SAN JOAQUIN VALLEY DRAINAGE AUTHORITY

P O Box 2157 Los Banos, CA 93635
209 826 9696 Phone 209 826 9698 Fax

WESTSIDE SAN JOAQUIN RIVER WATERSHED COALITION

September 16, 2016

Ms. Pamela Creedon, P.E.
Executive Officer
Central Valley Regional Water Quality Control Board
11020 Sun Center Drive, Suite 200
Rancho Cordova, CA 95670-6114

SUBJECT: WESTERN SAN JOAQUIN RIVER WATERSHED TREND MONITORING WORKPLAN WDR GENERAL ORDER R5-2014-0002

Dear Pamela:

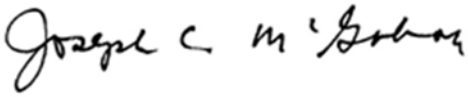
The Westside San Joaquin River Watershed Coalition (Westside Coalition), which is under the administration of the San Joaquin Valley Drainage Authority, serves as the third-party group for the growers within the Western San Joaquin River Watershed who are members of the Westside Coalition. The Waste Discharge Requirements, General Order R5-2014-0002, which applies to growers within the Watershed who are members of the Westside Coalition, were adopted by the Central Valley Regional Water Quality Control Board on January 9, 2014. The Order requires submittal of a Trend Monitoring Workplan one year after approval of the Groundwater Assessment Report (GAR). The GAR was approved on September 16, 2015 and the Trend Monitoring Workplan is due September 16, 2016.

The Trend Monitoring Workplan is attached and is comprised of two parts. One is an approach to develop a regional monitoring program with other stakeholders to take advantage of the cost savings by coordinating monitoring over several programs. The second is Phase I of a two-phased approach to developing the Trend Monitoring Workplan.

The Westside Coalition retained Luhdorff & Scalmanini, Consulting Engineers to assist the Westside Coalition in preparing the Regional Monitoring Program and Trend Monitoring Workplan.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel or represented members properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for knowingly submitting false information, including the possibility of fine and imprisonment for violations.

Sincerely,



Joseph C. McGahan
Watershed Coordinator
Westside San Joaquin River Watershed Coalition

enclosure

Western San Joaquin River Watershed
Groundwater Quality Trend Monitoring Workplan
Phase I - Monitoring Design Approach

September 2016

LUHDORFF & SCALMANINI
CONSULTING ENGINEERS

Western San Joaquin River Watershed

Groundwater Quality Trend Monitoring Workplan

Phase I - Monitoring Design Approach

September 2016

Prepared For
Westside San Joaquin River Watershed Coalition

Prepared By
Luhdorff and Scalmanini, Consulting Engineers

LUHDORFF & SCALMANINI
CONSULTING ENGINEERS

PROFESSIONAL GEOLOGIST
NICHOLAS ASHLEY WATTERSON
No. 9076
STATE OF CALIFORNIA

Sept. 16, 2016

Vicki Kretsinger Grabert
Senior Principal Hydrologist

Nicholas Watterson
Senior Hydrogeologist

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1 Introduction

The Westside San Joaquin River Watershed Coalition (Coalition) has prepared this Groundwater Quality Trend Monitoring Workplan (GQTM or Workplan) to address the requirements of the Waste Discharge Requirements General Order (WDRs or Order) for Growers within the Westside San Joaquin River Watershed (Order No. R5-2014-0002)(CVRWQCB, 2014). This Workplan is Phase I of a two-phase approach to developing the complete Workplan.

1.1 Background

The Central Valley Regional Water Quality Control Board (the CVRWQCB) initiated the Irrigated Lands Program (ILP) in 2003 with the adoption of a Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands. The ILP, later the Irrigated Lands Regulatory Program (ILRP), was developed to regulate discharges from irrigated agriculture to surface waters. The WDRs for Growers within the Western San Joaquin River Watershed, along with other orders to be adopted for the irrigated lands within the Central Valley, constitute the long-term ILRP, an expansion of the initial ILRP.

Following the CVRWQCB's adoption of the WDRs on January 9, 2014, the Notice of Applicability (NOA) was approved on March 17, 2014 for the Coalition. The approval date associated with the NOA started the timeline for several requirements, including submittal of a Notice of Intent (NOI) from entities wishing to join the Coalition and for the Coalition to submit an outline of the Groundwater Assessment Report (GAR) (WDRs, Section IV. A). The GAR provides the basis for the Groundwater Quality Management Plan (GQMP), the Groundwater Quality Trend Monitoring Program (particularly this Workplan Phase I – Monitoring Design Approach) and the Management Practices Evaluation Program (MPEP).

