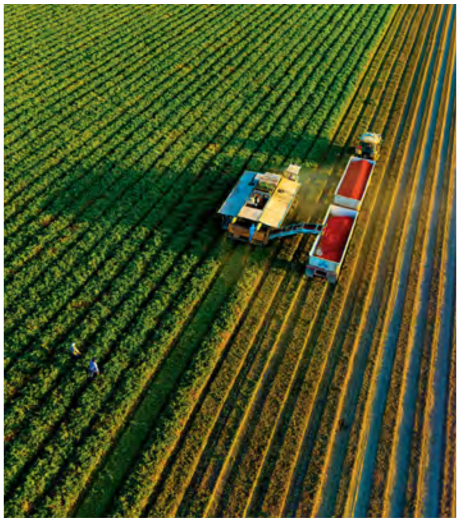
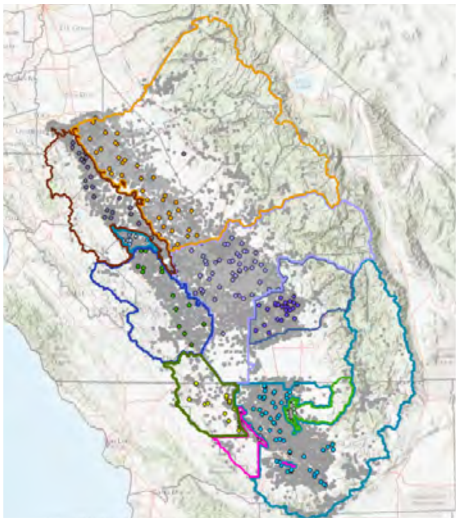
CENTRAL VALLEY
GROUNDWATER
MONITORING
COLLABORATIVE

Five-Year Assessment Report

November 30, 2021


FINAL DRAFT REPORT | OCTOBER 2021

CVGMC FIVE-YEAR ASSESSMENT REPORT

PREPARED FOR

CENTRAL VALLEY

GROUNDWATER MONITORING COLLABORATIVE

PREPARED BY

CVGMC TECHNICAL TEAM

TABLE OF CONTENTS

CVGMC Five-Year Assessment Report

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF TABLES

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF FIGURES

APPENDICES

LIST OF ACRONYMS AND ABBREVIATIONS

Acronym	Meaning	Acronym	Meaning
APN	Assessor Parcel Numbers	LSCE	Luhdorff and Scalmanini Consulting Engineers
BSK	BSK Associates Laboratory	MCL	Maximum Containment Level
BVC	Buena Vista Coalition's	MDL	Method Detection Limit
BVWSD	Buena Vista Water Storage District's	MPEP	Management Practices Evaluation Program
C	Citrus	Mg/L	Milligrams per liter
COC	Chain of custody	mg/L/yr	Milligrams per liter per year
CQAP	Comprehensive Quality Assurance Plan	ml	milligrams
CVGMC	Central Valley Groundwater Monitoring Collaborative	MQOs	Measurable Quality Objectives
CV-SALTS	Central Valley Salinity Alternatives for Long Term Sustainability	MS	Matrix spike
CVRWQCB (Regional Board)	Central Valley Regional Water Quality Control Board	MSD	Matrix spike duplicate
CWDC	Cawelo Water District Coalition's	MTA	Moore Twining Associates
°C	Celsius	N (NO3-N)	Nitrate
D	Deciduous	NA	Not Applicable
DAC	Disadvantaged Community	ND	non-detect
DBCP	Dibromo-chloropropane	NR	Not Recorded
DDW	Division of Drinking Water	NRCS	Natural Resources Conservation Service
DHS		NWIS	National Water Information System
DMS	Data Management System	ORP	Oxidation-Reduction Potential
DO	Dissolved Oxygen	P	Pasture
DPR	California Division of Pesticide Regulation	ph	potential of hydrogen
DTW	Depth to Water	PHG	State Public Health Goal
DWR	Department of Water Resources	PLSS	Public Land Survey System
		QA/ QC	Quality Assurance/ Quality Control
EC	electrical conductivity	QAPP	
EDF	Electronic Data Format	R	Rice
EPA	US Environmental Protection Agency	RL	Reporting Limit
ESJWQC	East San Joaquin Water Quality Coalition	RPD	

F	Field Crops	RWQCB	Regional Water Quality Control Board
FGL	Fruit Growers Laboratory	SAGBI	Soil Agricultural Groundwater Banking Index
Ft	feet or foot	SAMP	Salt and Nitrate Groundwater Monitoring Program
G	Grain & Hay	SC	Specific Conductivity
GAMA	Groundwater Ambient Monitoring and Assessment	SGMA	Sustainable Groundwater Management Act
GAR	Coalition Groundwater Quality Assessment Report	SGQMP	Subsequent Specific Groundwater Quality Management Plans
GDA	Grassland Drainage Area Coalition	SNMP	
GIS	Geographic Information Systems	SOP	Standard Operating Procedure
GQTM	Groundwater Quality Trend Monitoring	SSJV MPEP	Southern San Joaquin Valley Management Practices Evaluation Program
GQTMP	Groundwater Quality Trend Monitoring Workplan	SURGO	Soil Survey Geographic Database
GSP	Groundwater Sustainability Plan	T	Truck Crops
GTM	Groundwater Trend Monitoring	TCP	Tricholoropropane
GTMW	Groundwater Quality Trend Monitoring Workplan	TDS	Total Dissolved Solids
HVA	High Vulnerability Area	UC Davis	University of California Davis
ILRP	Irrigated Lands Regulatory Program	USEPA	United States environmental Protection Agency
KRWCA	Kern River Watershed Coalition Authority’s	USGS	U.S. Geological Survey’s
KBWQA	Kaweah Basin Water Quality Association	µS/cm	Microsiemens per centimeter
KRWQC	Kings River Water Quality Coalition	WDRs	Waste Discharge Requirements
LCS	Lab Control Spike	WSJRC (Coalition)	Westside San Joaquin River Watershed Coalition
LCSD	Lab control spike duplicate	WWQC	Westlands Water Quality Coalition
LVA	Low Vulnerability Areas	WWQC	Westside Water Quality Coalition

ACKNOWLEDGMENTS

Special thanks to all of the individual coalitions that collaborated and funded this report. Great appreciation is also expressed for the technical consultants who worked together to produce this landmark document.

Buena Vista Coalition and Provost & Pritchard Consulting Group

Cawelo Water District Coalition and Provost & Pritchard Consulting Group

East San Joaquin Water Quality Coalition and MLJ Environmental and Luhdorff & Scalmanini Consulting Engineers

Grassland Drainage Area Coalition and Luhdorff & Scalmanini Consulting Engineers

Kaweah Basin Water Quality Association and Provost and Pritchard Consulting Group

Kern River Watershed Coalition Authority and Provost and Pritchard Consulting Group

Kings River Water Quality Coalition and Kings River Conservation District and Luhdorff & Scalmanini Consulting Engineers

Westlands Water Quality Coalition and MLJ Environmental and Luhdorff & Scalmanini Consulting Engineers

Westside San Joaquin River Watershed Coalition and Luhdorff & Scalmanini Consulting Engineers

Westside Water Quality Coalition and Geosyntec Consultants

EXECUTIVE SUMMARY

The Central Valley Groundwater Monitoring Collaborative (CVGMC) is a group of irrigated agricultural lands coalitions across the Central Valley working collaboratively under a Memorandum of Agreement (MOA) to protect groundwater quality (https://cvgmc.org/). The CVGMC was created to comply with the various Waste Discharge Requirement General Orders of the participating Central Valley Irrigated Lands Regulatory Program (ILRP) Coalitions. The collaboration of these ten agricultural coalitions includes monitoring and characterizing regional groundwater quality conditions and trends. The CVGMC has worked collaboratively to prepare the ILRP Groundwater Quality Trend Monitoring Program Workplan (2018) and a Workplan Update (2020), and each individual agricultural coalition has also submitted separate regulatory documents such as Groundwater Quality Trend Monitoring Network Workplans and groundwater quality trend monitoring reports.

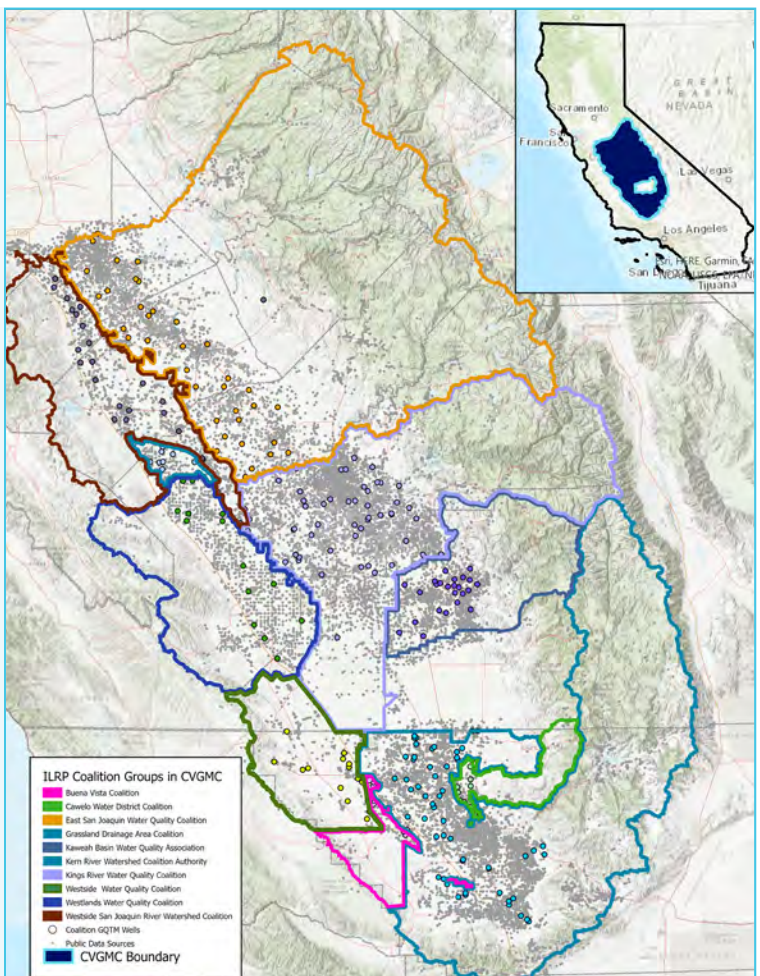
This CVGMC Five-Year Assessment Report marks the first time these ten coalitions have worked together to analyze nitrate concentrations and other groundwater quality data for most of the southern part of the Central Valley..

This report focuses on recent groundwater conditions of nutrients and salinity (e.g., nitrate and total dissolved solids, or TDS).

The ten coalitions that founded the CVGMC and have worked collaboratively since 2017 are listed below. Their boundaries correspond to the colors on the map to the right.

- **Buena Vista Coalition**
- **Cawelo Water District Coalition**
- **East San Joaquin Water Quality Coalition**
- **Grassland Drainage Area Coalition**
- **Kaweah Basin Water Quality Association**
- **Kern River Watershed Coalition Authority**
- **Kings River Water Quality Coalition**
- **Westlands Water Quality Coalition**
- **Westside San Joaquin River Watershed Coalition**
- **Westside Water Quality Coalition**

○ Coalition GQTM Wells
● Public Data Sources
CVGMC Boundary

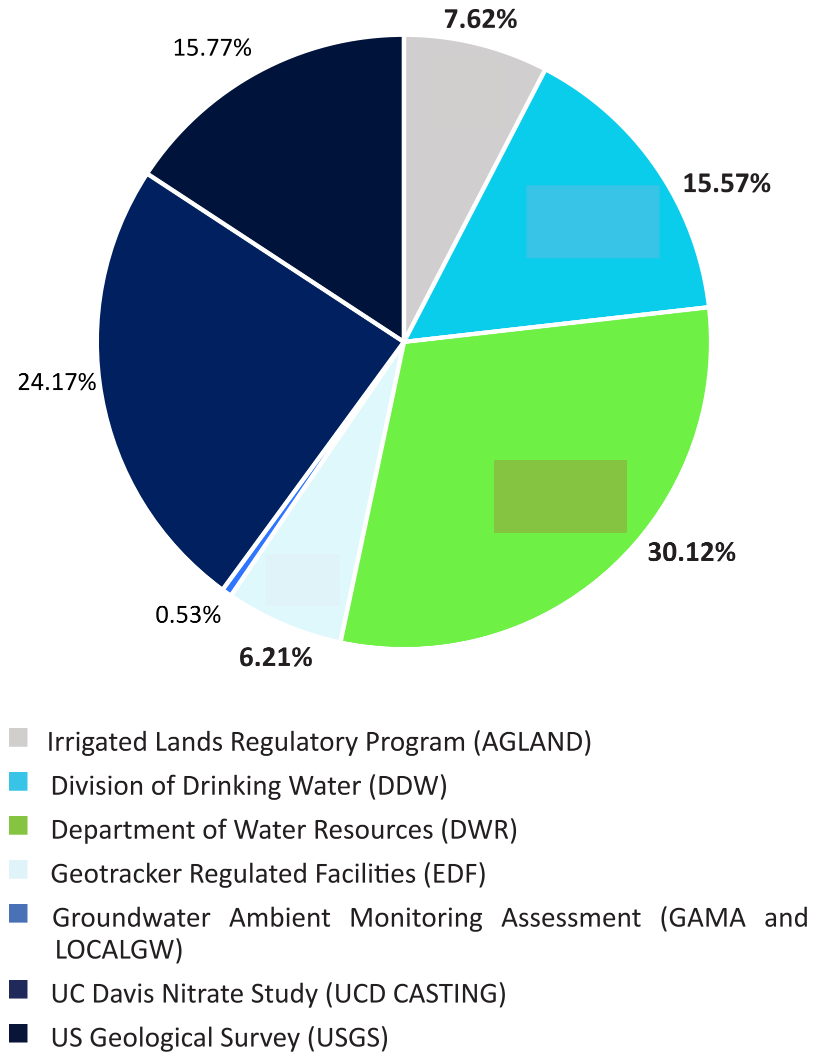


GQTM Wells and Publicly Available Nitrate, TDS, and Pesticide Well Locations

Each individual coalition maintains their own Groundwater Quality Trend Monitoring (GQTM) network, consisting of existing wells selected to characterize and track groundwater quality conditions in both high and low vulnerability areas on irrigated agricultural lands within each coalition's boundary. Wells in the GQTM network are largely completed in the upper part of the groundwater system, and the network of wells meets the General Order regulatory requirements.

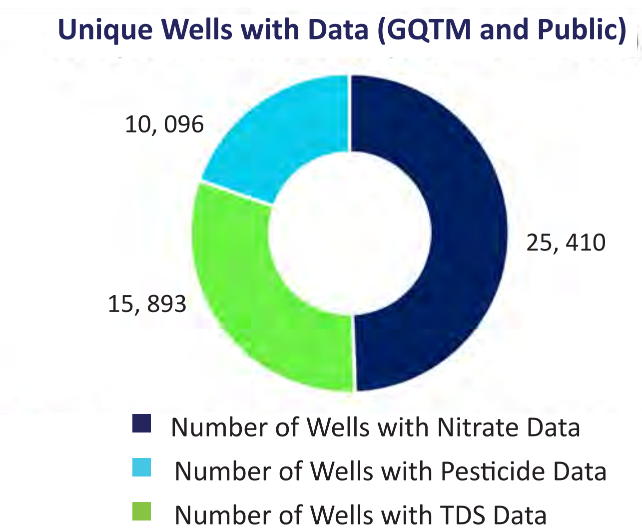
CVGMC has initiated the development and maintenance of one central data repository (their Data Management System, or DMS) to house all of the GQTM groundwater quality sample results over time. The coalitions' data that are uploaded to the CVGMC DMS are rigorously reviewed to meet the requirements of the Comprehensive Quality Assurance Plan (CVGMC QAP), resulting in a highly curated GQTM groundwater quality dataset. Publicly available groundwater quality data (for nitrate, TDS, and pesticides) supplement the GQTM monitoring data from many different sources including the ILRP Drinking Water Well Sampling Program (AGLAND), State Water Resources Control Board (State Board) Division of Drinking Water (DDW), California Department of Pesticide Regulation (DPR), California Department of Water Resources (DWR), State Board GeoTracker Regulated Facilities (EDF), State Board Groundwater Ambient Monitoring Assessment (GAMA and LOCALGW), University of California Davis Nitrate Study (UCD CASTING), and the U.S. Geological Survey. The nitrate and TDS public data underwent a cursory QA/QC process prior to their inclusion in the DMS and subsequent assessment.

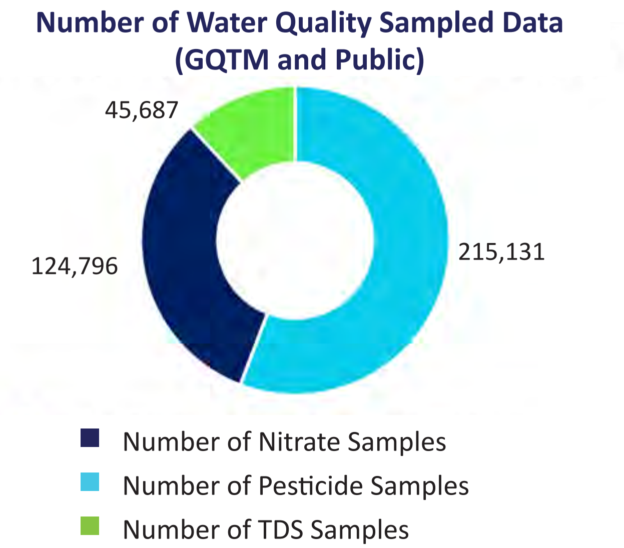
Number of Wells With Nitrate Data Within a 3-mile Buffer around the CVGMC Boundary that Fall Within the Central Valley Floor Footprint (Total 22,422 Wells)



The combination of GQTM and publicly available nitrate, TDS, and pesticide datasets result in hundreds of thousands of data points used for the ambient conditions and trends assessments in this report.

Table of Public and GQTM Data Used for Conditions Assessment						
CVGMC Dataset	Number of Wells with Nitrate Data	Number of Nitrate Samples	Number of Wells with TDS Data	Number of TDS Samples	Number of Wells with Pesticide Data	Number of Pesticide Samples
Entire Dataset	25,410	124,796	15,893	45,687	10,096	215,131
Within Central Valley Floor	22,673	107,628	13,983	38,401	8,502	215,131

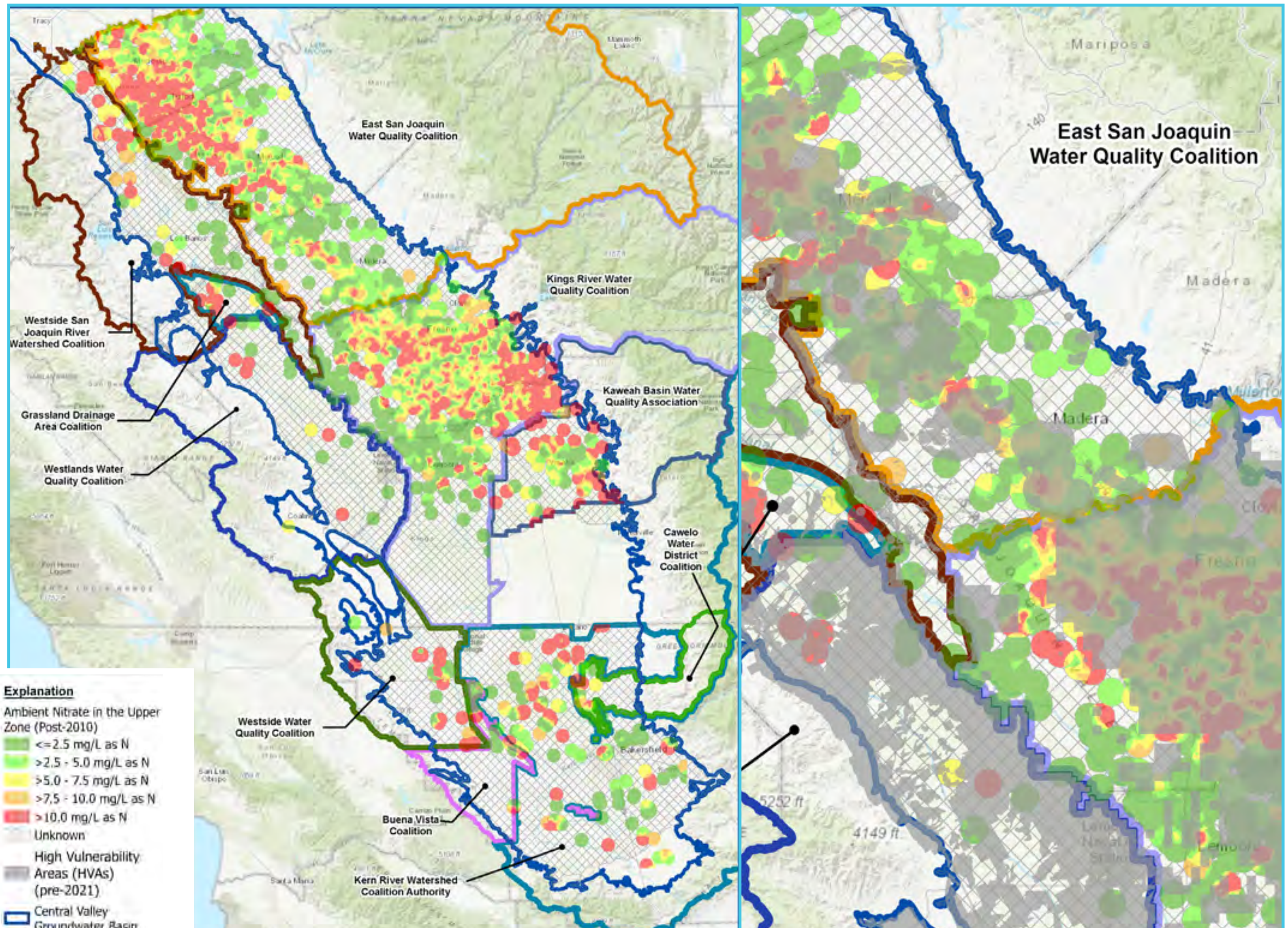




The purpose of this Five-Year Assessment Report is to focus on nitrate occurrence, distribution, and trends in groundwater. Nitrate conditions are presented in this report, spatially, and in time series and tabular form. The spatial distribution of nitrate is presented for GQTM wells as well as in a spatially interpolated recent snapshot of ambient nitrate conditions for the Upper Zone of the groundwater system. Nitrate and TDS trends are also analyzed and provided in tabular and map form. Salinity is a secondary focus of this Five-Year Assessment Report, and spatial and trend conditions are also provided similarly.

Although not the main focus of this assessment, pesticide data from non-GQTM wells for a subset of parameters (seven constituents associated with active irrigated agriculture and two constituents that are banned and no longer associated with irrigated agriculture) are compared to current water standards such as Maximum Contaminant Levels (MCLs), drinking water health advisory levels, or health-based screening levels and summarized tabularly and spatially. Similarly, general mineral data, although not a primary focus of this assessment, are also summarized tabularly for GQTM wells.

Nitrate and TDS conditions are compared to the most recent 2018 land use coverage of irrigated agriculture (from DWR's most recent dataset). All quality controlled publicly available nitrate data (including coalitions' GQTM data) are also compared to the originally designated High Vulnerability Areas (HVAs), which were developed by each coalition and approved by the Regional Water Quality Control Board, to determine whether HVA modifications and updates are warranted.



Ambient Nitrate in the Upper Zone (Post-2010) (Left Image) Zoomed in with HVA Overlays (Right Image).

Each individual coalition provides their own chapter specific to addressing: 1) their local GQTM network and 2020 sampling results, 2) their sampling quality assurance evaluation, 3) their local five-year assessment results, and 4) any edits or updates to their HVA, as needed.

The CVGMC has been working on enhancing their education and outreach activities, as well as coordination with other programs and projects. CVGMC launched its own website (www.cvgmc.org), which contains information about the coalitions and activities, participants, and describes how interested parties can become involved.

Snapshot of CVGMC Website

CVGMC also collaboratively maintains their DMS, which now houses hundreds of thousands of data points pertinent to the groundwater quality conditions in the San Joaquin Valley. Many of the monitoring results and analyses provided in this Five-Year Assessment Report satisfy similar objectives as other projects such as the Basin Plan Amendment, the CV-SALTS Nitrate Control Program, and Sustainable Groundwater Management Act (SGMA) Implementation.

A summary of the findings from this Five-Year Assessment are provided below:

1. Nitrate conditions are highly variable in the subsurface, as shown by GQTM well data and publicly available groundwater data.

2. The availability of GQTM and publicly available recent (post-2010) nitrate data in the Upper Zone is densest in the northeast and central-eastern portions of the CVGMC area, with much sparser Upper Zone recent (post-2010) nitrate data on the western side and southern portion of CVGMC.

3. Recent (post-2010) nitrate data for wells completed in the Upper Zone show two large areas of elevated nitrate occurring in the north central and central-eastern areas of the CVGMC. Other smaller pockets of elevated nitrate concentrations occur throughout each of the ten CVGMC coalitions.

4. Nitrate conditions in the Upper Zone of the CVGMC area are generally of better quality on the eastern edges of the Central Valley Floor, and in areas adjacent to parts of the San Joaquin River and the Fresno Slough.

5. Regional trend analyses exhibit increasing trends in many coalitions; however, recent trends in nitrate concentrations are more often stable or decreasing compared to long-term trends, and nitrate concentrations are decreasing in all land use areas within the entire CVGMC.

6. TDS concentrations on a well-by-well basis also exhibit variability, but general patterns suggest TDS conditions in the Upper Zone on the west side of the CVGMC area are higher and tend to exceed the secondary drinking water standard of 1,000 mg/L compared to the eastern areas of the CVGMC. Pockets of elevated TDS exist in the southern and southeastern CVGMC areas as well as some areas on the eastern side of the Central Valley Floor.

7. TDS trends for GQTM and publicly available groundwater wells vary but generally show more increasing patterns compared to trends in nitrate conditions, regardless of overlying land use.

8. Based on publicly available pesticide data for nine constituents of interest, pesticides associated with current agricultural practices are rarely found above health-based or screening levels.

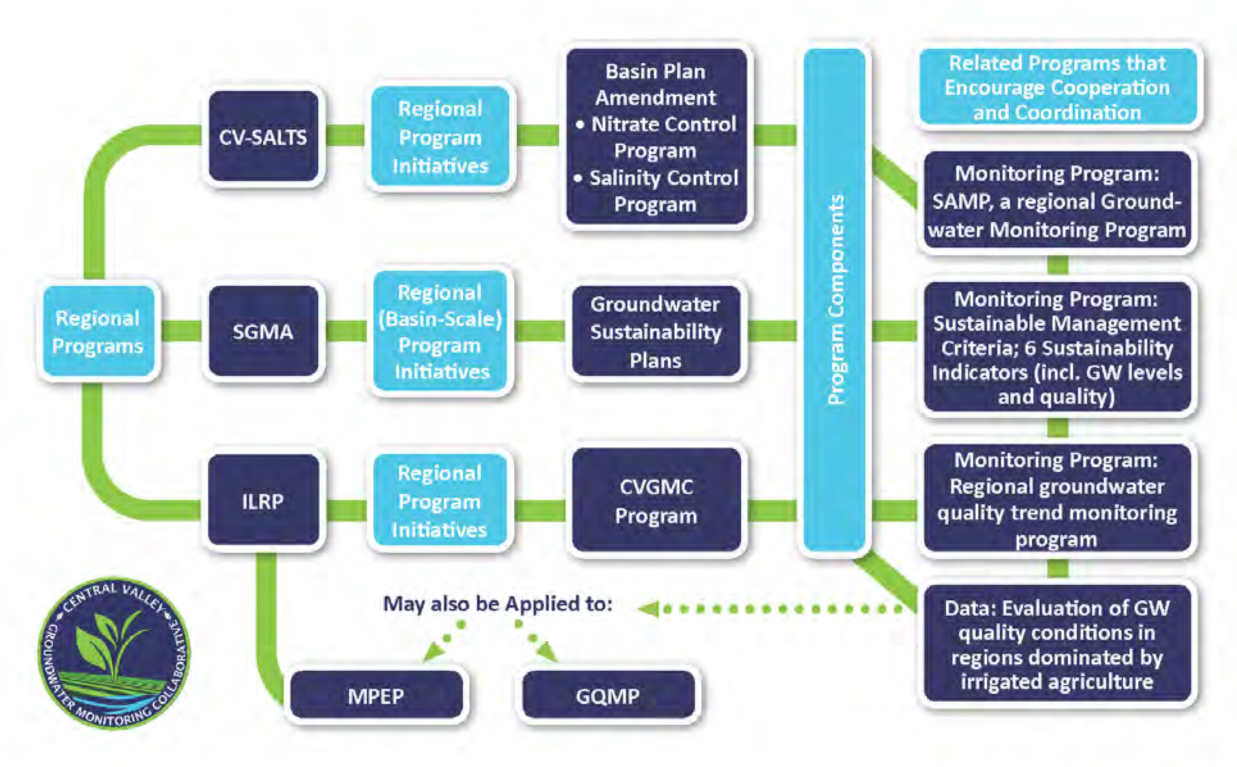
2. BACKGROUND AND GQTM OBJECTIVES

The Irrigated Lands Regulatory Program (ILRP) was started in 2003 to help protect aquatic life and to prevent agricultural runoff from impairing surface waters. In 2012, groundwater regulations were added to the program, including the development of General Orders that serve as general waste discharge requirements (WDRs) for waste discharges from irrigated lands that could potentially affect groundwater and/or surface waters of the state. The Central Valley Regional Water Quality Control Board (Regional Board, or Regional Water Board) revised the Irrigated Lands Regulatory Program Monitoring and Reporting Program General Orders (May 5, 2017; MRP Orders) for all agricultural coalitions to allow for participation in a regional groundwater quality trend monitoring program in lieu of individual trend monitoring programs. Ten agricultural coalitions developed a collaborative groundwater monitoring program to characterize groundwater quality across the southern portion of California's Central Valley (Central Valley). The ten Coalitions that formed the collaborative group responsible for this assessment report are presented in **Figure 2-1** and include:

1) Buena Vista Coalition
2) Cawelo Water District Coalition
3) East San Joaquin Water Quality Coalition
4) Grassland Drainage Area Coalition
5) Kaweah Basin Water Quality Association
6) Kern River Watershed Coalition Authority
7) Kings River Water Quality Coalition
8) Westlands Water Quality Coalition
9) Westside San Joaquin River Watershed Coalition
10) Westside Water Quality Coalition

A Conceptual Work Plan submitted to the Regional Board in October 2017 (CVGMC, 2017) describes the collaborative groundwater monitoring program developed by growers on irrigated agriculture land to fulfill groundwater monitoring requirements of the ILRP. This monitoring program, called the Central Valley Groundwater Monitoring Collaborative Program (CVGMC Program), is the first step in developing a Central Valley-wide program.

The program described in the Conceptual Work Plan (CVGMC, 2017) proposed the evaluation of groundwater quality conditions in regions dominated by irrigated agriculture. In addition, the CVGMC will collect groundwater quality information that can be used to evaluate potential effects of irrigated agriculture. Collected groundwater quality data may also be used to document long-term improvements in groundwater quality resulting from implementation of ILRP efforts, such as the localized Groundwater Quality Management Plans (GQMP) and the Management Practices Evaluation Program (MPEP). Additionally, because of the similarities between the regional groundwater quality trend monitoring program proposed in the Conceptual Work Plan and the groundwater monitoring program proposed by the Central Valley Salinity Alternative for Long-Term Sustainability (CV-SALTS) through the Salt and Nitrate Management Plan (SNMP), this program (CVGMC) is envisioned to serve as a functional equivalent to the Surveillance and Monitoring Program (SAMP) required to support implementation of the SNMP once the Basin Plan amendment process is complete. Within one year of the effective date of the Central Valley Salinity and Nitrate Control Program (i.e., following adoption of the Central Valley Basin Plan amendment), requirements were triggered for all dischargers of salt and nitrate to participate in other existing groundwater quality monitoring programs that contribute data to the Central Valley Salt and Nitrate Monitoring Program. The purpose of the Salt and Nitrate Groundwater Monitoring Program (or Central Valley Groundwater Monitoring Program [also referred to as the SAMP]) is to evaluate ambient water quality and trends in groundwater basins in the floor of the Central Valley Region, including the CVGMC region. **Figure 2-2** illustrates regional programs that have program components similar to CVGMC's that encourage cooperation and coordination.



On May 16, 2018, the CVGMC submitted the Phase 1: ILRP Technical Workplan (LSCE, MLJ, P&P; 2018) on behalf of its participating members. The CVGMC submitted a letter on July 25, 2019 highlighting updates to the proposed schedule and content presented in the May 2018 Workplan.

Waste Discharge Requirements General Orders (General Orders)[1] applicable to owners and operators of irrigated lands within the Central Valley require the development of a Groundwater Quality Trend Monitoring (GQTM) Workplan by either an individual third-party group (Coalition) or, alternatively, by a regional Groundwater Quality Trend Monitoring Group. The CVGMC is considered a regional Group. Regional Water Board staff reviewed the May 2018 Workplan and the July 25, 2019 letter and requested an update to the Workplan to reflect recent developments and updated timelines (Regional Board; April 1, 2020 letter). The May 2020 Workplan Update responded to the Regional Board's direction to address staff's comments and update the following items: 1) clarification that all available data will be considered when evaluating monitoring well networks, 2) updated monitoring period to reflect May – August (late Spring/Summer), 3) reference to a Comprehensive Quality Assurance Plan instead of a Quality Assurance Program Plan, 4) updated description of the Data Management System, and 5) updated reporting requirements and schedule as outlined in the July 25, 2019 letter. The updated Workplan was submitted to the Regional Board on May 18, 2020.

The contents of this Five-Year Assessment Report are based on the approved updated Workplan from May 2020.

2.1. GQTM Objectives

Each coalition was required to prepare a GQTM Workplan to establish long-term groundwater monitoring within their Coalition area. GQTM Workplans were due one year following approval or conditional approval of each Coalition's Groundwater Quality Assessment Report (GAR) by the Regional Board. The ten Coalitions comprising the CVGMC have completed these plans per the required ILRP General Order requirements. Conditional approvals of individual Coalition workplans have been issued for all ten Coalitions. Many of the individual Coalitions continue to coordinate with the Regional Board regarding the number of wells contained in their individual Coalition GQTM well networks and rationale for their selection.

The individual Coalition workplans address the development of the GQTM well networks. Generally, GQTM networks are distributed between high and low vulnerability regions, HVA and LVA respectively, within each Coalition's boundary. These monitoring networks are incorporated into the CVGMC network. Each monitoring network has identified relatively shallow wells (i.e., wells completed in the upper part of the groundwater system). These relatively shallow wells are not necessarily wells screened in the uppermost zone of first encountered groundwater. Due to great depths to groundwater in some Coalition areas, deeper wells are necessary to monitor the

[1] Waste Discharge Requirements General Order No. R5-2013-0120 cover: Buena Vista Water Quality Coalition, Cawelo Water District Coalition, Kaweah Basin Water Quality Association, Kern River Watershed Coalition Authority, Kings River Water Quality Coalition, and Westside Water Quality Coalition; Waste Discharge Requirements General Order No. R5-2021-0018 covers: Eastern San Joaquin River Watershed and Grassland Drainage Area; Waste Discharge Requirements General Order No. R5-2014-0001 covers: Westlands Water Quality Coalition; Waste Discharge Requirements General Order No. R5-2014-0002: and Westside San Joaquin River Watershed Coalition.

upper part of the groundwater system. The individual GQTM networks have been designed to meet the WDR General Order requirements. Collectively, as part of the CVGMC, the networks provide a means to more broadly assess groundwater quality trends and conditions related to irrigated agriculture.

Key considerations used to develop the monitoring networks on both a Coalition scale and CVGMC regional scale include:

- GQTM well network distributed in High Vulnerability Area (HVA) and Low Vulnerability Area (LVA) areas;
- GQTM well network composed largely of wells completed in the Upper Zone of the groundwater system (some areas of CVGMC region have significant depths to groundwater and corresponding greater well depths);
- GQTM wells distributed across irrigated agriculture, especially irrigated agriculture on lands enrolled in the ILRP and generally not located on irrigated lands not enrolled in the ILRP (e.g., generally not on lands covered by the Dairy General Order);
- GQTM wells in the vicinity of top commodities, especially top commodities associated with ILRP irrigated agriculture but also some non-ILRP irrigated agriculture; and
- GQTM wells in the vicinity of disadvantaged communities, including severely disadvantaged and disadvantaged unincorporated communities, as applicable.

The regional CVGMC network, including its design basis focused on the above considerations, provides for broad geographic coverage, and allows for an analysis of present and future trends and conditions in relation to agricultural land use. More importantly, the CVGMC GQTM results will provide for a more extensive dataset which will provide ambient data and opportunity to evaluate changes in the regional groundwater quality. The broad regional assessment and synthesis of CVGMC GQTM results is approved to occur every five years. This report combines the CVGMC Groundwater Trend Monitoring (GWTM) five-year results assessment with the Coalitions' Five-Year GAR update to result in a single, more informative, streamlined, and cost-effective program. In the future, this report could also be integrated with the SAMP.

2.2. Purpose of Five-Year Assessment Report

Reporting for the CVGMC has been approved to include more extensive analysis at five-year intervals. Every five years, a coordinated Five-Year Assessment Report (this report) will be provided to the Regional Board that characterizes groundwater quality across the portions of the Central Valley participating in the CVGMC, starting with this report. This report includes separate sections reporting on trends in groundwater quality in each Coalition region as well as sections that characterize groundwater quality across all participating regions. Each section is consistently formatted with common maps, figures, and text to facilitate review by Regional Board staff and other interested parties. All participating Coalitions coordinate so that data analysis and reporting methods used to evaluate groundwater quality are consistent within each Coalition region and across the CVGMC region. The Five-Year Assessment Report includes all elements in the Annual GQTM Report, with the additional analyses and presentations described below.

Groundwater elevations are reported in this first Five-Year Assessment Report using available groundwater elevation data (i.e., groundwater elevation contours available from the California Department of Water Resources (DWR) or Sustainable Groundwater Management Act (SGMA) Groundwater Sustainability Plans (GSPs)), with the reporting frequency of groundwater elevations after this first Five-Year Assessment Report to be determined in coordination with the Regional Board.

Table 2-1 summarizes all the Annual GQTM Report elements and additional reporting elements that have been approved to be included in the Five-Year Assessment Report. With the greater level of analysis conducted every five years, the Five-Year Assessment Report is intended to fulfill the requirements of individual Coalition five-year GAR updates, while also serving the objectives of the SAMP and satisfying all SAMP requirements.

Both the Annual GQTM Report and Five-Year Assessment Report include discussion of results and findings from the individual Coalition GQTM networks. The Annual GQTM Report focuses on graphical and tabulated presentation of monitoring results. The Five-Year Assessment Report incorporates additional data acquisition beyond the sample data collected from GQTM network wells and these data are analyzed statistically for trends. Findings related to groundwater quality trends, spatial patterns in trends, and statistical associations between trends and land use composition and management practices are the focus of discussion in the Five-Year Assessment Report. A discussion of findings related to uncertainties in the assessment of nitrate conditions is included. The need for refinements to the design of the individual Coalition GQTM networks may be negotiated by individual coalitions with the Regional Board, as needed. Individual Coalitions are responsible for implementing updates to their respective GQTM networks. Future adjustments in the GQTM networks will be reported in the next Five-Year Assessment Report.

Table 2-1. CVGMC Reporting and Implementation Elements for Annual GQTM and Five-Year Assessment Reports

Reporting Element	Description of Reporting/Implementation Method	Reporting/ Implementation Frequency	Primary Responsible Party	
			Individual Coalitions	CVGMC
Individual Coalition GQTM data submittal	Upload data to GeoTracker database; submit data to CVGMC DMS administrator in accordance with CVGMC data submittal and update process	Annual	Annual	Annual
CVGMC Data Management System update	CVGMC DMS administrator update DMS and related QA processes	Annual		Annual

Table 2-1. CVGMC Reporting and Implementation Elements for Annual GQTM and Five-Year Assessment Reports				
Reporting Element	Description of Reporting/Implementation Method	Reporting/ Implementation Frequency	Primary Responsible Party	
			Individual Coalitions	CVGMC
Comprehensive Quality Assurance Plan	Review and update as needed	Annual	Annual	Annual
Design of trend monitoring program	Map(s) of monitoring areas	Annual/Five-Year	Annual	Five-Year
	Map(s) of sampled wells	Annual/Five-Year	Annual	Five-Year
Tabulation of results	Summary statistics	Five-Year	Annual	Five-Year
	Complete analytical results	Annual/Five-Year	Annual	Five-Year
	Analytical reports	Annual/Five-Year	Annual	Five-Year
Distribution of nitrate concentrations in groundwater (simplified visualization)	Map of nitrate concentrations for most recent monitoring year (GQTM wells)	Annual/Five-Year	Annual/Five-Year	
Visual presentation and interpretation of results	Map(s) of results and/or trends within aquifer system (e.g., color gradient symbols)	Five-Year	Five-Year	Five-Year
Graphic presentation of time series data	Graphs of time series data illustrating temporal changes; nitrate time series (Annual Reports)	Annual/Five-Year	Annual	Five-Year
Groundwater levels	Map(s) of groundwater elevations (e.g., contours) within select areas as applicable to regional monitoring network	Five-Year	Five-Year	Five-Year
Update regional groundwater quality characterization (using readily available groundwater quality data)	Map(s) and tabulation of groundwater quality data relevant to irrigated agriculture	Five-Year		Five-Year
	Map(s) and tabulation of DPR groundwater pesticide monitoring data	Five-Year		Five-Year
Comparison of regional groundwater quality	Non-parametric statistical analyses of trends (e.g., Mann-Kendall test)	Five-Year		Five-Year

Table 2-1. CVGMC Reporting and Implementation Elements for Annual GQTM and Five-Year Assessment Reports				
Reporting Element	Description of Reporting/Implementation Method	Reporting/ Implementation Frequency	Primary Responsible Party	
			Individual Coalitions	CVGMC
trends: Temporal trends analyses	Parametric statistical analysis of trends (e.g., linear regression)	Five-Year		Five-Year
Comparison of regional groundwater quality trends: Presentation of spatial patterns in trends (i.e., maps showing trends)	Statistical summary of conditions and trends relative to monitoring areas	Five-Year		Five-Year
	Analyses of groundwater quality trends by depth zone	Five-Year	Five-Year	Five-Year
	Analyses of groundwater quality trends by location and locational characteristics (e.g., land use composition)	Five-Year	Five-Year	Five-Year
Rationale for trend monitoring program design	Discussion of basis for trend monitoring well selection	Annual/Five-Year	Annual	Five-Year
Synthesis of findings	Discussion of findings relating to groundwater quality trends and patterns (brief for Annual; more comprehensive for Five-Year)	Annual/Five-Year	Annual	Five-Year
	Evaluation of relationships between groundwater quality trends and land use	Five-Year	Five-Year	Five-Year
Evaluation of uncertainty and potential data gaps	Evaluation of representation of CVGMC well network in relation to trends and patterns observed across CVGMC region	Five-Year	Five-Year	Five-Year
Assess need for future monitoring refinements	Provide recommendations regarding monitoring network (brief for Annual; more comprehensive for Five-Year)	Annual/Five-Year	Annual	Five-Year
Address potential data gaps and monitoring refinements as needed	Implement actions to address Coalition area data gaps and monitoring refinements as needed	Annual/Five-Year	Annual/ Five-Year	

Table 2-1. CVGMC Reporting and Implementation Elements for Annual GQTM and Five-Year Assessment Reports

Reporting Element	Description of Reporting/Implementation Method	Reporting/ Implementation Frequency	Primary Responsible Party	
			Individual Coalitions	CVGMC
Coordination with education and outreach efforts	Evaluation of CVGMC design in relation to individual Coalition education and outreach efforts	Annual/Five-Year	Annual	Five-Year

2.3. Assessment Report Organization

The Five-Year Assessment Report contains regional assessments of nitrate, salinity (in the form of Total Dissolved Solids, or TDS), pesticides, and general minerals using a combination of GQTM wells and other publicly available groundwater data when applicable. The groundwater quality trend monitoring and setting for groundwater conditions are provided in Section 3. Section 4 describes groundwater quality data updates including brief summaries of data retrieved from CVGMC coalitions, public data, and Groundwater Sustainability Plans. Section 5 contains the bulk of the groundwater quality data assessment, including summary statistics for nitrate and TDS, the spatial distribution of nitrate and TDS, temporal trends in nitrate and TDS, an overview of pesticides in groundwater, and general minerals. Section 6 describes potential data gap areas and recommendations for the GQTM network. Sections 7 through Section 16 contain individual coalition sections that discuss the 2020 GQTM network and sampled wells, a summary of quality assurance evaluation for the 2020 sampling event, a discussion of the five-year assessment results as it pertains to the specific coalition area, and a discussion of the High Vulnerability Area (HVA) update. Section 17 contains information on CVGMC's outreach and education efforts. Section 18 provides conclusions and recommendations based on findings from this Five-Year Assessment Report.

3. CVGMC GROUNDWATER QUALITY TREND MONITORING AND SETTING

Section 3 describes the groundwater quality trend monitoring and setting for the ten Coalitions in the CVGMC.

3.1. GQTM Network Sampling Sites (CVGMC Area)

The GQTM network has been designed and refined since 2018. There are currently 267 wells being actively monitored for constituents such as nutrients, salts, and other general minerals within the CVGMC GQTM network (**Figure 3-1**). This is an increase of 34 wells from 233 in the original network in 2018. Monitored wells are strategically selected based on their depth information and proximity to irrigated lands. **Table 3-1** provides the number of GQTM wells associated with each of the ten CVGMC Coalitions for the original 2018 network through the current 2020 network. This table also provides the total acreage covered by the coalitions, as well as the number of acres of irrigated agriculture (based on DWR's 2018 Land Use GIS coverage[2]). Although there is an increase overall in the number of network wells, gains and losses vary by coalition.

Table 3-1. General Information on GQTM Wells

CVGMC Coalition Name	Acres	2018 DWR Land Use Irrigated Acres	Number of 2018 GQTM Wells	Number of 2020 GQTM Wells
Buena Vista Coalition	252,013	36,033	13	13
Cawelo Water District	266,277	34,480	17	15
East San Joaquin Water Quality Coalition	5,519,584	908,244	12	37
Grassland Drainage Area Coalition	103,888	79,724	8	11
Kaweah Basin Water Quality Association	958,237	236,439	14	24
Kern River Watershed Coalition Authority	3,580,002	577,681	29	59
Kings River Watershed Coalition Authority	2,748,674	939,230	94	52
Westlands Water Quality Coalition	1,311,691	425,758	16	15
Westside San Joaquin River Watershed Coalition	1,273,763	359,164	15	26
Westside Water Quality Coalition	688,091	108,240	15	15
Total	**16,702,220**	**3,704,993**	**233**	**267**

[2] DWR's 2018 land use coverage is the most recent publication of land and crop type spatial coverage available to the public. This dataset is found online at: https://data.cnra.ca.gov/dataset/statewide-crop-mapping, accessed August 2021.

3.2. Summary of GQTM Sampling Activities (2018 through 2020)

GQTM sampling events have occurred annually since 2018. Following the requirements prescribed in the General Order GQTM wells are tested for nitrate only each year, while every five years, wells are tested for all constituents including nitrate as N (or nitrate + nitrite as N), boron, calcium, magnesium, potassium, sodium, bicarbonate, carbonate, chloride, sulfate, and total dissolved solids. **Table 3-2** provides a summary of the number of GQTM wells sampled between 2018 and 2020 for each Coalition in CVGMC for the various constituents.

Table 3-2. GQTM Sampling Activities (2018-2020)

CVGMC Coalition Name	2018		2019		2020	
	Number of Wells Sampled in 2018 for Nitrate only	Number of Wells Sampled in 2018 for All Constituents	Number of Wells Sampled in 2019 for Nitrate only	Number of Wells Sampled in 2019 for All Constituents	Number of Wells Sampled in 2020 for Nitrate only	Number of Wells Sampled in 2020 for All Constituents
Buena Vista Coalition	0	10	12	0	10	0
Cawelo Water District	0	15	0	15	14	0
East San Joaquin Water Quality Coalition	0	12	10	10	20	13
Grassland Drainage Area Coalition	0	6	6	5	11	0
Kaweah Basin Water Quality Association	0	13	0	24	24	0
Kern River Watershed Coalition Authority	0	26	0	56[3]	54	0
Kings River Water Quality Coalition	0	80	0	89	46	0
Westlands Water Quality Coalition	0	11	5	8	10	5
Westside San Joaquin River Watershed Coalition	0	15	14	5	18	5
Westside Water Quality Coalition	0	9	13	0	11	0
Total	**0**	**197**	**60**	**212**	**218**	**23**

[3] KRWCA added additional wells in 2019 to supplement the GQTM network and all wells were measured for all constituents to ensure they were on the same 5-year cycle.

3.3. Irrigated Lands

DWR collects and provides land use data throughout the state. The most recent land use coverage that is publicly available is for 2018[4]. This land use data provides spatial coverage of irrigated lands across the CVGMC area. **Table 3-1** above denotes the irrigated agricultural acreage associated with each of the ten Coalitions and the entire CVGMC area.

3.4. Land Use

DWR's 2018 land use dataset was used to develop a simplified map of land uses. The simplified land use map in **Figure 3-2** designates land use as irrigated and urban. The designations were associated with DWR's 2018 land use attribute 'CLASS2'. Irrigated designations apply to 'C – Citrus', 'D – Deciduous', 'F – Field Crops', 'G – Grain & Hay', 'P – Pasture', 'R – Rice', 'T – Truck Crops', 'V – Vineyards', 'X – Not Cropped', and 'YP – Young Perennial'. Urban designations apply to 'U – Urban'. The 2018 DWR land use coverage does not provide native land uses within the CVGMC boundaries.

3.5. HVAs

Each Coalition has defined HVAs as part of their respective GARs submitted to the Regional Water Board. The Coalitions have provided GIS files of their HVAs to the Water Board, and in turn, the Water Board publishes the GIS coverage of these HVA layers[5]. **Figure 3-3** shows the locations of HVAs within and around the CVGMC area. Most of the HVAs within CVGMC are along a relatively narrow strip through the trough of the Central Valley Floor, running from the south-southeast to the north-northwest, with other smaller HVAs located on the western flank of the CVGMC. The publicly available Water Board GIS coverage of HVAs delineates areas outside of CVGMC located to the north, east, south, and west of CVGMC, as shown in the map in **Figure 3-3**.

Discussions and figures of any changes or updates to the HVAs pertaining to each of the ten individual Coalitions is provided in Sections 7 through 16.

3.6. Groundwater Elevations – Spring 2020 (Upper Zone)

Groundwater elevations can be used to indicate the direction of regional groundwater flow. Contours of equal groundwater elevation are developed and maintained by DWR on a regular basis for both spring and fall of many years in the recent past. Spring contours typically show the highest groundwater levels in the Central Valley, as this period precedes heavier periods of pumping and comes after the rainy season which can provide recharge to the water table. Spring

[4] https://data.cnra.ca.gov/dataset/statewide-crop-mapping, accessed August 2021.
[5] https://gispublic.waterboards.ca.gov/portalserver/rest/services/, accessed August 2021.

2020 elevation contours are provided in **Figure 3-4**, as provided by DWR[6]. **Figures 3-4a**, **b**, and **c** all zoom in to three different portions of the CVGMC: north, central, and south, respectively.

Groundwater level contours in Spring 2020 generally indicate that water levels are higher on the edges of the Central Valley Floor and decrease toward the valley axis. There are pockets of higher and lower elevations throughout the ten CVGMC Coalitions, likely due to local recharge and pumping areas.

Groundwater Sustainability Plans[7] (GSPs) for basins covered by CVGMC coalitions may provide more detailed information on groundwater levels and explain local flow patterns.

3.7. Delineation of the Upper Zone

The Upper Zone of the aquifer system was previously defined in the June 2016 CV-SALTS report entitled "Final Technical Memorandum: CV-SALTS Region 5: Updated Groundwater Quality Analysis and High-Resolution Mapping for Central Valley Salt and Nitrate Management Plan"[8]. This document describes how the Upper, Lower, and Production Zones are delineated across the Central Valley. The Upper Zone is defined as follows:

- The Upper Zone includes the depth from the bottom of the vadose zone to the top of the Lower Zone
- The depth of the Upper Zone is based on well construction information, as possible, and other comparable information that provides the best available indication of well depth; the analysis gives the highest weight to domestic well depths
- Where the Corcoran Clay is present, the Upper Zone does not extend below the Corcoran Clay.

The spatial distribution of the depth to the bottom of the Upper Zone is provided in **Figure 3-5**. This map illustrates the variability of the depth to the base of the Upper Zone across the CVGMC area, which ranges from less than 150 feet below the ground surface to greater than 500 feet below the ground surface. Generally, the depth to the bottom of the Upper Zone is slightly shallower on the east side of the valley compared to the central and western portion of the CVGMC area.

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[6] Seasonal groundwater level contours are available through DWR's SGMA Data Viewer (https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer#gwlevels, accessed August 2021).
[7] GSP documents are accessible via DWR's SGMA Portal: https://sgma.water.ca.gov/portal/gsp/status, accessed August 2021.
[8] This CV-SALTS document can be found here: https://www.cvsalinity.org/docs/committee-document/technical-advisory-docs/conceptual-model-development/3306-updated-groundwater-quality-analysis-and-high-resolution-mapping-for-central-valley-salt-and-nitrate-management-plan.html, accessed August 2021.

4. GROUNDWATER QUALITY DATA UPDATE: OTHER DATA SOURCES

As per the General Orders that regulate each Coalition requiring groundwater monitoring and reporting of agricultural land, groundwater quality data analyses are limited to the Central Valley Floor where agricultural activities predominate. The following text in Section 4 summarizes groundwater quality data retrieved and compiled for the Five-Year Assessment Report. CVGMC spends a lot of effort in developing a Data Management System (DMS) to house, maintain, and utilize GQTM data provided by CVGMC member Coalitions. For the purposes of this report, publicly available data[9] has also been added to the DMS to supplement knowledge gained from the GQTM well network and individual coalition data. The purpose of combining all publicly available nitrate, TDS, and pesticide data is to supplement and support the knowledge gained from the GQTM well networks, and to view these data on a regional scale, in order to better understand groundwater conditions within the CVGMC as a whole. Extensive Quality Assurance/Quality Control (QA/QC) has been performed on the GQTM data, and cursory QA/QC has been performed on publicly available data[10]. GQTM QA/QC includes formatting for consistency across coalitions, checking sample information against COCs or field sheets, comparing against the project QAPPs, calculating percent recoveries and relative percent differences, confirming QA codes have been applied properly, and adding missing QA codes.

4.1. Historical GQTM Data: CVGMC Coalitions

All historic and current monitoring data from the GQTM network wells were compiled into the CVGMC DMS. This includes groundwater quality sample data from 2018 through 2020, as summarized in Section 3.2. This dataset consists of 5,295 individual results from GQTM wells[11]. Constituents analyzed and included in the DMS are alkalinity as CaCO3, bicarbonate, boron, calcium, carbonate, chloride, hydroxide, magnesium, nitrate (including nitrate + nitrite), pH, potassium, sodium, specific conductivity, sulfate, and total dissolved solids.

An overview of the historical GQTM sampling data is provided in **Table 4-1** for nitrate, TDS, and general minerals, by coalition. This table provides the number of GQTM wells, the number of sampling events within the period of 2018-2020 for the wells in the GQTM network (including inactive wells), and the range of dates for those sampling events.

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[9] A full description of publicly available data used for this report is included in **Section 4.2**. In summary, Publicly available data was downloaded from the California Water Boards GAMA Groundwater Information System data download website from sources including: Division of Drinking Water (DDW), Department of Pesticide Regulation (DPR), Department of Water Resources (DWR), Geotracker Regulated Facilities (EDF), GAMA Domestic, Lawrence Livermore National Laboratory (LLNL), the U.S. Geological Survey, and UC Davis Nitrate Data: https://gamagroundwater.waterboards.ca.gov/gama/datadownload, accessed on March 1, 2021.

[10] It is assumed that in order to reach the public domain, via GAMA, that data has already undergone some level of QA/QC. Additional QA/QC has been performed on public data prior to entry into the DMS in order to remove duplicates and statistical outliers that may be erroneous and marked as "questionable."

[11] The GQTM well network changes annually. Wells have been added and removed to the GQTM well network between 2018 and 2020. Additionally, not all wells in the network have results as some may not have been/were not able to be sampled.

Table 4-1. Historical GQTM Data by Coalition									
CVGMC Coalition Name	Nitrate			TDS			General Minerals		
	Number of Unique GQTM Wells with Nitrate Data	Range of Number of Nitrate Sampling Events	Date Range of Nitrate Samples	Number of Unique GQTM Wells with TDS Data	Range of Number of TDS Sampling Events	Date Range of TDS Samples	Number of Unique GQTM Wells with General Minerals Data	Range of Number of General Minerals Sampling Events	Date Range of General Minerals Samples
Buena Vista Coalition	12	1 to 3	2018-08-08 to 2020-08-06	10	1	2018-08-08 to 2018-08-30	10	1	2018-08-08 to 2018-08-30
Cawelo Water District	15	2 to 3	2018-07-16 to 2020-09-24	15	2	2018-07-16 to 2019-10-10	15	2	2018-07-16 to 2019-10-10
East San Joaquin Water Quality Coalition	34	1 to 3	2018-10-30 to 2020-08-06	34	1 to 2	2018-10-30 to 2020-08-06	34	1 to 2	2018-10-30 to 2020-08-06
Grassland Drainage Area Coalition	11	2 to 3	2018-11-26 to 2020-08-27	11	1	2018-11-26 to 2019-08-01	11	1	2018-11-26 to 2019-08-01
Kaweah Basin Water Quality Association	24	2 to 3	2018-10-24 to 2020-06-24	24	1 to 2	2018-10-24 to 2019-09-09	24	1 to 2	2018-10-24 to 2019-09-09
Kern River Watershed Coalition Authority	60	1 to 3	2018-11-27 to 2020-08-31	58	1 to 2	2018-11-27 to 2019-08-29	58	1 to 2	2018-11-27 to 2019-08-29
Kings River Watershed Coalition Authority	92	1 to 3	2018-10-17 to 2020-06-26	92	1 to 2	2018-10-17 to 2019-06-28	92	1 to 2	2018-10-17 to 2019-06-28

Table 4-1. Historical GQTM Data by Coalition									
	Nitrate			TDS			General Minerals		
CVGMC Coalition Name	Number of Unique GQTM Wells with Nitrate Data	Range of Number of Nitrate Sampling Events	Date Range of Nitrate Samples	Number of Unique GQTM Wells with TDS Data	Range of Number of TDS Sampling Events	Date Range of TDS Samples	Number of Unique GQTM Wells with General Minerals Data	Range of Number of General Minerals Sampling Events	Date Range of General Minerals Samples
Westlands Water Quality Coalition	18	1 to 3	2018-11-12 to 2020-06-24	18	1 to 2	2018-11-12 to 2020-06-24	18	1 to 2	2018-11-12 to 2020-06-24
Westside San Joaquin River Watershed Coalition	25	1 to 3	2018-11-30 to 2020-08-27	25	1	2018-11-30 to 2020-08-24	25	1	2018-11-30 to 2020-08-24
Westside Water Quality Coalition	16	1 to 3	2018-11-06 to 2020-07-30	9	1	2018-11-06 to 2019-02-11	9	1	2018-11-06 to 2019-02-11

4.2. Publicly Available Data

Publicly available groundwater quality data are utilized to supplement nitrate and TDS data. The Water Board maintains a comprehensive groundwater quality monitoring program called the Groundwater Ambient Monitoring and Assessment (GAMA) Program. This program integrates existing monitoring programs and is based on interagency collaboration with the State and Regional Water Boards, Department of Water Resources, Department of Pesticide Regulations, U.S. Geological Survey, and Lawrence Livermore National Laboratory, and cooperation with local water agencies and well owners. The Water Board also maintains the Groundwater Information System known as part of GAMA[12], which allows users to download statewide and county-specific datasets.

Nitrate and TDS data were downloaded from the GAMA groundwater information system for the CVGMC area, including a 3-mile buffer around the border of the CVGMC area on March 1, 2021. Several sources of nitrate and TDS data are included in this bulk download, including data from: AGLAND (irrigated lands regulatory program monitored wells outside of the GQTM wells from the ten coalitions); DHS (Division of Drinking Water, or DDW, which contains groundwater samples from public supply wells); DPR (Department of Pesticide Regulation); DWR (Department of Water Resources); EDF (regulated facilities monitoring site data, also known as GeoTracker); GAMA (Water Board's Groundwater Ambient Monitoring and Assessment Program); LOCALGW (GAMA data from local water agencies and well owners); UCD CASTING (this contains nitrate data from the UC Davis nitrate study[13] associated with the SWRCB SBX2 1 Report to the Legislature); and the USGS (U.S. Geological Survey's National Water Information System, NWIS). These public data underwent a QA/QC process prior to being entered into the CVGMC DMS. This process includes removing duplicate entries and marking questionable sample results that appeared to be statistical outliers (potentially from mis-reporting measurement units or anomalous/incorrect entries).

The number of wells with nitrate, TDS, and pesticide data from each public source within a 3-mile buffer of the CVGMC border are delineated in **Table 4-2** below, based on whether the wells are located within the Central Valley Floor or outside the Valley Floor. As discussed above, the regulatory program drives the analyses of nitrate and TDS conditions as they pertain to irrigated agriculture. As a result, wells with nitrate and TDS data located outside the Valley Floor are not used for evaluations of conditions associated with this Five-Year Assessment Report, including trends or spatial distribution of nitrate/TDS.

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[12] https://gamagroundwater.waterboards.ca.gov/gama/datadownload, accessed March 2021.
[13] https://groundwaternitrate.ucdavis.edu/, accessed March 2021.

Table 4-2. Public Data Retrieval Summary						
Data Source	Number of Wells Within the Central Valley Floor			Number of Wells Outside the Valley Floor		
	With Nitrate Data	With TDS Data	With Pesticide Data	With Nitrate Data	With TDS Data	With Pesticide Data
Irrigated Lands Regulatory Program (AGLAND)	1,709	13	0	8	3	0
Division of Drinking Water (DDW)	3,492	2,640	3,184	1,574	947	987
Department of Pesticide Regulation (DPR)	1	0	2,192	0	0	38
Department of Water Resources (DWR)	6,754	5,771	0	451	370	0
Geotracker Regulated Facilities (EDF)	1,392	1,050	1,713	283	214	309
Groundwater Ambient Monitoring Assessment (GAMA and LOCALGW)	119	107	125	28	29	21
UC Davis Nitrate Study (UCD CASTING)	5,420	0	0	92	0	0
U.S. Geological Survey (USGS)	3,535	4,161	1,288	245	292	239
Total	**22,422**	**13,742**	**8,502**	**2,681**	**1,855**	**1,594**

Figures 4-1a through 4-1g provide the spatial distribution of all publicly available nitrate, TDS, and pesticide groundwater data within a three-mile buffer of the CVGMC, according to data source. This dataset, along with the GQTM coalition-specific data, provides the basis for the groundwater quality assessment presented in Section 5 of this report.

4.3. GSP Data

Within the CVGMC boundary, there are over 80 Groundwater Sustainability Agencies and about 36[14] Groundwater Sustainability Plans submitted to DWR (**Figure 4-2**). Groundwater levels and monitoring networks associated with SGMA requirements are publicly available, and many of those well sites were used for DWR's development of the 2020 Spring Groundwater Elevation Contour map. Although groundwater quality is not the primary focus of Groundwater Sustainability Plans, degradation of groundwater quality as a result of groundwater resource utilization is an important consideration. The CVGMC will incorporate any groundwater quality data made publicly available through DWR as a result of GSP implementation in their area for the next Five-Year Assessment Report. The CVGMC is also open to opportunities for future collaboration involved with GSAs expanding their GSP monitoring network.

5. FIVE-YEAR GROUNDWATER QUALITY DATA ASSESSMENT

This section of the report contains the bulk of the regional analyses required in the Five-Year Assessment Report, including summary statistics, spatial distribution, and temporal trends for nitrate and TDS. It also contains an overview of pesticide conditions and general minerals in groundwater within the CVGMC area.

5.1. Summary Statistics: Nitrate and TDS

Summary statistics are a helpful way to observe nitrate and TDS conditions within the CVGMC area. Statistics associated with GQTM and publicly available data are provided for wells within the Central Valley Floor portion of the CVGMC associated with irrigated agriculture.

5.1.1. CVGMC GQTM Data

Table 5-1 contains summary statistics[15] for nitrate and TDS for CVGMC GQTM data. This table also summarizes groundwater quality data based on what Coalition the well falls in spatially and the well depth category it falls in vertically. The table provides the number of GQTM wells sampled for nitrate or TDS, the total number of samples and detections, the range of dates associated with those samples, the range of nitrate/TDS concentrations, and the average and median detectable nitrate/TDS values.

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[14] As of August 27, 2021, according to the SGMA Portal (https://sgma.water.ca.gov/portal/service/gsadocument/submittedgsa)

[15] Summary statistics did not employ declustering techniques for the development of averages or medians. Naïve means are presented in Tables 5-1, 5-2, and 5-3 for the regions and well depth categories provided. Average and median "detectable" values utilized reported concentrations that were above the reporting limit. Declustering and taking into consideration non-detected concentrations would result in lower average and median values. The median and average values reported in Tables 5-1 and 5-2 are therefore higher than a declustered mean or average that includes a process for including non-detected concentrations would produce.

5.1.2. Other Data Sources

Table 5-2 contains summary statistics[16] for nitrate and TDS for publicly available data within the Central Valley Floor of the CVGMC area. This table summarizes groundwater quality data based on what Coalition the well with public data falls in spatially and the well depth category it falls in vertically, if known. The table provides the number of wells sampled for nitrate or TDS, the total number of samples and detections, the range of dates associated with those samples, the range of nitrate/TDS concentrations, the average and median detectable nitrate/TDS values, and the number of post-2000 and post-2010 nitrate/TDS samples.

5.1.3. All Data

Table 5-3 combines the data from the GQTM network and the publicly available data, to provide summary statistics[17] for nitrate and TDS for the entire CVGMC area reported by Coalition area and depth zone. This table summarizes groundwater quality data based on what Coalition the well falls in spatially and the well depth category it falls in vertically, if known. The table provides the number of wells sampled for nitrate or TDS, the total number of samples and detections, the range of dates associated with those samples, the range of nitrate/TDS concentrations, the average and median detectable nitrate/TDS values, and the number of post-2000 and post-2010 nitrate/TDS samples.

[16] Coalition averages and medians were not declustered for the development of this table, and as stated in the previous footnote, without including non-detect sample concentrations or declustering, the reported values in Table 5-2 using naïve means are likely overestimating mean concentrations in each region.
[17] As stated in the two previous footnotes, the average and median values in this table represent a "naïve" mean for each category, which is potentially overestimating the mean concentration in each region.

