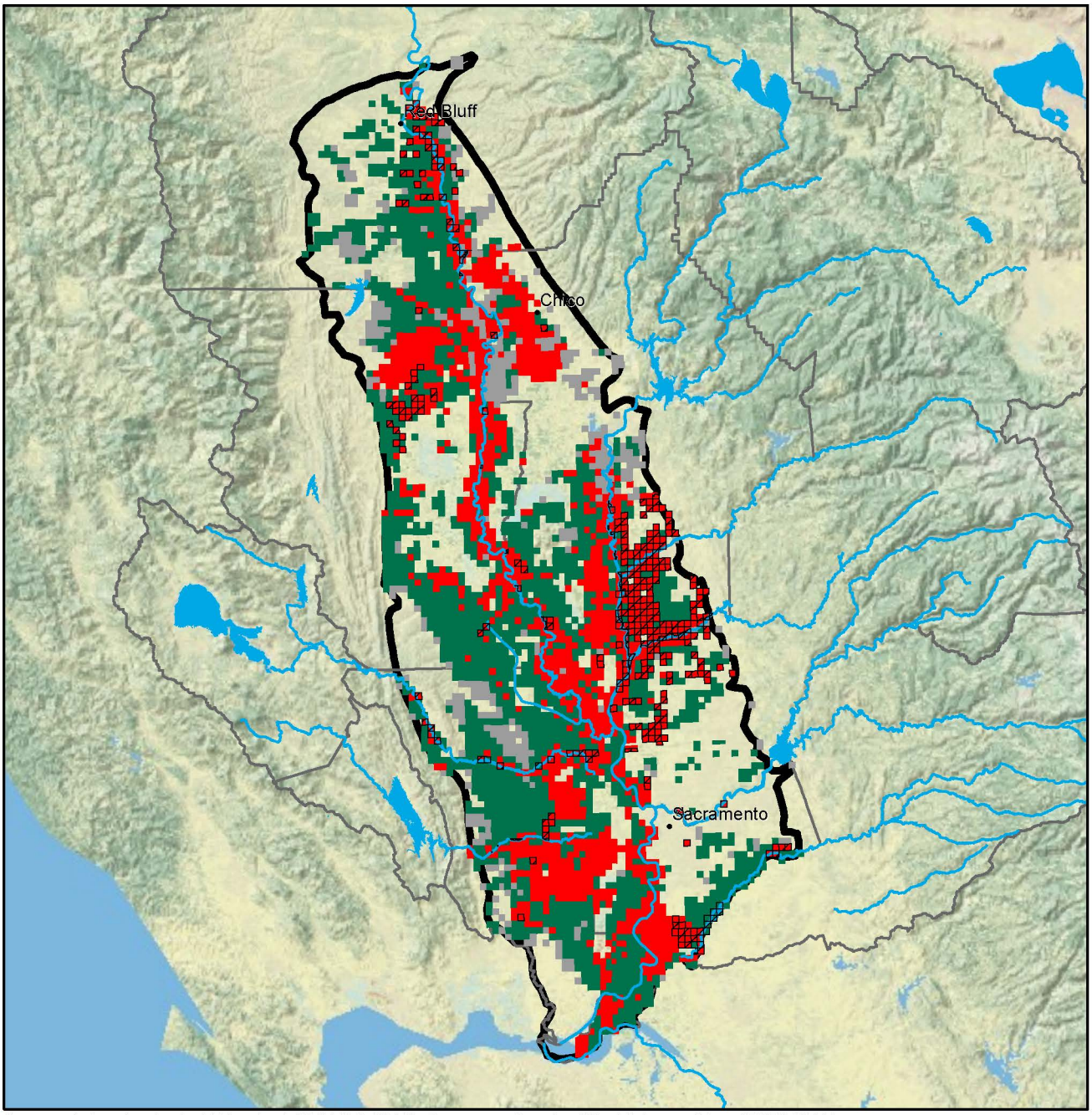
Road Type

- Interstates
- Highways
- SVWQC Boundary
- SVWQC Subwatersheds
- Rivers
- DWR Groundwater Basins witihin SVWQC Subwatersheds

0 5 10 20 30 40
Miles

N

FIGURE A1
Sacramento River Watershed Study Area
Comprehensive Groundwater Quality Management Plan



Source: Subwatersheds, Watershed (SVWQC 2013); Basemap, County, City, Highway, River (ESRI 2011).

LEGEND

- SACFEM Boundary
- Subwatersheds
- Cities
- Rivers
- Waterbodies
- DPR Groundwater Protection Areas

Vulnerability

- High
- Low
- Data Gap

0 5 10 20
Miles

N

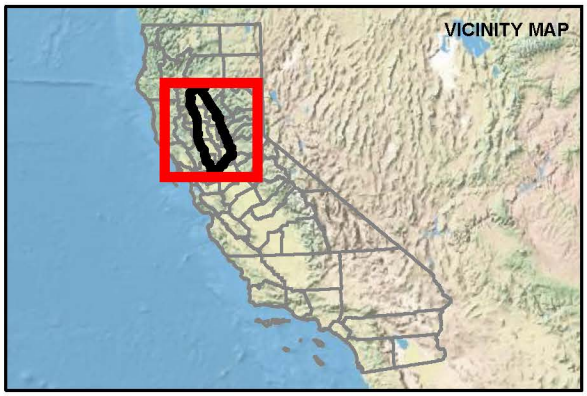
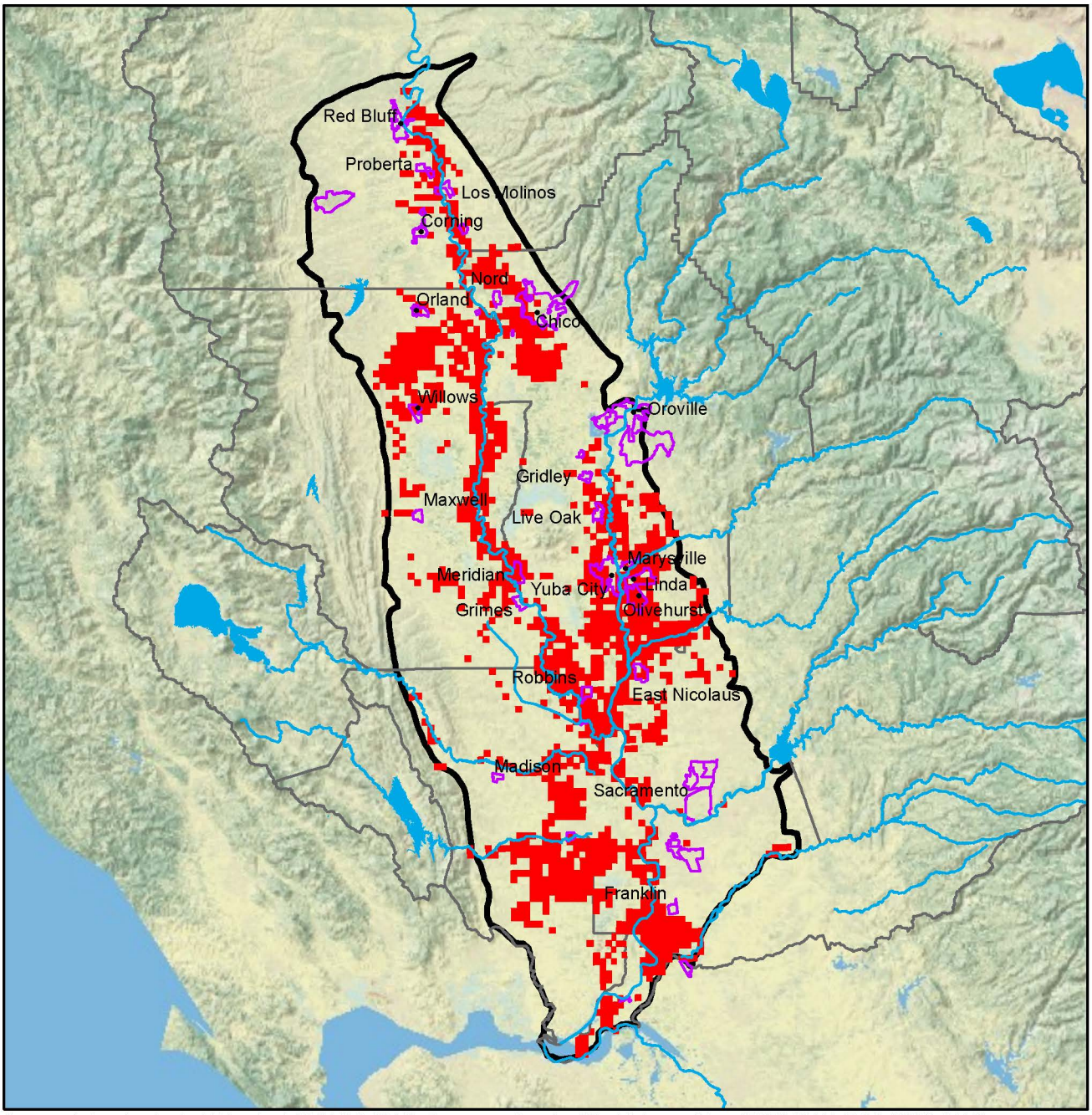


FIGURE A2
Sacramento Valley Floor Vulnerability Designation
Comprehensive Groundwater Quality Management Plan



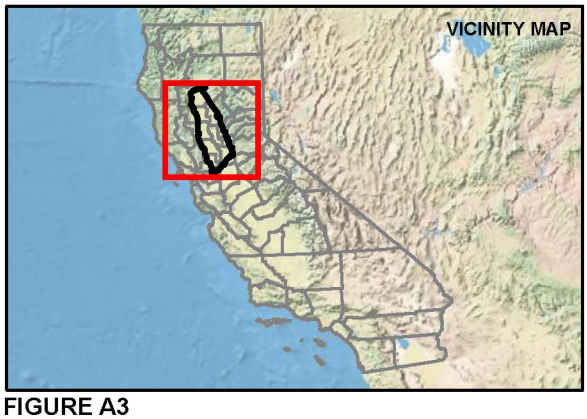
Source: Subwatersheds, Watershed (SVWQC 2013); Basemap, County, City, Highway, River (ESRI 2011). DAC (DWR 2015).

LEGEND

- SACFEM Boundary
- Subwatersheds
- Cities
- Rivers
- Waterbodies
- Disadvantaged Community Places (DAC)
- High Vulnerability Sections

0 5 10 20
Miles

N



Note:
SACFEM is a groundwater flow model encompassing the Sacramento Valley Basin.

FIGURE A3
DACs and HVAs within the Sacramento Valley Floor
Comprehensive Groundwater Quality Management Plan

B. General Information and Physical Setting

B1. General Information

B1.a. Land Use

The Sacramento River Watershed is home to a diverse array of land uses, including agriculture, open space, riparian vegetation, and urban development (Figure B1). Approximately 2.8 million people live within the watershed, over half of whom reside within the Sacramento metropolitan area. Other major cities within the watershed include Alturas, Oroville, Marysville, Yuba City, Redding, Red Bluff, Chico, Davis, and Woodland.

Agriculture is the key economic driver in the Sacramento River Watershed, and more than 1.3 million acres of irrigated agriculture is enrolled in the Coalition. Irrigated agriculture is concentrated around the Sacramento River and its tributaries in areas overlying the Sacramento Valley Groundwater Basin alluvial aquifer. The major crops grown in the Sacramento Valley floor include rice (which is managed by a separate entity, the California Rice Commission), almonds, walnuts, alfalfa, wheat, and corn (Figure B2). In addition, citrus and subtropical crops are grown primarily in Tehama County, and vineyards are scattered throughout southern portions of the watershed.

In addition to agriculture, the region includes approximately 22,000 acres of managed wetlands enrolled as members of the Coalition. These wetlands include large managed wetlands, wetland easements on private farmlands, and federally managed wildlife refuges. These wetlands, managed by a variety of entities, including public agencies, non-government organizations, and private organizations, provide habitat for millions of waterfowl, shorebirds, and migratory birds along the Pacific Flyway.

B1.b. Potential Agricultural Sources of COCs (Nitrate)

The primary COCs from irrigated agriculture are nutrients from fertilizers, salinity, and pesticides. The primary agricultural COC impacting groundwater quality in the Sacramento River Watershed is nitrate. Nitrate is typically introduced to the land surface in the form of nitrogen fertilizers. Once applied to crops, precipitation or irrigation water may leach excess fertilizer not used by the crops, to the subsurface. If this excess nitrate leaches past the root zone and is not denitrified by reducing conditions in the soil, it may reach the groundwater table. Much of this nitrate may get diluted, but the continuous addition of fertilizer may concentrate in the groundwater. The maximum contaminant level (MCL) for nitrate as NO_3 is 45 milligrams per liter for drinking water. The GAR compared observed nitrate concentrations at wells throughout the Coalition area to the MCL to determine whether groundwater supplies are impaired for drinking water and whether areas highly vulnerable to nitrate concentrations exist. Table 2 includes a summary of the main areas exhibiting high vulnerability to nitrate contamination within the Coalition's boundaries.

Agriculture is not the only potential source of nitrates to groundwater, and the GAR identified other sources such as natural sources, dairies, and rural septic systems. Because these are non-point sources of nitrate, and groundwater mixes vertically and horizontally, it is challenging to accurately identify the source of nitrate to groundwater. In many cases, the contamination could occur from various sources mixing together in the groundwater. One of the goals of this GQMP is to help identify where agriculture may or may not be the source of nitrate to groundwater.

B1.c. Designated Beneficial Uses

The *Water Quality Control Plan for the Sacramento River and San Joaquin River Basins* (Basin Plan) (CVRWQCB, 1998) outlines the designated beneficial uses of groundwater. The majority of groundwater

in the Sacramento Valley is considered suitable, or potentially suitable, for municipal and domestic water supply, agricultural supply, industrial service supply, and industrial process supply. However, there are some exceptions based on quality or yield characteristics (CVRWQCB, 1998). Within the region, total municipal, industrial, and agricultural water demand is approximately 8 million acre-feet, with groundwater meeting about 31 percent or 2.5 million acre-feet of the demand (DWR, 2009).

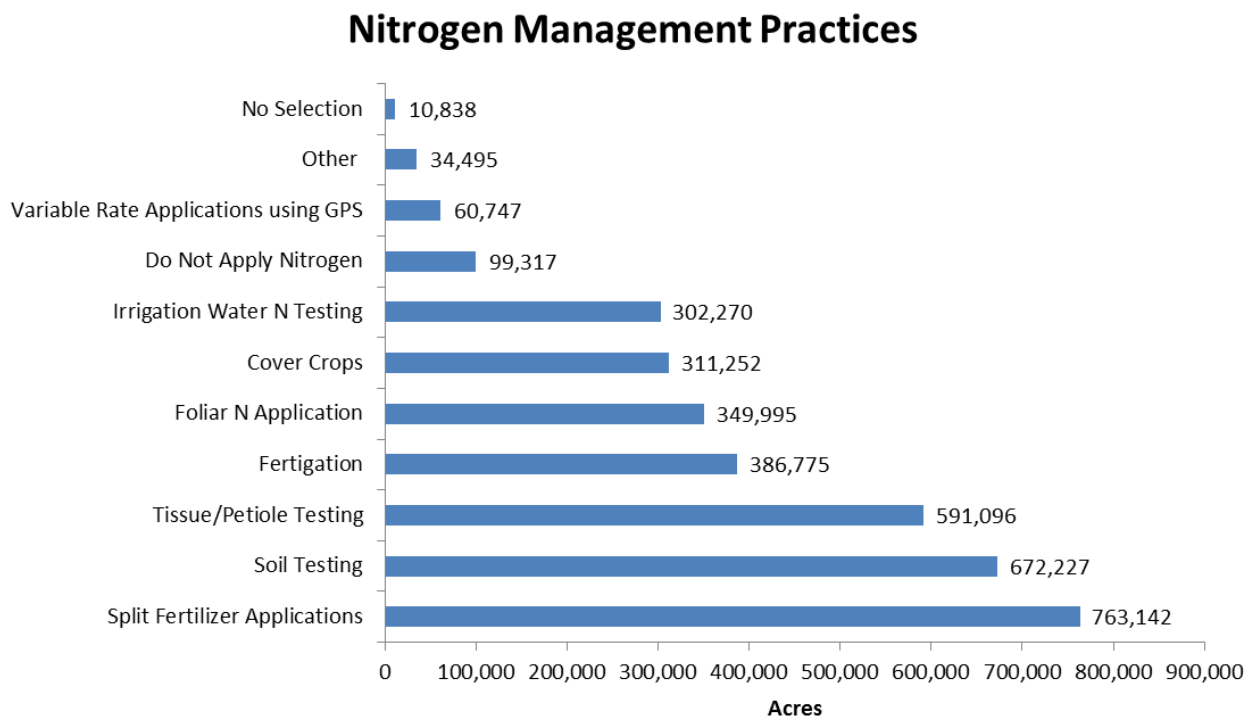
B1.d. Baseline Inventory of Existing Management Practices

Several types of management practices have been adopted by growers within the Sacramento Valley. The Coalition currently collects information on nutrient and wellhead management practices through Farm Evaluation surveys and publishes this information in annual Farm Evaluation Summary Reports.

Data are collected annually through Farm Evaluation survey templates from members with parcels in areas identified as HVAs. HVAs include regions that have surface or groundwater quality impairments or those determined highly vulnerable in the GAR.

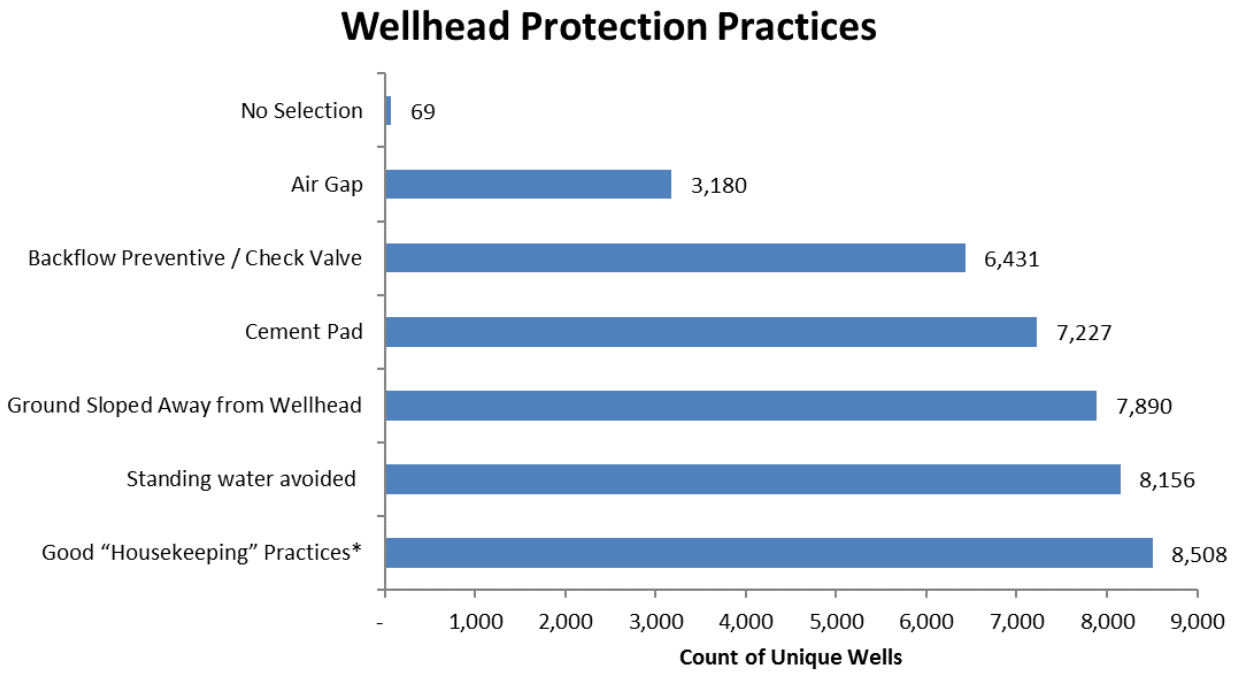
Coalition members currently implement a variety of nutrient management measures. According to the 2015 Farm Evaluation Summary Report (SVWQC, 2016a), many members hire pest control advisors and certified crop advisors to assist in developing crop fertility plans. Specific nitrogen management practices include splitting fertilizer applications throughout the growing season to better match the timing of nutrient applications to nutrient uptake in crops and taking soil and plant tissue samples to better assess nutrient requirements before applying fertilizer. The figure below shows the various nutrient management practices implemented by members shown as total acreage of practice implemented.

A comprehensive baseline inventory of nitrogen applications in HVAs for the 2016 crop year will be collected with the Nitrogen Management Plans (NMPs) Summary Reports starting in 2017.



Source: SVWQC, 2016b

As reported in the Farm Evaluation Reports, many Coalition members have irrigation wells and implement wellhead protection practices to prevent groundwater contamination (SVWQC, 2016b). These include "good housekeeping" practices, avoiding standing water around the wellhead, ensuring that the ground is sloped away from the wellhead, and having a cement pad and backflow preventive/check valve (SVWQC, 2016b). The figure below shows the various types of wellhead protection practices implemented by Coalition members by total number of wells.



Source: SVWQC, 2016b

While many farmers throughout the Central Valley have adopted management practices that reduce the rate at which nitrate is leached, there is insufficient data available for researchers to quantify how much improved management practices reduce nitrate loading and to what degree implementing additional practices will reduce nitrate loading rates (Dzurella et al., 2012). The MPEP and Trend Monitoring Program are aimed at improving this knowledge by conducting studies to quantify the effectiveness of management practices in reducing nitrate loading rates and by collecting supporting groundwater quality data.

Management practices that are not already widely implemented are typically associated with barriers to implementation such as high operating and capital costs, perceived or actual risks to yield, conflicting farm logistics, and farm tenure constraints (Dzurella et al., 2012). Increased farmer education and outreach, as well as specific studies to adapt practices to local conditions may help overcome these barriers (Dzurella et al., 2012). The GQMP outlines a management plan strategy to overcome some of these barriers, focusing on an outreach strategy that will use new information provided by the MPEP and Trend Monitoring Program, as well as member data provided by NMPs.

B1.e. Available Water Quality Information

Extensive technical work has been completed in agricultural regions across the United States, including the Sacramento Valley, by numerous agencies, organizations, and academic entities to collect information pertaining to nitrate contamination of groundwater. A summary of readily available data related to groundwater quality in the Sacramento Valley is included in Table 3. This information was used in the GAR to provide preliminary results of existing nitrate impacts, evaluate trends in observed water quality data, and develop a methodology to designate HVAs throughout the Sacramento River Watershed.

Table 3. Sources of Readily Available Data Collected as Part of the GAR Preparation

Data Set	Agency or Organization	Analytical Application
Previous studies and characterization of Sacramento Valley	USGS, DWR, CVRWQCB, and other related organizations	Understanding of background information and review of previous technical reports that are pertinent to the GAR analysis
Detailed and general geology of Sacramento Valley	USGS, California Division of Mines and Geology	Geology and hydrogeology information
GPAs	DPR	GPAs based on leaching and runoff for initial vulnerability analysis
Initial Hydrogeologic Vulnerable Areas	SWRCB	HVAs for initial vulnerability analysis
Land use surveys by county	DWR, Natural Resources Conservation Service, and Cal Ag Pesticide Use Reporting System	Land use and crop categories at the field level
Groundwater well databases and projects: GeoTracker GAMA, NWIS, Water Data Library, DPR groundwater quality database and well inventory reports, Yolo County well data	SWRCB, USGS, DWR, DPR, YCFCWCD	Groundwater quality data
Soil Survey Geographic data by soil map unit	Natural Resources Conservation Service	Surface soil texture, drainage class, salinity measured as electrical conductivity, permeability measured as hydraulic conductivity, pH
Stakeholder Outreach	Coalition Subwatershed Groups, Farming Advisors, NCWA Groundwater Advisory Group	Collect information on farming practices, groundwater quality monitoring programs, and general information on subwatershed characteristics

Note:

YCFCWCD = Yolo County Flood Control and Water Conservation District

The GAR analyzed historical and current groundwater monitoring networks to determine which networks were applicable to groundwater quality and to identify gaps in data. The DWR Northern and North Central Districts conduct groundwater-level monitoring for wells of varying depths and uses across the Sacramento Valley and publish groundwater contour maps.