The GAR outline was submitted June 13, 2014 (approved September 19, 2014), and the GAR was submitted March 16, 2015. The Coalition's GAR (LSCE et al., 2015) was approved by the CVRWQCB on September 16, 2015 establishing the GQMP's required submittal date of November 15, 2015, 60 days after review and approval of the GAR.[1] The CVRWQCB's approval also established the required GQTM Workplan submittal date of September 16, 2016, one year after the GAR approval.

The Order requires that a Groundwater Quality Assurance Project Plan (QAPP) be submitted at the same time as the GQTM. The QAPP has been separately submitted (Summers Engineering, 2016).

The Workplan is developed following the requirements listed in the Order and based on the foundational information developed in the GAR and GQMP. Requirements of the Order and where they can be found within the GQTM Workplan are listed in a checklist provided in **Table 1**.

[1] The CVRWQCB provided Conditional Approval of the GQMP on August 1, 2016; a revised GQMP was submitted on September 9, 2016.

As explained in this Workplan, significant effort is involved in thorough vetting of candidate monitoring wells for the monitoring network prior to official inclusion of these wells in the GQTM program. Therefore, the complete Workplan is being submitted in two phases. Phase I of the GQTM Workplan outlines the rationale and approach to the trend monitoring program and describes the analyses and reporting that will occur as part of the GQTM. Because of the considerable time required to investigate the suitability of existing wells for inclusion in the GQTM network, including locating the well, confirming well construction details, and coordinating with the well owner or monitoring entity, a second phase of the Workplan (Phase II – Determination of Specific Wells for GQTM) will be conducted to complete the monitoring network design. The required elements of the GQTM Workplan, and the phase under which these will be completed are shown in the checklist in **Table 1**.

1.2 Purpose

The Irrigated Lands Regulatory Program (ILRP) recognizes as a main goal to "ensure that irrigated agricultural discharges do not impair access by Central Valley communities and residents to safe and reliable drinking water." (WDRs, Attachment A, page 3). As part of achieving the ILRP goals, the program objectives include efforts to "promote coordination with other regulatory and non-regulatory programs associated with agricultural operations (e.g., DPR, the California Department of Public Health [DPH] Drinking Water Program,… State Water Board Groundwater Ambient Monitoring Assessment Program, the U.S. Geological Survey [USGS], and local groundwater programs [SB 1938, Assembly Bill [AB] 3030, and Integrated Regional Water Management Plans]) to minimize duplicative regulatory oversight while ensuring program effectiveness." (WDRs, Attachment A, page 4).

1.2.1 Westside GQTM

The objectives of the GQTM as specified in the WDRs (Attachment B, Section C) are 1) to determine current water quality conditions of groundwater relevant to irrigated agriculture, and 2) to develop long-term groundwater quality information that can be used to evaluate the regional effects of irrigated agricultural practices.

The GQTM design considers groundwater vulnerability, prioritization of High Vulnerability Areas (HVA), areas contributing recharge to communities reliant on groundwater (including disadvantaged communities [DACs] and disadvantaged unincorporated communities [DUCs]), top acreage commodities and other information summarized in previous related studies submitted by the Coalition as part of compliance with the ILRP.

The GQTM Workplan is designed to meet the WDR's objectives and provide information to meet additional objectives identified by the Coalition for the GQTM, including: 1) understanding long-term temporal trends in regional groundwater quality, particularly as they relate to effects from irrigated agriculture on potential sources of drinking water for communities; 2) evaluating groundwater quality conditions in the Coalition area, particularly in the groundwater HVA, and identifying differences in water quality spatially between areas and vertically in the aquifer system; and 3) distinguishing water quality changes associated with irrigated agriculture compared to other non-agricultural factors. Long-

term monitoring programs benefit from a simple design at the outset. Therefore, the GQTM emphasizes ongoing evaluation of the monitoring program design and incorporation of modifications to the network and program as necessary. This approach will result in more informative results over the long-term.

1.2.2 Proposed Groundwater Quality Regional Monitoring Program

The Central Valley includes over 1,000 miles of rivers, and a substantial aquifer network in its subsurface, which combine to support the majority of California's agricultural industry as well as over 6.5 million people. Many programs rely on water resources management to achieve sustainability. Monitoring programs with meaningful data are fundamental to management actions which are implemented to meet groundwater sustainability objectives. Developing a coordinated Groundwater Quality Regional Monitoring Program now, while various other groundwater programs are in their infancy, will strategically place the Central Valley in a prime position to achieve its management and sustainability goals for decades to come. Given the complexity and expense of implementing groundwater monitoring programs, the development of a coordinated groundwater quality regional monitoring program is envisioned to result in more effective and efficient monitoring than the utilization of separate programs working without coordination. The development of a coordinated approach will benefit all parties involved in the effort to assess groundwater quality within the Central Valley.