Table 5-1a. Summary Statistics for Nitrate for CVGMC GQTM Data									
Coalition	Depth Zone	Nitrate							
		Number of Individual GQTM Wells with Nitrate Results	Total Number of Nitrate Samples	Number of Nitrate Detections	Nitrate Date Range	Nitrate Range Minimum (mg/L as N)	Nitrate Range Maximum (mg/L as N)	Average Detectable Nitrate (mg/L as N)	Median Detectable Nitrate (mg/L as N)
Buena Vista Coalition	Upper	7	17	6	2018-08-22 to 2020-08-06	< 0.099	30	7.2	3.0
Buena Vista Coalition	Upper/ Lower	3	9	9	2018-08-22 to 2020-07-07	2.9	11	7.8	7.2
Buena Vista Coalition	Lower	2	6	0	2018-08-08 to 2020-07-07	< 0.099	< 0.3	NA	NA
Cawelo Water District	Upper	1	3	3	2018-11-15 to 2020-09-24	17.7	24	20.9	20.9
Cawelo Water District	Upper/ Lower	2	6	5	2018-07-31 to 2020-09-23	0.07	14.1	8.1	12.0
Cawelo Water District	Below Lower	12	35	27	2018-07-16 to 2020-09-22	0.02	14.3	2.7	0.7
East San Joaquin Water Quality Coalition	Upper	25	56	52	2018-10-30 to 2020-08-06	< 0.04	70	14.8	8.9
East San Joaquin Water Quality Coalition	Upper/ Lower	4	4	4	2020-08-04 to 2020-08-04	5.9	11	8.4	8.3
East San Joaquin Water Quality Coalition	Lower	2	2	2	2020-08-04 to 2020-08-04	2.4	7.6	5.0	5.0
East San Joaquin Water Quality Coalition	Below Lower	3	3	3	2020-08-04 to 2020-08-05	0.09	6.2	2.9	2.4
Grassland Drainage Area Coalition	Upper	8	19	16	2018-11-26 to 2020-08-27	< 0.025	89	28.8	13.5
Grassland Drainage Area Coalition	Upper/ Lower	3	9	6	2018-11-26 to 2020-08-26	< 0.025	6.7	3.6	3.6
Kaweah Basin Water Quality Association	Upper	19	47	47	2018-10-24 to 2020-06-24	0.04	30.1	8.7	5.8
Kaweah Basin Water Quality Association	Upper/ Lower	4	11	11	2018-10-24 to 2020-06-17	0.6	16.1	8.9	10.3

Table 5-1a. Summary Statistics for Nitrate for CVGMC GQTM Data

Coalition	Depth Zone	Nitrate							
		Number of Individual GQTM Wells with Nitrate Results	Total Number of Nitrate Samples	Number of Nitrate Detections	Nitrate Date Range	Nitrate Range Minimum (mg/L as N)	Nitrate Range Maximum (mg/L as N)	Average Detectable Nitrate (mg/L as N)	Median Detectable Nitrate (mg/L as N)
Kaweah Basin Water Quality Association	Lower	1	3	3	2018-12-04 to 2020-06-17	1.1	1.8	1.4	1.3
Kern River Watershed Coalition Authority	Upper	7	19	16	2018-11-27 to 2020-08-31	< 0.056	20	13.3	14.0
Kern River Watershed Coalition Authority	Upper/ Lower	14	32	32	2018-11-27 to 2020-08-12	0.41	23	7.1	3.4
Kern River Watershed Coalition Authority	Lower	8	17	17	2018-12-03 to 2020-08-26	3.3	17	10.1	11.0
Kern River Watershed Coalition Authority	Below Lower	31	68	53	2018-11-27 to 2020-08-26	< 0.028	31	6.7	5.5
Kings River Watershed Coalition Authority	Upper	39	97	81	2018-10-17 to 2020-06-26	< 0.099	24	7.8	7.4
Kings River Watershed Coalition Authority	Upper/ Lower	16	43	34	2018-10-18 to 2020-06-26	< 0.099	25	8.6	6.5
Kings River Watershed Coalition Authority	Lower	19	43	37	2018-10-17 to 2020-06-26	< 0.099	27	7.2	4.1
Kings River Watershed Coalition Authority	Below Lower	18	32	25	2018-10-19 to 2019-06-28	< 0.099	7.7	4.0	4.1
Westlands Water Quality Coalition	Upper	15	33	22	2018-11-12 to 2020-06-24	< 0.04	430	141.9	17.0
Westlands Water Quality Coalition	Upper/ Lower	3	3	1	2020-06-24 to 2020-06-24	< 0.04	38	38.0	38.0
Westside San Joaquin River Watershed Coalition	Upper	17	36	27	2018-11-30 to 2020-08-27	< 0.025	28	10.4	8.9
Westside San Joaquin River Watershed Coalition	Upper/ Lower	8	21	10	2018-11-30 to 2020-08-27	< 0.010	12	4.9	4.5
Westside Water Quality Coalition	Upper	6	16	16	2018-11-06 to 2020-07-29	1.7	440	73.4	24.0

Table 5-1a. Summary Statistics for Nitrate for CVGMC GQTM Data									
Coalition	Depth Zone	Nitrate							
		Number of Individual GQTM Wells with Nitrate Results	Total Number of Nitrate Samples	Number of Nitrate Detections	Nitrate Date Range	Nitrate Range Minimum (mg/L as N)	Nitrate Range Maximum (mg/L as N)	Average Detectable Nitrate (mg/L as N)	Median Detectable Nitrate (mg/L as N)
Westside Water Quality Coalition	Upper/ Lower	1	1	0	2020-07-29 to 2020-07-29	< 0.057	< 0.057	NA	NA
Westside Water Quality Coalition	Lower	4	8	6	2018-11-15 to 2020-07-30	< 0.057	7.6	3.9	3.1
Westside Water Quality Coalition	Below Lower	5	8	7	2018-12-05 to 2020-07-27	0.24	6.5	3.7	3.8

Table 5-1b. Summary Statistics for TDS for CVGMC GQTM Data									
Coalition	Depth Zone	TDS							
		Number of Individual GQTM Wells with TDS Results	Total Number of TDS Samples	Number of TDS Detections	TDS Date Range	TDS Range Minimum (mg/L)	TDS Range Maximum (mg/L)	Average Detectable TDS (mg/L)	Median Detectable TDS (mg/L)
Buena Vista Coalition	Upper	5	5	5	2018-08-22 to 2018-08-30	370	3800	1472	740
Buena Vista Coalition	Upper/ Lower	3	3	3	2018-08-22 to 2018-08-22	1100	1400	1233	1200
Buena Vista Coalition	Lower	2	2	2	2018-08-08 to 2018-08-08	210	2600	1405	1405
Cawelo Water District	Upper	1	2	2	2018-11-15 to 2019-09-11	1120	1500	1310	1310

Table 5-1b. Summary Statistics for TDS for CVGMC GQTM Data									
Coalition	Depth Zone	TDS							
		Number of Individual GQTM Wells with TDS Results	Total Number of TDS Samples	Number of TDS Detections	TDS Date Range	TDS Range Minimum (mg/L)	TDS Range Maximum (mg/L)	Average Detectable TDS (mg/L)	Median Detectable TDS (mg/L)
Cawelo Water District	Upper/ Lower	2	4	4	2018-07-31 to 2019-10-02	459	990	659	594
Cawelo Water District	Below Lower	12	24	24	2018-07-16 to 2019-10-10	160	670	339	280
East San Joaquin Water Quality Coalition	Upper	25	26	26	2018-10-30 to 2020-08-06	160	930	460	415
East San Joaquin Water Quality Coalition	Upper/ Lower	4	4	4	2020-08-04 to 2020-08-04	330	560	450	455
East San Joaquin Water Quality Coalition	Lower	2	2	2	2020-08-04 to 2020-08-04	190	520	355	355
East San Joaquin Water Quality Coalition	Below Lower	3	3	3	2020-08-04 to 2020-08-05	220	800	433	280
Grassland Drainage Area Coalition	Upper	8	8	8	2018-11-26 to 2019-08-01	1300	5200	3563	3950
Grassland Drainage Area Coalition	Upper/ Lower	3	3	3	2018-11-26 to 2018-12-11	1200	3400	2300	2300
Kaweah Basin Water Quality Association	Upper	19	28	28	2018-10-24 to 2019-09-09	72.9	819	311	248.5
Kaweah Basin Water Quality Association	Upper/ Lower	4	7	7	2018-10-24 to 2019-07-02	94.5	1350	595	510
Kaweah Basin Water Quality Association	Lower	1	2	2	2018-12-04 to 2019-07-02	145	148	147	146.5
Kern River Watershed Coalition Authority	Upper	7	12	12	2018-11-27 to 2019-07-29	360	1800	834	670
Kern River Watershed Coalition Authority	Upper/ Lower	14	20	20	2018-11-27 to 2019-08-15	170	1900	718	570
Kern River Watershed Coalition Authority	Lower	8	11	11	2018-12-03 to 2019-08-07	200	1800	586	450

Table 5-1b. Summary Statistics for TDS for CVGMC GQTM Data

Coalition	Depth Zone	TDS							
		Number of Individual GQTM Wells with TDS Results	Total Number of TDS Samples	Number of TDS Detections	TDS Date Range	TDS Range Minimum (mg/L)	TDS Range Maximum (mg/L)	Average Detectable TDS (mg/L)	Median Detectable TDS (mg/L)
Kern River Watershed Coalition Authority	Below Lower	29	39	39	2018-11-27 to 2019-08-29	170	2100	631	520
Kings River Watershed Coalition Authority	Upper	39	71	71	2018-10-17 to 2019-06-28	33	2500	451	360
Kings River Watershed Coalition Authority	Upper/ Lower	16	31	31	2018-10-18 to 2019-06-28	78	720	403	470
Kings River Watershed Coalition Authority	Lower	19	35	35	2018-10-17 to 2019-06-27	110	820	355	290
Kings River Watershed Coalition Authority	Below Lower	18	32	32	2018-10-19 to 2019-06-28	120	700	267	260
Westlands Water Quality Coalition	Upper	15	18	18	2018-11-12 to 2020-06-24	740	13000	5530	5950
Westlands Water Quality Coalition	Upper/ Lower	3	3	3	2020-06-24 to 2020-06-24	780	4000	2293	2100
Westside San Joaquin River Watershed Coalition	Upper	17	17	17	2018-11-30 to 2020-08-24	440	2900	1012	810
Westside San Joaquin River Watershed Coalition	Upper/ Lower	8	8	8	2018-11-30 to 2020-08-24	380	1500	708	590
Westside Water Quality Coalition	Upper	5	5	5	2018-11-06 to 2018-11-27	1300	26000	11500	11000
Westside Water Quality Coalition	Upper/ Lower	0	0	0	NA	NA	NA	NA	NA
Westside Water Quality Coalition	Lower	3	3	3	2018-11-15 to 2019-02-11	1400	2900	2367	2800
Westside Water Quality Coalition	Below Lower	1	1	1	2018-12-05 to 2018-12-05	3700	3700	3700	3700

Table 5-2a. Summary Statistics for Nitrate for Publicly Available Data									
Coalition	Depth Zone	Nitrate							
		Number of Individual Wells with Nitrate Results	Total Number of Nitrate Samples	Number of Nitrate Detections	Nitrate Sample Date Range	Nitrate Range Minimum (mg/L as N)	Nitrate Range Maximum (mg/L as N)	Average Detectable Nitrate (mg/L as N)	Median Detectable Nitrate (mg/L as N)
Buena Vista Coalition	Upper	23	79	65	1989-06-21 to 2020-12-02	0.092	46	9.552416288	6.8
Buena Vista Coalition	Lower	11	24	16	1954-08-07 to 2012-12-19	0.045	3.21	0.96761875	0.225
Buena Vista Coalition	Below Lower	25	90	62	1954-08-07 to 2020-12-10	0.045	14	4.261811507	2.5
Buena Vista Coalition	Unknown	120	230	164	1942-08-28 to 2021-01-05	0.02	3.95	0.371328591	0.2
Cawelo Water District	Upper	3	18	7	1957-05-24 to 2020-10-12	0.1	11	2.481428571	1
Cawelo Water District	Lower	26	129	115	1951-04-06 to 2020-12-29	0.02	33.9	5.794770435	3.86
Cawelo Water District	Below Lower	26	338	275	1955-08-31 to 2020-11-02	0.00316	35.2	7.2098204	7.7
Cawelo Water District	Unknown	108	266	169	1937-05-06 to 2021-01-06	0.02	54.9	5.387893491	2
East San Joaquin Water Quality Coalition	Upper	1775	6937	6454	1950-04-12 to 2021-02-24	0.021	4721.3	10.64183845	5.51
East San Joaquin Water Quality Coalition	Lower	386	5648	5474	1951-03-20 to 2021-01-20	< 0.0045	51	5.193759616	4.86
East San Joaquin Water Quality Coalition	Below Lower	604	7272	6915	1943-07-26 to 2021-01-12	0.009	129.9638663	5.624012044	4.751
East San Joaquin Water Quality Coalition	Unknown	1410	7142	6745	1946-07-26 to 2021-01-20	< 0.011	89.9752	6.081072721	5.08
Grassland Drainage Area Coalition	Upper	145	231	227	1962-12-07 to 2020-10-28	0.032	> 1280	161.4320243	81
Grassland Drainage Area Coalition	Lower	6	22	4	1968-07-17 to 2018-08-09	< 0.04	6.8	0.571	0.574

Table 5-2a. Summary Statistics for Nitrate for Publicly Available Data									
Coalition	Depth Zone	Nitrate							
		Number of Individual Wells with Nitrate Results	Total Number of Nitrate Samples	Number of Nitrate Detections	Nitrate Sample Date Range	Nitrate Range Minimum (mg/L as N)	Nitrate Range Maximum (mg/L as N)	Average Detectable Nitrate (mg/L as N)	Median Detectable Nitrate (mg/L as N)
Grassland Drainage Area Coalition	Below Lower	28	43	33	1950-09-25 to 2021-01-12	0.02	10.4	1.734727273	0.497
Grassland Drainage Area Coalition	Unknown	107	178	132	1946-05-02 to 2021-01-12	0.02	220	9.453121212	0.61
Kaweah Basin Water Quality Association	Upper	550	1177	1145	1946-05-17 to 2020-12-31	0.041	510	14.24513091	9.19828365
Kaweah Basin Water Quality Association	Lower	238	2309	2253	1956-09-04 to 2021-01-14	< 0.0090	22900	17.04351245	5.2
Kaweah Basin Water Quality Association	Below Lower	454	3197	2999	1947-04-15 to 2021-01-13	< 0.036	74.88030714	5.625792077	4.498644986
Kaweah Basin Water Quality Association	Unknown	1355	3658	3547	1942-03-19 to 2021-01-12	< 0.0090	116.9692864	9.77576632	7.098012647
Kern River Watershed Coalition Authority	Upper	341	1443	972	1950-01-09 to 2020-12-21	0.023	91.8	7.650019204	4.0832
Kern River Watershed Coalition Authority	Lower	423	3701	3241	1950-04-27 to 2021-01-12	0.0023	76.8	5.719708345	2.9
Kern River Watershed Coalition Authority	Below Lower	649	6362	5823	1944-11-17 to 2021-01-15	0.0045	74	4.416763689	3.6955
Kern River Watershed Coalition Authority	Unknown	3349	7869	7372	1937-05-05 to 2021-01-13	< 0.0090	183	5.281326981	2.5
Kings River Watershed Coalition Authority	Upper	2249	5818	5346	1946-09-20 to 2021-02-12	0.009	540	9.524654079	5.9
Kings River Watershed Coalition Authority	Lower	788	12287	11905	1954-01-06 to 2021-01-14	< 0.0023	59.78319783	5.359558417	5
Kings River Watershed Coalition Authority	Below Lower	580	11078	10236	1951-08-22 to 2021-01-14	0.014	65.98238482	5.134734533	4.3
Kings River Watershed Coalition Authority	Unknown	2831	6875	6260	1942-07-21 to 2021-01-14	0.0023	149.9593496	6.631838072	3.999548329

Table 5-2a. Summary Statistics for Nitrate for Publicly Available Data

Coalition	Depth Zone	Nitrate							
		Number of Individual Wells with Nitrate Results	Total Number of Nitrate Samples	Number of Nitrate Detections	Nitrate Sample Date Range	Nitrate Range Minimum (mg/L as N)	Nitrate Range Maximum (mg/L as N)	Average Detectable Nitrate (mg/L as N)	Median Detectable Nitrate (mg/L as N)
Westlands Water Quality Coalition	Upper	157	199	186	1951-08-22 to 2020-10-22	0.08	379	42.30101221	16.95
Westlands Water Quality Coalition	Lower	31	53	49	1951-08-22 to 2018-01-08	0.0023	10.6	2.772985714	1.9
Westlands Water Quality Coalition	Below Lower	335	382	351	1951-08-22 to 2015-09-17	0.009	22.1	1.129623932	0.384
Westlands Water Quality Coalition	Unknown	530	919	816	1946-05-01 to 2021-01-19	0.02	240	3.918280637	0.63
Westside San Joaquin River Watershed Coalition	Upper	417	1985	1507	1947-08-01 to 2021-02-04	0.01	271	8.557325453	7.805
Westside San Joaquin River Watershed Coalition	Lower	102	620	485	1947-09-19 to 2021-01-13	0.009	16	5.041810309	5.2
Westside San Joaquin River Watershed Coalition	Below Lower	189	1379	1309	1947-05-20 to 2021-01-14	0.023	29.4	6.853136156	6.1
Westside San Joaquin River Watershed Coalition	Unknown	686	1727	1402	1944-01-20 to 2021-01-15	0.01	660	10.66772115	3.4
Westside Water Quality Coalition	Upper	87	383	250	1951-01-22 to 2020-12-17	0.048	620	51.908144	19
Westside Water Quality Coalition	Lower	24	88	48	1953-04-22 to 2020-06-03	0.113	27.1	3.593770833	3.16
Westside Water Quality Coalition	Below Lower	25	110	47	1953-01-30 to 2020-11-13	0.023	61	6.22706383	5.2
Westside Water Quality Coalition	Unknown	169	303	261	1947-03-17 to 2020-10-27	0.02	80.9	4.391425287	2.7

Table 5-2b. Summary Statistics for TDS for Publicly Available Data									
		TDS							
Coalition	Depth Zone	Number of Individual Wells with TDS Results	Total Number of TDS Samples	Number of TDS Detections	TDS Sample Date Range	TDS Range Minimum (mg/L)	TDS Range Maximum (mg/L)	Average Detectable TDS (mg/L)	Median Detectable TDS (mg/L)
Buena Vista Coalition	Upper	17	164	158	1989-06-21 to 2020-08-26	1340	28000	9416	9850
Buena Vista Coalition	Lower	11	27	18	1956-02-01 to 2010-11-18	221	796	478	451
Buena Vista Coalition	Below Lower	21	84	71	1954-08-07 to 2020-12-10	132	13000	3752	3000
Buena Vista Coalition	Unknown	88	133	129	1937-03-03 to 2019-07-23	110	4700	1105	881
Cawelo Water District	Upper	15	112	111	1957-05-24 to 2019-08-28	190	15000	5186	4800
Cawelo Water District	Lower	22	45	30	1951-04-06 to 2010-04-23	131	1320	468	297
Cawelo Water District	Below Lower	26	64	45	1955-08-31 to 2018-12-05	140	1700	414	280
Cawelo Water District	Unknown	85	218	214	1936-10-13 to 2020-10-15	110	84000	2926	338.5
East San Joaquin Water Quality Coalition	Upper	654	4967	4180	1925-06-27 to 2020-12-16	< 20	20000	536	430
East San Joaquin Water Quality Coalition	Lower	314	1685	1427	1948-05-27 to 2020-10-13	< 1	4800	290	237
East San Joaquin Water Quality Coalition	Below Lower	486	2393	1989	1943-07-23 to 2021-01-12	38	6420	391	262
East San Joaquin Water Quality Coalition	Unknown	899	2134	1917	1928-09-20 to 2021-01-12	21	8310	421	290
Grassland Drainage Area Coalition	Upper	135	320	165	1962-12-07 to 2015-09-16	741	37600	9731	6810
Grassland Drainage Area Coalition	Lower	6	25	22	1968-07-17 to 2018-08-09	270	3380	1199	1150
Grassland Drainage Area Coalition	Below Lower	60	194	110	1950-09-25 to 2020-01-21	93	3060	1422	1325

Table 5-2b. Summary Statistics for TDS for Publicly Available Data

Coalition	Depth Zone	TDS							
		Number of Individual Wells with TDS Results	Total Number of TDS Samples	Number of TDS Detections	TDS Sample Date Range	TDS Range Minimum (mg/L)	TDS Range Maximum (mg/L)	Average Detectable TDS (mg/L)	Median Detectable TDS (mg/L)
Grassland Drainage Area Coalition	Unknown	119	272	244	1939-06-30 to 2018-01-23	354	34826	2215	1472
Kaweah Basin Water Quality Association	Upper	149	290	259	1946-05-17 to 2020-12-10	5.52	3900	446	281
Kaweah Basin Water Quality Association	Lower	105	503	483	1956-09-04 to 2021-01-12	60	2300	304	180
Kaweah Basin Water Quality Association	Below Lower	159	632	609	1947-04-15 to 2021-01-12	52	1410	189	153
Kaweah Basin Water Quality Association	Unknown	380	1085	1045	1941-10-15 to 2020-12-11	48	3960	283	180
Kern River Watershed Coalition Authority	Upper	255	1343	1235	1950-01-09 to 2020-12-03	97	140000	2334	999
Kern River Watershed Coalition Authority	Lower	427	1702	1474	1939-04-15 to 2021-01-05	27	7410	531	260
Kern River Watershed Coalition Authority	Below Lower	634	2155	1814	1941-01-28 to 2021-01-06	4.5	13000	529	240
Kern River Watershed Coalition Authority	Unknown	2820	5579	5510	1923-05-23 to 2020-12-24	7.5	231000	653	299
Kings River Watershed Coalition Authority	Upper	593	2445	2023	1946-09-20 to 2021-01-07	28	63600	1216	572
Kings River Watershed Coalition Authority	Lower	471	1778	1693	1951-08-14 to 2020-11-17	2.7	6020	271	230
Kings River Watershed Coalition Authority	Below Lower	362	1552	1507	1929-09-25 to 2021-01-11	32	88000	301	210
Kings River Watershed Coalition Authority	Unknown	937	1959	1770	1929-09-25 to 2021-01-04	48	116000	569	264
Westlands Water Quality Coalition	Upper	195	549	284	1951-08-13 to 2019-07-30	282	56500	8290	6545
Westlands Water Quality Coalition	Lower	42	93	56	1951-08-13 to 2010-07-08	487	3940	1450	1245

Table 5-2b. Summary Statistics for TDS for Publicly Available Data									
Coalition	Depth Zone	TDS							
		Number of Individual Wells with TDS Results	Total Number of TDS Samples	Number of TDS Detections	TDS Sample Date Range	TDS Range Minimum (mg/L)	TDS Range Maximum (mg/L)	Average Detectable TDS (mg/L)	Median Detectable TDS (mg/L)
Westlands Water Quality Coalition	Below Lower	723	1575	868	1951-04-16 to 2015-09-17	160	6230	1174	1040
Westlands Water Quality Coalition	Unknown	389	596	519	1929-09-25 to 2020-05-26	151	49900	2954	1290
Westside San Joaquin River Watershed Coalition	Upper	409	1864	1496	1937-10-01 to 2021-01-05	26	86500	1772	778.5
Westside San Joaquin River Watershed Coalition	Lower	113	704	586	1947-09-19 to 2021-01-05	110	3900	645	480
Westside San Joaquin River Watershed Coalition	Below Lower	202	904	636	1947-05-20 to 2021-01-05	199	23000	1049	831
Westside San Joaquin River Watershed Coalition	Unknown	647	1347	1239	1929-09-26 to 2020-07-14	< 1	86500	1559	840
Westside Water Quality Coalition	Upper	101	431	384	1951-01-22 to 2020-10-14	1090	91900	8546	5200
Westside Water Quality Coalition	Lower	35	139	108	1930-04-20 to 2020-06-03	30	31000	5799	4355
Westside Water Quality Coalition	Below Lower	31	139	124	1953-01-30 to 2020-11-12	381	12000	4269	4000
Westside Water Quality Coalition	Unknown	119	216	188	1942-07-28 to 2020-07-30	95	36000	5085	3280

Table 5-3a. Summary Statistics for Nitrate for All Data (GQTM and Publicly Available Data)[18]

Coalition	Depth Zone	Nitrate							
		Number of Individual Wells with Nitrate Results	Total Number of Nitrate Samples	Number of Nitrate Detections	Nitrate Sample Date Range	Nitrate Range Minimum (mg/L as N)	Nitrate Range Maximum (mg/L as N)	Average Detectable Nitrate (mg/L as N)	Median Detectable Nitrate (mg/L as N)
Buena Vista Coalition	Upper	30	96	71	1989-06-21 to 2020-12-02	0.092	46	9.35319801	6.7
Buena Vista Coalition	Upper/ Lower	3	9	9	2018-08-22 to 2020-07-07	2.9	11	7.755555556	7.2
Buena Vista Coalition	Lower	13	30	16	1954-08-07 to 2020-07-07	0.045	3.21	0.96761875	0.225
Buena Vista Coalition	Below Lower	25	90	62	1954-08-07 to 2020-12-10	0.045	14	4.261811507	2.5
Buena Vista Coalition	Unkno wn	120	230	164	1942-08-28 to 2021-01-05	0.02	3.95	0.371328591	0.2
Cawelo Water District	Upper	4	21	10	1957-05-24 to 2020-10-12	0.1	24	7.997	2.305
Cawelo Water District	Upper/ Lower	2	6	5	2018-07-31 to 2020-09-23	0.07	14.1	8.074	12
Cawelo Water District	Lower	26	129	115	1951-04-06 to 2020-12-29	0.02	33.9	5.794770435	3.86
Cawelo Water District	Below Lower	38	373	302	1955-08-31 to 2020-11-02	0.00316	35.2	6.809704007	7.42
Cawelo Water District	Unkno wn	108	266	169	1937-05-06 to 2021-01-06	0.02	54.9	5.387893491	2
East San Joaquin Water Quality Coalition	Upper	1800	6993	6506	1950-04-12 to 2021-02-24	0.021	4721.3	10.67522544	5.58
East San Joaquin Water Quality Coalition	Upper/ Lower	4	4	4	2020-08-04 to 2020-08-04	5.9	11	8.375	8.3

[18] Although cursory QA/QC has been performed by the CVGMC team on publicly-sourced nitrate and TDS data, there is still some unknown level of uncertainty associated with the accuracy of reported values from public sources.

Table 5-3a. Summary Statistics for Nitrate for All Data (GQTM and Publicly Available Data)[18]									
Coalition	Depth Zone	Nitrate							
		Number of Individual Wells with Nitrate Results	Total Number of Nitrate Samples	Number of Nitrate Detections	Nitrate Sample Date Range	Nitrate Range Minimum (mg/L as N)	Nitrate Range Maximum (mg/L as N)	Average Detectable Nitrate (mg/L as N)	Median Detectable Nitrate (mg/L as N)
East San Joaquin Water Quality Coalition	Lower	388	5650	5476	1951-03-20 to 2021-01-20	< 0.0045	51	5.193688849	4.86
East San Joaquin Water Quality Coalition	Below Lower	607	7275	6918	1943-07-26 to 2021-01-12	0.009	129.9638663	5.622829327	4.7505
East San Joaquin Water Quality Coalition	Unknown	1410	7142	6745	1946-07-26 to 2021-01-20	< 0.011	89.9752	6.081072721	5.08
Grassland Drainage Area Coalition	Upper	153	250	243	1962-12-07 to 2020-10-28	< 0.025	> 1280	152.47501	62
Grassland Drainage Area Coalition	Upper/ Lower	3	9	6	2018-11-26 to 2020-08-26	< 0.025	6.7	3.581666667	3.575
Grassland Drainage Area Coalition	Lower	6	22	4	1968-07-17 to 2018-08-09	< 0.04	6.8	0.571	0.574
Grassland Drainage Area Coalition	Below Lower	28	43	33	1950-09-25 to 2021-01-12	0.02	10.4	1.734727273	0.497
Grassland Drainage Area Coalition	Unknown	107	178	132	1946-05-02 to 2021-01-12	0.02	220	9.453121212	0.61
Kaweah Basin Water Quality Association	Upper	569	1224	1192	1946-05-17 to 2020-12-31	0.04	510	14.02510469	8.99729
Kaweah Basin Water Quality Association	Upper/ Lower	4	11	11	2018-10-24 to 2020-06-17	0.6	16.1	8.863636364	10.3
Kaweah Basin Water Quality Association	Lower	239	2312	2256	1956-09-04 to 2021-01-14	< 0.00903342	22900	17.02270991	5.2
Kaweah Basin Water Quality Association	Below Lower	454	3197	2999	1947-04-15 to 2021-01-13	< 0.036	74.88030714	5.625792077	4.498645
Kaweah Basin Water Quality Association	Unknown	1355	3658	3547	1942-03-19 to 2021-01-12	< 0.00903342	116.9692864	9.77576632	7.098013
Kern River Watershed Coalition Authority	Upper	348	1462	988	1950-01-09 to 2020-12-21	0.023	91.8	7.741516869	4.2

Table 5-3a. Summary Statistics for Nitrate for All Data (GQTM and Publicly Available Data)[18]									
Coalition	Depth Zone	Nitrate							
		Number of Individual Wells with Nitrate Results	Total Number of Nitrate Samples	Number of Nitrate Detections	Nitrate Sample Date Range	Nitrate Range Minimum (mg/L as N)	Nitrate Range Maximum (mg/L as N)	Average Detectable Nitrate (mg/L as N)	Median Detectable Nitrate (mg/L as N)
Kern River Watershed Coalition Authority	Upper/ Lower	14	32	32	2018-11-27 to 2020-08-12	0.41	23	7.12875	3.35
Kern River Watershed Coalition Authority	Lower	431	3718	3258	1950-04-27 to 2021-01-12	0.0023	76.8	5.742502992	2.9
Kern River Watershed Coalition Authority	Below Lower	680	6430	5876	1944-11-17 to 2021-01-15	0.0045	74	4.437501014	3.7
Kern River Watershed Coalition Authority	Unkno wn	3349	7869	7372	1937-05-05 to 2021-01-13	< 0.00903342	183	5.281326981	2.5
Kings River Watershed Coalition Authority	Upper	2288	5915	5427	1946-09-20 to 2021-02-12	0.009	540	9.498373586	5.9
Kings River Watershed Coalition Authority	Upper/ Lower	16	43	34	2018-10-18 to 2020-06-26	< 0.099	25	8.641176471	6.5
Kings River Watershed Coalition Authority	Lower	807	12330	11942	1954-01-06 to 2021-01-14	< 0.0023	59.7831978 3	5.36526115	5
Kings River Watershed Coalition Authority	Below Lower	598	11110	10261	1951-08-22 to 2021-01-14	0.014	65.9823848 2	5.131951338	4.3
Kings River Watershed Coalition Authority	Unkno wn	2831	6875	6260	1942-07-21 to 2021-01-14	0.0023	149.959349 6	6.631838072	3.999548
Westlands Water Quality Coalition	Upper	172	244	217	1951-08-22 to 2021-06-23	< 0.04	430	54.67700586	16
Westlands Water Quality Coalition	Upper/ Lower	3	6	3	2020-06-24 to 2021-06-22	< 0.04	38	26.3	34
Westlands Water Quality Coalition	Lower	31	53	49	1951-08-22 to 2018-01-08	0.0023	10.6	2.772985714	1.9
Westlands Water Quality Coalition	Below Lower	335	382	351	1951-08-22 to 2015-09-17	0.009	22.1	1.129623932	0.384
Westlands Water Quality Coalition	Unkno wn	530	919	816	1946-05-01 to 2021-01-19	0.02	240	3.918280637	0.63

Table 5-3b. Summary Statistics for TDS for All Data (GQTM and Publicly Available Data)									
Coalition	Depth Zone	TDS							
		Number of Individual Wells with TDS Results	Total Number of TDS Samples	Number of TDS Detections	TDS Sample Date Range	TDS Range Minimum (mg/L)	TDS Range Maximum (mg/L)	Average Detectable TDS (mg/L)	Median Detectable TDS (mg/L)
Buena Vista Coalition	Upper	22	169	163	1989-06-21 to 2020-08-26	370	28000	9.35319801	6.7
Buena Vista Coalition	Upper/ Lower	3	3	3	2018-08-22 to 2018-08-22	1100	1400	7.755555556	7.2
Buena Vista Coalition	Lower	13	29	20	1956-02-01 to 2018-08-08	210	2600	0.96761875	0.225
Buena Vista Coalition	Below Lower	21	84	71	1954-08-07 to 2020-12-10	132	13000	4.261811507	2.5
Buena Vista Coalition	Unkno wn	88	133	129	1937-03-03 to 2019-07-23	110	4700	0.371328591	0.2
Cawelo Water District	Upper	16	114	113	1957-05-24 to 2019-09-11	190	15000	7.997	2.305
Cawelo Water District	Upper/ Lower	2	4	4	2018-07-31 to 2019-10-02	459	990	8.074	12
Cawelo Water District	Lower	22	45	30	1951-04-06 to 2010-04-23	131	1320	5.794770435	3.86
Cawelo Water District	Below Lower	38	88	69	1955-08-31 to 2019-10-10	140	1700	6.809704007	7.42
Cawelo Water District	Unkno wn	85	218	214	1936-10-13 to 2020-10-15	110	84000	5.387893491	2
East San Joaquin Water Quality Coalition	Upper	679	4993	4206	1925-06-27 to 2020-12-16	< 20	20000	10.67522544	5.58
East San Joaquin Water Quality Coalition	Upper/ Lower	4	4	4	2020-08-04 to 2020-08-04	330	560	8.375	8.3
East San Joaquin Water Quality Coalition	Lower	316	1687	1429	1948-05-27 to 2020-10-13	< 1	4800	5.193688849	4.86
East San Joaquin Water Quality Coalition	Below Lower	489	2396	1992	1943-07-23 to 2021-01-12	38	6420	5.622829327	4.7505
East San Joaquin Water Quality Coalition	Unkno wn	899	2134	1917	1928-09-20 to 2021-01-12	21	8310	6.081072721	5.08

Table 5-3b. Summary Statistics for TDS for All Data (GQTM and Publicly Available Data)									
Coalition	Depth Zone	TDS							
		Number of Individual Wells with TDS Results	Total Number of TDS Samples	Number of TDS Detections	TDS Sample Date Range	TDS Range Minimum (mg/L)	TDS Range Maximum (mg/L)	Average Detectable TDS (mg/L)	Median Detectable TDS (mg/L)
Grassland Drainage Area Coalition	Upper	143	328	173	1962-12-07 to 2019-08-01	741	37600	152.47501	62
Grassland Drainage Area Coalition	Upper/ Lower	3	3	3	2018-11-26 to 2018-12-11	1200	3400	3.581666667	3.575
Grassland Drainage Area Coalition	Lower	6	25	22	1968-07-17 to 2018-08-09	270	3380	0.571	0.574
Grassland Drainage Area Coalition	Below Lower	60	194	110	1950-09-25 to 2020-01-21	93	3060	1.734727273	0.497
Grassland Drainage Area Coalition	Unknown	119	272	244	1939-06-30 to 2018-01-23	354	34826	9.453121212	0.61
Kaweah Basin Water Quality Association	Upper	168	318	287	1946-05-17 to 2020-12-10	5.52	3900	14.02510469	8.99729
Kaweah Basin Water Quality Association	Upper/ Lower	4	7	7	2018-10-24 to 2019-07-02	94.5	1350	8.863636364	10.3
Kaweah Basin Water Quality Association	Lower	106	505	485	1956-09-04 to 2021-01-12	60	2300	17.02270991	5.2
Kaweah Basin Water Quality Association	Below Lower	159	632	609	1947-04-15 to 2021-01-12	52	1410	5.625792077	4.498645
Kaweah Basin Water Quality Association	Unknown	380	1085	1045	1941-10-15 to 2020-12-11	48	3960	9.77576632	7.098013
Kern River Watershed Coalition Authority	Upper	262	1355	1247	1950-01-09 to 2020-12-03	97	140000	7.741516869	4.2
Kern River Watershed Coalition Authority	Upper/ Lower	14	20	20	2018-11-27 to 2019-08-15	170	1900	7.12875	3.35
Kern River Watershed Coalition Authority	Lower	435	1713	1485	1939-04-15 to 2021-01-05	27	7410	5.742502992	2.9
Kern River Watershed Coalition Authority	Below Lower	663	2194	1853	1941-01-28 to 2021-01-06	4.5	13000	4.437501014	3.7
Kern River Watershed Coalition Authority	Unknown	2820	5579	5510	1923-05-23 to 2020-12-24	7.5	231000	5.281326981	2.5

Table 5-3b. Summary Statistics for TDS for All Data (GQTM and Publicly Available Data)									
Coalition	Depth Zone	TDS							
		Number of Individual Wells with TDS Results	Total Number of TDS Samples	Number of TDS Detections	TDS Sample Date Range	TDS Range Minimum (mg/L)	TDS Range Maximum (mg/L)	Average Detectable TDS (mg/L)	Median Detectable TDS (mg/L)
Kings River Watershed Coalition Authority	Upper	632	2516	2094	1946-09-20 to 2021-01-07	28	63600	9.498373586	5.9
Kings River Watershed Coalition Authority	Upper/ Lower	16	31	31	2018-10-18 to 2019-06-28	78	720	8.641176471	6.5
Kings River Watershed Coalition Authority	Lower	490	1813	1728	1951-08-14 to 2020-11-17	2.7	6020	5.36526115	5
Kings River Watershed Coalition Authority	Below Lower	380	1584	1539	1929-09-25 to 2021-01-11	32	88000	5.131951338	4.3
Kings River Watershed Coalition Authority	Unknown	937	1959	1770	1929-09-25 to 2021-01-04	48	116000	6.631838072	3.999548
Westlands Water Quality Coalition	Upper	210	567	302	1951-08-13 to 2020-06-24	282	56500	54.67700586	16
Westlands Water Quality Coalition	Upper/ Lower	3	3	3	2020-06-24 to 2020-06-24	780	4000	26.3	34
Westlands Water Quality Coalition	Lower	42	93	56	1951-08-13 to 2010-07-08	487	3940	2.772985714	1.9
Westlands Water Quality Coalition	Below Lower	723	1575	868	1951-04-16 to 2015-09-17	160	6230	1.129623932	0.384
Westlands Water Quality Coalition	Unknown	389	596	519	1929-09-25 to 2020-05-26	151	49900	3.918280637	0.63

5.2. Distribution of Nitrate in Groundwater

The spatial distribution of nitrate in groundwater can be shown in multiple ways. For the purpose of this Five-Year Assessment Report, the spatial distribution of nitrate is illustrated looking at GQTM data alone and combined with other publicly available sourced data. Average nitrate over time and the most recent nitrate samples are shown for GQTM wells in order to observe the distribution of nitrate in groundwater across the CVGMC area. The ambient nitrate in the Upper Zone (described in Section 3-7) is estimated for this report using the combination of data sources.

5.2.1. CVGMC and Individual Coalitions' GQTM Data

Each of the ten coalitions in the CVGMC have collaborated to combine their monitoring data into one DMS. This database houses all the nitrate and TDS data for the GQTM wells in these coalitions. The spatial distribution of these data is presented for average nitrate over the period of record (typically 2018 through 2020) and for the most recent nitrate sample per well in the series of figures for **Figure 5-1** and **5-2**, respectively. **Figure 5-1a** shows the average nitrate conditions in GQTM wells for the entire CVGMC area. These average and most recent nitrate values in the GQTM wells are overlain by existing HVAs and irrigated agriculture (from DWR's 2018 land use coverage) in **Figures 5-1b** and **5-2b,** and **Figures 5-1c** and **5-2c**.

These series of figures (**Figures 5-1** and **5-2**) indicate that there are higher nitrate conditions scattered throughout portions of the Valley Floor, but there is also much variability. The HVAs shown on the maps (**Figures 5-1b** and **5-2b**) further illustrate the variability of nitrate in groundwater within the CVGMC area. Although there are some wells that have higher nitrate conditions within the HVA, other wells located within HVA areas have low nitrate levels. Within each coalition in CVGMC, there is typically more than one GQTM well within the each HVA area. Irrigated agriculture, based on DWR's most recent 2018 land use coverage, is also shown on these maps (**Figures 5-1c** and **5-2c**) to further illustrate the variability of nitrate conditions within land used for farming.

5.2.2. CVGMC and Other Data Sources

Combining the GQTM nitrate data with the other publicly available data helps to show a comprehensive view of nitrate conditions within the groundwater underlying the CVGMC area. **Figure 5-3** shows the spatial distribution of nitrate conditions within the CVGMC area, including areas outside the Central Valley Floor (although data outside the Valley Floor are sparse). The nitrate conditions in **Figure 5-3** show the most recent sample for every well that has a nitrate sample (either from the GQTM network or from publicly available wells) and does not discriminate between wells completed in various depth zones (or wells with unknown depth completion). This map helps show some more distinctive patterns of higher and lower nitrate levels within the CVGMC area. For example, there are some areas on the eastern portion of the Valley floor that have elevated nitrate levels; a narrow central strip running north-northwest to south-southeast shows lower nitrate levels. This map still provides evidence of highly variable conditions, with high and low nitrate concentrations sometimes plotting right next to each other. The following series of figures associated with **Figure 5-3** zoom in to three portions of CVGMC (north, central, and south) and overlay the most recent nitrate value in all wells with existing HVAs and irrigated agriculture (from DWR's 2018 land use coverage). These maps suggest that elevated nitrate conditions correspond to HVA areas, but not necessarily to irrigated agriculture.

5.2.3. CVGMC and Other Data Sources (with Known Construction in the Upper Zone)

The spatial distribution of ambient nitrate within the Upper Zone is of interest within the CVGMC area. There are several factors to consider when spatially representing ambient nitrate conditions in the Upper Zone. The methodology presented herein describes the processes developed to achieve the most representative and accurate representation of current nitrate conditions within the ten coalitions' boundaries.

There are several parameters and choices to consider while developing a map of ambient nitrate for the Upper Zone. These parameters include: the utilization of the actual nitrate data, and the parameters selected during the kriging spatial interpolation process. These choices involve those made while temporally declustering data, and while spatially declustering data. Each of these topics are described fully in the sections below.

Utilization of Groundwater Quality Data

Nitrate data is reported using different methods within the GQTM and public GAMA databases. In order to reconcile the two databases for use in the ambient nitrate analysis, several steps were taken to ensure that the most accurate and reliable data were used.

The first step involves well depth assignment. The ambient nitrate analysis considers only wells that are categorized into the "Upper Zone" depth category. This depth designation is based on the following criteria:

- Well depth and bottom of screened interval depth
- Well type
- Estimated well depth based on DWR's Well Completion Report spatial representation of statistics[19]
- Comparison of the well's actual or estimated depth with the CV-SALTS delineation of the bottom of the Upper Zone

[19] As accessible using DWR's Well Completion Report Map Application (https://www.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37), accessed March, 2021.

Wells from the GQTM dataset have reliable depth information, so depths from those wells are easily compared to the bottom of the CV-SALTS-defined Upper Zone using GIS mapping techniques. When the wells have depths above the defined Upper Zone bottom, those wells are placed in the Upper Zone. If the GQTM wells have depths that are completed below the bottom of the Upper Zone, they are not used for the ambient nitrate analysis for the Upper Zone.

The public dataset does not always have reliable depth information. For wells coming from the public dataset that do not have well depths or screened interval data, the well type is used as a proxy. In this case, all domestic wells are categorized into the Upper Zone (as the depths of domestic wells are what the CV-SALTS relied on most heavily for developing the depth of the Upper Zone), while other well types were assigned an estimated depth based on DWR's Well Completion Report spatial representation of well depth statistics, as available. DWR provides a one-mile grid mapping (based on Public Land Survey System (PLSS) sections) of the general statistics of well depths based on well types (well types include domestic, industrial, irrigation, municipal, and monitoring). Although this coverage has its own limitations (e.g., data and application are subject to change, attribute tables may include missing and duplicate records, incorrect values, and limited spatial resolution). The estimated depth was assigned based on well type and DWR well completion report statistics of mean well depth for the PLSS section that the well falls within. Once an estimate of well depth is assigned to the well, it is then plotted using GIS. Well depths are compared to the GIS coverage of the Upper Zone, which consists of the bottom of the vadose zone to the top of the Lower Zone, as defined by CV-SALTS, and placed in their appropriate well depth category.

Once all of the nitrate data has been categorized by depth to limit the dataset by wells within the Upper Zone, the groundwater concentration sample data are then further scrutinized and standardized. As described in other sections of this report, the public GAMA data went through a QA/QC process to handle questionable measurements. This helped to significantly clean up the dataset (essentially removing erroneous data from the dataset that could potentially skew the spatial interpolation incorrectly). Beyond this QA/QC process, however, the methodology of reporting non-detects is still an outstanding difference between the CVGMC-based data versus the various public entity-reported data. There are multiple methods that the GAMA public data use to represent non-detect nitrate sample results, sometimes entering the value of the reporting limit within the "value" field with a qualifier entered as "<"; other times there are non-detects in the public record listed with a value of "0" with or without a reporting limit (RL) in the "RL" field.

Non-detect nitrate sample entries were standardized and quantified for purposes of data utility[20]. The spatial interpolation process known as kriging was used for the analysis of ambient

[20] There is uncertainty associated with assigning concentration values to non-detect samples, because it assumes there actually is a concentration greater than 0 in the sampled water. The methodology incorporated in the ambient analyses attempts to compensate for this limitation by providing nitrate levels, which allow for lower concentrations to zero concentration to all be contained within the lowest nitrate level (<=2.5 mg/L as N).

nitrate. Spatial interpolation is a way to construct new values based on the range of a dataset (actual data), in this case used for the analysis of ambient nitrate. The specific method of interpolation used is known as kriging. This method relies on numerical values of nitrate to make its calculations and excluding non-detect nitrate levels could result in an artificially higher ambient nitrate level. A sample that returned a non-detect nitrate level should not be discarded simply because its actual low concentration is not quantified. Because there is still value in non-detect samples, the method of utilizing half of the reporting limit was adopted when the reporting limit was known (when the reporting limit was unavailable, the nitrate value was assumed to be low, and given an arbitrary value of 0.0225 mg/L as N). Laboratory and EPA methodology of nitrate concentration level measurement in water samples has not changed significantly in the last 20 years, which supports quantifying non-detect samples with a low value for recent nitrate data.

Declustering Data

Declustering is a tool employed to better represent data and reduce bias. Declustering data temporally and spatially are important steps to further ensure the most representative and reliable dataset is used for the ambient nitrate analysis. Temporal declustering reduces bias over time by reducing the relative weight of individual sampling points within one year when multiple samples are taken within a short amount of time compared to other years when little to no monitoring is performed on a particular well. The approach of using an annual temporal declustering parameter was also used in previous CV-SALTS projects (including the high-resolution salt and nitrate mapping), and for multiple Nitrate Control Program Management Zone Preliminary Management Zone Proposals. The time periods selected to represent current ambient conditions were Post-2000 and Post-2010. These two periods are selected for the temporal declustering process to ensure that only recent data are used (i.e., no historic data that has limited validity today), and to ensure that sufficient control points are available for the kriging analysis. Time-series data from individual wells are summarized (using the average) on an annual basis and then each annual value is summarized (again using the average) over the time period selected (Post-2000 or Post-2010).

Spatial declustering is employed to achieve more representative statistics and to better approximate the spatial distribution of variables. In this case, the spatial declustering of nitrate is used to reduce the weight of individual wells that are closely spaced. The spatial distance of 1,000 feet was selected for spatial declustering of nitrate data within the CVGMC area[21]. This helped reduce bias when multiple Upper Zone wells were within 1,000 feet of each other. Wells

[21] Other spatial declustering levels were tested including 1-mile and ½ mile levels. Analyzing the spatial area associated with the five nitrate levels associated with each declustering level indicated that a declustering level of 1,000 feet obeyed the general pattern of nitrate levels but provided more and sufficient resolution for the purposes of this assessment.

with temporally declustered nitrate values that were located within 1,000 feet of each other were summarized (using the average) using their latitude and longitude coordinates.

Spatial Interpolation (Kriging)

Once the nitrate data is declustered temporally and spatially, the spatial interpolation (kriging) occurs. There are several parameters associated with this geostatistical approach to represent the spatial distribution of ambient nitrate in groundwater. Since the variability of nitrate in groundwater has already been mapped (**Figures 5-1, 5-2, and 5-3**) in this regional view, it is not appropriate or accurate to assume that nitrate concentrations from one well would be valid in locations at greater distances. In order to restrain the distance each data control point can have, a 1.5-mile search radius was employed. This means that if no other well with nitrate data is available within 1.5 miles within the time frame of the analysis, the spatial interpolation ceases to expand and assign a value of ambient nitrate past 1.5 miles from that control point. The selection of this parameter can result in areas of unknown ambient nitrate where data gaps occur. Linear ordinary kriging was employed on the declustered dataset, which fits a linear relationship to the spatial patterns associated with changes in nitrate concentration. Other parameters such as grid spacing (0.1 mile spacing) were assigned to be small enough to allow for high resolution of the interpolated product. Additionally, nitrate data within a buffer zone of 3 miles outside the boundary of CVGMC was used in order to maximize understanding and estimate nitrate conditions along the CVGMC border.

Results of the Ambient Nitrate in the Upper Zone Analysis

Spatial interpolation is a useful technique that uses information at known locations to help estimate conditions in areas without data. Kriging is a type of spatial interpolation that uses complex mathematical formulas to estimate values at unknown points based on the values at known points. Kriging itself is a model that provides an estimated spatial coverage of conditions within a certain constrained geographic area of known data points. Ambient nitrate maps using this technique must be caveated to ensure that the viewer understands that the nitrate level in a specific area may not equal the value assigned by the kriging technique. Maps showing nitrate conditions indicate highly variable conditions in the Upper Zone, but kriging can be used as a spatial interpolation technique to help identify areas with lower or higher measured and estimated concentrations.

The **Figure 5-4a** map series show the results of the spatial interpolation (kriging) analysis on wells completed in the Upper Zone with nitrate data since 2000. The **Figure 5-4b** map series show the same kriging process, but for a more recent snapshot of time, using average nitrate data in Upper Zone wells since 2010. These maps illustrate both the coverage and the average concentration of nitrate data within the Upper Zone in the recent past. The series of maps display three zoomed in areas of CVGMC (north, central and south portions), along with an overlay of existing HVAs (**Figures 5-4a-1** through **3** for post-2000 ambient Upper Zone nitrate; and **Figures 5-4b-1** through **3** for post-2010 ambient Upper Zone nitrate) and irrigated agriculture (from DWR's most recent 2018 land use coverage) (**Figures 5-4a-4** through **6** for post-2000 ambient Upper Zone nitrate; and **Figures 5-4b-4** through **6** for post-2010 ambient Upper Zone nitrate). There is more data available and more spatial coverage when the post-2000 period is compared to the post-2010 period, but the general pattern of nitrate concentrations is similar.

5.3. Temporal Trends in Nitrate

Trends are key in understanding and projecting groundwater quality conditions. Individual wells and regions with multiple groundwater quality measurements through time provide insight into past and future groundwater conditions. This section details the methods in use to estimate and assess local and regional trends in Nitrate and TDS concentrations.

Nitrate trends are analyzed by individual well, by coalition, and by the entire CVGMC area. The regional trend analyses are categorized by land use and HVA designation. Land use designations include irrigated, urban, and other. All wells are designated a land use by the DWR's 2018 land use where possible and well type otherwise. Wells are attributed with the nearest land use type within 0.5 miles. Wells not within 0.5 miles of available land use data are designated a land use type corresponding to the well type classification rather than land use. Urban designations are applied to wells with domestic and municipal classifications. Irrigated designations are applied to wells classified as domestic/irrigation, dairy, and irrigation wells. Other designations apply to monitoring, observation, and unknown wells. Attaching land uses to wells allows a regional analysis of individual wells by associated equivalent land use types.

5.3.1. CVGMC GQTM Network Wells: Time Series Plots

Nitrate time series plots are generated for all GQTM wells, located in Appendix A. The time series plots display concentrations through time in addition to available information on the well's data source, depth, depth category, period of record, and number of measurements. GQTM time series plots will also display post-2000 Mann-Kendall results, but this analysis requires additional data and results will be added when minimum data criteria are met.

5.3.1.1. Parametric statistical analyses of trends

Nitrate trends are analyzed both parametrically and non-parametrically. Parametric trends assume a defined numerical relationship between the measured quantity and time, as well as normally distributed errors between the modeled and measured data. Parametric trends are estimated in GQTM wells and public wells with known construction in the Upper Zone using a linear regression model. Trends are analyzed only in wells with 3 or more data points, as any 2 points can be fit perfectly with a line. The coefficient of determination (R^2) is calculated for all trends to assess the linear regression model's fit to the data. R^2 values range from 0 to 1, with values closer to 1 representing better model fits. Linear trends with R^2 values less than 0.5 were not considered. Water quality changes can be seasonal, rapid, or otherwise not captured by a linear regression model, so these trends are only an approximation of changes in concentration over the period of record.

GQTM wells with linear trends meeting these criteria are displayed in **Figure 5-5**. These trends are categorized by best-fitting linear slope with darker shades of green and red representing greater rates (>0.5 mg/L/yr as N) of decreasing and increasing trends, respectively. Wells with trends with linear rates of 0 mg/L/yr were considered stable and are represented by yellow dots. Increasing, stable, and decreasing linear trends are distributed through northern, central, and southern regions of the CVGMC. Wells with trends not meeting minimum R^2 criteria are represented by grey dots. These trends are summarized by coalition and land use designation within **Table 5-4**.

Table 5-4. Summary of Parametric Nitrate Trends in GQTM Wells with 3+ Samples

Coalition	Land Use	Number of GQTM Wells			
		Insufficient Evidence of Linear Trend ($R^2 < 0.5$)	Decreasing Linear Trend	Stable Linear Trend	Increasing Linear Trend
Buena Vista Coalition	Irrigated	1	2	2	2
	Urban				
Cawelo Water District Coalition	Irrigated	11	1		1
	Urban				
East San Joaquin Water Quality Coalition	Irrigated	4	4	1	2
	Urban				
Grassland Drainage Area Coalition	Irrigated	1	2		2
	Urban				
Kaweah Basin Water Quality Association	Irrigated	2	1		5
	Urban	3			2
Kern River Watershed Coalition Authority	Irrigated	8	3	2	12
	Urban				
Kings River Watershed Coalition Authority	Irrigated	15	5	4	11
	Urban	4			2
Westlands Water Quality Coalition	Irrigated	4	3		3
	Urban				
Westside San Joaquin River Watershed Coalition	Irrigated	3	6		6
	Urban				
Westside Water Quality Coalition	Irrigated	1			4
	Urban				

Public well water quality data span a wider date range than GQTM data and are assessed over two periods of records. Full records are analyzed for wells with any data before 2000. These long-term trends are shown in **Figure 5-6**. Long-term linear trends in nitrate are only distributed through northern and central CVGMC, with mostly increasing trends in the northern region and decreasing trends in the central region.

Trends are additionally analyzed in all public upper zone wells with 3 or more data points since 2000. These recent trends are displayed in **Figure 5-7a**. Wells with recent trends are clustered in northern and central regions. Compared to long-term trends, recent increasing and decreasing trends are more evenly distributed, including in the southern region. Ninety-one percent of nitrate measurements on record were collected since 2000, so there are more trends in the post-2000 map compared to the full record map. Recent linear trends in GQTM and public Upper Zone wells are both displayed in **Figure 5-7b** with GQTM wells representing post-2018 trends.

5.3.1.2. Non-parametric statistical analyses of trends

Both Mann-Kendall and Theil-Sen non-parametric analyses are performed to characterize trends non-parametrically. Mann-Kendall analyses determine whether statistically significant increasing or decreasing monotonic trends exist (Mann, 1945; Kendall, 1975). Once a significant trend is identified, a Theil-Sen slope analysis is performed to quantify the magnitude of the trend. The Theil-Sen analysis calculates the slope between all possible pairs of points and uses the median slope as the estimate of the trend (Theil, 1950; Sen, 1968; Gilbert, 1987). Only trends in datasets with at least 8 points and with a 95% trend confidence were considered. Trends were also analyzed over the same two periods of record as the Upper Zone parametric analysis, with long-term trends in wells with data preceding 2000 and recent trends considering post-2000 data only.

GQTM wells were not included in the non-parametric analysis because of the requirement to analyze only wells with at least 8 data points. **Figure 5-8** displays the results of the long-term Mann-Kendall and Theil-Sen nitrate trend analyses on wells with known construction in the Upper Zone. Statistically significant Mann-Kendall trends have been subdivided according to the Theil-Sen slope, with slopes above or below 0.5 mg/L/yr as N. The results of the long-term non-parametric analysis are analogous to the long-term parametric analysis, in that there are predominantly wells with increasing trends in the northern regions, decreasing trends in central regions, and insufficient evidence of trends in southern regions. **Figure 5-9** shows the results of the post-2000 non-parametric analysis. Recent trends are similar to long-term trends with a greater distribution of wells and slightly more decreasing trends in central and southern regions.

5.3.2. Other Data Sources (Known Construction, Upper Zone): Time Series Plots

Nitrate time series plots are generated for all public wells with known construction in the Upper Zone, located in **Appendix B**. The time series plots display concentrations through time in addition to available information on the well's data source, depth, depth category, period of record, number of measurements, and results of the post-2000 Mann-Kendall trend analysis.

5.3.3. Regional Trends CVGMC GQTM Wells and Other Wells with Known Upper Zone Completion

Trends are analyzed regionally by combining all GQTM and Upper Zone public well Nitrate concentration measurements within each coalition. The regions' data are then subdivided by the land use associated with each well. The regional datasets encompass a wide range of Nitrate concentrations and are difficult to assess quantitatively given the high variability. A Mann-Kendall analysis is therefore performed on each regional dataset to identify whether statistically significant trends are exhibited for the full record and post-2000 data. These analyses are subject to the same requirement of at least 8 measurements, so results were not available for all coalitions' land use types. Results of the regional analyses are shown in **Table 5-5**.

Table 5-5. Summary of Non-Parametric Nitrate Trends in All Upper Zone Wells

Coalition	Trend Period	Mann-Kendall Trends by Land Use and HVA			
		Irrigated	Urban	Other	HVA
CVGMC	Full Record	No Trend	Decreasing	No Trend	No Trend
	Post-2000	Decreasing	Decreasing	No Trend	Decreasing
Buena Vista Coalition	Full Record	No Trend	N/A*	N/A	No Trend
	Post-2000	No Trend	N/A	No Trend	No Trend
Cawelo Water District Coalition	Full Record	Increasing	N/A	N/A	No Trend
	Post-2000	Increasing	N/A	N/A	Increasing
East San Joaquin Water Quality Coalition	Full Record	Decreasing	No Trend	No Trend	No Trend
	Post-2000	Decreasing	No Trend	No Trend	Decreasing
Grassland Drainage Area Coalition	Full Record	No Trend	N/A	N/A	Decreasing
	Post-2000	No Trend	N/A	N/A	Increasing
Kaweah Basin Water Quality Association	Full Record	Decreasing	Increasing	N/A	No Trend
	Post-2000	Decreasing	No Trend	N/A	No Trend
Kern River Watershed Coalition Authority	Full Record	Increasing	Decreasing	No Trend	Increasing
	Post-2000	Increasing	Decreasing	No Trend	Increasing
	Full Record	No Trend	Decreasing	N/A	No Trend

Table 5-5. Summary of Non-Parametric Nitrate Trends in All Upper Zone Wells

Coalition	Trend Period	Mann-Kendall Trends by Land Use and HVA			
		Irrigated	Urban	Other	HVA
Kings River Watershed Coalition Authority	Post-2000	No Trend	Decreasing	N/A	No Trend
Westlands Water Quality Coalition	Full Record	Increasing	N/A	N/A	Increasing
	Post-2000	No Trend	N/A	N/A	No Trend
Westside San Joaquin River Watershed Coalition	Full Record	Increasing	No Trend	No Trend	No Trend
	Post-2000	Increasing	No Trend	No Trend	No Trend
Westside Water Quality Coalition	Full Record	Increasing	N/A	No Trend	Increasing
	Post-2000	Increasing	No Trend	No Trend	Increasing

*N/A applies to regions without enough data to perform analysis

5.3.3.1. Nitrate Trends related to Land Use

Regional trends in **Table 5-5** differ due to the overlying land use associated with the wells incorporated in the analyses. Analysis of post-2000 data for the entire CVGMC shows statistically significant decreasing trends for irrigated and urban land uses, while no significant trends exist in other regions. Despite overall decreasing recent nitrate concentrations in all wells located on irrigated land in the CVGMC boundary, separate analysis of wells within each coalition shows increasing concentrations on irrigated lands in four coalitions. In all instances of a change in trend from long-term to recent records, trends either improved (i.e., increasing to no trend, or no trend to decreasing) or remained stable.

5.3.3.2. Nitrate Trends related to HVAs

Wells are selected within each coalition's provided HVA boundaries and incorporated in regional HVA analyses. The full record of data exhibits no statistically significant trend, but recent data show decreasing trends. This may suggest trends were increasing historically but decreasing more recently, resulting in no significant monotonic trend for the entire record. In two cases, recent data exhibit increasing trends despite long-term decreasing or insignificant trends. This may be the result of isolated locations of increasing nitrate concentrations, as concentrations are decreasing overall recently.

5.3.4. Evaluation of Uncertainty

Uncertainty refers to confidence in an outcome or result given that there is imperfect or unknown information that is used to generate the result. In the case of the characterization of the concentration of nitrate in groundwater, or understanding trends in concentration, uncertainty is generated primarily by observation uncertainty and measurement error. Observation uncertainty refers to sampling error, or the inability to sample appropriately. Measurement error results from an inability to correctly determine the concentration of a constituent, in this case an analytical instrument is unable to make an accurate measurement of the constituent, particularly at low concentrations. The characterization of nitrate concentration in groundwater clearly suffers from both. Wells were not placed with the goal of estimating the concentration of nitrate in the groundwater across a region. As a result, those wells exhibit a degree of clustering that can bias estimates of average concentration. Also, methods to measure the concentration of nitrate have a method detection limit and reporting limit that do not allow an accurate measurement (or any measurement) of low concentrations.

The uncertainty in the concentration of nitrate in groundwater due to biased spatial sampling (uneven distribution of wells) was accounted for using spatial declustering of the data. Declustering weights data that are in proximity to give those data a lower impact on the estimate of the mean. Trends were determined using Mann Kendall and Theil-Sen tests which utilize a probabilistic framework to determine the presence and magnitude of trends in concentration. The probabilistic framework incorporates a quantification of uncertainty in terms of the probability that a trend exists. Unfortunately, the analyses were unable to incorporate methods to account for non-detects in the nitrate data meaning that there will remain uncertainty about the mean concentration of nitrate, and trends in nitrate concentration as a result of measurement uncertainty. Statistical methods are available to account for non-detects and these can be used in the future if appropriate.

5.3.5. Summary

The well-by-well and regional parametric and non-parametric trend analyses on the network of GQTM and Upper Zone wells with publicly available data present a complex network of increasing, decreasing, and stable trends. While more individual wells and coalitions show evidence of increasing Nitrate concentrations, overall concentrations are declining or stable in irrigated, urban, and other regions within the entire CVGMC.

5.4. Distribution of TDS in Groundwater

The spatial distribution of TDS in groundwater is shown in multiple ways within this section. For the purpose of this Five-Year Assessment Report, the spatial distribution of TDS is illustrated with respect to GQTM data alone and combined with other publicly available sourced data. Average TDS over time and the most recent TDS samples are shown for GQTM wells in order to observe the distribution of TDS in groundwater across the CVGMC area. Ambient TDS in the Upper Zone (depth defined in Section 3-7) is also estimated for this report using the combination of data sources.

5.4.1. CVGMC and Individual Coalitions' GQTM Data

The DMS houses all the nitrate and TDS data for the GQTM wells in the ten CVGMC coalitions. The spatial distribution of these data is presented for average TDS over the period of record (typically 2018 through 2020) and for the most recent TDS sample per well in **Figures 5-10** and **Figures 5-11**, respectively.

These two figures indicate that there are higher TDS conditions scattered throughout portions of the Valley Floor, but there is also much variability. The HVAs shown on the maps further illustrate the variability of TDS in groundwater within the CVGMC area, because although there are some wells that have relatively higher TDS conditions within the HVA (above 1,000 mg/L), other wells located within HVA areas have low TDS levels (less than 250 mg/L). Within each coalition in CVGMC, there are typically more than one GQTM well within the HVA area. Irrigated agriculture, based on DWR's most recent 2018 land use coverage, is also shown on these maps to further illustrate the variability of TDS conditions within land used for farming.

5.4.2. CVGMC and Other Data Sources

Combining the GQTM TDS data with the other publicly available data helps to show a more comprehensive view of TDS conditions in groundwater within the CVGMC area. **Figure 5-12** shows the spatial distribution of TDS conditions within the CVGMC area, including areas outside the Central Valley Floor (although data outside the Valley Floor are sparse and not representative of the potential impacts of irrigated agriculture on groundwater quality). The TDS conditions in **Figure 5-12** show the most recent sample value for every well that has a TDS sample (either from the GQTM network or from publicly available wells) and does not discriminate between wells completed in various depth zones (or wells with unknown depth completion). Distinctive patterns of higher and lower TDS levels within the CVGMC are shown on this map. For example, there are many areas on the western portion of the Valley floor that have elevated TDS levels; most wells on the eastern side of the Valley have lower TDS levels. This map still provides evidence of highly variable conditions, with high and low TDS concentrations sometimes plotting right next to each other. Elevated TDS conditions do not clearly correspond to HVA areas or irrigated agriculture land use.

5.4.3. CVGMC and Other Data Sources (with Known Construction in the Upper Zone)

The same methodology of data utilization, declustering and kriging (a type of spatial interpolation was performed for wells completed within the Upper Zone with recent TDS data (Section 5.2.3). **Figures 5-13a** and **13b** show the results of the spatial interpolation analysis for developing the ambient TDS conditions in the Upper Zone for data since 2000 and 2010, respectively. Similar to the nitrate ambient maps, this map series of ambient TDS illustrate both the coverage and average estimated concentration of TDS data within the Upper Zone in the recent past. There is more data available and more spatial coverage when the post-2000 period is compared to the post-2010 period, but the general pattern of TDS levels is similar.

5.5. Temporal Trends in TDS

Temporal trends in TDS concentrations were analyzed using the same methodology as trends in nitrate (**Section 5.3**).

5.5.1. CVGMC GQTM Network Wells: Time Series Plots

TDS time series plots are generated for all GQTM wells, located in **Appendix C**. The TDS time series plots have the same format as the Nitrate time series plots in **Appendix A**, including available information on the well's data source, depth, depth category, period of record, and number of measurements. There is an attribute for results of the Mann-Kendall trend analysis as the GQTM wells reach the minimum requirements of eight (8) measurements for the non-parametric analysis.

5.5.2. Other Data Sources (Known Construction, Upper Zone)

TDS time series plots are additionally generated for all Upper Zone wells with publicly available data and are in **Appendix D**. Some of these wells meet the minimum data requirements for a Mann-Kendall trend analysis and the associated results are included in the time series plots where applicable.

No GQTM wells currently have the minimum 3 TDS measurements to perform a parametric analysis.

Parametric trends in TDS concentrations are analyzed for public wells with known construction in the upper zone. Trends are analyzed over the same long-term and post-2000 periods of record, and again only wells with linear trends with an R^2 of at least 0.5 are considered. Long-term parametric trends in wells in the Upper Zone are displayed in **Figure 5-14**. Wells with long-term parametric trends are distributed mostly in northern and central regions and contain a varied mix of increasing and decreasing concentrations, with more increasing trends overall. The post-2000 Upper Zone results are shown in **Figures 5-15**. The post-2000 trends are varied similarly to long-term trends, but with more well coverage in southern regions and an overall greater number of wells with concentrations decreasing at rates exceeding 25 mg/L/yr.

Mann-Kendall and Theil-Sen non-parametric analyses are also performed on the long-term and post-2000 TDS datasets. **Figure 5-16** shows the long-term non-parametric trends in TDS concentrations, with predominantly increasing trends and many wells with no statistically significant monotonic trends. Recent TDS trends in **Figure 5-17** are more variable, with a greater number of stable and decreasing trends overall compared to the long-term trends.

Mann-Kendall trends in TDS concentrations were also analyzed regionally by combining all data of similar land use or HVA designation within each coalition. **Table 5-6** summarizes the results of the regional TDS trend analyses. For all land use types and HVA, TDS concentrations are increasing in the CVGMC region. Both parametric and non-parametric analyses of Upper Zone wells show mostly lower rates of increasing trends.

Table 5-6. Summary of Non-Parametric TDS Trends in All Upper Zone Wells

Coalition	Trend Period	Mann-Kendall Trend by Land Use and HVA			
		Irrigated	Urban	Other	HVA
CVGMC	Full Record	Increasing	Increasing	Increasing	Increasing
	Post-2000	Increasing	Increasing	Increasing	Increasing
Buena Vista Coalition	Full Record	No Trend	N/A*	No Trend	No Trend
	Post-2000	Increasing	N/A	No Trend	N/A
Cawelo Water District Coalition	Full Record	Increasing	N/A	Increasing	N/A
	Post-2000	No Trend	N/A	Increasing	N/A
East San Joaquin Water Quality Coalition	Full Record	Increasing	Increasing	No Trend	Increasing
	Post-2000	No Trend	No Trend	N/A	Decreasing
Grassland Drainage Area Coalition	Full Record	Decreasing	N/A	N/A	No Trend
	Post-2000	Increasing	N/A	N/A	Increasing
Kaweah Basin Water Quality Association	Full Record	No Trend	No Trend	N/A	Increasing
	Post-2000	No Trend	No Trend	N/A	No Trend
Kern River Watershed Coalition Authority	Full Record	No Trend	Increasing	Increasing	No Trend
	Post-2000	Decreasing	Increasing	No Trend	Decreasing
Kings River Watershed Coalition Authority	Full Record	Increasing	Increasing	N/A	Increasing
	Post-2000	No Trend	Increasing	N/A	Increasing
Westlands Water Quality Coalition	Full Record	No Trend	N/A	N/A	No Trend
	Post-2000	No Trend	N/A	N/A	No Trend
Westside San Joaquin River Watershed Coalition	Full Record	No Trend	Decreasing	No Trend	Increasing
	Post-2000	No Trend	No Trend	N/A	Increasing
Westside Water Quality Coalition	Full Record	Increasing	N/A	Increasing	Increasing
	Post-2000	Increasing	N/A	Increasing	Increasing

*N/A applies to regions without enough data to perform analysis

5.5.3. Summary

Trends in TDS concentrations of public wells are varied with the largest well populations exhibiting increasing trends. GQTM wells will be included in the analysis as minimum data requirements are met. While some coalitions exhibit decreasing regional trends, almost all regions, including of other land use, indicate increasing TDS concentrations.

5.6. DPR Pesticide Monitoring Data

There are many chemicals that are identified by the CA Department of Pesticide Regulation (DPR) as potential contaminants to groundwater, including the following seven major chemicals that are actively used within irrigated agriculture[22]:

1) Atrazine
2) Simazine
3) Bromacil
4) Diuron
5) Prometon
6) Bentazon
7) Norflurazon

Two additional chemicals of interest to the CVGMC related to pesticides are 1,2,3 Trichloropropane (commonly known as 1,2,3-TCP) and 1,2-Dibromo-3-chloropropane (commonly known as DBCP). These two chemicals in particular are of concern for drinking water quality, but are not actively used in irrigated agriculture currently, as they have been banned. The following section (Section 5.6) pertains to pesticide conditions within the CVGMC area.

5.6.1. Data Summary

The list of chemicals above are of concern based on DPR-defined groundwater protection areas. DPR provides the list of chemicals of concern that were used as a basis for this Five-Year Assessment, even though the General Orders regulating irrigated agriculture do not require pesticide sampling. Several of these chemical constituents have maximum contaminant levels (MCLs). The list of chemicals and their regulatory or health limits are provided in **Table 5-7** below.

[22] As provided by DPR in the California Code of Regulations (Title 3. Food and Agriculture) Division 6. Pesticides and Pest Control Operations: Chapter 4. Environmental Protection, Subchapter 1. Groundwater, Article 1. Pesticide Contamination Prevention. Section 6800. Groundwater Protection List (https://www.cdpr.ca.gov/docs/legbills/calcode/040101.htm#a6800, accessed 8/12/2021).

Table 5-7. Pesticide Chemicals and MCLs[23]			
Pesticide Contaminant	CA Primary MCL (µg/L)	Drinking Water Health Advisory Level (µg/L)	Health-Based Screening Level (µg/L)
Atrazine	1	-	-
Bentazon	18	-	-
Bromacil	-	70	-
DBCP	0.2	-	-
Diuron	-	-	2
Norflurazon	-	-	10
Prometon	-	-	400
Simazine	4	-	-
1,2,3-TCP[24]	0.005	-	-

As stated above, CVGMC coalitions are not required to sample groundwater for pesticides. Pesticide sample data for these analytes are publicly available through the GAMA Program (as described in Section 4.2). Specifically for this Five-Year Assessment report, the coalitions downloaded and compiled all publicly available groundwater quality data for the nine chemicals listed in **Table 5-7**. The number of wells and samples with pesticide data (only the chemical analytes listed above) from public sources[25] are shown in **Table 5-8**. 215,131 groundwater samples were compiled for the pesticide assessment within the CVGMC area. There may be some uncertainty associated with the quality of publicly available data, as these publicly-sourced data did not go through the same rigorous QA/QC procedures that groundwater quality samples from the GQTM network wells underwent (Section 4).

Table 5-8 reports the number of samples by pesticide chemical and for each of the ten Coalitions in CVGMC. This table provides the total number of samples of each particular chemical, along with the number of non-detectable samples and the number of samples detected above and below the standard (MCL, health advisory level, or screening level). There are no occurrences in the public record of bromacil, bentazon, norflurazon, prometon, and simazine being sampled above their standards within the CVGMC area.

[23] From the California State Water Resources Control Board (https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/Chemicalcontaminants.html, and http://www.waterboards.ca.gov/water_issues/programs/water_quality_goals/docs/wq_goals_text.pdf, accessed 8/12/2021)

[25] Public data sources of pesticide constituents of interest in groundwater were compiled from: Division of Drinking Water, Department of Pesticide Regulation, Geotracker Regulated Facilities (EDF), Groundwater Ambient Monitoring Assessment (GAMA, including local groundwater studies), and the U.S. Geological Survey.

Table 5-8 Pesticide Monitoring Data Summary by Coalition[26]

Coalition Name	Atrazine (Primary MCL = 1 µg/L)				Bromacil (Drinking Water Health Advisory Level = 70 µg/L)				Bentazon (Primary MCL = 18 µg/L)			
	Number of Non-Detect Sample Results	Number of Detected Samples Below Standard	Number of Samples Above Standard	Total Number of Samples	Number of Non-Detect Sample Results	Number of Detected Samples Below Standard	Number of Samples Above Standard	Total Number of Samples	Number of Non-Detect Sample Results	Number of Detected Samples Below Standard	Number of Samples Above Standard	Total Number of Samples
Buena Vista Coalition	58	0	0	58	26	0	0	26	13	0	0	13
Cawelo Water District Coalition	82	0	0	82	36	0	0	36	10	0	0	10
East San Joaquin Water Quality Coalition	4,967	207	1	5,175	2,381	14	0	2,395	1,226	6	0	1,232
Grassland Drainage Area Coalition	57	2	0	59	6	0	0	6	4	0	0	4
Kaweah Basin Water Quality Association	2,250	57	0	2,307	1,185	2	0	1,187	535	1	0	536
Kern River Watershed Coalition Authority	3,366	86	3	3,455	2,141	1	0	2,142	938	0	0	938
Kings River Water Quality Coalition	8,122	188	3	8,313	3,573	27	0	3,600	1,820	1	0	1,821

[26] As noted above, publicly available pesticide groundwater data has not been rigorously QA/QC-ed. As a result, there is some inherent uncertainty with the quality of these data.