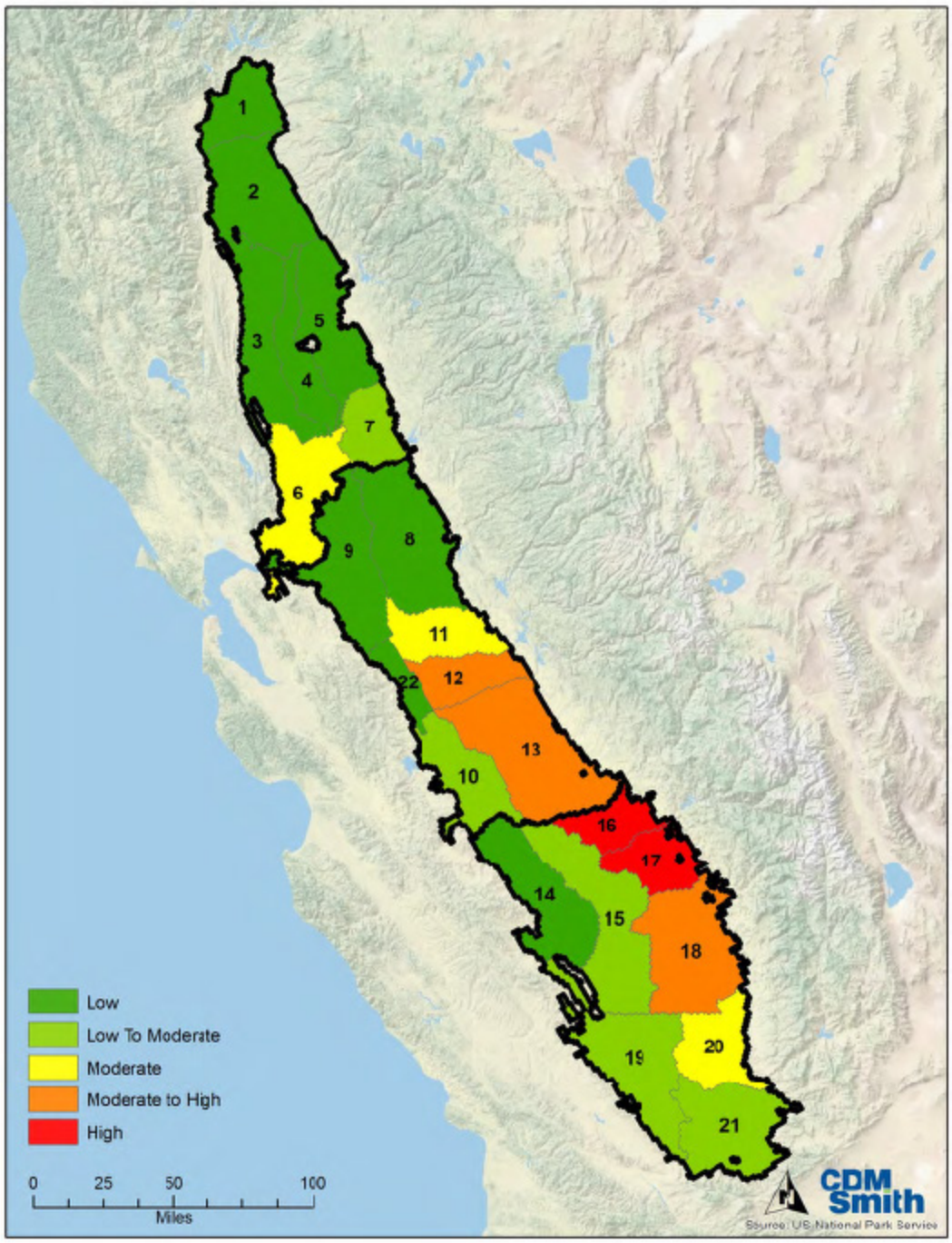
The California Statewide Groundwater Elevation Monitoring (CASGEM) program, which is maintained by DWR, provides additional groundwater-level data through an online database. Numerous agencies throughout the Sacramento Valley participate in the CASGEM program by uploading water-level data on a regular basis.

Accessible groundwater quality data sets are primarily maintained by public agencies. These include the GeoTracker GAMA geodatabase (SWRCB), the National Water Information System (NWIS) Web Portal (USGS), and the Water Data Library (DWR). These regional databases generally include a significant amount of information and cover large areas of the Sacramento Valley floor. However, they do not include all information pertaining to well construction, and limited trend data are available. Table 4 includes a summary of these accessible groundwater quality data sets. GAR Figures 3-1 to 3-5 (NCWA, 2016) plot the various networks of wells with groundwater quality measurements.

Another source of groundwater quality information comes from the CV-SALTS initiative. CV-SALTS began in 2006 and is aimed at addressing salinity issues, including nitrate in soil and water throughout the Central Valley[1]. CV-SALTS is developing a Central Valley floor-wide regional salt and nitrate management plan (SNMP) to meet the requirements of the State Recycled Water Policy. To inform the development of the SNMP, CV-SALTS prioritized areas, referred to as initial analysis zones (IAZs), in its Nitrate Implementation Measures Study to determine areas that have the greatest potential for salinity and nitrates to affect groundwater users. The IAZs were prioritized based on criteria, including ambient total dissolved solids and nitrate concentrations in groundwater, estimated nitrate and total dissolved solids loading to the upper groundwater aquifer, CASGEM Program Basin Prioritization Process and Ranking, and the overlying population (San Joaquin Valley Drainage Authority, 2016a). The results of this study specific to nitrate are shown on the map below, which shows nitrate prioritization by IAZ. As shown on this figure, the IAZs with the lowest nitrate priority rankings are generally located in the Sacramento Valley. The highest priority rankings for nitrate within the Sacramento Valley exist in IAZs 6 and 7, the Cache-Putah Creek area, and the area east of the Feather River and South of Yuba City, respectively. IAZ 6 is considered moderate priority and IAZ 7 is considered low to moderate priority.

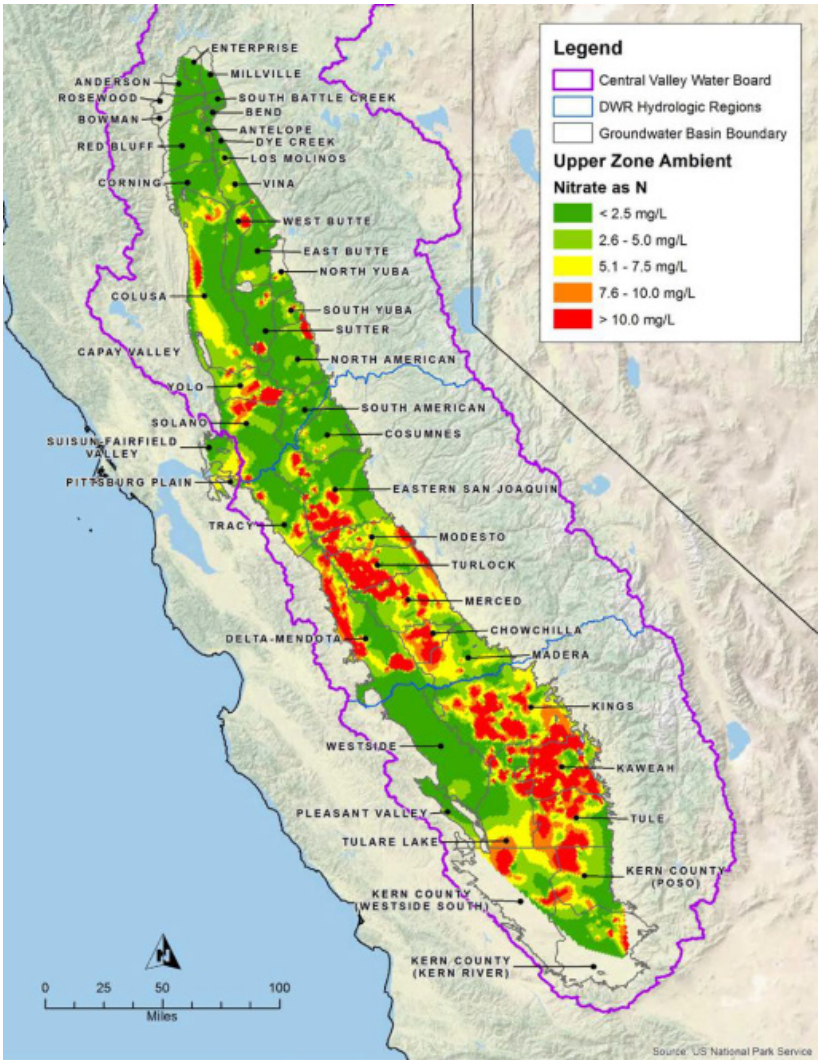
In 2016, the *Updated Groundwater Quality Analysis and High Resolution Mapping for the Central Valley Salt and Nitrate Management Plan* was completed at the DWR groundwater basin scale, providing an updated analysis of salt and nitrate ambient conditions, predicted trends out to 50 years, and updated information regarding potentially available assimilative capacity in groundwater (San Joaquin Valley Drainage Authority, 2016b). This study provided refined groundwater data for the Central Valley floor to support final policy decisions regarding management of salt and nitrate, as well as an assessment of salt and nitrate conditions outside of the Central Valley floor.

[1] Additional details regarding the CV-SALTS initiative is included in Section C4.a.



Source: San Joaquin Valley Drainage Authority, 2016a

Similar to the results at the IAZ scale, the *Updated Groundwater Analysis and High Resolution Mapping for Central Valley Salt and Nitrate Management Plan* ranked the Yolo subbasin as one of the highest priority areas for management actions. As the following map indicates, nitrate in shallow groundwater has limited impact on groundwater quality in the Sacramento Valley. Salinity appears to be a more prominent groundwater quality impairment, although not necessarily due to agricultural practices, as discussed in the GAR. Through the CV SALTS initiative, a broader salinity strategy is being developed (CV-SALTS, 2016).



Source: CV-SALTS, 2016

Section 3 of the CV-SALTS SNMP describes groundwater quality conditions in detail and shows trends of degradation in shallow groundwater (See Tables 3-8 through 3-9) (CV-SALTS, 2016). Based on this technical work, much of the Sacramento Valley shows no trend of degradation for nitrates or salinity. The IAZs were prioritized to establish a schedule for compliance with the salt and nitrate management requirements of the SNMP, which will be developed by local stakeholders. This allows stakeholders to focus resources on high priority areas first when developing a local SNMP. In the Sacramento Valley, SNMPs for IAZ 6 would be the highest priority, followed by IAZ 7. In addition, this prioritization staggers the submission of SNMP deliverables to the CVRWQCB, so that sufficient staff resources are available to review the deliverables.

The CV-SALTS program adds important groundwater quality information for use with the ILRP and other programs, and further confirms the findings of the GAR—that the Sacramento Valley floor has low potential for nitrate contamination of groundwater.

Table 4. Summary Evaluation of Available Well Water Quality Data Sources

Managing Agency	Database or Program	Characteristics					GAR Use?	Reason for Use	Comment
		Total Depth	Screen Interval/ Sampling Depth	Coverage	Well Type	Sample Dates			
SWRCB	GeoTracker GAMA Database	NA	NA	Overall adequate	NA	Varies by data set	Partial		This database does not include any well construction information
	California Department of Public Health	NA, considered deep	NA	Good study area coverage	Public supply	1982–2012	Partial	Provides deep aquifer information for drinking water quality	Only using the wells that are overlying irrigated agriculture
	DWR	NA	NA	Sparse	NA	2000–2008	No	Incomplete data set	Data set from DWR database were used
	USGS	NA, considered deep	NA	Sparse	Public supply	2006	No	Incomplete data set	Well type inferred from known USGS GAMA program info – USGS database used instead
	GAMA Program Domestic Wells Project	Generally less than 500 feet deep	NA	Tehama, Yuba, and El Dorado Counties	Domestic	2002–2005	Yes	Good coverage of three counties that include irrigated agriculture	Total depth known from reports, not from database; only one sample date per county
USGS	NWIS Database	Varies	Available for some wells	Good coverage	Varies	Varies	Yes	Good data set; includes well construction information	
	GAMA Program Priority Basin Project	Deep	Screen intervals available	Only in DWR basins	Public supply	2005–2008	Yes	QC'd data set and published results	Only one sample date per study area
	National Water-Quality Assessment	Shallow	Screen intervals available	Southeast Sacramento Valley	Domestic	1996, 2008	Yes	QC'd data set and published results	
DWR	Water Data Library	NA	NA	Mostly DWR Basins	Varies	Varies	Yes	Provides a good coverage	
	Monitoring Wells Network	Available	Available	Sacramento Valley floor	Monitoring	Varies	Yes	Provides specific monitoring data	These are multi-completion wells

Note:

NA = not available

B2. Groundwater Conditions

A summary of the soil conditions, geology and hydrogeology of the Sacramento Valley floor is provided in this section. For a comprehensive description, refer to the GAR (NCWA, 2016).

B2.a. Soil Data

The Coast, Cascade, and Sierra Nevada mountain ranges surrounding the Sacramento Valley have weathered and eroded to fill the valley bottom with alluvial material. Over time, soils formed within these alluvial parent materials on the landscapes formed by these deposits, giving rise to a relatively wide variety of soils and soil conditions within the Sacramento Valley floor.

Soils of the Sacramento Valley floor are diverse, ranging from well to poorly drained, and from sandy loams to clay textures. Generally, the more well-drained and coarser textured soils (sandy loams) exist on alluvial fans and basin rims, and the more poorly drained and finer textured soils (silty clays and clays) exist in basins. Soils of the valley floor basins tend to be moderately well to poorly drained, and range from non-saline to strongly saline depending on location. These soils tend to be alkaline and have a low to moderately low hydraulic conductivity. The soil underlying irrigated agriculture is primarily composed of varying categories of loam. Figure B3 shows the distribution of soil surface texture in the Sacramento Valley, and Figure B4 shows the distribution of soil drainage classes in the Sacramento Valley. Additional information pertaining to soil characteristics, soil unit descriptions, and sources of soil data, and figures of hydraulic conductivity, salinity, and pH are provided in the GAR (NCWA, 2016).

B2.b. Geology and Hydrogeology

The Sacramento Valley floor, which overlies the northern portion of the Central Valley alluvial aquifer, includes the Sacramento Valley Groundwater Basin and the Redding Area Groundwater Basin. Together, these two basins are referred to as the Sacramento Valley Groundwater Basin. A map of the detailed lithology of the Sacramento Valley is provided on Figure B5.

The hydrology of the Sacramento Valley floor includes a wide variety of hydrogeologic influences, ranging from foothills and mountains around the floor's edges, to the tidally influenced Delta at the floor's southern extreme, and major rivers and their tributaries throughout the length of the floor. In most of the Sacramento Valley, streams are in direct hydraulic connection with the underlying aquifer; however, groundwater is free to flow underneath river systems because regional groundwater flow patterns within the aquifer respond to recharge and discharge at a much larger scale than the individual rivers and streams. Therefore, the Sacramento Valley Groundwater Basin functions primarily as a single laterally extensive alluvial aquifer, not as numerous discrete, smaller groundwater subbasins.

Recharge to the Sacramento Valley Groundwater Basin occurs through several mechanisms in different areas: through leakage from streams primarily along the upper reaches of tributary streams along the basin boundary, through deep percolation of applied water in irrigated areas (most of the valley floor), from mountain-front recharge (subsurface inflow), and from deep percolation of precipitation. The majority of the valley floor constitutes a recharge zone for the shallow aquifer, whereas deep aquifer recharge occurs primarily through outcrops of the Tuscan Formation along the eastern side of the valley.

Discharge from the aquifer system occurs when groundwater is extracted by wells, discharged to streams, leaves the basin through subsurface outflow, is evapotranspired by phreatophytes, or discharges to the ground surface. In the Sacramento Valley, the low-lying Butte Sink in the Sutter Basin constitutes an area of significant groundwater discharge.

Depth to groundwater throughout most of the Sacramento Valley averages about 30 feet below ground surface, with shallower depths along the Sacramento River and greater depths along the basin margins. Seasonal fluctuations in groundwater levels occur as a result of recharge from precipitation and

snowmelt runoff, associated fluctuations in river stages, and the pumping of groundwater to supply agricultural and municipal demands.

The Sacramento Valley Watershed groundwater aquifers are generally considered to be of high quality but have some localized areas of concern. Naturally occurring constituents in higher concentrations result in local impairments. For example, marine sedimentary rocks occurring at the margins of the valley and near the Sutter Buttes result in brackish to saline water near the surface. Other local natural impairments include high arsenic and boron concentrations. Arsenic originates from dissolved minerals of the volcanic and granitic rocks of the Sierra Nevada and is generally in limited areas along the Sacramento and Feather Rivers. Some communities have impaired public water supply systems because of elevated arsenic concentrations, such as Los Molinos (Tehama County, south of Red Bluff). Boron has also been linked to old marine sediments from the Coast Ranges, and elevated levels can be found within the southern and middle portions of the Sacramento Valley (for example, in Yolo County).

Anthropogenic constituents linked to farming practices such as pesticides and nutrients (nitrates found in fertilizers) have not been identified as a threat to drinking water supplies of the Sacramento Valley. However, some public water supply systems that tend to have nitrate levels exceeding the MCL include Olivehurst, Chico, Antelope, and the Woodland-Davis area in Yolo County.

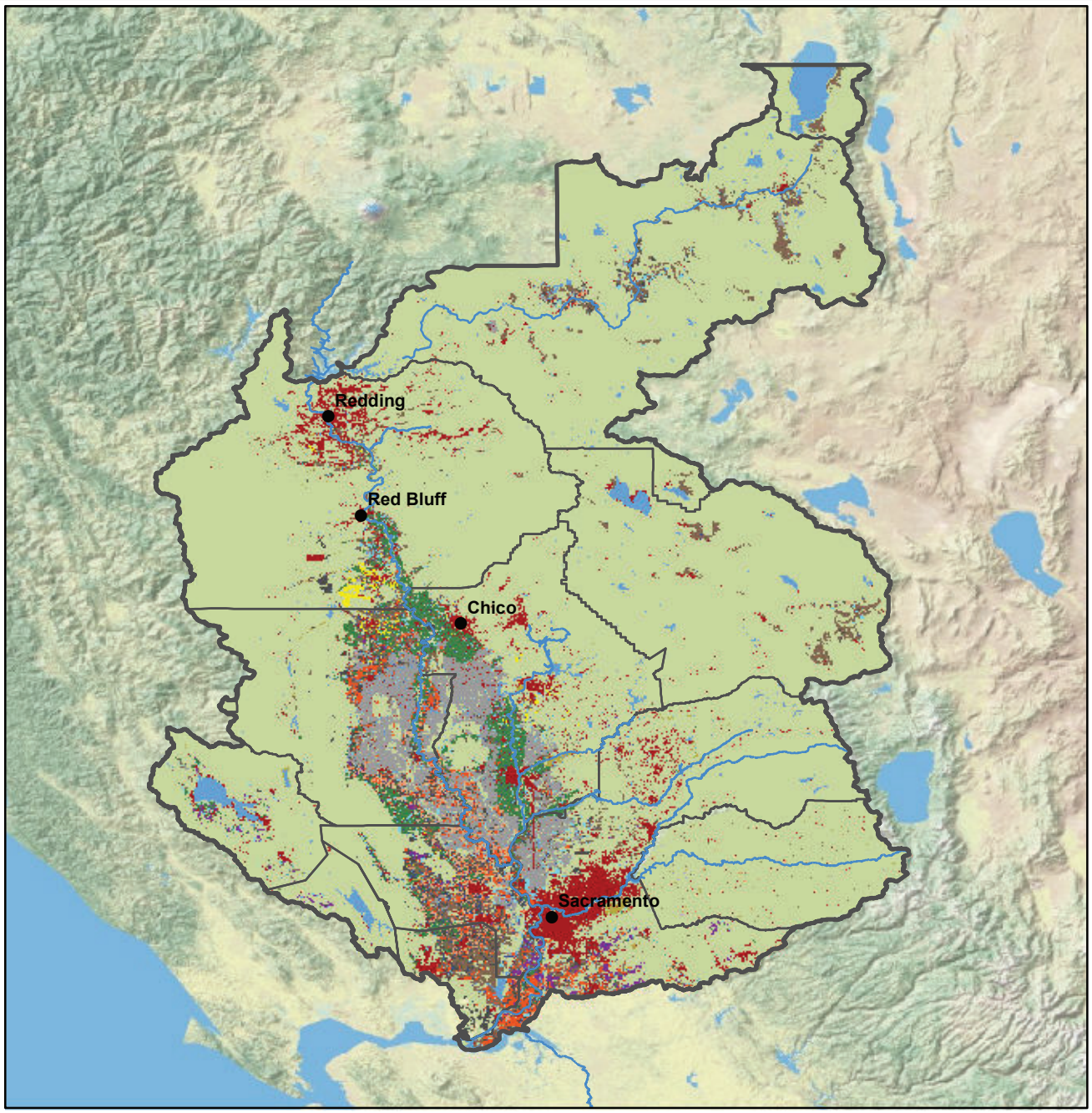
B2.c. Identification of Irrigation Supplies and Available Water Chemistry

The Sacramento Valley floor is generally blessed with an abundance of surface water supplies in most years because of senior water rights on the Sacramento River and a large watershed draining into the largest river in California. The surface water supplies are primarily managed by irrigation districts that divert water from the Sacramento River and its tributaries, and transport water to their agricultural customers via a large network of canals and pipes. In areas that are not within an irrigation district boundary, growers may have their own surface water rights and associated water distribution system, or they use groundwater to irrigate their fields. Groundwater is also used as a supplemental source of irrigation supply by irrigation districts in drought years and by the growers themselves to supplement any lack of surface water.

Figure B6 shows the water sources used throughout the Sacramento Valley. It depicts the regions in which surface water, groundwater, or a mix of surface water and groundwater is used for irrigation. The main regions reliant on groundwater or a mixture of surface water and groundwater for irrigation are represented by the blue and green areas, respectively. These regions include lands along the Sacramento River south of Red Bluff to the city of Sacramento, along the Feather River south from Oroville to its confluence with the Sacramento River, and in lands around the urban areas of Chico, Willows, Yuba City-Marysville, Woodland-Davis, and south of Sacramento.

The quality of irrigation water in the Sacramento Valley floor is generally very good and does not require treatment for irrigation. Annual monitoring reports (AMRs) include summaries of surface water chemistry as measured at monitoring compliance points. Monitoring results for the period of record for the Coalition's 2015 AMR (October 2014 through September 2015) indicate that with a few exceptions, there are no major water quality problems associated with agriculture and managed wetland discharges. Pesticides were rarely detected, with only two registered pesticides exceeding ILRP Trigger Limits in six monitoring samples. Trace elements, including arsenic, cadmium, lead, molybdenum, nickel, selenium, and zinc have rarely approached or exceeded water quality objectives. The majority of water quality exceedances consist of conductivity, dissolved oxygen, and *E. coli*. While irrigated agriculture may contribute to these exceedances, natural processes and sources are believed to be the cause (SVWQC, 2016c).