1.3 Previous Related Work

1.3.1.1 Groundwater Quality Assessment Report (GAR)

The GAR is a key element of the ILRP, with the focus on the assessment of groundwater conditions and long-term protection of regional groundwater quality. The GAR documents current groundwater quality in the Coalition region (with an emphasis on nitrate concentrations and trends), evaluates the influence of irrigated agriculture on groundwater quality, and provides a scientifically based classification system for evaluating and determining the relative groundwater vulnerability (higher or lower), especially for the area of the Coalition region within the Central Valley Floor (LSCE et al., 2015).

The GAR evaluates the relative vulnerability of groundwater to irrigated land agricultural impacts based on (1) hydrogeologic sensitivity, (2) overlying land uses and practices, and (3) groundwater quality observations (particularly nitrate but also salt and pesticide concentrations). Hydrogeologic sensitivity is a factor that is tied to the inherent physical characteristics of the geology and soils and underlying hydrogeologic and geologic conditions. Land use (location of cropping and management systems on the landscape, and locations of other non-agricultural land uses) is an indicator of potential groundwater quality stressors. The GAR assesses the spatial relationship between the hydrogeologic sensitivity of an area, the overlying land use, and the proximity of groundwater serving urban and rural communities (particularly recharge areas upgradient of communities that rely on groundwater) for areas within the Central Valley Floor of the Coalition region.

To determine high vulnerability areas (HVAs), a model for assessing groundwater vulnerability for the Western San Joaquin River Watershed was developed through statistical approaches and based on observed groundwater quality and hydrogeologic characteristics. HVAs, where irrigated agriculture

operations have impacted or are more likely to impact groundwater quality, were identified and prioritized in the GAR (LSCE et al., 2015).

Figure 1 shows the locations of HVAs, including High Well Vulnerability Areas (HWVAs) where hydrogeologic conditions did not indicate vulnerability, but where well data indicated an exceedance of the water quality objective for nitrate in groundwater. The prioritization of HVAs is shown in **Figure 2**. The prioritization system accounted for factors related to hydrogeologic vulnerability, existing groundwater quality conditions, land use, and other factors such as proximity to communities reliant on groundwater (including disadvantaged communities). An initial identification of existing wells that may assist GQTM efforts to track regional groundwater quality and its relationship with agricultural practices was also conducted as part of the GAR.

Information and results from the GAR form the basis for design of the GQTM and are incorporated and referenced throughout the Workplan.

1.3.1.2 Groundwater Quality Management Plan (GQMP)

The goals of the GQMP are to inform growers about management practices that are protective of groundwater quality, and have the growers implement those practices (LSCE and Summers Engineering, 2015; 2016). To achieve those goals, the Coalition identified the specific constituents applied by agriculture that leach to groundwater and result in impaired water quality, identify management practices to prevent/reduce leaching, and identify a process for documenting the implementation of those practices and improvements in groundwater quality.

The Coalition identified COCs based on constituents that were identified in the GAR which have been or have the potential to be found in groundwater as a result of impacts from irrigated agriculture. Constituents of concern identified in the GQMP for the Coalition region include nitrate, total dissolved solids (TDS), and pesticides (only one active pesticide, simazine, has had an exceedance of a water quality objective; DBCP and EDB were also detected in historical samples at concentrations that exceeded water quality objectives) (LSCE and Summers Engineering, 2015; 2016). The GQTM will provide information relating to long-term regional trends in groundwater quality, particularly related to COCs, which will be useful in evaluating the effectiveness of the GQMP strategy.

2 Preliminary Conceptual Outline and Approach to Develop a Central Valley Groundwater Quality Regional Monitoring Program

The Central Valley includes over 1,000 miles of rivers, and a substantial aquifer network in its subsurface, which combine to support the majority of California's agricultural industry as well as over 6.5 million people. Many programs rely on water resources management to achieve sustainability. Monitoring programs with meaningful data are fundamental to management actions which are implemented to meet groundwater sustainability objectives. Developing a coordinated Groundwater Quality Regional Monitoring Program now, while various other groundwater programs are in their infancy, will strategically place the Central Valley in a prime position to achieve its management and sustainability goals for decades to come.