Coalition Name	Atrazine (Primary MCL = 1 µg/L)				Bromacil (Drinking Water Health Advisory Level = 70 µg/L)				Bentazon (Primary MCL = 18 µg/L)			
	Number of Non-Detect Sample Results	Number of Detected Samples Below Standard	Number of Samples Above Standard	Total Number of Samples	Number of Non-Detect Sample Results	Number of Detected Samples Below Standard	Number of Samples Above Standard	Total Number of Samples	Number of Non-Detect Sample Results	Number of Detected Samples Below Standard	Number of Samples Above Standard	Total Number of Samples
Westlands Water Quality Coalition	123	1	0	124	12	0	0	12	11	0	0	11
Westside San Joaquin River Watershed Coalition	946	24	0	970	390	5	0	395	291	0	0	291
Westside Water Quality Coalition	25	0	0	25	3	0	0	3	2	0	0	2
Total in CVGMC's Central Valley Floor	**19,996**	**565**	**7**	**20,568**	**9,753**	**49**	**0**	**9,802**	**4,850**	**8**	**0**	**4,858**

Coalition Name	DBCP (Primary MCL = 0.2 µg/L)				Diuron (Health-Based Screening Level = 2 µg/L)				Norflurazon (Health-Based Screening Level = 10 µg/L)			
	Number of Non-Detect Sample Results	Number of Detected Samples Below Standard	Number of Samples Above Standard	Total Number of Samples	Number of Non-Detect Sample Results	Number of Detected Samples Below Standard	Number of Samples Above Standard	Total Number of Samples	Sum of Non-Detect	Sum of Measured Below Standard	Sum of Above Standard	Total Number of Samples
Buena Vista Coalition	253	0	0	253	26	0	0	26				0
Cawelo Water District Coalition	139	23	1	163	19	0	0	19	1	0	0	1

Coalition Name	DBCP (Primary MCL = 0.2 µg/L)				Diuron (Health-Based Screening Level = 2 µg/L)				Norflurazon (Health-Based Screening Level = 10 µg/L)			
	Number of Non-Detect Sample Results	Number of Detected Samples Below Standard	Number of Samples Above Standard	Total Number of Samples	Number of Non-Detect Sample Results	Number of Detected Samples Below Standard	Number of Samples Above Standard	Total Number of Samples	Sum of Non-Detect	Sum of Measured Below Standard	Sum of Above Standard	Total Number of Samples
East San Joaquin Water Quality Coalition	11,285	4,279	1,625	17,189	837	58	0	895	421	11	0	432
Grassland Drainage Area Coalition	54	0	0	54	5	0	0	5	4	0	0	4
Kaweah Basin Water Quality Association	3,567	2,252	272	6,091	587	493	4	1,084	261	73	0	334
Kern River Watershed Coalition Authority	9,185	2,014	939	12,138	752	17	2	771	108	0	0	108
Kings River Water Quality Coalition	11,968	12,175	7,443	31,586	1,969	964	5	2,938	1,445	358	0	1,803
Westlands Water Quality Coalition	130	1	4	135	13	0	0	13	3	0	0	3
Westside San Joaquin River Watershed Coalition	4,841	246	7	5,094	233	39	25	297	76	0	0	76
Westside Water Quality Coalition	240	0	0	240	2	0	0	2				0

Coalition Name	DBCP (Primary MCL = 0.2 µg/L)				Diuron (Health-Based Screening Level = 2 µg/L)				Norflurazon (Health-Based Screening Level = 10 µg/L)			
	Number of Non-Detect Sample Results	Number of Detected Samples Below Standard	Number of Samples Above Standard	Total Number of Samples	Number of Non-Detect Sample Results	Number of Detected Samples Below Standard	Number of Samples Above Standard	Total Number of Samples	Sum of Non-Detect	Sum of Measured Below Standard	Sum of Above Standard	Total Number of Samples
Total in CVGMC's Central Valley Floor	**41,662**	**20,990**	**10,291**	**72,943**	**4,443**	**1,571**	**36**	**6,050**	**2,319**	**442**	**0**	**2,761**

Coalition Name	Prometon (Health-Based Screening Level = 400 µg/L)				Simazine (Primary MCL = 4 µg/L)				1,2,3 TCP (Primary MCL = 0.005 µg/L)			
	Number of Non-Detect Sample Results	Number of Detected Samples Below Standard	Number of Samples Above Standard	Total Number of Samples	Number of Non-Detect Sample Results	Number of Detected Samples Below Standard	Number of Samples Above Standard	Total Number of Samples	Number of Non-Detect Sample Results	Number of Detected Samples Below Standard	Number of Samples Above Standard	Total Number of Samples
Buena Vista Coalition	18	0	0	18	67	0	0	67	281	0	0	281
Cawelo Water District Coalition	19	0	0	19	80	3	0	83	168	0	208	376
East San Joaquin Water Quality Coalition	1,297	18	0	1,315	4,855	250	0	5,105	14,490	82	2,851	17,423
Grassland Drainage Area Coalition	46	0	0	46	60	0	0	60	113	0	25	138

Coalition Name	Prometon (Health-Based Screening Level = 400 µg/L)				Simazine (Primary MCL = 4 µg/L)				1,2,3 TCP (Primary MCL = 0.005 µg/L)			
	Number of Non-Detect Sample Results	Number of Detected Samples Below Standard	Number of Samples Above Standard	Total Number of Samples	Number of Non-Detect Sample Results	Number of Detected Samples Below Standard	Number of Samples Above Standard	Total Number of Samples	Number of Non-Detect Sample Results	Number of Detected Samples Below Standard	Number of Samples Above Standard	Total Number of Samples
Kaweah Basin Water Quality Association	685	21	0	706	1,927	632	0	2,559	5,556	94	1,288	6,938
Kern River Watershed Coalition Authority	716	8	0	724	3,414	78	0	3,492	12,314	108	5,626	18,048
Kings River Water Quality Coalition	2,827	50	0	2,877	6,928	1,838	0	8,766	19,347	144	1,780	21,271
Westlands Water Quality Coalition	78	0	0	78	135	0	0	135	143	0	0	143
Westside San Joaquin River Watershed Coalition	322	8	0	330	938	50	0	988	5,073	2	819	5,894
Westside Water Quality Coalition	6	0	0	6	30	0	0	30	233	0	0	233
Total in CVGMC's Central Valley Floor	**6,014**	**105**	**0**	**6,119**	**18,434**	**2,851**	**0**	**21,285**	**57,718**	**430**	**12,597**	**70,745**

Coalition Name	Total Number of Non-Detect Pesticide Samples	Total Number of Pesticide Samples Measured Below Standard	Total Number of Samples Above Standard	Total Number of Pesticide Samples
Buena Vista Coalition	742	0	0	742

Coalition Name	Prometon (Health-Based Screening Level = 400 µg/L)				Simazine (Primary MCL = 4 µg/L)				1,2,3 TCP (Primary MCL = 0.005 µg/L)			
	Number of Non-Detect Sample Results	Number of Detected Samples Below Standard	Number of Samples Above Standard	Total Number of Samples	Number of Non-Detect Sample Results	Number of Detected Samples Below Standard	Number of Samples Above Standard	Total Number of Samples	Number of Non-Detect Sample Results	Number of Detected Samples Below Standard	Number of Samples Above Standard	Total Number of Samples

Cawelo Water District Coalition	554	26	209	789
East San Joaquin Water Quality Coalition	41,759	4,925	4,477	51,161
Grassland Drainage Area Coalition	349	2	25	376
Kaweah Basin Water Quality Association	16,553	3,625	1,564	21,742
Kern River Watershed Coalition Authority	32,934	2,312	6,570	41,816
Kings River Water Quality Coalition	57,999	15,745	9,231	82,975
Westlands Water Quality Coalition	648	2	4	654
Westside San Joaquin River Watershed Coalition	13,110	374	851	14,335
Westside Water Quality Coalition	541	0	0	541
Total in CVGMC's Central Valley Floor	**165,189**	**27,011**	**22,931**	**215,131**

5.6.2. Distribution of Key Pesticides

The spatial distribution of pesticide samples detected above their respective standard can be seen in **Figures 5-18a, b, and c**. These maps show the distribution of pesticide data above the groundwater standards overlain by existing HVAs and irrigated agriculture (from DWR's most recent 2018 land use coverage). These maps illustrate the distribution and occurrence of 1,2,3 -TCP and DBCP in groundwater throughout eight coalitions in CVGMC.

5.7. CVGMC General Mineral Data (GQTM only)

The Five-Year Assessment is primarily focused on nitrate, and secondarily on TDS, conditions within the CVGMC area. General minerals are included as part of the list of analytes sampled for GQTM wells. General mineral information is helpful for observing general chemical signatures of groundwater within certain areas. The following table (**Table 5-9**) summarizes the statistics for GQTM well general mineral sample results between 2018 and 2020. Since general minerals are sampled once every five years for GQTM wells, further analysis of general minerals will be considered for future assessments as more data become available.

Table 5-9 General Mineral Summary Statistics of GQTM Wells by Coalition											
General Mineral Analyte	Descriptor	Coalition[27]									
		BVC	CWD	ESJ	GDAC	KBWQA	KRWCA	KINGSRWCA	WSC	WSJR	WWQC
Bicarbonate as HCO3 (mg/L)	Number of Wells	10	15	34	11	24	58	92	18	25	9
	Number of Samples	10	29	35	11	37	82	169	21	25	9
	Number of Detections	10	29	35	11	37	82	167	21	25	9
	Date Range	8/8/ 2018	07/16/ 2018 to 10/10/ 2019	10/30/ 2018 to 8/6/ 2020	11/26/ 2018 to 8/1/ 2019	10/24/ 2018 to 9/9/ 2019	11/27/ 2018 to 8/29/ 2019	10/17/ 2018 to 6/28/ 2019	11/12/ 2018 to 6/24/ 2020	11/30/ 2018 to 8/24/ 2020	11/6/ 2018 to 2/11/ 2019
	Minimum concentration	29.28	26.84	82.96	63	48.8	8.9	< 3.66	69.54	120	59.78
	Maximum concentration	427	268.4	547.78	260	426	305	988.2	457.5	460	256.2
	Average Detectable Concentration	202.89	70.02	252.82	123.64	168.69	97.99	197.41	201.24	268.00	152.50
Boron (mg/L)	Number of Wells	10	15	34	11	24	58	92	18	25	9
	Number of Samples	10	30	35	11	37	82	169	21	25	9
	Number of Detections	9	25	35	11	29	73	62	21	25	9
	Date Range	8/8/ 2018	07/16/ 2018 to 10/10/ 2019	10/30/ 2018 to 8/6/ 2020	11/26/ 2018 to 8/1/ 2019	10/24/ 2018 to 9/9/ 2019	11/27/ 2018 to 8/29/ 2019	10/17/ 2018 to 6/28/ 2019	11/12/ 2018 to 6/24/ 2020	11/30/ 2018 to 8/24/ 2020	11/6/ 2018 to 2/11/ 2019

[2727] BVC – Buena Vista Coalition; CWD – Cawelo Water District Coalition; ESJ – East San Joaquin Water Quality Coalition; GDAC – Grassland Drainage Area Coalition; KBWQA – Kaweah Basin Water Quality Association; KRWCA – Kern River Watershed Coalition Authority; KINGSRWCA – Kings River Water Quality Coalition; WSC – Westlands Water Quality Coalition; WSJR – Westside San Joaquin River Watershed Coalition; WWQC – Westside Water Quality Coalition

Table 5-9 General Mineral Summary Statistics of GQTM Wells by Coalition

General Mineral Analyte	Descriptor	Coalition[27]									
		BVC	CWD	ESJ	GDAC	KBWQA	KRWCA	KINGSRWCA	WSC	WSJR	WWQC
	Minimum concentration	< 0.046	0.0167	0.02	0.74	< 0.0088	< 0.008	< 0.046	0.4	0.12	2.1
	Maximum concentration	3.4	0.75	0.18	8.1	0.368	6.5	4.3	9.6	3.3	48
	Average Detectable Concentration	1.26	0.14	0.05	4.45	0.06	0.59	0.67	3.40	0.73	12.21
Calcium (mg/L)	Number of Wells	10	15	34	11	24	58	92	18	25	9
	Number of Samples	10	30	35	11	37	82	169	21	25	9
	Number of Detections	10	30	35	11	37	82	169	21	25	9
	Date Range	8/8/2018	07/16/ 2018 to 10/10/ 2019	10/30/ 2018 to 8/6/ 2020	11/26/ 2018 to 8/1/ 2019	10/24/ 2018 to 9/9/ 2019	11/27/ 2018 to 8/29/ 2019	10/17/ 2018 to 6/28/ 2019	11/12/ 2018 to 6/24/ 2020	11/30/ 2018 to 8/24/ 2020	11/6/ 2018 to 2/11/ 2019
	Minimum concentration	13	1.59	11	100	0.979	2.8	0.99	26	26	87
	Maximum concentration	440	240	130	660	142	290	120	780	150	3500
	Average Detectable Concentration	151.00	45.50	61.89	395.45	46.41	87.69	37.77	350.05	80.00	721.89
Carbonate as CO3 (mg/L)	Number of Wells	10	15	34	11	24	58	92	18	25	9
	Number of Samples	10	29	35	11	37	82	169	21	25	9
	Number of Detections	1	4	3	1	1	10	24	0	6	0
	Date Range	8/8/ 2018	07/16/ 2018 to	10/30/ 2018 to	11/26/ 2018 to	10/24/ 2018 to	11/27/ 2018 to	10/17/ 2018 to 6/28/ 2019	11/12/ 2018 to	11/30/ 2018 to	11/6/ 2018 to

Table 5-9 General Mineral Summary Statistics of GQTM Wells by Coalition											
General Mineral Analyte	Descriptor	Coalition[27]									
		BVC	CWD	ESJ	GDAC	KBWQA	KRWCA	KINGSRWCA	WSC	WSJR	WWQC
			10/10/ 2019	8/6/ 2020	8/1/ 2019	9/9/ 2019	8/29/ 2019		6/24/ 2020	8/24/ 2020	2/11/ 2019
	Minimum concentration	< 1.8	< 1.1	< 0.72	< 2	< 1.1	< 0.23	< 1.8	< 0.72	< 2	< 1.8
	Maximum concentration	2.52	15.6	29.4	2.7	1.92	21.6	51	< 0.72	5.2	< 1.8
	Average Detectable Concentration	2.52	10.05	15.80	2.70	1.92	8.49	17.36	NA	3.57	NA
Chloride (mg/L)	Number of Wells	10	15	34	11	24	58	92	18	25	9
	Number of Samples	10	30	35	11	37	82	169	21	25	9
	Number of Detections	10	30	35	11	37	82	168	21	25	9
	Date Range	8/8/2018	07/16/ 2018 to 10/10/ 2019	10/30/ 2018 to 8/6/ 2020	11/26/ 2018 to 8/1/ 2019	10/24/ 2018 to 9/9/ 2019	11/27/ 2018 to 8/29/ 2019	10/17/ 2018 to 6/28/ 2019	11/12/ 2018 to 6/24/ 2020	11/30/ 2018 to 8/24/ 2020	11/6/ 2018 to 2/11/ 2019
	Minimum concentration	30	25	5.1	65	0.982	5.7	< 0.51	42	65	130
	Maximum concentration	1000	290	250	1100	530	800	350	1600	370	13000
	Average Detectable Concentration	299.70	97.56	40.59	455.91	48.45	119.14	40.06	541.24	181.64	2702.22
Magnesium (mg/L)	Number of Wells	10	15	34	11	24	58	92	18	25	9
	Number of Samples	10	29	35	11	37	82	169	21	25	9
	Number of Detections	9	21	35	11	35	79	168	21	25	9

Table 5-9 General Mineral Summary Statistics of GQTM Wells by Coalition

General Mineral Analyte	Descriptor	Coalition[27]									
		BVC	CWD	ESJ	GDAC	KBWQA	KRWCA	KINGSRWCA	WSC	WSJR	WWQC
	Date Range	8/8/ 2018	07/16/ 2018 to 10/10/ 2019	10/30/ 2018 to 8/6/ 2020	11/26/ 2018 to 8/1/ 2019	10/24/ 2018 to 9/9/ 2019	11/27/ 2018 to 8/29/ 2019	10/17/ 2018 to 6/28/ 2019	11/12/ 2018 to 6/24/ 2020	11/30/ 2018 to 8/24/ 2020	11/6/ 2018 to 2/11/ 2019
	Minimum concentration	< 0.046	< 0.02	1.7	31	0.0986	< 0.025	< 0.046	9.9	16	79
	Maximum concentration	180	7.35	74	290	70.6	63	48	600	180	880
	Average Detectable Concentration	29.67	1.81	20.96	133.73	19.11	5.77	12.52	249.33	52.32	237.22
Nitrate as N (mg/L)	Number of Wells	12	15	34	11	24	60	92	18	25	16
	Number of Samples	32	44	65	28	61	136	215	36	57	33
	Number of Detections	15	35	61	22	61	118	177	23	37	29
	Date Range	8/8/ 2018 to 8/6/ 2020	07/16/ 2018 to 9/24/ 2020	10/30/ 2018 to 8/6/ 2020	11/26/ 2018 to 8/27/ 2020	10/24/ 2018 to 6/24/ 2020	11/27/ 2018 to 8/31/ 2020	10/17/ 2018 to 6/26/ 2020	11/12/ 2018 to 6/24/ 2020	11/30/ 2018 to 8/27/ 2020	11/6/ 2018 to 7/30/ 2020
	Minimum concentration	< 0.099	< 0.02	< 0.04	< 0.025	0.04	< 0.028	< 0.099	< 0.04	< 0.01	< 0.057
	Maximum concentration	30	24	70	89	30.1	31	27	430	28	440
	Average Detectable Concentration	7.53	5.05	13.45	21.89	8.36	8.21	7.29	137.36	8.92	42.16
Potassium (mg/L)	Number of Wells	10	15	34	11	24	58	92	18	25	9
	Number of Samples	10	30	35	11	37	82	169	21	25	9

Table 5-9 General Mineral Summary Statistics of GQTM Wells by Coalition											
General Mineral Analyte	Descriptor	Coalition[27]									
		BVC	CWD	ESJ	GDAC	KBWQA	KRWCA	KINGSRWCA	WSC	WSJR	WWQC
	Number of Detections	4	27	35	11	36	74	148	21	23	8
	Date Range	8/8/ 2018	07/16/ 2018 to 10/10/ 2019	10/30/ 2018 to 8/6/ 2020	11/26/ 2018 to 8/1/ 2019	10/24/ 2018 to 9/9/ 2019	11/27/ 2018 to 8/29/ 2019	10/17/ 2018 to 6/28/ 2019	11/12/ 2018 to 6/24/ 2020	11/30/ 2018 to 8/24/ 2020	11/6/ 2018 to 2/11/ 2019
	Minimum concentration	< 0.91	< 0.25	0.69	1.3	< 0.075	< 0.34	< 0.91	< 1.2	< 0.13	< 0.91
	Maximum concentration	14	6	20	9	5.42	7.7	61	25	4.4	15
	Average Detectable Concentration	8.10	2.02	5.34	4.13	2.38	2.34	4.52	8.69	2.74	6.35
Sodium	Number of Wells	10	15	34	11	24	58	92	18	25	9
	Number of Samples	10	30	35	11	37	82	169	21	25	9
	Number of Detections	10	30	35	11	37	82	169	21	25	9
	Date Range	8/8/ 2018	07/16/ 2018 to 10/10/ 2019	10/30/ 2018 to 8/6/ 2020	11/26/ 2018 to 8/1/ 2019	10/24/ 2018 to 9/9/ 2019	11/27/ 2018 to 8/29/ 2019	10/17/ 2018 to 6/28/ 2019	11/12/ 2018 to 6/24/ 2020	11/30/ 2018 to 8/24/ 2020	11/6/ 2018 to 2/11/ 2019
	Minimum concentration	61	53	13	62	8.16	21	2.3	170	50	220
	Maximum concentration	960	210	220	610	198	540	910	3200	860	5100
	Average Detectable Concentration	331.10	91.84	53.77	412.91	39.55	115.43	77.25	859.05	155.16	1665.56
Sulfate (mg/L)	Number of Wells	10	15	34	11	24	58	92	18	25	9

Table 5-9 General Mineral Summary Statistics of GQTM Wells by Coalition

General Mineral Analyte	Descriptor	Coalition[27]									
		BVC	CWD	ESJ	GDAC	KBWQA	KRWCA	KINGSRWCA	WSC	WSJR	WWQC
	Number of Samples	10	30	35	11	37	82	169	21	25	9
	Number of Detections	10	30	35	11	37	81	166	21	25	9
	Date Range	8/8/ 2018	07/16/ 2018 to 10/10/ 2019	10/30/ 2018 to 8/6/ 2020	11/26/ 2018 to 8/1/ 2019	10/24/ 2018 to 9/9/ 2019	11/27/ 2018 to 8/29/ 2019	10/17/ 2018 to 6/28/ 2019	11/12/ 2018 to 6/24/ 2020	11/30/ 2018 to 8/24/ 2020	11/6/ 2018 to 2/11/ 2019
	Minimum concentration	82	3.6	3.8	350	2.85	< 0.4	< 0.4	250	34	480
	Maximum concentration	770	550	210	2800	190	1200	1600	4900	1600	11000
	Average Detectable Concentration	372.70	109.31	38.97	1541.82	39.18	219.86	62.78	2008.10	265.96	2555.56
Total Dissolved Solids (mg/L)	Number of Wells	10	15	34	11	24	58	92	18	25	9
	Number of Samples	10	30	35	11	37	82	169	21	25	9
	Number of Detections	10	30	35	11	37	82	169	21	25	9
	Date Range	8/8/ 2018	07/16/ 2018 to 10/10/ 2019	10/30/ 2018 to 8/6/ 2020	11/26/ 2018 to 8/1/ 2019	10/24/ 2018 to 9/9/ 2019	11/27/ 2018 to 8/29/ 2019	10/17/ 2018 to 6/28/ 2019	11/12/ 2018 to 6/24/ 2020	11/30/ 2018 to 8/24/ 2020	11/6/ 2018 to 2/11/ 2019
	Minimum concentration	210	160	160	1200	72.9	170	33	740	380	1300
	Maximum concentration	3800	1500	930	5200	1350	2100	2500	13000	2900	26000
	Average Detectable Concentration	1387.00	446.57	450.86	3218.18	356.13	675.85	387.34	5067.62	914.80	7588.89

6. CVGMC GQTM NETWORK REFINEMENTS

6.1. Potential Data Gap Areas

The relationship between irrigated agricultural land and groundwater quality, with particular focus on nitrate, is complex. Groundwater moves vertically and laterally, according to local and regional gradients and stresses. The current GQTM well network has been developed by the individual coalitions and approved by the Regional Board. Each coalition based their network well locations on different criteria, including representativeness[28]. The recent ambient nitrate maps can be used to identify areas within the Central Valley Floor (where most irrigated agriculture occurs) where the nitrate conditions in the Upper Zone have the most uncertainty. The ambient nitrate maps incorporate all of the GQTM wells as well as the publicly available nitrate data for wells completed in the Upper Zone. Areas outside of the 1.5-mile search radius of an Upper Zone well with recent nitrate data are described as areas of unknown recent ambient nitrate in the Upper Zone. There may be wells within those "unknown" ambient nitrate areas that are completed in lower aquifer zones or have unknown well construction but with recent or historical nitrate information.

For purposes of further exploring the relationship between irrigated agriculture and groundwater quality, areas of unknown recent ambient nitrate in the Upper Zone from the 2010 ambient analysis are filtered for those areas that overlie irrigated agriculture. The table below (**Table 6-1**) presents the acreage associated with irrigated agriculture within each of the ten Coalitions in CVGMC (using the most recent DWR land use survey from 2018), along with the number of acres of irrigated agriculture with unknown Upper Zone ambient nitrate (using the post-2010 spatial interpolation analysis of recent ambient nitrate described in Section 5.2.3). When designing their GQTM networks, coalitions had the discretion to select a representative monitoring approach over a network designed to cover a geographic grid. Many coalitions elected to use that representative approach that selected wells within monitoring areas that were representative of the diverse crop types, soil types, and nutrient/irrigation management practices used within their respective coalitions that may have potential impacts on groundwater quality. Therefore, identification of areas with unknown nitrate conditions in the Upper Zone that intersect irrigated agriculture may falsely lead to the assumption that there are significant gaps in GQTM network coverage. Coalition's GQTM workplans should be individually assessed for any applicable gaps in coverage.

The spatial distribution of these areas can be seen in **Figure 6-1**. This map shows the CVGMC region, along with the ambient post-2010 nitrate in the Upper Zone. Gray areas on this map represent portions of the Central Valley Floor with "Unknown" ambient nitrate levels from the

[28] Not every coalition used a grid-pattern to develop their network, so what may appear to be a data gap spatially, is not necessarily a data gap for groundwater conditions associated with representativeness of particular commodities of irrigated agriculture within coalitions.

post-2010 spatial interpolation exercise that intersect with irrigated agriculture (according to DWR's 2018 land use GIS coverage). The locations of active GQTM wells are overlaying these nitrate-based areas on the map, in order to see the density and distribution of GQTM wells. There are less of these areas where irrigated agriculture intersects areas without recent Upper Zone nitrate data on the east side of the Central Valley Floor compared to the west side. The Tulare Lakebed is another data gap area, but this area can be disregarded because its groundwater has been de-designated for beneficial municipal and agricultural uses[29].

Table 6-1 Data Gap Area Summary

CVGMC Coalition Name	Post-2010 Ambient Nitrate Data Gap Area in Irrigated Ag Land (DWR 2018 Land Use)	Total Irrigated Acres in Coalition (DWR 2018 Land Use)	Percent Data Gap in Irrigated Ag Land	Total Acres in Coalition	Percent Irrigated Ag within Total Coalition Area
Buena Vista Coalition	17,458	36,033	48%	252,013	14%
Cawelo Water District Coalition	8,337	34,480	24%	266,277	13%
East San Joaquin Water Quality Coalition	220,773	908,244	24%	5,519,584	16%
Grassland Drainage Area Coalition	49,013	79,724	61%	103,888	77%
Kaweah Basin Water Quality Association	125,045	236,439	53%	958,237	25%
Kern River Watershed Coalition Authority	354,180	577,681	61%	3,580,002	16%
Kings River Water Quality Coalition	302,744	939,230	32%	2,748,674	34%
Westlands Water Quality Coalition	354,198	425,758	83%	1,311,691	32%
Westside San Joaquin River Watershed Coalition	225,206	359,164	63%	1,273,763	28%
Westside Water Quality Coalition	74,674	108,240	69%	688,091	16%

[29] Information about the de-designation of the Tulare Lake bed can be found in Appendix D of the Basin Plan Amendment Staff Report for Tulare Lake Bed MUN and AGR Evaluation: https://www.waterboards.ca.gov/centralvalley/water_issues/salinity/tulare_lakebed_mun_evaluation/, accessed September 1, 2021.

6.2. Recommendations

There are 3,177 wells completed in the Upper Zone that provide recent (post-2010) nitrate data within the CVGMC area. The eastern portion of the Central Valley Floor has adequate coverage, including from GQTM network wells. All GQTM networks for CVGMC coalitions have been vetted and approved by the Regional Board to be sufficient for satisfying the requirements of the General Orders that regulate these irrigated lands. The collaboration between the ten coalitions in the southern part of the Central Valley allow for these GQTM wells to be viewed as a whole, providing a much more high-quality in-depth look at groundwater conditions on a regional scale. Based on the spatial coverage of Upper Zone groundwater data, a list of potential data gap areas are listed below from north to south:

- East of Dos Palos (approximately 7 miles east), a data gap area exists within Westside San Joaquin River Watershed Coalition, but this area is within the San Joaquin River corridor, so surface water may be utilized more than groundwater.
- West of Mendota (approximately 10 miles west and slightly south), a data gap area exists within Westlands Water Quality Coalition, but there are GQTM wells to the north and south of this data gap area.
- West of Helm (approximately 11 miles west), a data gap area exists within Westlands Water Quality Coalition on the west side of the Central Valley Floor.
- North of Huron (approximately 6 miles north), a data gap exists within Westlands Water Quality Coalition again on the west side of the Central Valley Floor.
- Southwest of Bakersfield (approximately 13 miles southwest where I-5 and Highway 223 intersect), a data gap area exists within the Kern River Watershed Coalition Authority.

DRAFT REPORT | SEPTEMBER 2021

7. BUENA VISTA COALITION GROUNDWATER FIVE-YEAR ASSESSMENT REPORT

PREPARED FOR

BUENA VISTA COALITION

PREPARED BY

7.1. GROUNDWATER QUALITY TREND MONITORING RESULTS 2020

7.1.1. GQTM Summary of 2020 Network and Sampled Wells

7.1.1.1. GQTM Network Development Background

The primary objective of the Buena Vista Coalition's (BVC) monitoring efforts is to maintain compliance with requirements of the Tulare Lake Basin General Order R5-2013-0120 (General Order), which requires the BVC to characterize water quality within the BVC region. Groundwater trend monitoring (GTM) is intended to evaluate long term trends in groundwater quality, reflective of potential impacts from irrigated agricultural practices. However, collected data are also reflective of larger aquifer characteristics and potential influences (e.g., septic systems and other dischargers). Additionally, collected data may also reflect potential longstanding impacts which are not from current land management practices.

The BVC Groundwater Quality Trend Monitoring Workplan (GTMW) network design was based off the results of the Groundwater Quality Assessment Report (GAR) and the subsequent specific groundwater quality management plans (SGQMP) informed by the GAR. The BVC GTMW network includes monitoring wells in the three GAR-identified High Vulnerability Areas (HVA) of the Coalition and is consistent with its previously approved SGQMPs. The 13-well trend monitoring network detailed in the GTMW Response was conditionally approved by the Central Valley Regional Water Quality Control Board (Regional Board) (CVRWQCB) on August 30, 2018, and initial groundwater sampling took place during August of 2018.

7.1.1.2. Well Site Locations

In addition to building off the monitoring networks of the previously established SGQMPs, the selection criteria for the monitoring wells included in the Coalition's GTMW are intended to meet the requirements identified in Attachment B, Section IV.C of the General Order, which include:

- Implementation over both high and low vulnerability areas;
- Employs shallow wells, but not necessarily wells completed in the uppermost zone of first encountered groundwater;
- Considers using wells in existing monitoring networks; and
- Consists of a sufficient number of wells to provide coverage in the BVC area so that current water quality conditions of groundwater and composite regional effects of irrigated agriculture can be assessed.

Due to the long-term monitoring requirement, it is anticipated that the well network will need to be modified over time. Necessary changes will be made to maintain a regional representation of groundwater quality.

The spatial representation of wells included in the Coalition's GTMW was designed to meet the requirements identified in Attachment B, Section IV.E of the General Order, which include:

- Representation of the variety of agriculture commodities produced within the BVC (particularly those commodities comprising the most irrigated agricultural acreage);
- The conditions discussed/identified in the GAR related to the vulnerability prioritization within the BVC; and
- The areas identified in the GAR as contributing significant recharge to urban and rural communities where groundwater serves as a significant source of supply.

As previously discussed in the BVC's submitted GTMW, a variety of factors were considered when identifying monitoring locations to be included in the GTMW network that would adequately monitor groundwater quality trends. Three HVAs within the BVC were mapped as vulnerable to groundwater quality impacts in the GAR and specific Groundwater Quality Management Plans (GQMP) were prepared for each of these areas. Each plan recommended wells to monitor groundwater quality trends within its subject area with the Shallow Groundwater GQMP identifying seven piezometers and the Southern Area GQMP identifying four deep wells. To provide additional spatial coverage within the Coalition boundary the BVC also uses two of the Buena Vista Water Storage District's (BVWSD) existing wells.

Figure 7-1 displays a map of the BVC well monitoring locations. **Table 7-1** provides General Order required well location and construction details, including: well use, sanitary seal depth, total well depth, perforated intervals, year drilled, and latitude and longitude of sampling locations. Between the 2019 and 2020 sampling periods there were no changes to the BVC GTMW network.

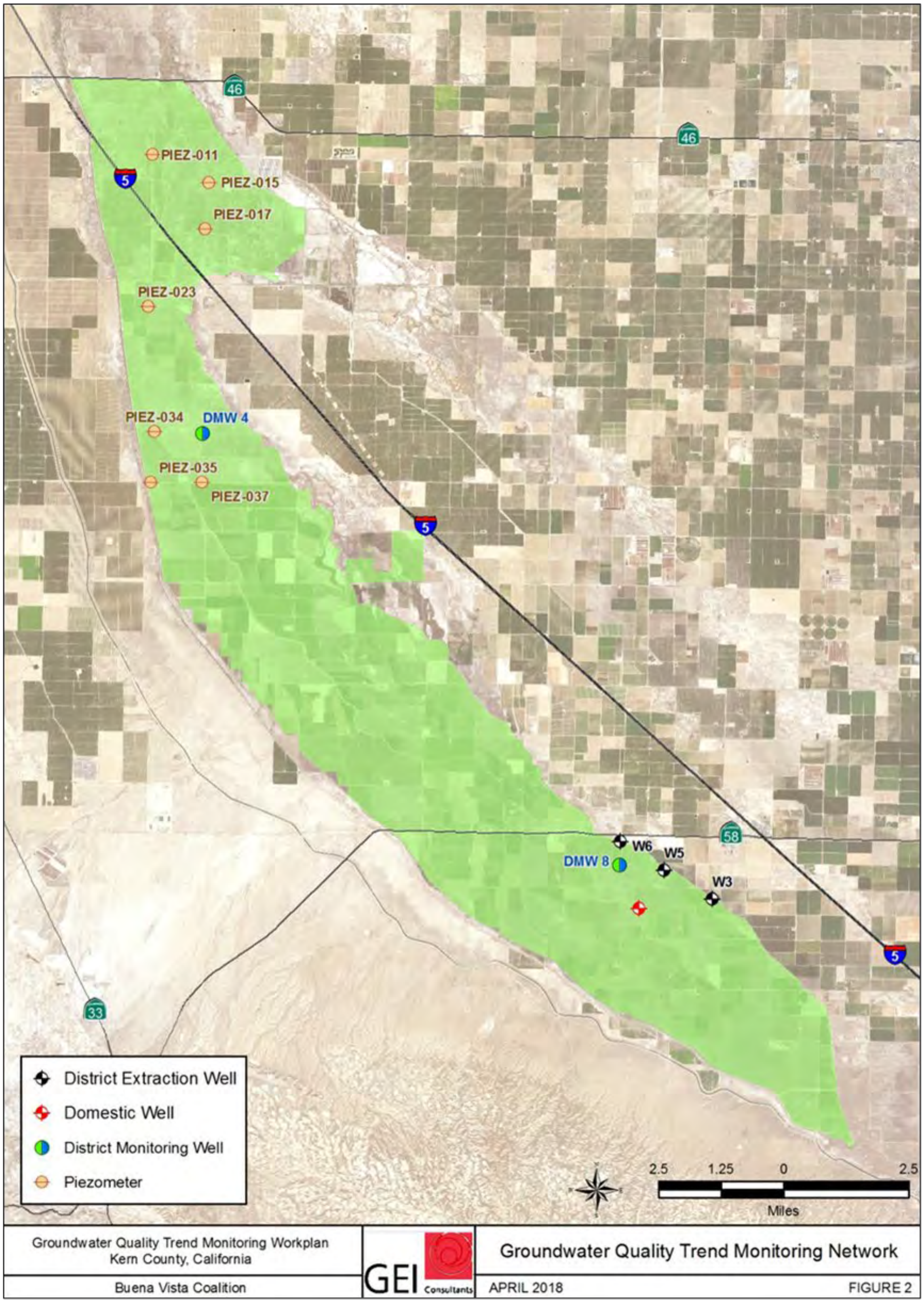

Figure 7-1. BVC GTMW Network

Table 7-1. 2020 GQTM Network Wells												
Field Point Name / GQTM Well ID	GQTM Well Name	Well Use	Well Construction Information					Latitude	Longitude	Datum	Depth to the Bottom of Upper Zone (feet)
			Seal Depth (feet)	Total Well Depth (feet)	Depth Top of Screen (feet)	Depth Bottom of Screen (feet)	Year Drilled				
BVCWD00001	W3	Irrigation	440	460	180	440	1991	35.38106	-119.415	WGS84	313.805
BVCWD00002	MW4	Irrigation	374	374	334	374	1992	35.51373	-119.598	WGS84	295.92
BVCWD00003	W5	Irrigation	475	485	195	455		35.39773	-119.433	WGS84	303.978
BVCWD00004	W6	Irrigation	470	480	210	450		35.39731	-119.448	WGS84	292.635
BVCWD00005	Domestic	Domestic						35.37812	-119.441	WGS84	298.868
BVCWD00006	MW8	Irrigation	404	404	374	404	1994	35.39054	-119.448	WGS84	298.868
BVCWD00007	PZ-11	Observation		20			1991	35.59445	-119.618	WGS84	341.319
BVCWD00008	PZ-15	Observation		20			1991	35.58645	-119.597	WGS84	340.896
BVCWD00009	PZ-17	Observation		20			1991	35.57297	-119.599	WGS84	342.448
BVCWD00010	PZ-23	Observation		20			1991	35.55035	-119.618	WGS84	329.99
BVCWD00011	PZ-34	Observation		20			1991	35.51404	-119.615	WGS84	355.336
BVCWD00012	BVCWD00012	Observation		20			1991	35.49936	-119.616	WGS84	341.854
BVCWD00013	BVCWD00013	Observation		20			1991	35.49958	-119.598	WGS84	338.169

7.1.2. Summary of Quality Assurance Evaluation for 2020 Sampling Event

7.1.2.1. Purging, sample handling, and custody

The BVC collected groundwater quality samples during the summer of 2020. BVC attempted to sample a total of 13 wells. Due to lowered groundwater levels, ultimately five irrigation wells, one domestic well, and four piezometers were able to be sampled. NO_3 as Nitrogen (Nitrate) results were compared against the Primary Maximum Contaminant Level (MCL) of 10.0 mg/L.

All 2020 samples were collected following the BVC Standard Operating Procedure (SOP) by Provost & Pritchard field crew. As described in the SOP, all wells were purged until a volume equal to or greater than three well casings was expelled and measured field parameters stabilized (less than 10% difference for three consecutive readings). Collected field parameters include pH, electrical conductivity (EC), temperature, dissolved oxygen (DO), and, when possible, depth to water (DTW). Field parameters and laboratory results are summarized in **Table 7-2**.

Once collected, samples are sealed within plastic bags and transported on wet ice directly from the field to the BSK Associates Laboratory (BSK). All samples are accompanied by a chain of custody (COC) that records changes in sample custody. Records are maintained within the contracted lab that include the checking in and out of samples during the analytical process as well as the disposal of samples following completion of the analytical process and archival. Samples are held under proper storage conditions until all analyses are conducted.

Table 7-2. 2020 GQTM Sampling Results									
Field Point Name / GQTM Well ID	GQTM Well Name	Well Use	Date Sampled	Nitrate as N (mg/L)	pH	Specific Conductance (uS/cm)	Temperature (°C)	Dissolved Oxygen (mg/L)	Depth to Water (ft)
				Lab	Field	Field	Field	Field	Field
BVCWD00001	W3	Irrigation	7/7/2020	10	7.37	2050	21.54	8.52	NR
BVCWD00002	MW4	Irrigation	7/7/2020	< 0.3	7.97	4020	20.51	9.48	48.25
BVCWD00003	W5	Irrigation	7/7/2020	7.1	7.48	1880	22.09	5.48	NR
BVCWD00004	W6	Irrigation	7/7/2020	9.5	7.56	2020	22.51	4.58	NR
BVCWD00005	Domestic	Domestic	8/6/2020	< 0.099	7.53	1020	25.41	6.33	250
BVCWD00006	MW8	Irrigation	7/7/2020	< 0.099	8.91	407	20.37	8.85	140.85
BVCWD00007	PZ-11	Observation	8/6/2020	< 0.3	7.03	3730	20.94	14.69	16.8
BVCWD00008	PZ-15	Observation	8/6/2020	6.5	7.65	8610	22.64	10.6	16.5
BVCWD00009	PZ-17	Observation	8/6/2020	< 0.5	7.26	5640	23.37	20.79	14.9
BVCWD00010	PZ-23	Observation	8/6/2020	0.24	7.11	573	23.69	17.3	14.5

NR=Not Recorded

7.1.2.2. Access and field and analytical completeness

Due to the fluctuation of groundwater conditions and changes in well suitability, the submitted GTMW network was, and continues to be, considered dynamic. Field crews were unable to successfully acquire samples from the three piezometers which were dry during the 2020 sampling timeframe. No qualified field and laboratory results occurred during the 2020 season.

Tables summarizing completeness of field and analytical testing, field quality control, and evaluation of sample hold times are available in **Table 7-3**, **Table 7-4**, and **Table 7-5**, respectively.

Table 7-3. Completeness of Field and Analytical Testing

Constituent	Test Type	Analytical Method	Matrix	Wells Planned for Sampling	Dry	Wells Sampled	Field and Transport Completeness %	Total Samples Analyzed	Analytical Completeness %
Oxygen, Dissolved	Field parameter	EPA 360.1	Ground-water	13	3	10	100.0	10	100
pH	Field parameter	EPA 150.1	Ground-water	13	3	10	100.0	10	100
Specific Conductivity	Field parameter	EPA 120.1	Ground-water	13	3	10	100.0	10	100
Temperature	Field parameter	SM 2550	Ground-water	13	3	10	100.0	10	100
Nitrate as N	Laboratory	EPA 300.0	Ground-water	13	3	10	100.0	10	100
			Total	**65**	**15**	**50**	**100.0**	**50**	**100**

Table 7-4. Completeness of Field QC

Constituent	Analytical Method	Matrix	Total Well Samples Analyzed	Field Duplicate Samples Analyzed	Field Blank Samples Analyzed	Total Samples Analyzed (well and duplicates)	Field Duplicate Completeness %	Field Blank Completeness %
Nitrate as N	EPA 300.0	groundwater	10	1	1	12	8.3	8.3
		Total	**10**	**1**	**1**	**12**	**8.3**	**8.3**

Completeness values below the acceptability requirement of 5 percent are presented in **bold**.

Table 7-5. Evaluation of Sample Hold Times						
Constituent	**Analytical Method**	**Matrix**	**Hold Time**	**Total Samples Analyzed**	**Samples Analyzed within Hold Time**	**Acceptability %**
Nitrate as N	EPA 300.0	groundwater	48 hours	12	12	100
			Total	**12**	**12**	**100**
Acceptability values below 90 percent are presented in **bold**.						

7.1.2.3. Analytical precision and accuracy

Reducing cross-contamination and measurement errors is critical to ensuring accurate sampling results. **Table 7-6** and **Table 7-7** summarize both field and laboratory accuracy quality control checks. The acceptability of field duplicates, field blanks, and laboratory controls and spikes was 100%.

Table 7-6. Evaluation of Field Duplicates and Blanks							
Constituent	**Analytical Method**	**Matrix**	**Sample Type**	**Acceptability Requirement**	**Total Samples**	**Samples within Acceptability**	**Acceptability %**
Nitrate as N	EPA 300.0	groundwater	Field Duplicate	RPD ≤ 25	1	1	100
				Field Duplicate Total	**1**	**1**	**100**
Acceptability values below 90 percent are presented in **bold**.							
Constituent	**Analytical Method**	**Matrix**	**Sample Type**	**Acceptability Requirement**	**Total Samples**	**Samples within Acceptability**	**Acceptability %**
Nitrate as N	EPA 300.0	groundwater	Field Blank	< RL or 1/5 environmental sample	1	1	100
				Field Duplicate Total	**1**	**1**	**100**
Acceptability values below 90 percent are presented in **bold**.							

Table 7-7. Evaluation of Lab Controls and Spikes							
Constituent	Analytical Method	Matrix	Sample Type	Acceptability Requirement	Total Samples	Samples within Acceptability	Acceptability %
Lab Blanks							
Nitrate as N	EPA 300.0	groundwater	Lab Blank	< RL	3	3	100
				Lab Blank Total	3	3	100
Lab Control Spikes							
Nitrate as N	EPA 300.0	groundwater	LCS	PR 90-110	3	3	100
				Lab Control Total	3	3	100
Matrix Spikes							
Nitrate as N	EPA 300.0	groundwater	MS	PR 80-120	12	12	100
				Matrix Spike Total	12	12	100
Analytical Duplicates							
Nitrate as N	EPA 300.0	groundwater	MSD/LCSD/Lab Dup	RPD ≤ 25	6	6	100
				Analytical Duplicate Total	6	6	100
Acceptability values below 90 percent are presented in **bold**.							
LCS=lab control spike; MS=matrix spike; MSD=matrix spike duplicate; LCSD=lab control spike duplicate							

7.1.2.4. Quality assurance evaluation conclusions

As demonstrated in **Tables 7-3** through **7-7**, groundwater quality results collected in 2020 reached 100% QC completeness with no qualified results. The 100% completeness exceeds the minimum completeness requirement of 90% specified in the General Order. Laboratory results, field blanks, field duplicates, and laboratory spikes also achieved 100% completeness. All results appear accurate and were reported to the proper level of precision. Much of BSK's laboratory equipment can analyze constituents to a lower level than the minimum detection and reporting levels, allowing the BVC to have confidence that adequate precision is achieved. If future sampling results deem necessary, the BVC will take corrective actions as described in the CVGMC Comprehensive Quality Assurance Plan (CQAP) to address potential issues and work to prevent them from reoccurring.

7.1.3. Five-Year Assessment Results and Discussion

Luhdorff & Scalmanini Consulting Engineers (LSCE) conducted both parametric and non-parametric analyses of Nitrate as N (Nitrate or NO_3-N) and TDS trends within the BVC primary area boundary. Methodology for each of these analyses is discussed in **Section 5**.

All of the **Section 5** figures pertinent to this individual coalition section are presented in **Appendix E**. The first figure in **Appendix E** (**Figure E-1**) displays average Nitrate conditions in

BVC's GQTM network wells for 2018-2020. Additional information regarding BVC's GQTM network can be found in **Section 7.1**. Five categories were used to describe average Nitrate conditions:

- Less than or equal to 2.5 mg/L Nitrate as N
- Greater than 2.5 mg/L to 5 mg/L Nitrate as N
- Greater than 5 mg/L to 7.5 mg/L Nitrate as N
- Greater than 7.5 mg/L to 10 mg/L Nitrate as N
- Greater than 10 mg/L Nitrate as N

Eight wells have an average Nitrate as N concentration less than or equal to 2.5 mg/L (as N). Two wells have an average Nitrate as N concentration greater than 5 mg/L – 7.5 mg/L. Two wells have an average Nitrate as N concentration above 10 mg/L.

The second figure in **Appendix E** (**Figure E-2**) displays the most recent Nitrate sample collected at each of BVC's GQTM network wells. The same five categories were used to describe Nitrate conditions as previously defined.

Eight wells show a Nitrate as N concentration less than or equal to 2.5 mg/L as N. One well shows a Nitrate concentration greater than 5 mg/L – 7.5 mg/L. Two wells have a Nitrate concentration above 7.5 mg/L – 10 mg/L. One well has a Nitrate concentration above 10 mg/L.

The third figure in **Appendix E** (**Figure E-3**) displays the most recent Nitrate sample for all wells located within the BVC primary area boundary, using the same five categories to depict Nitrate conditions.

Most wells sampled within the BVC primary area indicate Nitrate concentrations of less than 5.0 mg/L with a few scattered Nitrate samples above 10 mg/L.

The fourth figure in **Appendix E** (**Figure E-4**) displays ambient nitrate in the Upper Zone using data from 2000-2020, using the same five categories to depict Nitrate conditions.

Kriging modeling results do not completely cover BVC's primary area. Modeling results in the northern and central area of the BVC indicate low ambient Nitrate as N concentrations (<5.0 mg/L as N). Modeled ambient Nitrate as N concentrations appear to surpass 10 mg/L as N in a few isolated spots in the northern-central and southeastern edges of the Coalition boundary. The fifth figure in **Appendix E** (**Figure E-5**) shows an even more recent snapshot of ambient Upper Zone nitrate conditions, but this has less coverage compared to the post-2000 ambient nitrate map.

The sixth figure in **Appendix E** (**Figure E-6**) displays parametric Nitrate trends in the Upper Zone of the aquifer using data from 2000-2020. Analysis was only performed on upper zone wells with at least three or more Nitrate as N results. Linear regression trend results were split into five categories:

- Decreasing Nitrate as N trend (linear rate >0.5 mg/L/yr)
- Decreasing Nitrate as N trend (linear rate <0.5 mg/L/yr)
- Stable Nitrate as N (linear rate = 0 mg/L/yr)
- Increasing Nitrate as N trend (linear rate <0.5 mg/L/yr)
- Increasing Nitrate as N trend (linear rate >0.5 mg/L/yr)

BVC had six wells with sufficient data to conduct the linear regression trend analysis. Of those six wells, two wells show a mild increasing Nitrate trend (<0.5 mg/L/yr), two wells show a stable Nitrate trend, one well had a mild decreasing Nitrate trend (<0.5 mg/L/yr), and one well had a decreasing Nitrate tend (>0.5 mg/L/yr). The two wells with a mild increasing Nitrate trend are located in the northern region of the BVC. These two wells are piezometers drilled to approximately 20 feet deep, intended to monitor water quality in the perched zone of the aquifer and are not representative of the rest of the underlying aquifer. The southern region of the BVC appears to have stable or decreasing Nitrate trends.

The seventh figure in **Appendix E** (**Figure E-7**) displays non-parametric Nitrate trends in the Upper Zone using data from 2000-2020. The Mann-Kendall Test and Theil-Sen Estimator analysis were performed on Upper Zone wells with at least eight or more Nitrate samples.

Non-parametric Nitrate trend results were categorized into five categories:

- Decreasing Nitrate as N trend (T-S slope >0.5 mg/L/yr)
- Decreasing Nitrate as N trend (T-S slope <0.5 mg/L/yr)
- Stable Nitrate as N (T-S slope = 0 mg/L/yr)
- Increasing Nitrate as N trend (T-S slope <0.5 mg/L/yr)
- Increasing Nitrate as N trend (T-S slope >0.5 mg/L/yr)

Two wells within the BVC had sufficient data to conduct the Mann-Kendall Test and Theil-Sen Estimator analysis. The well in the southern section of the Coalition showed a mild increasing Nitrate as N trend (T-S slope > 0.5 mg/L/yr). The well in the northern section of the Coalition showed a stable Nitrate as N trend.

The table in **Appendix E** (**Table E-1**) provides a summary of parametric Nitrate as N trends for GQTM wells with at least three or more samples between 2018-2020. Within BVC, 1 well has insufficient evidence of a linear trend ($R^2 < 0.5$), two had a decreasing linear trend, two had a stable linear trend, and two had an increasing linear trend.

The eighth figure in **Appendix E** (**Figure E-8**) displays the most recent TDS sample collected at each of BVC's GQTM network wells. Five categories were used to describe TDS conditions:

- Less than or equal to 250 mg/L
- Greater than 250 mg/L to 500 mg/L

- Greater than 500 mg/L to 750 mg/L
- Greater than 750 mg/L to 1,000 mg/L
- Greater than 1,000 mg/L

Two wells show a TDS concentration less than or equal to 250 mg/L. Two wells show a TDS concentration greater than 500 mg/L – 750 mg/L. Six wells have a TDS concentration greater than 1,000 mg/L.

7.1.4. Five-Year High Vulnerability Area Update

7.1.4.1. Background

BVC submitted their original GAR on February 4, 2015. In response, the Central Valley Regional Water Quality Control Board (Regional Board) requested revisions to the originally proposed HVAs. BVC submitted revised HVAs to the Regional Board on March 18, 2015.

7.1.4.2. 5-Year HVA Update Methodology

BVC assessed all publicly available data via the GAMA Geotracker database to conduct its five-year HVA update. This data set includes the GTM results from 2018-2020 of BVC's GTM network. LCSE queried GAMA Geotracker for Nitrate and TDS measurements collected between 1942-2021. The dataset underwent several QA/QC checks by LSCE and was trimmed to only include measurements that occurred within ILRP Coalitions participating in the CVGMC. To assess the distribution of NO_3-N exceedances in comparison to historical HVAs within BVC, the dataset was filtered to only include:

- Results within the BVC primary area boundary
- Analytical results from between 2015 and 2021
- NO3-N results

Using ArcGIS, NO_3-N data was overlaid onto the original HVA boundary layer. Exceedances, if any, outside of HVAs were isolated and their historical NO_3-N results reviewed. Between 2015 and 2021, 111 NO_3-N results were within the BVC at 32 unique well locations. A total of 15 NO_3-N results in two unique well locations exceeded the MCL of 10 mg/L. All nitrate exceedances fell within the previously determined HVAs.

7.1.4.3. Existing HVA Compared to Nitrate Exceedances

Figure 7-2 demonstrates that all nitrate exceedance results within the BVC between 2015-2021 fell within previously determined HVA boundaries. The best readily available data supports maintaining current HVA boundaries. Nitrate exceedances and the appropriateness of HVA boundaries will be re-evaluated in the future as required by the General Order.

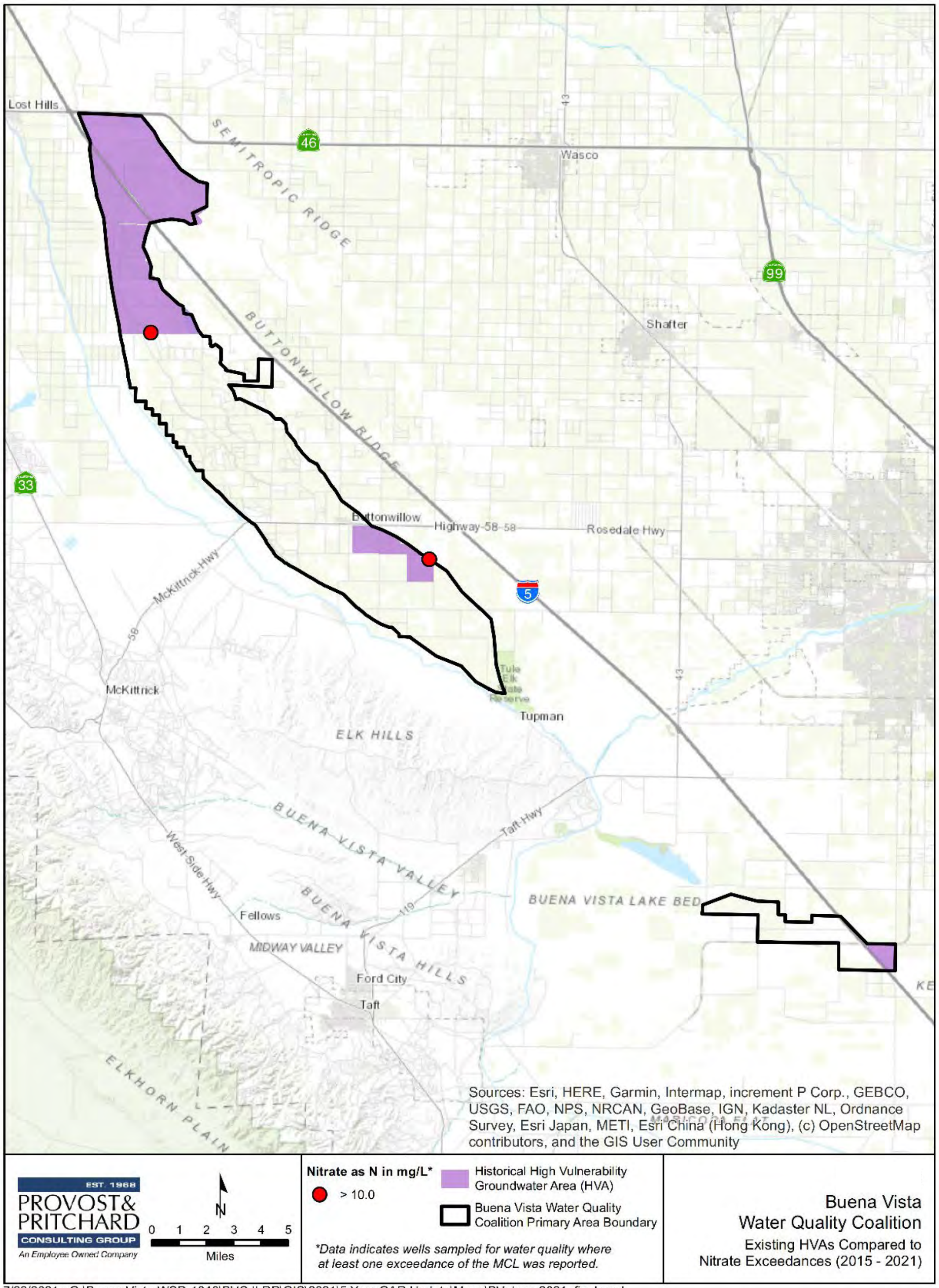

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Figure 7-2. BVC Historical HVAs in Comparison to 2015-2021 Nitrate Exceedances

7.1.4.4. HVA Update

As demonstrated in **Figure 7-3**, no updates to HVA boundaries were made due to all nitrate exceedances falling within previously established HVAs. BVC will continue to monitor irrigated agriculture's impacts on groundwater by:

- Conducting annual groundwater trend monitoring;
- Continuing to implement previously established SGQMPs;
- Establishing groundwater protection formulas, targets, and values;
- Providing relevant continuing education opportunities for members on priority management practices protective of groundwater quality; and,
- Participation in the Southern San Joaquin Valley Management Practices Evaluation Program (**SSJV MPEP**).

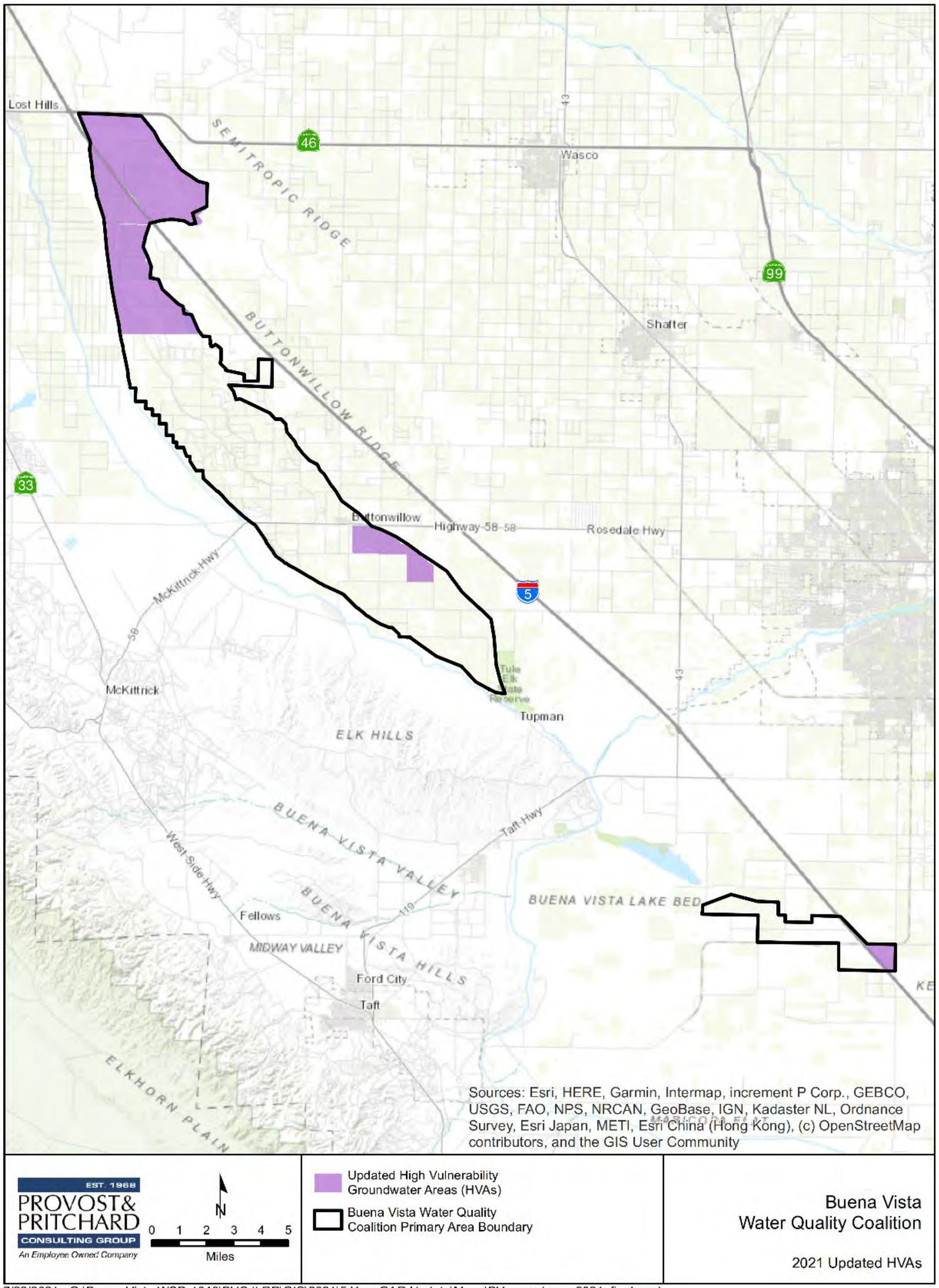

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Figure 7-3. BVC 5-Year HVA Update Boundaries

DRAFT REPORT | SEPTEMBER 2021

8. CAWELO WATER DISTRICT COALITION GROUNDWATER QUALITY FIVE-YEAR ASSESSMENT REPORT

PREPARED FOR

CAWELO WATER DISTRICT COALITION

PREPARED BY

8. CAWELO WATER DISTRICT COALITION GROUNDWATER QUALITY FIVE-YEAR ASSESSMENT REPORT

8.1. GROUNDWATER QUALITY TREND MONITORING RESULTS 2020

8.1.1. GQTM Summary of 2020 Network and Sampled Wells

8.1.1.1. GQTM Network Development Background

The primary objective of the Cawelo Water District Coalition's (CWDC) groundwater quality monitoring effort is to maintain compliance with requirements of the Irrigated Lands Regulatory Program (ILRP) Waste Discharge Requirements General Order for Growers Within the Tulare Lake Basin Area that are Members of a Third-Party Group (General Order). The General Order requires the CWDC to characterize groundwater quality within the CWDC region. Groundwater monitoring is intended to be used to evaluate long term trends in groundwater quality, reflective of potential impacts from agricultural practices. However, collected data may also reflect natural conditions associated with larger aquifer characteristics and potential influences from other sources (e.g., septic systems and other dischargers). Additionally, collected data may also reflect potential longstanding impacts which are not from current land management practices.

The General Order requires a Groundwater Quality Trend Monitoring Workplan (GQTMP) to be submitted to the Central Valley Regional Water Quality Control Board (RWQCB) one year from Groundwater Quality Assessment Report (GAR) approval. The CWDC received a conditional approval of the GAR in a letter dated April 13, 2016; therefore, the GQTMP was submitted on April 19, 2017. A revision (GQTMP-Rev) of CWDC's GWTMP was submitted on May 16, 2018. RWQCB staff comments on GQTMP-Rev were received on June 29, 2018 and an update was submitted on July 31, 2018 to address the comments received on the GQTMP-Rev. The 15-well monitoring network detailed in the GQTMP-Rev Update was conditionally approved by the RWQCB on August 20, 2018, and initial groundwater sampling began during the fall of 2018.

8.1.1.2. Well Site Locations

Attachment B, Section IV.C.2 of the General Order requires the CWDC to implement a groundwater monitoring network that represents both High Vulnerability Areas (HVA) and Low Vulnerability Areas (LVA) and employs relatively shallow wells or existing monitoring well networks. The network must consist of a sufficient number of wells to provide adequate coverage in the CWDC to assess water quality conditions of groundwater and regional effects of irrigated agriculture. In vetting the proposed monitoring areas, consideration was made to include HVAs and LVAs, as determined in the GAR, to ensure that the trend monitoring network design was as representative as possible.

To develop a cost-effective monitoring program, it was clear that incorporating existing wells of an ongoing monitoring program would benefit the GQTMP. It was vital that wells with known or obtainable construction information were incorporated in the GQTMP and each GQTMP well required thorough evaluation. The GQTMP proposed to use the Waste Discharge Requirements (WDR) Study Wells located within the CWDC as a foundation for the selection of monitoring wells. **Table 8-1** provides General Order required well location and construction details, including well use, sanitary seal depth, total well depth, perforated intervals, year drilled, and latitude and longitude of sampling locations.

The CWDC coverage extends approximately 16 miles in the north and south directions within the elongated region and about 8 miles wide in the general east to west direction. Groundwater elevation gradients give a prominent indication that subsurface flows move in the general east to west direction. The GQTMP proposed to establish a monitoring network that addresses subsurface flows and select wells that create a “picket fence” approach that corresponds to the elongated region of CWDC. This approach is best suited to better understand the long-term quality of groundwater and the increasing potential impacts of irrigated agriculture as subsurface flows traverse the CWDC area.

The process by which potential groundwater impacts are transported from agricultural practices at the land surface to the aquifer is related to the irrigation water that percolates past the root zone of crops. CWDC’s land use is primarily agriculture with 97% of crops being almonds, citrus, pistachios, and vineyards. Each of these main four crops tend to form crop-specific “regions” within the CWDC; however, these crop types can also be randomly distributed throughout the CWDC. The GQTMP well locations provide coverage to sufficiently monitor the potential impacts of management practices for these crop regions. The remaining 3% of crop acreage is distributed throughout the CWDC area and do not concentrate in any region of CWDC. These crops are dispersed throughout the primary crops and their potential impacts to groundwater quality will intermingle with the dominate potential of the primary crops.

Groundwater recharge also occurs via the intentional percolation of surface water in recharge basins, incidental percolation of earth-lined reservoirs, and seepage from natural streams. Other recharge sources that are not a direct result of irrigation practices can have an impact on long-term studies of groundwater quality. The GQTMP considers these factors and wells are located accordingly (CWDC GQTMP, 2018).

Due to the long-term monitoring requirement, it is anticipated that the well network will need to be dynamic and modified over time. Necessary changes will be made to maintain a regional representation of groundwater quality. In addition, the CWDC supports the concept presented in Section 3.6, “Dynamic Network: Adaptive Design and Refinement”, of the Central Valley Groundwater Monitoring Collaborative (CVGMC) Technical Workplan. The initial well network design will require ongoing evaluation of the spatial representation and sufficiency to fulfill the requirements of the General Order. **Figure 8-1** displays the current distribution of monitoring wells sampled in 2020. Between the 2019 and 2020 sampling periods there were no changes to CWDC GQTM network.

Table 8-1. 2020 GQTM Network Wells												
Field Point Name / GQTM Well ID	GQTM Well Name	Well Use	Well Construction Information					Latitude	Longitude	Datum	Depth to the Bottom of Upper Zone (feet)
			Seal Depth (feet)	Total Well Depth (feet)	Depth Top of Screen (feet)	Depth Bottom of Screen (feet)	Year Drilled				
CAWDC00001	CAWDC00001	Irrigation		1400	450	1400	1967	35.67115	-119.107	NAD83	506.114
CAWDC00002	CAWDC00002	Irrigation	50	1780	725	1780	2006	35.64593	-119.117	NAD83	517.391
CAWDC00003	CAWDC00003	Irrigation		2030	650	1970	1969	35.653	-119.165	NAD83	380.449
CAWDC00004	CAWDC00004	Irrigation		1200	510	1200	1960	35.59522	-119.116	NAD83	538.36
CAWDC00005	CAWDC00005	Irrigation		1220	500		1954	35.56601	-119.182	NAD83	374.989
CAWDC00006	CAWDC00006	Irrigation		1605	601	1605	2016	35.54056	-119.169	NAD83	393.187
CAWDC00007	CAWDC00007	Irrigation	55	1500	400	1500	1997	35.52492	-119.17	NAD83	379.177
CAWDC00009	CAWDC00009	Irrigation	50	1215	560	1215	1990	35.52744	-119.11	NAD83	383.507
CAWDC00011	CAWDC00011	Irrigation		1065	822	1065	2000	35.50627	-119.148	NAD83	361.265
CAWDC00012	CAWDC00012	Irrigation	50	1310	440		1992	35.46276	-119.075	NAD83	391.476
CAWDC00013	CAWDC00013	Irrigation		1000	544	1000	1976	35.6023	-119.169	NAD83	409.581
CAWDC00014	CAWDC00014	Irrigation						35.45566	-119.087	NAD83	371.63
CAWDC00015	CAWDC00015	Irrigation						35.48444	-119.118	NAD83	380.954
CAWDC00016	CAWDC00016	Irrigation	50	1630	680	1630	2016	35.54395	-119.179	NAD83	392.421
CAWDC00017	CAWDC00017	Irrigation			500	1050		35.51405	-119.1699	WGS 84	357.235

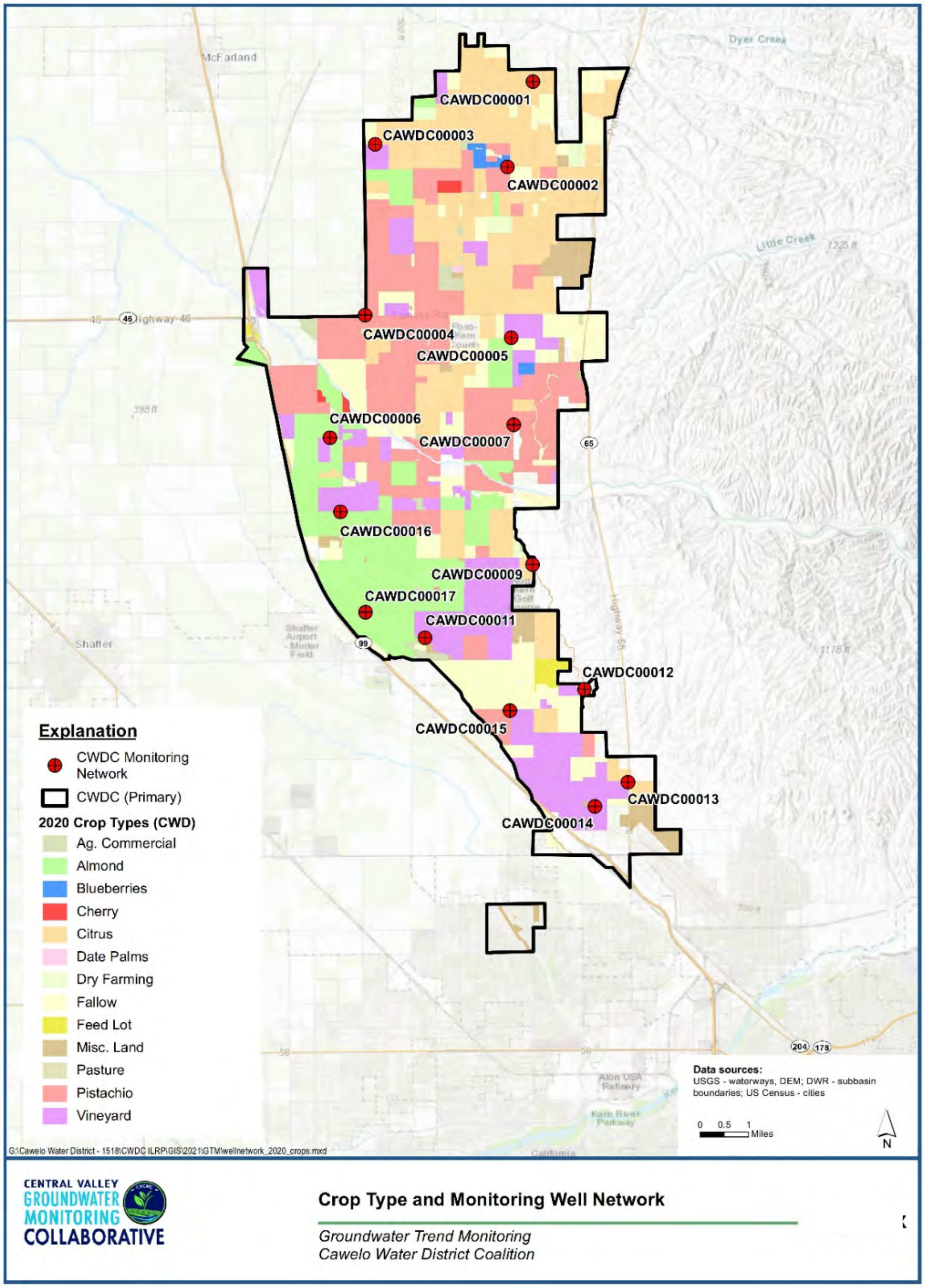

Figure 8-1. CWDC 2020 GQTM Network Well Locations

8.1.2. Summary of Quality Assurance Evaluation for 2020 Sampling Event

8.1.2.1. Purging, sample handling, and custody

The CWDC collected groundwater quality samples during the summer of 2020. A total of 14 wells were sampled, all of which were irrigation wells. For NO_3 as N (Nitrate), results were compared against the 10 mg/L Primary Maximum Contaminant Level (MCL) for Nitrate.

All 2020 samples were collected following the CWDC Standard Operating Procedure (SOP) by CWDC field crew. As described in the SOP, all wells were purged until a volume equal to or greater than three well casings was expelled and measured field parameters stabilized (less than 10% difference for three consecutive readings). Sampling event field parameters are recorded on field sheets. Field notes and purge volumes are also recorded on field sheets. Collected field parameters include pH, electrical conductivity (EC), temperature, dissolved oxygen (DO), and, when feasible, depth to water (DTW). Table 2 summarizes all laboratory and field parameter results for 2020.