Groundwater quality is also adequate for irrigation. Some areas may have higher concentrations of nitrate in groundwater than others as identified in the GAR and shown with the HVAs.



Source: Land Use by County (DWR 2013); Subwatersheds (SVWQC 2013); Basemap, City, County, River (ESRI 2013). Datum is NAD83.

LEGEND

- Cities
- Rivers
- SVWQC Boundary
- SVWQC Subwatersheds

Land Use Category

- Citrus and Subtropical
- Deciduous Fruits and Nuts
- Field Crops
- Grain and Hay
- Pasture
- Vineyards
- Rice
- Tilled Lands
- Livestock, Dairy, Poultry
- Surface Water
- Barren and Wasteland
- Native Vegetation
- Urban
- Idle

0 5 10 20 30 40
Miles

N

Notes:
1. DWR land use data was obtained by county between 1994 and 2008 in the year that that county was surveyed.
2. El Dorado land use data was obtained from NRCS SSURGO 2003 surveys.

FIGURE B1
Land Use in the Sacramento River Watershed
Comprehensive Groundwater Quality Management Plan

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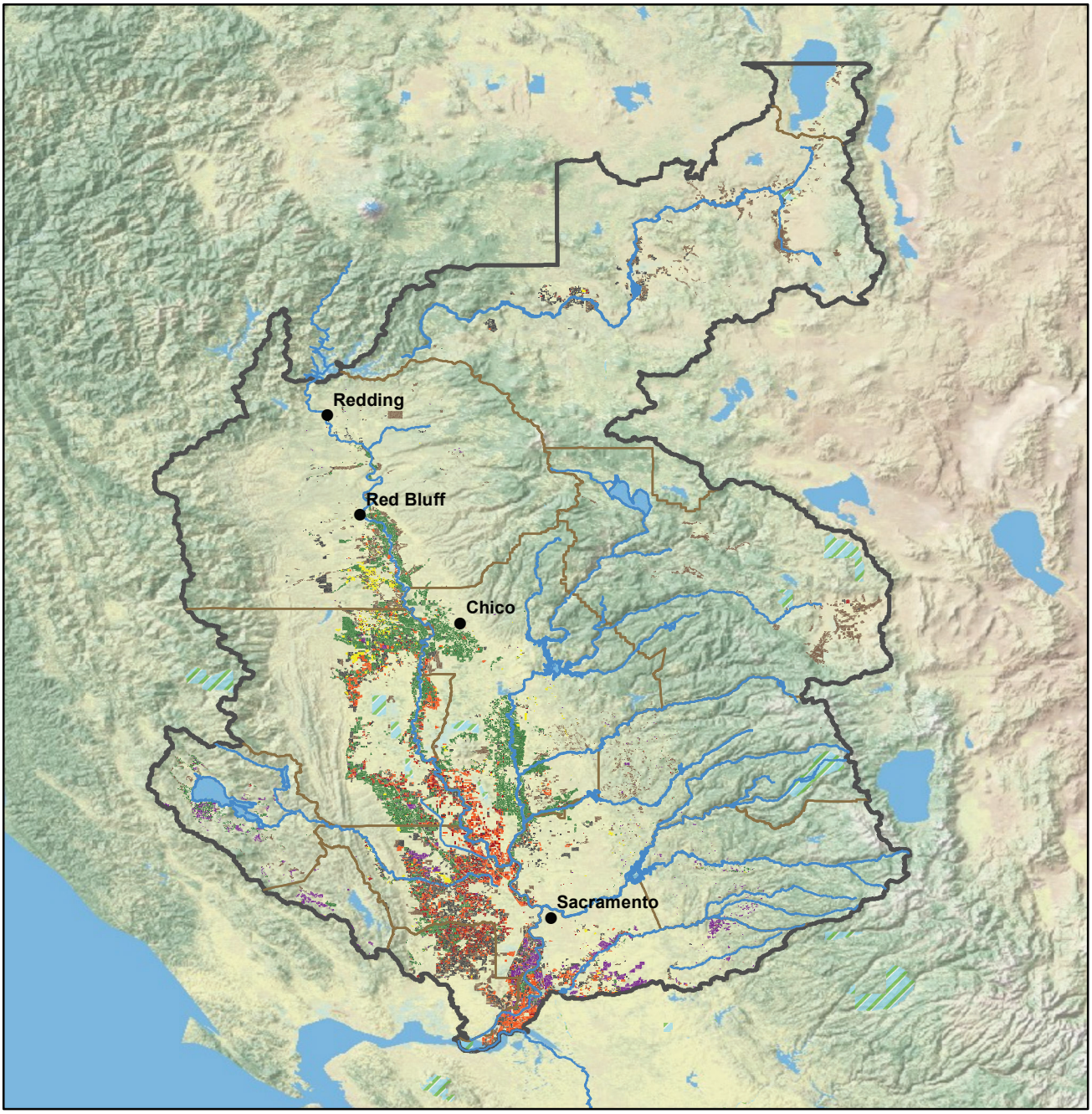

Source: Land Use (DWR, CalAg PUR 2013); Subwatersheds (SVWQC 2013); Basemap, City, County, River (ESRI 2011). Datum is NAD83.

LEGEND

- Cities
- Rivers
- SVWQC Boundary
- Subwatersheds
- National Wildlife Refuges
- Wetland Easements

Crop Categories

- Annual Fruit, Vegetables & Seeds
- Citrus, Olives & Ornamental
- Deciduous Fruits & Nuts
- Fields
- Grains & Hay
- Pastures
- Vineyards

N

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Miles

Notes:
1. Cal Ag PUR Field Boundaries land use data for registered pesticides was obtained from 2013. Most recent DWR land use data is represented for countries with no PUR data.

FIGURE B2
Major Irrigated Crop Categories in the Sacramento River Watershed
Comprehensive Groundwater Quality Management Plan

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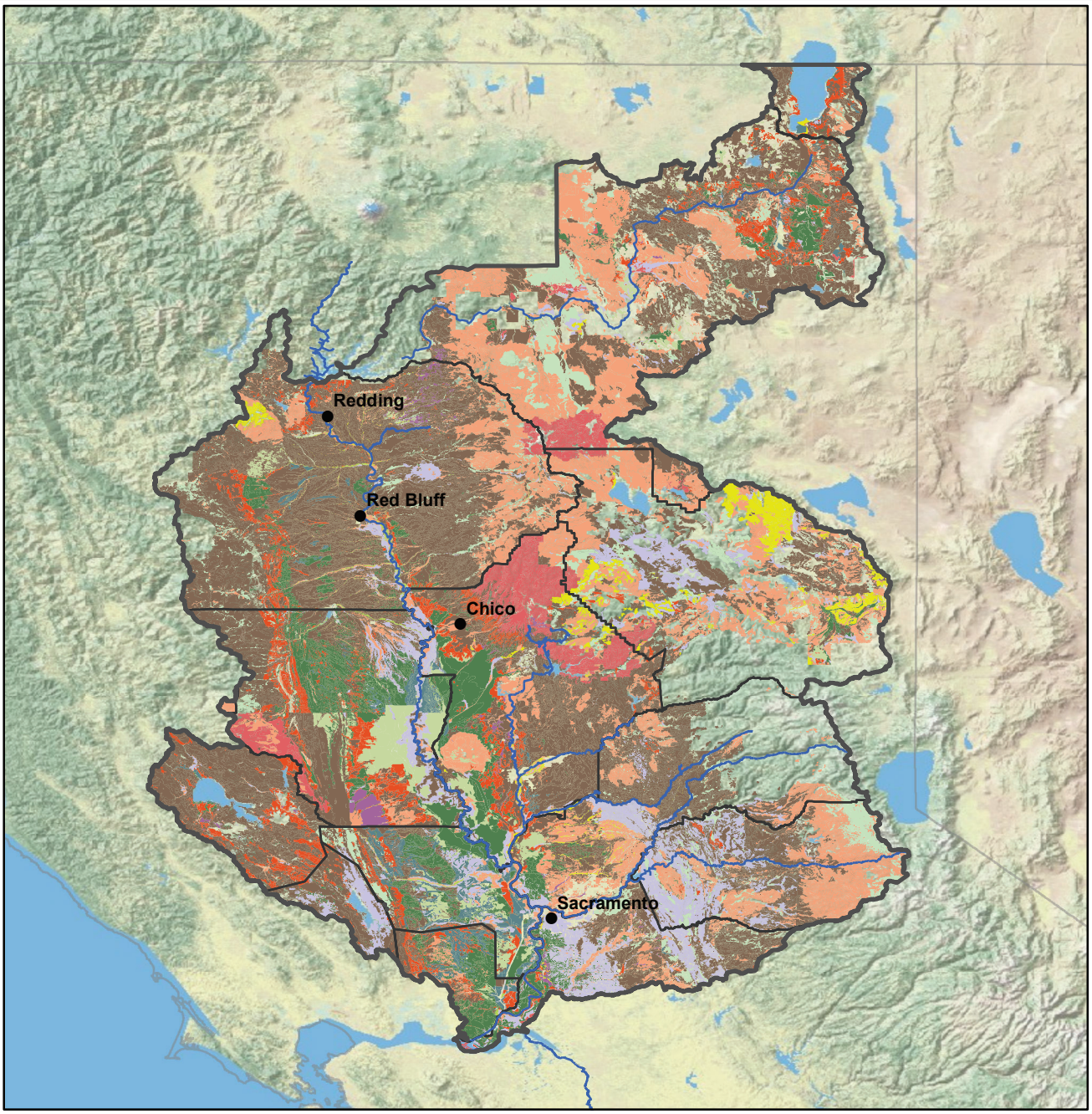

Source: SSURGO Texture (NRCS 2013); Subwatersheds (SVWQC 2013); Basemap, City, County, River (ESRI 2013). Datum is NAD83.

LEGEND

- Cities
- Rivers
- SVWQC Boundary
- SVWQC Subwatersheds
- Bedrock
- Clay
- Clay loam
- Decomposed plant material
- Loam
- Loamy sand
- Sand
- Sandy clay loam
- Sandy loam
- Silt loam
- Silty clay
- Silty clay loam

Notes:
1. Blank areas are unclassified.

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FIGURE B3
Soil Surface Texture in the Sacramento River Watershed
Comprehensive Groundwater Quality Management Plan

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FIGURE 4_SOIL TEXTURE IN THE SVWQC AREA.MXD MCORONA1 11/25/2013 5:06:00 PM

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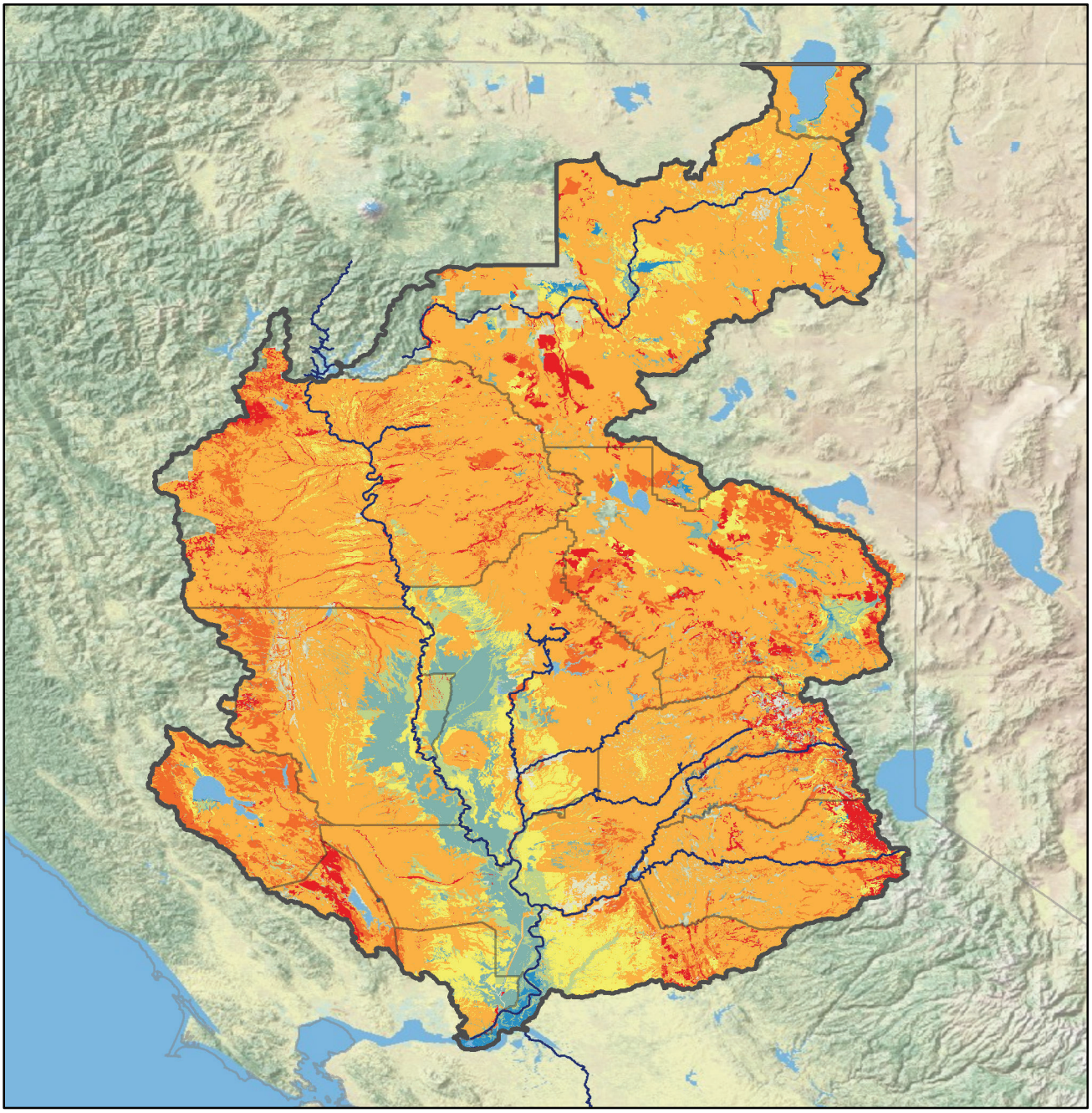

Source: SSURGO Drainage (NRCS 2013), Subwatersheds (SVWQC 2013); Basemap, City, County, River (ESRI 2013). Datum is NAD83.

LEGEND

- Cities
- Rivers
- SVWQC Boundary
- SVWQC Subwatersheds

NRCS Drainage Class

- Very poorly drained
- Poorly drained
- Somewhat poorly drained
- Moderately well drained
- Well drained
- Somewhat excessively drained
- Excessively drained

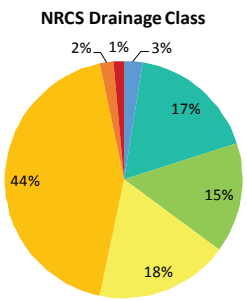

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FIGURE B4
Soil Drainage Classes in the Sacramento River Watershed
Comprehensive Groundwater Quality Management Plan

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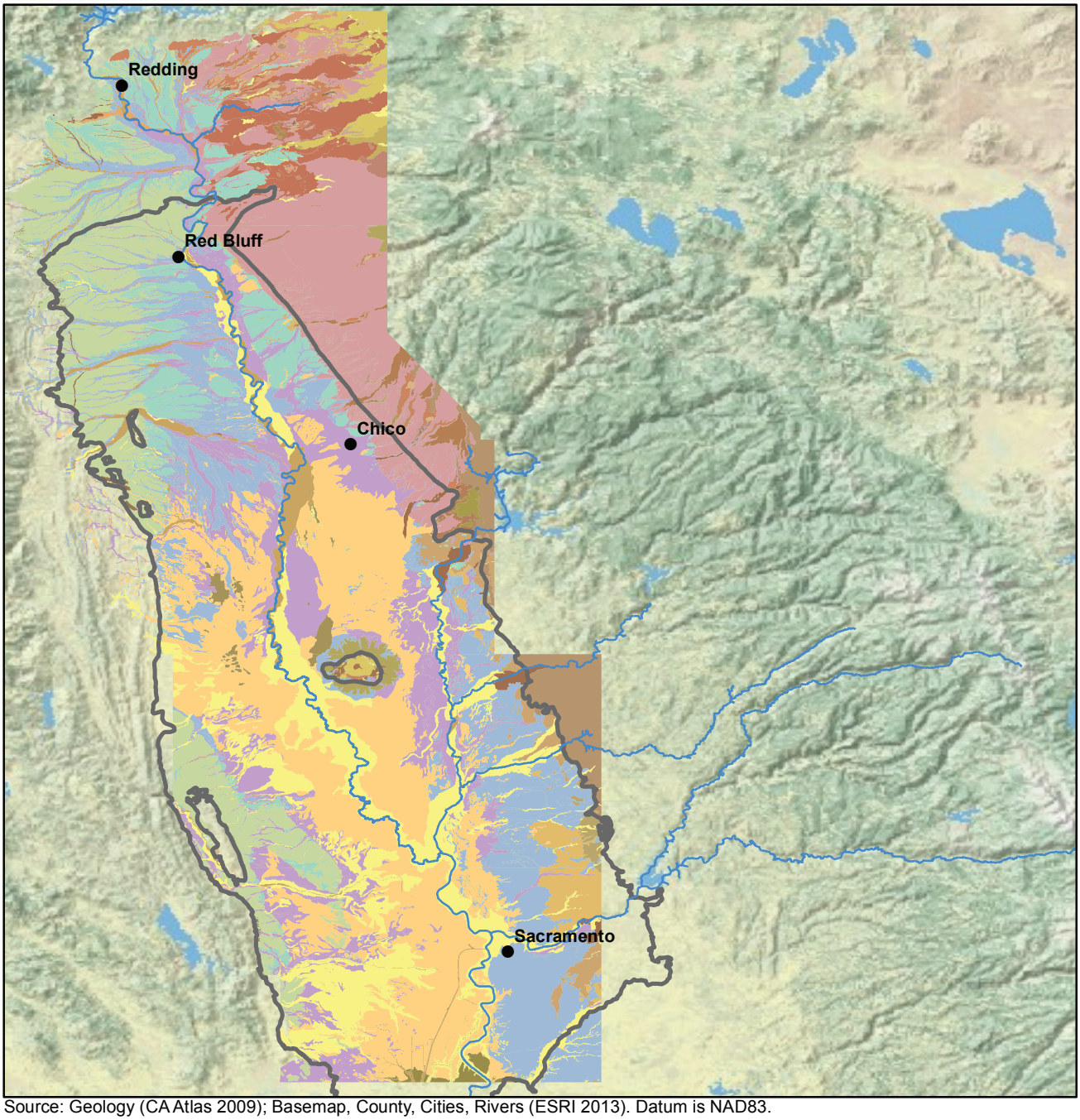

Source: Geology (CA Atlas 2009); Basemap, County, Cities, Rivers (ESRI 2013). Datum is NAD83.

LEGEND

- Sacramento Valley Groundwater Basin
- Cities
- Rivers
- Alluvium
- Andesite
- Basalt
- Basaltic Andesite of Antelope Creek
- Basin Deposits, Undivided
- Blue Ridge Rhyolite of Coe (1977)
- Channel Deposits
- Chico Formation
- Cinder Blanket Deposits, Black Butte
- Cinder Cone Deposits
- Cinder Deposits associated with Basalt of Whitmor
- Flank Fissure
- Ione Formation
- Ishi Tuff Member
- Laguna Formation
- Landslides
- Lovejoy Basalt
- Marsh Deposits
- Mehrten Formation
- Metamorphic and Igneous Rocks
- Modesto Formation
- Montgomery Creek Formation
- Nomlaki Tuff Member
- Older Gravel Deposits
- Olivine Basalts
- Overbank Deposits
- Peat Deposits
- Red Bluff Formation
- Rhyolite Domes in Sutter Buttes Area
- Riverbank Formation
- Rockland Ash Bed
- Sedimentary Rocks in Sutter Buttes Area
- Stream Channel Deposits
- Sutter Formation of Williams and Curtis (1977)
- Tailings
- Tehama Formation
- Tuff
- Tuff Breccia
- Turlock Lake Formation
- Tuscan Formation
- Volcanic Lake Bed

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Miles

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FIGURE B5
Detailed Lithology in the Sacramento Basin
Comprehensive Groundwater Quality Management Plan

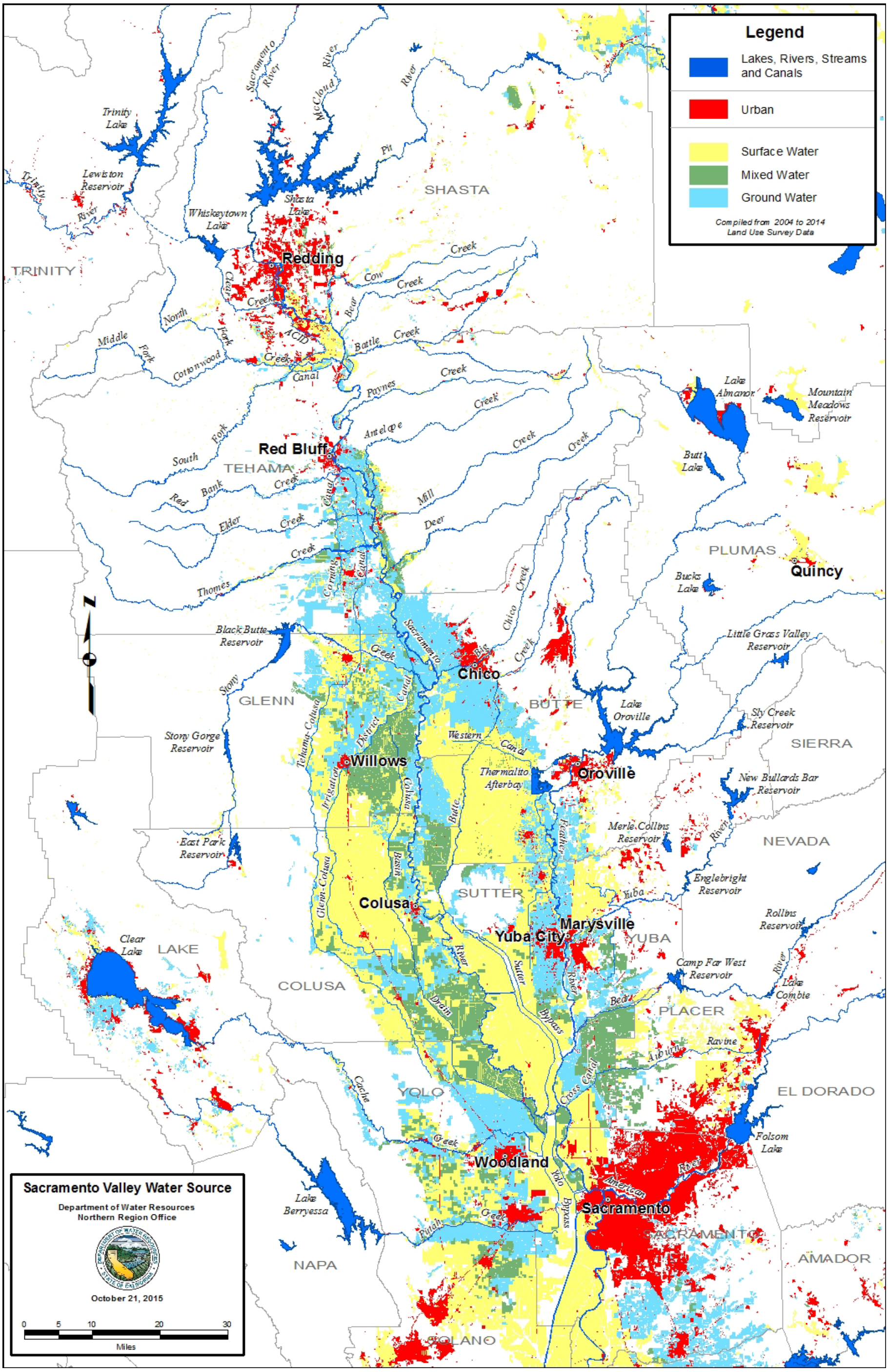


FIGURE B6
Sacramento Valley Water Source Map (DWR, 2015)
Comprehensive Groundwater Quality Management Plan

C. Management Plan Strategy

C1. Management Plan Approach

The goal of the GQMP is to outline a process to assist Coalition members in adopting effective management practices that are protective of groundwater quality. The following GQMP objectives were developed to meet this goal:

6. Document information regarding sources of nitrate contamination in groundwater and collect current management practices for members in HVAs
7. Study effectiveness of various management practices protective of groundwater quality
8. Conduct outreach to members via Subwatershed Action Plans
9. Evaluate effectiveness and adaptive management
10. Prioritize HVAs in regions where DAC drinking water sources could be affected

The Coalition will revise the goals and objectives to align them with the SNMP regulatory framework and recommended policies developed and adopted through the CV-SALTS Basin Plan Amendment process when it is adopted. The SNMP will establish a revised regulatory framework that provides flexibility necessary to make salt and nitrate management decisions at the appropriate temporal, geographic and/or management zone scales[2]. The SNMP is proposed to be implemented through WDRs and to set requirements for compliance based on existing ambient water quality conditions and estimated available assimilative capacity. Once adopted, the SNMP may result in revisions to the HVAs identified through the GAR, resulting in revisions to this GQMP.

The HVAs established by the GAR were ranked to prioritize implementation of actions and develop a management practices strategy and schedule to comply with the Coalition's Order requirements. Three priority categories were identified, with the highest priority ranking being 1 and the lowest priority ranking being 3. The following list describes the priority rankings (shown on Figure C1):

1. HVA sections with a priority ranking of 1 refer to areas that have the following characteristics:
    a. Are close to or are upgradient from DACs on the Sacramento Valley floor and where known groundwater quality impacts have occurred.
    b. Have shown potential agricultural impacts on groundwater quality (such as in Yolo and Solano Counties).
2. HVA sections with a priority ranking of 2 refer to areas that have the following characteristics:
    a. Have shown high concentrations of nitrate in groundwater in older samples and where the contamination is likely the result of legacy farming practices (Delta area) or related to other potential influencers (such as dairies and septic systems). These areas will warrant further coordination with other programs to assess whether high vulnerability is the result of agriculture or other influencers.
    b. Are located within DPR GPAs, particularly in Yuba County.
3. HVA sections with a priority ranking of 3 refer to all other areas that have the following characteristics:

[2] See the CV-SALTS Strategy and Framework. http://www.cvsalinity.org/index.php/docs/committee-document/executive-committee-docs/1411-cv-salts-program-work-plan-v-8-approved-3912pdf/file.html.

a. Are HVAs that are scattered in between low vulnerability sections and close to streams. These areas have not shown nitrate contamination in the past but are located in areas of high hydrogeologic susceptibility and are, therefore, included in this GQMP for action implementation.

This GQMP lays out performance goals and performance measures to achieve the above objectives, with subwatershed-specific actions specified in Subwatershed Action Plans. A schedule with specific milestones has been developed to ensure timely implementation and proper prioritization.

C2. Actions

C2.a. Compliance with Receiving (Groundwater) Water Limitations

This GQMP describes the actions that the Coalition will take to comply with the WDRs. The Coalition will collect information pertaining to member management practices in the form of Farm Evaluation surveys and NMPs. In addition, the Coalition is identifying additional management practices and evaluating their effectiveness through the MPEP process. This GQMP also presents performance goals, a schedule with milestones, and specific Subwatershed Action Plans to protect groundwater quality.

The Coalition, along with other Central Valley water quality coalitions (excluding the California Rice Coalition), convened a NMP Technical Advisory Work Group (TAWG) to assist the coalitions in developing guidelines for reporting nitrogen fertilizer use information related to crop consumption and need. This information will be reported in NMPs and will be the basis for the "Nitrogen Removed" metric. The NMP TAWG consists of coalition representatives, CDFA representatives, commodity experts, University of California research agronomists, and practicing agronomists. In December 2015, the NMP TAWG submitted a Crop Nitrogen Knowledge Gap Study Plan that describes the current understanding of nitrogen uptake and removal by crops, recommended methods for calculating nitrogen removal, and knowledge gaps (Central Valley Water Quality Coalitions, 2015). This information will be used to help collect nitrate use to be reported in the NMPs.

C2.b. Education and Outreach Strategy

The Coalition's education and outreach strategy is aimed at educating its members about the sources of the groundwater quality exceedances in order to promote prevention, protection, and remediation efforts that can maintain and improve groundwater quality throughout the Sacramento River Watershed.

The Coalition currently notifies and educates subwatershed landowners, farm operators, and wetland managers about the exceedances of water quality standards and the causes of exceedances throughout the watershed through meetings and direct mailings. The member meetings and trainings are held in various counties throughout the watershed several times a year. The Coalition and subwatershed groups also call additional meetings at any time if needed. The purpose of these meetings is to review water quality data collected throughout the year, educate members on current and new best management practices (BMPs), and discuss updates or changes related to reports or management plans required by the CVRWQCB. These meetings and outreach programs will continue to occur during the Order's requirements implementation and will address groundwater quality data and management practices known to improve groundwater quality as the information becomes available through the submission of NMPs and the development of the MPEP.

Additional meetings within a smaller geographical area or with a subgroup of members within subwatersheds are also held periodically and on an as needed basis. If determined appropriate, these meetings could target growers with lands in HVAs and focus on management strategies known to be protective of groundwater for particular crops grown in that region. Member landowners in these areas

could be identified through a list of assessor parcel numbers. Commodity-specific outreach meetings may also be organized once MPEP study results identify specific BMPs by crop.

The Coalition also provides information to its members through emails, newsletters, and the AMR. It posts educational materials such as information on BMPs on its website (http://www.svwqc.org/outreach-and-education/). Education and outreach activities are also reported on in the Coalition's AMR.

In addition, the University of California Davis Cooperative Extension (UCCE) program provides management recommendations through crop specialists and farm advisors that work directly with the growers. Approximately 50 to 60 full time farm advisors in the Sacramento Valley focus on research and education associated with management practices. An example of education and outreach by farm advisors is through Nitrogen Management Certification Training Courses for crop advisors in the private sector, who work directly with growers. These trainings were done as part of a credentialing and certification program overseen by the California Association of Pest Control Advisers and the California Department of Food and Agriculture (CDFA). Approximately 150 to 200 Sacramento Valley crop advisers were certified through this program between early 2015 and spring 2016.

C2.c. Management Practices Strategy

One of the primary objectives of the GQMP and the MPEP is to identify, validate, and list management practices known to be effective in reducing nitrate contamination of groundwater. A comprehensive list of these management practices has not been developed yet; however, the Coalition has outlined a strategy aimed at collecting information and determining the effectiveness of various management practices.

The Coalition's management practices strategy consists of developing a list of practices known to be effective in protecting groundwater quality, as part of the MPEP effort. The list resulting from the MPEP effort will be updated as new information becomes available. The Coalition will first identify and summarize relevant information from past NMPs and farm management plans, such as from the annual Farm Evaluation Summary Reports. Future information acquired through NMPs and the Trend Monitoring Program will also be incorporated and shared with members as it becomes available and on an annual basis through the AMR.

The Coalition will also review the findings of MPEP interim deliverables and reports as they become available (additional details on the MPEP process are described in Section C4.a). The list will first incorporate information collected through the MPEP Literature Review and will be revised over time with information from the MPEP Annual Progress Reports (due May 1 annually), MPEP Field Study Reports (upon completion of each study), and the Management Practice Evaluation Report (due May 2023, and revised every 6 years). The Coalition will inform its members of changes to the list of effective management practices as the information becomes available.

C3. Organization, Duties and Responsibilities

The Coalition is organized by subwatershed groups. It is administered by NCWA and coordinated by Bruce Houdesheldt, Director of Regulatory Affairs for NCWA, who is the key point of contact with the CVRWQCB and is the liaison between the CVRWQCB and the various Subwatershed Coordinators. The Subwatershed Coordinators are individuals who conduct outreach to members in their subwatersheds and are the point of contact with the Coalition Coordinator. Key individuals involved in implementing the GQMP are identified in Table 5 and shown in the organizational chart provided below.

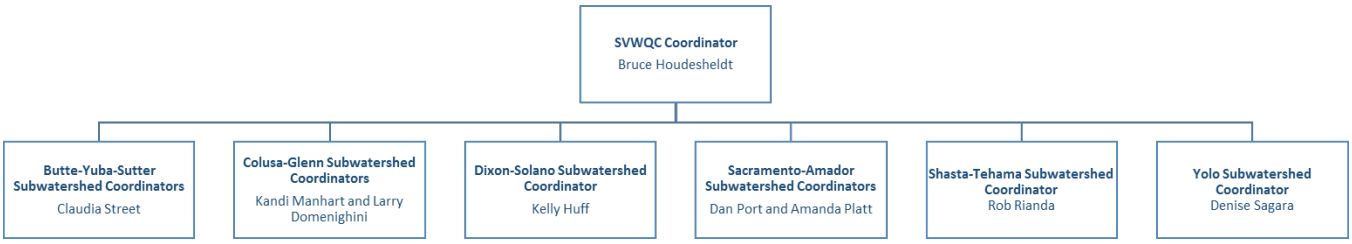
Table 5. Contacts for Subwatersheds Identified in This GQMP

Subwatershed	County	Subwatershed Coordinators
Butte-Yuba-Sutter	Butte, Yuba, Sutter	Claudia Street, Executive Director of Yuba Sutter Farm Bureau
Colusa-Glenn	Colusa, Glenn	Kandi Manhart, Colusa Glenn Subwatershed Program Manager Larry Domenighini, Colusa Glenn Subwatershed Program Board President / Grower
Dixon-Solano	Solano	Kelly Huff, Project Manager, Dixon RCD
Sacramento-Amador	Sacramento, Amador	Dan Port, Sacramento-Amador Water Quality Alliance Board Member / Rancher Amanda Platt, Coordinator, Amador RCD
Shasta-Tehama	South Shasta, Tehama	Rob Rianda, Shasta-Tehama Watershed Education Coalition Coordinator
Yolo	Yolo	Denise Sagara, Yolo County Farm Bureau Education Corporation

Source: SVWQC, 2016d

Member growers are required to attend annual outreach meetings to learn about the program's requirements for that year, and receive information on water quality conditions and management practices protective of water quality. At these meetings, growers can also ask questions and exchange information with each other on management practices.

SVWQC Organizational Chart



C4. Management Plan Implementation Strategies

C4.a. Other Entities or Agencies Providing Data Assistance

The coalition is participating in a joint effort to implement the MPEP in order to evaluate the efficacy of management practices aimed at protecting groundwater quality. The Coalition partnered with four other Central Valley coalitions, including the East San Joaquin Water Quality Coalition, San Joaquin County and Delta Water Quality Coalition, Westlands Water Quality Coalition, and the Westside San Joaquin River Watershed Coalition, to implement the MPEP and conduct studies within the Central Valley. Together, the Coalitions have met and developed an MPEP work plan that highlights the administrative process, MPEP study design, and a timeline of implementation to meet the MPEP objectives.

The primary goal of the MPEP is to determine which practices effectively minimize nitrate leaching to groundwater in HVAs. To determine this, the MPEP will be implemented in four phases: 1) a literature review to collect information regarding practices that are known to be effective, 2) field studies, 3) modeling of nitrate leaching at the field scale, and 4) expansion of modeling to the landscape scale. The results of these studies will be used to compile a list of management practices and descriptions of their effectiveness, and to create a Management Practice Evaluation Report. The results of the Management Practice Evaluation Report will be reviewed and shared with Coalition members, and

relevant information will be reported on in the Management Plan Status Report as part of the AMR. The Coalitions have been submitting grant proposals to fund studies, and a pilot study to evaluate nitrate leaching in walnut orchards was awarded funding and began in spring of 2016.

The CV-SALTS initiative began in 2006 and addresses salinity and nitrate issues in soil and water throughout the Central Valley. The CVRWQCB is currently undertaking a process to develop a Basin Plan amendment for CV-SALTS involving the development of SNMPs. This process will establish a revised regulatory framework that will provide the flexibility necessary to make salt and nitrate management decisions at the appropriate temporal, geographic and/or management zone scales. Specific to the Sacramento Valley, the Yolo and Solano County areas are one of the top priorities identified by CV-SALTS to address nitrate and salinity.

In addition, water quality goals may be developed and adopted as site-specific water quality objectives. As part of the ongoing implementation of the LTILRP, groundwater quality results may be re-evaluated in the context of CV-SALTS requirements. Information collected through the CV-SALTS initiative will be reviewed and incorporated into the AMRs, the GAR update and GQMPs as appropriate.

Groundwater quality data are available through regular monitoring from public agencies such as DWR, USGS, and SWRCB. Additional data will be collected through the Groundwater Quality Trend Monitoring Program.

C4.b. Management Practices

As described in Section B, Coalition members currently implement a variety of nutrient management and wellhead protection practices to prevent groundwater pollution. These practices are reported in Farm Evaluation surveys (SVWQC, 2016b) and include the following actions:

- Splitting up fertilizer applications throughout the growing season
- Testing soil or plant tissue to manage nutrient applications
- Following good housekeeping procedures and preventing standing water around the wellhead
- Employing crop advisors to develop crop fertility plans and manage nutrient applications

In addition, growers in areas that are affected by high nitrate concentrations and who use groundwater for irrigation could implement “pump and fertilize” practices to help improve groundwater quality. The goal of this management practice is for growers to use less commercial fertilizer, commensurate with the amount of nitrate in the irrigation water, and crops effectively remove nitrate from the irrigation water (King et al., 2012).

Members located in HVAs as identified by the GAR will be required to submit annual NMP summary reports with additional details regarding the amount of nitrogen applied, irrigation sources and water chemistry, and anticipated crop yield to develop the applied-over-removed nitrogen ratio. The information that the Coalition collects through the Farm Evaluation surveys and NMPs can be used to track effectiveness and inform future nutrient management practices implementation.

Current nutrient and groundwater protection practices will continue to be implemented and refined over time as new information regarding the effectiveness of the practices becomes available. Specifically, the results of the MPEP and Trend Monitoring Program will be used to determine whether practices currently implemented are effective or need to be improved.

C4.c. Outreach Strategy and Outreach Effectiveness Evaluation

As referenced in Section C2.b, the Coalition conducts a variety of outreach activities with its members and plans to expand these activities to include outreach regarding the GQMP for members within HVAs. Furthermore, this GQMP includes Subwatershed Action Plans specific to each subwatershed containing

HVAs. These plans (located in Appendix B) are a method of targeted outreach to assist Subwatershed Coordinators in outreach to members in their subwatersheds.

The effectiveness of the Coalition's outreach methods will be evaluated in several ways, including the following:

1. Tracking member attendance at meetings
2. Using Farm Evaluation surveys to document nutrient and wellhead practices, and track the adaptation of new practices for members located in HVAs
3. Using NMPs to document nitrogen use by members located in HVAs and track changes in nitrogen use over time
4. Assessing changes in groundwater quality through monitoring data collected through the Trend Monitoring Program

UCCE advisors also interact with growers through public education activities in the form of annual meetings issue driven and targeted workshops, newsletters, blogs, weekly e-mail updates, and other creative approaches. Advisors also make farm visits to help troubleshoot problems and advise growers.

C4.d. Performance Goals

The Coalition's performance goals were developed to meet the objectives of the GQMP and ensure the continued protection of groundwater quality in HVAs throughout the Sacramento Valley floor. Performance measures are associated with each performance goal to outline specific actions that can be used to meet the goal. In addition, subwatershed-specific actions are outlined for identified HVAs in the Subwatershed Action Plans.

Performance Goal 1. Collect information from members in HVAs on management practices and potential sources of nitrate contamination in groundwater

Performance measures are as follows:

1. Collect information on current management practices through Farm Evaluation surveys and NMPs.
2. Identify areas with groundwater quality impairments resulting from nitrate through the Trend Monitoring Program.
3. Through Subwatershed Action Plans, identify subwatershed-specific actions to collect data and determine potential sources of nitrate contamination.

Performance Goal 2. Determine the effectiveness of various management practices protective of groundwater quality

Performance measures are as follows:

1. Develop and distribute a list of management practices protective of groundwater quality based on MPEP results as they become available.

Performance Goal 3. Have members adopt new management practices protective of groundwater quality

Performance measures are as follows:

1. Conduct outreach via Coalition meetings facilitated by Subwatershed Action Plans to educate and inform members of management practices proven effective in protecting groundwater quality.
2. Provide outreach and training on results related to MPEP work.
3. Provide updates on new information pertaining to groundwater quality data, as summarized in AMRs.

4. Track member attendance at meetings focused on nitrogen usage and management.
5. Track member adoption of new management practices.

Performance Goal 4. Evaluate effectiveness of new management practices

Performance measures are as follows:

1. Use Trend Monitoring Program to track changes in groundwater quality.
2. Participate in the MPEP process to conduct studies evaluating the effectiveness of management practices.

Performance Goal 5. Evaluate data and revise HVAs, if appropriate

Performance measures are as follows:

1. Use data collected by subwatershed groups and through the Trend Monitoring Program to determine whether the source of nitrate contamination is a result of irrigated agriculture.
2. Revise HVAs in the GAR 5-year update if appropriate.
3. Review data pertaining to current data gap areas and assess the vulnerability designation of these areas in the GAR 5-year update.

C4.e. Subwatershed Action Plans

The Subwatershed Action Plans include information specific to each subwatershed that includes HVAs as designated by the GAR to provide a more targeted approach to outreach. Each Subwatershed Action Plan includes general information about the subwatershed area, land use, groundwater quality, and groundwater vulnerability. In addition, the action plans include two parts to address existing and potential groundwater contamination.

Part one highlights options for further review based on specific HVAs. This potential action plan approach is described in Table 6, with additional details provided in each plan in Appendix B. Table 6 includes the subwatershed, the main HVAs within each subwatershed, and outlines potential options for implementation for that specific subwatershed, based on the known or expected sources of nitrate contamination. The general types of actions differ based on the priority ranking of HVAs, as follows:

- Priority 1 HVAs: Subwatersheds to review member practices based on Farm Evaluation surveys and NMPs, consider increased usage of measuring nitrogen in irrigation water and pump and fertilize options
- Priority 2 HVAs: Coalition and Subwatersheds to coordinate with other agencies to collect additional monitoring information or to conduct representative monitoring as necessary
- Priority 3 HVA: Coalition to conduct trend monitoring and members to implement farming practices protective of groundwater quality

Part two lists items relevant to all HVAs regardless of priority based on the GQMP elements.

As described in the Subwatershed Action Plans and Table 6, one of the GQMP approaches is to identify and evaluate additional existing data and new data (e.g., *Updated Groundwater Quality Analysis and High Resolution Mapping for the Central Valley Salt and Nitrate Management Plan* [San Joaquin Valley Drainage Authority, 2016b]) not readily available during GAR development. Based on this data review, the need for additional monitoring or implementation actions will be evaluated as part of the Coalition's AMR. Also, actions to conduct further review of HVAs may be conducted through the Trend Monitoring Program and will be documented in the GAR 5-year update.

Table 6. High Vulnerability Areas and Subwatershed Potential Action Plan Approaches

Subwatershed	Main High Vulnerability Areas	Potential Options for Implementation
Butte-Yuba-Sutter	Urban areas of Chico and Yuba City	• There are known impacts from septic tanks in urban areas. • The approach is to assess the contribution of agriculture versus the historical impact of septic tanks by coordinating with Butte County and Yuba County health departments for monitoring and data review.
	Yuba County area overlying DPR GPAs	• Coarser and highly drained soils may facilitate the percolation of nitrate to groundwater. • The approach is to review more recent groundwater quality data from Yuba County Water Agency and DWR, and continue to monitor these wells as part of Trend Monitoring Program.
Colusa-Glenn	Northern Glenn County	• There are potential impacts from existing dairies in the area. • The approach is to request and review dairy monitoring data (provided by CVRWQCB), which provides additional shallow groundwater quality information.
	Urban areas including Willows, Williams, and Colusa	• There are potential impacts from septic tanks and from areas overlying DPR GPAs by Willows, where higher drained soils may facilitate the percolation of nitrate to groundwater. • The approach is to work with Colusa County, Glenn County, and the cities and towns to evaluate septic system information and to consider representative monitoring in some areas.
Dixon-Solano	Northeastern Solano County near the City of Dixon	• There are potential impacts from dairies and historical wastewater ponds that may be contributing to the localized groundwater quality issues. • The approach is to review more recent well data and historical land uses, particularly dairies and wastewater ponds, near the city of Dixon. There could also be review of available WDR reports for wastewater plants and to consider representative monitoring and implementation of management practices. For example, “pump and fertilize” would be an option to consider in the affected areas that use groundwater for irrigation.
Sacramento-Amador	The Delta area	• There are potential impacts from past land uses, including historical dairies. • The approach is to coordinate with DWR or the San Joaquin County and Delta Water Quality Coalition to identify new sources of water quality data for shallow groundwater within the area. Alternatively, representative monitoring may be conducted to confirm the more recent shallow groundwater quality.
Shasta-Tehama	Red-Bluff and Corning areas	• Impacts are likely the result of point- and non-point wastewater treatment systems. • The approach is to assess the contribution of historical agriculture versus impacts from existing onsite wastewater treatment systems by working with the Tehama County Environmental Health Department to develop a groundwater well network to monitor as part of the Trend Monitoring Program.
	Areas overlying DPR GPAs in the southern portion of the subwatershed, by the Sacramento River	• Areas overlying DPR GPAs in the southern portion of the subwatershed by the Sacramento River may facilitate the percolation of nitrate to groundwater. • The approach is to conduct Trend Monitoring to help establish whether impacts to groundwater in these areas may occur.
Yolo	Davis-Woodland area	• Impacts are likely the result of irrigated agriculture. • The approach is to work with YCFCWCD to develop a strategy and timeline for focused monitoring and implementation of management practices. For example, “pump and fertilize” would be an option to consider in the affected areas that use groundwater for irrigation. Accelerated implementation actions should be considered for this area.

C4.f. Schedule and Milestones

The Coalition developed the following schedule with milestones based on this Comprehensive GQMP strategy.