Once collected, samples are sealed within plastic bags and transported on wet ice directly from the field to the Fruit Growers Laboratory (FGL). All samples are accompanied by a chain of custody (COC) that records changes in sample custody. Records are maintained within the contracted lab that include the checking in and out of samples during the analytical process as well as the disposal of samples following completion of the analytical process and archival. Samples are held under proper storage conditions until all analyses are conducted.

Table 8-2. 2020 GQTM Sampling Results									
Field Point Name / GQTM Well ID	GQTM Well Name	Well Use	Date Sampled	Nitrate as N (mg/L)	pH	Specific Conductance (uS/cm)	Temperature (°C)	Dissolved Oxygen (mg/L)	Depth to Water (ft)
				Lab	Field	Field	Field	Field	Field
CAWDC00001	CAWDC00001	Irrigation	9/17/2020	0.07	8.73	776	26.69	9.83	NR
CAWDC00002	CAWDC00002	Irrigation	9/22/2020	0.02	9.09	414	27.61	10.26	NR
CAWDC00003	CAWDC00003	Irrigation	9/16/2020	3.6	8.44	859	27.91	9.38	NR
CAWDC00004	CAWDC00004	Irrigation	9/23/2020	12	8.01	1130	23.17	10.17	NR
CAWDC00005	CAWDC00005	Irrigation	9/16/2020	6.8	8.54	704	26.8	9.92	NR
CAWDC00006	CAWDC00006	Irrigation	9/16/2020	3	8.75	427	25.42	11.5	NR
CAWDC00007	CAWDC00007	Irrigation	9/15/2020	0.3	8.71	345	27.39	10.04	NR
CAWDC00009	CAWDC00009	Irrigation	9/15/2020	0.02	9.58	274	27.98	9.4	NR
CAWDC00011	CAWDC00011	Irrigation	9/22/2020	1.6	8.92	686	28.56	10.38	NR
CAWDC00012	CAWDC00012	Irrigation	9/17/2020	0.03	9.51	280	28.63	9.71	NR
CAWDC00013	CAWDC00013	Irrigation	9/15/2020	0.03	9.31	570	21.63	9.4	NR
CAWDC00014	CAWDC00014	Irrigation	9/17/2020	0.02	9.19	703	25.22	9.92	NR
CAWDC00016	CAWDC00016	Irrigation	9/16/2020	14.3	7.88	1330	24.91	10.42	NR
CAWDC00017	CAWDC00017	Irrigation	9/24/2020	20.9	8.04	1920	23.67	11.39	NR

8.1.2.2. Access and field and analytical completeness

Due to the fluctuation of groundwater conditions and changes in well suitability, the submitted GQTMP network was, and continues to be, considered dynamic. Field crews were unable to successfully acquire a sample during the 2020 sampling time frame for one well due to mechanical failure of the well pump (CAWDC00015). All other wells were successfully sampled and groundwater quality results for samples collected in 2020 reached 100% Quality Assurance/Quality Control (QA/QC) completeness.

The 100% completeness exceeds the minimum completeness requirement of 90% specified in the General Order. Results also reached 100% parameter completeness. Qualified field and laboratory results were ultimately rare (4.3%). All other results appear accurate and were reported to the proper level of precision. Much of FGL's equipment can analyze constituents to a lower level than the minimum detection and reporting levels, which allows the CWDC to have confidence that adequate precision is achieved. Tables summarizing completeness of field and analytical testing, field quality control, and evaluation of sample hold times are available in **Table 8-3**, **Table 8-4**, and **Table 8-5**, respectively.

Table 8-3. Completeness of Field and Analytical Testing

Constituent	Test Type	Analytical Method	Matrix	Wells Planned for Sampling	Dry	Wells Sampled	Field and Transport Completeness %	Total Samples Analyzed	Analytical Completeness %
Oxygen, Dissolved	Field parameter	Field Instrument	groundwater	15	1	14	93.3	14	100
pH	Field parameter	Field Instrument	groundwater	15	1	14	93.3	14	100
Specific Conductivity	Field parameter	Field Instrument	groundwater	15	1	14	93.3	14	100
Temperature	Field parameter	Field Instrument	groundwater	15	1	14	93.3	14	100
Nitrate as N	Laboratory	EPA 300.0	groundwater	15	1	14	93.3	14	100
			Total	**75**	**5**	**70**	**93.3**	**70**	**100**

Table 8-4. Completeness of Field QC								
Constituent	Analytical Method	Matrix	Total Well Samples Analyzed	Field Duplicate Samples Analyzed	Field Blank Samples Analyzed	Total Samples Analyzed (well and duplicates)	Field Duplicate Completeness %	Field Blank Completeness %
Nitrate as N	EPA 300.0	groundwater	14	3	6	23	13	26.1
		Total	**14**	**3**	**6**	**23**	**13**	**26.1**
Completeness values below the acceptability requirement of 5 percent are presented in **bold**.								

Table 8-5. Evaluation of Sample Hold Times						
Constituent	Analytical Method	Matrix	Hold Time	Total Samples Analyzed	Samples Analyzed within Hold Time	Acceptability %
Nitrate as N	EPA 300.0	groundwater	48 hours	23	22	95.7
			Total	**23**	**22**	**95.7**
Acceptability values below 90 percent are presented in **bold**.						

8.1.2.3. Analytical precision and accuracy

Reducing cross-contamination and measurement errors is critical to ensuring accurate sampling results. **Table 8-6** and **Table 8-7** summarize both field and laboratory accuracy quality control checks. The acceptability of field duplicates, field blanks, and laboratory controls and spikes were 100%.

Table 8-6. Evaluation of Field Duplicates and Blanks							
Constituent	Analytical Method	Matrix	Sample Type	Acceptability Requirement	Total Samples	Samples within Acceptability	Acceptability %
Nitrate as N	EPA 300.0	groundwater	Field Duplicate	RPD ≤ 25	3	3	100
				Field Duplicate Total	**3**	**3**	**100**
Acceptability values below 90 percent are presented in **bold**.							
Constituent	**Analytical Method**	**Matrix**	**Sample Type**	**Acceptability Requirement**	**Total Samples**	**Samples within Acceptability**	**Acceptability %**
Nitrate as N	EPA 300.0	groundwater	Field Blank	< RL or 1/5 environmental sample	6	6	100
				Field Duplicate Total	**6**	**6**	**100**
Acceptability values below 90 percent are presented in **bold**.							

Table 8-7. Evaluation of Lab Controls and Spikes							
Constituent	Analytical Method	Matrix	Sample Type	Acceptability Requirement	Total Samples	Samples within Acceptability	Acceptability %
Lab Blanks							
Nitrate as N	EPA 300.0	groundwater	Lab Blank	< RL	**7**	**2**	**28.6**
				Lab Blank Total	**7**	**2**	**28.6**
Lab Control Spikes							
Nitrate as N	EPA 300.0	groundwater	LCS	PR 90-110	7	7	100
				Lab Control Total	7	7	100
Matrix Spikes							
Nitrate as N	EPA 300.0	groundwater	MS	PR 80-120	26	26	100
				Matrix Spike Total	26	26	100
Analytical Duplicates							
Nitrate as N	EPA 300.0	groundwater	MSD/LCSD/Lab Dup	RPD ≤ 25	13	13	100
				Analytical Duplicate Total	13	13	100
Acceptability values below 90 percent are presented in **bold**.							
LCS=lab control spike; MS=matrix spike; MSD=matrix spike duplicate; LCSD=lab control spike duplicate							

8.1.2.4. Quality assurance evaluation conclusions

CWDC results not meeting CQAP criteria include a hold time exceedance and laboratory blanks outside the acceptability criteria. For 2020, all CWDC results besides laboratory blanks appear to meet the CQAP criteria. Only 28.6% of laboratory blanks were considered acceptable, failing to meet the 90% acceptability criteria. All field blanks and duplicates met completeness and acceptability criteria. The CWDC will take corrective actions as described in the CVGMC Comprehensive Quality Assurance Plan (CQAP) to address these issues and work to prevent them from reoccurring.

8.1.3. Five-Year Assessment Results and Discussion

Luhdorff & Scalmanini Consulting Engineers (LSCE) conducted both parametric and non-parametric analyses of Nitrate as N (Nitrate or NO_3-N) and Total Dissolved Solids (TDS) trends within the CWDC primary area boundary. Methodology for each of these analyses is discussed in **Section 5**.

All of the **Section 5** figures pertinent to this individual coalition section are presented in **Appendix F**. The **Figure F-1** in **Appendix F** displays average Nitrate conditions in CWDC's GQTM network wells for 2018-2020. Additional information regarding CWDC's GQTM network can be found in **Section 8.1**. Five categories were used to depict average Nitrate conditions over the time period:

- Less than or equal to 2.5 mg/L as N
- Greater than 2.5 mg/L to 5 mg/L as N
- Greater than 5 mg/L to 7.5 mg/L as N
- Greater than 7.5 mg/L to 10 mg/L as N
- Greater than 10 mg/L as N

Twelve wells have an average Nitrate concentration less than or equal to 2.5 mg/L as N. Two wells have an average Nitrate concentration greater than 5 mg/L – 7.5 mg/L. Three wells have an average Nitrate concentration above 10 mg/L.

The **Figure F-2** in **Appendix F** displays the most recent Nitrate sample collected at each of CWDC's GQTM network wells, using the same five categories used to depict Nitrate conditions as mentioned above.

Twelve wells have a Nitrate concentration less than or equal to 2.5 mg/L as N. Two wells have a Nitrate concentration greater than 5 mg/L to 7.5 mg/L. Three wells have a Nitrate concentration above 10 mg/L.

The **Figure F-3** in **Appendix F** displays the most recent Nitrate sample for all wells located within the CWDC primary area boundary, using the same five categories to depict Nitrate conditions as mentioned above.

A range of nitrate concentrations are observed throughout the CWDC. In general, Nitrate concentrations are lower (<5.0 mg/L) in the eastern portion of the coalition. Higher Nitrate concentrations are observed (>5.0 mg/L) in the central and western portions of the coalition.

The **Figure F-4** in **Appendix F** displays ambient nitrate in the Upper Zone using data from 2000-2020, using the same five categories to depict Nitrate conditions as mentioned above.

Kriging modeling results indicate that the southern and northern portion of the Coalition have low levels of ambient Nitrate in the Upper Zone (≤2.5 mg/L as N). Ambient Nitrate concentrations appear to surpass 10 mg/L as N in the northwestern corner of the Coalition. The central region along the western boundary of the Coalition displays a mixture of ambient conditions ranging from more than 2.5 mg/L as N to 10 mg/L as N. A more recent display of ambient nitrate in the Upper Zone using data from 2010 to 2020 is provided in **Figure F-5**.

Figure F-6 in **Appendix F** displays parametric Nitrate trends in the Upper Zone of the aquifer using data from 2000-2020. Analysis was only performed on Upper Zone wells with at least three Nitrate results. Linear regression trend results were split into five categories:

- Decreasing Nitrate trend (linear rate >0.5 mg/L/yr as N)
- Decreasing Nitrate trend (linear rate <0.5 mg/L/yr as N)
- Stable (linear rate = 0 mg/L/yr as N)
- Increasing Nitrate trend (linear rate <0.5 mg/L/yr as N)
- Increasing Nitrate trend (linear rate >0.5 mg/L/yr as N).

CWDC had two wells with sufficient data to conduct the linear regression trend analysis. Of those two wells, one well shows an increasing Nitrate trend (linear rate of <0.5 mg/L/yr) and one shows a decreasing Nitrate trend (linear rate of <0.5 mg/L).

Figure F-7 in **Appendix F** displays non-parametric Nitrate trends in the Upper Zone using data from 2000-2020. The Mann-Kendall Test and Theil-Sen Estimator analysis were performed on Upper Zone wells with at least eight or more Nitrate samples.

Non-parametric Nitrate trend results were split into five categories:

- Decreasing Nitrate trend (T-S slope >0.5 mg/L/yr as N)
- Decreasing Nitrate trend (T-S slope <0.5 mg/L/yr as N)
- Stable (T-S slope = 0 mg/L/yr as N)
- Increasing Nitrate trend (T-S slope <0.5 mg/L/yr as N)
- Increasing Nitrate trend (T-S slope >0.5 mg/L/yr as N).

Five wells within the CWDC had sufficient data to conduct the Mann-Kendall Test and Theil-Sen Estimator analysis. Two wells in the central region of the Coalition had stable Nitrate trends. One well in the southwest corner of the Coalition had an increasing Nitrate trend (T-S slope >0.5 mg/L/yr). Two wells along the western border of the Coalition had a decreasing Nitrate trend (T-S slope <0.5 mg/L/yr). Five wells had insufficient evidence of any Nitrate trend.

Table F-1 in **Appendix F** provides a summary of parametric Nitrate trends for GQTM wells with at least three or more samples between 2018-2020. Within CWDC, 11 wells had insufficient evidence of a linear trend ($R^2 < 0.5$), one had a decreasing linear trend, zero had a stable linear trend, and one had an increasing linear trend.

Figure F-8 in **Appendix F** displays the most recent TDS sample collected at each of CWDC's GQTM network wells. Five categories were used to depict TDS conditions:

- Less than or equal to 250 mg/L
- Greater than 250 mg/L to 500 mg/L
- Greater than 500 mg/L to 750 mg/L
- Greater than 750 mg/L to 1,000 mg/L
- Greater than 1,000 mg/L

Eleven wells show a TDS concentration less than or equal to 250 mg/L. Four wells show a TDS concentration greater than 500 mg/L to 750 mg/L. One well has a TDS concentration greater than 1,000 mg/L.

8.1.4. Five-Year High Vulnerability Area Update

8.1.4.1. Background

CWDC submitted their original GAR on May 4, 2015. In response, the Regional Board provided a conditional approval of CWDC's GAR and proposed HVAs on April 13, 2016.

8.1.4.2. 5-Year HVA Update Methodology

CWDC assessed all publicly available data via the GAMA Geotracker database to conduct its five-year HVA update. This data set includes the Groundwater Trend Monitoring (GTM) results from 2018-2020 of CWDC's GQTM network. LSCE queried GAMA Geotracker for Nitrate as N (Nitrate or NO3-N) and TDS measurements collected between 1942-2021. The dataset underwent several QA/QC checks by LSCE and was limited to only include measurements that occurred within ILRP Coalitions participating in the CVGMC. To assess the distribution of NO3-N exceedances in comparison to existing HVAs within CWDC, the dataset was filtered to only include:

- Results within the CWDC primary area boundary
- Analytical results from between 2015 and 2021
- NO3-N results

Using ArcGIS, NO3-N data was overlaid onto the existing HVA boundary layer. Exceedances outside of existing HVAs were isolated and their historical NO3-N results reviewed. Between 2015 and 2021, 214 NO3-N results were measured within the CWDC at 64 unique well locations. A total of 13 NO3-N results exceeded the MCL of 10 mg/L. A total of four nitrate exceedances at two unique well locations fell outside of the existing HVAs.

8.1.4.3. Existing HVA Compared to Nitrate Exceedances

Figure 8-2 displays nitrate exceedance results in comparison to existing HVAs within the CWDC between 2015-2021. The majority of the nitrate exceedances fall within existing HVA boundaries. Two wells with nitrate exceedances fell outside of existing HVA boundaries.

8.1.4.4. HVA Update

Table 8-8 displays the nitrate exceedances outside of the existing CWDC HVAs that were evaluated for potential inclusion into updated HVAs. A well point was considered for HVA expansion if it shows a historical trend of nitrate exceedances, is in direct proximity to irrigated agriculture, and is not in close proximity (<1.5 miles) to other sources of significant nitrate discharge such as dairies, food processors, confined animal feeding facilities, golf courses, etc.

Table 8-8. Nitrate Exceedances between 2015-2021 outside of CWDC Historical HVAs

Well Code	Sample Date	Result	Latitude	Longitude	GPS Datum
CAWDC00004	9/26/2018	14	35.59522	-119.116	NAD83
CAWDC00004	10/2/2019	14.1	35.59522	-119.116	NAD83
CAWDC00004	9/23/2020	12	35.59522	-119.116	NAD83
AGW080014563-GF-H	10/12/2020	11	35.52553	-119.138	NAD83

Well AGW080014563-GF-H was ultimately not selected for HVA inclusion. Well AGW080014563-GF-H failed to demonstrate a statistically significant increase in nitrate results, presenting only one nitrate result of 11 mg/L taken in 2020. In addition, no laboratory QA/QC reporting limits or method detection limits were submitted with the laboratory result. Without knowledge of the precision and accuracy of the laboratory result, there cannot be confidence that the 11 mg/L reading is truly an MCL exceedance. Finally, Well AGW080014563-GF-H is approximately 1.25 miles downgradient of a potentially significant nitrate discharger (North Kern Golf Course) which further clouds the validity of the nitrate result.

Well CAWDC00004 was selected for HVA inclusion. The well demonstrates a historical pattern of nitrate exceedances, is not near another significant nitrate discharger, and is in proximity to irrigated agriculture. A one-mile buffer was drawn around the well point selected for HVA inclusion. Any assessor’s parcel number (APN) with more than 50% of its acreage within the buffer was included into the new HVA parcel. **Figure 8-3** displays the updated HVA areas for CWDC. In the future, nitrate exceedances and the appropriateness of HVA boundaries will be re-evaluated as required by the General Order.

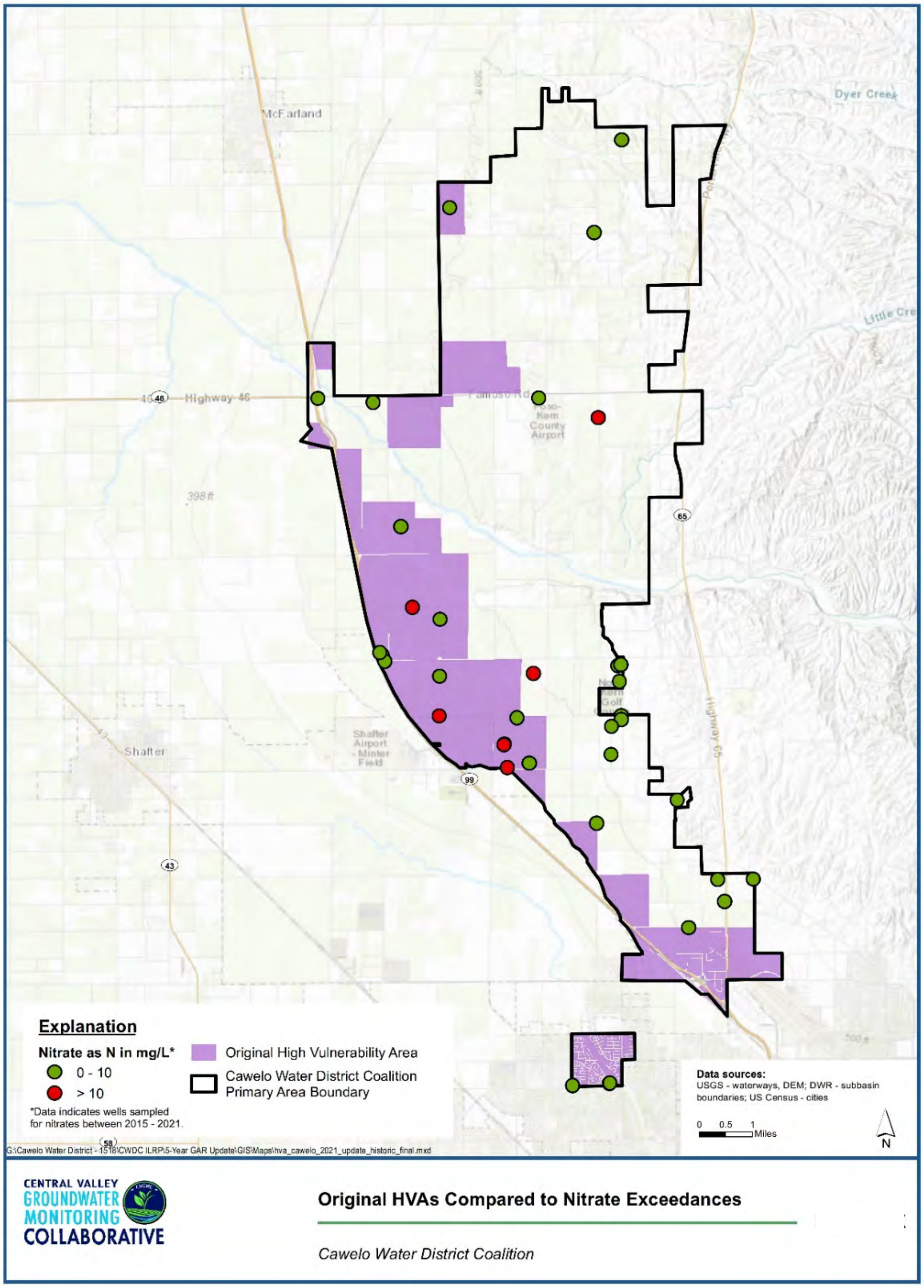

Figure 8-2. CWDC Original HVAs Compared to Nitrate Exceedances

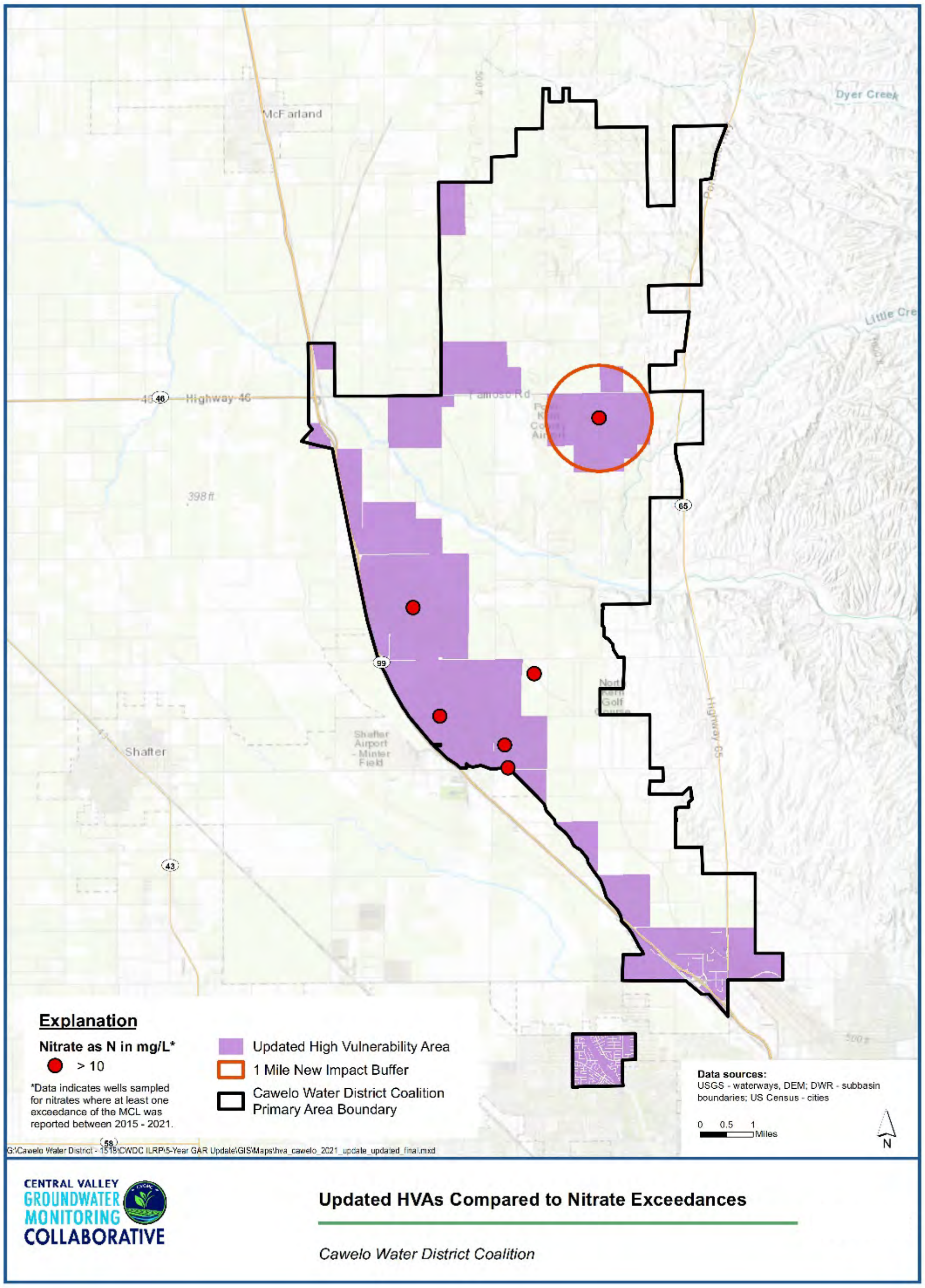

Figure 8-3. CWDC Updated HVAs Compared to Nitrate Exceedances

DRAFT REPORT | SEPTEMBER 2021

9. EAST SAN JOAQUIN WATER QUALITY COALITION FIVE-YEAR ASSESSMENT REPORT

PREPARED FOR

EAST SAN JOAQUIN WATER QUALITY COALITION

PREPARED BY

9. EAST SAN JOAQUIN WATER QUALITY COALITION FIVE-YEAR ASSESSMENT REPORT

9.1. GROUNDWATER QUALITY TREND MONITORING RESULTS 2020

9.1.1. GQTM Summary of 2020 Network and Sampled Wells

9.1.1.1. 2020 Well Network

For the GQTM Program, the East San Joaquin Water Quality Coalition (ESJWQC) monitored 37 network wells in 2020. The network wells included 24 domestic wells and 13 monitoring wells. Sixteen monitoring wells were added to the network in 2020. In accordance with the annual and five-year GQTM sampling schedule, the new network wells sampled for the first time as part of the GQTM were tested for nitrate + nitrite, total dissolved solids (TDS), major cations and anions (boron, calcium, sodium, magnesium, potassium, carbonate, bicarbonate, chloride, sulfate), and alkalinity, as required every five years. The other network wells previously sampled for the GQTM were only tested for nitrate, as required for annual monitoring. The Coalition provided the Central Valley Regional Water Quality Control Board (Regional Water Board) with an update in the GQTM Workplan 2020 Revisions and Update, submitted May 14, 2020. **Table 9-1** and **Figure 9-1** present the wells in the 2020 GQTM Well Network, including the sixteen new monitoring wells.

Table 9-1. 2020 GQTM Network Wells												
Field Point Name / GQTM Well ID	GQTM Well Name	Well Use	Well Construction Information					Latitude	Longitude	Datum	Depth to the Bottom of Upper Zone (feet)
			Seal Depth (feet)	Total Well Depth (feet)	Depth Top of Screen (feet)	Depth Bottom of Screen (feet)	Year Drilled				
ESJQC00001	P01	Domestic	50	135	115	135	1987	37.7522	-120.994	NAD83	166
ESJQC00002	P02	Domestic	80	180	160	180	1988	37.6467	-120.894	NAD83	199
ESJQC00003	P03	Domestic	50	105	85	105	1987	37.6031	-121.048	NAD83	145
ESJQC00004	P04	Domestic	20	136	116	136	1977	37.5641	-120.783	NAD83	222
ESJQC00005	P05	Domestic	20	180	160	175	1981	37.4629	-120.772	NAD83	96
ESJQC00006	P06	Domestic	185	236	215	235	1993	37.4048	-120.589	NAD83	196
ESJQC00007	P07	Domestic	195	230	220	230	2003	37.3308	-120.735	NAD83	149
ESJQC00008	P08	Domestic	150	180	170	180	1990	37.3178	-120.432	NAD83	231
ESJQC00009	P09	Domestic	150	180	170	180	1989	37.3092	-120.556	NAD83	100
ESJQC00010	P10	Domestic		180			1965	37.2144	-120.535	NAD83	138
ESJQC00011	P11	Domestic						37.1497	-120.347	NAD83	100
ESJQC00012	P12	Domestic	20	276	160	172	1985	36.9287	-120.092	NAD83	243
ESJQC00013	ESJQC00013	Domestic	50	175	160	175	1990	37.57331	-120.798	NAD83	225
ESJQC00014	ESJQC00014	Domestic	50	160	140	160	2012	37.50324	-120.986	NAD83	152
ESJQC00015	ESJQC00015	Domestic	20	80	70	80	1974	37.52658	-120.941	NAD83	149
ESJQC00016	ESJQC00016	Domestic	95	143	128	143	1994	37.37653	-120.859	NAD83	150
ESJQC00017	ESJQC00017	Domestic	20	400	200	400	2015	36.88898	-120.021	NAD83	302
ESJQC00018	ESJQC00018	Domestic	195	227	217	227	1988	37.4459	-120.71	NAD83	183
ESJQC00019	ESJQC00019	Domestic	122	162	142	162	2017	37.34129	-120.833	NAD83	137
ESJQC00020	ESJQC00020	Domestic	56	174	154	174	2012	37.64254	-120.788	NAD83	198
ESJQC00021	ESJQC00021	Domestic	35	186	166	186	2003	37.7221	-121.019	NAD83	187

Table 9-1. 2020 GQTM Network Wells												
Field Point Name / GQTM Well ID	GQTM Well Name	Well Use	Well Construction Information					Latitude	Longitude	Datum	Depth to the Bottom of Upper Zone (feet)
			Seal Depth (feet)	Total Well Depth (feet)	Depth Top of Screen (feet)	Depth Bottom of Screen (feet)	Year Drilled				
ESJQC00022	ESJQC00022	Domestic	20	124	112	122	1974	37.14877	-120.489	NAD83	139
ESJQC00023	ESJQC00023	Domestic	23	238	198	238	2005	36.79265	-120.237	NAD83	203
ESJQC00024	ESJQC00024	Domestic	20	188	148	188	1977	37.42899	-120.73	NAD83	167
ESJQC00025	ESJQC00025	Observation	79	197	92	192	2019	37.01468	-120.383	NAD83	164
ESJQC00026	ESJQC00026	Observation	90	230	110	220	2019	36.9527	-120.341	NAD83	202
ESJQC00027	ESJQC00027	Observation	71	139	74	134	2019	36.89483	-120.382	NAD83	196
ESJQC00028	ESJQC00028	Observation	168	345	185	335	2019	37.0694	-120.074	NAD83	289
ESJQC00030	ESJQC00030	Observation	84	290	105	280	2019	37.18317	-120.325	NAD83	89
ESJQC00031	ESJQC00031	Observation	120	285	225	275	2019	37.13714	-120.221	NAD83	62
ESJQC00032	ESJQC00032	Observation	140	390	150	380	2019	37.05456	-120.286	NAD83	122
ESJQC00033	ESJQC00033	Observation	155	375	190	365		37.01826	-120.271	NAD83	180
ESJQC00035	ESJQC00035	Observation	130	210	140	200	2019	36.92368	-120.255	NAD83	171
ESJQC00036	ESJQC00036	Observation	124	350	135	340	2019	36.8257	-120.205	NAD83	247
ESJQC00037	ESJQC00037	Observation	180	320	200	310	2019	36.88146	-120.111	NAD83	223
ESJQC00038	ESJQC00038	Observation	170	330	190	320	2019	37.075	-120.195	NAD83	262
ESJQC00039	ESJQC00039	Observation	361	510	400	500	2019	37.075	-120.195	NAD83	262
ESJQC00001	P01	Domestic	50	135	115	135	1987	37.7522	-120.994	NAD83	166
ESJQC00002	P02	Domestic	80	180	160	180	1988	37.6467	-120.894	NAD83	199

9.1.1.2. 2020 Groundwater Results

MLJ Environmental collected groundwater samples on August 4th through August 6th at 33 wells shown in **Figure 9-1**; 2020 was the third year of monitoring conducted as part of the ESJWQC GQTM Program. Four wells could not be sampled. Two wells were not sampled due to inability to access the well, one well was dry, and one well is part of a nested well cluster that could not safely be sampled because of gas production occurring from one of the wells in the nested well cluster.

Nitrate + nitrate as N results ranged from non-detect (ND) to 70 mg/L (**Table 9-2**). A total of 11 wells had nitrate concentrations at or exceeding the drinking water MCL of 10 mg/L as nitrogen and nine wells had concentrations less than 5 mg/L. Other results included six wells with nitrate concentrations between 7.5 and 10 mg/L and seven wells with concentrations between 5 and 7.5 mg/L.

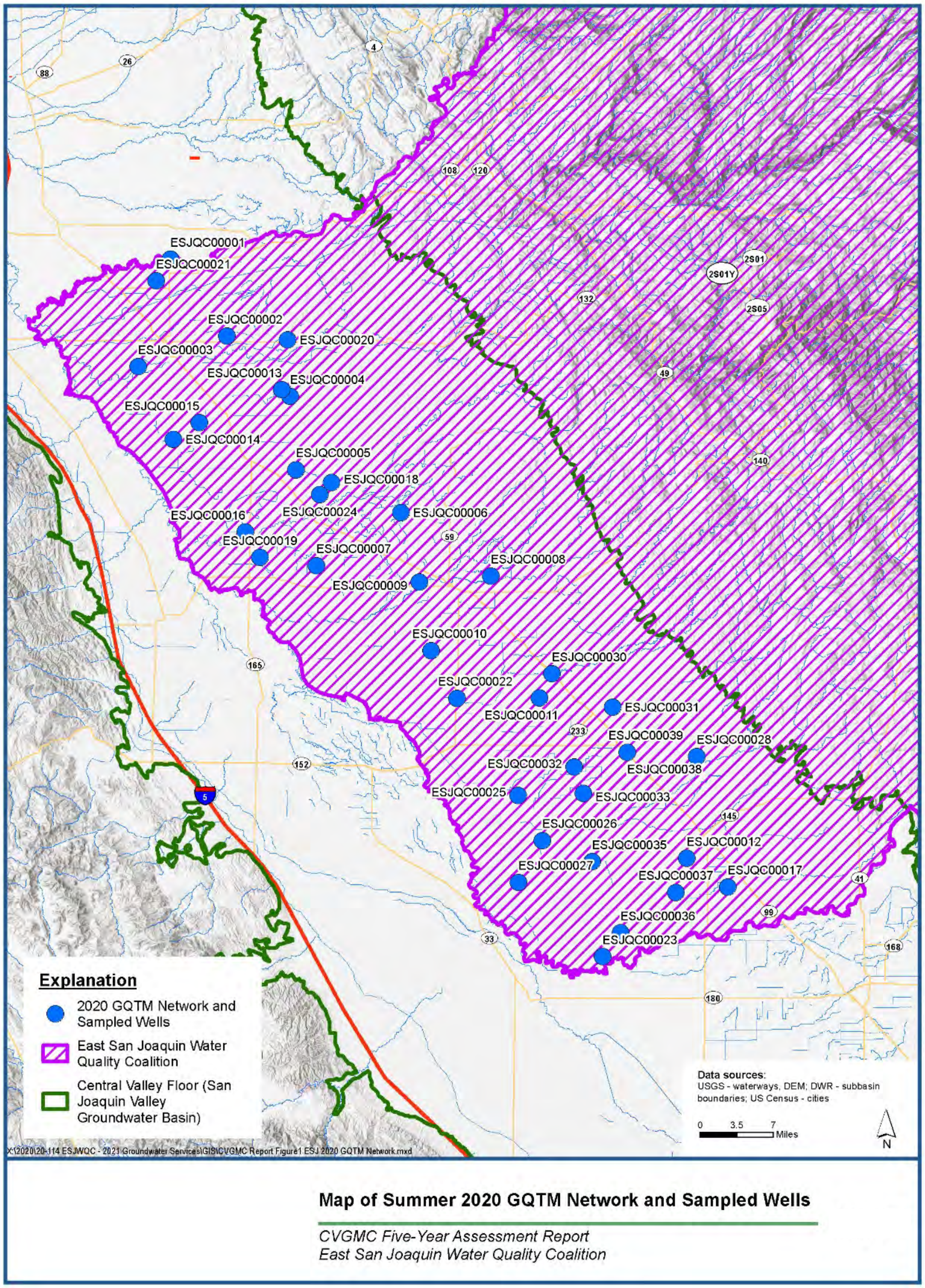

Figure 9-1. Map of Summer 2020 GQTM Network and Sampled Wells

Table 9-2. 2020 GQTM Sampling Results									
Field Point Name / GQTM Well ID	GQTM Well Name	Well Use	Date Sampled	Nitrate as N (mg/L) Lab	pH Field	Specific Conductance (uS/cm) Field	Temperature (°C) Field	Dissolved Oxygen (mg/L) Field	Depth to Water (ft) Field
ESJQC00001	P01	Domestic	8/6/2020	0.83	7.47	177.5	19	1.52	43.23
ESJQC00002	P02	Domestic	8/6/2020	3.5	7.46	324.3	23.2	7.41	68.63
ESJQC00004	P04	Domestic	8/6/2020	20	7.19	839	20	7.35	98.34
ESJQC00005	P05	Domestic	8/6/2020	61	6.73	1162	18.4	5.88	NR
ESJQC00006	P06	Domestic	8/5/2020	5.3	6.92	306.9	21.6	7.15	53.21
ESJQC00007	P07	Domestic	8/5/2020	< 0.5	7.79	270.6	22.5	0.79	95.36
ESJQC00008	P08	Domestic	8/5/2020	6	7	413.4	22.1	5.66	NR
ESJQC00009	P09	Domestic	8/5/2020	8.8	7.01	579	20.3	5.35	NR
ESJQC00010	P10	Domestic	8/5/2020	9.7	7.07	1193	20	3.31	10.8
ESJQC00011	P11	Domestic	8/5/2020	7.9	7.09	706	24.7	6.91	NR
ESJQC00012	P12	Domestic	8/4/2020	7.7	6.88	805	32.4	4.17	180.22
ESJQC00013	ESJQC00013	Domestic	8/6/2020	13	7.36	473.4	20	5.58	92.87
ESJQC00014	ESJQC00014	Domestic	8/6/2020	13	7.29	788	19.7	0.97	16.59
ESJQC00015	ESJQC00015	Domestic	8/6/2020	23	7.05	1047	19	3.18	21.59
ESJQC00016	ESJQC00016	Domestic	8/5/2020	70	6.49	1290	21.4	0.82	13.31
ESJQC00017	ESJQC00017	Domestic	8/4/2020	2.5	6.89	249	21.4	10.18	NR
ESJQC00018	ESJQC00018	Domestic	8/6/2020	18	7.62	386	21.7	7.49	135.05
ESJQC00019	ESJQC00019	Domestic	8/5/2020	0.061	7.53	1103	26.1	0.64	43.51
ESJQC00020	ESJQC00020	Domestic	8/6/2020	5.9	7.21	431	27	4.64	93.81
ESJQC00021	ESJQC00021	Domestic	8/6/2020	6.7	7.3	218.1	19.9	6.38	53.14
ESJQC00022	ESJQC00022	Domestic	8/5/2020	15	7.31	785	22.9	6.62	65.1
ESJQC00023	ESJQC00023	Domestic	8/4/2020	0.097	7.7	170	21.7	0.98	NR
ESJQC00024	ESJQC00024	Domestic	8/6/2020	20	7.11	382.1	19.3	7	43.95

Table 9-2. 2020 GQTM Sampling Results									
Field Point Name / GQTM Well ID	GQTM Well Name	Well Use	Date Sampled	Nitrate as N (mg/L) Lab	pH Field	Specific Conductance (uS/cm) Field	Temperature (°C) Field	Dissolved Oxygen (mg/L) Field	Depth to Water (ft) Field
ESJQC00026	ESJQC00026	Observation	8/4/2020	11	7.32	822	24.1	6.45	135.55
ESJQC00027	ESJQC00027	Observation	8/4/2020	8.7	7.45	1453	25.4	2.74	86.87
ESJQC00030	ESJQC00030	Observation	8/5/2020	0.09	8	846	22.8	3.31	246.88
ESJQC00031	ESJQC00031	Observation	8/5/2020	6.2	7.3	406.3	19.1	3.44	236.29
ESJQC00032	ESJQC00032	Observation	8/4/2020	2.4	7.74	324.4	24.7	2.46	247.33
ESJQC00033	ESJQC00033	Observation	8/4/2020	7.6	7.34	677	24.8	2.86	243.62
ESJQC00035	ESJQC00035	Observation	8/4/2020	10	7.59	716	22.3	5.32	125.21
ESJQC00036	ESJQC00036	Observation	8/4/2020	5.9	8.79	562	21.7	7.71	130.24
ESJQC00037	ESJQC00037	Observation	8/4/2020	6.6	7.38	693	23	6.77	147.95
ESJQC00039	ESJQC00039	Observation	8/4/2020	2.4	7.74	268.2	25	5.38	331.89
ESJQC00001	P01	Domestic	8/6/2020	0.83	7.47	177.5	19	1.52	43.23
ESJQC00002	P02	Domestic	8/6/2020	3.5	7.46	324.3	23.2	7.41	68.63
ESJQC00004	P04	Domestic	8/6/2020	20	7.19	839	20	7.35	98.34
ESJQC00005	P05	Domestic	8/6/2020	61	6.73	1162	18.4	5.88	NR
ESJQC00006	P06	Domestic	8/5/2020	5.3	6.92	306.9	21.6	7.15	53.21
ESJQC00007	P07	Domestic	8/5/2020	< 0.5	7.79	270.6	22.5	0.79	95.36

9.1.2. Summary of Quality Assurance Evaluation for 2020 Sampling Event

The sections below include an assessment of completeness, precision, and accuracy for data generated from groundwater samples collected during 2020. Precision, accuracy, and completeness are evaluated based on Measurement Quality Objectives (MQOs) as outlined in the CQAP. **Table 3** through **Table 4** include counts and percentages for completeness per method and analyte for 2020. **Table 5** includes a summary of holding time evaluations and **Table 6** through **Table 7** include counts of each measure of precision and accuracy evaluated. All flagged data (data that did not meet MQOs) are reviewed for overall quality on batch and sample levels and assessed for usability. Ninety percent of the samples collected and analyzed must meet the acceptability criteria. This section details the instances when MQOs were not met for at least 90% of the samples and includes rationale for accepting the data.

All results that did not meet MQOs are flagged based on the CVGMC CQAP Data Management Standard Operating Procedures (SOP). All results were loaded to GeoTracker.

Table 9-4. Completeness of Field QC

Constituent	Analytical Method	Matrix	Total Well Samples Analyzed	Field Duplicate Samples Analyzed	Field Blank Samples Analyzed	Total Samples Analyzed (well and duplicates)	Field Duplicate Completeness %	Field Blank Completeness %
Nitrate as N	EPA 300.0	groundwater	33	2	2	37	5.4	5.4
		Total	**33**	**2**	**2**	**37**	**5.4**	**5.4**

Completeness values below the acceptability requirement of 5 percent are presented in **bold**.

Table 9-5. Evaluation of Sample Hold Times

Constituent	Analytical Method	Matrix	Hold Time	Total Samples Analyzed	Samples Analyzed within Hold Time	Acceptability %
Nitrate as N	EPA 300.0	groundwater	28 days	37	37	100
			Total	**37**	**37**	**100**

Acceptability values below 90 percent are presented in **bold**.

9.1.2.1. Purging, sample handling, and custody

All groundwater samples are collected according to detailed SOPs (provided in the CQAP). The SOPs contain instructions for collecting samples and cleaning equipment between samples. These methods are summarized below for monitoring that occurred in 2020.

Water levels were measured using an electronic sounder and the depth to water is recorded to the nearest 0.01 feet. All depth measurements were made from the top (the highest point) of the inner well casing. The measuring point location was recorded on the field sheet and used in all subsequent measurements. If there was no measuring point or access to the inside of the well, a note was made on the field data sheet.

Field parameters (pH, water temperature, Specific Conductivity (SC), Oxidation-Reduction Potential (ORP), Dissolved Oxygen (DO), and turbidity) were measured using field meters specified in the CQAP. The meters were calibrated for pH, ORP, DO, and turbidity within 24 hours prior to beginning sampling. For pH, a single 3-point calibration was done using pH 4, 7, and 10 standards. Conductivity was calibrated within 24 hours prior to sampling, and then recalibrated to the nearest calibration solution whenever the conductivity of the well changes substantially. Calibration standards were maintained at temperatures close to the temperature of the well water.

Except as noted below, purging was performed for all groundwater monitoring wells prior to sample collection in order to remove stagnant water from within the well casing and ensure that a representative sample was obtained. To ensuring that the water collected was an adequate representation of the water quality in the groundwater, field parameters were monitored with a flow through system and samples were collected once the measurements were stabilized. Samples that had a final turbidity greater than 10 NTU were filtered in the field using a 0.45-micron filter.

After samples were collected, they were kept away from sunlight and kept at ≤ 6°C until extraction or analysis. Field personnel plan to collect ten percent of the total samples for quality assurance purposes (5% field duplicate and 5% blank samples). Duplicate field parameter measurements are not necessary. Field QC samples are stored at ≤ 6°C alongside environmental samples until extraction or analysis. Field blank samples were processed in the field identically as the other samples using deionized water as sample water. The blank samples were submitted to the laboratory as semi-blind samples.

Any deviation from the written SOP requires notification of the Project QA Officer. There were no deviations or problems noted on the field sheet; no corrective actions were necessary. Deviations will also be reviewed by the CVGMC Program QA Officer to determine acceptability of data.

9.1.2.2. Access and field analytical completeness

Completeness is assessed on three levels: field and transport, analytical, and batch completeness. Field and transport completeness is based on the number of samples successfully collected and transported to the appropriate laboratories. Field and transport completeness may be less than 100% due to bottle breakage during sample transport to the laboratory or inability to access a site. Wells that lack enough water to collect samples (e.g., dry) are considered “sampled” and are counted towards field and transport completeness. Analytical completeness is based on the number of samples successfully analyzed by the laboratory. Analytical completeness may be less than 100% due to factors outside the study’s control (e.g., bottles breaking while at the laboratory or if an analysis failed or was not performed due to laboratory error). Batch completeness assesses whether chemistry and toxicity batches were processed with the required quality control (QC) samples as prescribed in the CQAP.

Overall, field and transport completeness for well samples and field parameters was 89.8% for 2020 sampling (Table 3). All samples submitted to the laboratory were analyzed. Therefore, analytical completeness was 100% for 2020 (Table 3). Field parameter measurements (ORP, DO, pH, SC, water temperature and turbidity) were taken at each site for all sampling events when there was enough water for sample collection. Oxidation-reduction potential, total alkalinity, hydroxide, and turbidity are not required in the WDR. Measurements of ORP are taken to determine the potential for the reduction of nitrate and turbidity is measured to determine if a sample should be filtered. Total alkalinity and hydroxide results are included from the laboratory when the carbonate and bicarbonate analysis is conducted since carbonate, bicarbonate and hydroxide make up total alkalinity. The results are included in the counts in **Tables 9-3** through **9-7**.

Field duplicate and field blank samples are collected by sampling crews in the field and transported to the laboratories. Field QC samples are collected during each event, as prescribed by the CQAP. At a minimum, field blank and field duplicate samples must each comprise 5% of the samples collected (overall 10% field QC). Field QC samples were collected at a frequency greater than 5% ranging from 5.4% to 11.8% of the environmental samples collected for 2020 (**Table 9-4**).

9.1.2.2.1. Batch Completeness

Each chemistry batch must be processed with a minimum set of QC samples as prescribed in the CQAP. Batch completeness is determined based on whether all required QC samples were run with every batch. One hundred percent (100%) of chemistry batches (23 of 23) met batch completeness requirements.

9.1.2.2.2. Hold Time Compliance

Each sample must be stored, extracted (if applicable), and analyzed within a specific timeframe to meet hold time requirements as outlined in the CQAP. Results associated with hold time violations are flagged. All well samples were analyzed within hold time with an overall hold time compliance of 100% for 2020.

9.1.2.3. Analytical precision and accuracy

Precision and accuracy for groundwater samples are evaluated for each type of QC sample analyzed during 2020 in **Table 9-6** and **Table 9-7**.

Briefly, they are addressed as follows:

- Evaluation of blank samples (field blank and laboratory blank): Table 6 and Table 7;
- Evaluation of field duplicate precision for chemistry: Table 6;
- Evaluation of laboratory accuracy of recovery (laboratory control spike, matrix spike): Table 7; and
- Evaluation of laboratory precision of duplicate samples (laboratory control spike duplicate, matrix spike duplicate, and laboratory duplicate): Table 7.

During 2020, each batch was processed with a combination of any of the following QC samples: field blank, laboratory blank, matrix spike (MS), laboratory control spike (LCS), laboratory duplicate, and field duplicate. Blank samples (field blank and laboratory blank) are analyzed to determine sources of contamination in either the field (field blanks) or the laboratory (laboratory blank). Percent recoveries in LCS and MS samples are calculated to assess laboratory accuracy in recovering known concentrations of analytes. Relative percent differences (RPDs) are calculated in duplicate samples (i.e., laboratory duplicate, LCS duplicate (LCSD), MS duplicate (MDS)) to assess the laboratory's precision of recoveries. In turn, the RPD calculated for field duplicates assesses field sampling precision.

An evaluation of the precision and accuracy for each analyte is discussed below. Batches are accepted by evaluating all measures of precision and accuracy. Justification for accepting data when MQOs acceptability criteria fell below 90% is provided. Overall, precision and accuracy criteria were met for more than 90% of the samples for all criteria and all data are considered usable.

When the concentration of a constituent in a sample exceeds the highest point on a calibration curve, a dilution of the sample is required. The laboratory reports the result of the diluted sample multiplied by the dilution factor to represent the concentration of the analyte detected in the original sample. All diluted samples are flagged accordingly in the database. The reporting limit (RL) associated with a diluted sample is multiplied by the dilution factor, thereby, increasing the reporting limit. Therefore, for each dilution that occurs, there is a corresponding increase in the limit of quantification.

Reporting limits identified in the CQAP are set at levels where laboratory instruments can reliably detect analytes in samples. Although instruments can detect analytes below the RL, accurate detections become less reliable, and results reported below the RL are associated with variability. Laboratories report all detections, even when analytes are detected at concentrations below the RL. When the concentration of an analyte is reported below the RL and above the Method Detection Limit (MDL), the result is reported as an estimated value and flagged in the laboratory report with a "J Flag".

As outlined in the CQAP, QC samples include laboratory blank, field blank, field duplicate, laboratory control spike (LCS), matrix spike (MS), and laboratory duplicate (often LCSD or MSD samples) samples for all analytes listed in Table 3 with the following exceptions: 1) no MS samples are required for alkalinity as CaCO3, bicarbonate, carbonate, hydroxide, and total dissolved solids (TDS) and 2) no LCS samples are run for carbonate and hydroxide.

All analytes were within the MQO acceptability criteria of 90% for blanks (field and laboratory), LCS, and lab duplicates (including LCSD and MSD). Analytes that were not within the MQO acceptability criteria of 90% are outlined below with an explanation for accepting the data and considering the data usable.

Measurement quality objectives were met for more than 90% of the samples for all analytes for all QC types except for matrix spikes and field duplicates. Analytes that failed to meet the 90% acceptability threshold for MS recoveries include: calcium (3 of 4, 75%) and sodium (3 of 4, 75%). Nitrate + nitrite as N failed to meet the 90% acceptability threshold for field duplicate precision (1 of 2, 50%).

Table 9-6. Evaluation of Field Duplicates and Blanks

Constituent	Analytical Method	Matrix	Sample Type	Acceptability Requirement	Total Samples	Samples within Acceptability	Acceptability %
Nitrate as N	EPA 300.0	groundwater	Field Duplicate	RPD ≤ 25	2	1	100
				Field Duplicate Total	**2**	**1**	**100**
Acceptability values below 90 percent are presented in **bold**.							
Constituent	**Analytical Method**	**Matrix**	**Sample Type**	**Acceptability Requirement**	**Total Samples**	**Samples within Acceptability**	**Acceptability %**
Nitrate as N	EPA 300.0	groundwater	Field Blank	< RL or 1/5 environmental sample	2	2	100
				Field Duplicate Total	**2**	**2**	**100**
Acceptability values below 90 percent are presented in **bold**.							

Table 9-7. Evaluation of Lab Controls and Spikes							
Constituent	Analytical Method	Matrix	Sample Type	Acceptability Requirement	Total Samples	Samples within Acceptability	Acceptability %
Lab Blanks							
Nitrate as N	EPA 300.0	groundwater	Lab Blank	< RL	5	5	100
				Lab Blank Total	5	5	100
Lab Control Spikes							
Nitrate as N	EPA 300.0	groundwater	LCS	PR 90-110	5	5	100
				Lab Control Total	5	5	100
Matrix Spikes							
Nitrate as N	EPA 300.0	groundwater	MS	PR 80-120	12	12	100
				Matrix Spike Total	12	12	100
Analytical Duplicates							
Nitrate as N	EPA 300.0	groundwater	MSD/LCSD/Lab Dup	RPD ≤ 25	6	6	100
				Analytical Duplicate Total	6	6	100
Acceptability values below 90 percent are presented in **bold**.							
LCS=lab control spike; MS=matrix spike; MSD=matrix spike duplicate; LCSD=lab control spike duplicate							

9.1.2.3.1. Calcium

Two pairs of MS/MSD samples were run with the batch analyzed for calcium. One set of MS/MSD recoveries were both within control limits with MS recoveries of 87% and 100%, respectively. For the second set of MS and MSD recoveries, only the MSD was above the upper control limit of 125% with a recovery of 129%, while the MS recovery was within limits at 87%. While the percent recoveries varied for the second set of MS/MSD samples, the RPD for the pair was within 25% (4.68%). The LCS associated with the batch recovered within limits at 96%. The batch was accepted based on the acceptable MS/MSD recoveries and the acceptable LCS recovery. All calcium results were accepted and are considered usable.

9.1.2.3.2. Sodium

Two pairs of MS/MSD samples were run with the batch analyzed for sodium. One set of MS/MSD recoveries were both within control limits with MS recoveries of 90% and 92%, respectively. For the second set of MS and MSD recoveries, the MS was below the lower control limit of 75% with a recovery of 52%, while the MS recovery was within limits at 83%. While the percent recoveries varied for the second set of MS/MSD samples, the RPD for the pair was within 25% (4.51%). The LCS associated with the batch recovered within limits at 92%. The batch was accepted based on the acceptable MS/MSD recoveries and the acceptable LCS recovery. All sodium results were accepted and are considered usable.

9.1.2.3.3. Nitrate + Nitrite as N

The field duplicate RPD for nitrate + nitrite as N exceeded the acceptable limit of 25% in the samples collected from well ESJQC00023. The environmental result was 0.097 mg/L and the duplicate result was 0.13 mg/L, with a resulting RPD of 29.07%. All other batch QC samples met MQOs and the data were accepted. All nitrate + nitrite as N results were accepted and are considered usable.

9.1.2.3.4. Corrective Actions

Corrective action is an activity that should be used to stop the re-occurrence of non-conformities. In some cases, the Coalition will address corrective action options to improve QC measures that are consistently demonstrating failure to meet MQOs. No corrective actions were determined to be necessary for groundwater monitoring that occurred in 2020.

9.1.2.4. Quality Assurance Evaluation Conclusions

All results were accepted and considered usable.

9.1.2.5. Electronic Data Submittal and Data Uploaded to GeoTracker

The Coalition loaded the 2020 monitoring results to GeoTracker on March 16, 2021. The Electronic Data Format (EDF) included environmental and QC results for the GQTM network wells monitored by the Coalition.

9.1.3. Five-Year Assessment Results and Discussion

LSCE provided a series of figures and a table specific to the East San Joaquin Water Quality Coalition in **Appendix G** as part of the Five-Year Assessment. The figures include maps of nitrate and TDS concentrations and trends in GQTM and Upper Zone wells.

The map of average nitrate conditions in GQTM wells displays 5 ranges of nitrate concentrations ranging from less than 2.5 mg/L to greater than 10 mg/L (**Figure G-1**). All concentration ranges are present within the East San Joaquin Water Quality Coalition boundaries. Most central and southern wells have concentrations below 10 mg/L as N while 8 higher (>10 mg/L as N) concentrations are located near the northwestern corner of the coalition boundary. Two other wells with higher concentrations are located at the western edge, and one is located east of the Valley Floor. Recent nitrate conditions in GQTM wells (**Figure G-2**) are largely the same as average conditions, indicating little change in concentrations during the period of record (2018 – 2020). The figure of most recent nitrate conditions from all wells (**Figure G-3**) regardless of depth or data source presents similar results to the most recent GQTM conditions with a larger distribution of wells with higher (>10 mg/L as N) concentrations in the northwest. Additional higher concentrations are located near the southwest, and some are dispersed outside of the

Valley Floor. Low concentrations (<2.5 mg/L as N) are distributed around the higher concentrations of the southwest and along the eastern edge of the basin.

Ambient nitrate concentrations were interpolated with a kriging method using averaged nitrate data in the Upper Zone post-2000 and post-2010 (**Figure G-4**). Ambient concentrations are categorized similarly to the well concentrations, ranging from less than 2.5 mg/L as N to greater than 10 mg/L as N. Higher concentrations are again distributed in the northwest but are sparser in the southwest compared to the most recent concentration in all wells map. Ambient concentrations post-2010 (**Figure G-5**) are largely the same as the post-2000 concentrations; indicating measurements since 2010 haven't differed significantly from measurements from 2000 through 2010.

Non-parametric methods were used to analyze trends in post-2000 nitrate concentrations. Mann-Kendall analyses were performed on wells with 8 or more measurements to identify statistically significant upward or downward trends. For wells with at least a 95% confidence in a monotonic trend, a Theil-Sen slope analysis was performed to quantify the rate of the trend. The post-2000 non-parametric trend map (**Figure G-6**) displays wells without a significant trend, stable wells (i.e., trend of 0 mg/L/yr as N), and increasing and decreasing trends at rates above or below 0.5 mg/L/yr as N. Most trends outside of the Valley Floor are stable. Within the Valley Floor trends are varied with most at a low rate of increase. Where wells with increasing concentrations are clustered together, wells with decreasing concentration also become more prevalent.

A parametric linear regression analysis was also used to determine trends in post-2000 nitrate concentrations. Unlike the non-parametric methods, the linear regression assumes a model to predict changes in concentration with time. Because this analysis incorporates a more rigid model but only require a minimum of 3 measurements, it captures some wells not captured by the non-parametric analysis. Conversely, many trends identified as significant in the Mann-Kendall analysis may not be suitably fit with a linear model. Wells with reasonably fitting linear trends (i.e. R^2-value above 0.5) are displayed in the parametric trend map of Upper Zone wells (**Figure G-7**). Linear trends are only found in wells within the Valley Floor and are more evenly varied in increasing and decreasing trends compared to the non-parametric analysis. Wells located in the northern portion of the valley exhibit many higher decreasing rates, while higher rates of increasing concentrations are distributed in the central valley.

The summarized table of GQTM well parametric analyses gives the results of 11 GQTM wells within the coalition boundary (**Table G-1**). All wells are located on irrigated land. Four of the wells don't show strong evidence of linear trends, 4 wells are decreasing, 1 is stable, and 2 are increasing.

The most recent TDS sample in GQTM wells is provided in **Figure G-8**, which shows relatively low TDS concentrations, never exceeding the secondary MCL of 1,000 mg/L.

9.1.4. Five-Year High Vulnerability Area Update

9.1.4.1. Existing HVA Compared to Nitrate Exceedances

In accordance with the WDRs and to address elements of the five-year review and update of the GAR, the Coalition reviewed the HVA delineated in the 2019 GAR update. The Coalition previously completed an update of the original HVA in 2019. To evaluate the sufficiency of the 2019 HVA, all readily and publicly available data on historical nitrate concentrations were examined within the Coalition region and compared with the 2019 HVA. Consistent with the original 2013 GAR and the designation of the HVA in the original GAR and 2019 HVA update, the evaluation of the HVA is focused on the San Joaquin Valley Groundwater Basin (Central Valley Floor) where all but a very small amount of the irrigated area in the Coalition region is located.

Of the 5,449 wells within the Coalition region with historical nitrate concentration data, 4,319 wells are located within the Central Valley Floor. Of these 4,319 wells, 833 wells have historical concentrations of nitrate that exceed the primary drinking water MCL of 10 mg/L (as nitrogen). Of the 833 exceedance wells, 809 (97 percent) are located within the extent of the 2019 HVA (the combined 2019 HVA and Tentative HVA).

The 24 wells with historical nitrate exceedance records located outside the 2019 HVA were reviewed with respect to their location relative to the 2019 HVA and the characteristics and conditions of each site.

9.1.4.2. HVA Update

The five-year review of the Coalition's HVA seeks to account for all nitrate exceedances in the Coalition that may be related to irrigated agriculture activities. The review of the HVA described above indicates 24 exceedances located outside of the extent of the 2019 HVA. Although a relationship between the nitrate exceedances located outside the 2019 HVA and irrigated agriculture is uncertain, the 24 exceedance locations tend to be in close proximity to the 2019 HVA. Of the 24 exceedance locations outside the 2019 HVA, 18 (75 percent) are within one quarter mile and all but two (92 percent) are within one mile of the 2019 HVA. Because of the continued strong spatial agreement and close distance between the original HVA and historical nitrate exceedance wells, only minor modifications to the 2019 HVA were performed to address the exceedance wells outside the 2019 HVA.

Given the small number of exceedance wells outside the HVA and their proximity to the 2019 HVA, modifications to the extent of the HVA were made using professional judgement with consideration of the hydrogeologic characteristics near the exceedance wells. In all cases, the outline of the HVA was expanded and redrawn to encompass all exceedance wells outside the HVA using guidance from mapping of soil hydraulic conductivity from NRCS SURGO data (NRCS,

2013) and recharge potential from the Soil Agricultural Groundwater Banking Index (SAGBI) (O'Geen et al., 2015) together with the vulnerability considerations used in the original GAR.

In cases where exceedances occurred farther from the 2019 HVA and in areas where other conditions do not suggest high vulnerability, additional HVA was included around each of these outlier wells extending a radius of one quarter mile around the point of each exceedance. The extent of the area to include around these outlier exceedances was determined through consideration of the typical scale of soil characteristics as mapped by NRCS (2013) and the high fraction of exceedance wells occurring within one quarter mile of the 2019 HVA. No modifications to the 2019 HVA were made that resulted in removing areas previously designated as HVA; the HVA modifications completed for the 2021 HVA only includes an expansion of the HVA. The extent of the 2021 HVA is presented in **Figure 9-3**.

The HVA modifications completed for the 2021 HVA represent an increase in area of 688 acres from the 2019 HVA. The total area within the 2021 HVA (including Tentative HVA) is 857,270 acres.

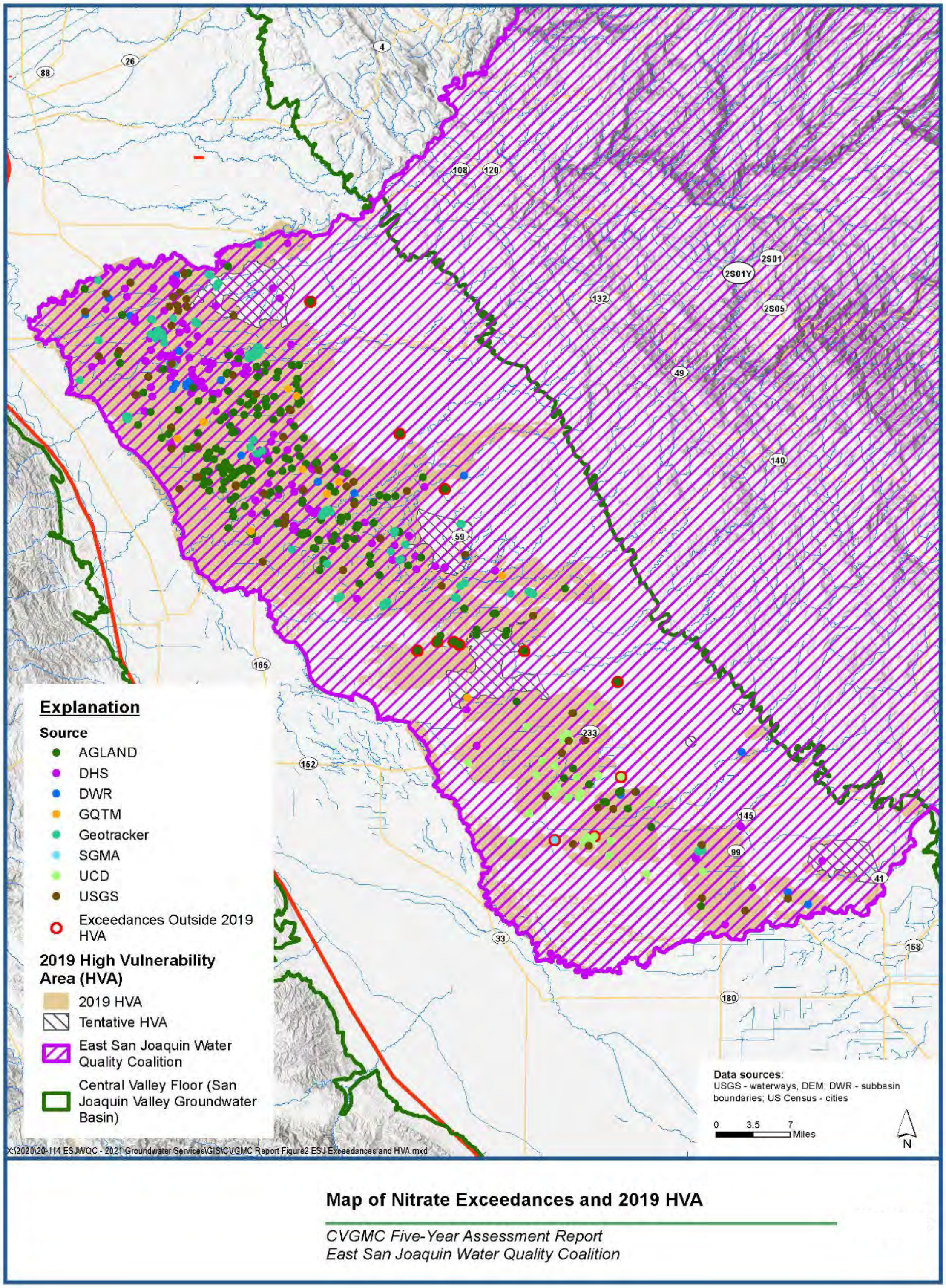

Figure 9-2. Map of Nitrate Exceedances and 2019 HVA

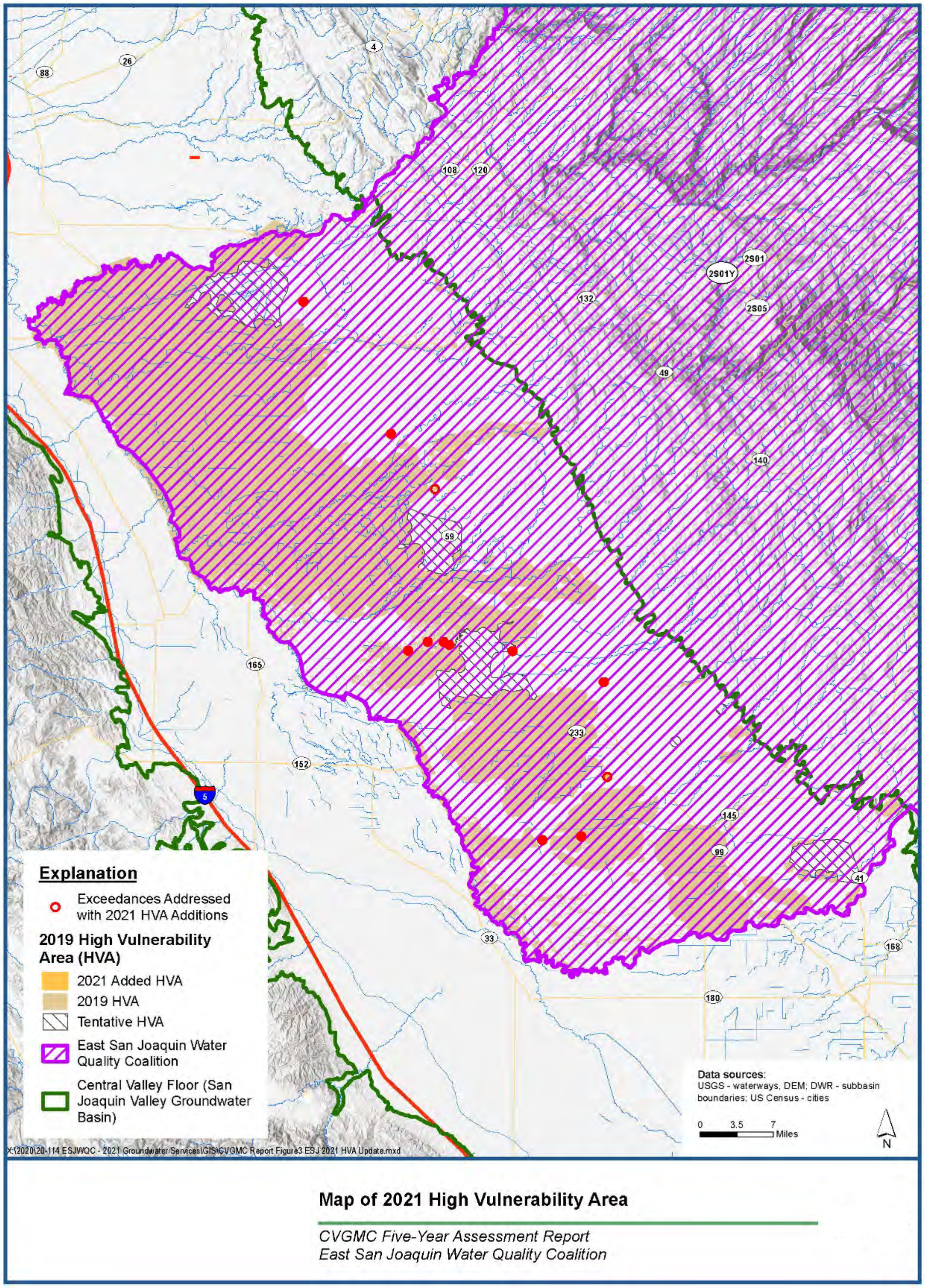

Figure 9-3. Map of 2021 High Vulnerability Area

DRAFT REPORT | SEPTEMBER 2021

10. GRASSLAND DRAINAGE AREA COALITION FIVE-YEAR ASSESSMENT REPORT

PREPARED FOR

GRASSLAND DRAINAGE AREA COALITION

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10. GRASSLAND DRAINAGE AREA COALITION FIVE-YEAR ASSESSMENT REPORT

10.1. GROUNDWATER QUALITY TREND MONITORING RESULTS 2020

10.1.1. GQTM Summary of 2020 Network and Sampled Wells

The Grassland Drainage Area Coalition (GDA Coalition) completed monitoring of the Groundwater Quality Trend Monitoring network of eleven wells in Summer 2020. Details on the 2020 GQTM network wells are presented in **Table 10-1** and well locations are shown on **Figure 10-1**. The GDA Coalition 2020 GQTM well network sampling event occurred during mid to late August 2020 and included sampling of a total of eleven wells. In accordance with the annual and five-year GQTM sampling schedule, all wells had previously been sampled for the GQTM and were only tested for nitrate, as required for annual monitoring. All wells sampled for the GQTM were also tested for field parameters, including specific conductance, pH, temperature, dissolved oxygen, oxidation-reduction potential, and turbidity. The results from the 2020 sampling event are presented in **Table 10-2**.

Results for five of the sampled wells (GDACX00001, GDACX00005, GDACX00008, GDACX00013, GDACX00014), exceeded the primary drinking water MCL of 10 milligrams per liter (mg/L) for nitrate (as nitrogen). Three wells exceeded the nitrate MCL by a considerable amount with concentrations ranging between 28 mg/L and 82 mg/L, well above the MCL of 10 mg/L. Two other exceedance wells had concentrations between 13 and 14 mg/L. No wells were sampled for the broader suite of five-year analytes; however, specific conductance field measurements show high salinity in most wells ranging from 1,736 µS/cm to 6,647 µS/cm. The recommended secondary drinking water MCL for specific conductance is 900 µS/cm, with upper and short term MCLs of 1,600 and 2,200 µS/cm, respectively. These observations are consistent with regional groundwater conditions in the area, which have elevated levels of naturally occurring salinity.