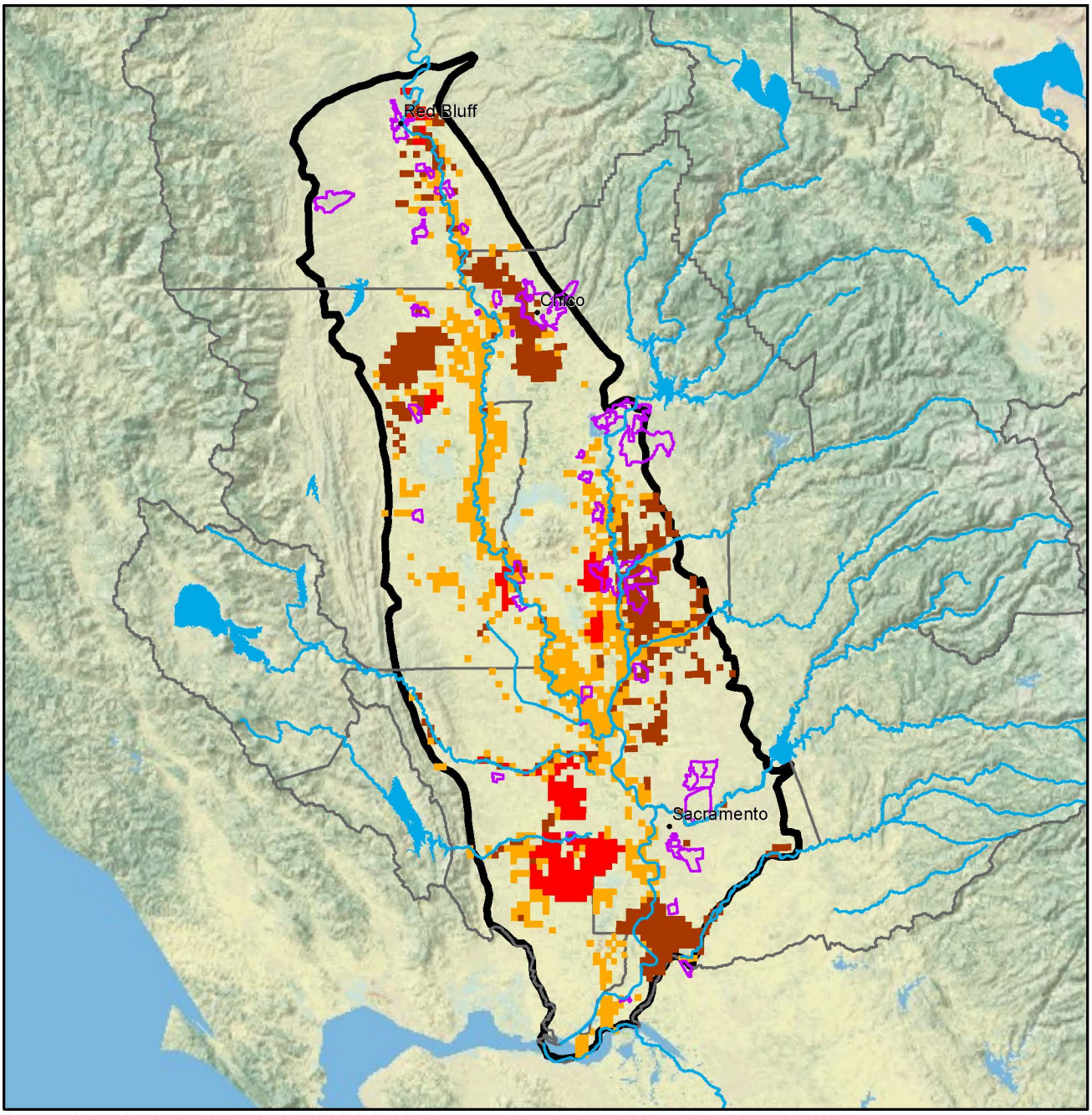
Milestone 1. Within 1 year of GQMP approval, and annually thereafter, collect information from members with lands designated as HVAs pertaining to nutrient applications, nitrate management practices, and crop yields through Farm Evaluations and NMPs. Provide information to members within HVAs and subwatershed coordinators.

Milestone 2. Within 3 years of GQMP approval, provide to members a list of management practices that have been demonstrated to be effective in reducing nitrate contamination of groundwater based on the MPEP Literature Review, modeling and/or field studies.

Milestone 3. Within 5 years of GQMP approval, demonstrate work toward an improved understanding of groundwater quality in areas categorized as having data gaps, and revise HVAs in the GAR update if necessary.

Milestone 4. Within 5 years of GQMP approval, demonstrate that members in HVAs are implementing nitrate management practices known to be effective, to the extent possible.

The GQMP action plan is closely linked to the MPEP process. Currently, the effectiveness of management practices is not fully known, but the MPEP will further this knowledge. As information pertaining to specific management practices or management practices related to specific commodities is developed through the MPEP Literature Review and relevant MPEP studies, it will be provided to members. Furthermore, the collection of additional groundwater quality data depends on technical work, including the CV-SALTS initiative and the Trend Monitoring Program. Consequently, the milestone schedule presented above for the GQMP is contingent upon the milestone completions from those other related programs.



Source: Subwatersheds, Watershed (SVWQC 2013); Basemap, County, City, Highway, River (ESRI 2011).

LEGEND

- SACFEM Boundary
- Subwatersheds
- Cities
- Rivers
- Waterbodies
- Disadvantaged Community Places (DAC)

High Vulnerability Ranking

- 1
- 2
- 3

0 5 10 20
Miles

N

FIGURE C1
Ranking of High Vulnerability Areas on the Sacramento Valley Floor
Comprehensive Groundwater Quality Management Plan

D. Monitoring Design

Groundwater quality monitoring helps identify areas that have impacts from nitrate, prevents further groundwater contamination by employing applicable management practices, and informs a general trend of groundwater quality over time to identify when issues arise that need to be managed.

D1. General Requirements

The GAR identification of HVAs and data gaps (Figure A2) helps the development of objectives that inform the Groundwater Quality Trend Monitoring Program.

Groundwater quality monitoring will be conducted through the monitoring efforts associated with the Trend Monitoring Program and MPEP. The Coalition is a participating member of the MPEP Group Coordination Committee, which submitted a revised MPEP work plan on July 29, 2016. The Coalition's Trend Monitoring Work Plan is due 1 year after GAR approval, on September 14, 2017.

D2. Groundwater Monitoring Additional Requirements

Additional requirements for groundwater quality monitoring are as follows:

- Groundwater reporting requirements: data collected through groundwater quality monitoring efforts will be summarized and submitted with the AMR.
- High level (programmatic) strategies for prioritization, implementation, and evaluation of MPEPs and trend monitoring results will be developed and reported in the Trend Monitoring Work Plan.
- Potential representative monitoring to close data gaps identified in the GAR:

  Section C4.e and the Subwatershed Action Plans outline the method to fill data gaps by reviewing data that were not readily available for the GAR and evaluating whether or not additional representative monitoring is needed. Additional data will be assembled and evaluated during the required GAR 5-year updates.
- Regional approach to trend monitoring.

Many Central Valley programs require groundwater quality monitoring to various degrees. The development of a coordinated, regional monitoring program will benefit all entities involved in these programs throughout the Central Valley. These programs include those overseen by the CVRWQCB, including the ILRP, the Dairy Program, and the Oil Fields Program, as well as other programs such the State Water Resources Drinking Water Program, SGMA, CASGEM, and CV-SALTS. In addition, as part of SGMA, groundwater quality monitoring and data analysis will be important for the avoidance of the degradation of groundwater quality, as being one of the undesirable results determined by DWR.

The Coalition along with several other coalitions are working cooperatively with the CVRWQCB to develop a Groundwater Regional Monitoring Program (GRMP). The GRMP would incorporate additional state and local agencies to develop a coordinated approach to groundwater monitoring. The program is still in the development phase; however, if the GRMP is approved, the first activity would be to develop a conceptual approach to groundwater monitoring, followed by a work plan. The goal of the GRMP would be to create a more efficient and effective assessment of groundwater quality to protect groundwater resources throughout the Central Valley.

E. Data Evaluation and Reporting

E1. Data Analysis Methods

Data collected as part of the GQMP implementation and various monitoring and reporting requirements will be analyzed using statistical methods such as minimum, mean, and maximum results, and will be presented in various forms, including graphs, maps, and tables. Vulnerability calculations will be revised with the new data and presented in the 5-year GAR update.

E2. Program Effectiveness Tracking

This Section outlines requirements for assessing and tracking management practice implementation and effectiveness.

The Coalition will aggregate information from members' NMP Summary Reports to characterize the input, uptake, and loss of nitrogen fertilizer applications by specific crops in the Sacramento River Watershed. Per the Order, the Coalition's assessment of NMP information must include, at a minimum, comparisons of farms with the same crops, similar soil conditions, and similar practices (e.g., irrigation management). At a minimum, the statistical summary of nitrogen consumption ratios by crop or other equivalent reporting units and the estimated nitrogen consumed for the different crop types and soil conditions will describe the range, percentiles (10th, 25th, 50th, 75th, 90th) and any outliers. A box and whisker plot or equivalent tabular or graphical presentation of the data approved by the Executive Officer may be used. The nitrogen consumption ratio is the ratio of total nitrogen available for crop uptake (from sources including, but not limited to, fertilizers, manures, composts, nitrates in irrigation supply water and soil) to the estimated crop consumption of nitrogen. The summary of nitrogen management data must include a quality assessment of the collected information by township (e.g. missing data, potentially incorrect/inaccurate reporting), and a description of corrective actions to be taken regarding any deficiencies in the quality of data submitted, if such deficiencies were identified. The third-party will also provide an aggregate of the data submitted by its Members in an electronic format, compatible with ArcGIS, identified to at least the township level.

The effectiveness of the GQMP will be evaluated in several ways, including the following:

- Collecting and evaluating publically available groundwater quality data
- Collecting and tracking current management practices implemented by members (as reported in Farm Evaluation surveys)
- Identifying new management practices effective in protecting groundwater quality (as reported by the MPEP)
- Collecting, tracking and verifying nitrogen removed data and additional management practices implemented by members (as reported in NMPs and future Farm Evaluation surveys)
- Analyzing additional groundwater quality data collected through the Trend Monitoring Program

The effectiveness of management practice implementation will be assessed based on the MPEP and Trend Monitoring Program. A description of the methods used to evaluate the effectiveness of management practices will be described in the Trend Monitoring Work Plan, which is due on September 14, 2017.

Effective implementation of nitrogen management practices should result in improved water quality conditions. Education of Coalition members in HVAs about the nitrogen usage and leaching will be a key outcome of the NMP Summary Report analysis.

The information collected will be reported to the CVRWQCB through NMP Summary Reports, as required by the Order. In addition, the Coalition will submit a Management Plan Status Report as part of its AMR, as required by the Order. The Management Plan Status Report will include all 13 requirements listed in the Order. In addition, the Coalition will report GQMP implementation progress and other pertinent information to its members at Coalition Management Advisory Committee meetings.

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Appendix A
Cross Reference between GQMP Requirements, GAR, and Future Documents

APPENDIX A

Requirements Cross-reference Table

The following table lists GQMP requirements as mandated in the WDR Order. The table indicates the section of the GQMP, the location of information contained in the GAR, and coordination with future ILRP documents.

Required GQMP Element (Appendix MRP-1) of the Sacramento River Watershed WDR General Order	Where Addressed in		
	GQMP Section	GAR	Coordination with Future Documents
Introduction and Background	A		
Discussion of COCs and water quality objectives or triggers requiring preparation of the GQMP	A1.b	18.1	
Identification of Management plan boundaries to be covered by GQMP including how the boundaries were delineated	A3	2.1.1	
Summarize previous work conducted to identify the occurrence of the COCs for the GQMP area	A5	4.2.4	
Physical Setting and General Information	B		
General Requirements	B1		
Land Use Maps	B1.a	2	GAR 5-Year Update
Potential Ag Sources of COCs	B1.b	4.2	GAR 5-Year Update
List of designated beneficial uses	B1.c	2.2	GAR 5-Year Update
Baseline inventory of existing management practices	B1.d		NMP; MPEP
Summary of available water quality information	B1.e	1.2.4; 3.2	GAR 5-Year Update; CV-SALTS; MPEP; Trend Monitoring Program; NMP
Groundwater – Additional Requirements	B2		
Soil data	B2.a	1.2.4.4	
Description of geology and hydrogeology	B2.b	2.1	
Identification of irrigation supplies and available water chemistry	B2.c	2.1	GAR 5-Year Update
Management Plan Strategy	C		
Approach and Prioritization	C1.		
Actions	C2		
Compliance with receiving water limitations	C2.a		NMP; MPEP
Education strategy	C2.b		MPEP
Management practices strategy	C2.c		MPEP

Required GQMP Element (Appendix MRP-1) of the Sacramento River Watershed WDR General Order	Where Addressed in		
	GQMP Section	GAR	Coordination with Future Documents
Duties and Responsibilities	C3		
Identification of key individuals	C3		AMR
Discussion of responsibilities	C3		AMR
Organizational chart	C3		AMR
Management Plan Implementation Strategies	C4		
Entities or agencies providing data assistance	C4.a		CV-SALTS; MPEP
Identification of management practices	C4.b		MPEP; NMP; AMR
Outreach strategy and outreach effectiveness evaluation	C4.c		MPEP; Trend Monitoring Program; NMP; AMR
Schedule	C4.f		MPEP; NMP; Trend Monitoring Program; GAR 5-Year Update
Performance goals	C4.d		MPEP; NMP; Trend Monitoring Program; GAR 5-Year Update
Monitoring Design	D		
General requirements	D1		
Groundwater monitoring additional requirements	D2		Trend Monitoring Program; GAR 5-Year Update; AMR
Data Evaluation	E		
Data analysis methods	E1		Trend Monitoring Program; GAR 5-Year Update
Program effectiveness tracking	E2		Trend Monitoring Program; NMP; GAR 5-Year Update; AMR

Note:

Surface water has been excluded from the GQMP because it is addressed in the Sacramento Valley Water Quality Coalition's 2015 Comprehensive Surface Water Quality Management Plan and other water quality management plans.

Appendix B
Subwatershed Action Plans

APPENDIX B

Subwatershed Action Plans

Subwatershed Action Plans were developed for the six subwatersheds that include HVAs as identified in the revised GAR (per conditional approval requirements). The following plans highlight subwatershed-specific information regarding land use, groundwater quality and vulnerability. The action plan is based on the GQMP elements and provides recommended options for implementation.

Appendix B-1
Butte-Yuba-Sutter Subwatershed

Butte-Yuba-Sutter Subwatershed Action Plan

This Subwatershed Action Plan provides general information about the Butte-Yuba-Sutter Subwatershed and identifies management activities to be implemented to address areas that present a high vulnerability to groundwater quality impact. This Subwatershed Action Plan is a component of the Comprehensive Groundwater Quality Management Plan (GQMP), which addresses the requirements of the Waste Discharge Requirements General Order for Growers within the Sacramento River Watershed (R5-2014-0030-R1). The GQMP has been prepared on behalf of the Northern California Water Association (NCWA) and the Sacramento Valley Water Quality Coalition (Coalition).

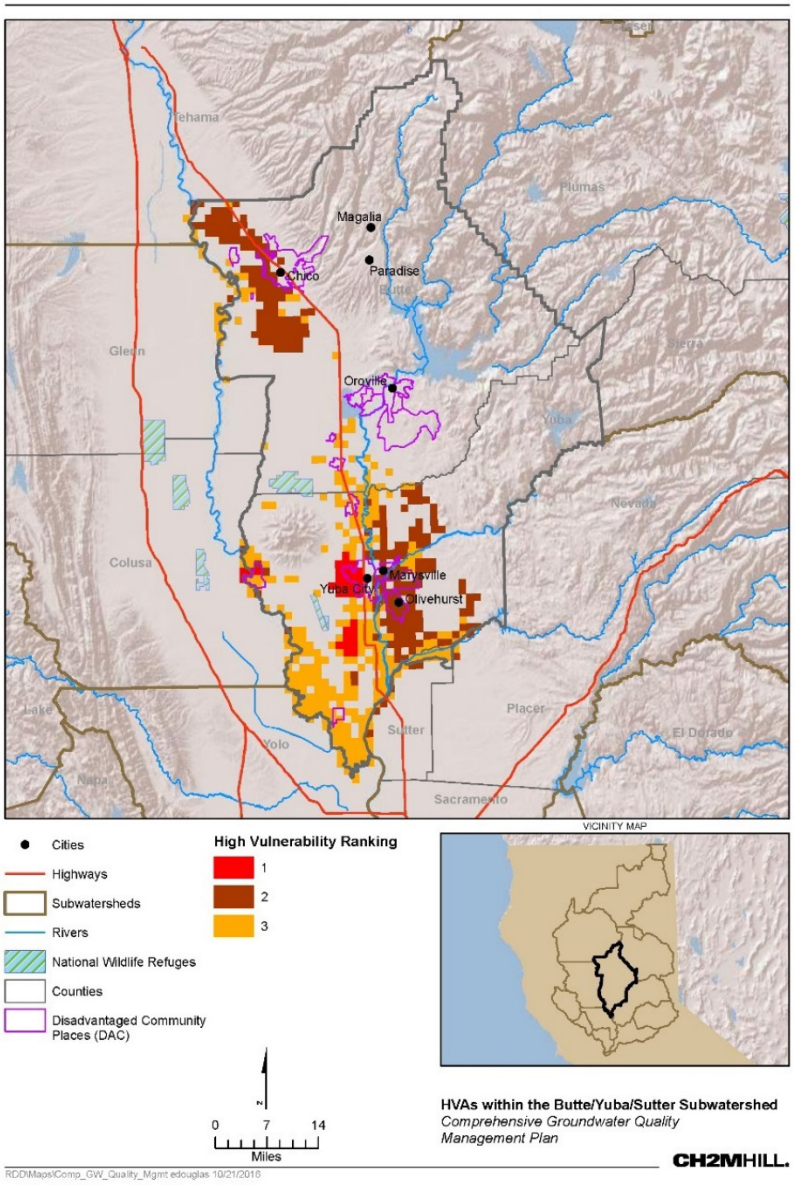
Introduction

The Butte-Yuba-Sutter Subwatershed encompasses all of Butte and Yuba Counties and the majority of Sutter County. The subwatershed covers an area of approximately 1.8 million acres. Lake Oroville, as well as the Sacramento, Feather, Yuba, and Bear Rivers are within the subwatershed, and the major population centers include Chico, Oroville, and Yuba City.

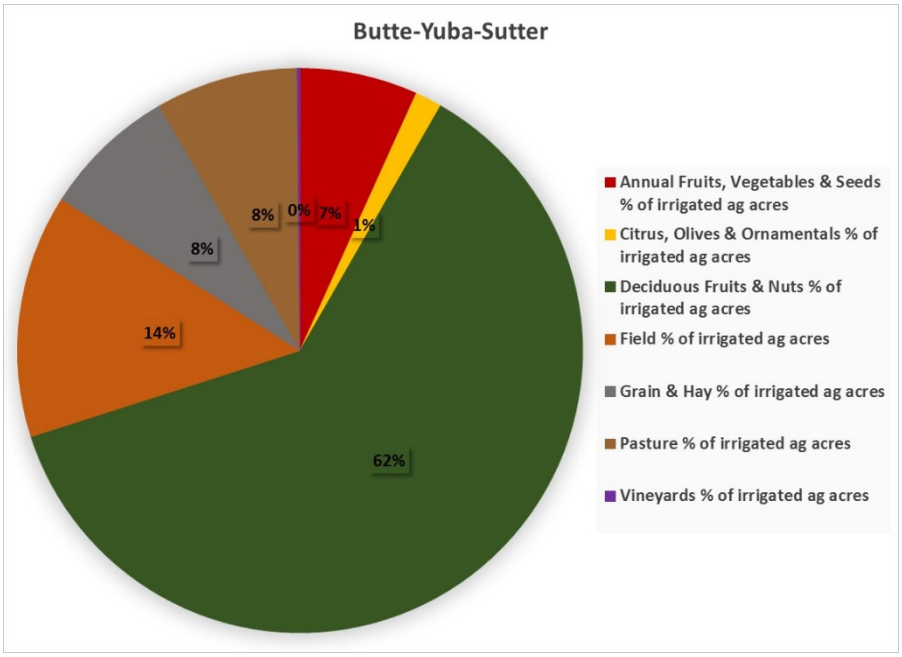
A large portion of the subwatershed, including all of Sutter County, is located on the Sacramento Valley floor, where the majority of agricultural production occurs. The subwatershed also extends into the upper watershed; however, no land is farmed upstream from Lake Oroville.

In 2013, there were approximately 257,247 acres of irrigated land in the subwatershed enrolled in the Coalition. The management for the Butte-Yuba-Sutter Subwatershed is provided by the Sutter County Resource Conservation District and the Yuba Sutter Farm Bureau.

The first groundwater technical report for the Coalition was the Groundwater Quality Assessment Report (GAR), conditionally approved by CVRWQCB September 16, 2016. The GAR identified High Vulnerability Areas (HVAs) susceptible to nitrate contamination of groundwater. The map to the right shows the high vulnerability areas (HVAs) and their priority rankings based on the analysis performed in the Groundwater Quality Assessment Report (GAR). A summary of this analysis is provided below. The HVAs are the areas covered under the GQMP.



Land Use



The primary land use within the Butte-Yuba-Sutter Subwatershed is irrigated agriculture. Excluding rice, the major irrigated crops include orchards (almonds, walnuts, peaches, prunes, and olives), row crops (beans and tomatoes), alfalfa, and pasture.

The pie chart to the left shows the predominant crop categories grown in the Butte-Yuba-Sutter Subwatershed as a percentage of total irrigated acres within the subwatershed based on Pesticide Use Reporting 2013 data (as presented in the GAR [NCWA, 2016]).

Groundwater Quality and Vulnerability

Groundwater Quality

The GAR reviewed previous studies on groundwater quality and analyzed well data pertaining to constituents of concern, including nitrate, salinity, and pesticides. The GAR established that the Butte-Yuba-Sutter Subwatershed has generally high-quality groundwater with a few areas of concern related to nitrate. It found that the primary sources of salinity are not the result of agriculture, and that pesticides do not constitute a factor of high vulnerability in this subwatershed.

Nitrate samples from 1,032 wells within the Butte-Yuba-Sutter Subwatershed were analyzed. Fifteen percent of samples had nitrate concentrations greater than half of the maximum contaminant level (MCL) of 45 milligrams per liter, and only 5 percent of wells showed nitrate concentrations above the MCL. Elevated concentrations of nitrate were detected as follows: in the urban areas of Butte County near Chico, Durham, and east of Corning between Highway 99 and the Sacramento River; in mixed urban-agricultural areas within Sutter County west of Yuba City and Marysville; and at the intersection of Butte, Sutter and Yuba Counties. A majority of agricultural lands show very low levels of nitrate, and septic systems in urban areas are considered an important source of nitrate concentrations in groundwater.

Groundwater quality monitoring within this subwatershed is largely conducted by California Department of Water Resources (DWR) and local agencies. Butte County monitors wells for field and salinity parameters, including temperature, pH, and electrical conductivity. Sutter County has 34 monitoring wells that DWR samples for groundwater quality constituents every 3 years. In addition, the Town of Robbins regularly monitors privately owned wells. Yuba County Water Agency (YCWA) coordinates with DWR's North Central Region Office to collect groundwater samples from a network of wells in the North and South Yuba Subbasins to analyze for arsenic, nitrate, sodium, and total dissolved solids.

In addition, all three counties have wells that are regularly monitored for groundwater levels by DWR and by California Statewide Groundwater Elevation Monitoring entities. These wells could potentially be used to monitor groundwater quality as well.

Groundwater Vulnerability

Both intrinsic and anthropogenic factors influence the vulnerability of groundwater to contamination from irrigated agriculture. Intrinsic factors include existing, physical factors such as hydrogeologic and soil conditions, the presence of

naturally occurring contaminants, and geochemical characteristics. Anthropogenic factors include practices surrounding crop type, irrigation, and nutrient and pesticide management. In addition, the California Department of Pesticide Regulation (DPR) identified areas that may be vulnerable to pesticide contamination because of the presence of coarser soil and geologic materials. These areas, known as DPR Groundwater Protection Areas (GPAs), were included in the GAR vulnerability analysis. The final HVAs for the Butte-Yuba-Sutter Subwatershed are provided on the map on the first page of this Subwatershed Action Plan. The priority ranking was based on the presence of known contaminated areas and the potential for affecting disadvantaged communities that rely on groundwater for drinking water.

Action Plan

This Subwatershed Action Plan includes two parts to address existing and potential groundwater contamination from nitrate in this subwatershed. Part one includes potential actions that can be taken to conduct additional analysis specific to higher priority HVAs within the subwatershed. Part two includes actions highlighted in the GQMP that apply to all HVAs on the Sacramento Valley floor.

Part One

Table 1 summarizes the main priority ranking 1 and 2 HVAs within the Butte-Yuba-Sutter Subwatershed. Table 1 lists the potential impacts on groundwater from contamination and highlights potential options for further review.

Table 1. HVAs and Additional Analysis Summary Table

HVA (Priority Ranking 1 and 2)	Potential Impacts	Potential Options for Implementation
Urban areas of Chico and Yuba City	Known impacts from septic systems	Need to assess the contribution of agriculture versus the historical impact of septic tanks by coordinating with Butte County and Sutter County health departments for monitoring and data review.
Yuba County area overlying DPR GPAs	Coarser and highly drained soils may facilitate the percolation of nitrate to groundwater	Review more recent groundwater quality data from YCWA and DWR and continue to monitor these wells as part of Trend Monitoring Program.

All other HVAs ranked as priority 3 are located near the Sacramento and Feather River systems and are related to high hydrogeologic susceptibility, where no known impact on groundwater quality has occurred. These areas will be addressed through the Trend Monitoring Program and outreach activities.

The above actions to conduct further review of HVAs may be conducted through the Trend Monitoring Program and will be documented in the GAR 5-year update.

Part Two

The following list includes GQMP items that are relevant to all HVAs, regardless of priority ranking:

- Farm Evaluation and NMP information: Information reported by growers regarding nitrogen usage and nutrient management practices will be summarized in Annual Monitoring Reports (AMRs) and used to evaluate the effectiveness of the GQMP.
- Management Practice Evaluation Program (MPEP) Work Plan: The MPEP is being developed, and management practices identified will be rolled out to growers through education and outreach programs.
- Education and Outreach: The Coalition and Subwatershed Coordinators will continue educating their growers on effective management practices and the importance of compliance, specifically in HVAs.
- Performance goals were developed to meet the objectives of the GQMP to ensure the continued protection of groundwater quality in HVAs throughout the Sacramento Valley floor. The following goals will be aligned to MPEP and focus on education and outreach:

  - Performance Goal 1. Collect information from members in HVAs on management practices and identify potential sources of nitrate contamination in groundwater.
  - Performance Goal 2. Determine the effectiveness of various management practices protective of groundwater quality.
  - Performance Goal 3. Have members adopt new management practices protective of groundwater quality.
  - Performance Goal 4. Evaluate effectiveness of new management practices.
  - Performance Goal 5. Evaluate data and revise HVAs, if appropriate.
- The following implementation schedule milestones were developed:
  - Milestone 1. Within 1 year of GQMP approval, and annually thereafter, collect information from members with lands designated as HVAs pertaining to nitrogen applications, nitrate management practices, and crop yields through Farm Evaluations and NMPs. Provide information to members within HVAs and Subwatershed Coordinators.
  - Milestone 2. Within 3 years of GQMP approval, provide to members a list of management practices that have been demonstrated to be effective in reducing nitrate contamination of groundwater based on the MPEP Literature Review, modeling and/or field studies.
  - Milestone 3. Within 5 years of GQMP approval, demonstrate work toward an improved understanding of groundwater quality in areas categorized as having data gaps, and revise HVAs in the GAR update if necessary.
  - Milestone 4. Within 5 years of GQMP approval, demonstrate that members in HVAs are implementing nitrate management practices known to be effective, to the extent reasonable and feasible.
- Monitoring and Reporting: Information collected as part of the GQMP will be reported in a Management Plan Status Report as part of the AMR.

Contacts

Claudia Street, Executive Director of Yuba Sutter Farm Bureau

Reference

Northern California Water Association (NCWA). 2016. *Sacramento Valley Water Quality Coalition Groundwater Quality Assessment Report*. Final. January.

Appendix B-2
Colusa-Glenn Subwatershed

Colusa-Glenn Subwatershed Action Plan

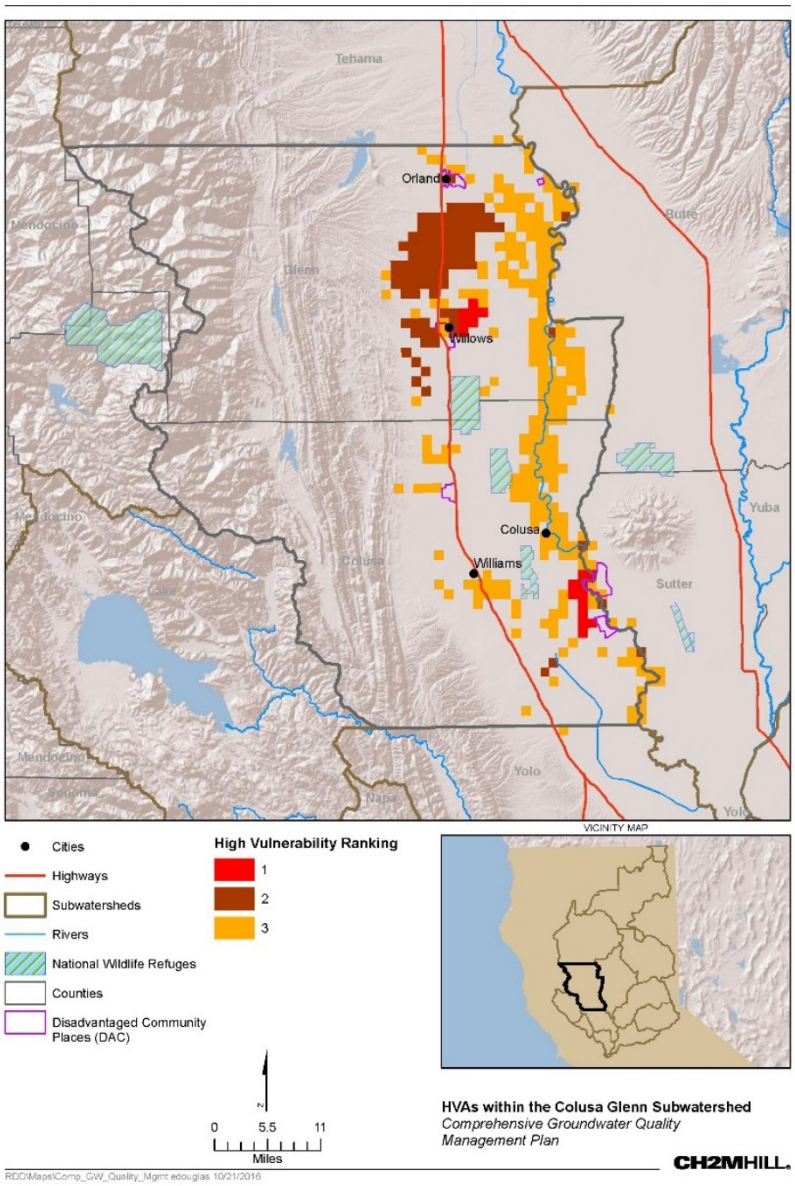
This Subwatershed Action Plan provides general information about the Colusa-Glenn Subwatershed and identifies management activities to be implemented to address areas that present a high vulnerability to groundwater quality impact. This Subwatershed Action Plan is a component of the Comprehensive Groundwater Quality Management Plan (GQMP), which addresses the requirements of the Waste Discharge Requirements General Order for Growers within the Sacramento River Watershed (R5-2014-0030-R1). The GQMP has been prepared on behalf of the Northern California Water Association and the Sacramento Valley Water Quality Coalition (Coalition).

Introduction

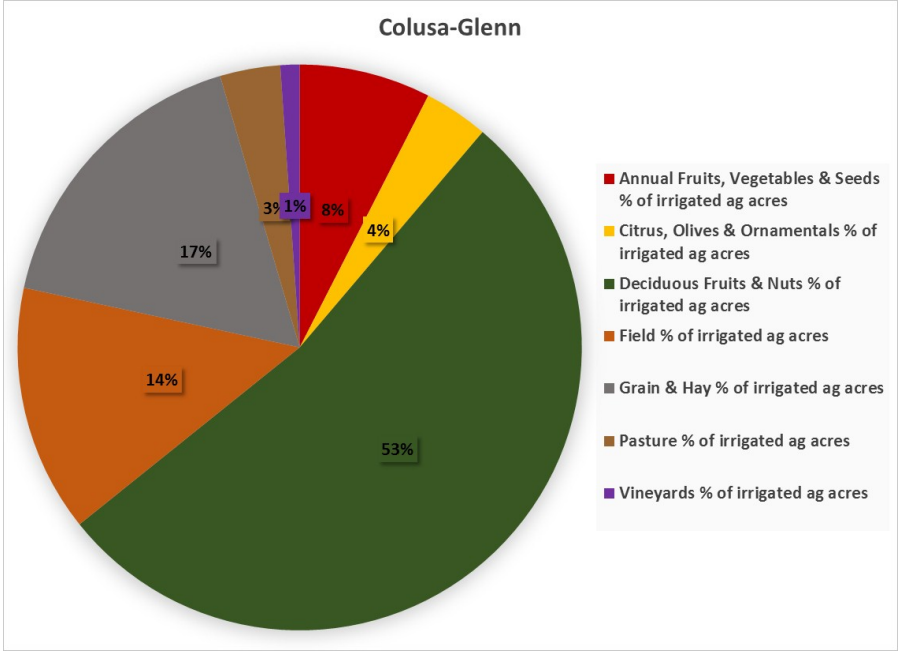
The Colusa-Glenn Subwatershed covers an area of approximately 1.5 million acres and encompasses all of Glenn County and most of Colusa County. The Sacramento River, Stony Creek, Walker Creek, and the Colusa Basin drain are within the subwatershed. The major population centers include Williams, Colusa, Willows, and Orland. The entire subwatershed is located on the Sacramento Valley floor, and agriculture is the major land use.

In 2013, there were approximately 304,279 acres of irrigated land in the Subwatershed enrolled in the Coalition. The management for the Colusa-Glenn Subwatershed is provided by the Colusa Glenn Subwatershed Program, with outreach and educational services provided by the Glenn County Resource Conservation District.

The first groundwater technical report for the Coalition was the Groundwater Quality Assessment Report (GAR), conditionally approved by CVRWQCB September 16, 2016. The map to the right shows the high vulnerability areas (HVAs) and their priority rankings based on the analysis performed in the Groundwater Quality Assessment Report (GAR). A summary of this analysis is provided below. The HVAs are the areas covered under the GQMP.



Land Use



The primary land use within the Colusa-Glenn Subwatershed is irrigated agriculture. Excluding rice, the major irrigated crops include orchards (almonds, prunes, and walnuts), row crops (tomatoes, melons, squash, beets, and cucumbers), pasture, wheat, alfalfa/hay, and corn.

The pie chart to the left shows the predominant crop categories grown in the Colusa-Glenn Subwatershed as a percentage of total irrigated acres within the subwatershed based on Pesticide Use Reporting 2013 data (as presented in the GAR [NCWA, 2016]). More than 50 percent of the irrigated agricultural area is planted in orchards.

In addition to irrigated agriculture, three large National Wildlife Refuges are located within the subwatershed, providing habitat for migrating birds along the Pacific Flyway.

Groundwater Quality and Vulnerability

Groundwater Quality

The GAR reviewed previous studies on groundwater quality and analyzed well data pertaining to constituents of concern, including nitrate, salinity, and pesticides. The GAR established that the Colusa-Glenn Subwatershed has generally high-quality groundwater with a few areas of concern related to nitrate. It found that the primary sources of salinity are not the result of agriculture, and that pesticides do not constitute a factor of high vulnerability in this subwatershed.

Nitrate samples from 359 wells within the subwatershed were analyzed. Thirteen percent of samples had nitrate concentrations greater than half of the maximum contaminant level (MCL) of 45 milligrams per liter, and only 2 percent of wells showed nitrate concentrations above the MCL. Elevated concentrations of nitrate were detected in northern Glenn County around the cities of Willows, Williams, and Colusa. A majority of agricultural lands show low levels of nitrate. Dairy operations may influence nitrate concentrations in the northern Glenn County portion of the subwatershed, and septic systems in urban areas are considered an important source of nitrate concentrations in groundwater.

Groundwater quality monitoring within this subwatershed is conducted sporadically by the California Department of Water Resources (DWR) and the United States Geological Survey. Public water supply wells are monitored for drinking water quality, and results are reported to the California Department of Public Health.

In addition, many wells are regularly monitored for groundwater levels by DWR and by California Statewide Groundwater Elevation Monitoring entities. These wells could potentially be used to monitor groundwater quality as well.

Groundwater Vulnerability

Both intrinsic and anthropogenic factors influence the vulnerability of groundwater to contamination from irrigated agriculture. Intrinsic factors include existing, physical factors such as hydrogeologic and soil conditions, the presence of naturally occurring contaminants, and geochemical characteristics. Anthropogenic factors include practices surrounding

crop type, irrigation, and nutrient and pesticide management. In addition, the California Department of Pesticide Regulation (DPR) identified areas that may be vulnerable to pesticide contamination because of the presence of coarser soil and geologic materials. These areas, known as DPR Groundwater Protection Areas (GPAs) were included in the GAR vulnerability analysis. The final HVAs for the Colusa-Glenn Subwatershed are provided on the map on the first page of this Subwatershed Action Plan. The priority ranking was based on the presence of known contaminated areas and the potential for affecting disadvantaged communities that rely on groundwater for drinking water.

Action Plan

This Subwatershed Action Plan includes two parts to address existing and potential groundwater contamination resulting from nitrate in this subwatershed. Part one includes potential actions that can be taken to conduct additional analysis specific to higher priority HVAs within the subwatershed. Part two includes actions highlighted in the GQMP that apply to all HVAs on the Sacramento Valley floor.

Part One

Table 1 summarizes the main priority ranking 1 and 2 HVAs within the Colusa-Glenn Subwatershed. Table 1 lists the potential impacts on groundwater from contamination and highlights potential options for further review.

Table 1. HVAs and Additional Analysis Summary Table

HVA (Priority Ranking 1 and 2)	Potential Impacts	Potential Options for Implementation
Northern Glenn County	Potential impacts from known dairies in the area	Request and review dairy monitoring data (provided by the Central Valley Regional Water Quality Control Board), which provides additional shallow groundwater quality information.
Urban areas including Willows, Williams, and Colusa	Potential impacts from septic tanks; areas overlying DPR GPAs by Willows where higher drained soils may facilitate the percolation of nitrate to groundwater	Need to work with Colusa County, Glenn County, and the cities and towns to evaluate septic system information. Consider representative monitoring in some areas.

All other HVAs ranked as priority 3 are located near the Sacramento River and are scattered in the southern part of the subwatershed. These areas are related to high hydrogeologic susceptibility, where no known impact on groundwater quality has occurred. Further review of these areas may be addressed through the Trend Monitoring Program and outreach activities.

The above actions to conduct further review of HVAs may be conducted through the Trend Monitoring Program and will be documented in the GAR 5-year update.

Part Two

The following list includes GQMP items that are relevant to all HVAs regardless of priority ranking:

- Farm Evaluation and NMP information: Information reported by growers regarding nitrogen usage and management practices will be summarized in Annual Monitoring Reports (AMRs) and used to evaluate the effectiveness of the GQMP.
- Management Practice Evaluation Program (MPEP) Work Plan: The MPEP is being developed, and management practices identified will be rolled out to growers through education and outreach programs.
- Education and Outreach: The Coalition and Subwatershed Coordinators will continue educating their growers on effective management practices and the importance of compliance, specifically in HVAs.

- Performance goals were developed to meet the objectives of the GQMP to ensure the continued protection of groundwater quality in HVAs throughout the Sacramento Valley floor. The following goals will be aligned to MPEP and focus on education and outreach:
  - Performance Goal 1. Collect information from members in HVAs on management practices and identify potential sources of nitrate contamination in groundwater.
  - Performance Goal 2. Determine the effectiveness of various management practices protective of groundwater quality.
  - Performance Goal 3. Have members adopt new management practices protective of groundwater quality.
  - Performance Goal 4. Evaluate effectiveness of new management practices.
  - Performance Goal 5. Evaluate data and revise HVAs, if appropriate.
- The following implementation schedule milestones were developed:
  - Milestone 1. Within 1 year of GQMP approval, and annually thereafter, collect information from members with lands designated as HVAs pertaining to nutrient applications, nitrate management practices, and crop yields through Farm Evaluations and NMPs. Provide information to members within HVAs and Subwatershed Coordinators.
  - Milestone 2. Within 3 years of GQMP approval, provide a list to members of management practices that have been demonstrated to be effective in reducing nitrate contamination of groundwater based on the MPEP Literature Review, modeling and/or field studies.
  - Milestone 3. Within 5 years of GQMP approval, demonstrate work toward an improved understanding of groundwater quality in areas categorized as having data gaps, and revise HVAs in the 5-year GAR update if necessary.
  - Milestone 4. Within 5 years of GQMP approval, demonstrate that members in HVAs are implementing nitrate management practices known to be effective, to the extent possible.
    - Monitoring and Reporting: Information collected as part of the GQMP will be reported in a Management Plan Status Report as part of the AMR.

Contacts

Kandi Manhart, Colusa Glenn Subwatershed Program Manager

Larry Domenighini, Colusa Glenn Subwatershed Program Board President/Grower

Reference

Northern California Water Association (NCWA). 2016. *Sacramento Valley Water Quality Coalition Groundwater Quality Assessment Report*. Final. January.

Appendix B-3
Dixon-Solano Subwatershed

Dixon-Solano Subwatershed Action Plan

This Subwatershed Action Plan provides general information about the Dixon-Solano Subwatershed and identifies management activities to be implemented to address areas that present a high vulnerability to groundwater quality impact. This Subwatershed Action Plan is a component of the Comprehensive Groundwater Quality Management Plan (GQMP), which addresses the requirements of the Waste Discharge Requirements General Order for Growers within the Sacramento River Watershed (R5-2014-0030-R1). The GQMP has been prepared on behalf of the Northern California Water Association (NCWA) and the Sacramento Valley Water Quality Coalition (Coalition).

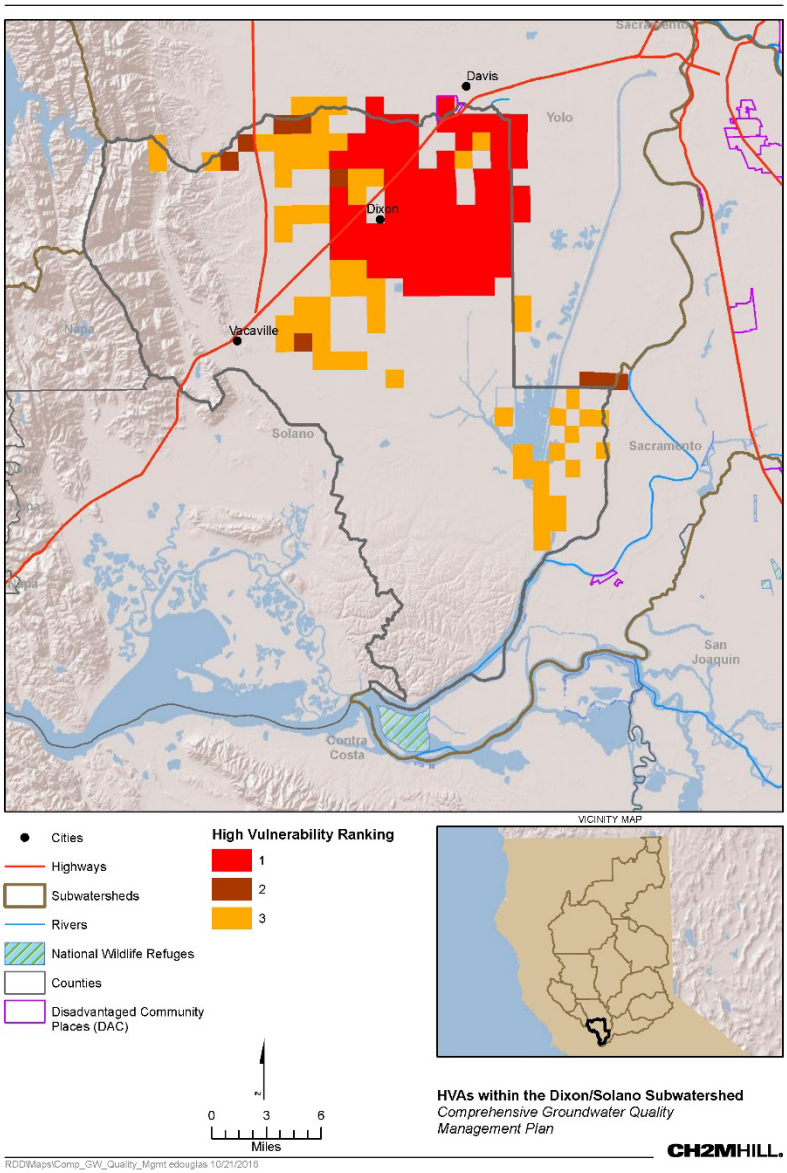
Introduction

The Dixon-Solano Subwatershed covers an area of approximately 324,400 acres and encompasses eastern Solano County. The major waterways include the Sacramento River, Ulatis and Pleasants Creeks, and Cache and Shag Sloughs. In addition, the northwestern portion of the Sacramento-San Joaquin Delta is located within the subwatershed, and the major population centers include Dixon and Vacaville.

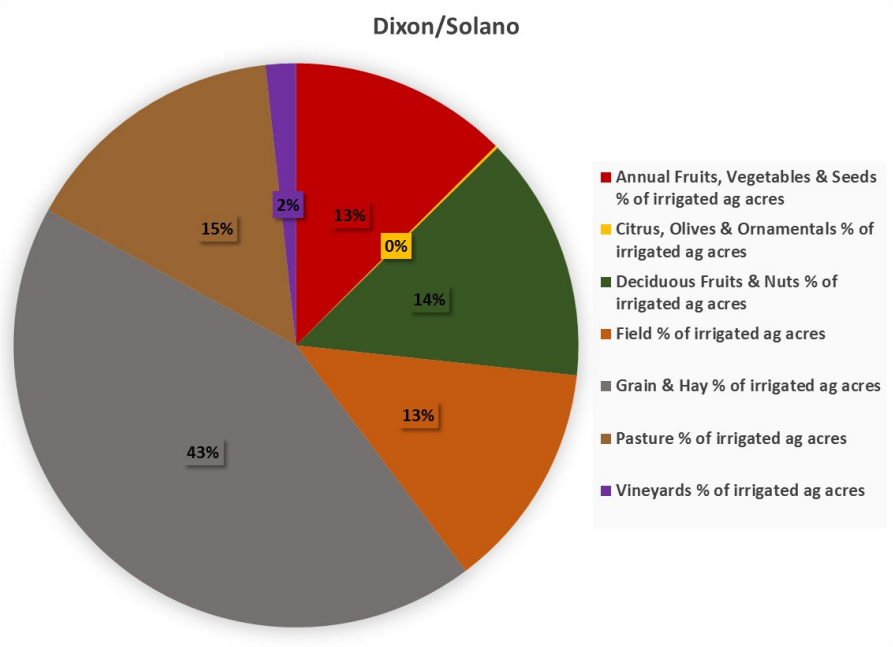
The majority of the subwatershed is located on the Sacramento Valley floor, where the majority of agricultural production occurs.