Table 10-1. 2020 GQTM Network Wells

Field Point Name / GQTM Well ID	GQTM Well Name	Well Use	Well Construction Information					Latitude	Longitude	Datum	Depth to the Bottom of Upper Zone (feet)
			Seal Depth (feet)	Total Well Depth (feet)	Depth Top of Screen (feet)	Depth Bottom of Screen (feet)	Year Drilled				
GDACX00001	GDA001	Domestic	55	160	76	116	1993	36.9539	-120.81	NAD83	234.43
GDACX00002	GDA002	Domestic	180	227	200	220	2013	36.9104	-120.656	NAD83	319.41
GDACX00003	GDA003	Irrigation	50	410	270	390	1994	36.891	-120.661	NAD83	345.04
GDACX00004	GDA004	Irrigation	20	205	50	140	2013	36.8941	-120.793	NAD83	107.75
GDACX00005	GDA005	Domestic	110	200	130	190	2008	36.8489	-120.672	NAD83	378.8
GDACX00008	GDA008	Domestic	140	245	170	230	1992	36.85003	-120.718	NAD83	201
GDACX00011	GDA011	Municipal	150	308	168	288	1990	36.7763	-120.374	NAD83	204.345
GDACX00012	GDA012	Observation		80				36.85087	-120.494	NAD83	219.908
GDACX00013	GDA013	Observation		80				36.85157	-120.654	NAD83	391.749
GDACX00014	GDA014	Observation		80				36.82181	-120.656	NAD83	378.74
GDACX00016	GDA016	Irrigation		234				36.8813	-120.604	NAD83	288.32

Table 10-2. 2020 GQTM Sampling Results									
Field Point Name / GQTM Well ID	GQTM Well Name	Well Use	Date Sampled	Nitrate as N (mg/L) Lab	pH Field	Specific Conductance (uS/cm) Field	Temperature (°C) Field	Dissolved Oxygen (mg/L) Field	Depth to Water (ft) Field
GDACX00001	GDA001	Domestic	8/18/2020	14	7.48	3349	21.5	4.2	NR
GDACX00002	GDA002	Domestic	8/27/2020	< 0.027	7.19	3074	22.2	0.44	49.37
GDACX00003	GDA003	Irrigation	8/20/2020	6.7	7.54	3949	20.3	0.53	80
GDACX00004	GDA004	Irrigation	8/26/2020	0.75	7.74	1736	19.3	6.32	NR
GDACX00005	GDA005	Domestic	8/25/2020	28	7.62	4304	21.6	3.27	NR
GDACX00008	GDA008	Domestic	8/25/2020	13	7.28	1947	21.3	6.37	NR
GDACX00011	GDA011	Municipal	8/20/2020	< 0.027	7.07	3779	19.4	2.14	NR
GDACX00012	GDA012	Observation	8/26/2020	5.6	7.44	5453	19.8	1.74	37
GDACX00013	GDA013	Observation	8/26/2020	62	7.37	6028	21	1.88	4.98
GDACX00014	GDA014	Observation	8/26/2020	82	7.37	6647	23.7	7.8	9.38
GDACX00016	GDA016	Irrigation	8/20/2020	1.7	7.39	4682	21.5	0.75	71.69

NR=Not Recorded

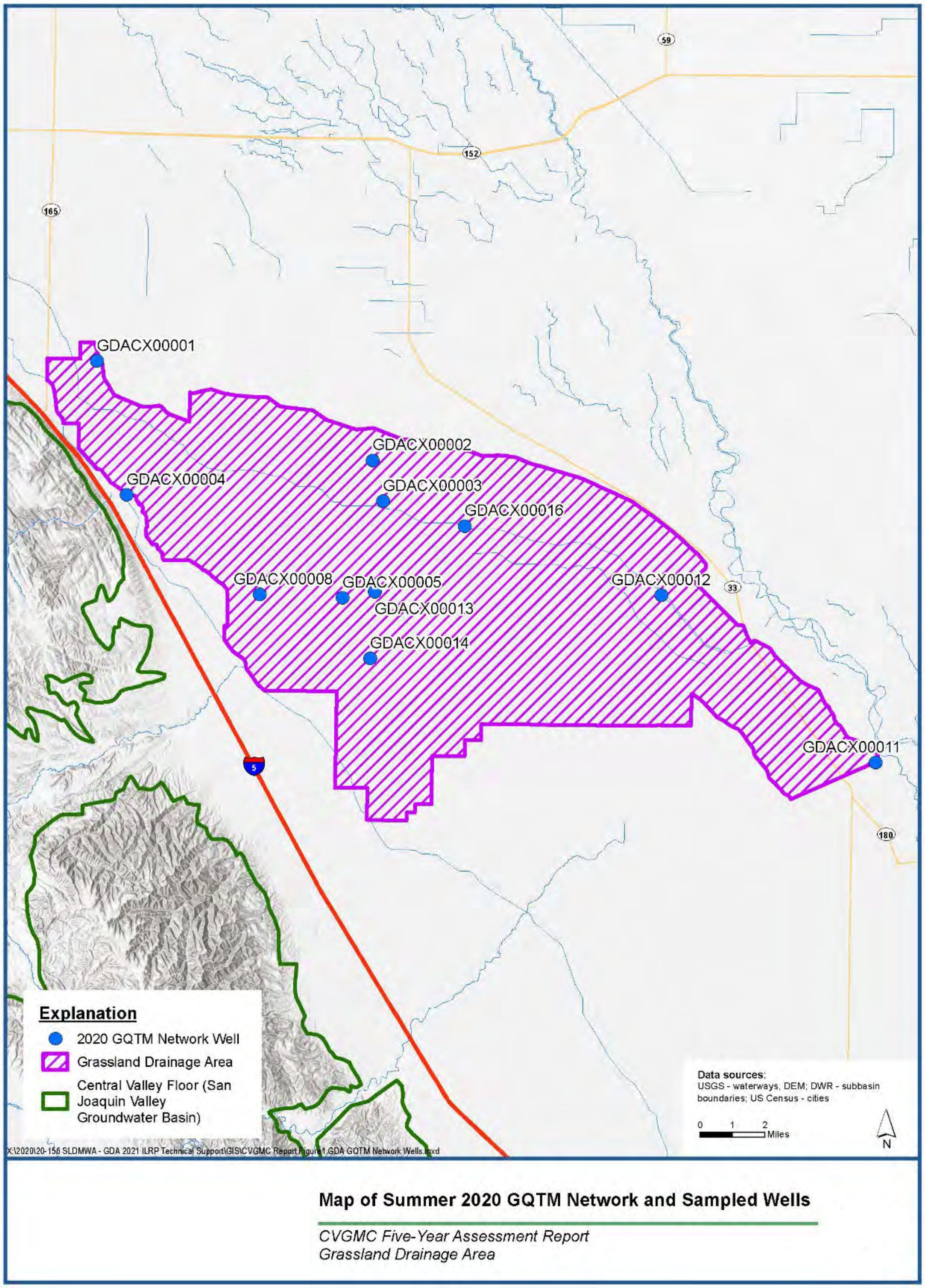

Figure 10-1. Map of Summer 2020 GQTM Network and Sampled Wells Summary of Quality Assurance Evaluation for 2020 Sampling Event

Consistent with the QAPP, field measurements of electrical conductivity (EC) at 25ºC, pH, dissolved oxygen (DO) and temperature (T) were obtained during the sample retrieval and the laboratory performed analysis for nitrate as nitrogen (NO3 as N). Additional field parameters of turbidity and oxidation-reduction potential (ORP) were also recorded during sampling.

10.1.1.1. Purging, sample handling, and custody

Wells were purged according to the SOP. Samples were retrieved upon stabilization of indicator parameters (i.e., EC and pH) and after the turbidity of the discharging water dropped below 10 NTUs. Purging and sampling activities were documented on field sheets provided in the QAPP. Samples were collected in laboratory-supplied bottles and transported under prescribed chain of custody to the laboratory according to the QAPP.

10.1.1.2. Access and field and analytical completeness

A total of eleven wells were planned for sampling and all of the eleven planned wells were sampled in 2020 resulting in 100 percent completeness for well sampling and field parameters (**Table 10-3**). Additionally, all well samples collected were analyzed at the laboratory resulting in 100 percent analytical completeness (**Table 10-3**). For the purpose of field quality control (QC), the QAPP prescribes the collection of one duplicate sample and one blank sample for every 20 samples retrieved (each must be at least 5 percent of total samples). Exceeding the standards set out in the QAPP, three duplicate samples were retrieved representing 27 percent of the wells sampled for nitrate. Three field blanks were sampled and were submitted to the laboratory resulting in 27 percent of the samples analyzed for nitrate. The assessment of completeness for field QC sampling is summarized in **Table 10-4**. A summary of the hold times specified in the QAPP for the laboratory analyses is presented in **Table 10-5**. All analyses were conducted within the allowed hold time.

Table 10-3 Completeness of Field and Analytical Testing

Constituent	Test Type	Analytical Method	Matrix	Wells Planned for Sampling	Wells Sampled	Field and Transport Complete-ness %	Total Samples Analyzed	Analytical Complete-ness %
Oxygen, Dissolved	Field parameter	SM4500-O G-2001	Ground-water	11	11	100	11	100
pH	Field parameter	SM4500-H+ B-2000	Ground-water	11	11	100	11	100
Specific Conductivity	Field parameter	SM2510-B 1997	Ground-water	11	11	100	11	100
Temperature	Field parameter	SM2550-B 2000	Ground-water	11	11	100	11	100
Nitrate + Nitrite as N	Laboratory	EPA 353.2M	Ground-water	11	11	100	11	100
			Total	**55**	**55**	**100**	**55**	**100**

** ORP and turbidity are optional field parameters.*

Table 10-4 Completeness of Field QC								
Constituent	Analytical Method	Matrix	Total Well Samples Analyzed	Field Duplicate Samples Analyzed	Field Blank Samples Analyzed	Total Samples Analyzed	Field Duplicate Complete-ness %	Field Blank Complete-ness %
Nitrate + Nitrite as N	EPA 353.2M	Ground-water	11	3	3	17	17.6	17.6
Total			**11**	**3**	**3**	**17**	**17.6**	**17.6**

Completeness values below the acceptability requirement of 5 percent are presented in bold

Table 10-5 Evaluation of Sample Hold Times							
Constituent	Analytical Method	Matrix	Hold Time	Total Samples Analyzed	Samples Analyzed within Hold Time	Acceptability %	Hold Time
Nitrate + Nitrite as N	EPA 353.2M	ground water	28 days	17	17	100	Nitrate + Nitrite as N
				Total	**17**	**17**	**100**

Acceptability values below 90 percent are presented in bold

10.1.1.3. Analytical precision and accuracy

The laboratory performed all QA/QC for laboratory precision and accuracy in accordance with the QAPP including lab blanks, lab duplicates, matrix spikes, and lab control spikes. Results of the assessment of precision and accuracy are summarized in **Tables 10-6** and **10-7** and include evaluation of chemistry QC with field and laboratory blank samples; laboratory control and matrix spikes to evaluate accuracy; and field, laboratory, and matrix spike duplicates to evaluate precision. Lab blanks, lab control spikes and lab control duplicates for nitrate had five, ten and ten samples respectively and all samples were within acceptability. Therefore, lab blanks, lab control spikes and lab control duplicates had 100% acceptability. Matrix spikes for nitrate had 10 samples and 6 samples were within acceptability which resulted in 60% acceptability. The Nitrate matrix spikes may have been outside the acceptability range because of potential heterogeneity of the native sample or other matrix effects associated, potentially a result of the high concentrations of Nitrate in the matrix sample. The analytical precision and accuracy was deemed acceptable for these constituents based on the combined results from laboratory controls, including laboratory blanks (see laboratory report QC comments and narrative).

Table 10-6 Evaluation of Field Duplicates and Blanks

Constituent	Analytical Method	Matrix	Sample Type	Acceptability Requirement	Total Samples	Samples within Acceptability	Acceptability %
Nitrate + Nitrite as N	EPA 353.2M	Ground-water	Field Duplicate	RPD ≤ 25	3	3	100
				Field Duplicate Total	**3**	**3**	**100**

Acceptability values below 90 percent are presented in bold

Constituent	Analytical Method	Matrix	Sample Type	Acceptability Requirement	Total Samples	Samples within Acceptability	Acceptability %
Nitrate + Nitrite as N	EPA 353.2M	ground water	Field Blank	< RL or 1/5 environmental sample	3	3	100
				Field Blank Total	**3**	**3**	**100**

Acceptability values below 90 percent are presented in bold

Table 10-7 Evaluation of Field Duplicates and Blanks

Constituent	Analytical Method	Matrix	Sample Type	Acceptability Requirement	Total Samples	Samples within Acceptability	Acceptability %
Lab Blanks							
Nitrate + Nitrite as N	EPA 353.2M	ground water	Lab Blank	< RL	5	5	100
				Lab Blank Total	**5**	**5**	**100**
Lab Control Spikes							
Nitrate + Nitrite as N	EPA 353.2M	ground water	LCS	PR 90-110	10	10	100
				Lab Control Total	**10**	**10**	**100**
Matrix Spikes							
Nitrate + Nitrite as N	EPA 353.2M	Ground-water	MS	PR 80-120	10	6	60
				Matrix Spike Total	**10**	**6**	**60**
Analytical Duplicates							
Nitrate + Nitrite as N	EPA 353.2M	ground water	MSD/LCSD/Lab Dup	RPD ≤ 25	10	10	100
				Analytical Duplicate Total	**10**	**10**	**100**

Acceptability values below 90 percent are presented in bold.
LCS=lab control spike; MS=matrix spike; MSD=matrix spike duplicate; LCSD=lab control spike duplicate

10.1.1.4. Quality assurance evaluation conclusions

All groundwater quality data are considered acceptable based on the review of QA/QC procedures and results in accordance with the requirements in the QAPP. The recovery percentages recorded for some matrix spikes for nitrate were discussed and reviewed with laboratory staff and are not believed to be caused by issues related to laboratory accuracy and precision or otherwise indicative of issues affecting the reliability of the data. No issues were identified that would significantly affect the reliability or usability of the data obtained as part of the 2020 sampling event; therefore, all data were accepted and are considered useable.

10.1.1.5. Electronic Data Submittal and Data Uploaded to GeoTracker

In accordance with the requirements for electronic data submittal, this section briefly describes the information the Coalition has already submitted to GeoTracker.

10.1.2. Five-Year Assessment Results and Discussion

LSCE provided a series of figures and a table specific to Grassland Drainage Area Coalition in **Appendix H** as part of the Five-Year Assessment. The figures include maps of nitrate and TDS concentrations and trends in GQTM and Upper Zone wells.

The map of average nitrate conditions (**Figure H-1**) displays 5 scales of nitrate concentrations ranging from less than 2.5 mg/L to greater than 10 mg/L. All concentration ranges except 7.5-10.0 mg/L are present within the Grassland Drainage Area Coalition boundaries. Four centrally located wells and the northern-most well have higher (>10 mg/L as N) concentrations. The other 6 wells have concentrations no more than 7.5 mg/L as N. Recent nitrate conditions in GQTM wells (**Figure H-2**) are the same as average conditions, indicating little change in concentrations during the period of record (2018 – 2020). The figure of most recent nitrate conditions from all wells regardless of depth or data source (**Figure H-3**) presents similar results to the most recent GQTM conditions with significantly more wells represented. Concentrations exceeding 10 mg/L as N are mostly distributed through the center of the coalition. Most wells otherwise have concentrations less than 2.5 mg/L as N.

Ambient nitrate concentrations were interpolated with a kriging method using averaged nitrate data in the Upper Zone post-2000 and post-2010 (**Figures H-4** and **H-5**, respectively). Ambient concentrations are categorized similarly to the well concentrations, ranging from less than 2.5 mg/L as N to greater than 10 mg/L as N. Higher concentrations are concentrated in the west central region, with a sparsely disbursed mix of concentrations otherwise. Due to the post-2000 data availability, the ambient concentration map is largely the same as the GQTM well maps. Additionally, the post-2010 ambient concentrations are identical to the post-2000 concentrations.

A parametric linear regression analysis was also used to determine trends in post-2000 nitrate concentrations. Unlike the non-parametric methods, the linear regression assumes a model to predict changes in concentration with time. The rigid assumptions of the model allow less rigid data requirements compared to the Mann-Kendall analysis, including wells with 3 or more measurements in the analysis. Wells with reasonably fitting linear trends (i.e., R^2-value above 0.5) are displayed in the parametric trend map of Upper Zone wells (**Figure H-6**). Linear trends are found in 3 wells within centrally located within the coalition boundaries and 1 is located on the western edge. Of the 3 centrally located wells, there are decreasing trends in Nitrate concentration in the northern and southern wells. The centrally located well and the well on the western edge are increasing in Nitrate concentration, but at rates below 0.5 mg/L/yr as N.

Non-parametric methods were used to analyze trends in post-2000 nitrate concentrations. Mann-Kendall analyses were performed on wells with 8 or more measurements to identify statistically significant upward or downward trends. Non-parametric nitrate trends in the Upper Zone for post-2000 data are shown in **Figure H-7**. A small group of wells in the eastern edge of the Coalition show insufficient evidence of a nitrate trend or a decreasing nitrate trend. Given these analysis criteria, there are not yet results for GQTM wells within Grassland Drainage Area Coalition boundaries.

The summarized table of GQTM well parametric analyses gives the results of 5 GQTM wells within the coalition boundary (**Table H-1**). All wells are located on irrigated land. One of the wells doesn't show strong evidence of a linear trend, 2 wells are decreasing and 2 are increasing.

The map of recent TDS concentrations is subdivided into concentration scales ranging from less than 250 mg/L to greater than 1000 mg/L (**Figure H-8**). Eleven wells are shown in the map, all of which have TDS concentrations exceeding 1000 mg/L.

10.1.3. Five-Year High Vulnerability Area Update

10.1.3.1. Existing HVA Compared to Nitrate Exceedances

In accordance with the WDRs and to address elements of the five-year review and update of the GAR, the Coalition reviewed the HVA delineated in the original 2016 GAR. To evaluate the sufficiency of the 2016 HVA, all readily and publicly available data on historical nitrate concentrations were examined within the Coalition region and compared with the 2016 HVA. Of the total of 296 unique wells within the Coalition region with nitrate concentration data, 152 wells have historical concentrations of nitrate exceeding the MCL of 10 mg/L (**Figure 10-2**). Of these historical nitrate exceedance wells, 145 wells (95 percent) are located within the 2016 HVA boundary developed as part of the original GAR.

The seven nitrate exceedance records for wells located outside the extent of the 2016 HVA were individually reviewed to evaluate trends and patterns in concentrations and characteristics of the wells and sites. During this review, it was determined that three of the exceedance wells

(SL0601924429-MW-1, SL0601924429-MW-2, SL0601924429-MW-3) located outside of the 2016 HVA (**Figure 10-2**) are associated with a former fertilizer facility regulated contamination site for which nitrogen is a constituent of concern. The historical nitrate concentrations in these regulated facility monitoring wells are as high as 1,060 mg/L (as nitrogen) and are not related to agricultural management practices.

One of the other exceedance wells (12S12E12R001M) located outside the 2016 HVA was previously investigated during the preparation of the GAR in 2016 and was excluded at that time because of questionable and conflicting information. The well was sampled twice in 1953, first in March and again in September. Records for the March 1953 sampling indicate a nitrate concentration of 51.1mg/L with a TDS of 34,826 mg/L. The results for the September 1953 indicate nitrate concentrations of 0.07 mg/L and TDS concentrations of 11,438 mg/L. Although the TDS concentrations for both samples collected in 1953 are high, the concentration measured in the March 1953 sample is similar to the concentration of typical seawater or brine (35,000 mg/L) and is considerably higher than the concentration of tile drain water in the area. No other wells with high nitrate concentrations are known to exist in the area and most of the data for nearby wells indicate nitrate concentrations less than 2.5 mg/L. The closest well with nitrate data is GQTM well GDACX00016 which had a nitrate concentration of 1.7 mg/L in 2020. Considerable discussion of the rationale for not considering the data at 12S12E12R001M an exceedance is presented in the 2016 GAR Addendum. Consistent with development of the 2016 HVA, the 12S12E12R001M datapoint was again not considered an exceedance in the review and update of the HVA.

10.1.3.2. HVA Update

The five-year review of the Coalition’s HVA seeks to account for all nitrate exceedances in the Coalition that may be related to irrigated agriculture activities. The review of the HVA described above indicates three exceedances located outside of the extent of the 2016 HVA. The three nitrate exceedances located outside and with potential to be related to irrigated agricultural practices are all in very close proximity to the 2016 HVA. Because of the continued strong spatial agreement and close distance between the original HVA and historical nitrate exceedance wells, only minor modifications to the 2016 HVA were performed to address the three exceedance wells outside the 2016 HVA. Given the small number of exceedance wells outside the HVA and their close proximity to the original HVA, modifications to the extent of the HVA were made using professional judgement with consideration of the hydrogeologic characteristics near the exceedance wells. In all cases, the outline of the HVA was expanded and redrawn to encompass all exceedance wells outside the HVA using guidance from mapping of soil hydraulic conductivity from NRCS SURGO data (NRCS, 2013) and recharge potential from the Soil Agricultural Groundwater Banking Index (SAGBI) (O’Geen et al., 2015) together with the vulnerability considerations used in the original GAR. Some of the exceedance wells outside the HVA were located very near the 2016 HVA and where soil or other hydrogeologic factors do not suggest high vulnerability conditions. In such cases, only slight adjustments to the 2016 HVA were made to encompass the exceedance wells. No modifications to the original HVA were made that resulted in removing areas previously designated as HVA; the HVA modifications completed for the 2021 HVA only includes an expansion of the HVA. The extent of the 2021 HVA is presented in **Figure 10-3**.

The HVA modifications completed for the 2021 HVA represent an increase in area of 152 acres from the 2016 HVA. The total area within the 2021 HVA is 34,105 acres.

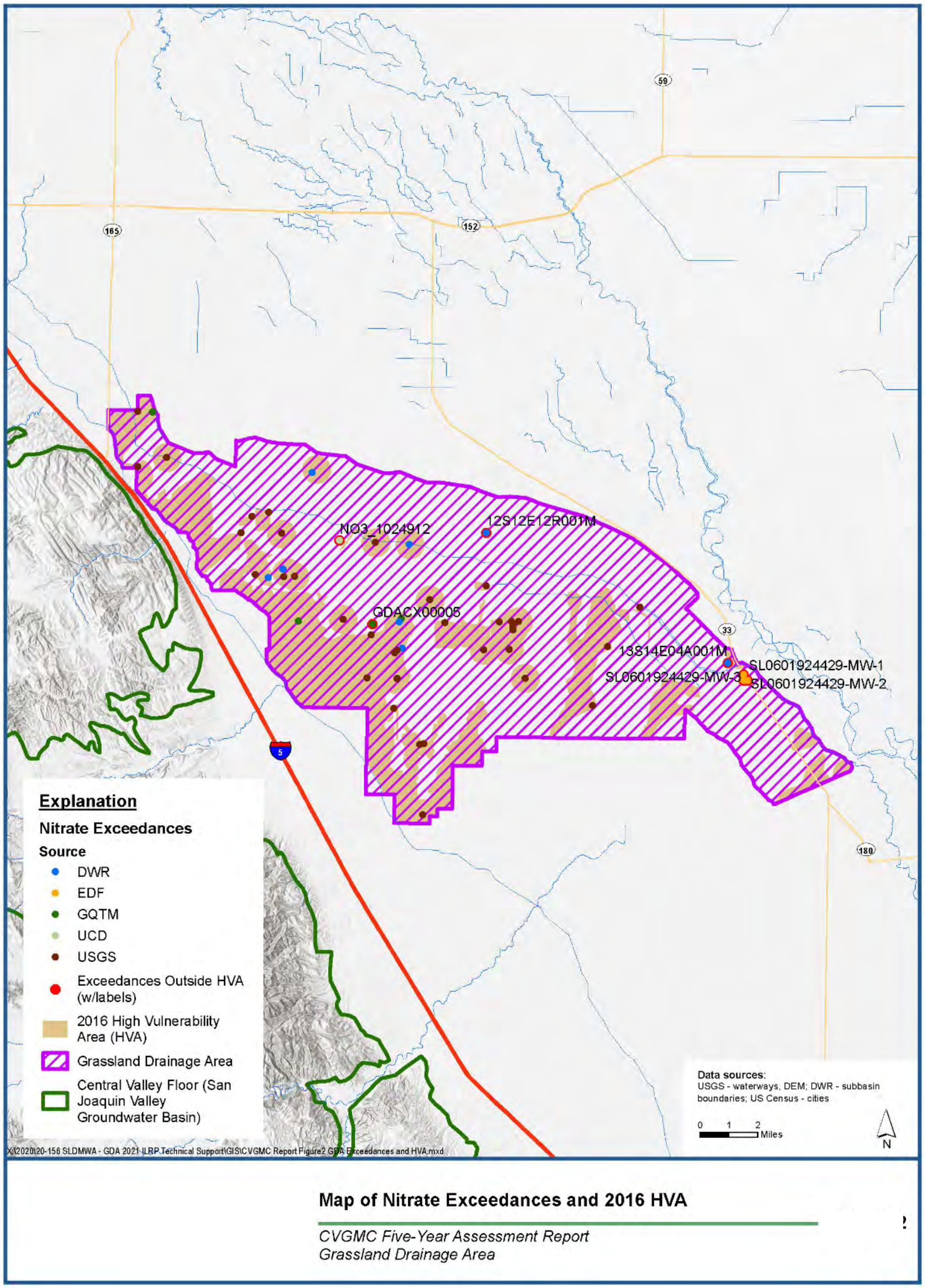

Figure10-2. Map of Nitrate Exceedances and 2016 HVA

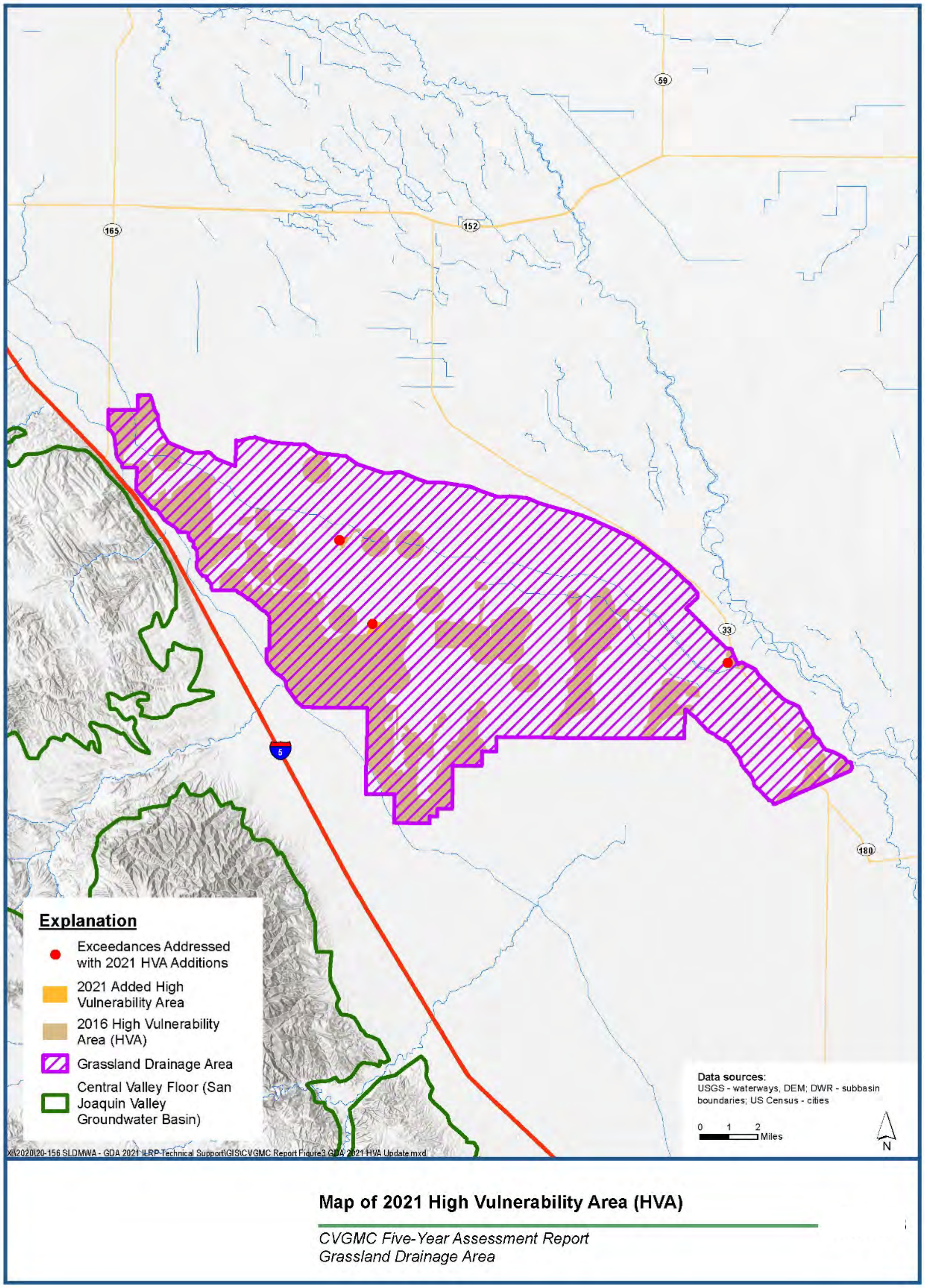

Figure 10-3. Map of 2021 High Vulnerability Area (HVA)

DRAFT REPORT | SEPTEMBER 2021

11. KAWEAH BASIN WATER QUALITY ASSOCIATION GROUNDWATER QUALITY FIVE-YEAR ASSESSMENT REPORT

PREPARED FOR

KAWEAH BASIN WATER QUALITY ASSOCIATION

KAWEAH BASIN
WATER QUALITY ASSOCIATION

PREPARED BY

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

11. KAWEAH BASIN WATER QUALITY ASSOCIATION GROUNDWATER QUALITY FIVE-YEAR ASSESSMENT REPORT

11.1. Groundwater Quality Trend Monitoring Results 2020

11.1.1. GQTM Summary of 2020 Network and Sampled Wells

11.1.1.1. GQTM Network Development Background

Attachment B, Section IV.C.2 of the General Order requires the Trend Monitoring Workplan to implement a groundwater monitoring network that represents both high and low vulnerability areas and employs relatively shallow wells or existing monitoring well networks. The network must consist of a sufficient number of wells to provide adequate coverage in the Kaweah Basin Water Quality Association (KBWQA) area to assess water quality conditions of groundwater and regional effects of irrigated agriculture. In vetting the proposed monitoring areas, consideration was made to include high vulnerability areas (HVA) and low vulnerability areas (LVA), as proposed in the 2015 Groundwater Quality Assessment Report (GAR), in order to ensure that the trend monitoring network design was as representative as possible. A map depicting the proposed monitoring areas overlaid on the HVAs and LVAs, as defined in the GAR, is presented as **Figure 11--1**.

Monitoring areas were not spatially delineated but rather by specific criteria. Potential general monitoring areas were initially selected by reviewing crop maps for the largest crop types (by acreage) and selecting areas near each of the crop types that were:

- Located above relatively shallow groundwater.
- Generally, upgradient of a disadvantaged community (DAC) or within relatively close proximity of a DAC.
- Located in both LVAs and HVAs.
- In areas with greater potential recharge as documented in the GAR.
- Generally representative of Natural Resources Conservation Service (NRCS) soil textural classes present in the KBWQA area.
- Not downgradient from an area where other land application practices would potentially lead to water quality issues that could not be differentiated from those resulting from farming practices.

11.1.1.2. Well Site Locations

Once the initial crop type monitoring locations were selected, additional monitoring areas were selected so that areas with deeper groundwater were represented. Within the KBWQA area

11 crop types comprise approximately 95% of cropped acreage. In selecting proposed monitoring areas, efforts were made to ensure that each of the 11 most prominent crop types were represented in the trend monitoring network design. Crop types with the largest acreage were considered more strongly than areas with minor crop types with respect to monitoring network coverage. As a result, more proposed monitoring areas were selected from crops with the largest acreage (i.e., citrus, walnuts, and pecans).

Each well that met the initial criteria was evaluated via Digimaps/aerial review to determine its suitability in terms of proximity to potential existing groundwater impacts not related to irrigated lands, or other limiting variables. Wells located in proximity to dairies, certain industrial practices, or high densities of septic systems, were removed from consideration. Many wells were difficult to locate using this method due to missing or out of date Assessor Parcel Numbers (APN). Location information was found to be more accurate for wells with available well permits than location information found in well logs. **Figure 11-1** provides a map of KBWQA's 24 well monitoring network that was sampled in summer of 2020. **Table 11-1** show's provides General Order required well location and construction details, including: well use, sanitary seal depth, total well depth, perforated intervals, year drilled, and latitude and longitude of sampling locations.

Table 11-1. 2020 GQTM Network Wells

Field Point Name / GQTM Well ID	GQTM Well Name	Well Use	Well Construction Information					Latitude	Longitude	Datum	Depth to the Bottom of Upper Zone (feet)
			Seal Depth (feet)	Total Well Depth (feet)	Depth Top of Screen (feet)	Depth Bottom of Screen (feet)	Year Drilled				
KBWQA00001	KBWQA00001	Domestic	50	116	56	116	1995	36.42906	-119.108579	NAD83	30.1379
KBWQA00002	KBWQA00002	Domestic	20	247			2001	36.25549	-119.230255	NAD83	217.749
KBWQA00003	KBWQA00003	Domestic	20	275			1992	36.17874	-119.465623	NAD83	198.738
KBWQA00004	KBWQA00004	Domestic	20	140			1997	36.38413	-119.110619	NAD83	140.664
KBWQA00005	KBWQA00005	Irrigation	20	176	96	166	1998	36.39552	-119.144009	NAD83	117.63
KBWQA00006	KBWQA00006	Irrigation	21	93			1992	36.36701	-119.073148	NAD83	134.264
KBWQA00007	KBWQA00007	Irrigation	20	192	92	192	1994	36.34411	-119.116969	NAD83	134.639
KBWQA00008	KBWQA00008	Domestic	20	160			1997	36.33072	-119.146025	NAD83	137.689
KBWQA00009	KBWQA00009	Irrigation	20				2002	36.1639	-119.344966	NAD83	249.05
KBWQA00010	KBWQA00010	Irrigation	20	159	140	155	2013	36.35541	-119.165169	NAD83	121.11
KBWQA00011	KBWQA00011	Irrigation	20	168	60	120	2013	36.36278	-119.188157	NAD83	119.402
KBWQA00012	KBWQA00012	Irrigation	20	210	90	130	1991	36.38733	-119.18658	NAD83	136.946
KBWQA00013	KBWQA00013	Domestic	20	237	140	195	1993	36.42116	-119.231659	NAD83	167.308
KBWQA00014	KBWQA00014	Domestic	20	180			1990	36.37277	-119.25757	NAD83	191.592

Table 11-1. 2020 GQTM Network Wells												
Field Point Name / GQTM Well ID	GQTM Well Name	Well Use	Well Construction Information					Latitude	Longitude	Datum	Depth to the Bottom of Upper Zone (feet)
			Seal Depth (feet)	Total Well Depth (feet)	Depth Top of Screen (feet)	Depth Bottom of Screen (feet)	Year Drilled				
KBWQA00015	KBWQA00015	Domestic	20	150			1995	36.35863	-119.219952	NAD83	176.199
KBWQA00016	KBWQA00016	Domestic	23	180	100	180	2002	36.36813	-119.277349	NAD83	184.703
KBWQA00017	KBWQA00017	Domestic	20	168			2002	36.38125	-119.285407	NAD83	193.464
KBWQA00018	KBWQA00018	Irrigation	20	150	88	120	1991	36.33437	-119.184547	NAD83	125.394
KBWQA00019	KBWQA00019	Domestic	20	271	90	130	1991	36.21964	-119.38589	NAD83	216.25
KBWQA00020	KBWQA00020	Domestic	55	130	80	130	1992	36.29554	-119.174476	NAD83	176.318
KBWQA00021	KBWQA00021	Irrigation	20	225			1993	36.26765	-119.107291	NAD83	219.093
KBWQA00022	KBWQA00022	Domestic	20	192			1992	36.2648	-119.26506	NAD83	231.381
KBWQA00023	KBWQA00023	Domestic	20	209	189	209	2003	36.33706	-119.361466	NAD83	191.313
KBWQA00024	KBWQA00024	Domestic	25	258	82	250	2005	36.36729	-119.436826	NAD83	208.19

The selected groundwater monitoring well distribution was influenced by several factors, including:

- The spatial distribution of major crop areas for example, citrus, walnuts and pecans.
- The large areas of dairy land located in the northwestern, southwestern, and western portions of the Primary Area that were generally avoided, as groundwater quality data attributable to general farming practices would be difficult to discern from that of dairy lands.
- The significantly deeper groundwater depths in the western half of the Primary Area that would result in more significant time-lags between the actions on the land surface and the potential resulting changes in groundwater quality.
- The areas of higher potential recharge, as determined in the GAR, are generally located in the central eastern portion of the Primary Area.

Where available, selected wells draw water from the Upper Zone, as defined in Section 3.3 of the Central Valley Groundwater Monitoring Collaborative (CVGMC) Workplan. The Upper Zone includes the area from the bottom of the vadose zone to any confining layers (specifically the Corcoran Clay, if present).

Due to the long-term monitoring requirement, it is anticipated that the well network will need to be modified over time. Necessary changes will be made to maintain a regional representation of groundwater quality. The KBWQA will maintain information for backup wells to ensure the continuity of the trend monitoring program. In addition, the KBWQA supports the concept presented in Section 3.6, “Dynamic Network: Adaptive Design and Refinement”, CVGMC Technical Workplan. The initial well network design will require ongoing evaluation of the spatial representation and sufficiency to fulfill the requirements of the General Order.

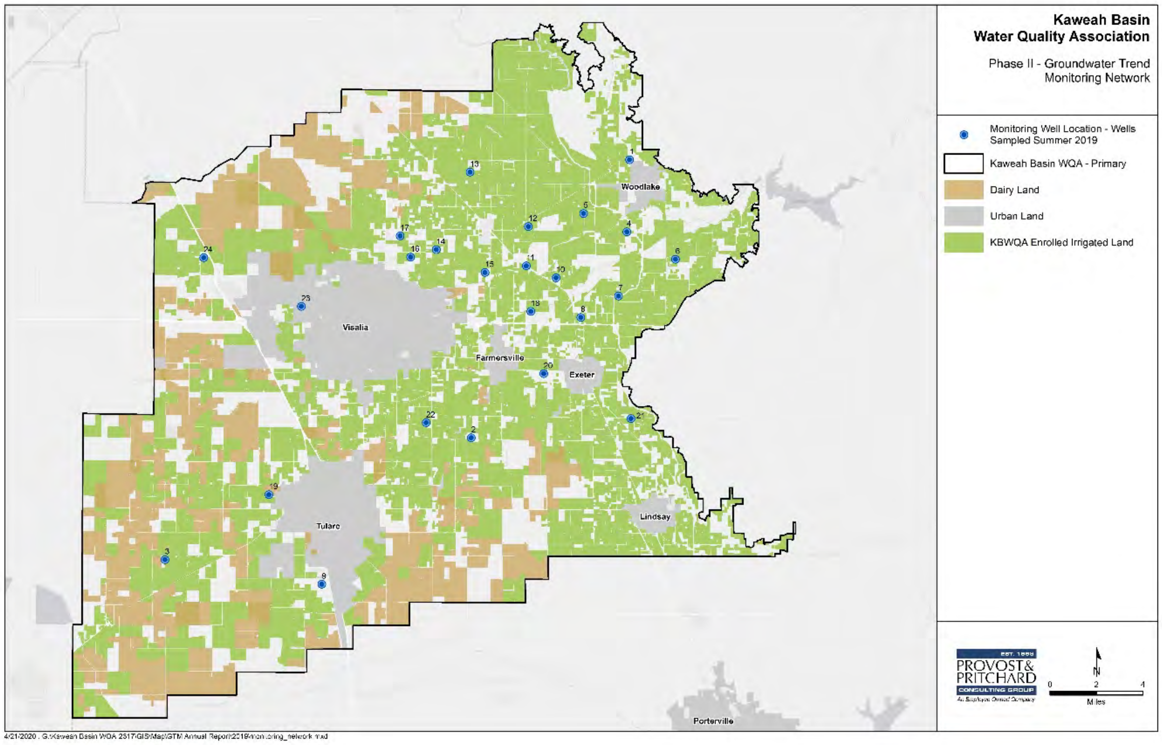

Figure 11-1. KBWQA GQTM Network

11.1.2. Summary of Quality Assurance Evaluation for 2020 Sampling Event

11.1.2.1. Purging, Sample Handling, and Custody

The KBWQA collected groundwater samples during the summer of 2020. All 24 wells within the network were sampled, including 15 domestic wells and 9 agricultural wells. For nitrate as nitrogen (NO_3-N) results were compared against the Primary Maximum Contaminant Level (MCL) of 10 milligrams per liter (mg/L).

Groundwater quality samples collected in 2020 samples followed sampling procedures described in the 2019 KBWQA Standard Operating Procedure (SOP). As described in the SOP, wells were purged until a volume equal to or greater than three well casings was expelled and measured field parameters stabilized (less than 10% difference for three consecutive readings). Sampling event field parameters, field notes and purge volumes are recorded on field sheets. Collected field parameters include pH, electrical conductivity, temperature, and dissolved oxygen (DO). Field parameters and laboratory results are summarized in **Table 11-2**.

Once collected, samples are sealed within plastic bags and transported on wet ice directly from the field to the Moore Twining Associates (MTA) laboratory. All samples are accompanied by a chain of custody (COC) that records changes in sample custody. Records are maintained within the contracted lab that include the checking in and out of samples during the analytical process as well as the disposal of samples following completion of the analytical process and archival. Samples are held under proper storage conditions until all analyses are completed.

Table 11-2. 2020 GQTM Sampling Results									
Field Point Name / GQTM Well ID	GQTM Well Name	Well Use	Date Sampled	Nitrate as N (mg/L) Lab	pH Field	Specific Conductance (uS/cm) Field	Temperature (°C) Field	Dissolved Oxygen (mg/L) Field	Depth to Water (ft) Field
KBWQA00001	KBWQA00001	Domestic	6/4/2020	15	7.14	1330	23.19	6.68	45
KBWQA00002	KBWQA00002	Domestic	6/9/2020	0.2	7.89	107	20.92	7.7	105
KBWQA00003	KBWQA00003	Domestic	6/10/2020	14	7.64	410	21.11	5.75	183
KBWQA00004	KBWQA00004	Domestic	6/4/2020	4.9	7.56	409	22.69	2.75	9
KBWQA00005	KBWQA00005	Irrigation	6/17/2020	4.1	7.28	365	20.94	6.34	70
KBWQA00006	KBWQA00006	Irrigation	6/9/2020	25	7.04	992	20.52	5.76	40
KBWQA00007	KBWQA00007	Irrigation	6/2/2020	13	7.26	798	20.57	10.33	47.5
KBWQA00008	KBWQA00008	Domestic	6/2/2020	1.8	7.4	211	20.69	6.2	50.75
KBWQA00009	KBWQA00009	Irrigation	6/10/2020	0.14	9.27	279	22.78	1.86	205
KBWQA00010	KBWQA00010	Irrigation	6/17/2020	1.8	7.18	238	19.01	2.39	16
KBWQA00011	KBWQA00011	Irrigation	6/2/2020	2.6	7.46	288	30.93	5.57	15.2
KBWQA00012	KBWQA00012	Irrigation	6/24/2020	25*	7.77	1130	22.03	6.92	91
KBWQA00013	KBWQA00013	Domestic	6/4/2020	12	7.51	786	21.94	7.53	145
KBWQA00014	KBWQA00014	Domestic	6/9/2020	5.6	7.58	378	19.81	9.74	113
KBWQA00015	KBWQA00015	Domestic	6/4/2020	4.1	7.97	282	19.32	8.03	85
KBWQA00016	KBWQA00016	Domestic	6/2/2020	16	7.3	534	19.91	8.93	101.7
KBWQA00017	KBWQA00017	Domestic	6/2/2020	14	7.64	587	20.37	8.09	116
KBWQA00018	KBWQA00018	Irrigation	6/4/2020	0.55	6.95	175	18.54	10.82	68
KBWQA00019	KBWQA00019	Domestic	6/10/2020	5.9	9.69	215	21.61	5.63	183
KBWQA00020	KBWQA00020	Domestic	6/9/2020	4.1	7.38	523	20.02	6	96
KBWQA00021	KBWQA00021	Irrigation	6/9/2020	16	7.7	2130	22.17	6.12	145

Table 11-2. 2020 GQTM Sampling Results									
Field Point Name / GQTM Well ID	GQTM Well Name	Well Use	Date Sampled	Nitrate as N (mg/L) Lab	pH Field	Specific Conductance (uS/cm) Field	Temperature (°C) Field	Dissolved Oxygen (mg/L) Field	Depth to Water (ft) Field
KBWQA00022	KBWQA00022	Domestic	6/9/2020	4.6	7.47	441	20.58	5.77	116
KBWQA00023	KBWQA00023	Domestic	6/4/2020	6.4	7.5	440	21.76	7.48	146
KBWQA00024	KBWQA00024	Domestic	6/10/2020	19	7	1170	22.03	8.26	122

*Result was analyzed as Nitrate + Nitrite as N. Nitrite as N was ND.

NR=Not Recorded

11.1.2.2. Access and Field and Analytical Completeness

Due to the fluctuation of groundwater conditions and changes in well suitability, the submitted GTM network was, and continues to be, considered dynamic. Field crews were able to successfully acquire samples from all 24 wells within the network during the 2020 sampling timeframe. No qualified field or laboratory results occurred during the 2020 season.

Completeness of field and analytical testing, field quality control, and evaluation of sample hold times summaries are available in **Table 11-3**, **Table 11-4**, and **Table 11-5**, respectively.

Table 11-3. Completeness of Field and Analytical Testing

Constituent	Test Type	Analytical Method	Matrix	Wells Planned for Sampling	Wells Sampled	Field and Transport Completeness %	Total Samples Analyzed	Analytical Completeness %
Oxygen, Dissolved	Field parameter	EPA 360.1	Ground-water	24	100	24	100	24
pH	Field parameter	EPA 150.1	Ground-water	24	100	24	100	24
Specific Conductivity	Field parameter	EPA 120.1	Ground-water	24	100	24	100	24
Temperature	Field parameter	SM 2550	Ground-water	24	100	24	100	24
Nitrate as N	Laboratory	EPA 300.0	Ground-water	24	100	24	100	24
			Total	**120**	**120**	**100**	**120**	**100**

Table 11-4. Completeness of Field QC

Constituent	Analytical Method	Matrix	Total Well Samples Analyzed	Field Duplicate Samples Analyzed	Field Blank Samples Analyzed	Total Samples Analyzed (well and duplicates)	Field Duplicate Completeness %	Field Blank Completeness %
Nitrate as N	EPA 300.0	groundwater	24	2	2	28	7.1	7.1
		Total	**24**	**2**	**2**	**28**	**7.1**	**7.1**

Completeness values below the acceptability requirement of 5 percent are presented in **bold**.

Table 11-5. Evaluation of Sample Hold Times						
Constituent	Analytical Method	Matrix	Hold Time	Total Samples Analyzed	Samples Analyzed within Hold Time	Acceptability %
Nitrate as N	EPA 300.0	groundwater	28 days / 48 hours	28	28	100
			Total	**28**	**28**	**100**
Acceptability values below 90 percent are presented in **bold**.						

11.1.2.3. Analytical precision and accuracy

Reducing cross-contamination and measurement errors is critical to ensuring accurate GTM sampling results. **Table 11-6** and **Table 11-7** summarize both field and laboratory accuracy quality control checks. The acceptability of field duplicates, field blanks, and laboratory controls and spikes was 100%.

Table 11-6. Evaluation of Field Duplicates and Blanks							
Constituent	Analytical Method	Matrix	Sample Type	Acceptability Requirement	Total Samples	Samples within Acceptability	Acceptability %
Nitrate as N	EPA 300.0	groundwater	Field Duplicate	RPD ≤ 25	2	2	100
				Field Duplicate Total	**2**	**2**	**100**
Acceptability values below 90 percent are presented in **bold**.							
Constituent	Analytical Method	Matrix	Sample Type	Acceptability Requirement	Total Samples	Samples within Acceptability	Acceptability %
Nitrate as N	EPA 300.0	groundwater	Field Blank	< RL or 1/5 environmental sample	2	2	100
				Field Duplicate Total	**2**	**2**	**100**
Acceptability values below 90 percent are presented in **bold**.							

Table 11-7. Evaluation of Lab Controls and Spikes							
Constituent	Analytical Method	Matrix	Sample Type	Acceptability Requirement	Total Samples	Samples within Acceptability	Acceptability %
Lab Blanks							
Nitrate as N	EPA 300.0	groundwater	Lab Blank	< RL	7	7	100
				Lab Blank Total	7	7	100
Lab Control Spikes							
Nitrate as N	EPA 300.0	groundwater	LCS	PR 90-110	14	14	100
				Lab Control Total	14	14	100
Matrix Spikes							
Nitrate as N	EPA 300.0	groundwater	MS	PR 80-120	28	28	100
				Matrix Spike Total	28	28	100
Analytical Duplicates							
Nitrate as N	EPA 300.0	groundwater	MSD/LCSD/Lab Dup	RPD ≤ 25	21	21	100
				Analytical Duplicate Total	21	21	100
Acceptability values below 90 percent are presented in **bold**.							
LCS=lab control spike; MS=matrix spike; MSD=matrix spike duplicate; LCSD=lab control spike duplicate							

11.1.2.4. Quality Assurance Evaluation Conclusions

As demonstrated in **Tables 11-3** through **11-7**, groundwater quality results collected in 2020 reached 100% QC completeness with no qualified results. The 100% completeness exceeds the minimum completeness requirement of 90% specified in the General Order. Laboratory results, field blanks, field duplicates, and laboratory spikes also reached 100% completeness. All results appear accurate and were reported to the proper level of precision. Much of MTA's laboratory equipment can analyze constituents to a lower level than the minimum detection and reporting levels, allowing the KBWQA to have confidence that adequate precision is achieved. If future sampling results deem necessary, the KBWQA will take corrective actions as described in the CVGMC Comprehensive Quality Assurance Plan (CQAP) to address potential issues and work to prevent them from reoccurring.

11.1.3. Five-Year Assessment Results and Discussion

11.1.3.1. Nitrate Concentrations

LSCE provided a series of figures and a table specific to Kaweah Basin Water Quality Association in **Appendix I** as part of the Five-Year Assessment. The nitrate map figures (**Figures I-1** through **I-3**) show nitrate concentrations with green to orange colors representing relative concentrations that are less than or equal to the Maximum Contaminant Level (MCL) of 10 mg/L

Nitrate-Nitrogen. Red represents concentrations that are greater than the MCL, and therefore may require replacement drinking water upon further investigation.

Other figures (**Figures I-4** and **I-5**) in **Appendix I** show ambient Upper Zone nitrate data since 2000 and 2010, respectively. The data points have been kriged to show areas of higher and lower nitrate concentrations. The lowest concentrations are within the Kaweah River delta, while concentrations tend to increase away from the delta and its distributaries.

11.1.3.2. Nitrate Point Data

The first figure in **Appendix I** (**Figure I-1**) shows average nitrate concentrations in KBWQA groundwater quality trend monitoring wells. The lowest concentrations are within the Kaweah River delta, while concentrations tend to increase along the north and south edges away from the delta and its distributaries. The data is sparser in the west of the coalition than in the east due to the GQTM network configuration.

Figure I-2 in **Appendix I** shows the most recent nitrate concentrations in KBWQA groundwater quality trend monitoring wells. The lowest concentrations are within the Kaweah River delta, while concentrations tend to increase along the north and south edges away from the delta and its distributaries. The data is sparser in the west of the coalition than in the east due to the GQTM network configuration.

Figure I-3 in **Appendix I** shows the most recent nitrate concentrations from all wells that had nitrate testing performed. The lowest concentrations tend to be in the Kaweah River delta and along its distributaries, and in the vicinity of Visalia and Tulare.

Figure I-6 in **Appendix I** shows parametric nitrate trends in the Upper Zone after 2000. A linear regression trend analysis was used. The analysis was run for wells with three or more nitrate samples without requiring any samples having been collected before 2000. The green points located mostly in the western areas of the KBWQA represent nitrate trends that are decreasing. Pink and red points are interspersed throughout the region and represent increasing nitrate concentrations.

Figure I-7 in **Appendix I** shows nonparametric nitrate trends in the Upper Zone after 2000. The Mann-Kendall and Teil-Sen trend analyses were used. The analyses were run for wells with eight or more nitrate samples without requiring any samples having been collected before 2000. Green points represent nitrate trends that are decreasing. Yellow represents nitrate concentrations that are unchanged. Pink and red represent increasing nitrate concentrations. Black dots represent insufficient data. Most results are in the Visalia and Tulare cities and show predominantly increasing nitrate trends. The distribution is non-homogeneous.

11.1.3.3. Other Data

Figure I-8 in **Appendix I** shows the most recent Total Dissolved Solids (TDS) data in groundwater quality trend monitoring wells. 42% of TDS samplings were greater than 250mg/L. These wells tended to be away from the Delta, its tributaries, and urban centers.

Table I-1 in **Appendix I** shows a summary of parametric trends in groundwater quality trend monitoring wells for the San Joaquin water quality coalitions. Most coalitions do not at this time have enough wells to evaluate linear trends parametrically. Two coalitions had one well with an increasing linear trend. Two coalitions had one well with insufficient evidence of a linear trend. The KBWQA area contained one increasing linear trend at one well location within irrigated land use.

11.1.4. Five-Year High Vulnerability Area Update

11.1.4.1. Existing HVA Compared to Nitrate as Nitrogen Results

The 2015 GAR reviewed nitrogen concentration data up to February 25, 2014. Publicly available data via the State's GeoTracker GAMA database were downloaded. The data was compiled by Luhdorff & Scalmanini Consulting Engineers who also performed the Quality Assurance and Quality Control checks. A number of filters were applied to obtain the necessary information:

- KBWQA Coalition only
- Sample Dates on and after February 25, 2014
- Nitrate as N as the only Analyte Name
- NO_3-N results greater than or equal to 10 mg/L

Using ArcGIS NO_3-N data was overlaid onto the HVA map to locate which NO_3-N results were in LVAs and therefore further scrutinized. For the 13 such wells found, all station data was subset and reviewed to ascertain if trend data is available over time.

From February 25, 2014 until December 31, 2020, there have been 534 NO_3-N results equal to or above the MCL of 10 mg/L measured within the Kaweah Basin Water Quality Association boundaries. 529 of these results occurred in the Primary Area, whereas 5 occurred in the Supplemental Area.

Most results at or above the MCL fall within previously delineated HVAs. 20 of these NO_3-N results were measured in 13 wells within LVAs. 8 wells had one result in this period, while 3 had two results, and 2 had three results. These 13 wells are candidates for potentially revising the surrounding areas to High Vulnerability status.

Some of these LVA wells with new NO_3-N results at or above the MCL were found to be collected from the same physical wells, but depending on the monitoring network, they were given a different 'well code'. These occurrences typically showed equivalent sample data as well as equivalent GPS locations.

Duplicated well information was combined as follows:

- KBWQA00012 and AGC100012325-KBWQA00012
- KBWQA00024, AGC100012325-KBWQA00024, and AGW080011471-HOUSE DOME
- S4-TUSK-HLS03 and USGS-363000119080001
- S4-TUSK-KAW27 and USGS-361200119010001

Figure 11-2 shows the 2015 HVA and LVA delineations. The green dots represent wells with NO_3-N results under 10 mg/L since February 25, 2014. The red dots represent wells that had at least one result at or above the MCL since then. There are 13 labeled wells that denote new wells with NO_3-N results at or above the MCL in LVA areas.

11.1.4.2. HVA Update

To determine which areas to update to HVA status, the following methodology was applied. For the wells in LVA areas with detected NO_3-N at or above the MCL, historical well sampling data was considered, where available. Only 3 wells had a sampling history that went beyond samplings detecting MCL or higher results.

- Areas that met any of the following requirements were considered for an updated HVA status:
- More than one confirmed result of NO_3-N at or above the MCL in a groundwater well and irrigated agriculture may cause or contribute to the result.
- At least one confirmed result of NO3-N at or above the MCL in a groundwater well indicating a potential condition of active degradation defined as up-trending NO_3-N detections and irrigated agriculture may cause or contribute to the result.
- At least one confirmed result of NO_3-N at or above the MCL in a groundwater well where there is a clustered trend of two or more wells in the same LVA cell and irrigated agriculture may cause or contribute to the result.

Table 11-8 details findings from the above assessment. Four LVA wells with NO_3-N results above the MCL have been placed in an HVA. The three newly designated HVA cells have been noted in **Figure 11-3** with hatched red rectangles.

Four wells which had one confirmed result at or above the MCL and did not show an upward trend or a clustered trend have been placed on a 'Watch List'. These wells are noted in yellow cells in **Figure 11-3**. More data is needed to assess their trends. One well on this list had multiple results at or above the MCL but demonstrated a recent downward NO_3-N concentration trend over three years to acceptable NO_3-N levels.

Two wells with single NO_3-N results equaling 10 mg/L were not updated to HVA, nor added to the 'Watch List', due to failing the above requirements, and because the NO_3-N results were within the typical method detection limit (MDL) margin of error. Note that the datasets did not report any MDL information.

Two wells were not upgraded to HVA due to being outside the influence of irrigated agriculture, and therefore outside the jurisdiction of this program.

Once approved by the RWQCB the KBWQA will update existing parcel information, contact appropriate members informing them of this change, and describe what this change means for the member. It is also recommended that the next step for Watch List wells be a review of new nitrate test data in the next GAR update in five years.

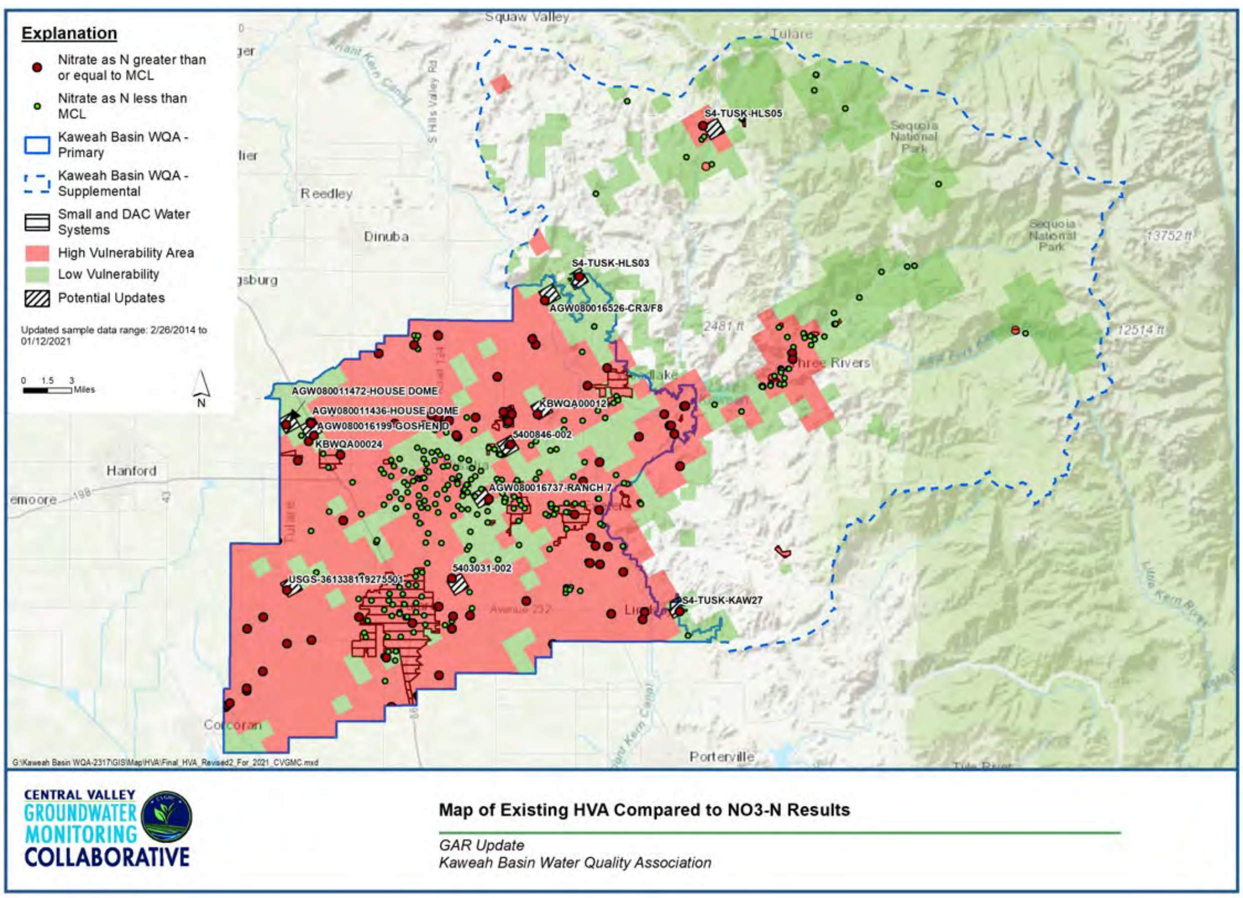

Figure 11-2. Map of Existing HVA Compared to NO_3-N Results

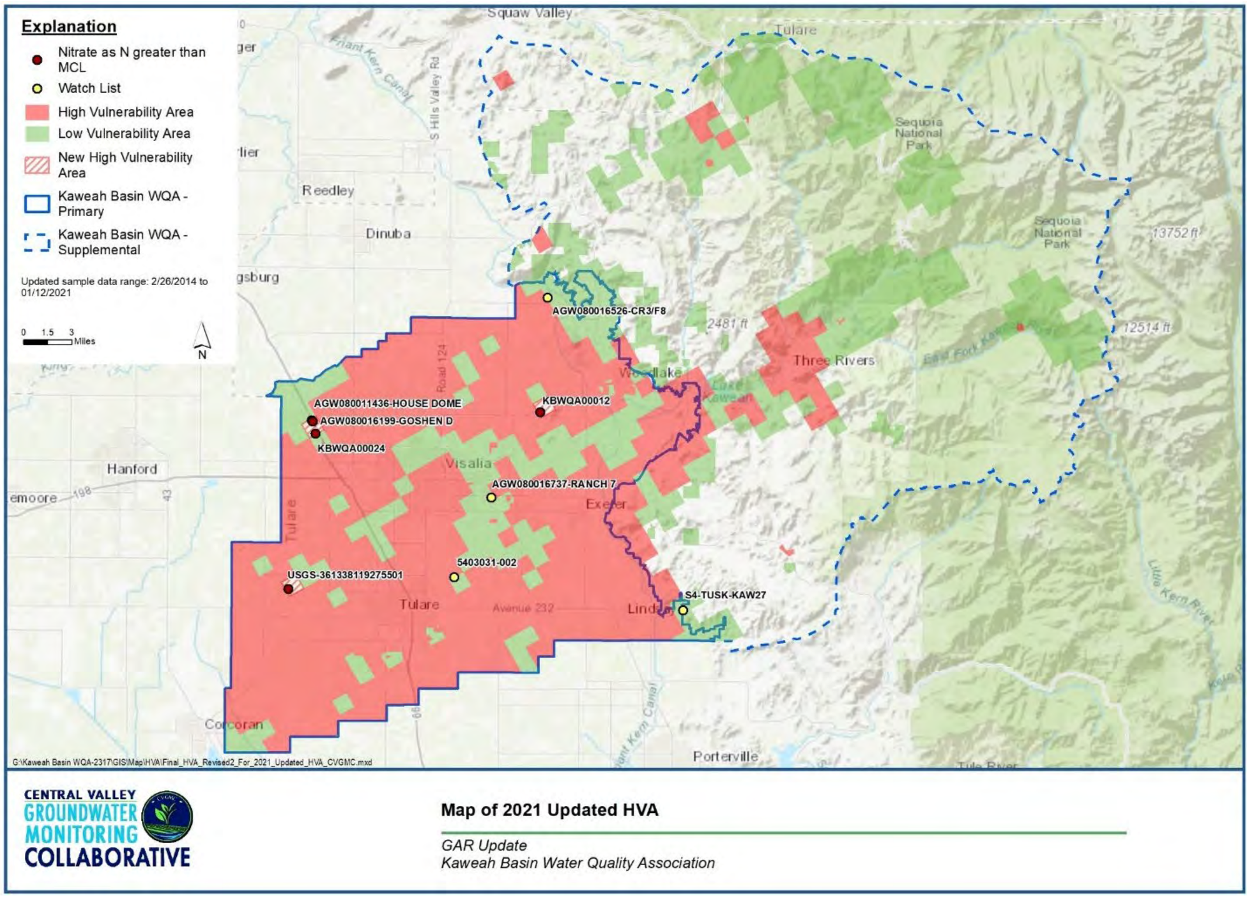

Figure 11-3. Map of 2021 Updated HVA

DRAFT REPORT | SEPTEMBER 2021

12. KERN RIVER WATERSHED COALITION AUTHORITY GROUNDWATER QUALITY FIVE-YEAR ASSESSMENT REPORT

PREPARED FOR

KERN RIVER WATERSHED COALITION AUTHORITY

Kern River Watershed Coalition Authority

PREPARED BY

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

12. KERN RIVER WATERSHED COALITION AUTHORITY GROUNDWATER QUALITY FIVE-YEAR ASSESSMENT REPORT

12.1. Groundwater Quality Trend Monitoring Results 2020

12.1.1. GQTM Summary of 2020 Network and Sampled Wells

12.1.1.1. GQTM Network Development Background

The primary objective of the Kern River Watershed Coalition Authority's (KRWCA) monitoring efforts is to maintain compliance with requirements of the Tulare Lake Basin General Order R5-2013-0120 (General Order), which requires the KRWCA to characterize water quality within the KRWCA region. As of 2020, KRWCA's groundwater quality trend monitoring (GTM) network consists of 61 active wells. Groundwater monitoring is intended to evaluate long term trends in groundwater quality, reflective of potential impacts from irrigated agricultural practices. However, collected data are also reflective of larger aquifer characteristics and potential influences (e.g., septic systems and other dischargers). Additionally, collected data may also reflect potential longstanding impacts which are not from current land management practices.

Figure 12-1 provides a map of KRWCA's 2020 monitoring network relative to major crop commodities. The 61 wells in the monitoring network were selected using the following criteria:

- Well located within a proposed monitoring area as defined by township/range;
- Well use other than point source monitoring;
- Well seal present to a minimum depth of 20 feet made of cement or bentonite;
- Well is not constructed with the screened intervals across, or beneath, a significant clay layer (i.e. Corcoran Clay); and
- Well is not located within ¼ mile of a significant point discharger.

The first round of network well selection (presented in the Groundwater Trend Monitoring Workplan (GTMW)- Phase II addendum) was intended to develop a monitoring network that was the most representative of regional impacts of irrigated agriculture. Thus, wells were only included if they drew water from the Upper Zone of the aquifer, as defined in Section 3.3 of the Central Valley Groundwater Monitoring Collaborative (CVGMC) workplan. A detailed explanation of the methodology used for determining initial network well selection can be found within the GTMW-Phase II Addendum, Section 1.1, "Groundwater Quality Trend Monitoring Implementation and Work Plan Approach," and was presented to the Central Valley Regional Water Quality Board (Regional Board) on October 8, 2018.

This original methodology ultimately yielded only 32 viable wells. Further Regional Board direction resulted in the KRWCA submitting GTMW-Phase II Addendum 2.0, which added an additional 31 wells to expand the geographic scope of the monitoring network. These 31 additional wells were not included in the first GTM Workplan Phase II-Addendum due to their perforated interval not being within 50-150 feet of average first encountered groundwater level within the area of question (Upper Zone). The Regional Board indicated during an in-person meeting on October 8, 2018, that to fill geographic coverage gaps the KRWCA could add wells into the network with depths and perforated intervals deeper than the Upper Zone of the aquifer. After the 2018 sampling season, two wells were ultimately removed from the network due to permanent mechanical failures preventing field sampling staff from successfully collecting a water sample.

12.1.1.2. Well Site Locations

The KRWCA groundwater trend monitoring network candidate wells were evaluated based on several factors, including local depth to groundwater. **Table 12-1** provides General Order required well location and construction details, including: well use, sanitary seal depth, total well depth, perforated intervals, year drilled, and latitude and longitude of sampling locations. Between the 2019 and 2020 sampling periods there were no changes to the KRWCA GTM network.