In 2013, there were approximately 126,284acres of irrigated land in the subwatershed enrolled in the Coalition. The management for the Dixon-Solano Subwatershed is provided by the Dixon Resource Conservation District (RCD).

The first groundwater technical report for the Coalition was the Groundwater Quality Assessment Report (GAR), conditionally approved by CVRWQCB September 16, 2016. The map to the right shows the high vulnerability areas (HVAs) and their priority rankings based on the analysis performed in the Groundwater Quality Assessment Report (GAR). A summary of this analysis is provided below. The HVAs are the areas covered under the GQMP.



Land Use



Irrigated agriculture is a major land use in the Dixon-Solano Subwatershed. The major irrigated crops include field crops (alfalfa, hay, wheat, and field corn), wine grapes, orchards (walnuts, prunes, and almonds), vegetables (primarily processing tomatoes), and seed crops (dry beans and sunflowers).

The pie chart to the left shows the predominant crop categories grown in the Dixon-Solano Subwatershed as a percentage of total irrigated acres within the subwatershed based on Pesticide Use Reporting 2013 data (as presented in the GAR [NCWA, 2016]).

Groundwater Quality and Vulnerability

Groundwater Quality

The GAR reviewed previous studies on groundwater quality and analyzed well data pertaining to constituents of concern, including nitrate, salinity, and pesticides. The GAR established that the Dixon-Solano Subwatershed has generally high-quality groundwater with a few areas of concern related to nitrate. It found that the primary sources of salinity are not a result of agriculture, and that pesticides do not constitute a factor of high vulnerability in this subwatershed.

Nitrate samples from 167 wells within the Dixon-Solano Subwatershed were analyzed. Twenty-five percent of samples had nitrate concentrations greater than half of the maximum contaminant level (MCL) of 45 milligrams per liter, and 6 percent of wells showed nitrate concentrations above the MCL. Elevated concentrations of nitrate were detected around the city of Dixon. A majority of agricultural lands show very low levels of nitrate, and septic systems in urban areas are considered an important source of nitrate concentrations in groundwater.

Groundwater quality monitoring within this subwatershed is largely conducted in urban areas such as the cities of Rio Vista, Dixon, and Vacaville, which use groundwater as a municipal water supply source. The Solano Irrigation District (SID) monitors four agricultural wells, and the Solano County Water Agency (SCWA) maintains a database of wells, groundwater levels, and groundwater quality.

In addition, SID and SCWA monitor a large network of wells for groundwater levels, and these wells could be used to monitor groundwater quality as well.

Groundwater Vulnerability

Both intrinsic and anthropogenic factors influence the vulnerability of groundwater to contamination from irrigated agriculture. Intrinsic factors include existing, physical factors such as hydrogeologic and soil conditions, the presence of naturally occurring contaminants, and geochemical characteristics. Anthropogenic factors include practices surrounding crop type, irrigation, and nutrient and pesticide management. In addition, the California Department of Pesticide Regulation (DPR) identified areas that may be vulnerable to pesticide contamination because of the presence of coarser soil and geologic materials. These areas, known as DPR Groundwater Protection Areas (GPAs), were included in the GAR vulnerability analysis. The final HVAs for the Dixon-Solano Subwatershed are provided on the map on the first page of this

Subwatershed Action Plan. The priority ranking was based on the presence of known contaminated areas and the potential for affecting disadvantaged communities that rely on groundwater for drinking water.

Action Plan

This Subwatershed Action Plan includes two parts to address existing and potential groundwater contamination from nitrate in this subwatershed. Part one includes potential actions that can be taken to conduct additional analysis specific to higher priority HVAs within the subwatershed. Part two includes actions highlighted in the GQMP that apply to all HVAs on the Sacramento Valley floor.

Part One

Table 1 summarizes the main priority ranking 1 and 2 HVAs within the Dixon-Solano Subwatershed. Table 1 lists the potential impacts on groundwater from contamination and highlights potential options for further review.

Table 1. HVAs and Additional Analysis Summary Table

HVA (Priority Ranking 1 and 2)	Potential Impacts	Potential Options for Implementation
Northeastern Solano County near the City of Dixon	Potential impacts from dairies and historical wastewater ponds	Review more recent well data and historical land uses, particularly dairies and wastewater ponds, near the city of Dixon. Also could review available waste discharge requirement (WDR) reports for wastewater plants. Consider some representative monitoring and implementation of management practices. For example, "pump and fertilize" would be an option to consider in the impacted areas that use groundwater for irrigation.

All other HVAs ranked as priority 3 are located near streams in the Sacramento-San Joaquin Delta and west of the urban areas surrounding Dixon. These priority 3 HVAs are related to high hydrogeologic susceptibility, where no known impact on groundwater quality has occurred. These areas will be addressed through the Trend Monitoring Program and outreach.

The above actions to conduct further review of HVAs may be conducted through the Trend Monitoring Program and will be documented in the GAR 5-year update.

Part Two

The following list includes GQMP items that are relevant to all HVAs regardless of priority ranking:

- Farm Evaluation and NMP information: Information reported by growers regarding nitrogen usage and nutrient management practices will be summarized in Annual Monitoring Reports (AMRs) and used to evaluate the effectiveness of the GQMP.
- Management Practice Evaluation Program (MPEP) Work Plan: The MPEP is being developed, and management practices identified will be rolled out to growers through education and outreach programs.
- Education and Outreach: The Coalition and Subwatershed Coordinators will continue educating their growers on effective management practices and the importance of compliance, specifically in HVAs.
- Performance goals were developed to meet the objectives of the GQMP to ensure the continued protection of groundwater quality in HVAs throughout the Sacramento Valley floor. The following goals will be aligned to MPEP and focus on education and outreach:
  - Performance Goal 1. Collect information from members in HVAs on management practices and identify potential sources of nitrate contamination in groundwater.
  - Performance Goal 2. Determine the effectiveness of various management practices protective of groundwater quality.

  - Performance Goal 3. Have members adopt new management practices protective of groundwater quality.
  - Performance Goal 4. Evaluate effectiveness of new management practices.
  - Performance Goal 5. Evaluate data and revise HVAs, if appropriate.
- The following implementation schedule milestones were developed:
  - Milestone 1. Within 1 year of GQMP approval, and annually thereafter, collect information from members with lands designated as HVAs pertaining to nutrient applications, nitrate management practices, and crop yields through Farm Evaluations and NMPs. Provide information to members within HVAs and Subwatershed Coordinators.
  - Milestone 2. Within 3 years of GQMP approval, provide to members a list of management practices that have been demonstrated to be effective in reducing nitrate contamination of groundwater based on the MPEP Literature Review, modeling and/or field studies.
  - Milestone 3. Within 5 years of GQMP approval, demonstrate work toward an improved understanding of groundwater quality in areas categorized as having data gaps, and revise HVAs in the 5-year GAR update if necessary.
  - Milestone 4. Within 5 years of GQMP approval, demonstrate that members in HVAs are implementing nitrate management practices known to be effective, to the extent possible.
- Monitoring and Reporting: Information collected as part of the GQMP will be reported in a Management Plan Status Report as part of the AMR.

Contact

Kelly Huff, Project Manager, Dixon RCD

Reference

Northern California Water Association (NCWA). 2016. *Sacramento Valley Water Quality Coalition Groundwater Quality Assessment Report*. Final. January.

Appendix B-4
Sacramento-Amador Subwatershed

Sacramento-Amador Subwatershed Action Plan

This Subwatershed Action Plan provides general information about the Sacramento-Amador Subwatershed and identifies management activities to be implemented to address areas that present a high vulnerability to groundwater quality impact. This Subwatershed Action Plan is a component of the Comprehensive Groundwater Quality Management Plan (GQMP), which addresses the requirements of the Waste Discharge Requirements General Order for Growers within the Sacramento River Watershed (R5-2014-0030-R1). The GQMP has been prepared on behalf of the Northern California Water Association (NCWA) and the Sacramento Valley Water Quality Coalition (Coalition).

Introduction

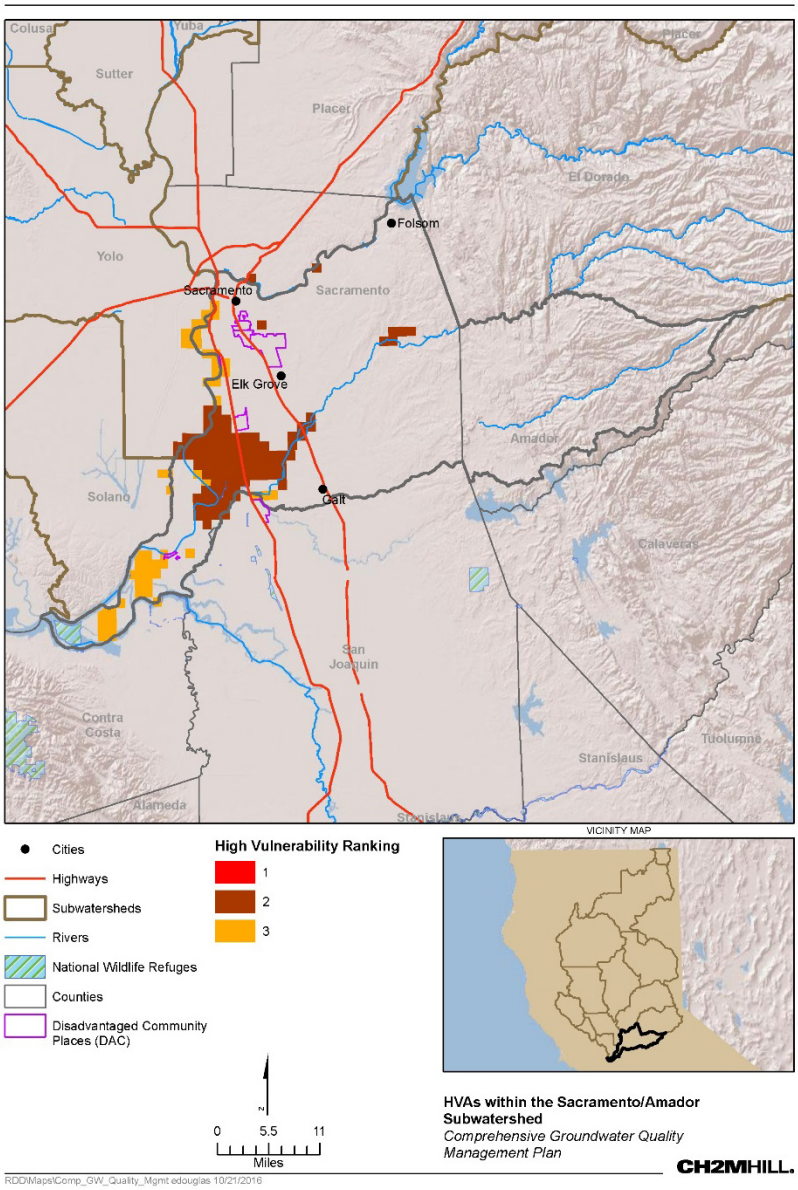
The Sacramento-Amador Subwatershed covers an area of approximately 750,300 acres and includes portions of Sacramento County (south of the American River) and Amador County (north of the Mokelumne River).

The major waterways include the Sacramento and Cosumnes Rivers, and Deer and Laguna Creeks. In addition, a portion of the Sacramento-San Joaquin Delta is located within the subwatershed, and the major population centers include Elk Grove, Galt, and Sacramento.

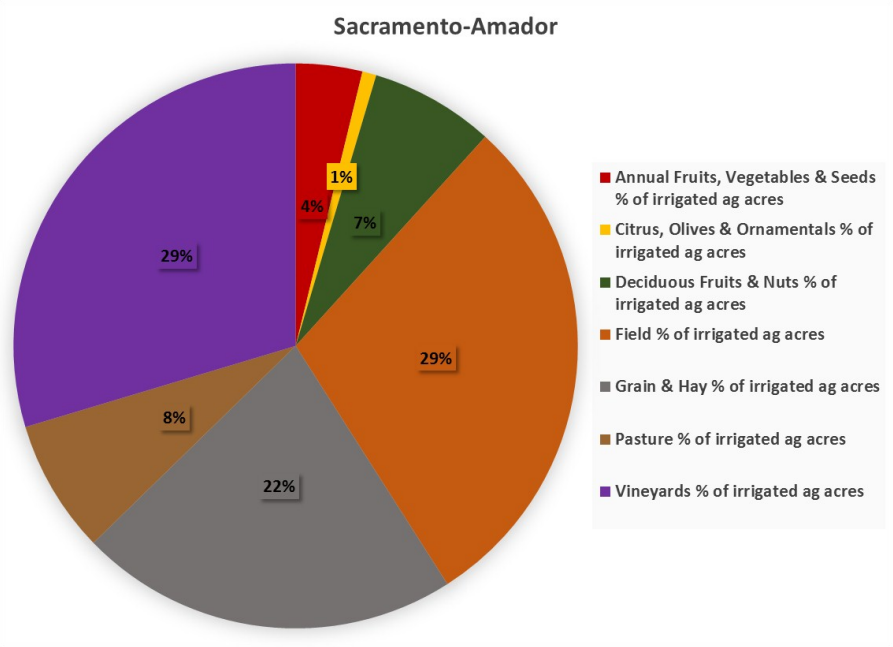
The majority of the Subwatershed, is located on the Sacramento Valley floor, where the majority of agricultural production occurs.

In 2013, there were approximately 119,784 acres of irrigated land in the subwatershed enrolled in the Coalition. The management for the Sacramento-Amador Subwatershed is provided by the Sacramento-Amador Water Quality Alliance and the Amador Resource Conservation District (RCD).

The first groundwater technical report for the Coalition was the Groundwater Quality Assessment Report (GAR), conditionally approved by CVRWQCB September 16, 2016. The map to the right shows the high vulnerability areas (HVAs) and their priority rankings based on the analysis performed in the Groundwater Quality Assessment Report (GAR). A summary of this analysis is provided below. The HVAs are the areas covered under the GQMP.



Land Use



Irrigated agriculture is an important land use component in the Sacramento-Amador Subwatershed. The major irrigated crops include wine grapes, citrus, mixed pasture, grain and alfalfa/hay, orchards (walnuts), fields, and vegetable crops (corn, safflower, and tomatoes).

The pie chart to the left shows the predominant crop categories grown in the Sacramento-Amador Subwatershed as a percentage of total irrigated acres within the subwatershed based on Pesticide Use Reporting 2013 data (as presented in the GAR [NCWA, 2016]).

Groundwater Quality and Vulnerability

Groundwater Quality

The GAR reviewed previous studies on groundwater quality and analyzed well data pertaining to constituents of concern, including nitrate, salinity, and pesticides. The GAR established that the Sacramento-Amador Subwatershed has generally good quality groundwater with a few areas of concern. It found that the primary sources of salinity are not the result of agriculture, and that pesticides do not constitute a factor of high vulnerability in this subwatershed.

Nitrate samples from 317 wells within the Sacramento-Amador Subwatershed were analyzed. Ten percent of samples had nitrate concentrations greater than half of the maximum contaminant level (MCL) of 45 milligrams per liter, and only 4 percent of wells showed nitrate concentrations above the MCL. Elevated concentrations of nitrate were detected in areas along Snodgrass Slough in the northern Delta. However, these data were collected from shallow wells in the 1980s, and no recent data are available for shallow wells in the region. Newer, deeper wells in the area show elevated but stable nitrate concentrations. A majority of agricultural lands show very low levels of nitrate. Historical dairy operations may have influenced nitrate concentrations measured in the past, and septic systems in urban areas are considered an important source of nitrate concentrations in groundwater.

Groundwater quality monitoring within this subwatershed is conducted by the Sacramento County Water Agency (SCWA) in partnership with the California Department of Water Resources (DWR), United States Geological Survey (USGS), and Sacramento State University (SCWA, 2006). Groundwater quality is also measured along the Cosumnes River through a collaboration between The Nature Conservancy and the University of California at Davis. The Southeast Sacramento County Agricultural Water Authority also outlined a groundwater quality monitoring program in its 2002 Groundwater Management Plan.

In addition, many wells are regularly monitored for groundwater levels by DWR, SCWA, Amador Water Agency, USGS, and California Statewide Groundwater Elevation Monitoring entities. These wells could be used to monitor groundwater quality as well.

Groundwater Vulnerability

Both intrinsic and anthropogenic factors influence the vulnerability of groundwater to contamination from irrigated agriculture. Intrinsic factors include existing, physical factors such as hydrogeologic and soil conditions, the presence of naturally occurring contaminants, and geochemical characteristics. Anthropogenic factors include practices surrounding crop type, irrigation, and nutrient and pesticide management. In addition, the California Department of Pesticide Regulation (DPR) identified areas that may be vulnerable to pesticide contamination because of the presence of coarser soil and geologic materials. These areas, known as DPR Groundwater Protection Areas were included in the GAR vulnerability analysis. The final HVAs for the Sacramento-Amador Subwatershed are provided on the map on the first page of this Subwatershed Action Plan. The priority ranking was based on the presence of known contaminated areas, and the potential for affecting disadvantaged communities that rely on groundwater for drinking water.

Action Plan

This Subwatershed Action Plan includes two parts to address existing and potential groundwater contamination resulting from nitrate in this subwatershed. Part one includes potential actions that can be taken to conduct additional analysis specific to higher priority HVAs within the subwatershed. Part two includes actions highlighted in the GQMP that apply to all HVAs on the Sacramento Valley floor.

Part One

Table 1 summarizes the main priority ranking 1 and 2 HVAs within the Sacramento-Amador Subwatershed. Table 1 lists the potential impacts on groundwater from contamination and highlights potential options for further review.

Table 1. HVAs and Additional Analysis Summary Table

HVA (Priority Ranking 1 and 2)	Potential Impacts	Potential Options for Implementation
The Delta Area	Potential impacts from past land uses (historical dairies)	Coordinate with DWR or the San Joaquin County and Delta Water Quality Coalition to identify new sources of water quality data for shallow groundwater within the area. Alternatively, representative monitoring may be conducted to confirm the more recent shallow groundwater quality.

All other HVAs ranked as priority 3 are located near the Sacramento River system at the western end of the Delta and are related to high hydrogeologic susceptibility, where no known impact on groundwater quality has occurred. These areas will be addressed through the Trend Monitoring Program and outreach.

The above actions to conduct further review of HVAs may be conducted through the Trend Monitoring Program and will be documented in the GAR 5-year update.

Part Two

The following list includes GQMP items that are relevant to all HVAs regardless of priority ranking:

- Farm Evaluation and NMP information: Information reported by growers regarding nitrogen usage and nutrient management practices will be summarized in Annual Monitoring Reports (AMRs) and used to evaluate the effectiveness of the GQMP.
- Management Practice Evaluation Program (MPEP) Work Plan: The MPEP is being developed, and management practices identified will be rolled out to growers through education and outreach programs.
- Education and Outreach: The Coalition and Subwatershed Coordinators will continue educating their growers on effective management practices and the importance of compliance, specifically in HVAs.

- Performance Goals were developed to meet the objectives of the GQMP to ensure the continued protection of groundwater quality in HVAs throughout the Sacramento Valley floor. The following goals will be aligned to MPEP and focus on education and outreach:
  - Performance Goal 1. Collect information from members in HVAs on management practices and identify potential sources of nitrate contamination in groundwater.
  - Performance Goal 2. Determine the effectiveness of various management practices protective of groundwater quality.
  - Performance Goal 3. Have members adopt new management practices protective of groundwater quality.
  - Performance Goal 4. Evaluate effectiveness of new management practices.
  - Performance Goal 5. Evaluate data and revise HVAs, if appropriate.
- The following implementation schedule milestones were developed:
  - Milestone 1. Within 1 year of GQMP approval, and annually thereafter, collect information from members with lands designated as HVAs pertaining to nutrient applications, nitrate management practices and crop yields through Farm Evaluations and NMPs. Provide information to members within HVAs and Subwatershed Coordinators.
  - Milestone 2. Within 3 years of GQMP approval, provide to members a list of management practices that have been demonstrated to be effective in reducing nitrate contamination of groundwater based on the MPEP Literature Review, modeling and/or field studies.
  - Milestone 3. Within 5 years of GQMP approval, demonstrate work toward an improved understanding of groundwater quality in areas categorized as having data gaps, and revise HVAs in the GAR update if necessary.
  - Milestone 4. Within 5 years of GQMP approval, demonstrate that members in HVAs are implementing nitrate management practices known to be effective, to the extent possible.
- Monitoring and Reporting: Information collected as part of the GQMP will be reported in a Management Plan Status Report as part of the AMR.

Contacts

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Amanda Platt, Coordinator, Amador RCD

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Appendix B-5
Shasta-Tehama Subwatershed

SACRAMENTO VALLEY WATER QUALITY COALITION

2016 Comprehensive Groundwater Quality Management Plan

Shasta-Tehama Subwatershed Action Plan

This Subwatershed Action Plan provides general information about the Shasta-Tehama Subwatershed and identifies management activities to be implemented to address areas that present a high vulnerability to groundwater quality impact. This Subwatershed Action Plan is a component of the Comprehensive Groundwater Quality Management Plan (GQMP), which addresses the requirements of the Waste Discharge Requirements General Order for Growers within the Sacramento River Watershed (R5-2014-0030-R1). The GQMP has been prepared on behalf of the Northern California Water Association (NCWA) and the Sacramento Valley Water Quality Coalition (Coalition).

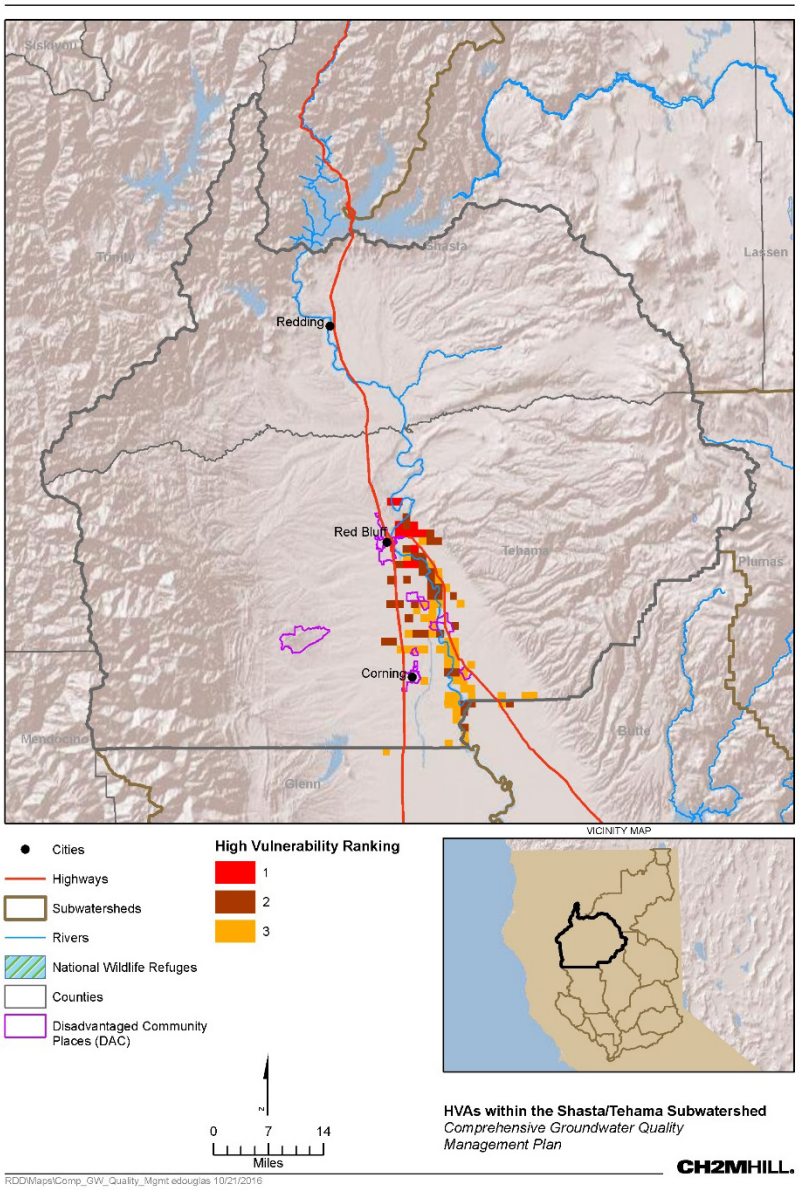
Introduction

The Shasta-Tehama Subwatershed encompasses all of Tehama County and Shasta County below Shasta Dam, covering an area of approximately 3 million acres.

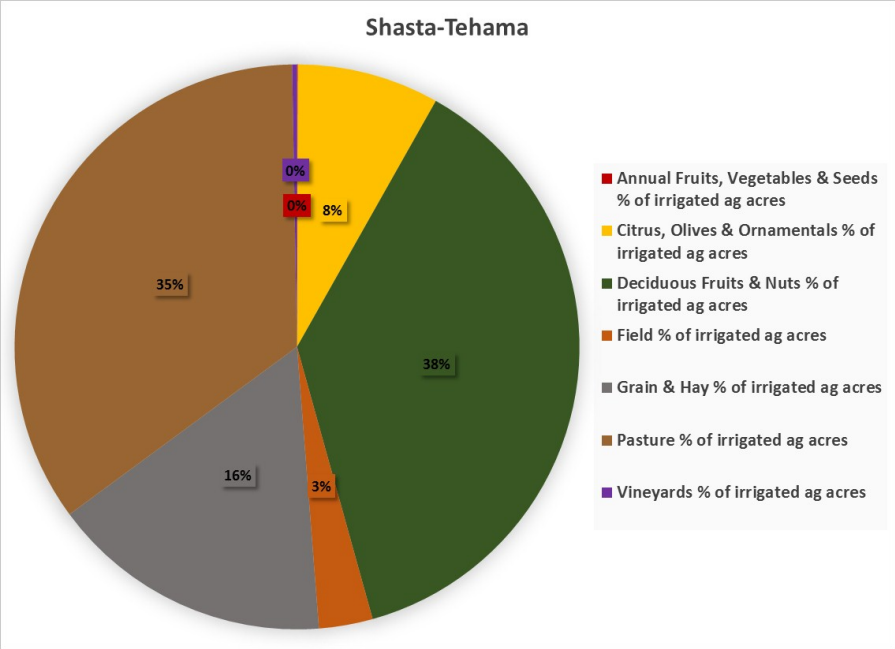
The Sacramento River, and Thomes, Elder, Cottonwood, Red Bank, Burch, and Cow Creeks are within the subwatershed, and the major population centers include Redding, Red Bluff, and Corning. A portion of the subwatershed is located on the Sacramento Valley floor, where the majority of agricultural production occurs.

In 2013, there were approximately 84,096 acres of irrigated land in the subwatershed enrolled in the Coalition. The management for the Shasta-Tehama Subwatershed is provided by the Shasta-Tehama Watershed Education Coalition (STWEC).

The first groundwater technical report for the Coalition was the Groundwater Quality Assessment Report (GAR), conditionally approved by CVRWQCB September 16, 2016. The map to the right shows the high vulnerability areas (HVAs) and their priority rankings based on the analysis performed in the Groundwater Quality Assessment Report (GAR). A summary of this analysis is provided below. The HVAs are the areas covered under the GQMP.



Land Use



Irrigated agriculture is a significant land use within the Shasta-Tehama Subwatershed. The major irrigated crops include pasture, orchards (walnuts, prunes, plums, olives, and almonds), and field and forage crops (corn, dry beans, and wheat).

The pie chart to the left shows the predominant crop categories grown in the Shasta-Tehama Subwatershed as a percentage of total irrigated acres within the subwatershed based on Pesticide Use Reporting 2013 data (as presented in the GAR [NCWA, 2016]).

Groundwater Quality and Vulnerability

Groundwater Quality

The GAR reviewed previous studies on groundwater quality and analyzed well data pertaining to constituents of concern, including nitrate, salinity, and pesticides. The GAR established that the Shasta-Tehama Subwatershed has generally high-quality groundwater with a few areas of concern related to nitrate. It found that the primary sources of salinity are not the result of agriculture, and that pesticides do not constitute a factor of high vulnerability in this subwatershed.

Nitrate samples from 1,123 wells within the Shasta-Tehama Subwatershed were analyzed. Six percent of samples had nitrate concentrations greater than half of the maximum contaminant level (MCL) of 45 milligrams per liter, and only 2 percent of wells showed nitrate concentrations above the MCL. Elevated concentrations of nitrate were detected primarily in and north of the Red Bluff area. A majority of agricultural lands show low levels of nitrate, and septic systems in urban areas are considered an important source of nitrate concentrations in groundwater. A study was conducted by the DWR's Northern Region Office in 2013 in the Antelope area east of Red Bluff to assess the source of elevated nitrate concentrations recorded in groundwater. DWR sampled more than 60 domestic wells throughout the area in the spring and fall and found that nitrate concentrations were highest in wells located in a densely populated area. The study concluded that individual and community onsite wastewater treatment systems are likely the primary source of nitrate contamination of groundwater in the Antelope area (DWR, 2016).

Groundwater quality monitoring within this Subwatershed has been collected in the past by Tehama County in collaboration with public agencies. However, Tehama County does not currently own or manage a groundwater quality monitoring network (Tehama County, 2012).

Many wells are monitored regularly by DWR, Tehama County, Shasta County, and California Statewide Groundwater Elevation Monitoring entities. These wells could be used to monitor groundwater quality as well.

Groundwater Vulnerability

Both intrinsic and anthropogenic factors influence the vulnerability of groundwater to contamination from irrigated agriculture. Intrinsic factors include existing, physical factors such as hydrogeologic and soil conditions, the presence of naturally occurring contaminants, and geochemical characteristics. Anthropogenic factors include practices surrounding

crop type, irrigation, and nutrient and pesticide management. In addition, the California Department of Pesticide Regulation (DPR) identified areas that may be vulnerable to pesticide contamination because of the presence of coarser soil and geologic materials. These areas, known as DPR Groundwater Protection Areas (GPAs), were included in the GAR vulnerability analysis. The final HVAs for the Shasta-Tehama Subwatershed are provided on the map on the first page of this Subwatershed Action Plan. The priority ranking was based on the presence of known contaminated areas and the potential for affecting disadvantaged communities that rely on groundwater for drinking water.

Action Plan

This Subwatershed Action Plan includes two parts to address existing and potential groundwater contamination from nitrate in this subwatershed. Part one includes potential actions that can be taken to conduct additional analysis specific to higher priority HVAs within the subwatershed. Part two includes actions highlighted in the GQMP that apply to all HVAs on the Sacramento Valley floor.

Part One

Table 1 summarizes the main priority ranking 1 and 2 HVAs within the Shasta-Tehama Subwatershed. Table 1 lists the potential impacts on groundwater from contamination and highlights potential options for further review.

Table 1. HVAs and Additional Analysis Summary Table

HVA (Priority Ranking 1 and 2)	Potential Impacts	Potential Options for Implementation
Red Bluff and Corning areas	Impacts likely attributable to point- and non-point wastewater treatment systems	Need to assess contribution of historical agriculture versus impacts from existing onsite wastewater treatment systems by working with the Tehama County Environmental Health Department to develop a groundwater well network to monitor as part of the Trend Monitoring Program.
Areas overlying DPR GPAs in the southern portion of the subwatershed by the Sacramento River	Coarser and highly drained soils may facilitate the percolation of nitrate to groundwater	Trend Monitoring will help establish whether impacts on groundwater in these areas may have occurred.

All other HVAs ranked as priority 3 are located near the Sacramento River and scattered to the West of the River. These priority 3 HVAs are related to high hydrogeologic susceptibility, where no known impact on groundwater quality has occurred. These areas will be addressed through the Trend Monitoring Program and outreach.

The above actions to conduct further review of HVAs may be conducted through the Trend Monitoring Program and will be documented in the GAR 5-year update.

Part Two

The following list includes GQMP items that are relevant to all HVAs regardless of priority ranking:

- Farm Evaluation and NMP information: Information reported by growers regarding nitrogen usage and nutrient management practices will be summarized in Annual Monitoring Reports (AMRs) and used to evaluate the effectiveness of the GQMP.
- Management Practice Evaluation Program (MPEP) Work Plan: The MPEP is being developed, and management practices identified will be rolled out to growers through education and outreach programs.
- Education and Outreach: The Coalition and Subwatershed Coordinators will continue educating their growers on effective management practices and the importance of compliance, specifically in HVAs.

- Performance goals were developed to meet the objectives of the GQMP to ensure the continued protection of groundwater quality in HVAs throughout the Sacramento Valley floor. The following goals will be aligned to MPEP and focus on education and outreach:
  - Performance Goal 1. Collect information from members in HVAs on management practices and identify potential sources of nitrate contamination in groundwater.
  - Performance Goal 2. Determine the effectiveness of various management practices protective of groundwater quality.
  - Performance Goal 3. Have members adopt new management practices protective of groundwater quality.
  - Performance Goal 4. Evaluate effectiveness of new management practices.
  - Performance Goal 5. Evaluate data and revise HVAs, if appropriate.
- The following implementation schedule milestones were developed:
  - Milestone 1. Within 1 year of GQMP approval, and annually thereafter, collect information from members with lands designated as HVAs pertaining to nutrient applications, nitrate management practices, and crop yields through Farm Evaluations and NMPs. Provide information to members within HVAs and Subwatershed Coordinators.
  - Milestone 2. Within 3 years of GQMP approval, provide to members a list of management practices that have been demonstrated to be effective in reducing nitrate contamination of groundwater based on the MPEP Literature Review, modeling and/or field studies.
  - Milestone 3. Within 5 years of GQMP approval, demonstrate work toward an improved understanding of groundwater quality in areas categorized as having data gaps, and revise HVAs in the GAR update if necessary.
  - Milestone 4. Within 5 years of GQMP approval, demonstrate that members in HVAs are implementing nitrate management practices known to be effective, to the extent possible.
- Monitoring and Reporting: Information collected as part of the GQMP will be reported in a Management Plan Status Report as part of the AMR.

Contact

Rob Rianda, STWEC Coordinator

References

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Appendix B-6
Yolo Subwatershed

Yolo Subwatershed Action Plan

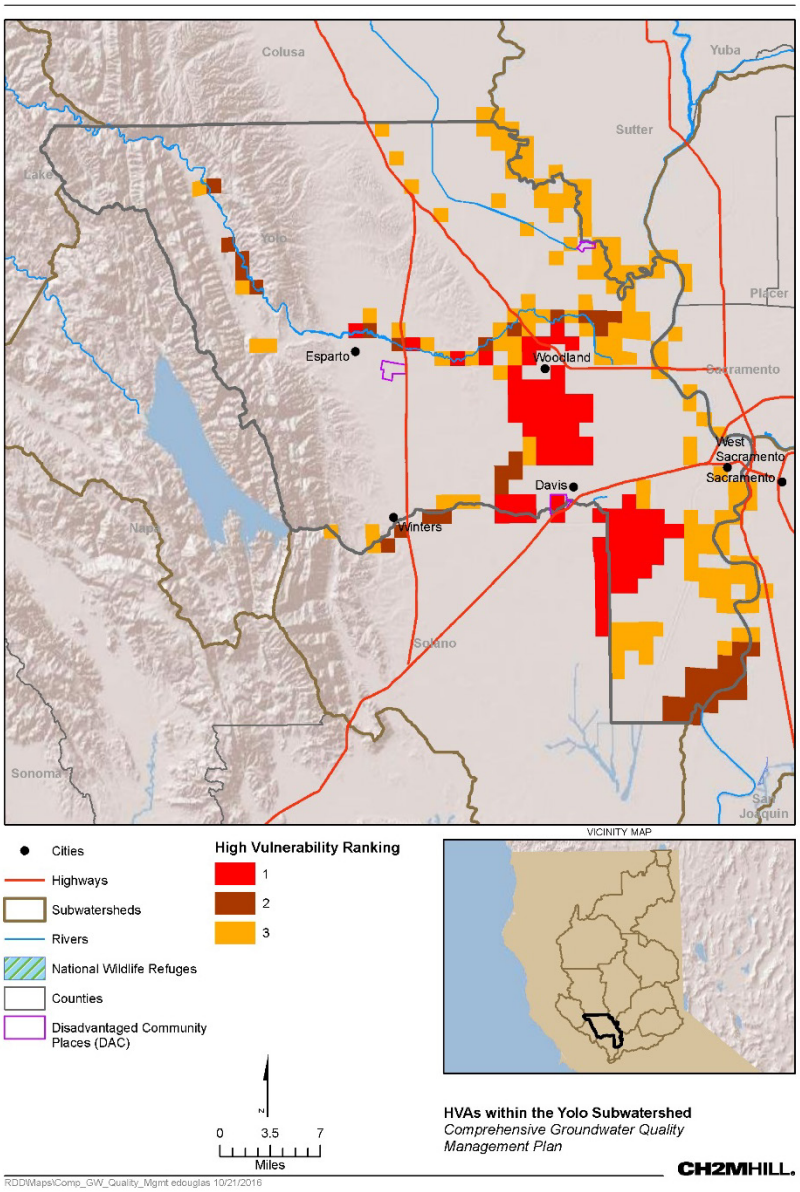
This Subwatershed Action Plan provides general information about the Yolo Subwatershed and identifies management activities to be implemented to address areas that present a high vulnerability to groundwater quality impact. This Subwatershed Action Plan is a component of the Comprehensive Groundwater Quality Management Plan (GQMP), which addresses the requirements of the Waste Discharge Requirements General Order for Growers within the Sacramento River Watershed (R5-2014-0030-R1). The GQMP has been prepared on behalf of the Northern California Water Association (NCWA) and the Sacramento Valley Water Quality Coalition (Coalition).

Introduction

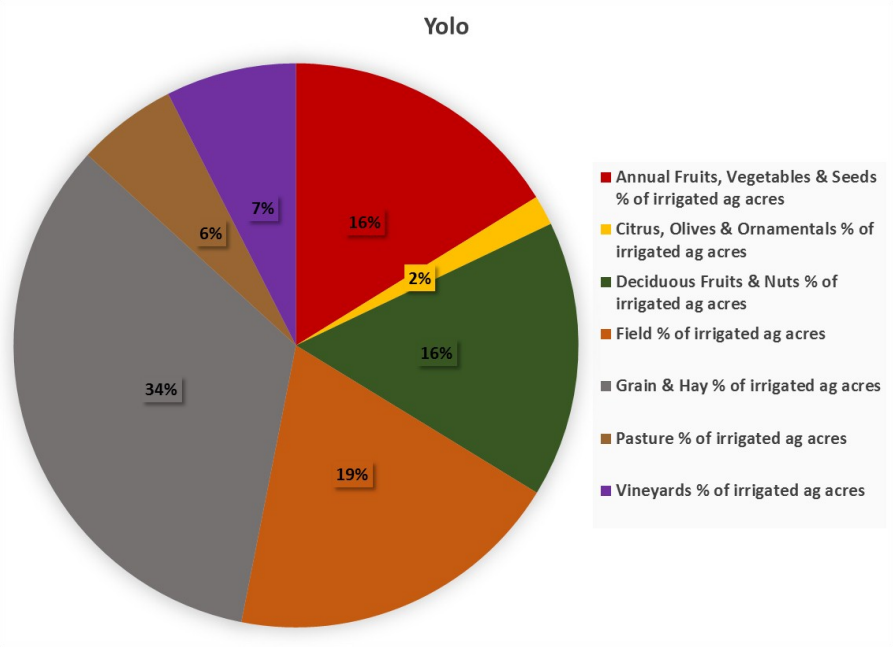
The Yolo Subwatershed encompasses all of Yolo County and a small portion of Colusa County. The subwatershed covers an area of approximately 653,300 acres. The Sacramento River, Cache Creek, Putah Creek, and Willow Slough are within the subwatershed, and the major population centers include West Sacramento, Davis, Woodland, and Winters. The entire Subwatershed is located within the Sacramento Valley floor.

In 2013, there were approximately 257,284 acres of irrigated land in the Subwatershed enrolled in the Coalition. The management for the Yolo Subwatershed is provided by the Yolo County Farm Bureau.

The first groundwater technical report for the Coalition was the Groundwater Quality Assessment Report (GAR), conditionally approved by CVRWQCB September 16, 2016. The map to the right shows the high vulnerability areas (HVAs) and their priority rankings based on the analysis performed in the Groundwater Quality Assessment Report (GAR). A summary of this analysis is provided below. The HVAs are the areas covered under the GQMP.



Land Use



Irrigated agriculture is a major land use within the Yolo Subwatershed. Excluding rice, the major irrigated crops include field crops (alfalfa, hay, wheat, and field corn), wine grapes, orchards (walnuts, prunes, and almonds), vegetables (primarily processing tomatoes), and seed crops (dry beans and sunflowers).

The pie chart to the left shows the predominant crop categories grown in the Yolo Subwatershed as a percentage of total irrigated acres within the subwatershed based on Pesticide Use Reporting 2013 data (as presented in the GAR [NCWA, 2016]).

Groundwater Quality and Vulnerability

Groundwater Quality

The GAR reviewed previous studies on groundwater quality and analyzed well data pertaining to constituents of concern (COCs), including nitrate, salinity, and pesticides. The GAR established that groundwater quality is variable in the Yolo Subwatershed. While the deep aquifer has high-quality groundwater, the shallow and intermediate aquifers show increasing concentrations of nitrate and salinity (YCFCWCD, 2006). The GAR also found that pesticides do not constitute a factor of high vulnerability in this subwatershed.

Nitrate samples from 394 wells within the Yolo Subwatershed were analyzed. Twenty-four percent of samples had nitrate concentrations greater than half of the maximum contaminant level (MCL) of 45 milligrams per liter, and 7 percent of wells showed nitrate concentrations above the MCL. Elevated concentrations of nitrate are a problem near the cities of Davis and Woodland, which rely on groundwater for their municipal water supplies. Irrigated agriculture and septic systems in urban areas may be sources of elevated nitrate concentrations in groundwater.

Groundwater quality monitoring within this subwatershed is conducted for a small number of wells on a regular basis by the California Department of Water Resources (DWR). However, there are no routine groundwater quality management activities currently being conducted by agricultural entities. A network of privately owned wells was sampled for COCs in the past, but the process was halted after no significant changes in concentrations were observed.

A large network of wells within Yolo County is monitored for groundwater levels by the Yolo County Flood Control and Water Conservation District (YCFCWCD), DWR, and by California Statewide Groundwater Elevation Monitoring entities. These wells could be used to monitor groundwater quality as well.

In addition, the Yolo County area is one of three areas selected for an implementation study by the Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS) effort. Because of this effort, a large amount of information pertaining to salts and nutrient loading is available for Yolo County. These additional data and the CV-SALTS implementation study will help address the HVAs in this subwatershed.

Groundwater Vulnerability

Both intrinsic and anthropogenic factors influence the vulnerability of groundwater to contamination from irrigated agriculture. Intrinsic factors include existing, physical factors such as hydrogeologic and soil conditions, the presence of naturally occurring contaminants, and geochemical characteristics. Anthropogenic factors include practices surrounding crop type, irrigation, and nutrient and pesticide management. In addition, the California Department of Pesticide Regulation (DPR) identified areas that may be vulnerable to pesticide contamination because of the presence of coarser soil and geologic materials. These areas, known as DPR Groundwater Protection Areas, were included in the GAR vulnerability analysis. The final HVAs for the Yolo Subwatershed are provided on the map on the first page of this Subwatershed Action Plan. The priority ranking was based on the presence of known contaminated areas and the potential for affecting disadvantaged communities that rely on groundwater for drinking water.

Action Plan

This Subwatershed Action Plan includes two parts to address existing and potential groundwater contamination from nitrate in this subwatershed. Part one includes potential actions that can be taken to conduct additional analysis specific to higher priority HVAs within the subwatershed. Part two includes actions highlighted in the GQMP that apply to all HVAs on the Sacramento Valley floor.

Part One

Table 1 summarizes the main priority ranking 1 and 2 HVAs within the Yolo Subwatershed. Table 1 lists the potential impacts on groundwater from contamination and highlights potential options for further review.

Table 1. HVAs and Additional Analysis Summary Table

HVA (Priority Ranking 1 and 2)	Potential Impacts	Potential Options for Implementation
Davis-Woodland area	Impacts likely resulting from irrigated agriculture	Need to work with YCFCWCD to develop a strategy and timeline for focused monitoring and implementation of management practices. For example, “pump and fertilize” would be an option to consider in the affected areas that use groundwater for irrigation. Accelerated implementation actions should be considered for this area.

All other HVAs ranked as priority 3 are primarily located near the Cache Creek and Sacramento River systems and are related to high hydrogeologic susceptibility, where no known impact on groundwater quality has occurred. These areas will be addressed through the Trend Monitoring Program and outreach activities.

The above actions to conduct further review of HVAs may be conducted through the Trend Monitoring Program and will be documented in the GAR 5-year update.

Part Two

The following list includes GQMP items that are relevant to all HVAs regardless of priority ranking:

- Farm Evaluation and NMP information: Information reported by growers regarding nitrogen usage and nutrient management practices will be summarized in Annual Monitoring Reports (AMRs) and used to evaluate the effectiveness of the GQMP.
- Management Practice Evaluation Program (MPEP) Work Plan: The MPEP is being developed, and management practices identified will be rolled out to growers through education and outreach programs.
- Education and Outreach: The Coalition and Subwatershed Coordinators will continue educating their growers on effective management practices and the importance of compliance, specifically in HVAs.

- Performance goals were developed to meet the objectives of the GQMP to ensure the continued protection of groundwater quality in HVAs throughout the Sacramento Valley floor. The following goals will be aligned to MPEP and focus on education and outreach:
  - Performance Goal 1. Collect information from members in HVAs on management practices and identify potential sources of nitrate contamination in groundwater.
  - Performance Goal 2. Determine the effectiveness of various management practices protective of groundwater quality.
  - Performance Goal 3. Have members adopt new management practices protective of groundwater quality.
  - Performance Goal 4. Evaluate effectiveness of new management practices.
  - Performance Goal 5. Evaluate data and revise HVAs, if appropriate.
- The following implementation schedule milestones were developed:
  - Milestone 1. Within 1 year of GQMP approval, and annually thereafter, collect information from members with lands designated as HVAs pertaining to nutrient applications, nitrate management practices, and crop yields through Farm Evaluations and NMPs. Provide information to members within HVAs and Subwatershed Coordinators.
  - Milestone 2. Within 3 years of GQMP approval, provide to members a list of management practices that have been demonstrated to be effective in reducing nitrate contamination of groundwater based on the MPEP Literature Review, modeling and/or field studies.
  - Milestone 3. Within 5 years of GQMP approval, demonstrate work toward an improved understanding of groundwater quality in areas categorized as having data gaps, and revise HVAs in the GAR update if necessary.
  - Milestone 4. Within 5 years of GQMP approval, demonstrate that members in HVAs are implementing nitrate management practices known to be effective, to the extent possible.
- Monitoring and Reporting: Information collected as part of the GQMP will be reported in a Management Plan Status Report as part of the AMR.

Contact:

Denise Sagara, Yolo County Farm Bureau Education Corporation

Reference

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Yolo County Flood Control and Water Conservation District (YCFCWCD). 2006. Groundwater Management Plan. June.