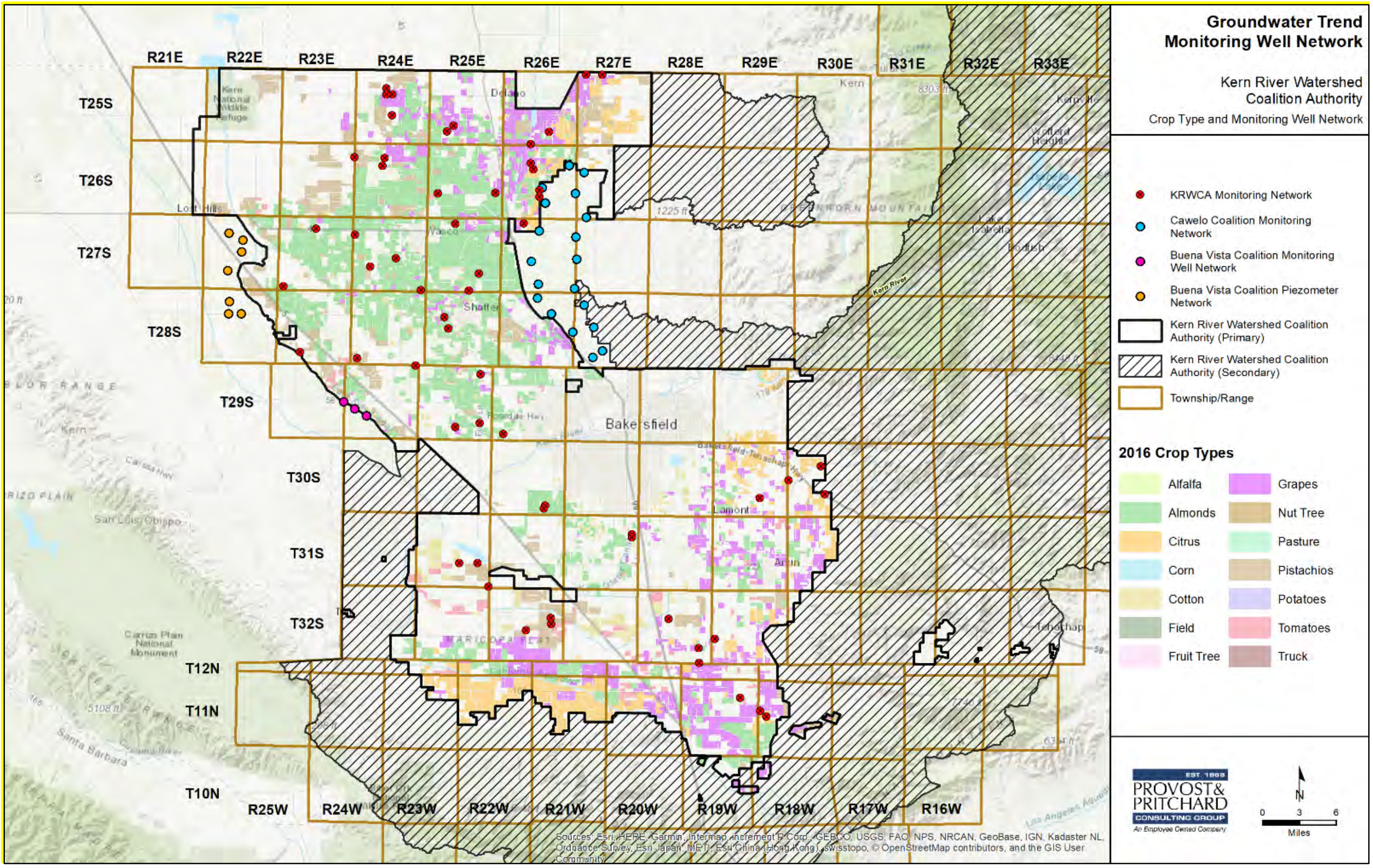

Figure 12-1. 2020 KRWCA GTM Network

Table 12-1. 2020 GQTM Network Wells

Field Point Name / GQTM Well ID	GQTM Well Name	Well Use	Well Construction Information					Latitude	Longitude	Datum	Depth to the Bottom of Upper Zone (feet)
			Seal Depth (feet)	Total Well Depth (feet)	Depth Top of Screen (feet)	Depth Bottom of Screen (feet)	Year Drilled				
KRWCA00002	KRWCA00002	Domestic/Irrigation	50	600	400	600	1998	35.7193	-119.15622	NAD83	419.679
KRWCA00003	KRWCA00003	Domestic/Irrigation	50	440	340	440	1998	35.7046	-119.18271	NAD83	375.936
KRWCA00004	KRWCA00004	Irrigation	50	800	400	800	2008	35.78729	-119.080091	NAD83	512.487
KRWCA00005	KRWCA00005	Domestic	50	405	185	405	2004	35.78725	-119.10359	NAD83	508.473
KRWCA00006	KRWCA00006	Domestic/Irrigation	50	400	200	400	2005	35.68653	-119.43757	NAD83	253.26
KRWCA00007	KRWCA00007	Domestic/Irrigation	100	400	320	400	2000	35.68506	-119.39371	NAD83	302.87
KRWCA00008	KRWCA00008	Irrigation	300	900	400	900	2016	35.64652	-119.23305	NAD83	308.57
KRWCA00009	KRWCA00009	Domestic/Irrigation	87	400	320	400	1994	35.56781	-119.37549	NAD83	306.43
KRWCA00010	KRWCA00010	Irrigation	50	828	468	828	1976	35.60911	-119.29039	NAD83	293.08
KRWCA00011	KRWCA00011	Irrigation	50	800	360	440	2006	35.55116	-119.25534	NAD83	343.813
KRWCA00012	KRWCA00012	Irrigation	350	810	380	810	2014	35.53089	-119.2698	NAD83	350.256
KRWCA00013	KRWCA00013	Irrigation	250	800	400	800	2008	35.610693	-119.191118	NAD83	363.265
KRWCA00015	KRWCA00015	Irrigation	150	380	160	380	2003	35.455102	-119.512413	NAD83	293.032
KRWCA00016	KRWCA00016	Irrigation	40	827	300	827	2013	35.48564	-119.29826	NAD83	303.43
KRWCA00017	KRWCA00017	Domestic	50	400	320	400	1991	35.49916	-119.304602	NAD83	304.69
KRWCA00019	KRWCA00019	Domestic	140	601	221	361	2012	35.44119	-119.34497	NAD83	319.57
KRWCA00020	KRWCA00020	Irrigation	50	620	379	620	2013	35.43179	-119.25136	NAD83	275.65
KRWCA00021	KRWCA00021	Observation		350	260	350	2013	35.374429	-119.251713	NAD83	274.22

Table 12-1. 2020 GQTM Network Wells												
Field Point Name / GQTM Well ID	GQTM Well Name	Well Use	Well Construction Information					Latitude	Longitude	Datum	Depth to the Bottom of Upper Zone (feet)
			Seal Depth (feet)	Total Well Depth (feet)	Depth Top of Screen (feet)	Depth Bottom of Screen (feet)	Year Drilled				
KRWCA00022	KRWCA00022	Observation		310	210	310	1992	35.36932	-119.28697	NAD83	297.84
KRWCA00023	KRWCA00023	Irrigation	50	910	390	910	2017	35.28895	-118.84698	NAD83	377.763
KRWCA00024	KRWCA00024	Irrigation	50	1220	560	1220	2015	35.31066	-118.80545	NAD83	204.863
KRWCA00025	KRWCA00025	Domestic	350	500	400	500	2011	35.294204	-118.75335	NAD83	
KRWCA00026	KRWCA00026	Irrigation	190	960	280	960	2008	35.20861	-119.27829	NAD83	129.323
KRWCA00027	KRWCA00027	Irrigation	50	720	540	700	2007	35.03113	-118.83457	NAD83	498.378
KRWCA00028	KRWCA00028	Irrigation	50	1020	540	1020	1996	35.13774	-119.1453	NAD83	187.365
KRWCA00029	KRWCA00029	Observation		430	360	430		35.361708	- 119.217059	NAD83	273.059
KRWCA00030	KRWCA00030	Domestic/Irrigation	100	340	300	340	2006	35.71845	-119.30423	NAD83	275.37
KRWCA00031	KRWCA00031	Domestic	100	298	158	298	2008	35.72512	-119.29483	NAD83	271.37
KRWCA00033	KRWCA00033	Irrigation	465	930	360	930	2007	35.76129	-119.38377	NAD83	263.38
KRWCA00034	KRWCA00034	Irrigation	340	1200	340	1200	2007	35.76822	-119.39262	NAD83	263.38
KRWCA00035	KRWCA00035	Irrigation	472	945	340	945	2007	35.76133	-119.39262	NAD83	263.38
KRWCA00036	KRWCA00036	Irrigation	320	947	392	912	2007	35.73679	-119.3843	NAD83	290.81
KRWCA00037	KRWCA00037	Observation	400	800	420	760	2008	35.67693	-119.39702	NAD83	302.87
KRWCA00038	KRWCA00038	Irrigation	270	800	310	800	2008	35.64534	-119.31651	NAD83	323.914
KRWCA00039	KRWCA00039	Irrigation	150	1240	560	1220	2009	35.67488	-119.17845	NAD83	314.736
KRWCA00040	KRWCA00040	Irrigation	50	805	386	805	2002	35.68179	-119.18251	NAD83	314.736
KRWCA00041	KRWCA00041	Irrigation	50	1105	451	652	2005	35.6504	-119.16936	NAD83	380.449
KRWCA00042	KRWCA00042	Irrigation	150	1000	600	1000	2008	35.64225	-119.16942	NAD83	402.526

Table 12-1. 2020 GQTM Network Wells												
Field Point Name / GQTM Well ID	GQTM Well Name	Well Use	Well Construction Information					Latitude	Longitude	Datum	Depth to the Bottom of Upper Zone (feet)
			Seal Depth (feet)	Total Well Depth (feet)	Depth Top of Screen (feet)	Depth Bottom of Screen (feet)	Year Drilled				
KRWCA00043	KRWCA00043	Irrigation	390	680	400	680	2002	35.60139	-119.49158	NAD83	379.632
KRWCA00044	KRWCA00044	Irrigation	50	500	200	300	2003	35.64534	-119.31651	NAD83	323.914
KRWCA00045	KRWCA00045	Domestic	50	620	420	620	2003	35.53034	-119.33923	NAD83	315.68
KRWCA00047	KRWCA00047	Irrigation	50	930	460	930	2008	35.5573	-119.41239	NAD83	310.979
KRWCA00049	KRWCA00049	Irrigation	340	700	340	700	2009	35.44934	-119.42926	NAD83	292.281
KRWCA00052	KRWCA00052	Irrigation	50	600	260	600	2006	35.32732	-118.75949	NAD83	
KRWCA00053	KRWCA00053	Irrigation	300	1000	300	1000	2008	35.18113	-119.23581	NAD83	117.372
KRWCA00054	KRWCA00054	Irrigation	300	1000	300	1000	2008	35.20176	-119.25198	NAD83	139.035
KRWCA00056	KRWCA00056	Irrigation	155	710	200	700	2008	35.24492	-119.03009	NAD83	275.813
KRWCA00057	KRWCA00057	Irrigation	155	710	200	697	2008	35.24142	-119.03004	NAD83	275.813
KRWCA00059	KRWCA00059	Irrigation	50	1000	500	1000	2008	35.05301	-118.8728	NAD83	393.194
KRWCA00060	KRWCA00060	Irrigation	50	1080	560	1080	2008	35.03788	-118.8436	NAD83	383.315
KRWCA00061	KRWCA00061	Irrigation	150	1002	496	1002	2002	35.14492	-119.1461	NAD83	188.563
KRWCA00062	KRWCA00062	Irrigation	150	1050	907	1050	2008	35.13023	-119.18154	NAD83	181.466
KRWCA00063	KRWCA00063	Irrigation	40	1002	438	1002	2013	35.14533	-118.97646	NAD83	133.741
KRWCA00064	KRWCA00064	Irrigation	50	1200	560	1200	2004	35.1111	-118.93257	NAD83	227.389
KRWCA00065	KRWCA00065	Irrigation	50	1200	520	1200	2001	35.0967	-118.93201	NAD83	252.305
KRWCA00066	KRWCA00066	Irrigation	150	920	314	900	2008	35.12235	-118.90996	NAD83	217.11
KRWCA00067	KRWCA00067	Irrigation	310	681	241	440	2006	35.59588	-119.43375	NAD83	348.225
KRWCA00068	KRWCA00068	Irrigation	160	610	230	610	2008	35.2781	-119.15558	NAD83	249.22
KRWCA00069	KRWCA00069	Irrigation	160	810	200	810	2008	35.27417	-119.15775	NAD83	243.9

12.1.2. Summary of Quality Assurance Evaluation for 2020 Sampling Event

12.1.2.1. Purging, sample handling, and custody

For the 2020 sampling season, the KRWCA collected groundwater quality samples in July and August. A total of 54 wells were sampled: 14 domestic wells, 37 agricultural wells, and 3 monitoring wells. For nitrate, results were compared against the Primary Maximum Contaminant Level (MCL) for nitrate as nitrogen (N), which is 10.0 mg/L.

All 2020 samples were collected following the 2020 KRWCA Standard Operating Procedure (SOP) by a Moore-Twining Associates (MTA) field crew. As described in the SOP, all wells were purged until a volume equal to or greater than three well casings was expelled and measured field parameters stabilized (less than 10% difference for three consecutive readings). Collected field parameters include pH, electrical conductivity (EC), temperature, dissolved oxygen (DO), and, when possible, depth to water (DTW). Field parameters and laboratory results are summarized in **Table 12-2**.

Once collected, samples are sealed within plastic bags and transported on wet ice directly from the field to the MTA laboratory. All samples are accompanied by a chain of custody (COC) that records changes in sample custody. Records are maintained within the contracted lab that include the checking in and out of samples during the analytical process as well as the disposal of samples following completion of the analytical process and archival. Samples are held under proper storage conditions until all analyses are conducted.

Table 12-2. 2020 GQTM Sampling Results									
Field Point Name / GQTM Well ID	GQTM Well Name	Well Use	Date Sampled	Nitrate as N (mg/L) Lab	pH Field	Specific Conductance (uS/cm) Field	Temperature (°C) Field	Dissolved Oxygen (mg/L) Field	Depth to Water (ft) Field
KRWCA00002	KRWCA00002	Domestic/Irrigation	6/30/2020	23*	7.28	1500	24.32	8.68	340.7
KRWCA00003	KRWCA00003	Domestic/Irrigation	6/30/2020	19*	7.83	1170	24.14	6.84	276.59
KRWCA00004	KRWCA00004	Irrigation	6/30/2020	2.2*	6.92	513	24.43	7.8	262.53
KRWCA00005	KRWCA00005	Domestic	7/8/2020	13*	6.96	757	24.09	8.2	188.46
KRWCA00006	KRWCA00006	Domestic/Irrigation	8/6/2020	11	5.99	1520	21.14	10.98	189
KRWCA00007	KRWCA00007	Domestic/Irrigation	8/10/2020	6.9	7.85	1090	26.53	8.54	278
KRWCA00008	KRWCA00008	Irrigation	8/6/2020	6.2	7.95	389	21.05	8.29	296.33
KRWCA00009	KRWCA00009	Domestic/Irrigation	8/20/2020	16	6.53	1330	22.24	8.31	295.35
KRWCA00010	KRWCA00010	Irrigation	7/22/2020	3.2	7.92	304	21.77	7.72	305.49
KRWCA00011	KRWCA00011	Irrigation	7/30/2020	6.3	7.19	519	22.63	5.19	327.35
KRWCA00012	KRWCA00012	Irrigation	7/22/2020	7.5	7.76	596	22.96	7.4	386.46
KRWCA00013	KRWCA00013	Irrigation	7/23/2020	14	6.74	915	22.62	8.83	440
KRWCA00015	KRWCA00015	Irrigation	7/30/2020	4.6	6.57	2800	20.63	1.99	50.74
KRWCA00017	KRWCA00017	Domestic	8/6/2020	17	7.61	1600	24.02	7.1	229
KRWCA00019	KRWCA00019	Domestic	8/31/2020	10	7.19	1460	23.55	8.98	236.85
KRWCA00020	KRWCA00020	Irrigation	8/6/2020	11	7.77	666	23.32	6.99	330.35
KRWCA00021	KRWCA00021	Observation	7/14/2020	0.69	7.87	273	20.74	10.07	169.3
KRWCA00022	KRWCA00022	Observation	7/13/2020	2.3	7.83	488	20.7	9.61	177.4
KRWCA00023	KRWCA00023	Irrigation	8/10/2020	1.8	6.69	1030	21.08	1.85	397.35
KRWCA00024	KRWCA00024	Irrigation	8/10/2020	0.12	8.31	719	25.9	1.25	461.72
KRWCA00025	KRWCA00025	Domestic	8/10/2020	< 0.1	8.59	908	33.19	1.24	253.95
KRWCA00026	KRWCA00026	Irrigation	8/13/2020	< 0.15	8.66	1280	27.19	2.85	134
KRWCA00028	KRWCA00028	Irrigation	8/13/2020	< 0.1	8.06	1090	29.06	1.18	145.77

Table 12-2. 2020 GQTM Sampling Results									
Field Point Name / GQTM Well ID	GQTM Well Name	Well Use	Date Sampled	Nitrate as N (mg/L) Lab	pH Field	Specific Conductance (uS/cm) Field	Temperature (°C) Field	Dissolved Oxygen (mg/L) Field	Depth to Water (ft) Field
KRWCA00029	KRWCA00029	Observation	7/14/2020	3.8	8.57	245	22.58	5.46	195
KRWCA00030	KRWCA00030	Domestic/Irrigation	7/22/2020	14	7.53	1270	23.26	6.55	136.12
KRWCA00031	KRWCA00031	Domestic	7/8/2020	20*	7.13	1830	21.98	8.04	128.37
KRWCA00033	KRWCA00033	Irrigation	7/23/2020	1.7	9.11	318	24.09	1.38	280.2
KRWCA00034	KRWCA00034	Irrigation	7/23/2020	1.6	9.21	278	23.97	6.33	270.95
KRWCA00035	KRWCA00035	Irrigation	7/23/2020	1.5	8.02	372	24.37	6.46	288.54
KRWCA00036	KRWCA00036	Irrigation	7/23/2020	3.1	9.06	604	25.07	4.29	117
KRWCA00038	KRWCA00038	Irrigation	7/30/2020	1.5	7.97	218	22.13	7.19	330.19
KRWCA00039	KRWCA00039	Irrigation	7/22/2020	31	8.58	1930	24.89	7.17	365
KRWCA00040	KRWCA00040	Irrigation	7/23/2020	17	7.8	1200	25.11	7.05	376
KRWCA00041	KRWCA00041	Irrigation	8/26/2020	2.1	8.52	919	26.56	1.03	341.48
KRWCA00042	KRWCA00042	Irrigation	8/20/2020	7.5	7.27	843	26.14	8.07	314.09
KRWCA00043	KRWCA00043	Irrigation	7/29/2020	< 0.1	8.88	925	26.36	1.1	280.53
KRWCA00044	KRWCA00044	Irrigation	7/29/2020	4.3	7.12	2070	22.95	8.11	333
KRWCA00045	KRWCA00045	Domestic	8/26/2020	17	7.2	804	24.53	9.45	364.4
KRWCA00047	KRWCA00047	Irrigation	7/29/2020	5.8	8.12	893	24.62	6.81	374.81
KRWCA00049	KRWCA00049	Irrigation	8/20/2020	4	8.31	1180	23.75	3.45	293.97
KRWCA00052	KRWCA00052	Irrigation	8/26/2020	6.6	7.26	715	18.45	8.74	206.41
KRWCA00054	KRWCA00054	Irrigation	8/13/2020	< 0.1	8.11	1030	28.19	1.19	134.34
KRWCA00056	KRWCA00056	Irrigation	8/12/2020	0.57	7.58	363	20.98	10.57	290.9
KRWCA00057	KRWCA00057	Irrigation	8/12/2020	0.41	7.5	388	21.09	10.64	268.75
KRWCA00059	KRWCA00059	Irrigation	8/10/2020	13	7.25	562	18.83	13.61	111.81
KRWCA00060	KRWCA00060	Irrigation	8/26/2020	8.4	7.54	771	19.74	7.19	160.55

Table 12-2. 2020 GQTM Sampling Results									
Field Point Name / GQTM Well ID	GQTM Well Name	Well Use	Date Sampled	Nitrate as N (mg/L) Lab	pH Field	Specific Conductance (uS/cm) Field	Temperature (°C) Field	Dissolved Oxygen (mg/L) Field	Depth to Water (ft) Field
KRWCA00061	KRWCA00061	Irrigation	8/13/2020	< 0.1	8.03	819	28.87	1.23	340.97
KRWCA00062	KRWCA00062	Irrigation	8/13/2020	< 0.25	8.1	2190	28.25	1.27	267.73
KRWCA00063	KRWCA00063	Irrigation	8/12/2020	0.41	7.49	702	23.06	2.47	322.53
KRWCA00064	KRWCA00064	Irrigation	8/12/2020	5.3	7.46	602	24.83	2.12	367.8
KRWCA00065	KRWCA00065	Irrigation	8/6/2020	15	7.71	1050	22.34	6	424.25
KRWCA00066	KRWCA00066	Irrigation	8/12/2020	15	6.85	1980	21.68	9.89	626.12
KRWCA00068	KRWCA00068	Irrigation	8/12/2020	3.1	7.53	412	21.87	7.52	230.5
KRWCA00069	KRWCA00069	Irrigation	8/12/2020	1.7	7.55	333	21.21	9.71	245
KRWCA00002	KRWCA00002	Domestic/Irrigation	6/30/2020	23*	7.28	1500	24.32	8.68	340.7
KRWCA00003	KRWCA00003	Domestic/Irrigation	6/30/2020	19*	7.83	1170	24.14	6.84	276.59
KRWCA00004	KRWCA00004	Irrigation	6/30/2020	2.2*	6.92	513	24.43	7.8	262.53
KRWCA00005	KRWCA00005	Domestic	7/8/2020	13*	6.96	757	24.09	8.2	188.46
KRWCA00006	KRWCA00006	Domestic/Irrigation	8/6/2020	11	5.99	1520	21.14	10.98	189

*Nitrate as N result was calculated from Nitrate + Nitrite as N result.

12.1.2.2. Access and field and analytical completeness

Due to the fluctuations of groundwater conditions and changes in well suitability, the submitted GTM network was, and continues to be, considered dynamic. Four wells in the KRWCA GTM network were not sampled during the 2020 sampling season due to mechanical failure or lack of access. Tables summarizing completeness of field and analytical testing, field quality control, and evaluation of sample hold times are available in **Table 12-3**, **Table 12-4**, and **Table 12-5**, respectively.

Table 12-3. Completeness of Field and Analytical Testing

Constituent	Test Type	Analytical Method	Matrix	Wells Planned for Sampling	No Access	Mechanical Failure of Well Pump	Wells Sampled	Field and Transport Completeness %	Total Samples Analyzed	Analytical Completeness %
Oxygen, Dissolved	Field parameter	EPA 360.1	Ground-water	59	1	4	54	91.5	54	100
pH	Field parameter	EPA 150.1	Ground-water	59	1	4	54	91.5	54	100
Specific Conductivity	Field parameter	EPA 120.1	Ground-water	59	1	4	54	91.5	54	100
Temperature	Field parameter	SM 2550	Ground-water	59	1	4	54	91.5	54	100
Nitrate as N	Laboratory	EPA 300.0	Ground-water	59	1	4	54	91.5	54	100
			Total	295	5	20	270	91.5	270	100

Table 12-4. Completeness of Field QC

Constituent	Analytical Method	Matrix	Total Well Samples Analyzed	Field Duplicate Samples Analyzed	Field Blank Samples Analyzed	Total Samples Analyzed (well and duplicates)	Field Duplicate Completeness %	Field Blank Completeness %
Nitrate as N	EPA 300.0	groundwater	54	3	3	60	5.0	5.0
		Total	54	3	3	60	5.0	5.0

Completeness values below the acceptability requirement of 5 percent are presented in **bold**.

Table 12-5. Evaluation of Sample Hold Times						
Constituent	Analytical Method	Matrix	Hold Time	Total Samples Analyzed	Samples Analyzed within Hold Time	Acceptability %
Nitrate + Nitrite as N / Nitrate as N	SM 4500-NO3 F / EPA 300.0	groundwater	28 days / 48 hours	60	60	100
			Total	60	60	100
Acceptability values below 90 percent are presented in **bold**.						

12.1.2.3. Analytical precision and accuracy

Reducing cross-contamination and measurement errors is critical to ensuring accurate GTM sampling results. **Table 12-6** and **Table 12-7** summarize both field and laboratory accuracy quality control checks. The acceptability of field duplicates, field blanks, and laboratory controls and spikes was 100%.

Table 12-6. Evaluation of Field Duplicates and Blanks							
Constituent	Analytical Method	Matrix	Sample Type	Acceptability Requirement	Total Samples	Samples within Acceptability	Acceptability %
Nitrate as N	EPA 300.0	groundwater	Field Duplicate	RPD ≤ 25	3	3	100
				Field Duplicate Total	**3**	**3**	**100**
Acceptability values below 90 percent are presented in **bold**.							
Constituent	Analytical Method	Matrix	Sample Type	Acceptability Requirement	Total Samples	Samples within Acceptability	Acceptability %
Nitrate as N	EPA 300.0	groundwater	Field Blank	< RL or 1/5 environmental sample	3	3	100
				Field Duplicate Total	**3**	**3**	**100**
Acceptability values below 90 percent are presented in **bold**.							

Table 12-7. Evaluation of Lab Controls and Spikes							
Constituent	Analytical Method	Matrix	Sample Type	Acceptability Requirement	Total Samples	Samples within Acceptability	Acceptability %
Lab Blanks							
Nitrate as N	EPA 300.0	groundwater	Lab Blank	< RL	15	15	100
				Lab Blank Total	15	15	100
Lab Control Spikes							
Nitrate as N	EPA 300.0	groundwater	LCS	PR 90-110	30	30	100
				Lab Control Total	30	30	100
Matrix Spikes							
Nitrate as N	EPA 300.0	groundwater	MS	PR 80-120	56	56	100
				Matrix Spike Total	56	56	100
Analytical Duplicates							
Nitrate as N	EPA 300.0	groundwater	MSD/LCSD/Lab Dup	RPD ≤ 25	43	43	100
				Analytical Duplicate Total	43	43	100
Acceptability values below 90 percent are presented in **bold**.							
LCS=lab control spike; MS=matrix spike; MSD=matrix spike duplicate; LCSD=lab control spike duplicate							

12.1.2.4. Quality assurance evaluation conclusions

As demonstrated in **Tables 12-3** through **12-7**, groundwater quality results collected in 2020 reached 100% QC completeness with no qualified results. The 100% completeness exceeds the minimum completeness requirement of 90% specified in the Tulare Lake Basin General Order. Results also reached 100% parameter completeness. If future sampling results deem necessary, the KRWCA will take corrective actions as described in the CQAP to address potential issues and work to prevent them from reoccurring.

12.1.3. Five-Year Assessment Results and Discussion

Luhdorff & Scalmanini Consulting Engineers (LSCE) conducted both parametric and non-parametric analyses of Nitrate as N (Nitrate or NO_3-N) and Total Dissolved Solids (TDS) trends within the KRWCA primary area boundary. Methodology for each of these analyses is discussed in **Section 5**.

All of the **Section 5** figures pertinent to this individual coalition section are presented in **Appendix J**. The first figure in **Appendix J** displays average Nitrate conditions in KRWCA's GTM network wells from 2018 to 2020. Additional information regarding KRWCA's GTM network can be found in **Section 12.1**. Five categories were used to depict average Nitrate conditions:

- Less than or equal to 2.5 mg/L Nitrate as N

- Greater than 2.5 mg/L to 5 mg/L Nitrate as N
- Greater than 5 mg/L to 7.5 mg/L Nitrate as N
- Greater than 7.5 mg/L to 10 mg/L Nitrate as N
- Greater than 10 mg/L Nitrate as N

KRWCA's GTM wells display a range of average Nitrate as N results from less than 2.5 mg/L to more than 10 mg/L (**Figure J-1**). Wells showing concentrations above 7.5 mg/L tend to form clusters in the northeast, north central, and southeast portions of the Coalition. Wells with Nitrate as N concentrations less than 5 mg/L appear scattered throughout the Coalition.

Figure J-2 in **Appendix J** displays the most recent Nitrate as N sample collected at each of KRWCA's GTM network wells. Five categories were used to depict Nitrate conditions:

- Less than or equal to 2.5 mg/L Nitrate as N
- Greater than 2.5 mg/L to 5 mg/L Nitrate as N
- Greater than 5 mg/L to 7.5 mg/L Nitrate as N
- Greater than 7.5 mg/L to 10 mg/L Nitrate as N
- Greater than 10 mg/L Nitrate as N

The most recent measured Nitrate as N concentrations in KRWCA's GTM wells mirror the patterns displayed in **Figure J-2** in **Appendix J** in KRWCA GTM wells and previously described above. Since there are three years of GTM data, the consistency of pattern is not surprising.

Figure J-3 in **Appendix J** displays the most recent Nitrate as N sample for all wells located within the KRWCA primary area boundary. Five categories were used to depict Nitrate conditions:

- Less than or equal to 2.5 mg/L Nitrate as N
- Greater than 2.5 mg/L to 5 mg/L Nitrate as N
- Greater than 5 mg/L to 7.5 mg/L Nitrate as N
- Greater than 7.5 mg/L to 10 mg/L Nitrate as N
- Greater than 10 mg/L Nitrate as N

Similar to the Nitrate as N concentration patterns shown in KRWCA's GTM wells, the most recent Nitrate as N sample for all wells within KRWCA display a range of Nitrate as N results from less than 2.5 mg/L to more than 10 mg/L. Overall, there is considerable variability in Nitrate as N concentrations in wells throughout the KRWCA. The spatial coverage of the data is of high quality with Nitrate as N results dispersed throughout much of the Coalition's acreage. Wells with Nitrate as N results above 10 mg/L are mostly located along the eastern portions of the Coalition. Additional pockets of Nitrate as N results above 10 mg/L can be found in the southwestern and southeastern portion of the Coalition.

Figure J-4 in **Appendix J** displays ambient Nitrate concentrations in KRWCA's Upper Zone using data from 2000-2020. Five categories were used to depict Nitrate as N conditions:

- Less than or equal to 2.5 mg/L Nitrate as N
- Greater than 2.5 mg/L to 5 mg/L Nitrate as N
- Greater than 5 mg/L to 7.5 mg/L Nitrate as N
- Greater than 7.5 mg/L to 10 mg/L Nitrate as N
- Greater than 10 mg/L Nitrate as N

Kriging modeling results (seen in **Figures J-4** and **J-5**) align with the results shown in the **Figure J-1** in **Appendix J** showing average Nitrate as N in GQTM wells and **Figure J-2** in **Appendix J** showing most recent Nitrate as N conditions in GQTM wells, rather than the results shown in **Figure J-3** (most recent Nitrate as N sample in all wells). Modeled concentrations of Nitrate as N in the Upper Zone are above 10 mg/L in the northeastern corner, north central, and southeastern portion of the Coalition. Of specific note is that modeling results generally suggest lower levels of Nitrate as N (less than 5.0 mg/L) surrounding the City of Bakersfield (the major population center within the KRWCA) (**Figures J-4** and **J-5)**.

Figure J-6 in **Appendix J** displays parametric Nitrate as N trends in the Upper Zone of the aquifer using data from 2000-2020. Analysis was only performed on Upper Zone wells with at least three Nitrate as N results. Linear regression trend results were split into five categories:

- Decreasing Nitrate as N trend (linear rate >0.5 mg/L/yr)
- Decreasing Nitrate as N trend (linear rate <0.5 mg/L/yr)
- Stable Nitrate as N (linear rate = 0 mg/L/yr)
- Increasing Nitrate as N trend (linear rate <0.5 mg/L/yr)
- Increasing Nitrate as N trend (linear rate > 0.5 mg/L/yr).

Figure J-6 in **Appendix J** displays only parametric Nitrate as N trends meeting the minimum R^2 factor of 0.5. Other trends not well described by linear regression are characterized in the non-parametric analysis. GQTM wells with insufficient evidence of linear trends are summarized in the table in Appendix J. **Figure J-7** in **Appendix J** displays non-parametric Nitrate as N trends in the Upper Zone using data from 2000-2020. The Mann-Kendall Test and Theil-Sen Estimator analysis were performed on Upper Zone wells with at least eight or more Nitrate as N samples.

Non-parametric Nitrate trend results were split into five categories:

- Decreasing Nitrate as N trend (T-S slope >0.5 mg/L/yr)
- Decreasing Nitrate as N trend (T-S slope <0.5 mg/L/yr)
- Stable Nitrate as N (T-S slope = 0 mg/L/yr)

- Increasing Nitrate as N trend (T-S slope <0.5 m/L/yr)
- Increasing Nitrate as N trend (T-S slope >0.5 mg/L/yr).

Wells with fewer than 8 measurements that also do not meet parametric trend criteria will be analyzed non-parametrically as more measurements are reported.

Table J-1 in **Appendix J** provides a summary of parametric Nitrate as N trends for GQTM wells with at least three samples between 2018-2020. Within KRWCA, eight wells had insufficient evidence of a linear trend ($R^2 < 0.5$), three had a decreasing linear trend, two had a stable linear trend, and twelve had an increasing linear trend.

Figure J-8 in **Appendix J** displays the most recent TDS sample collected at each of KRWCA's GQTM network wells. Five categories were used to depict TDS conditions:

- Less than or equal to 250 mg/L
- Greater than 250 mg/L to 500 mg/L
- Greater than 500 mg/L to 750 mg/L
- Greater than 750 mg/L to 1,000 mg/L
- Greater than 1,000 mg/L

TDS concentrations within KRWCA range from less than 250 mg/L to greater than 1,000 mg/L. The majority of TDS results indicate concentrations less than 500 mg/L. There are isolated instances of TDS concentrations above 750 mg/L and even fewer results above 1,000 mg/L.

12.1.4. Five-Year High Vulnerability Area Update

12.1.4.1. Background

KRWCA's original high vulnerability areas (HVAs) were designated in the Groundwater Quality Assessment Report (GAR), submitted in February 2015, and conditionally approved by the Regional Board in July 2016.

12.1.4.2. 5-Year HVA Update Methodology

KRWCA assessed all publicly available data via the GAMA Geotracker database to conduct its five-year HVA update. This data set includes the GTM results from 2018-2020 of KRWCA's GTM network. LSCE queried GAMA Geotracker for Nitrate as N (Nitrate or NO_3-N) and Total Dissolved Solids (TDS) measurements collected between 1942-2021. The dataset underwent several QA/QC checks by LSCE and was limited to only include measurements that occurred within ILRP Coalitions participating in the CVGMC. To assess the distribution of NO_3-N exceedances in comparison to KRWCA's original HVAs, the dataset was filtered to only include:

- Results within the KRWCA primary area boundary
- Analytical results from 2015 through 2021
- NO_3-N results

Using ArcGIS, NO_3-N data was overlaid onto the original HVA boundary layer. Exceedances outside of HVAs were isolated and their historical NO_3-N results reviewed.

12.1.4.3. Existing HVA Compared to Nitrate Exceedances

Between 2015 and 2021, 6,211 NO_3-N results were measured within the KRWCA at 5,921 unique well locations. A total of 851 NO_3-N results exceeded the MCL of 10 mg/L as N. Of the 851 NO_3-N exceedances, 590 were located within the previously established HVAs and 261 were located outside of previously established HVAs. These 261 exceedances resulted from 25 unique wells sampled multiple times between 2015-2021. **Figure 12-2** displays the locations of each unique well point with NO_3-N exceedances in comparison to KRWCA's original HVAs.

General Order R5-2013-0120-08 Attachment E defines groundwater HVAs as, "areas identified in the approved Groundwater Quality Assessment Report where known groundwater quality impacts exist for which irrigated agricultural operations are a potential contributor or where conditions make groundwater more vulnerable to impacts from irrigated agricultural activities." Based upon this definition, exceedances outside of previously Regional Board approved HVAs were evaluated and exceedances were considered for use in HVA expansion if the sampled well met the following criterion:

- Demonstrated a trend of NO_3-N exceedances
- Located in proximity to irrigated agriculture
- Located more than ½ miles away from other sources of significant nitrate discharges such as dairies, food processors, confined animal feeding facilities, golf courses, etc.
- Is not a monitoring well used specifically for any other Regional Board Report of Waste Discharge permit (i.e., oil field or landfill monitoring well)

Between 2015 to 2021**,** 261 NO_3-N exceedances from 25 unique well points were located outside of KRWCA's previously established HVAs. All of these results were considered for potential use to expand HVAs. All other recorded NO_3-N exceedances were already located inside of KRWCA's previously established HVAs and no further analysis was required. Of the 25 well points, three well points demonstrated a historical trend of NO_3-N exceedances, are located in proximity to irrigated agriculture, and are not used as a monitoring well for oil and gas fields or landfills. A total of 22 wells were deemed not representative of the impacts of irrigated agriculture on groundwater quality. Of those 22 wells, 14 are monitoring wells for local landfills, three are dairy monitoring wells, and five are oil and gas field monitoring wells. Given that these wells are specifically meant to monitor for groundwater quality impacts of other industries regulated by the Regional Board, they do not provide reliable NO_3-N results representative of the impacts of irrigated agriculture on groundwater quality and were not included in the HVA expansion analysis. **Table 12-8** summarizes NO_3-N exceedances outside of KRWCA's historical HVAs and determinations for final inclusion in the HVA expansion analysis.

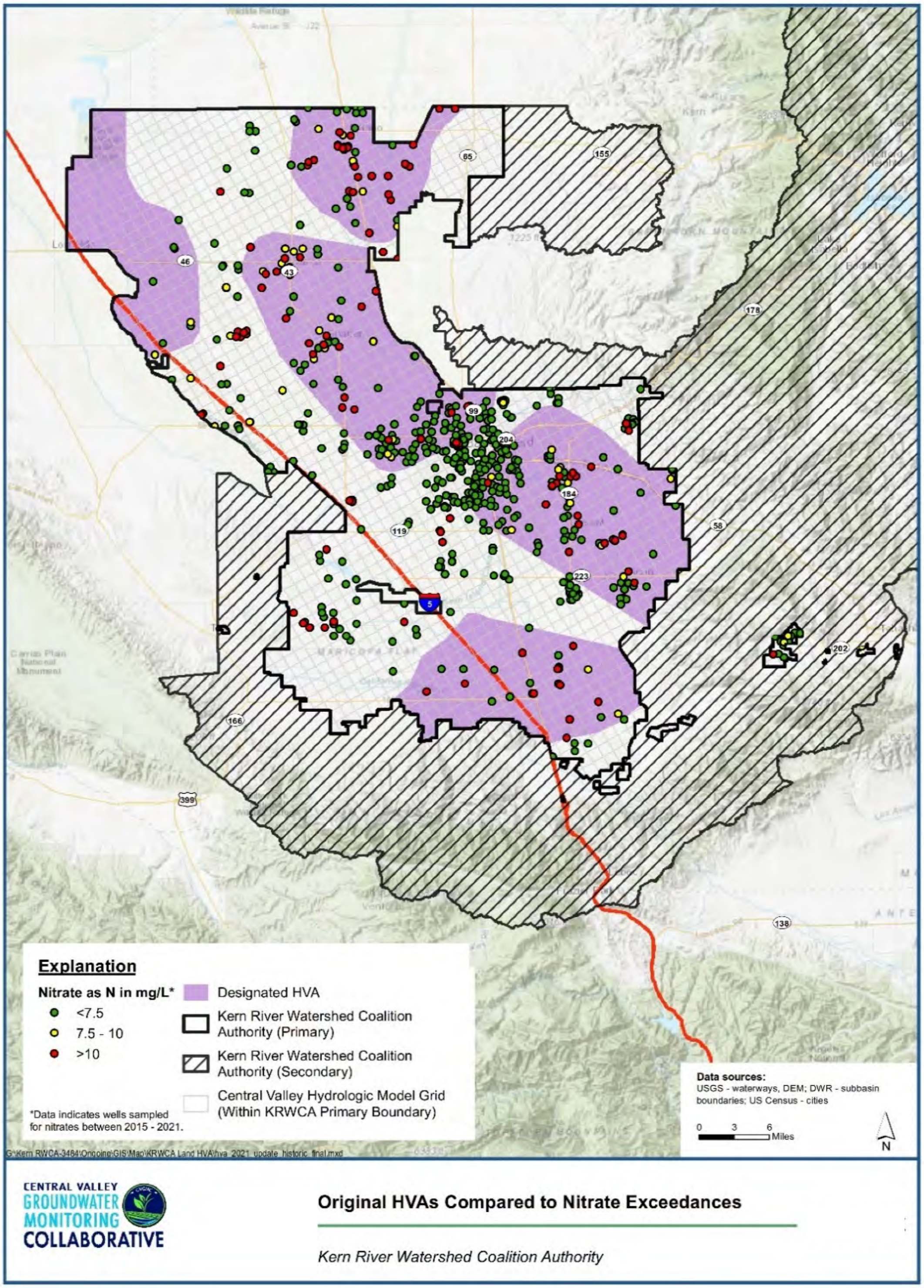

Figure 12-2. Original HVAs Compared to Nitrate Exceedances for KRWCA

Table 12-8. Nitrate Exceedances Outside of KRWCA's Historical HVAs Determinations for Inclusion in HVA Expansion

GAMA Geotracker Well Code	Sample Date	Nitrate as N Result	Unit	Latitude	Longitude	Datum	HVA Inclusion Determination	Rationale
1500344-001	10/15/2015	6.5	mg/L	35.265226	-119.1076	NAD83	Yes	Close proximity to irrigated agriculture and historical trend of Nitrate exceedances
	1/12/2016	7.2	mg/L	35.265226	-119.1076	NAD83		
	4/6/2016	7.0	mg/L	35.265226	-119.1076	NAD83		
	7/11/2016	6.9	mg/L	35.265226	-119.1076	NAD83		
	8/8/2016	11.0	mg/L	35.281403	-119.0937	NAD83		
	9/30/2016	8.9	mg/L	35.281403	-119.0937	NAD83		
	10/6/2016	7.8	mg/L	35.265226	-119.1076	NAD83		
	10/27/2016	7.7	mg/L	35.281403	-119.0937	NAD83		
	11/14/2016	7.2	mg/L	35.281403	-119.0937	NAD83		
	2/15/2017	6.5	mg/L	35.281403	-119.0937	NAD83		
	4/4/2017	7.0	mg/L	35.265226	-119.1076	NAD83		
	4/13/2017	6.6	mg/L	35.281403	-119.0937	NAD83		
	6/12/2017	6.6	mg/L	35.281403	-119.0937	NAD83		
	8/17/2017	7.1	mg/L	35.281403	-119.0937	NAD83		
	4/9/2018	6.2	mg/L	35.265226	-119.1076	NAD83		
	6/11/2018	6.8	mg/L	35.281403	-119.0937	NAD83		
	8/21/2018	7.8	mg/L	35.281403	-119.0937	NAD83		
	10/2/2018	6.8	mg/L	35.281403	-119.0937	NAD83		
	1/16/2019	6.0	mg/L	35.281403	-119.0937	NAD83		
	6/12/2019	6.3	mg/L	35.265226	-119.1076	NAD83		
	9/19/2019	11.0	mg/L	35.154603	-119.1641	NAD83		
	10/16/2019	5.3	mg/L	35.281403	-119.0937	NAD83		
	4/6/2020	17.0	mg/L	35.265226	-119.1076	NAD83		
	4/29/2020	3.2	mg/L	35.265226	-119.1076	NAD83		
	5/6/2020	6.1	mg/L	35.265226	-119.1076	NAD83		
	7/15/2020	5.3	mg/L	35.281403	-119.0937	NAD83		
	9/15/2020	5.8	mg/L	35.265226	-119.1076	NAD83		
	10/14/2020	6.7	mg/L	35.281403	-119.0937	NAD83		
	11/11/2020	5.8	mg/L	35.265226	-119.1076	NAD83		
1503537-002	9/14/2017	11.0	mg/L	35.252266	-119.1056	NAD83	No	1/2 mile from Vanden Berge Dairy, on CEMEX Concrete property
	10/12/2017	11.0	mg/L	35.252266	-119.1056	NAD83		
	10/9/2019	11.0	mg/L	35.252266	-119.1056	NAD83		
	10/16/2019	12.0	mg/L	35.252266	-119.1056	NAD83		
	11/18/2020	10.0	mg/L	35.252266	-119.1056	NAD83		
1510025-016	5/27/2015	11.0	mg/L	35.108711	-118.6088	NAD83	Yes	Close proximity to irrigated agriculture
	5/29/2015	10.0	mg/L	35.108711	-118.6088	NAD83		
	6/4/2015	8.8	mg/L	35.108711	-118.6088	NAD83		
	6/5/2015	8.6	mg/L	35.108711	-118.6088	NAD83		

GAMA Geotracker Well Code	Sample Date	Nitrate as N Result	Unit	Latitude	Longitude	Datum	HVA Inclusion Determination	Rationale
	6/6/2015	7.7	mg/L	35.108711	-118.6088	NAD83		and historical trend of Nitrate exceedances
	6/7/2015	7.5	mg/L	35.108711	-118.6088	NAD83		
	6/8/2015	7.2	mg/L	35.108711	-118.6088	NAD83		
	6/16/2015	6.3	mg/L	35.108711	-118.6088	NAD83		
	6/23/2015	6.1	mg/L	35.108711	-118.6088	NAD83		
	6/30/2015	5.6	mg/L	35.108711	-118.6088	NAD83		
	7/1/2015	5.6	mg/L	35.108711	-118.6088	NAD83		
	7/7/2015	5.9	mg/L	35.108711	-118.6088	NAD83		
	8/11/2015	5.3	mg/L	35.108711	-118.6088	NAD83		
	8/12/2015	5.2	mg/L	35.108711	-118.6088	NAD83		
	8/18/2015	5.3	mg/L	35.108711	-118.6088	NAD83		
	8/19/2015	5.4	mg/L	35.108711	-118.6088	NAD83		
	8/26/2015	5.1	mg/L	35.108711	-118.6088	NAD83		
	9/1/2015	5.4	mg/L	35.108711	-118.6088	NAD83		
	6/4/2016	10.0	mg/L	35.108711	-118.6088	NAD83		
	6/7/2016	9.9	mg/L	35.108711	-118.6088	NAD83		
	6/8/2016	9.5	mg/L	35.108711	-118.6088	NAD83		
	6/18/2016	8.3	mg/L	35.108711	-118.6088	NAD83		
	6/19/2016	8.0	mg/L	35.108711	-118.6088	NAD83		
	6/20/2016	7.9	mg/L	35.108711	-118.6088	NAD83		
	6/22/2016	7.6	mg/L	35.108711	-118.6088	NAD83		
	6/23/2016	7.3	mg/L	35.108711	-118.6088	NAD83		
	6/24/2016	7.2	mg/L	35.108711	-118.6088	NAD83		
	6/25/2016	6.8	mg/L	35.108711	-118.6088	NAD83		
	6/26/2016	6.6	mg/L	35.108711	-118.6088	NAD83		
	6/27/2016	6.6	mg/L	35.108711	-118.6088	NAD83		
	6/28/2016	6.5	mg/L	35.108711	-118.6088	NAD83		
	7/7/2016	5.9	mg/L	35.108711	-118.6088	NAD83		
	7/13/2016	5.5	mg/L	35.108711	-118.6088	NAD83		
	7/27/2016	5.3	mg/L	35.108711	-118.6088	NAD83		
	7/29/2016	5.4	mg/L	35.108711	-118.6088	NAD83		
	8/10/2016	5.4	mg/L	35.108711	-118.6088	NAD83		
	8/24/2016	5.5	mg/L	35.108711	-118.6088	NAD83		
	8/31/2016	5.4	mg/L	35.108711	-118.6088	NAD83		
	9/7/2016	5.5	mg/L	35.108711	-118.6088	NAD83		
	9/14/2016	5.5	mg/L	35.108711	-118.6088	NAD83		
	9/21/2016	5.5	mg/L	35.108711	-118.6088	NAD83		
	9/28/2016	5.4	mg/L	35.108711	-118.6088	NAD83		
	6/20/2017	10.0	mg/L	35.108711	-118.6088	NAD83		
	6/21/2017	11.0	mg/L	35.108711	-118.6088	NAD83		

GAMA Geotracker Well Code	Sample Date	Nitrate as N Result	Unit	Latitude	Longitude	Datum	HVA Inclusion Determination	Rationale
	6/25/2017	9.0	mg/L	35.108711	-118.6088	NAD83		
	6/26/2017	8.6	mg/L	35.108711	-118.6088	NAD83		
	6/27/2017	7.8	mg/L	35.108711	-118.6088	NAD83		
	7/11/2017	6.2	mg/L	35.108711	-118.6088	NAD83		
	7/19/2017	6.0	mg/L	35.108711	-118.6088	NAD83		
	8/10/2017	5.6	mg/L	35.108711	-118.6088	NAD83		
	8/31/2017	5.4	mg/L	35.108711	-118.6088	NAD83		
	9/4/2017	5.9	mg/L	35.108711	-118.6088	NAD83		
	9/6/2017	5.7	mg/L	35.108711	-118.6088	NAD83		
	9/7/2017	5.7	mg/L	35.108711	-118.6088	NAD83		
	9/8/2017	5.5	mg/L	35.108711	-118.6088	NAD83		
	9/9/2017	5.4	mg/L	35.108711	-118.6088	NAD83		
	9/11/2017	5.4	mg/L	35.108711	-118.6088	NAD83		
	9/12/2017	5.4	mg/L	35.108711	-118.6088	NAD83		
	9/13/2017	5.4	mg/L	35.108711	-118.6088	NAD83		
	9/15/2017	5.4	mg/L	35.108711	-118.6088	NAD83		
	9/16/2017	5.3	mg/L	35.108711	-118.6088	NAD83		
	9/17/2017	5.3	mg/L	35.108711	-118.6088	NAD83		
	9/18/2017	5.3	mg/L	35.108711	-118.6088	NAD83		
	9/19/2017	5.2	mg/L	35.108711	-118.6088	NAD83		
	9/28/2017	5.2	mg/L	35.108711	-118.6088	NAD83		
	10/5/2017	5.1	mg/L	35.108711	-118.6088	NAD83		
	10/12/2017	5.2	mg/L	35.108711	-118.6088	NAD83		
	6/7/2018	16.0	mg/L	35.108711	-118.6088	NAD83		
	6/8/2018	15.0	mg/L	35.108711	-118.6088	NAD83		
	6/9/2018	13.0	mg/L	35.108711	-118.6088	NAD83		
	6/10/2018	13.0	mg/L	35.108711	-118.6088	NAD83		
	6/11/2018	12.0	mg/L	35.108711	-118.6088	NAD83		
	6/14/2018	11.0	mg/L	35.108711	-118.6088	NAD83		
	6/15/2018	10.0	mg/L	35.108711	-118.6088	NAD83		
	6/16/2018	11.0	mg/L	35.108711	-118.6088	NAD83		
	6/21/2018	9.5	mg/L	35.108711	-118.6088	NAD83		
	6/23/2018	9.3	mg/L	35.108711	-118.6088	NAD83		
	6/24/2018	9.3	mg/L	35.108711	-118.6088	NAD83		
	6/25/2018	9.1	mg/L	35.108711	-118.6088	NAD83		
	6/26/2018	8.9	mg/L	35.108711	-118.6088	NAD83		
	6/28/2018	9.0	mg/L	35.108711	-118.6088	NAD83		
	6/29/2018	8.8	mg/L	35.108711	-118.6088	NAD83		
	7/2/2018	8.8	mg/L	35.108711	-118.6088	NAD83		
	7/4/2018	8.9	mg/L	35.108711	-118.6088	NAD83		

GAMA Geotracker Well Code	Sample Date	Nitrate as N Result	Unit	Latitude	Longitude	Datum	HVA Inclusion Determination	Rationale
	7/6/2018	8.9	mg/L	35.108711	-118.6088	NAD83		
	7/8/2018	9.1	mg/L	35.108711	-118.6088	NAD83		
	7/9/2018	8.7	mg/L	35.108711	-118.6088	NAD83		
	7/10/2018	8.8	mg/L	35.108711	-118.6088	NAD83		
	7/11/2018	9.0	mg/L	35.108711	-118.6088	NAD83		
	7/12/2018	8.8	mg/L	35.108711	-118.6088	NAD83		
	7/14/2018	8.9	mg/L	35.108711	-118.6088	NAD83		
	7/15/2018	8.8	mg/L	35.108711	-118.6088	NAD83		
	7/16/2018	8.7	mg/L	35.108711	-118.6088	NAD83		
	7/17/2018	8.6	mg/L	35.108711	-118.6088	NAD83		
	7/19/2018	9.1	mg/L	35.108711	-118.6088	NAD83		
	7/22/2018	8.8	mg/L	35.108711	-118.6088	NAD83		
	7/23/2018	8.6	mg/L	35.108711	-118.6088	NAD83		
	7/24/2018	8.9	mg/L	35.108711	-118.6088	NAD83		
	7/29/2018	9.4	mg/L	35.108711	-118.6088	NAD83		
	7/30/2018	9.2	mg/L	35.108711	-118.6088	NAD83		
	8/8/2018	9.0	mg/L	35.108711	-118.6088	NAD83		
	8/9/2018	8.8	mg/L	35.108711	-118.6088	NAD83		
	8/16/2018	9.0	mg/L	35.108711	-118.6088	NAD83		
	8/30/2018	8.8	mg/L	35.108711	-118.6088	NAD83		
	10/10/2018	8.6	mg/L	35.108711	-118.6088	NAD83		
	5/13/2019	16.0	mg/L	35.108711	-118.6088	NAD83		
	6/11/2019	11.0	mg/L	35.108711	-118.6088	NAD83		
	7/9/2020	4.4	mg/L	35.108711	-118.6088	NAD83		
GAOG10009209-07B01	3/20/2018	12.0	mg/L	35.166567	-119.3306	NAD83	No	Oil & Gas Monitoring Well
	6/5/2019	12.0	mg/L	35.166567	-119.3306	NAD83		
	4/2/2020	11.0	mg/L	35.166567	-119.3306	NAD83		
GAOG10009209-MW-S3	10/3/2017	47.4	mg/L	35.147982	-119.3068	NAD83	No	Oil & Gas Monitoring Well
	5/2/2018	70.0	mg/L	35.147982	-119.3068	NAD83		
	6/4/2019	0.0	mg/L	35.147982	-119.3068	NAD83		
	10/21/2019	0.0	mg/L	35.147982	-119.3068	NAD83		
	3/9/2020	0.0	mg/L	35.147982	-119.3068	NAD83		
GAOG10009209-MW-S4	4/17/2018	22.6	mg/L	35.155429	-119.2702	NAD83	No	Oil & Gas Monitoring Well
	9/11/2018	8.8	mg/L	35.155429	-119.2702	NAD83		
	6/5/2019	14.0	mg/L	35.155429	-119.2702	NAD83		
	10/22/2019	4.3	mg/L	35.155429	-119.2702	NAD83		
	3/10/2020	0.0	mg/L	35.155429	-119.2702	NAD83		
GAOG10009209-MW-S6	12/18/2018	24.8	mg/L	35.153172	-119.3167	NAD83	No	Oil & Gas Monitoring Well
	6/6/2019	0.0	mg/L	35.153172	-119.3167	NAD83		
	10/23/2019	0.0	mg/L	35.153172	-119.3167	NAD83		

GAMA Geotracker Well Code	Sample Date	Nitrate as N Result	Unit	Latitude	Longitude	Datum	HVA Inclusion Determination	Rationale
	3/11/2020	0.0	mg/L	35.153172	-119.3167	NAD83		
KERN-21	1/11/2016	15.4	mg/L	35.471833	-119.4391	NAD83	No	Dairy Monitoring Well and lack of historical Nitrate exceedances
KRWCA00006	12/12/2018	10.0	mg/L	35.68653	-119.4376	NAD83	Yes	Close proximity to irrigated agriculture and historical trend of Nitrate exceedances
	7/18/2019	11.0	mg/L	35.68653	-119.4376	NAD83		
	8/6/2020	11.0	mg/L	35.68653	-119.4376	NAD83		
L10001684814-BT1-01	11/19/2015	11.0	mg/L	35.41313	-119.4655	NAD83	No	Buttonwillow Sanitary Landfill Monitoring Well
	4/7/2016	9.1	mg/L	35.41313	-119.4655	NAD83		
	11/30/2016	15.0	mg/L	35.41313	-119.4655	NAD83		
	6/7/2017	18.0	mg/L	35.41313	-119.4655	NAD83		
	11/27/2017	26.0	mg/L	35.41313	-119.4655	NAD83		
	5/23/2018	24.0	mg/L	35.41313	-119.4655	NAD83		
	11/15/2018	26.0	mg/L	35.41313	-119.4655	NAD83		
	5/16/2019	29.0	mg/L	35.41313	-119.4655	NAD83		
	11/16/2020	28.0	mg/L	35.41313	-119.4655	NAD83		
L10001684814-BT1-16	4/1/2015	23.0	mg/L	35.244392	-119.2803	NAD83	No	Buttonwillow Sanitary Landfill Monitoring Well
L10001684814-BT1-18	6/27/2016	22.0	mg/L	35.24442	-119.2803	NAD83	No	Buttonwillow Sanitary Landfill Monitoring Well
	6/1/2017	21.0	mg/L	35.24442	-119.2803	NAD83		
	8/16/2017	21.0	mg/L	35.24442	-119.2803	NAD83		
	11/27/2017	23.0	mg/L	35.24442	-119.2803	NAD83		
	5/23/2018	23.0	mg/L	35.24442	-119.2803	NAD83		
	5/16/2019	23.0	mg/L	35.24442	-119.2803	NAD83		
	11/16/2020	23.0	mg/L	35.24442	-119.2803	NAD83		
L10001684814-BT1-19	6/27/2016	23.0	mg/L	35.244104	-119.2802	NAD83	No	Buttonwillow Sanitary Landfill Monitoring Well
	9/1/2016	24.0	mg/L	35.244104	-119.2802	NAD83		
	11/30/2016	24.0	mg/L	35.244104	-119.2802	NAD83		
	11/27/2017	24.0	mg/L	35.244104	-119.2802	NAD83		
	5/23/2018	22.0	mg/L	35.244104	-119.2802	NAD83		
	5/16/2019	22.0	mg/L	35.244104	-119.2802	NAD83		

GAMA Geotracker Well Code	Sample Date	Nitrate as N Result	Unit	Latitude	Longitude	Datum	HVA Inclusion Determination	Rationale
L10001684814-BT2-05	4/1/2015	17.0	mg/L	35.4112	-119.4687	NAD83	No	Buttonwillow Sanitary Landfill Monitoring Well
	11/27/2017	15.0	mg/L	35.4112	-119.4687	NAD83		
	5/23/2018	18.0	mg/L	35.4112	-119.4687	NAD83		
	11/19/2018	16.0	mg/L	35.4112	-119.4687	NAD83		
	5/16/2019	14.0	mg/L	35.4112	-119.4687	NAD83		
	11/17/2020	17.0	mg/L	35.4112	-119.4687	NAD83		
L10003029180-SW1-18	1/20/2015	11.0	mg/L	35.304213	-119.2413	NAD83	No	Shafter-Wasco Landfill Monitoring Well
	8/11/2015	11.0	mg/L	35.304213	-119.2413	NAD83		
	2/10/2016	12.0	mg/L	35.304213	-119.2413	NAD83		
	3/9/2017	13.0	mg/L	35.304213	-119.2413	NAD83		
	3/6/2019	15.0	mg/L	35.304213	-119.2413	NAD83		
	8/21/2019	14.0	mg/L	35.304213	-119.2413	NAD83		
	3/2/2020	14.0	mg/L	35.304213	-119.2413	NAD83		
L10003029180-SW1-19	8/11/2015	11.0	mg/L	35.303666	-119.2413	NAD83	No	Shafter-Wasco Landfill Monitoring Well
	8/18/2016	12.0	mg/L	35.303666	-119.2413	NAD83		
	3/8/2017	12.0	mg/L	35.303666	-119.2413	NAD83		
	8/9/2017	13.0	mg/L	35.303666	-119.2413	NAD83		
	3/12/2018	12.0	mg/L	35.303666	-119.2413	NAD83		
	3/6/2019	13.0	mg/L	35.303666	-119.2413	NAD83		
	8/21/2019	11.0	mg/L	35.303666	-119.2413	NAD83		
	3/2/2020	11.0	mg/L	35.303666	-119.2413	NAD83		
	8/5/2020	11.0	mg/L	35.303666	-119.2413	NAD83		
L10003029180-SW1-20	1/15/2015	21.0	mg/L	35.30408	-119.2448	NAD83	No	Shafter-Wasco Landfill Monitoring Well
	8/12/2015	21.0	mg/L	35.30408	-119.2448	NAD83		
	3/13/2018	22.0	mg/L	35.30408	-119.2448	NAD83		
	8/28/2018	23.0	mg/L	35.30408	-119.2448	NAD83		
	3/4/2019	22.0	mg/L	35.30408	-119.2448	NAD83		
	8/21/2019	23.0	mg/L	35.30408	-119.2448	NAD83		
	8/5/2020	23.0	mg/L	35.30408	-119.2448	NAD83		
L10003029180-SW1-21	1/15/2015	21.0	mg/L	35.305319	-119.2424	NAD83	No	Shafter-Wasco Landfill Monitoring Well
	8/11/2015	21.0	mg/L	35.305319	-119.2424	NAD83		
	3/8/2017	20.0	mg/L	35.305319	-119.2424	NAD83		
	3/8/2018	19.0	mg/L	35.305319	-119.2424	NAD83		
	8/28/2018	19.0	mg/L	35.305319	-119.2424	NAD83		
	8/21/2019	18.0	mg/L	35.305319	-119.2424	NAD83		
	3/2/2020	20.0	mg/L	35.305319	-119.2424	NAD83		
	8/3/2020	21.0	mg/L	35.305319	-119.2424	NAD83		
L10003029180-SW1-22	2/10/2016	18.0	mg/L	35.305311	-119.2413	NAD83	No	Shafter-Wasco Landfill
	3/6/2019	17.0	mg/L	35.305311	-119.2413	NAD83		
	8/21/2019	17.0	mg/L	35.305311	-119.2413	NAD83		

GAMA Geotracker Well Code	Sample Date	Nitrate as N Result	Unit	Latitude	Longitude	Datum	HVA Inclusion Determination	Rationale
	2/27/2020	16.0	mg/L	35.305311	-119.2413	NAD83		Monitoring Well
	8/3/2020	17.0	mg/L	35.305311	-119.2413	NAD83		
L10003029180-SW1-23	1/20/2015	18.0	mg/L	35.303055	-119.2413	NAD83	No	Shafter-Wasco Landfill Monitoring Well
	2/10/2016	17.0	mg/L	35.303055	-119.2413	NAD83		
	8/18/2016	17.0	mg/L	35.303055	-119.2413	NAD83		
	8/9/2017	18.0	mg/L	35.303055	-119.2413	NAD83		
	3/6/2019	18.0	mg/L	35.303055	-119.2413	NAD83		
	8/21/2019	19.0	mg/L	35.303055	-119.2413	NAD83		
	2/27/2020	18.0	mg/L	35.303055	-119.2413	NAD83		
SL205314279-BWM-32M	4/9/2020	23.0	mg/L	35.373193	-119.0785	NAD83	No	Bakersfield Refinery Superfund Site
T10000005199-RTH-1	2/17/2016	2.1	mg/L	35.393772	-118.8238	NAD83	No	Valley Waste Disposal Landfill Monitoring Well
	5/17/2016	2.7	mg/L	35.393772	-118.8238	NAD83		
	2/1/2017	2.7	mg/L	35.393772	-118.8238	NAD83		
	4/26/2017	2.7	mg/L	35.393772	-118.8238	NAD83		
	10/17/2017	3.6	mg/L	35.393772	-118.8238	NAD83		
	6/19/2018	15.0	mg/L	35.393772	-118.8238	NAD83		
	12/4/2018	16.0	mg/L	35.393772	-118.8238	NAD83		
T10000005199-RTH-12D	5/18/2017	5.6	mg/L	35.396524	-118.8262	NAD83	No	Valley Waste Disposal Landfill Monitoring Well
	7/18/2017	5.4	mg/L	35.396524	-118.8262	NAD83		
	10/19/2017	5.4	mg/L	35.396524	-118.8262	NAD83		
	6/20/2018	25.0	mg/L	35.396524	-118.8262	NAD83		
	8/28/2018	20.0	mg/L	35.396524	-118.8262	NAD83		
	11/28/2018	22.0	mg/L	35.396524	-118.8262	NAD83		
	3/11/2019	21.0	mg/L	35.396524	-118.8262	NAD83		
	7/31/2019	21.0	mg/L	35.396524	-118.8262	NAD83		
T10000005199-RTH-6	12/3/2015	14.0	mg/L	35.387691	-118.8221	NAD83	No	Valley Waste Disposal Landfill Monitoring Well
	2/1/2017	3.8	mg/L	35.387691	-118.8221	NAD83		
	7/19/2017	4.5	mg/L	35.387691	-118.8221	NAD83		
	6/19/2018	22.0	mg/L	35.387691	-118.8221	NAD83		
	11/19/2018	32.0	mg/L	35.387691	-118.8221	NAD83		
	3/13/2019	27.1	mg/L	35.387691	-118.8221	NAD83		
	2/18/2020	27.1	mg/L	35.387691	-118.8221	NAD83		
	2/18/2020	26.0	mg/L	35.387691	-118.8221	NAD83		
	8/6/2020	24.8	mg/L	35.387691	-118.8221	NAD83		
USGS-352800119260001	1/11/2016	15.4	mg/L	35.471833	-119.4391	NAD83	No	Located <0.25 miles from West Star Dairy and lack of

GAMA Geotracker Well Code	Sample Date	Nitrate as N Result	Unit	Latitude	Longitude	Datum	HVA Inclusion Determination	Rationale
								historical trend of Nitrate exceedances

12.1.4.4. HVA Update

The most recent data from 2015-2021 overwhelmingly supports maintaining the current HVA boundaries, with slight expansions to incorporate applicable new Nitrate as N exceedances since the publication of KRWCA's GAR. In KRWCA's Regional Board approved GAR, Assessor Parcel Numbers (APNs) were selected for inclusion in an HVA if more than 50% of the APN's acreage was located within the same Central Valley Hydrologic Model (CVHM) 1x1 square mile grid as a qualifying Nitrate as N exceedance. KRWCA used the same approved methodology to expand its HVAs in this 5-Year GAR update. Nitrate as N exceedances that qualified for HVA expansion are summarized in **Table 12-8**. **Figure 12-3** displays new designated HVAs based upon this 5-Year GAR update analysis.

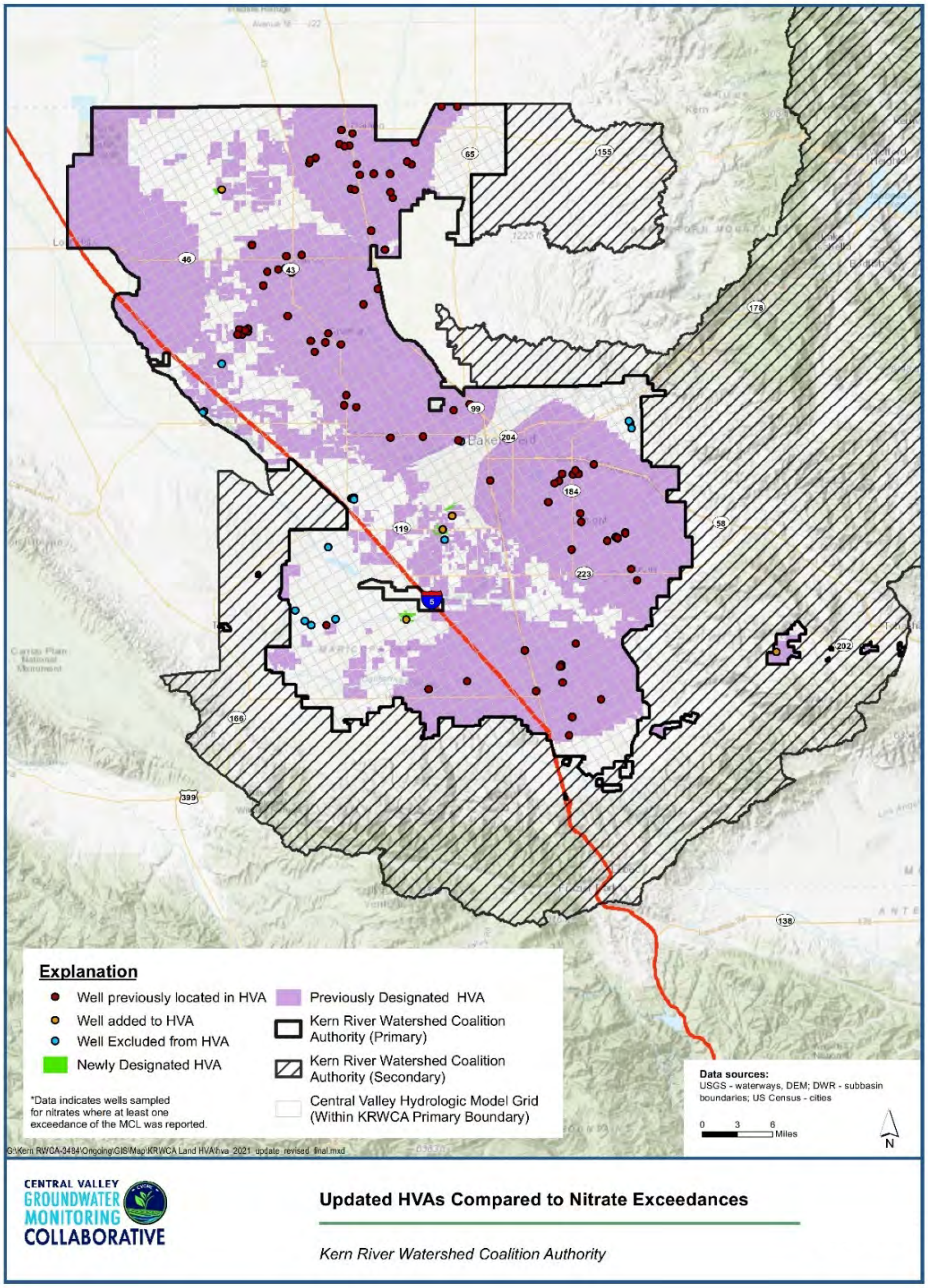

Figure 12-3. Updated HVAs Compared to Nitrate Exceedances for KRWCA

DRAFT REPORT | SEPTEMBER 2021

13. KINGS RIVER WATER QUALITY COALITION GROUNDWATER QUALITY FIVE-YEAR ASSESSMENT REPORT

PREPARED FOR

KINGS RIVER WATER QUALITY COALITION

KINGS RIVER WATER QUALITY COALITION

PREPARED BY

Luhdorff & Scalmanini Consulting Engineers

13. KINGS RIVER WATER QUALITY COALITION GROUNDWATER QUALITY FIVE-YEAR ASSESSMENT REPORT

13.1. Groundwater Quality Trend Monitoring Results 2020

13.1.1. GQTM Summary of 2020 Network and Sampled Wells

The Kings River Water Quality Coalition (KRWQC) 2020 GQTM Well Network consisted of 52 wells (28 Irrigation, 13 Domestic, 6 Monitoring, 4 Public, and 1 Domestic/Irrigation). Forty-six wells were sampled in 2020 between June 17 and 26. During the 2020 sampling, 3 wells were discovered to be destroyed, access to two were blocked and one site was unavailable. Data collected at each accessible wellsite included physical parameters (i.e., electrical conductivity, dissolved oxygen, pH, temperature) and depth to water, when available. Nitrate-N was the only chemical constituent monitored in 2020. **Table 13-1** lists the 2020 GQTM network wells, and **Table 13-2** provides the 2020 GQTM sampling results.

Table 13-1. 2020 GQTM Network Wells											
Field Point Name / GQTM Well ID	GQTM Well Name	Well Use	Well Construction Information					Latitude	Longitude	Datum	Depth to the Bottom of Upper Zone (feet)
			Seal Depth (feet)	Total Well Depth (feet)	Depth Top of Screen (feet)	Depth Bottom of Screen (feet)	Year Drilled				
KRWQC00002	TM13S17E01	Irrigation		150	120	150	1950	36.77854	-120.07	WGS 1984	309.432
KRWQC00003	TM13S20E01	Irrigation		270	260	270	1993	36.8216	-119.754	WGS 1984	188.609
KRWQC00005	TM13S21E01	Irrigation		142	112	142	1956	36.82285	-119.732	WGS 1984	192.103
KRWQC00007	TM13S21E04	Irrigation		140	140	164	1980	36.75344	-119.639	WGS 1984	192.63
KRWQC00008	TM13S22E01	Domestic	20	240	168	208	2013	36.83115	-119.597	WGS 1984	110.74
KRWQC00009	TM13S22E03	Domestic	20	140	100	140	1990	36.77128	-119.573	WGS 1984	134.186
KRWQC00010	TM13S22E04	Irrigation	20	200	60	100	2006	36.76925	-119.556	WGS 1984	132.895
KRWQC00011	TM13S23E01	Irrigation		118	20	97	1975	36.75675	-119.462	WGS 1984	139.288
KRWQC00012	TM14S16E01	Observation	230	310	240	270	2015	36.6635	-120.239	WGS 1984	238.386
KRWQC00014	TM14S18E02	Domestic		120	110	120	1950	36.7354	-119.961	WGS 1984	269.32
KRWQC00016	TM14S19E02	Irrigation		249	239	340	1962	36.69895	-119.943	WGS 1984	261.575
KRWQC00017	TM14S19E03	Irrigation		170	136	170	1958	36.67694	-119.935	WGS 1984	259.129
KRWQC00018	TM14S20E01	Irrigation		188	188	215	1977	36.70496	-119.81	WGS 1984	217.917
KRWQC00019	TM14S20E02	Irrigation	20	202	185	230	2009	36.68557	-119.842	WGS 1984	223.399

Table 13-1. 2020 GQTM Network Wells												
Field Point Name / GQTM Well ID	GQTM Well Name	Well Use	Well Construction Information					Latitude	Longitude	Datum	Depth to the Bottom of Upper Zone (feet)
			Seal Depth (feet)	Total Well Depth (feet)	Depth Top of Screen (feet)	Depth Bottom of Screen (feet)	Year Drilled				
KRWQC00020	TM14S21E01	Municipal	50	405	392.5	415	1992	36.69544	-119.717	WGS 1984	272.456
KRWQC00021	TM14S21E02	Municipal	50	460	400	460	1994	36.69841	-119.684	WGS 1984	239.488
KRWQC00022	TM14S22E01	Irrigation	20	300	240	260	2009	36.73643	-119.62	WGS 1984	191.339
KRWQC00025	TM14S22E04	Domestic	20	78	58	78	2006	36.67855	-119.621	WGS 1984	191.99
KRWQC00026	TM14S23E01	Irrigation	20	154	90	139	2009	36.69141	-119.473	WGS 1984	183.603
KRWQC00027	TM15S16E01	Observation	220	350	240	270	2015	36.62458	-120.216	WGS 1984	229.794
KRWQC00028	TM15S16E02	Domestic	20	300	240	300	2013	36.5797	-120.224	WGS 1984	325.057
KRWQC00030	TM15S18E02	Domestic		350	250	350	1991	36.58744	-119.99	WGS 1984	306.2
KRWQC00031	TM15S18E03	Irrigation	20	500	280	480	2016	36.58594	-119.994	WGS 1984	306.2
KRWQC00032	TM15S19E01	Observation	210	280	220	250	2015	36.60483	-119.872	WGS 1984	222.233
KRWQC00033	TM15S21E01	Irrigation		160	151	160	1976	36.6029	-119.687	WGS 1984	197.571
KRWQC00034	TM15S21E02	Irrigation		137	102	137	1955	36.58901	-119.655	WGS 1984	209.772
KRWQC00036	TM15S22E02	Irrigation	20	240	120	240	2015	36.64101	-119.557	WGS 1984	142.077
KRWQC00037	TM15S22E03	Irrigation	20	300	140	300	2015	36.63108	-119.616	WGS 1984	179.394

Table 13-1. 2020 GQTM Network Wells												
Field Point Name / GQTM Well ID	GQTM Well Name	Well Use	Well Construction Information					Latitude	Longitude	Datum	Depth to the Bottom of Upper Zone (feet)
			Seal Depth (feet)	Total Well Depth (feet)	Depth Top of Screen (feet)	Depth Bottom of Screen (feet)	Year Drilled				
KRWQC00038	TM15S22E04	Irrigation	20	340	180	340	2018	36.62407	-119.621	WGS 1984	209.118
KRWQC00042	TM15S23E01	Domestic/Irrigation	22	235	188	231	2006	36.64754	-119.501	WGS 1984	214.646
KRWQC00043	TM15S23E02	Irrigation	20	240	175	195	1994	36.64454	-119.501	WGS 1984	214.646
KRWQC00046	TM15S24E01	Irrigation	20	380	128	180	2009	36.62731	-119.377	WGS 1984	163.528
KRWQC00052	TM16S20E01	Observation	240	300	260	290	2015	36.50359	-119.809	WGS 1984	297.783
KRWQC00054	TM16S21E01	Irrigation		111	92	111	1955	36.55981	-119.683	WGS 1984	222.908
KRWQC00057	TM16S23E01	Municipal	110	245	130	235	2006	36.53885	-119.428	WGS 1984	185.597
KRWQC00066	TM16S25E01	Municipal	52	440	68	425	1972	36.4872	-119.253	WGS 1984	180.134
KRWQC00067	TM17S18E01	Domestic	50	240	210	240	1975	36.48785	-119.984	WGS 1984	378.873
KRWQC00068	TM17S18E02	Irrigation	50	552	218	552	1980	36.47745	-119.966	WGS 1984	377.618
KRWQC00070	TM17S18E04	Irrigation	47	560	320	520	1994	36.45922	-120.036	WGS 1984	431.05
KRWQC00071	TM17S18E05	Irrigation	60	510	330	510	1992	36.46612	-119.968	WGS 1984	387.006
KRWQC00074	TM17S19E02	Domestic	20	240	180	240	2005	36.40901	-119.853	WGS 1984	239.235
KRWQC00078	TM17S21E02	Observation	200	280	250	280	2015	36.43817	-119.655	WGS 1984	207.224

Table 13-1. 2020 GQTM Network Wells

Field Point Name / GQTM Well ID	GQTM Well Name	Well Use	Well Construction Information					Latitude	Longitude	Datum	Depth to the Bottom of Upper Zone (feet)
			Seal Depth (feet)	Total Well Depth (feet)	Depth Top of Screen (feet)	Depth Bottom of Screen (feet)	Year Drilled				
KRWQC00079	TM17S22E01	Domestic	20	233	212	233	2004	36.4426	-119.618	WGS 1984	193.338
KRWQC00080	TM17S22E03	Domestic	20	300	160	300	2009	36.41555	-119.587	WGS 1984	201.075
KRWQC00081	TM17S23E01	Domestic	20	295	206.8	305	1999	36.44545	-119.5	WGS 1984	194.119
KRWQC00082	TM17S24E01	Domestic	20	240	194	240	1992	36.48674	-119.344	WGS 1984	185.991
KRWQC00083	TM17S24E02	Irrigation	80	340	170	230	1991	36.47774	-119.336	WGS 1984	182.84
KRWQC00091	TM20S20E01	Observation	290	315	295	315	2004	36.15983	-119.776	WGS 1984	509.538
KRWQC00092	TM12S21E01	Irrigation	20	345	140	220	2003	36.86758	-119.688	WGS 1984	134.669
KRWQC00093	TM13S18E01	Domestic	20	261	261	270	1987	36.8264	-119.98	WGS 1984	241.172
KRWQC00094	TM14S24E01	Irrigation	20	250	216	250	1997	36.6691	-119.412	WGS 1984	181.361
KRWQC00095	TM16S19E03	Irrigation	20	405	360	400	1999	36.5631	-119.905	WGS 1984	266.149

*Depth Top of Screen represents the top of the top most screen and the Depth Bottom of Screen represents the bottom of the bottom most screen.

Table 13-2. 2020 GQTM Sampling Results									
Field Point Name / GQTM Well ID	GQTM Well Name	Well Use	Date Sampled	Nitrate as N (mg/L) Lab	pH Field	Specific Conductance (uS/cm) Field	Temperature (°C) Field	Dissolved Oxygen (mg/L) Field	Depth to Water (ft) Field
KRWQC00002	TM13S17E01	Irrigation	6/17/2020	8.1	7.45	678	21.5	5.77	83.7
KRWQC00003	TM13S20E01	Irrigation	6/23/2020	3.4	8.23	245.9	21.1	5.9	NR
KRWQC00005	TM13S21E01	Irrigation	6/23/2020	4.6	7.76	268.4	21.5	4.85	NR
KRWQC00007	TM13S21E04	Irrigation	6/19/2020	4.2	7.56	408.4	24.6	3.55	61
KRWQC00008	TM13S22E01	Domestic	6/19/2020	6.2	7.95	638	28.2	5.81	75.9
KRWQC00009	TM13S22E03	Domestic	6/19/2020	10	7.53	523	24	4.31	48.5
KRWQC00010	TM13S22E04	Irrigation	6/19/2020	5.2	7.79	394.7	21	4.72	39.8
KRWQC00011	TM13S23E01	Irrigation	6/23/2020	0.21	7.32	50.2	17.1	6.15	7
KRWQC00012	TM14S16E01	Observation	6/25/2020	< 0.099	8.12	1402	23.4	1.35	80.8
KRWQC00014	TM14S18E02	Domestic	6/17/2020	7	7.29	1020	20.5	5.14	NR
KRWQC00016	TM14S19E02	Irrigation	6/18/2020	4.1	7.53	879	18.8	0.41	88.7
KRWQC00017	TM14S19E03	Irrigation	6/18/2020	1.9	7.75	940	19.1	0.85	NR
KRWQC00018	TM14S20E01	Irrigation	6/18/2020	17	7.8	696	21.9	3.81	90.6
KRWQC00019	TM14S20E02	Irrigation	6/18/2020	6.7	7.55	703	20.4	6.81	94
KRWQC00020	TM14S21E01	Municipal	6/24/2020	2.9	8.68	312.9	24.8	3.81	82.9
KRWQC00022	TM14S22E01	Irrigation	6/22/2020	21	7.37	808	21.2	3.31	73

Table 13-2. 2020 GQTM Sampling Results									
Field Point Name / GQTM Well ID	GQTM Well Name	Well Use	Date Sampled	Nitrate as N (mg/L) Lab	pH Field	Specific Conductance (uS/cm) Field	Temperature (°C) Field	Dissolved Oxygen (mg/L) Field	Depth to Water (ft) Field
KRWQC00025	TM14S22E04	Domestic	6/22/2020	1.8	7.5	137	24	5.17	67.5
KRWQC00026	TM14S23E01	Irrigation	6/23/2020	24	7.52	552	21.7	3.08	30.7
KRWQC00027	TM15S16E01	Observation	6/25/2020	< 0.099	8.52	957	23.1	2.91	103
KRWQC00028	TM15S16E02	Domestic	6/25/2020	< 0.2	7.82	3606	20.7	0.98	110.4
KRWQC00030	TM15S18E02	Domestic	6/18/2020	18	7.48	1133	22.1	6.2	227.5
KRWQC00031	TM15S18E03	Irrigation	6/18/2020	6.5	7.54	727	22.5	1.76	229.2
KRWQC00032	TM15S19E01	Observation	6/26/2020	13	8.65	459.2	22.8	1.88	161.3
KRWQC00033	TM15S21E01	Irrigation	6/24/2020	7.6	8.51	658	20.4	5.81	71.9
KRWQC00034	TM15S21E02	Irrigation	6/22/2020	3.1	7.62	223	17.8	6.42	70.1
KRWQC00036	TM15S22E02	Irrigation	6/22/2020	4.1	7.31	161.8	17.3	4.81	60.1
KRWQC00037	TM15S22E03	Irrigation	6/22/2020	7.7	7.51	358.3	18.2	5.65	60.5
KRWQC00038	TM15S22E04	Irrigation	6/22/2020	1.1	8.22	130.1	19.4	6.07	137
KRWQC00042	TM15S23E01	Domestic/Irrigation	6/22/2020	3.2	7.44	210.5	22.9	3.53	74
KRWQC00043	TM15S23E02	Irrigation	6/22/2020	4.9	6.9	184.3	19.7	2.53	74.3
KRWQC00052	TM16S20E01	Observation	6/26/2020	7.2	8.36	254.7	22	3.98	167.6
KRWQC00054	TM16S21E01	Irrigation	6/24/2020	6.8	8.36	259.1	19.5	5.36	NR

Table 13-2. 2020 GQTM Sampling Results									
Field Point Name / GQTM Well ID	GQTM Well Name	Well Use	Date Sampled	Nitrate as N (mg/L) Lab	pH Field	Specific Conductance (uS/cm) Field	Temperature (°C) Field	Dissolved Oxygen (mg/L) Field	Depth to Water (ft) Field
KRWQC00067	TM17S18E01	Domestic	6/26/2020	< 0.099	7.83	964	25.1	0.81	233.6
KRWQC00068	TM17S18E02	Irrigation	6/26/2020	< 0.099	8.46	884	23.2	0.56	NR
KRWQC00070	TM17S18E04	Irrigation	6/25/2020	< 0.099	8.15	906	21.8	2.2	NR
KRWQC00071	TM17S18E05	Irrigation	6/26/2020	< 0.099	8.49	707	21.6	0.59	NR
KRWQC00074	TM17S19E02	Domestic	6/25/2020	1.9	8.7	855	26.2	1.64	161.6
KRWQC00078	TM17S21E02	Observation	6/26/2020	3.3	10.7	357	21.9	2.12	76.2
KRWQC00080	TM17S22E03	Domestic	6/23/2020	11	8.26	416.6	20.7	2.29	109.9
KRWQC00081	TM17S23E01	Domestic	6/23/2020	3.2	8.12	438.2	33.6	1.42	124.9
KRWQC00082	TM17S24E01	Domestic	6/24/2020	13	8.01	617	20.6	6.15	69.3
KRWQC00083	TM17S24E02	Irrigation	6/24/2020	24	7.54	940	21.4	6.18	92.8
KRWQC00091	TM20S20E01	Observation	6/26/2020	0.13	7.54	1919	21.4	6.18	131
KRWQC00093	TM13S18E01	Domestic	6/17/2020	3.5	8.14	238.5	20.3	5.29	83.3
KRWQC00094	TM14S24E01	Irrigation	6/23/2020	0.6	7.69	159.1	20.5	4.38	70.8
KRWQC00095	TM16S19E03	Irrigation	6/18/2020	3.3	8.54	330.5	24.7	2.36	213.7

13.1.2. Summary of Quality Assurance Evaluation for 2020 Sampling Event

13.1.2.1. Purging, sample handling, and custody

The 2020 GQTM Well Network consisted of a mix of irrigation, domestic, public, and monitoring wells as previously discussed. Every effort was made to purge each well as required.

Except as noted, purging was performed for all groundwater monitoring wells prior to sample collection to remove stagnant water from within the well casing and ensure that a representative sample was obtained. Irrigation wells were allowed to run for 5 to 10 minutes (if not already running) prior to samples being collected. This allowed for the clearing of any sand from the discharge prior to sampling.

Sampling for monitoring wells was done using a clean bailer which generally produces 500 ml of water per extraction (maximum capacity of 1000 ml). The data recorded from these wells reflects water collected after several bailer volumes are extracted from the well (a sufficient volume to submerge the instruments is collected, discarded and recollected, approximately 2 gallons per cycle).

Samples are placed in pre-labeled bottles provided by the contracted laboratory. Date and time of sample is recorded on each bottle. The samples are then placed in a cooler with blue ice for thermal control for the remainder of the day's sampling event. When the sampling is finished for the day, the samples are transferred to a laboratory provided cooler and covered with wet ice for transport to the lab.

Chains of custody are completed at each sample site and signed off at the end of the sampling day.

Field sheets are completed at each site recording location, date, time of sample, and physical parameter data, plus any other information of value.

13.1.2.2. Access and field and analytical completeness

As shown in **Table 13-3**, 46 of the 52 wells were sampled in 2020. Of the six wells that were not sampled, three wells were destroyed, two wells were not accessible, and one well was not sampled for other reasons. Access completeness was 88.5%. Physical parameter data (EC, DO, pH, temp) were collected at all sampled sites. Completeness for this data was 100%.

As shown in **Table 13-2**, depth to water was collected at sites where the pump was not in operation at the time of arrival or suitable access was available. Of the wells where a sample was collected, depth to water was unavailable at eight wells. Five wells were running at the time of arrival and three had no access to the well casing. For the 2020 GQTM Well Network, completeness was 83% for depth to water.

As shown in **Table 13-4**, the KRWQC submitted a field blank daily while sampling. Additionally, KRWQC randomly selected one field duplicate sample daily. The analytical lab reported no issues with any samples submitted during the 2020 sampling event. Field blank and duplicate completeness was 12.9% (8/62) for the 2020 well network.

As shown in **Table 13-5**, all samples were analyzed within the 48-hour hold time as required for Nitrate as N. The sample acceptability was 100% for the evaluation of sample hold times.

Table 13-3. Completeness of Field and Analytical Testing

Constituent	Test Type	Analytical Method	Matrix	Wells Planned for Sampling	No Access	Other	Destroyed Well	Wells Sampled	Field and Transport Complete-ness %	Total Samples Analyzed	Analytical Complete-ness %
Oxygen, Dissolved	Field parameter	EPA 360.1	Ground-water	52	2	1	3	46	88.5	46	100
pH	Field parameter	EPA 150.1	Ground-water	52	2	1	3	46	88.5	46	100
Specific Conductivity	Field parameter	EPA 120.1	Ground-water	52	2	1	3	46	88.5	46	100
Temperature	Field parameter	SM 2550	Ground-water	52	2	1	3	46	88.5	46	100
Nitrate as N	Laboratory	EPA 300.0	Ground-water	52	2	1	3	46	88.5	46	100
			Total	**260**	**10**	**5**	**15**	**230**	**88.5**	**230**	**100**

Table 13-4. Completeness of Field QC

Constituent	Analytical Method	Matrix	Total Well Samples Analyzed	Field Duplicate Samples Analyzed	Field Blank Samples Analyzed	Total Samples Analyzed (well and duplicates)	Field Duplicate Completeness %	Field Blank Completeness %
Nitrate as N	EPA 300.0	groundwater	46	8	8	62	12.9	12.9
		Total	46	8	8	62	12.9	12.9

Completeness values below the acceptability requirement of 5 percent are presented in **bold**.

Table 13-5. Evaluation of Sample Hold Times

Constituent	Analytical Method	Matrix	Hold Time	Total Samples Analyzed	Samples Analyzed within Hold Time	Acceptability %
Nitrate as N	EPA 300.0	groundwater	48 hours	62	62	100
			Total	**62**	**62**	**100**

Acceptability values below 90 percent are presented in **bold**.

13.1.2.3. Analytical precision and accuracy

The contracted laboratory conducted the requisite number of internal quality control checks on the samples provided and reported 100% acceptability of the data reported. As shown in Table 6, field duplicate and field blank sample met the acceptability requirement for 100% acceptability. As shown in Table 7, the evaluation of lab controls and spikes, which consisted of lab blanks, lab control spikes, matrix spikes, and analytical duplicates, resulted in 100% acceptability with all samples evaluated to be within acceptability.

Table 13-6. Evaluation of Field Duplicates and Blanks

Constituent	Analytical Method	Matrix	Sample Type	Acceptability Requirement	Total Samples	Samples within Acceptability	Acceptability %
Nitrate as N	EPA 300.0	groundwater	Field Duplicate	RPD ≤ 25	8	8	100
				Field Duplicate Total	**8**	**8**	**100**
Acceptability values below 90 percent are presented in **bold**.							
Constituent	**Analytical Method**	**Matrix**	**Sample Type**	**Acceptability Requirement**	**Total Samples**	**Samples within Acceptability**	**Acceptability %**
Nitrate as N	EPA 300.0	groundwater	Field Blank	< RL or 1/5 environmental sample	8	8	100
				Field Duplicate Total	**8**	**8**	**100**
Acceptability values below 90 percent are presented in **bold**.							

Table 13-7. Evaluation of Lab Controls and Spikes							
Constituent	Analytical Method	Matrix	Sample Type	Acceptability Requirement	Total Samples	Samples within Acceptability	Acceptability %
Lab Blanks							
Nitrate as N	EPA 300.0	groundwater	Lab Blank	< RL	10	10	100
				Lab Blank Total	10	10	100
Lab Control Spikes							
Nitrate as N	EPA 300.0	groundwater	LCS	PR 90-110	10	10	100
				Lab Control Total	10	10	100
Matrix Spikes							
Nitrate as N	EPA 300.0	groundwater	MS	PR 80-120	40	40	100
				Matrix Spike Total	40	40	100
Analytical Duplicates							
Nitrate as N	EPA 300.0	groundwater	MSD/LCSD/Lab Dup	RPD ≤ 25	20	20	100
				Analytical Duplicate Total	20	20	100
Acceptability values below 90 percent are presented in **bold**.							
LCS=lab control spike; MS=matrix spike; MSD=matrix spike duplicate; LCSD=lab control spike duplicate							

13.1.2.4. Quality assurance evaluation conclusions

As discussed previously, completeness and acceptability for analytical, field duplicate, field blank, hold time, were all found to be within the required range.

13.1.2.5. Electronic Data Submittal and Data Uploaded to GeoTracker

In accordance with the requirements for electronic data submittal, data was uploaded to GeoTracker on March 8, 2021.

13.1.3. Five-Year Assessment Results and Discussion

Luhdorff & Scalmanini Consulting Engineers (LSCE) conducted both parametric and non-parametric analyses of Nitrate as N (Nitrate or NO_3-N) and Total Dissolved Solids (TDS) trends within the KRWQC boundary. Methodology for each of these analyses is discussed in **Section 5**. All of the **Section 5** figures pertinent to this individual coalition section are presented in **Appendix K**.

The average nitrate condition in GQTM wells varies throughout the Kings River Water Quality Coalition boundary as shown in **Figure K-1** in **Appendix K**. According to the analysis, the total number of GQTM wells with average nitrate (N) conditions of less than or equal to 2.5 mg/L, greater than 2.5 to 5.0 mg/L, and greater than 10 mg/L have similar representations within the well network. The vast majority of the GQTM wells with average nitrate conditions greater than 10 mg/L are found in the Kings groundwater subbasin, except for one well located in the Tulare Lake groundwater subbasin northeast of Hanford. Analysis of the Kings subbasins finds GQTM wells in the east, south, and west have average nitrate results of greater than 10 mg/L.

The most recent nitrate sample result in GQTM wells varies throughout the Kings River Water Quality Coalition boundary as shown in **Figure K-2** in **Appendix K**. According to the analysis, the total number of GQTM wells with the most recent nitrate sample result of less than or equal to 2.5 mg/L, greater than 2.5 to 5.0 mg/L, and greater than 10 mg/L have similar representations for sampling sites located in the KRWQC boundary. The vast majority of the GQTM wells with nitrate conditions greater than 10 mg/L are found in the Kings groundwater subbasin, except for one well located in the Tulare Lake groundwater subbasin northeast of Hanford. Analysis of the Kings subbasins finds GQTM wells in the east, south, and west have recent nitrate results of greater than 10 mg/L.

The most recent nitrate sample results from publicly available data sources for all well types including varying seal depth, well depth, screen interval, and year drilled is presented in the next figure in **Appendix K (Figure K-3)**. Wells with nitrate conditions greater than 10 mg/L are pervasive within the Kings and the northern Tulare Lake subbasins. Additionally, wells with nitrate conditions of less than or equal to 2.5 mg/L are also found in the Kings (west) and Tulare Lake (north) subbasins.

As shown in **Figure K-4** in **Appendix K**, the ambient nitrate in the Upper Zone for 2000 and after varies throughout the Kings River Water Quality Coalition boundary. According to the analysis, areas with nitrate (N) conditions of less than or equal to 2.5 mg/L, greater than 2.5 to 5.0 mg/L, and greater than 10 mg/L have similar representations within the KRWQC boundary. Analysis of the Kings subbasins finds areas in the east, south, and west with ambient nitrate in the Upper Zone of greater than 10 mg/L. Additionally, the Tulare Lake subbasin includes some areas in the north with ambient nitrate in the Upper Zone of greater than 10 mg/L.

As shown in **Figure K-5** in **Appendix K**, the ambient nitrate in the Upper Zone for 2010 and after varies throughout the Kings River Water Quality Coalition boundary. According to the analysis, areas with nitrate (N) conditions of less than or equal to 2.5 mg/L, greater than 2.5 to 5.0 mg/L, and greater than 10 mg/L have similar representations within the KRWQC boundary. Analysis of the Kings subbasins finds areas in the east, south, and west with ambient nitrate in the Upper Zone of greater than 10 mg/L.

A linear regression analysis was performed on the dataset of GQTM wells with information from 2000 to present within the KRWQC with three or more nitrate samples. More thorough and representative analysis of the GQTM network will be completed when results from additional sampling years are available. Analysis performed for wells within the KRWQC indicates locations of increasing, decreasing, and stable nitrate trends. As shown in **Figure K-6** in **Appendix K**, the most prevalent trends for nitrates include decreasing (linear rate less than 0.5 mg/L/yr) and increasing (linear rate less than 0.5 mg/L/yr and linear rate greater than 0.5 mg/L/yr).

As shown in **Table K-1** in **Appendix K**, results for 41 GQTM wells were analyzed within the KRWQC boundary for parametric nitrate trends. Nineteen (15 irrigation and 4 urban) wells were determined to have insufficient evidence of linear trend. Thirteen wells (11 irrigation and 2 urban) were determined to have an increasing linear trend. Five irrigation wells were determined to have a decreasing linear trend. Four irrigation wells were determined to have a stable linear trend.

A non-parametric trend analysis (Mann-Kendall and Theil-Sen trend analysis, n > 8) was performed on available data within the KRWQC. Analysis performed for wells within the KRWQC indicates locations of increasing, decreasing, and stable nitrate trends. **Figure K-7** in **Appendix K** shows the spatial distribution of non-parametric trend analysis. Data concentrated around the Fresno-Clovis metropolitan area indicates decreasing trends in the north and increasing trends in the south. Data concentrated around Lemoore in the Tulare Lake subbasin indicate stable nitrate trends. Additionally, there were locations within KRWQC in which there was insufficient evidence to determine nitrate trends.

More thorough and representative analysis of the GQTM network will be completed when results from additional sampling years are available.

Recent TDS concentrations in GQTM wells indicate most of the Coalition has TDS concentrations below the secondary drinking water standard of 1,000 mg/L, with the exception of three wells near the western border (**Figure K-8**).

13.1.4. Five-Year High Vulnerability Area Update

13.1.4.1. Existing HVA Compared to Nitrate Exceedances

In accordance with the WDRs and to address elements of the five-year review and update of the GAR, the Coalition reviewed the HVA delineated in 2015 as part of the original GAR. To evaluate the sufficiency of the 2015 HVA, all readily and publicly available data on historical nitrate concentrations were examined within the Coalition region and compared with the 2015 HVA. Consistent with the original GAR and the approach used in designation of the 2015 HVA, the evaluation of the HVA is focused on the San Joaquin Valley Groundwater Basin (Central Valley Floor) where all but a very small amount of the irrigated area in the Coalition region is located.

Of the 3,452 wells within the Coalition region with historical nitrate concentration data, 3,286 wells are located within the Central Valley Floor. Of these 3,286 wells, 458 wells have historical concentrations of nitrate that exceed the primary drinking water MCL of 10 mg/L (as nitrogen). Of the 458 exceedance wells, 438 (96 percent) are located within the extent of the 2015 HVA. The 20 wells with historical nitrate exceedance records located outside the 2015 HVA were reviewed with respect to their location relative to the 2015 HVA and the characteristics and conditions of each site.

During the review of the outlier exceedance wells, it was determined that eleven of the exceedance wells (all located at the same site: L10006109169) located outside of the 2015 HVA (**Figure 13-2**) are associated with the monitoring network for an active solid waste disposal facility (landfill) regulated contamination site. The facility was established in 1971 and covers an area of 440 acres. The historical nitrate concentrations in these regulated facility monitoring wells are as high as 45 mg/L and are not likely related to agricultural management practices. Four nearby domestic wells (within 1.5 miles) sampled recently as part of the ILRP Drinking Water Well Monitoring requirement, which commenced in 2020, indicate no detectable levels of nitrate in the groundwater at these locations around the site.

One other exceedance well (1000530-002) located outside the 2015 HVA is shown as a public water supply well located in the middle of an orchard without any nearby communities (**Figure 13-2)**. This well is in the same vicinity as the landfill site discussed above; however, review of aerial photography indicates the well does not currently exist at the location and no such water system number was found in a search for the associated public water system on the State Water Resource Control Board's Drinking Water Division Water Systems database (https://sdwis.waterboards.ca.gov/PDWW/JSP/WaterSystems.jsp?PointOfContactType=none&number=&WaterSystemStatus=A&name=&county=Fresno). Considering this information, it is believed that this datapoint is erroneously located and other attributes (e.g., water system number) associated with the record also appear to be in error.

The landfill monitoring wells and the erroneously located public supply well are not reflective of groundwater conditions resulting from agricultural practices in the area.

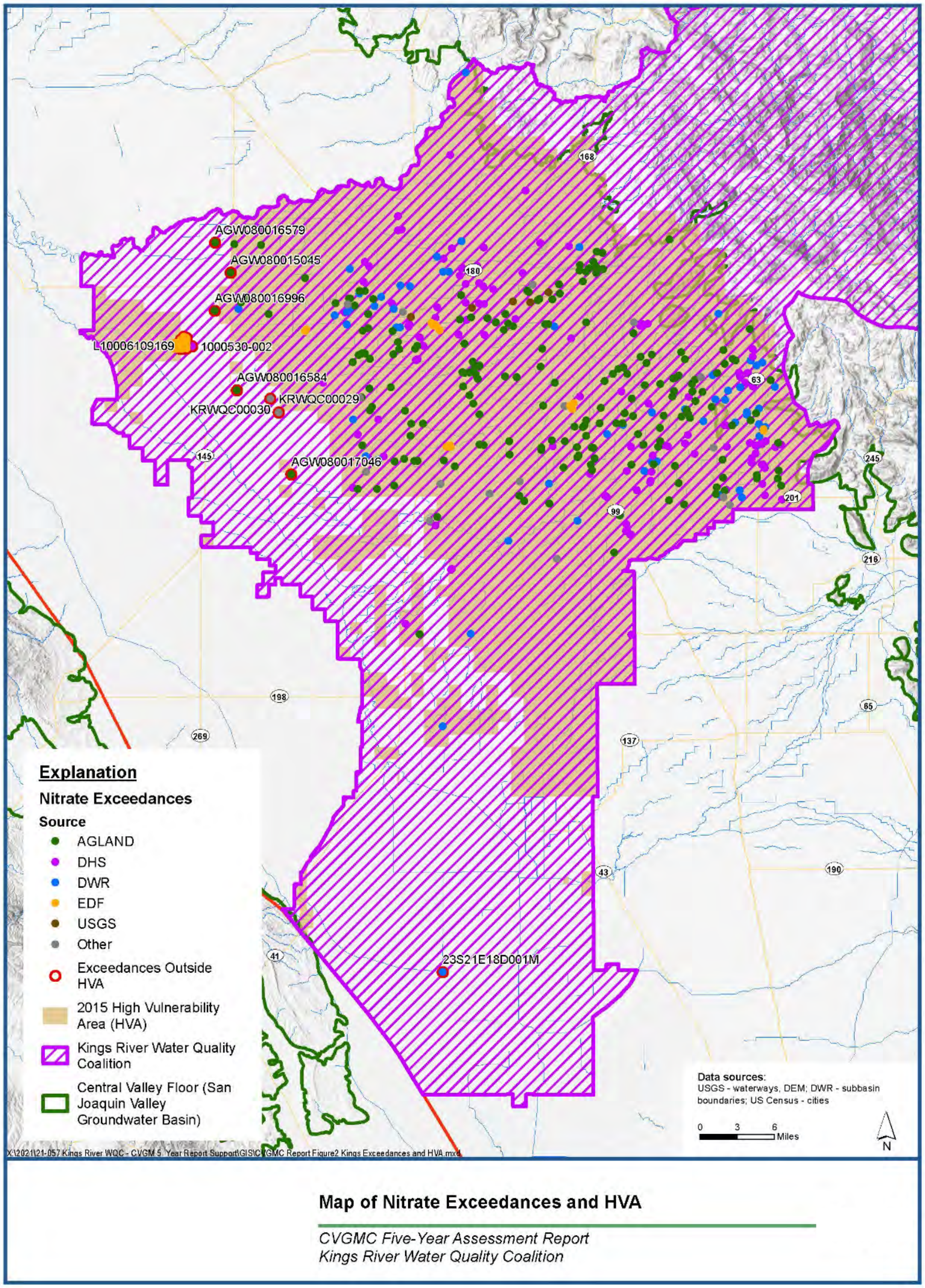

Figure 13-2. Map of Nitrate Exceedances and HVA

13.1.4.2. HVA Update

The five-year review of the Coalition's HVA seeks to account for all nitrate exceedances in the Coalition that may be related to irrigated agriculture activities. The review of the HVA and exceedance wells described above indicates eight exceedances located outside of the extent of the 2015 HVA that should be considered in the 2021 HVA update. Although a relationship between the nitrate exceedances located outside the 2015 HVA and irrigated agriculture is uncertain, the eight exceedance locations tend to be in close proximity to the 2015 HVA. Of the eight exceedance locations outside the 2015 HVA, three (38 percent) are within one quarter mile and four (50 percent) are within one half mile of the 2015 HVA. One exceedance well located far from the 2015 HVA is in an area that was de-designated for Municipal and Domestic Supply (MUN) and Agricultural Supply (AGR) beneficial uses as part of an amendment to the Water Quality Control Plan for the Tulare Lake Basin (Basin Plan) approved in 2017. For this reason, this well (23S21E18D001M) was not considered for inclusion in the update to the HVA. Because of the strong spatial agreement and close distance between the 2015 HVA and historical nitrate exceedance wells, only minor modifications to the 2015 HVA were performed to address the seven noted exceedance wells outside the 2015 HVA.

Given the small number of exceedance wells outside the HVA and their close proximity to the 2015 HVA, modifications to the extent of the HVA were made through consideration of the hydrogeologic characteristics near the exceedance wells. In all cases, the outline of the HVA was expanded and redrawn to encompass exceedance wells outside the HVA using guidance from mapping of soil hydraulic conductivity from NRCS SURGO data (NRCS, 2013) and soil deep percolation potential from the Soil Agricultural Groundwater Banking Index (SAGBI; O'Geen et al., 2015). Modifications to the HVA were performed with consideration of the occurrence of soils with higher hydraulic conductivity and greater deep percolation potential, characteristics which may make soils more vulnerable to leaching of nitrate to groundwater. For exceedances occurring at a greater distance from the 2015 HVA, soils with more vulnerable characteristics encompassing the exceedance location were identified within a radius of one quarter mile of the exceedance wells

In one case, an exceedance occurred far from the 2015 HVA and in an area where soil conditions do not suggest potential for higher vulnerability. In this instance, additional HVA was included around the exceedance location extending a radius of one quarter mile around the exceedance point. The extent of the area to include around the outlier exceedance was determined through consideration of the typical scale of soil characteristics as mapped by NRCS (2013) and the relatively higher fraction of exceedance wells occurring within one quarter mile of the 2015 HVA.

For consistency with the delineation of the 2015 HVA, which was completed following Public Land Survey System section and quarter section lines, the quarter sections overlapping the soils identified as having higher percolation potential in the vicinity of exceedance wells were included in the HVA. One exceedance well that was within 100 feet from the 2015 HVA was encompassed through a minor modification to the HVA boundary. Several small areas located with the de-designated area of the Coalition that were included as HVA in 2015 were removed from the HVA. These removed HVA areas total 130 acres. No other modifications to the 2015 HVA were made that resulted in removing areas previously designated as HVA. The extent of the 2021 HVA is presented in **Figure 13-3**.

The HVA modifications completed for the 2021 HVA represent an overall increase in area of 1,481 acres from the 2015 HVA. The total area within the 2021 HVA is 962,009 acres.

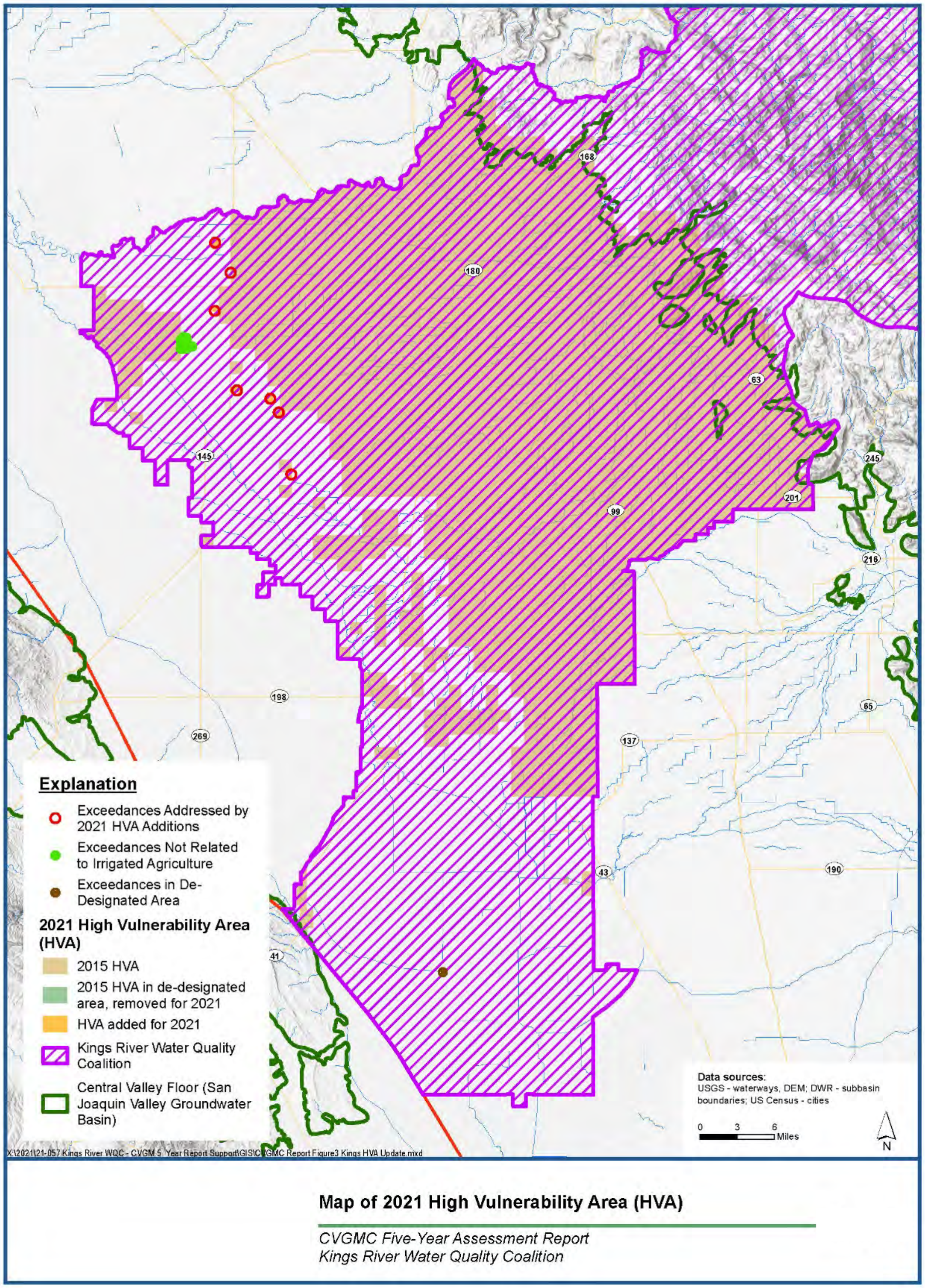

Figure 13-3. Map of 2021 High Vulnerability Area (HVA)

DRAFT REPORT | SEPTEMBER 2021

14. WESTLANDS WATER QUALITY COALITION GROUNDWATER QUALITY FIVE-YEAR ASSESSMENT REPORT

PREPARED FOR

WESTLANDS WATER QUALITY COALITION

Westlands Water Quality Coalition

PREPARED BY

MLJ ENVIRONMENTAL

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14. WESTLANDS WATER QUALITY COALITION GROUNDWATER QUALITY FIVE-YEAR ASSESSMENT REPORT

14.1. Groundwater Quality Trend Monitoring Results 2020

14.1.1. GQTM Summary of 2020 Network and Sampled Wells

For the Groundwater Quality Trend Monitoring (GQTM) Program, Westlands Water Quality Coalition (WWQC or Coalition) monitored 15 network wells in 2020. Five monitoring wells were installed in 2019 for groundwater monitoring related to the Sustainable Groundwater Management Act (SGMA). In accordance with the annual and five-year GQTM sampling schedule, the five new network wells sampled for the first time as part of the GQTM were tested for nitrate + nitrite, total dissolved solids (TDS), major cations and anions (boron, calcium, sodium, magnesium, potassium, carbonate, bicarbonate, chloride, sulfate), and alkalinity, as required every five years. The other network wells previously sampled for the GQTM were only tested for nitrate, as required for annual monitoring. The Coalition provided the Central Valley Regional Water Quality Control Board (Regional Water Board) with a Technical Memorandum of the finalized 2020 GQTM Well Network on June 3, 2020. **Table 14-1** and **Figure 14-1** present the wells in the 2020 GQTM Well Network, including the five SGMA wells. Efforts by WWQC to find additional monitoring wells are ongoing.

The WWQC began year three of the implementation of the GQTM in Summer of 2020. MLJ Environmental conducted the 2020 groundwater sampling during a single sampling event in between June 22 and 26. Consistent with the sampling approach utilized in previous year, groundwater samples were collected from all 15 wells using no-purge methods. The results from the 2020 GQTM sampling event are presented in **Table 14-2**. Nitrate + nitrate concentrations ranged from below detectable levels (non-detect or ND) to 430 mg/L (Table 2). A total of five wells had nitrate concentrations exceeding the drinking water MCL of 10 mg/L as nitrogen. The nitrate concentrations in the other GQTM wells were relatively low with all wells having concentrations less than 5 mg/L, including six wells with concentrations below detectable levels.

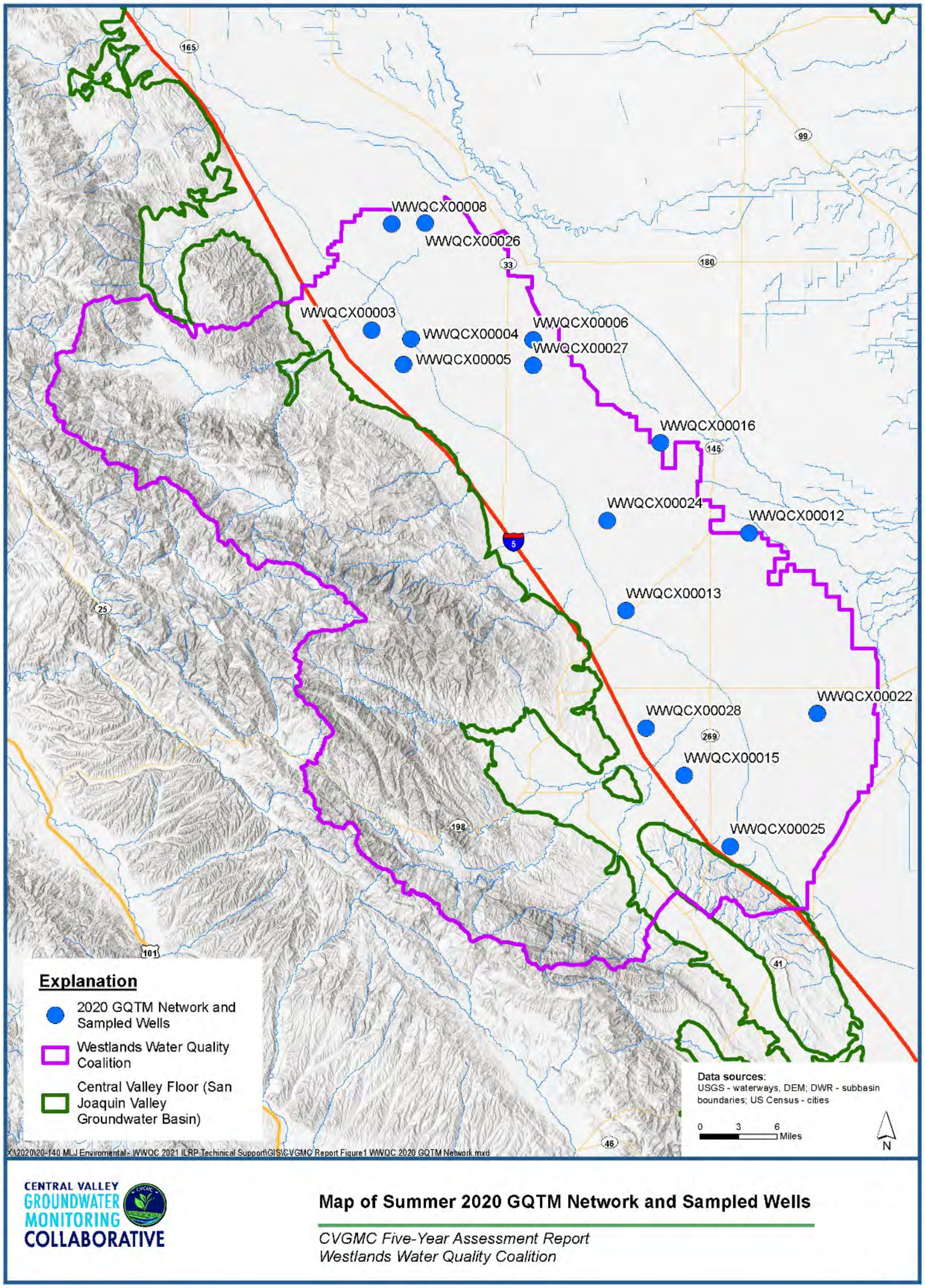


Figure 14-1. Map of Summer 2020 GQTM Network and Sampled Wells

Table 14-1. 2020 GQTM Network Wells												
Field Point Name / GQTM Well ID	GQTM Well Name	Well Use	Well Construction Information					Latitude	Longitude	Datum	Depth to the Bottom of Upper Zone (feet)
			Seal Depth (feet)	Total Well Depth (feet)	Depth Top of Screen (feet)	Depth Bottom of Screen (feet)	Year Drilled				
WWQCX00003	WWQC_03	Observation	188	215	199	209	1988	36.65689	-120.578	NAD83	465.077
WWQCX00004	WWQC_04	Observation		199	184	194		36.64697	-120.523	NAD83	512.889
WWQCX00005	WWQC_05	Observation	350	379	363	373	1988	36.6185	-120.533	NAD83	550.316
WWQCX00006	WWQC_06	Observation	250	267	252	262	1986	36.64667	-120.352	NAD83	492.295
WWQCX00008	WWQC_08	Observation	182	208	193	203	1987	36.7762	-120.551	NAD83	407.813
WWQCX00012	WWQC_12	Observation	275	350	300	350	2018	36.42986	-120.049	NAD83	462.881
WWQCX00013	WWQC_13	Irrigation	20	400		400		36.34233	-120.221	NAD83	532.874
WWQCX00015	WWQC_15	Observation		500	350	490		36.157	-120.139	NAD83	658.943
WWQCX00016	WWQC_16	Observation	225	310	250	300	2018	36.53123	-120.173	NAD83	415.394
WWQCX00022	WWQC_22	Irrigation						36.22663	-119.954	NAD83	524.661
WWQCX00024	WWQC_SGMA_1B	Observation	135	610	550	600	2020	36.44368	-120.247	NAD83	580.037
WWQCX00025	WWQC_SGMA_2B	Observation	150	720	610	710	2020	36.07706	-120.075	NAD83	700.081
WWQCX00026	WWQC_SGMA_3B	Observation	150	400	370	390	2020	36.77776	-120.504	NAD83	408.525
WWQCX00027	WWQC_SGMA_4B	Observation	168	485	355	475	2020	36.61785	-120.352	NAD83	501.66
WWQCX00028	WWQC_SGMA_6B	Observation	172	610	510	600	2020	36.21017	-120.192	NAD83	516.94

Table 14-2. 2020 GQTM Sampling Results									
Field Point Name / GQTM Well ID	GQTM Well Name	Well Use	Date Sampled	Nitrate as N (mg/L) Lab	pH Field	Specific Conductance (uS/cm) Field	Temperature (°C) Field	Dissolved Oxygen (mg/L) Field	Depth to Water (ft) Field
WWQCX00003	WWQC_03	Observation	6/24/2020	370	7.25	10023	24.3	5.54	162.01
WWQCX00004	WWQC_04	Observation	6/24/2020	430	7.1	9469	23.9	5.59	93.1
WWQCX00005	WWQC_05	Observation	6/24/2020	300	7.09	15249	25.9	0.97	283.88
WWQCX00006	WWQC_06	Observation	6/23/2020	0.092	7.24	6319	23.3	2.15	56.29
WWQCX00008	WWQC_08	Observation	6/24/2020	< 0.04	7.51	3551	23.9	5.95	16.92
WWQCX00012	WWQC_12	Observation	6/23/2020	< 0.04	7.56	10470	21.8	1.86	195.19
WWQCX00013	WWQC_13	Irrigation	6/23/2020	1.1	7.54	1804	24.8	3.6	NR
WWQCX00015	WWQC_15	Observation	6/23/2020	16	7.52	2365	22.8	5.12	346.7
WWQCX00016	WWQC_16	Observation	6/23/2020	< 0.04	7.29	7778	24.3	1.04	159.05
WWQCX00022	WWQC_22	Irrigation	6/23/2020	0.58	7.93	1289	23.2	0.08	NR
WWQCX00024	WWQC_SGMA_1B	Observation	6/24/2020	< 0.04	7.09	2647	27.6	1.09	303.21
WWQCX00025	WWQC_SGMA_2B	Observation	6/24/2020	< 0.04	6.85	1272	26.1	1.1	490.02

NR= Not Recorded

14.1.2. Summary of Quality Assurance Evaluation for 2020 Sampling Event

The sections below include an assessment of completeness, precision, and accuracy for data generated from groundwater samples collected during 2020. Precision, accuracy, and completeness are evaluated based on Measurement Quality Objectives (MQOs) as outlined in the CVGMC CQAP. **Table 14-3** and **Table 14-4** include counts and percentages for completeness per method and analyte for 2020. **Table 14-5** includes a summary of holding time evaluations and **Table 14-6** through **Table 14-7** include counts of each measure of precision and accuracy evaluated. All flagged data (did not meet MQOs) are reviewed for overall quality on batch and sample levels and assessed for usability. Ninety percent of the samples collected and analyzed must meet the acceptability criteria. This section details the instances when MQOs were not met for at least 90% of the samples and includes rationale for accepting the data.

All results that do not meet MQOs are flagged based on the CVGMC CQAP Data Management Standard Operating Procedures (SOP). All results are loaded to GeoTracker.

14.1.2.1. Purging, Sample Handling, and Custody

All groundwater samples were collected according to the detailed SOPs provided in the CQAP. The SOPs contain instructions for collecting samples and cleaning equipment between samples. These methods are summarized below.

Upon arrival at the well, an attempt was made to measure the depth to water. Water levels were measured using an electronic sounder and the depth to water was recorded to the nearest 0.01 feet. All depth measurements were made from the top (the highest point) of the inner well casing. The measuring point location was recorded on the field sheet and used in all subsequent measurements. If there was no measuring point or access to the inside of the well, a note was made on the field data sheet.

Field parameters (pH, water temperature, conductivity, DO, and turbidity) were measured using field meters specified in the CQAP for WWQC. The meters were calibrated for pH, DO, and turbidity no more than 24 hours prior to the beginning of sampling. For pH, a single 3-point calibration was done using pH 4, 7, and 10 standards. Conductivity was calibrated within 24 hours prior to sampling, and then recalibrated to the nearest calibration solution whenever the conductivity of the well changed substantially. Calibration standards were maintained at temperatures close to the temperature of the well water.

To ensure water collected is an adequate representation of the water quality in the groundwater three methods are used: purging the well and monitoring field parameters with a flow through system and wait to collect a sample until the measurements are stable, a three-casing volume purge of water from the well and sample collection after the appropriate volume of water has been purged from the well, or to use a no-purge sampler such as a HydraSleeve. Water samples collected from irrigation wells used the parameter stabilization method while monitoring wells utilized HydraSleeves. Three casing volume purges are only used occasionally and determined on an individual well basis.

Two different HydraSleeves were used for sampling depending on volume amount needed for sample collection. When the full suite of parameters was required (e.g., a new well), HydraSleeves were placed in the middle of the screened interval of the well and left for a minimum of twenty-four hours before collection. For wells that required nitrate only analysis, a HydraSleeve Speedbag was used in which the Speedbag was placed in the middle of the screened interval and retrieved immediately.

Samples were collected in appropriate containers and adhered to proper preservation requirements. If a sample had a final turbidity greater than 10, it was filtered in the field using a 0.45-micron filter. After samples were collected, samples were kept away from sunlight and kept at a temperature ≤ 6°C until extraction or analysis.

Field personnel plan to collect at least five percent of the total samples for quality assurance purposes (field duplicate and blank samples). Field blank samples were processed in the field using deionized water as sample water. Field duplicates were collected using an additional HydraSleeve during sample collection. Two HydraSleeves were tethered together and set within the screened interval. When retrieved one HydraSleeve was utilized for an environmental sample and the second HydraSleeve was used for the duplicate sample. Samples were delivered to appropriate laboratories in a timely manner to ensure holding time requirements were met.

14.1.2.2. Access and field and analytical completeness

Completeness is assessed on three levels: field and transport, analytical, and batch completeness. Field and transport completeness is based on the number of samples successfully collected and transported to the appropriate laboratories. Field and transport completeness may be less than 100% due to bottle breakage during sample transport to the laboratory or inability to access a site. Wells that lack enough water to collect samples (e.g., dry) are considered “sampled” and are counted towards field and transport completeness. Analytical completeness is based on the number of samples successfully analyzed by the laboratory. Analytical completeness may be less than 100% due to bottles breaking while at the laboratory or if an analysis failed or was not performed due to laboratory error. Batch completeness assesses whether chemistry and toxicity batches were processed with the required Quality Control (QC) samples as prescribed in the CQAP.

Overall field and transport completeness for well samples and field parameters was 100% for 2020 sampling (**Table 14-3**). All samples submitted to the laboratory were analyzed. Therefore, analytical completeness was 100% for 2020 (Table 6). Field parameter measurements (oxidation-reduction potential, DO, pH, SC, water temperature, and turbidity) were taken at each site for all sampling events when there was enough water for sample collection. Oxidation-reduction potential and turbidity measurements are not required by the GO. Turbidity measurements are only taken to determine if a sample should be filtered. Measurements of ORP are taken to determine the potential for the reduction of nitrate and turbidity is not measured when the sample collection method is with a HydraSleeve. Total alkalinity and hydroxide results are not required by the General Order; however, these results are included from the laboratory when the carbonate and bicarbonate analysis is conducted since carbonate, bicarbonate and hydroxide make up total alkalinity.

Field duplicate and field blank samples were collected by sampling crews in the field and transported to the laboratories. At a minimum, field QC samples must comprise 5% of the samples collected. Field duplicate and field blank samples were collected at a frequency greater than 5% ranging from 5.9% to 14.3% the environmental samples collected for 2020 (**Table 14-4**).

Table 14-3. Completeness of Field and Analytical Testing

Constituent	Test Type	Analytical Method	Matrix	Wells Planned for Sampling	Wells Sampled	Field and Transport Completeness %	Total Samples Analyzed	Analytical Completeness %
Oxygen, Dissolved	Field parameter	EPA 360.1	Ground-water	15	15	100.0	15	100.0
pH	Field parameter	EPA 150.1	Ground-water	15	15	100.0	15	100.0
Specific Conductivity	Field parameter	EPA 120.1	Ground-water	15	15	100.0	15	100.0
Temperature	Field parameter	SM 2550	Ground-water	15	15	100.0	15	100.0
Nitrate as N	Laboratory	EPA 300.0	Ground-water	15	15	100.0	15	100.0
			Total	**75**	**75**	**100.0**	**75**	**100.0**

Table 14-4. Completeness of Field QC

Constituent	Analytical Method	Matrix	Total Well Samples Analyzed	Field Duplicate Samples Analyzed	Field Blank Samples Analyzed	Total Samples Analyzed (well and duplicates)	Field Duplicate Completeness %	Field Blank Completeness %
Nitrate as N	EPA 300.0	groundwater	15	1	1	17	5.9	**5.9**
		Total	**15**	**1**	**1**	**17**	**5.9**	**5.9**

Completeness values below the acceptability requirement of 5 percent are presented in **bold**.

14.1.2.2.1. Batch Completeness

Each chemistry batch must be processed with a minimum set of QC samples as prescribed in the CQAP. Batch completeness is determined based on whether all required QC samples were run with every batch. One hundred percent of chemistry batches (14 of 14) met batch completeness requirements.

14.1.2.2.2. Hold Time Compliance

Each sample must be stored, extracted (if applicable), and analyzed within a specific timeframe to meet hold time requirements as outlined in the CQAP. Results associated with hold time violations were flagged. The overall hold time compliance was 100% for 2020 (**Table 14-5**).

Table 14-5. Evaluation of Sample Hold Times

Constituent	Analytical Method	Matrix	Hold Time	Total Samples Analyzed	Samples Analyzed within Hold Time	Acceptability %
Nitrate as N	EPA 300.0	groundwater	28 days	17	17	100
			Total	**17**	**17**	**100**

Acceptability values below 90 percent are presented in **bold**.

14.1.2.3. Analytical precision and accuracy

Precision and accuracy are evaluated for each type of QC sample analyzed during 2020 in **Table 14-6** and **Table 14-7**. Briefly, they are addressed as follows:

- Evaluation of blank samples (field blank and laboratory blank): **Table 14-6**;
- Evaluation of field duplicate precision for chemistry: **Table 14-6**;
- Evaluation of laboratory accuracy of recovery (LCS, MS): **Table 14-7**, and
- Evaluation of laboratory precision of duplicate samples (MSD and laboratory duplicate): **Table 14-7**.

During 2020, each batch was processed with a combination of any of the following QC samples: field blank, laboratory blank, matrix spike (MS), laboratory control spike (LCS), laboratory duplicate, and field duplicate. Blank samples (field blank and laboratory blank) are analyzed to determine sources of contamination in either the field (field blanks or the laboratory (laboratory blank). Percent recoveries in LCS and MS samples are calculated to assess laboratory accuracy in recovering known concentrations of analytes. Relative percent differences (RPDs) are calculated in duplicate samples (laboratory duplicate, LCS duplicate (LCSD), MS duplicate (MSD)) to assess the laboratory's precision of recoveries. In turn, the RPD calculated for field duplicates assesses field sampling precision.

An evaluation of the precision and accuracy for each analyte is discussed below. Batches are accepted by evaluating all measures of precision and accuracy. Justification for accepting data when MQO acceptability criteria fell below 90% is provided. Overall, precision and accuracy criteria were met for more than 90% of the samples for all criteria and all data are considered usable.

When the concentration of a constituent in a sample exceeds the highest point on a calibration curve, a dilution of the sample is required. The laboratory reports the result of the diluted sample multiplied by the dilution factor to represent the concentration of the analyte detected in the original sample. All diluted samples are flagged accordingly in the database. The reporting limit (RL) associated with a diluted sample is multiplied by the dilution factor, thereby, increasing the reporting limit. Therefore, for each dilution that occurs, there is a corresponding increase in the limit of quantification.

Reporting limits are identified in the CQAP and set at levels where laboratory instruments can reliably detect analytes in samples. Although instruments can detect analytes below the RL, accurate detections become less reliable, and results reported below the RL are associated with variability. Laboratories report all detections, even when analytes are detected at concentrations below the RL. When the concentration of an analyte is reported below the RL and above the Method Detection Limit (MDL), the result is reported as an estimated value and flagged in the laboratory report with a "J Flag".

As outlined in the CQAP, QC samples include laboratory blank, field blank, field duplicate, LCS, MS, and laboratory duplicate (often LCSD or MSD samples) samples for all analytes listed in Table 11 with the following exceptions: 1) no MS samples are required for alkalinity as CaCO3, bicarbonate, carbonate, hydroxide, and total dissolved solids (TDS) and 2) no LCS samples are required for alkalinity as CaCO3, bicarbonate, carbonate, and hydroxide.

All analytes were within the MQO acceptability criteria of 90% for blanks (field and laboratory), LCS, MS, and lab duplicates (including LCSD and MSD). Analytes that were not within the MQO acceptability criteria of 90% are outlined below with explanation for accepting the data and considering the data usable. For MS/MSDs, the laboratory usually performed two sets of MS analysis per batch. The Coalitions counted only the MS/MSD pairs that were within the acceptable limits since only one MS/MSD pair is required per batch.

Table 14-6. Evaluation of Field Duplicates and Blanks							
Constituent	**Analytical Method**	**Matrix**	**Sample Type**	**Acceptability Requirement**	**Total Samples**	**Samples within Acceptability**	**Acceptability %**
Nitrate as N	EPA 300.0	groundwater	Field Duplicate	RPD ≤ 25	1	1	100
Field Duplicate Total					**1**	**1**	**100**
Acceptability values below 90 percent are presented in **bold**.							
Constituent	**Analytical Method**	**Matrix**	**Sample Type**	**Acceptability Requirement**	**Total Samples**	**Samples within Acceptability**	**Acceptability %**
Nitrate as N	EPA 300.0	groundwater	Field Blank	< RL or 1/5 environmental sample	1	1	100
Field Duplicate Total					**1**	**1**	**100**
Acceptability values below 90 percent are presented in **bold**.							

Table 14-7. Evaluation of Lab Controls and Spikes							
Constituent	Analytical Method	Matrix	Sample Type	Acceptability Requirement	Total Samples	Samples within Acceptability	Acceptability %
Lab Blanks							
Nitrate as N	EPA 300.0	groundwater	Lab Blank	< RL	2	2	100
Lab Blank Total					2	2	100
Lab Control Spikes							
Nitrate as N	EPA 300.0	groundwater	LCS	PR 90-110	2	2	100
Lab Control Total					2	2	100
Matrix Spikes							
Nitrate as N	EPA 300.0	groundwater	MS	PR 80-120	8	8	100
Matrix Spike Total					8	8	100
Analytical Duplicates							
Nitrate as N	EPA 300.0	groundwater	MSD/LCSD/Lab Dup	RPD ≤ 25	4	4	100
Analytical Duplicate Total					4	4	100
Acceptability values below 90 percent are presented in **bold**.							
LCS=lab control spike; MS=matrix spike; MSD=matrix spike duplicate; LCSD=lab control spike duplicate							

14.1.2.3.1. Corrective Actions

Corrective action is an activity that should be used to stop the re-occurrence of non-conformities. In some cases, the Coalition will address corrective action options to improve QC measures that are consistently demonstrating failure to meet MQOs. No corrective actions were determined to be necessary based on groundwater monitoring and analysis that occurred in 2020.

14.1.2.4. Quality Assurance Evaluation Conclusions

All results were accepted and considered usable.

14.1.2.5. Electronic Data Submittal and Data Uploaded to GeoTracker

The Coalition loaded the 2020 monitoring results to GeoTracker on March 16, 2021. The Electronic Data Format (EDF) included environmental and QC results for 15 wells monitored by the Coalition.

14.1.3. Five-Year Assessment Results and Discussion

Luhdorff & Scalmanini Consulting Engineers (LSCE) conducted both parametric and non-parametric analyses of Nitrate as N (Nitrate or NO_3-N) and Total Dissolved Solids (TDS) trends within the CWDC primary area boundary. Methodology for each of these analyses is discussed in **Section 5**. All of the **Section 5** figures pertinent to this individual coalition section are presented in **Appendix L**.

Average nitrate conditions are seen in **Figure L-1** in **Appendix L**. This shows seven wells having average nitrate conditions exceeding the drinking water standard of 10 mg/L as N. Other wells in the GQTM network show much lower average nitrate values below 5 and 2.5 mg/L as N. The second figure in **Appendix L** (**Figure L-2**) shows the most recent nitrate sample in GQTM wells, which show the same pattern of high nitrate in seven wells and low nitrate in the others. **Figure L-3** in **Appendix L** shows the most recent nitrate sample in all wells with nitrate data, regardless of well construction. This figure covers more area within Westlands Water Quality Coalition and also helps illustrate the variability within the coalition.

Figures L-4 and **L-5** in **Appendix L** show ambient nitrate in the Upper Zone since 2000 and 2010, respectively. These maps illustrate the lack of recent nitrate sample data from wells known to be constructed in the Upper Zone.

Figure L-6 in **Appendix L** shows parametric nitrate trends in wells completed in the Upper Zone since 2000. Of the seven wells with sufficient data, four of them exhibit increasing nitrate trends and three show decreasing nitrate trends. **Table L-1** in **Appendix L** provides further insight into the parametric trends analysis from GQTM wells. Four wells located in land designated as irrigated lands have insufficient evidence of a linear trend using the criteria of $R^2 < 0.5$. Overall groundwater quality trends are unclear due to the short period of record. The understanding of groundwater quality trends will improve as the period of record increases.

The last figure in **Appendix L** (**Figure L-7**) shows the most recent TDS sample in GQTM wells. Within the Westlands Water Quality Coalition, the majority of GQTM wells have TDS values exceeding 1,000 mg/L.

14.1.4. Five-Year High Vulnerability Area Update

14.1.4.1. Existing HVA Compared to Nitrate Exceedances

In accordance with the WDRs and to address elements of the five-year review and update of the GAR, the Coalition reviewed the HVA delineated in the original 2015 GAR. To evaluate the sufficiency of the 2015 HVA, all readily and publicly available data on historical nitrate concentrations were examined within the Coalition region and compared with the 2015 HVA. Consistent with the original 2015 GAR and the designation of the HVA in the original GAR, the evaluation of the HVA is focused on the San Joaquin Valley Groundwater Basin (Central Valley Floor) where all but a very small amount of the irrigated area in the Coalition region is located.

Of the total of 1,069 unique wells with nitrate concentration data located within the Central Valley Floor area of the Coalition region, 111 wells have historical concentrations of nitrate exceeding the MCL of 10 mg/L (**Figure 14-2**). Of these historical nitrate exceedance wells, 108 wells (97 percent) are located within the 2015 HVA boundary developed as part of the original GAR.

The three historical nitrate exceedance records for wells located outside the extent of the 2015 HVA were reviewed with respect to their location relative to the 2015 HVA and the characteristics and conditions of each site.

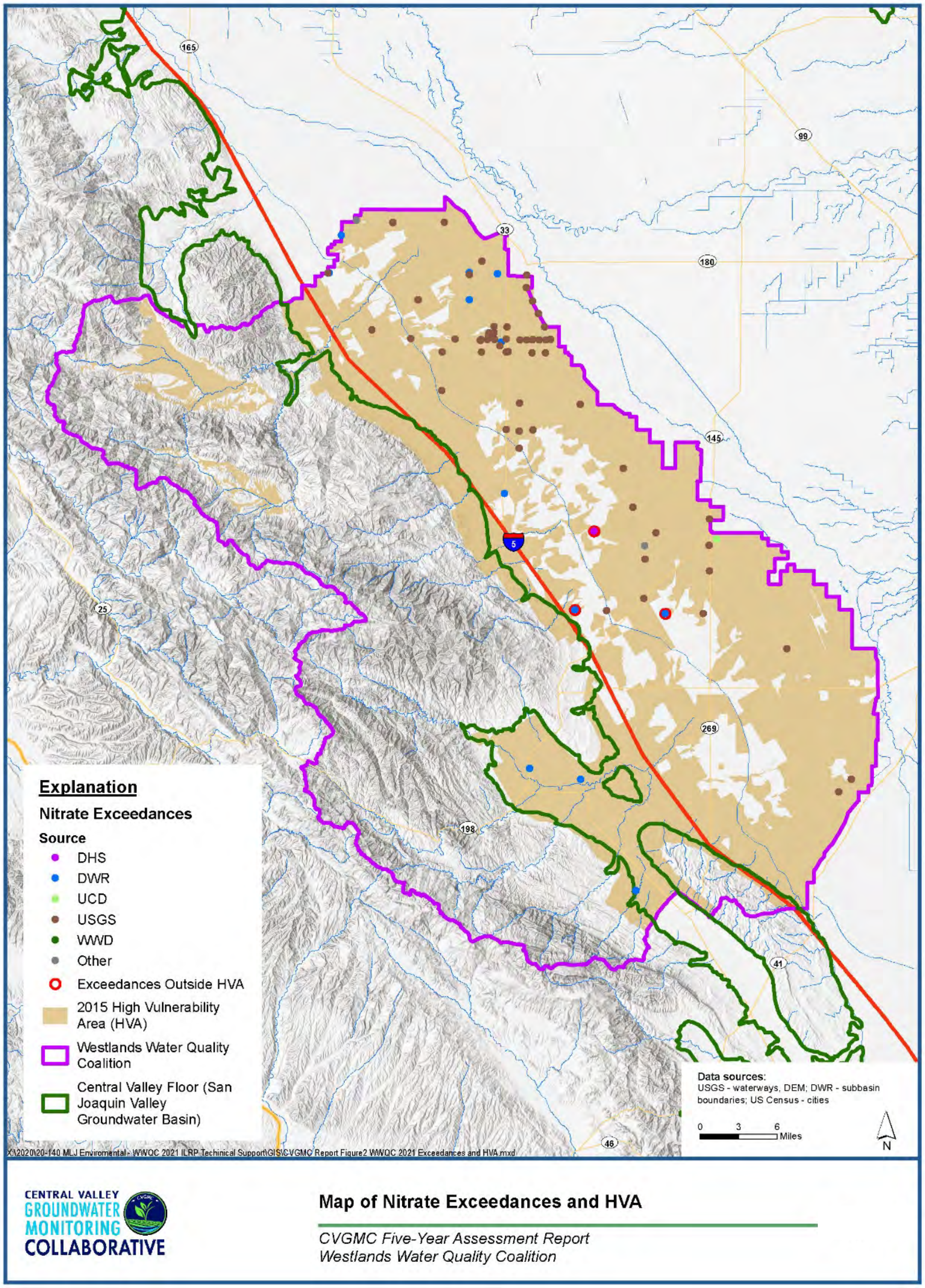


Figure 14-2. Map of Nitrate Exceedances and HVA

14.1.4.2. HVA Update

The five-year review of the Coalition's HVA seeks to account for all nitrate exceedances in the Coalition that may be related to irrigated agriculture activities. The review of the HVA described above indicates three exceedances located outside of the extent of the 2015 HVA. The three nitrate exceedances located outside and with potential to be related to irrigated agricultural practices are all very close to the 2015 HVA. Because of the continued strong spatial agreement and close distance between the original HVA and historical nitrate exceedance wells, only minor modifications to the 2015 HVA were performed to address the three exceedance wells outside the 2015 HVA. Given the small number of exceedance wells outside the HVA and their proximity to the original HVA, modifications to the extent of the HVA were made using professional judgement with consideration of the hydrogeologic characteristics near the exceedance wells. In all cases, the outline of the HVA was expanded and redrawn to encompass all exceedance wells outside the HVA using guidance from mapping of soil hydraulic conductivity from NRCS SURGO data (NRCS, 2013) and recharge potential from the Soil Agricultural Groundwater Banking Index (SAGBI; O'Geen et al., 2015) together with the vulnerability considerations used in the original GAR. The exceedance wells outside the HVA were located very near the 2015 HVA and where soil or other hydrogeologic factors do not suggest high vulnerability conditions. As a result, only slight adjustments to the 2015 HVA were made to encompass the exceedance wells. No modifications to the original HVA were made that resulted in removing areas previously designated as HVA; the HVA modifications completed for the 2021 HVA only includes an expansion of the HVA. The extent of the 2021 HVA is presented in **Figure 14-3**.

The HVA modifications completed for the 2021 HVA represent an increase in area of only 9 acres from the 2016 HVA. The total area within the 2021 HVA is 620,790 acres.

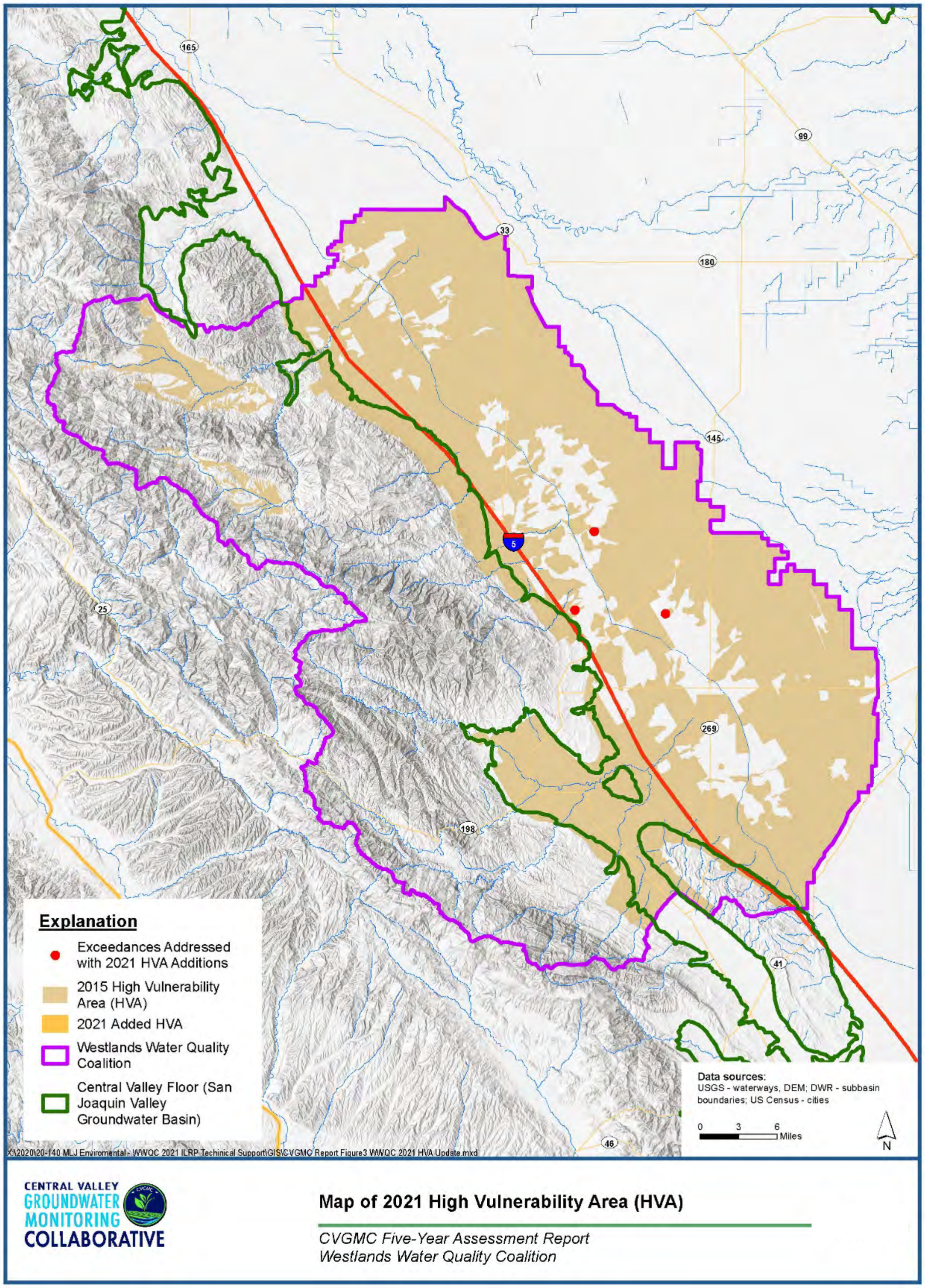


Figure 14-3. Map of 2021 High Vulnerability Area (HVA)

DRAFT REPORT | SEPTEMBER 2021

15. WESTSIDE WATER QUALITY COALITION GROUNDWATER QUALITY FIVE-YEAR ASSESSMENT REPORT

PREPARED FOR

WESTSIDE WATER QUALITY COALITION

PREPARED BY

Geosyntec consultants

15. WESTSIDE WATER QUALITY COALITION GROUNDWATER QUALITY FIVE-YEAR ASSESSMENT REPORT

15.1. Groundwater Quality Trend Monitoring Results 2020

15.1.1. GQTM Summary of 2020 Network and Sampled Wells

Groundwater monitoring objectives are to evaluate groundwater quality trends by collecting groundwater samples from wells located downgradient of Westside Water Quality Coalition (WWQC) member's irrigated lands. The aim is to sample first encountered groundwater that is representative of irrigated lands and to avoid monitoring areas that may be impacted with poor groundwater quality from other non-irrigated land sources.

First encountered groundwater within the WWQC jurisdiction exists in the unconfined/semi-confined zone; however, perched groundwater has been detected periodically (**Figure 15-1**). Groundwater quality trend monitoring consists of annually measuring the depth-to-groundwater (DTW) and collecting groundwater samples from each well in the monitoring well network. The 2020 monitoring network consisted of 15 wells total that are used for monitoring or domestic or irrigation supply (**Table 15-1**). Of those 15 wells, 5 wells are screened in the perched zone and 10 wells are screened in the unconfined/semi-confined zone (**Figure 15-1**).

The 2020 annual groundwater monitoring event was conducted July 27 through July 30, 2020. Four of the 5 perched zone wells were dry during the 2020 monitoring event. Four irrigation wells in the monitoring well network do not have sounding tubes; therefore, DTW was not measured in those wells. Field parameters and groundwater samples were collected from 11 wells during the 2020 monitoring event (**Table 15-2**). Two quality control samples that consisted of a field blank and a duplicate were collected for quality control.

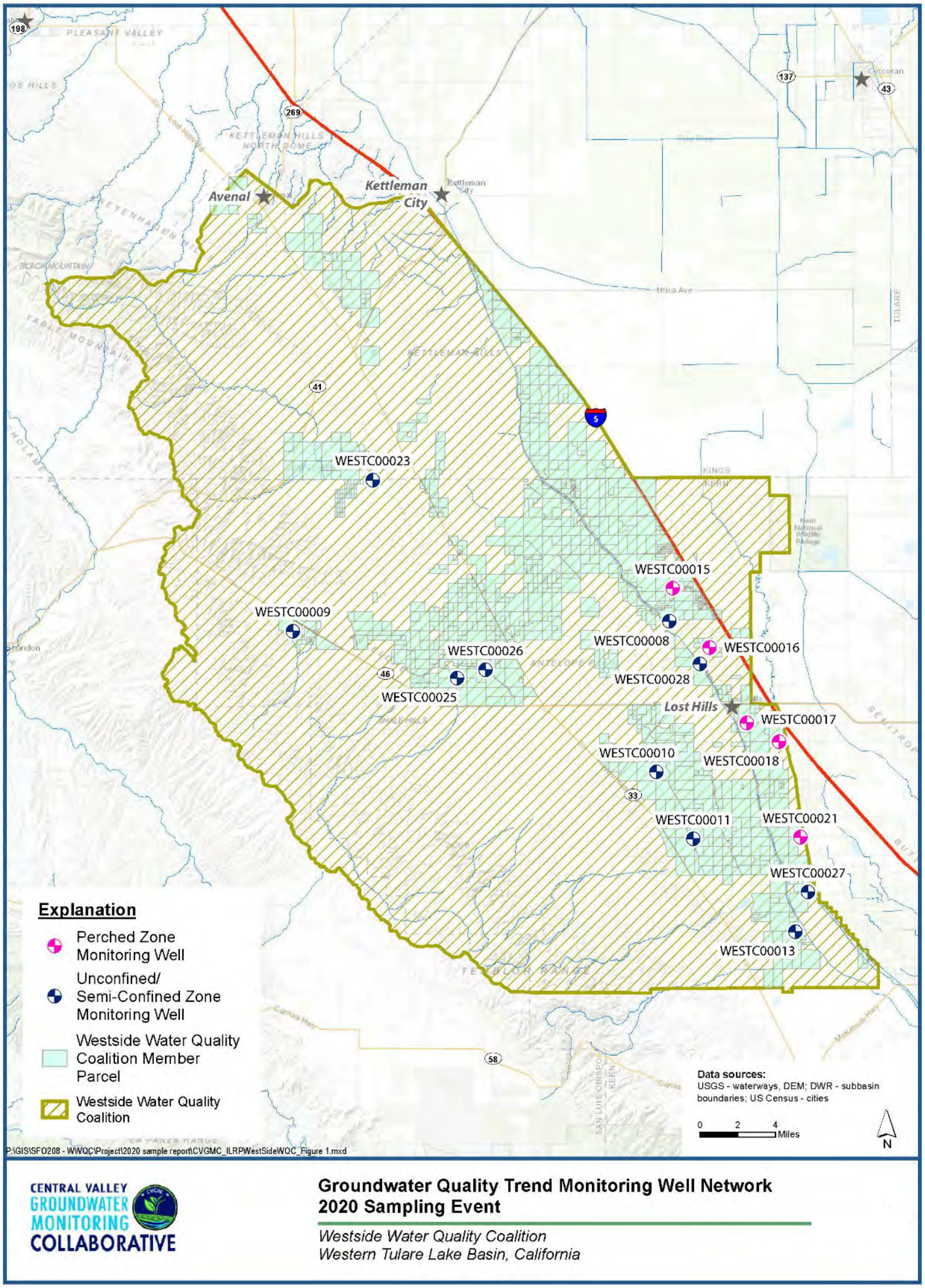


Figure 15-1 Groundwater Quality Trend Monitoring Well Network 2020 Sampling Event

Table 15-1. 2020 GQTM Network Wells												
Field Point Name / GQTM Well ID	GQTM Well Name	Well Use	Well Construction Information					Latitude	Longitude	Datum	Depth to the Bottom of Upper Zone (feet)
			Seal Depth (feet)	Total Well Depth (feet)	Depth Top of Screen (feet)	Depth Bottom of Screen (feet)	Year Drilled				
WESTC00008	USGS Lost Hills Well	Observation	175	230	210	230		35.67971	-119.748	NAD83	319.634
WESTC00009	Berrenda Mesa-1	Domestic		250				35.66881	-120.091	NAD83	98.1813
WESTC00010	Aera 19M1	Observation	170	237	170	230	2006	35.56449	-119.761	NAD83	254.739
WESTC00011	USGS Well BWSD #5	Observation	246	280	260	280	2018	35.51202	-119.726	NAD83	253.389
WESTC00013	Belridge_5B2	Observation	20	274	191	211	1986	35.44109	-119.63	NAD83	244.65
WESTC00015	DWR T25S/R21E-31R1_10	Observation	10	19	10	20	1998	35.70281	-119.743	NAD83	331.311
WESTC00016	DWR T26S/R21E-16R1	Observation		22	12	22	1989	35.65927	-119.718	NAD83	311.555
WESTC00017	DWR T27S/R21E-11A_BEL #2	Observation		20	10	20	1990	35.60157	-119.675	NAD83	333.98
WESTC00018	DWR T27S/R22E-18B1_BEL #3A	Observation		20	10	20	1990	35.58705	-119.653	NAD83	333.76
WESTC00021	DWR Bel 15	Observation		20	10	20	1990	35.51398	-119.626	NAD83	342.94
WESTC00023	LP Farms Well 2018	Irrigation	225		225	365	2018	35.78864	-120.028	NAD83	31.2225
WESTC00025	Global Ag Well_2	Irrigation						35.63648	-119.949	NAD83	303.747
WESTC00026	Global Ag Well_3	Irrigation						35.64289	-119.922	NAD83	303.747
WESTC00027	Aera 21N1	Observation		335				35.47157	-119.618	NAD83	324.048
WESTC00028	Munger K-2	Irrigation						35.6469	-119.72	NAD83	306.44

Table 15-2. 2020 GQTM Sampling Results									
Field Point Name / GQTM Well ID	GQTM Well Name	Well Use	Date Sampled	Nitrate as N (mg/L) Lab	pH Field	Specific Conductance (uS/cm) Field	Temperature (°C) Field	Dissolved Oxygen (mg/L) Field	Depth to Water (ft) Field
WESTC00008	USGS Lost Hills Well	Observation	7/29/2020	39	6.98	16805	25.4	0.07	46.04
WESTC00009	Berrenda Mesa-1	Domestic	7/28/2020	19	8.18	2010	25.12	6.12	NR
WESTC00010	Aera 19M1	Observation	7/29/2020	1.7	7.67	4600	30.17	0.64	146.94
WESTC00011	USGS Well BWSD #5	Observation	7/30/2020	< 0.057	7.17	3635	27.2	0.036	157.14
WESTC00013	Belridge_5B2	Observation	7/29/2020	11	7.54	4520	23.54	< 0.01	84.7
WESTC00015	DWR T25S/R21E-31R1_10	Observation	7/28/2020	60	8.23	22500	26.43	1.18	7.09
WESTC00023	LP Farms Well 2018	Irrigation	7/27/2020	2.7	7.59	2870	24.35	8.91	NR
WESTC00025	Global Ag Well_2	Irrigation	7/27/2020	6.5	7.6	2720	28.68	3.68	NR
WESTC00026	Global Ag Well_3	Irrigation	7/27/2020	3.8	6.95	3610	29.78	5.89	NR
WESTC00027	Aera 21N1	Observation	7/29/2020	< 0.057	7.76	2850	24.38	< 0.01	25.3
WESTC00028	Munger K-2	Irrigation	7/27/2020	0.38	6.81	14882	24.1	3.38	NR

15.1.1.1. Purging, sample handling, and custody

A portable submersible pump was used to purge groundwater monitoring wells prior to sampling. At least three (3) well casing volumes were purged followed by measuring field parameters. Once the field parameters had stabilized, groundwater samples were collected.

If the irrigation or domestic well was not in operation upon arrival, the pump was turned on and operated for 10 minutes. After operation of the pump for 10 minutes, or if the pump was operating upon arrival, the well was purged from the spigot for 2 minutes. After purging, field parameters were measured and then a groundwater sample was collected.

All samples were placed into laboratory-provided jars, labeled, placed on ice, and submitted to the analytical laboratory under chain-of-custody (COC) procedures.

The samples were received at BSK Associates Laboratory at 3.8°C, 4.2°C and 5.1°C, within the Central Valley Groundwater Monitoring Collaborative (CVGMC) Groundwater Comprehensive Quality Assurance Plan (CQAP) specified acceptance criteria of less than or equal to 6°C. The samples were preserved with sulfuric acid, pH less than 2, as specified in the CQAP.

The following issues are noted regarding the COC:

The collection dates for samples DUP-20200729, FB-20200729, WESTC00010-20200729, WESTC00023-20200727 and WESTC00025-20200727 were recorded within the sample ID on the COC form but the date on those samples was not completed on the COC. The laboratory assigned collection dates of July 27, 2020 for samples WESTC00023-20200727 and WESTC00025-20200727, and July 29, 2020 for samples DUP-20200729, FB-20200729 and WESTC00010-20200729.

Incorrect error corrections were noted on the COC instead of the proper procedure of a single strike through, correction, and initials and date of person making the correction.

There was a time lapse between the time the samples were relinquished to laboratory and the time the laboratory received the samples, 14:07 and 14:13, respectively.

15.1.1.2. Access and field and analytical completeness

The 2020 annual monitoring event was led by Wood Environment & Infrastructure Solutions, Inc. (Wood). Prior to conducting field work, Wood coordinated with the United States Geological Survey (USGS), Aera Energy, and WWQC to gain access to the wells in the monitoring well network. The USGS field technician monitored 3 of the 15 wells and a Wood field geologist monitored the remaining wells. One well, WESTC00020, that was a part of the 2019 monitoring well network, was discovered to be abandoned during this monitoring event and was subsequently removed from the monitoring well network. No issues occurred with accessing the remaining wells.

As noted above, 4 of the 15 wells were dry and not sampled; therefore, 11 groundwater samples were collected as part of the 2020 groundwater monitoring event and submitted to BSK Associates Laboratory for nitrate + nitrite as nitrogen (N) and nitrate as N analysis by Standard Method 4500 (**Table 15-3**). Additionally, 1 field duplicate sample, designated as DUP, was collected from WESTC00010 and 1 field blank sample, designated as FB, were collected and submitted for the same analysis as the groundwater samples. Therefore, field duplicate and field blanks samples were both collected at a 7.7% frequency, meeting the 5% frequency requirement specified in the CQAP (**Table 15-4**).

The CQAP specified holding time for the analysis via SM 4500 is 28 days from collection to analysis. The holding times were met for the sample analyses. Therefore, the acceptability rate of samples analyzed within holding time was 100%, meeting the 90% frequency requirement specified in the CQAP (**Table 15-5**).

The groundwater samples were reported to the reporting limit (RL). The CQAP specified RL for nitrate + nitrite as N and nitrate as N, 0.1 milligrams per liter (mg/L), was met.

Table 13-3. Completeness of Field and Analytical Testing

Constituent	Test Type	Analytical Method	Matrix	Wells Planned for Sampling	Dry	Wells Sampled	Field and Transport Completeness %	Total Samples Analyzed	Analytical Completeness %
Oxygen, Dissolved	Field parameter	EPA 360.1	Ground-water	15	4	11	100.0	11	100
pH	Field parameter	EPA 150.1	Ground-water	15	4	11	100.0	11	100
Specific Conductivity	Field parameter	EPA 120.1	Ground-water	15	4	11	100.0	11	100
Temperature	Field parameter	SM 2550	Ground-water	15	4	11	100.0	11	100
Nitrate as N	Laboratory	EPA 300.0	Ground-water	15	4	11	100.0	11	100
			Total	**75**	**20**	**55**	**100.0**	**55**	**100**

Table 15-4. Completeness of Field QC

Constituent	Analytical Method	Matrix	Total Well Samples Analyzed	Field Duplicate Samples Analyzed	Field Blank Samples Analyzed	Total Samples Analyzed (well and duplicates)	Field Duplicate Completeness %	Field Blank Completeness %
Nitrate as N	EPA 300.0	groundwater	11	1	1	13	7.7	7.7
		Total	**11**	**1**	**1**	**13**	**7.7**	**7.7**

Completeness values below the acceptability requirement of 5 percent are presented in **bold**.

Table 15-5. Evaluation of Sample Hold Times

Constituent	Analytical Method	Matrix	Hold Time	Total Samples Analyzed	Samples Analyzed within Hold Time	Acceptability %
Nitrate as N	EPA 300.0	groundwater	28 days	13	13	100
			Total	**13**	**13**	**100**

Acceptability values below 90 percent are presented in **bold**.

15.1.1.3. Analytical precision and accuracy

One field duplicate, DUP-20200729, was collected with the sample set. Acceptable precision (relative percent difference [RPD] ≤25%) was demonstrated between the field duplicate and the original sample, WESTC00010-20200729. Therefore, the acceptability rate of the field duplicate sample with the RPD within the acceptability requirement was 100%, meeting the 90% frequency requirement specified in the CQAP (**Table 15-6**).

One field blank, FB-20200729, was collected with the sample set. Nitrate + nitrite as N was not detected in the field blank above the reporting limit (RL). Therefore, the acceptability rate of the field blank with results less than the RL or less than one-fifth the sample concentrations was 100%, meeting the 90% frequency requirement specified in the CQAP (**Table 15-6**).

Method blanks were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). One method blank was reported (batch ADH0428). Nitrate + nitrite as N was not detected in the method blank above the RL. Therefore, the acceptability rate of the method blank with results less than the RL was 100%, meeting the 90% frequency requirement specified in the CQAP (**Table 15-7**).

Laboratory control samples (LCSs) were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). One LCS/LCS duplicate (LCSD) pair was reported. The recovery and RPD results were within the CQAP specified acceptance criteria.

Therefore, the acceptability rate of LCS/LCSD pairs with recoveries between 90-110% and RPDs less than or equal to 25% was 100%, meeting the 90% frequency requirement specified in the CQAP (**Table 15-7**).

Matrix spike (MS)/MS duplicate (MSD) pairs were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). One project specified MS/MSD pair was reported, using sample WESTC00010-20200729. The recovery and RPD results were within the CQAP specified acceptance criteria. Therefore, the acceptability rate of MS/MSD pairs with recoveries between 80-120% and RPDs less than or equal to 25% was 100%, meeting the 90% frequency requirement specified in the CQAP (**Table 15-7**).

Additionally, one batch MS/MSD pair was reported. Since these were batch quality control (QC), the results did not impact project data quality.

Table 15-6. Evaluation of Field Duplicates and Blanks

Constituent	Analytical Method	Matrix	Sample Type	Acceptability Requirement	Total Samples	Samples within Acceptability	Acceptability %
Nitrate as N	EPA 300.0	groundwater	Field Duplicate	RPD ≤ 25	1	1	100
				Field Duplicate Total	**1**	**1**	**100**
Acceptability values below 90 percent are presented in **bold**.							
Constituent	**Analytical Method**	**Matrix**	**Sample Type**	**Acceptability Requirement**	**Total Samples**	**Samples within Acceptability**	**Acceptability %**
Nitrate as N	EPA 300.0	groundwater	Field Blank	< RL or 1/5 environmental sample	1	1	100
				Field Duplicate Total	**1**	**1**	**100**
Acceptability values below 90 percent are presented in **bold**.							

Table 15-7. Evaluation of Lab Controls and Spikes							
Constituent	Analytical Method	Matrix	Sample Type	Acceptability Requirement	Total Samples	Samples within Acceptability	Acceptability %
Lab Blanks							
Nitrate as N	EPA 300.0	groundwater	Lab Blank	< RL	1	1	100
				Lab Blank Total	1	1	100
Lab Control Spikes							
Nitrate as N	EPA 300.0	groundwater	LCS	PR 90-110	2	2	100
				Lab Control Total	2	2	100
Matrix Spikes							
Nitrate as N	EPA 300.0	groundwater	MS	PR 80-120	4	4	100
				Matrix Spike Total	4	4	100
Analytical Duplicates							
Nitrate as N	EPA 300.0	groundwater	MSD/LCSD/Lab Dup	RPD ≤ 25	3	3	100
				Analytical Duplicate Total	3	3	100
Acceptability values below 90 percent are presented in **bold**.							
LCS=lab control spike; MS=matrix spike; MSD=matrix spike duplicate; LCSD=lab control spike duplicate							

15.1.1.4. Quality assurance evaluation conclusions

The data were reviewed based on the CQAP; the United States Environmental Protection Agency (USEPA) National Functional Guidelines (NFG) for Inorganic Superfund Methods Data Review, November 2020 (EPA-542-R-20-006); the pertinent method referenced by the laboratory report, and professional and technical judgment. The nitrate + nitrite as N data reported in BSK Associates Laboratory Fresno laboratory report ADG3356 are considered usable for supporting project objectives. The results are considered valid.

15.1.1.5. Electronic Data Submittal and Data Uploaded to GeoTracker

In accordance with the requirements for electronic data submittal, the 2020 data will be uploaded to GeoTracker by November 30, 2021.

15.1.2. Five-Year Assessment Results and Discussion

The results from the 5-year assessment are discussed in the following sections. The methodology was previously described in the report in **Section 5**.

All of the **Section 5** figures pertinent to this individual coalition section are presented in **Appendix M**. The first figure in **Appendix M** (**Figure M-1**) shows average nitrate conditions in groundwater quality trend monitoring wells. The red areas show where concentrations of nitrate as N are above 10.0 mg/L. Orange, yellow, light green and green areas show ambient nitrate concentrations of 7.5-10.0 mg/L, 5.0-7.5 mg/L, 2.5-5.0 mg/L, and less than 2.5 mg/L, respectively. Four wells have average nitrate conditions above the maximum contaminate level (MCL) of 10.0 mg/L within the WWQC jurisdiction. When comparing these data to the second figure in **Appendix M** that shows the most recent nitrate concentrations in GQTM wells (**Figure M-2**), one data point location to the south increased in nitrate concentration. The third figure in **Appendix M** shows the most recent nitrate data in all wells that have measured nitrate data available.

Figures M-4 and **M-5** in **Appendix M** show ambient nitrate concentrations in the Upper Zone of the Central Valley groundwater basin post-2000 and post-2010, respectively. The red areas show where concentrations of nitrate as N are above 10.0 mg/L within the WWQC jurisdiction. Orange, yellow, light green and green areas show ambient nitrate concentrations of 7.5-10.0 mg/L, 5.0-7.5 mg/L, 2.5-5.0 mg/L, and less than 2.5 mg/L, respectively. Areas above 10 mg/L (red) are generally along the eastern central area of the WWQC and toward the south.

Parametric nitrate trends in the Upper Zone (post-2000) are shown in **Figure M-6** in **Appendix M**. Four of the 6 data points have increasing nitrate trends where the linear rate is greater than 0.5 mg/L per year. Two of the 6 data points show decreasing nitrate trends where the linear rate is greater than 0.5 mg/L per year. These trends were analyzed using a minimum of 3 samples per data point location. **Figure M-7** shows non-parametric nitrate trends in the Upper Zone since 2000. And indicate either decreasing or insufficient evidence of a trend. **Table M-1** in **Appendix M** shows the results of parametric trends.

The most recent total dissolved solids (TDS) samples taken from GQTM wells are shown on **Figure M-8** in **Appendix M**. All data points within the WWQC jurisdiction have TDS concentrations greater than 1,000 mg/L.

15.1.3. Five-Year High Vulnerability Area Update

The high vulnerability areas (HVA) were reviewed with available nitrate data. **Figure 15-2** shows the nitrate exceedances compared to the HVA boundaries. **Figure 15-3** shows where the current HVA's are and where the new HVA expansion areas are. Only two areas were suggested for HVA expansion. There are a few clusters of nitrate data exceeding 10 mg/L which are also shown on **Figure 15-3** with designated areas (ex: Area 1). We did not expand the HVA's into these extents because of other sources affecting the data in those areas. Justification for those areas are discussed in the following sections.

15.1.3.1. Existing HVA Compared to Nitrate Exceedances

Nitrate concentrations in groundwater from 1947 to 2020 are shown on **Figure 15-2**. These data include publicly available data and data collected by WWQC. Nitrate concentrations below the maximum contaminant level (MCL) of 10 milligrams per liter (mg/L) are shown as green dots and nitrate concentrations above the MCL are shown as yellow squares. The HVAs provided to WWQC by the Regional Water Quality Control Board are shown in purple. Numerous data points where nitrate exceeds the MCL are within the HVA area. Several clusters and points of data are outside of the HVA areas. It should be noted that the data shown on **Figure 15-2** does not necessarily represent irrigated lands as many of these data points are not in proximity to irrigated farmland.

15.1.3.1.1. HVA Update

Figure 15-3 shows generally the same data as **Figure 15-2**; however, **Figure 15-3** also shows 3 areas that WWQC recommends for inclusion as HVAs based on exceedances of nitrate that may represent irrigated lands. These areas are shown as purple hatching in the southern portion of the WWQC jurisdiction. The remaining data that show exceedances of nitrate and are located outside the HVAs were not included with the HVAs. These data are referenced by Area shown on **Figure 15-3** and are discussed below.

15.1.3.1.2. Area 1

It appears that the data shown in Area 1 on **Figure 15-3** were collected at a landfill facility (Waste Management-Kettleman Hills Facility) and represent groundwater quality beneath the landfill. For this reason, WWQC did not expand the HVA into the location of the landfill facility.

The groundwater beneath the landfill facility is stratigraphy confined with restricted flow paths, has low or stagnant horizontal groundwater velocities, and has geographic and hydraulic isolation from regional groundwater sources. The landfill facility is located on Kettleman Hills with a ground surface evaluation of about 900 feet. The nearest irrigated land to the landfill facility is about 0.5 mile southwest and is situated within a valley, Kettleman Plain. The ground surface elevation at the irrigated land parcel is about 700 feet; approximately 200 feet lower. Since these data represent groundwater quality beneath the landfill and groundwater at the landfill facility is generally isolated, suggesting that groundwater does not flow toward the facility. These data do not represent nitrate concentration as a result of irrigated lands. If groundwater were to flow toward the landfill from the irrigated land parcel, it is likely that Kettleman Hills would act as a barrier to groundwater flow.

15.1.3.1.3. Area 2

It appears that the data shown in Area 2 on **Figure 15-3** were collected beneath a composting facility (Liberty Compositing) and represent groundwater quality beneath the composting facility. Additionally, the groundwater flow direction at the composting facility is generally to the southwest. The nearest irrigated lands are adjacent to the composting facility to the south and northwest indicating that the composting facility is hydraulically upgradient from irrigated lands. For this reason, WWQC did not expand the HVA into the location of the composting facility.

15.1.3.1.4. Area 3

It appears that the data shown in Area 3 on **Figure 15-3** were collected beneath a landfill facility (H.M. Holloway Facility) and represent groundwater quality beneath the landfill facility. Additionally, the groundwater flow direction at the landfill facility is to the west-northwest. The nearest irrigated lands to the landfill facility are approximately 1.5 miles to the west and to the south indicating that the landfill facility is hydraulically upgradient from irrigated lands. For this reason, WWQC did not expand the HVA into the location of the composting facility.

15.1.3.1.5. Area 4

The elevated nitrate data shown in Area 4 on **Figure 15-3** are within the Lost Hills Oil Field. Additionally, the nitrate data points are within the aquifer exemption area for Lost Hills Oil Field. Aquifer exemption areas are zones where groundwater has no current or future source of drinking water due to naturally occurring harmful levels of petroleum and/or minerals or other constituents. Since the groundwater is this area is known to be of poor quality, WWQC did not expand the HVAs into the location of the oil field.

15.1.3.1.6. Area 5

The elevated nitrate data shown in Area 5 on **Figure 15-3** are located on the ridge and within either North or South Belridge Oil Field. Additionally, the 3 of the 4 nitrate data points are within the aquifer exemption area for North and South Belridge Oil Fields. As mentioned above, aquifer exemption areas are zones where groundwater has no current or future source of drinking water due to naturally occurring harmful levels of petroleum and/or minerals or other constituents. Since the groundwater is this area is known to be of poor quality, WWQC did not expand the HVAs into the location of the oil field.

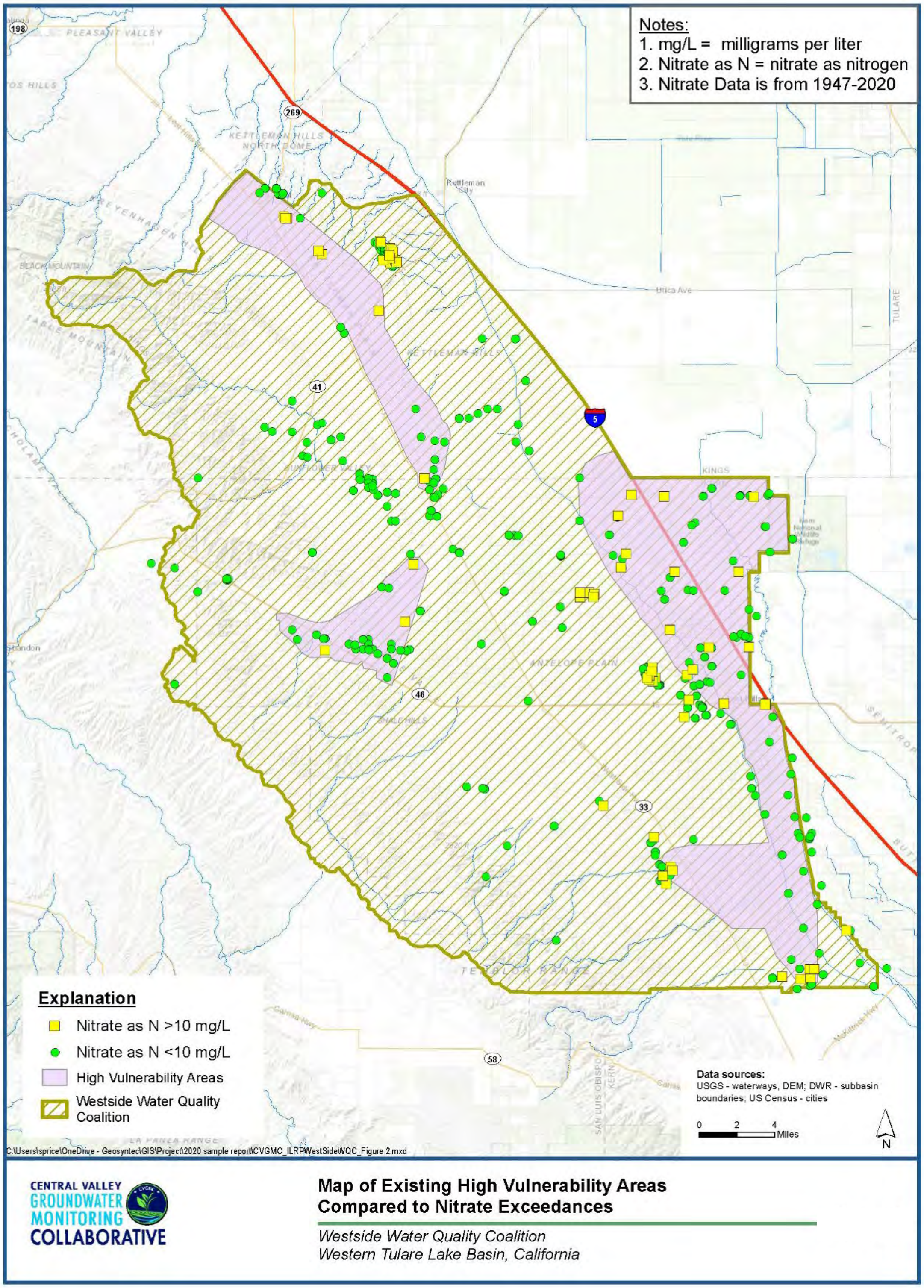


Figure 15-2 Map of Existing High Vulnerability Areas Compared to Nitrate Exceedances

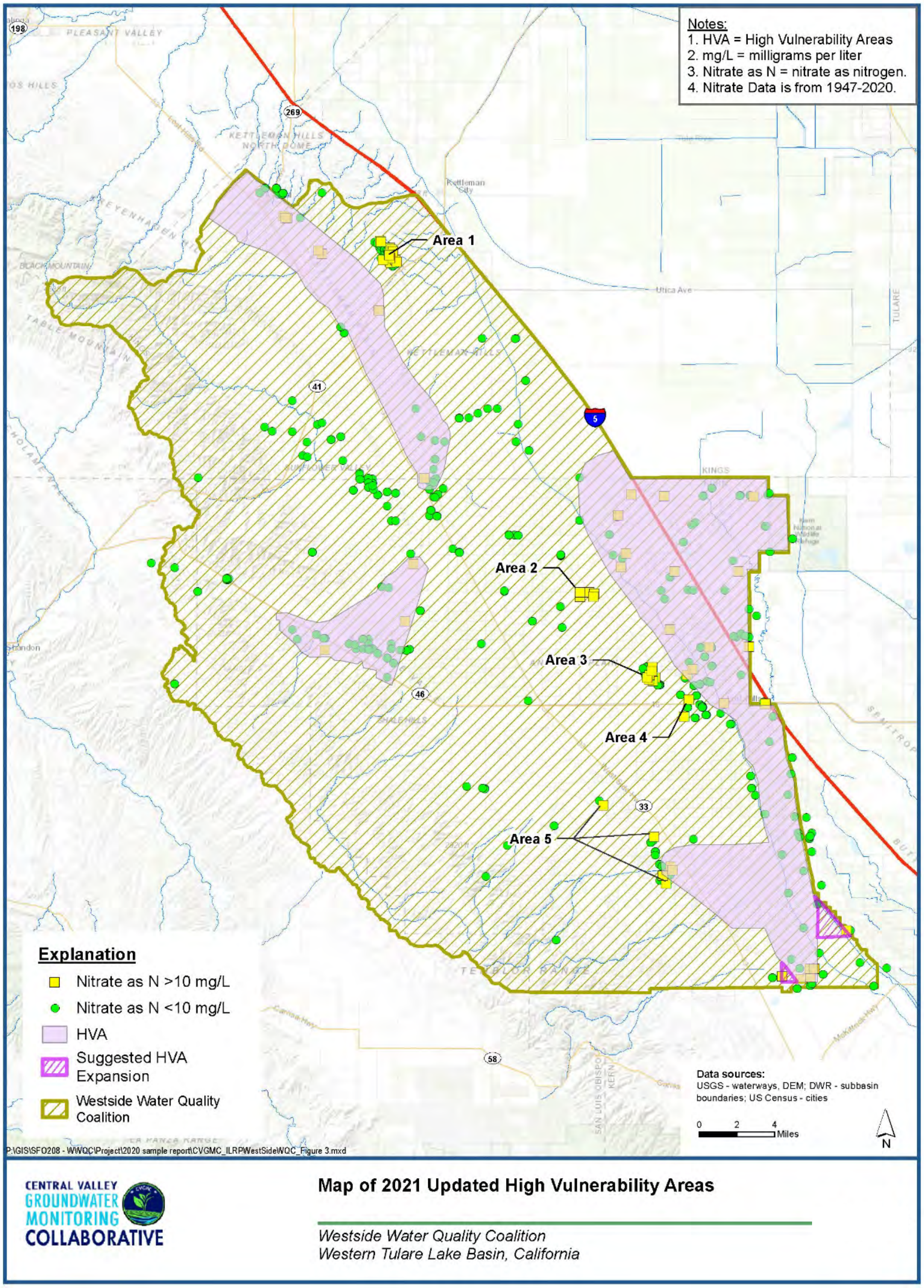


Figure 15-3 Map of 2021 Updated High Vulnerability Areas

DRAFT REPORT | SEPTEMBER 2021

16. WESTSIDE SAN JOAQUIN RIVER WATERSHED COALITION GROUNDWATER QUALITY FIVE-YEAR ASSESSMENT REPORT

PREPARED FOR

WESTSIDE SAN JOAQUIN RIVER WATERSHED COALITION

PREPARED BY

Luhdorff & Scalmanini Consulting Engineers

16. WESTSIDE SAN JOAQUIN RIVER WATERSHED COALITION GROUNDWATER QUALITY FIVE-YEAR ASSESSMENT REPORT

16.1. Groundwater Quality Trend Monitoring Results 2020

16.1.1. GQTM Summary of 2020 Network and Sampled Wells

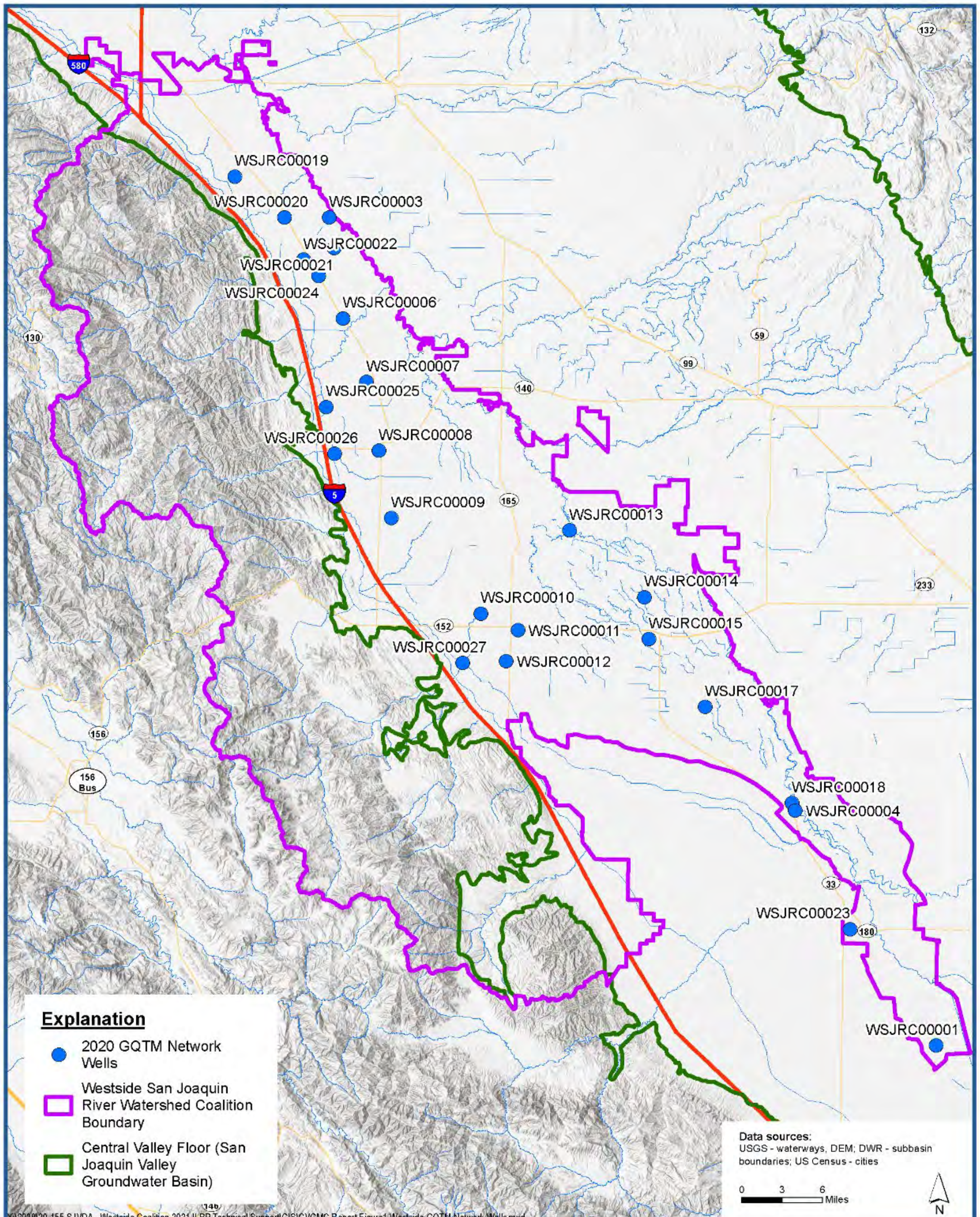
The Westside San Joaquin River Watershed Coalition (Coalition) completed monitoring of the Groundwater Quality Trend Monitoring network of 25 wells in Summer 2020 (**Figure 16-1**). Details on the 2020 GQTM network wells are presented in **Table 16-1**. The Westside Coalition GQTM well network 2020 sampling event occurred during mid to late August 2020 and included sampling of a total of 23 wells. While conducting the 2020 sampling activities three network wells could not be sampled for a variety of reasons listed below. One replacement well was sampled in 2020.

- WSJRC00012: damaged by heavy machinery and not operational in 2020; well repairs were completed and the well has been returned to service.
- WSJRC00020: dry in 2020 and removed from the network; a nearby well (WSJRC00028) was identified for use as replacement and sampled in 2020.
- WSJRC00023: not operational and all pumping equipment had been removed from the well in 2020; the Coalition is coordinating with the owner to determine the future status of the well for the GQTM network.

In accordance with the annual and five-year GQTM sampling schedule, five wells sampled for the first time as part of the GQTM were tested for nitrate + nitrite, total dissolved solids (TDS), and major cations and anions as required every five years, meanwhile the remaining network wells previously sampled for the GQTM were only tested for nitrate, as required for annual monitoring. All wells sampled for the GQTM were also tested for field parameters, including specific conductance, pH, temperature, dissolved oxygen, oxidation-reduction potential, and turbidity. The results from the 2020 sampling event are presented in **Table 16-2**.

Results for six of the sampled wells (WSJRC00002, WSJRC00006, WSJRC00008, WSJRC00024, WSJRC00025 and WSJRC00028) exceeded the primary drinking water MCL of 10 milligrams per liter (mg/L) for nitrate (as nitrogen). Four of the wells exceeding the MCL for nitrate had concentrations only marginally higher than the MCL of 10 mg/L. Well WSJRC00008 had a result of 10 mg/L; however, a duplicate sample measured above MCL at 11 mg/L. Wells WSJRC00002 and WSJRC00006 had relatively higher nitrate concentrations above the MCL at 16 and 17 mg/L, respectively. Of the five wells sampled for the first time as part of the GQTM program, which included sampling for a broader suite of analytes as required at a five-year interval, three of the five wells exceeded the secondary recommended drinking water MCL for total dissolved solids

(TDS) of 500 mg/L and one well (WSJRC00028) had a TDS concentration at or above the secondary upper MCL of 1,000 mg/L. The relatively high TDS concentrations in many network wells is reflective of the naturally high salinity of groundwater in the region. Chloride concentrations in all five wells sampled for chloride in 2020 remain below the secondary recommended drinking water MCL of 250 mg/L. One well had sulfate concentrations above the secondary recommended drinking water MCL of 250 mg/L, but below the upper secondary MCL of 500 mg/L. No wells had boron concentrations above the State public health goal (PHG) of 1 mg/L, although high levels of boron are common in groundwater in parts of the Coalition region due to the naturally occurring boron in sediments.



Map of Summer 2020 GQTM Network and Sampled Wells

CVGMC Five-Year Assessment Report
Westside San Joaquin River Watershed Coalition

Figure 16-1. Map of Summer 2020 GQTM Network and Sampled Wells

Table 16-1. 2020 GQTM Network Wells												
Field Point Name / GQTM Well ID	GQTM Well Name	Well Use	Well Construction Information					Latitude	Longitude	Datum	Depth to the Bottom of Upper Zone (feet)
			Seal Depth (feet)	Total Well Depth (feet)	Depth Top of Screen (feet)	Depth Bottom of Screen (feet)	Year Drilled				
WSJRC00001	WSJ001	Domestic	20	212	165	205		36.60985	-120.263	NAD83	458.175
WSJRC00002	WSJ002	Domestic	50	212	172	212	1980	37.5716	-121.209	NAD83	192.206
WSJRC00003	WSJ003	Irrigation	20	255	130	250	1991	37.49403	-121.086	NAD83	168.26
WSJRC00004	WSJ004	Municipal	100	245	115	220	2005	36.86157	-120.452	NAD83	207.382
WSJRC00006	WSJ006	Domestic	60	200	164	184	2008	37.38611	-121.066	NAD83	195.051
WSJRC00007	WSJ007	Domestic	65	203	20	160	1991	37.31794	-121.033	NAD83	184.632
WSJRC00008	WSJ008	Domestic	120	175	155	175	2009	37.2445	-121.016	NAD83	144.79
WSJRC00009	WSJ009	Domestic	80	205	100	140		37.17213	-120.998	NAD83	159.045
WSJRC00010	WSJ010	Municipal	90	540	135	275	2002	37.07059	-120.876	NAD83	150.839
WSJRC00011	WSJ011	Municipal	50	242	125	208	1991	37.05321	-120.826	NAD83	181.183
WSJRC00012	WSJ012	Domestic	150	210	170	200	2008	37.01647	-120.841	NAD83	200.68
WSJRC00013	WSJ013	Irrigation	50	210	80	180	2001	37.16078	-120.758	NAD83	198.18
WSJRC00014	WSJ014	Irrigation	50	180	60	180	1997	37.0897	-120.657	NAD83	172.058
WSJRC00015	WSJ015	Irrigation	50	184	60	180	2008	37.04465	-120.65	NAD83	178.493
WSJRC00017	WSJ017	Irrigation	20	165	60	160	1986	36.97232	-120.574	NAD83	225.534
WSJRC00018	WSJ018	Irrigation		245	86	236	1967	36.86651	-120.456	NAD83	179.918
WSJRC00019	WSJ019	Domestic	20	185	130	150	1968	37.53697	-121.214	NAD83	150.93
WSJRC00020	WSJ020	Domestic		193	175	193	1955	37.49363	-121.147	NAD83	221.887
WSJRC00021	WSJ021	Domestic	22	275	160	270	2005	37.46162	-121.079	NAD83	182.762
WSJRC00022	WSJ022	Domestic	20	370	350	370	2002	37.44868	-121.12	NAD83	199.224

Table 16-1. 2020 GQTM Network Wells											
Field Point Name / GQTM Well ID	GQTM Well Name	Well Use	Well Construction Information					Latitude	Longitude	Datum	Depth to the Bottom of Upper Zone (feet)
			Seal Depth (feet)	Total Well Depth (feet)	Depth Top of Screen (feet)	Depth Bottom of Screen (feet)	Year Drilled				
WSJRC00023	WSJ023	Irrigation		250				36.73438	-120.378	NAD83	305.597
WSJRC00024	WSJ024	Observation	71	115	95	115	2010	37.43139	-121.099	NAD83	193.961
WSJRC00025	WSJ025	Observation	92	135	115	135	2010	37.2907	-121.088	NAD83	124.01
WSJRC00026	WSJ026	Irrigation	25	170	120	150	1999	37.24066	-121.075	NAD83	167.974
WSJRC00027	WSJ027	Observation	75	160	150	160	2010	37.0173	-120.9	NAD83	216.064
WSJRC00028	WSJ028	Domestic	50	260	160	260	2020	37.49364	-120.147	NAD83	221.887

Table 16-2. 2020 GQTM Sampling Results									
Field Point Name / GQTM Well ID	GQTM Well Name	Well Use	Date Sampled	Nitrate as N (mg/L) Lab	pH Field	Specific Conductance (uS/cm) Field	Temperature (°C) Field	Dissolved Oxygen (mg/L) Field	Depth to Water (ft) Field
WSJRC00001	WSJ001	Domestic	8/21/2020	< 0.027	7.41	4129	19.7	0.38	77.56
WSJRC00002	WSJ002	Domestic	8/17/2020	16	6.97	1764	20	6.76	NR
WSJRC00003	WSJ003	Irrigation	8/18/2020	0.26	7.46	2749	19.5	2.96	NR
WSJRC00004	WSJ004	Municipal	8/20/2020	< 0.027	7.76	845	18.7	1.48	150
WSJRC00006	WSJ006	Domestic	8/18/2020	17	7.65	1235	22.1	4.78	61.88
WSJRC00007	WSJ007	Domestic	8/18/2020	7.7	7.65	1399	20.5	5.8	NR
WSJRC00008	WSJ008	Domestic	8/20/2020	10	7.76	1381	20.5	3.58	NR
WSJRC00009	WSJ009	Domestic	8/25/2020	6.1	7.37	1195	20.7	3.72	NR

Table 16-2. 2020 GQTM Sampling Results									
Field Point Name / GQTM Well ID	GQTM Well Name	Well Use	Date Sampled	Nitrate as N (mg/L) Lab	pH Field	Specific Conductance (uS/cm) Field	Temperature (°C) Field	Dissolved Oxygen (mg/L) Field	Depth to Water (ft) Field
WSJRC00010	WSJ010	Municipal	8/17/2020	4.5	7.45	781	19.1	2.74	NR
WSJRC00011	WSJ011	Municipal	8/17/2020	7.3	7.32	1469	22	2.78	120
WSJRC00013	WSJ013	Irrigation	8/27/2020	< 0.027	7.34	1788	18.2	1.46	10.13
WSJRC00014	WSJ014	Irrigation	8/27/2020	< 0.027	7.58	1332	19.5	5.03	NR
WSJRC00015	WSJ015	Irrigation	8/27/2020	< 0.027	7.39	1345	20.5	5.6	NR
WSJRC00017	WSJ017	Irrigation	8/25/2020	< 0.027	7.33	1598	22.3	2.81	NR
WSJRC00018	WSJ018	Irrigation	8/25/2020	0.11	7.65	781	21.6	5.46	NR
WSJRC00019	WSJ019	Domestic	8/17/2020	8.8	7.32	1371	21.5	7.02	89.31
WSJRC00021	WSJ021	Domestic	8/17/2020	5.2	7.53	1859	20.3	3.45	NR
WSJRC00022	WSJ022	Domestic	8/17/2020	7.1	6.69	1464	22.6	3.01	NR
WSJRC00024	WSJ024	Observation	8/24/2020	12	7.69	1079	20.2	4.51	48.35
WSJRC00025	WSJ025	Observation	8/24/2020	12	7.34	1788	18.2	1.46	17.62
WSJRC00026	WSJ026	Irrigation	8/18/2020	8.9	7.32	1040	19.7	7.46	NR
WSJRC00027	WSJ027	Observation	8/24/2020	1.8	7.57	752	24.2	2.37	96.7
WSJRC00028	WSJ028	Domestic	8/17/2020	11	7.09	1769	20.7	4.83	NR

NR= Not Recorded

16.1.2. Summary of Quality Assurance Evaluation for 2020 Sampling Event

Consistent with the QAPP, field measurements of electrical conductivity (EC) at 25oC, pH, dissolved oxygen (DO) and temperature (T) were obtained during the sample retrieval and the laboratory performed analysis for nitrate + nitrite as nitrogen, boron (B), sodium (Na), potassium (K), calcium (Ca), magnesium (Mg), chloride (Cl), sulfate (SO4), carbonate and bicarbonate alkalinity, and total dissolved solids (TDS), in accordance with the annual and five-year sampling schedule in the GQTM Workplan and QAPP. Additional field parameters of turbidity and oxidation-reduction potential (ORP) were also recorded during sampling.

16.1.2.1. Purging, sample handling, and custody

Wells were purged according to the SOP. Samples were retrieved upon stabilization of indicator parameters (i.e., EC and pH) and after the turbidity of the discharging water dropped below 10 NTUs. Purging and sampling activities were documented on field sheets provided in the QAPP. Samples were collected in laboratory-supplied bottles and transported under prescribed chain of custody to the laboratory according to the QAPP.

16.1.2.2. Access and field and analytical completeness

A total of 25 wells were planned for sampling and 23 wells were able to be sampled to include a well that was not previously planned to be sampled. Excluding WSJRC00020 which was replaced by WSJRC00028 this results in an overall 92 percent completeness for well sampling and field parameters (**Table 16-3**). Additionally, all well samples collected were analyzed at the laboratory resulting in 100 percent analytical completeness (**Table 16-3**). For the purpose of field quality control (QC), the QAPP prescribes the collection of one duplicate sample and one blank sample for every 20 samples retrieved (each must be at least 5 percent of total samples). In accordance with the QAPP, six duplicate samples were retrieved representing 26 percent of the wells sampled for nitrate. One duplicate sample was taken for all other constituents representing 20 percent of the wells sample for the five-year analysis. Five field blanks were submitted to the laboratory resulting in 21.7 percent of the samples analyzed for nitrate and one field blank was taken for five-year analysis representing 20 percent of the total five-year samples. The assessment of completeness for field QC sampling is summarized in **Table 16-4**. A summary of the hold times specified in the QAPP for the laboratory analyses is presented in **Table 16-5**. All analyses were conducted within the allowed hold time.

Table 16-3. Completeness of Field and Analytical Testing										
Constituent	Test Type	Analytical Method	Matrix	Wells Planned for Sampling	Dry	No Access	Wells Sampled	Field and Transport Completeness %	Total Samples Analyzed	Analytical Completeness %
Oxygen, Dissolved	Field parameter	EPA 360.1	Ground-water	26	1	2	23	92.3	23	100
pH	Field parameter	EPA 150.1	Ground-water	26	1	2	23	92.3	23	100
Specific Conductivity	Field parameter	EPA 120.1	Ground-water	26	1	2	23	92.3	23	100
Temperature	Field parameter	SM 2550	Ground-water	26	1	2	23	92.3	23	100
Nitrate as N	Laboratory	EPA 300.0	Ground-water	26	1	2	23	92.3	23	100
			Total	130	5	10	115	92.3	115	100

Table 16-4. Completeness of Field QC								
Constituent	Analytical Method	Matrix	Total Well Samples Analyzed	Field Duplicate Samples Analyzed	Field Blank Samples Analyzed	Total Samples Analyzed (well and duplicates)	Field Duplicate Completeness %	Field Blank Completeness %
Nitrate as N	EPA 300.0	groundwater	23	6	5	34	17.6	14.7
		Total	**23**	**6**	**5**	**34**	**17.6**	**14.7**
Completeness values below the acceptability requirement of 5 percent are presented in **bold**.								

Table 16-5. Evaluation of Sample Hold Times						
Constituent	Analytical Method	Matrix	Hold Time	Total Samples Analyzed	Samples Analyzed within Hold Time	Acceptability %
Nitrate as N	EPA 300.0	groundwater	28 days	34	34	100
			Total	**34**	**34**	**100**
Acceptability values below 90 percent are presented in **bold**.						

16.1.2.3. Analytical precision and accuracy

The laboratory performed all QA/QC for laboratory precision and accuracy in accordance with the QAPP including lab blanks, lab duplicates, matrix spikes, and lab control spikes. Results of the assessment of precision and accuracy are summarized in **Tables 16-6** and **16-7** and include evaluation of chemistry QC with field and laboratory blank samples; laboratory control and matrix spikes to evaluate accuracy; and field, laboratory, and matrix spike duplicates to evaluate precision. Analytical precision and accuracy met all acceptability requirements for nitrate samples tested. All lab blanks, lab control spikes, and lab control duplicates had 100 percent acceptability among samples tested. Of the 14 matrix spikes analyzed, 12 were within the acceptability range resulting in an overall matrix spike acceptability of 85.7%.

Table 16-6. Evaluation of Field Duplicates and Blanks

Constituent	Analytical Method	Matrix	Sample Type	Acceptability Requirement	Total Samples	Samples within Acceptability	Acceptability %
Nitrate as N	EPA 300.0	groundwater	Field Duplicate	RPD ≤ 25	6	6	100
				Field Duplicate Total	**6**	**6**	**100**
Acceptability values below 90 percent are presented in **bold**.							
Constituent	**Analytical Method**	**Matrix**	**Sample Type**	**Acceptability Requirement**	**Total Samples**	**Samples within Acceptability**	**Acceptability %**
Nitrate as N	EPA 300.0	groundwater	Field Blank	< RL or 1/5 environmental sample	5	5	100
				Field Duplicate Total	**5**	**5**	**100**
Acceptability values below 90 percent are presented in **bold**.							

Table 16-7. Evaluation of Lab Controls and Spikes							
Constituent	Analytical Method	Matrix	Sample Type	Acceptability Requirement	Total Samples	Samples within Acceptability	Acceptability %
Lab Blanks							
Nitrate as N	EPA 300.0	groundwater	Lab Blank	< RL	4	4	100
				Lab Blank Total	4	4	100
Lab Control Spikes							
Nitrate as N	EPA 300.0	groundwater	LCS	PR 90-110	8	8	100
				Lab Control Total	8	8	100
Matrix Spikes							
Nitrate as N	EPA 300.0	groundwater	MS	PR 80-120	14	14	100
				Matrix Spike Total	14	14	100
Analytical Duplicates							
Nitrate as N	EPA 300.0	groundwater	MSD/LCSD/Lab Dup	RPD ≤ 25	11	11	100
				Analytical Duplicate Total	11	11	100
Acceptability values below 90 percent are presented in **bold**.							
LCS=lab control spike; MS=matrix spike; MSD=matrix spike duplicate; LCSD=lab control spike duplicate							

16.1.2.4. Quality assurance evaluation conclusions

All groundwater quality data are deemed acceptable based on the review of QA/QC procedures and results in accordance with the requirements in the QAPP. No field duplicate or field blanks were outside of acceptability limits for any analyte.

16.1.2.5. Electronic Data Submittal and Data Uploaded to GeoTracker

In accordance with the requirements for electronic data submittal, the Coalition has already submitted all 2020 GQTM results to GeoTracker.

16.1.3. Five-Year Assessment Results and Discussion

Luhdorff & Scalmanini Consulting Engineers (**LSCE**) conducted both parametric and non-parametric analyses of Nitrate as N (**Nitrate or NO_3-N**) and Total Dissolved Solids (**TDS**) trends within the CWDC primary area boundary. Methodology for each of these analyses is discussed in **Section 5**. All of the **Section 5** figures pertinent to this individual coalition section are presented in **Appendix N**.

Average nitrate conditions in GQTM wells are presented in **Figure N-1** in **Appendix N**. Nitrate concentrations in GQTM wells sampled in 2020 were generally low (**Figure N-2**), although six nitrate MCL exceedances (>10 mg/L) did occur. The six nitrate exceedances in 2020 occurred in wells located in the more northern and western parts of the Coalition region generally in the area between Gustine and Tracy. Three additional wells located within this region had nitrate concentration between 7.5 mg/L and the MCL of 10 mg/L with four more with concentrations between 5 and 7.5 mg/L.

Most wells have been very stable over the time period sampled and six wells have never had a detectible level of Nitrate. While wells in the GQTM network have been relatively stable there have been some changes of note. Namely WSJRC00018 became detectable at low levels in 2020. WSJRC00019 went from being above MCL at 14 mg/L in 2019 to below MCL at 8.8 mg/L in 2020. Most significantly WSJRC00022 went from being undetectable in 2019 to approaching the MCL at 7.1 mg/L in 2020. Overall groundwater quality trends are unclear due to the short period of record. 14 wells have a three-year record, four (4) wells have a two-year record and seven wells have been sampled one time. The understanding of groundwater quality trends will improve as the period of record increases. **Figure N-3** provides more insight into the spatial distribution of nitrate samples for all wells with nitrate data, regardless of well depth. Spatially interpolated (kriged) ambient nitrate in wells completed in the Upper Zone are shown for two recent snapshots: Post-2000 (**Figure N-3**) and Post-2020 (**Figure N-5**). These three figures (**Figures N-3** through **N-5**) suggest that nitrate concentrations are lower in the eastern and southeast, with some elevated nitrate concentrations in the north and west.

Parametric nitrate trends in the Upper Zone since 2000 indicate a mixture of increasing, decreasing, and stable nitrate conditions (**Figure N-6**). Non-parametric trend analyses in the Upper Zone since 2000 indicate that there is insufficient evidence of a trend in wells with eight or more samples (**Figure N-7**).

Recent TDS conditions in the Coalition's GQTM well network indicate most concentrations are below the secondary drinking water MCL of 1,000 mg/L, with the exception of three wells in the northeast (**Figure N-8**).

Overall, there is good coverage throughout the GQTM network. The network provides greater coverage in the northern extent with southern areas more sparsely monitored but still with sufficient coverage. MA 10 is the only MA lacking coverage. Future efforts to improve the monitoring network should focus on the southern MA's and specifically MA 10.

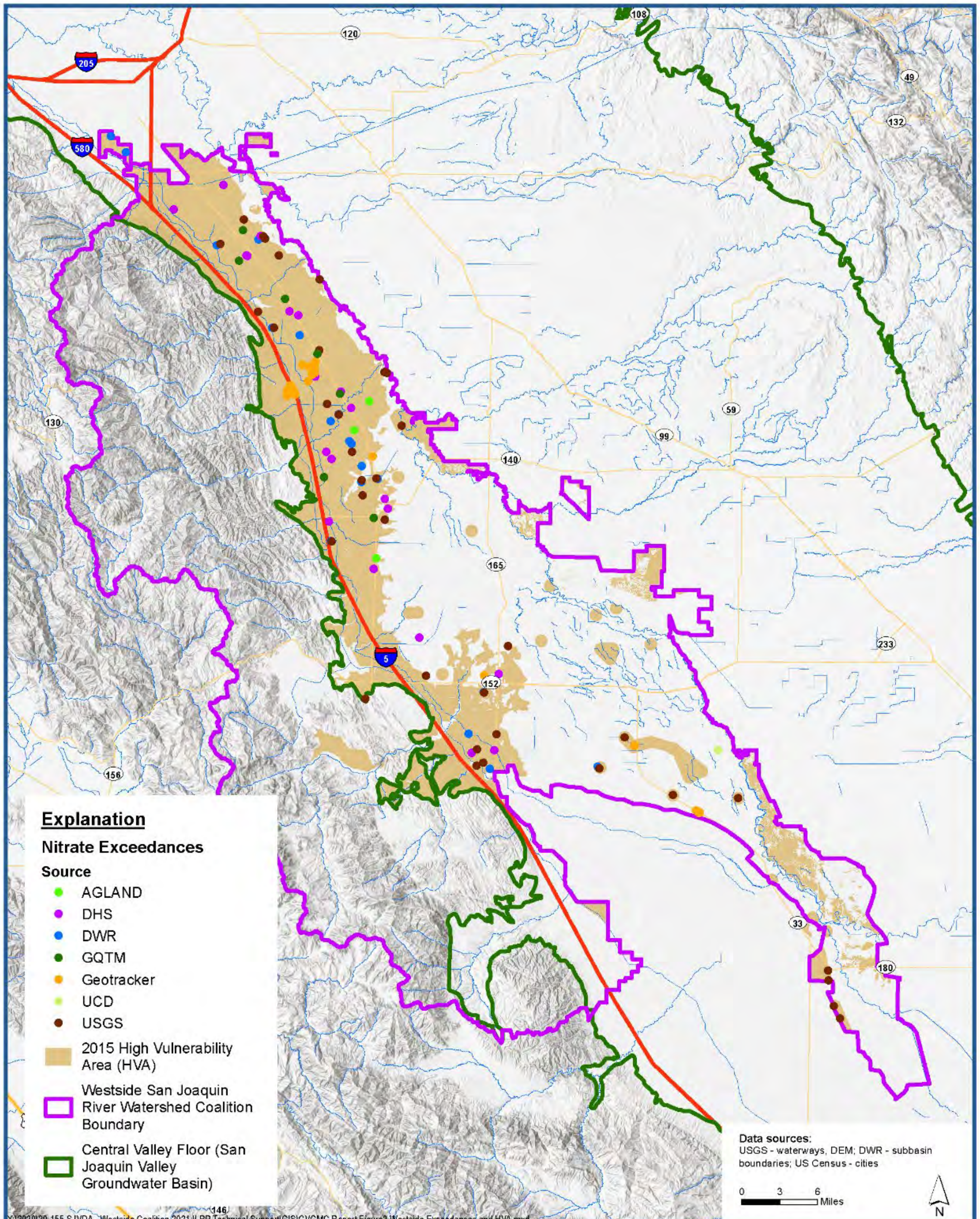
16.1.4. Five-Year High Vulnerability Area Update

16.1.4.1. Existing HVA Compared to Nitrate Exceedances

To evaluate the current (2015) HVA, all readily and publicly available data on historical nitrate concentrations were examined within the Coalition region. Consistent with the designation of the 2015 HVA in the original GAR, the review of the HVA focusses on the area of the Coalition within alluvial groundwater basins designated by DWR, with a strong focus on the San Joaquin Valley Groundwater Basin (Central Valley Floor) where the vast majority of irrigated agriculture in the Coalition occurs. Of the 1,401 wells with historical nitrate concentration data located within the Coalition, only 19 wells were located outside of the Central Valley Floor with 1,382 wells located within the Central Valley Floor area. Of the 1,382 wells within the Central Valley Floor area, 207 wells have historical concentrations of nitrate exceeding the MCL of 10 mg/L (**Figure 16-2**). Of the 207 historical nitrate exceedance wells, all are located within the 2015 HVA boundary developed as part of the original GAR.

16.1.4.2. HVA Update

The five-year review of the Coalition's HVA seeks to account for all nitrate exceedances in the Coalition that may be related to irrigated agriculture activities. The review of the HVA described above indicates no exceedances occurring outside of the extent of the 2015 HVA. This suggests the existing 2015 HVA is appropriate and sufficient and no modifications to the HVA extent are needed at this time. As a result, the 2021 HVA is unchanged from the HVA previously approved in the 2015 GAR (**Figure 16-3**).

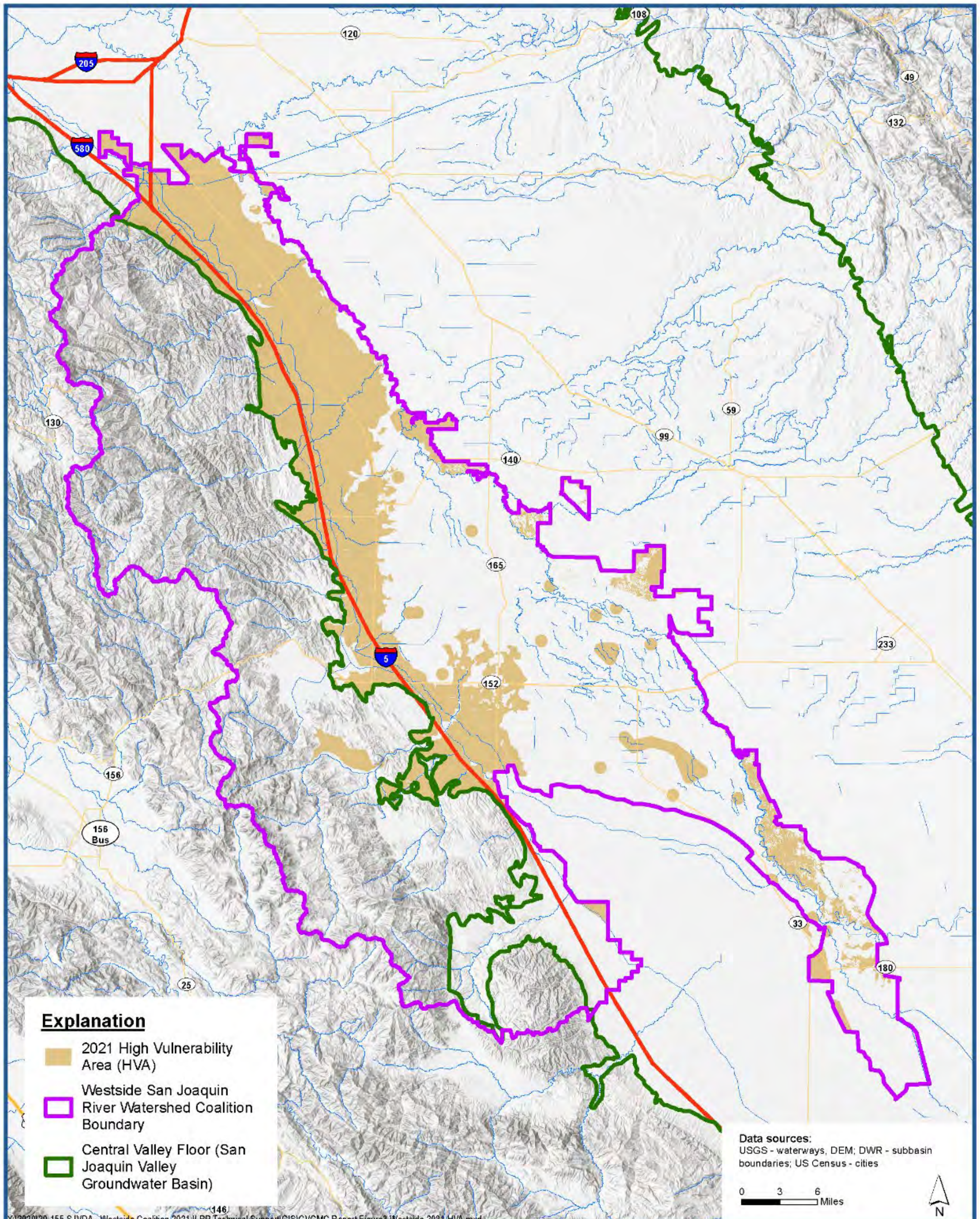


CENTRAL VALLEY GROUNDWATER MONITORING COLLABORATIVE

Map of Nitrate Exceedances and 2015 HVA

CVGMC Five-Year Assessment Report
Westside San Joaquin River Watershed Coalition

Figure 16-2. Map of Nitrate Exceedances and 2015 HVA



CENTRAL VALLEY GROUNDWATER MONITORING COLLABORATIVE

Map of 2021 High Vulnerability Area (HVA)

CVGMC Five-Year Assessment Report
Westside San Joaquin River Watershed Coalition

Figure 16-3. Map of High Vulnerability Area (HVA)

17. CVGMC EDUCATION AND OUTREACH EFFORTS

17.1. ILRP Education and Outreach Activities

CVGMC, established in 2017, has performed several educational and outreach-related activities. CVGMC has a website, www.cvgmc.org, which contains information about the coalition and activities, participants, and describes how interested parties can become involved. The ten coalitions of CVGMC coordinated to construct the DMS, which now houses hundreds of thousands of data points pertinent to the groundwater conditions in the San Joaquin Valley.

17.2. Coordination with CV-SALTS and Other Projects

CVGMC Coalitions continue to be involved in the Central Valley Salinity Alternative for Long-Term Sustainability (CV-SALTS) process by attending meetings, participating in committees, and envisions future coordination with groundwater monitoring elements included in CV-SALTS efforts.

Many of the monitoring and analysis provided in the GARs and this Five-Year Assessment Report satisfy similar objectives as the Basin Plan Amendment and the Surveillance & Monitoring Program (SAMP). For example, the groundwater requirements associated with the BPA includes a Salt and Nitrate Groundwater Monitoring Program that "shall be sufficiently robust to evaluate ambient water quality and trends in groundwater basins in the floor of the Central Valley Region". The BPA's monitoring program also includes a QAPP, similar to CVGMC's quality assurance project plan. Additionally, the BPA states that "to the extent possible, the Groundwater Monitoring Program will utilize data collected by existing Central Valley Water Board water quality monitoring programs to be cost-effective and establish consistency in how groundwater quality data are collected, managed, assessed, and reported. In this regard, the Irrigated Lands Regulatory Program Groundwater Quality Trend Monitoring Program implemented by the Central Valley Groundwater Monitoring Collaborative is anticipated to provide the foundation for the development of the Groundwater Monitoring Program."

17.3. Coordination with SGMA Implementation

CVGMC was created to comply with the various Waste Discharge Requirements of the participating Irrigated Lands Regulatory Program agricultural coalitions, including monitoring and characterizing regional groundwater quality conditions and trends. The monitoring and trends analyses associated with CVGMC ties in well with SGMA implementation including coordination with GSP efforts and potential groundwater management activities or projects.

ConclusionsThe following conclusions are made following the assessment of groundwater conditions with regards to nitrate, TDS, and pesticides in the CVGMC area:

- As seen and discussed in Sections 5.1 through 5.3, nitrate conditions are highly variable within the GQTM wells as well as the publicly available data.
- Recent (post-2010) nitrate data in the Upper Zone is the densest in the northeast and central-east portions of the CVGMC area, with much sparser Upper Zone recent (post-2010) nitrate data on the western side and southern portion of CVGMC.
- As illustrated in the **Figure 5-4a** and **5-4b** series of maps, recent nitrate data for wells completed in the Upper Zone show two large hotspots occurring in the north-central (northwestern portion of the East San Joaquin Water Quality Coalition) and the eastern-central (spanning the eastern portion of the Kings River Water Quality Coalition and the northern and western areas of the Kaweah Basin Water Quality Association) areas of the CVGMC. Other smaller pockets of elevated nitrate occur throughout each of the ten coalitions in CVGMC.
- Nitrate conditions in the Upper Zone are generally of better quality on the eastern edges of the Central Valley Floor, and in areas adjacent to parts of the San Joaquin River and the Fresno Slough.
- Trends in nitrate concentrations are highly variable well-by-well. Regional trend analyses exhibit increasing trends in many coalitions. However, recent trends are more often stable or decreasing compared to long-term trends, and overall nitrate concentrations are decreasing within the entire CVGMC area.
- Despite a high amount of variability, general patterns can be observed that suggest that TDS conditions on the west side of the CVGMC area are higher and tend to exceed the secondary drinking water standard of 1,000 mg/L compared to the east. Pockets of elevated TDS exist in the south and southeast CVGMC area as well as throughout some areas on the eastern side of the Central Valley Floor.
- Trends in TDS concentrations are also highly variable, but a larger portion of wells exhibit increasing TDS trends compared to nitrate trends. Regionally, TDS concentrations exhibit an increasing trend throughout the entire CVGMC area.
- Pesticide data in groundwater wells show exceedances of health standards for DBCP and 1,2,3-TCP on the eastern side and southern portion of CVGMC. Out of the remaining seven pesticide constituents analyzed and associated with current agricultural practices, only a small amount of atrazine and diuron exceedances are found in groundwater in isolated locations in the eastern side of the CVGMC area (**Figure 5-19**).

18. REFERENCES

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