2.1 Background

Groundwater quality monitoring is an element of many programs in the Central Valley. These programs include programs such as the Irrigated Lands Regulatory Program (ILRP), the Dairy Program, and the Oil Fields Program overseen by the Central Valley Regional Water Quality Control Board (CVRWQCB). The CVRWQCB also requires groundwater quality monitoring as part of many individual Waste Discharge Requirements (WDR). In addition to monitoring overseen by the CVRWQCB, various other state programs, such as the State Water Resources Drinking Water Program, the Sustainable Groundwater Management Act (SGMA), California Statewide Groundwater Elevation Monitoring Program (CASGEM) and Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) have groundwater monitoring elements. Given the complexity and expense of implementing groundwater monitoring programs, the development of a coordinated groundwater quality regional monitoring program would result in more effective and efficient monitoring than the utilization of separate programs working without coordination. The development of a coordinated approach will benefit all parties involved in the effort to assess groundwater quality within the Central Valley.

2.2 Groundwater Quality Regional Monitoring Program Development

The San Joaquin Valley Drainage Authority (SJVDA, representing the Westside San Joaquin River Watershed Coalition) as well as other stakeholders realize the benefits of coordinating the many groundwater monitoring efforts in the Central Valley. In order to help develop a coordinated program, the SJVDA will work cooperatively with the CVRWQCB to develop a Groundwater Quality Regional Monitoring Program (GQRMP). The group will seek participation from other entities such as the State Water Resources Control Board (SWRCB), California Department of Water Resources (DWR), local SGMA Groundwater Sustainability Agencies (GSA), and other interested stakeholders to develop a coordinated groundwater monitoring approach. Several other stakeholders have expressed an interest in participating in such a program.

2.3 Groundwater Quality Regional Monitoring Program Group

The GQRMP Group will organize through a Memorandum of Understanding (MOU). The initial participants are expected to consist of several ILRP coalition groups as well as dairy interests and other dischargers. The CVRWQCB will be an important participant in the process. The Central Valley Salinity Coalition will also likely have a strong interest in joining the process. The Initial participants will engage other groups, including: SWRCB, DWR, local SGMA GSAs, stakeholders, and other regulated parties with an interest in groundwater quality. The MOU will be structured to allow new members to join as the program develops. Given the fact that SGMA GSA groups are in their initial development phases it is likely that GSAs will not have the capacity to join the GQRMP immediately. While the group recruits additional members, the initial group will begin working to develop a proposed monitoring approach.

2.4 Key Components of Program Development

The following key components are envisioned for program implementation:

1. Organize the initial Group, Meet, and Execute MOU
2. Refine Conceptual Approach
3. Develop GQRMP Workplan
4. Prepare Operational Workplan

These components are further described below.

2.4.1 GQRMP Organization and MOU

2.4.1.1 Organize Initial Group

Contacts with the potential partners will be initiated immediately to discuss participation in the GQRMP. Initial contacts will focus on dischargers to groundwater that are currently monitoring, or are required to develop groundwater monitoring programs. Additional contacts will be made with entities that currently monitor, or will need to monitor for groundwater depth and/or quality without a regulatory driver. These groups include newly forming GSAs and counties. The initial effort to contact interested entities will take approximately two months.

2.4.1.2 Conduct Initial Group Kickoff Meeting

This meeting will take place 2 months after CVRWQCB approval of the submittal of the GQRMP Preliminary Conceptual Approach. The kickoff meeting will introduce key program drivers including common monitoring requirements (e.g. frequency, constituents, groundwater elevation), costs of program development, timelines for the various programs including initiation of monitoring and program reporting schedules, availability of wells to meet the monitoring requirements, and reporting requirements of the various programs. The kickoff meeting will also identify any potential additional participants that should be contacted about their interest in joining the GQRMP, and include a discussion of the options for governance structure including voting, and financial commitments to the

Program. Initial discussions about technical and administrative assistance (if desired) will take place at this time resulting in an understanding of the schedule for contracting with consultants to assist the GQRMP. The schedule for upcoming meetings will be developed (e.g. quarterly, monthly).

2.4.1.3 Establish Governance Structure

Prior to finalizing the MOU, the interested entities will develop the framework for the governance of the GQRMP including options for interested entities that join in the future. A Chair (or Co-Chairs) will be nominated and elected by the member entities to initiate discussions with the CVRWQCB about Program progress, identification of potential consultants for technical and administrative assistance, and obtain the initial financial contributions to the Program.

2.4.1.4 Develop MOU

During the kickoff meeting, entities interested in pursuing the GQRMP will establish a subcommittee to develop a Memorandum of Understanding. The MOU will be circulated for signature by authorized officials of the interested entities. The MOU will be executed within four months after the kickoff meeting. A copy of the executed MOU will be provided to the CVRWQCB to demonstrate the interest in, and the commitment to further development of the GQRMP.

2.4.1.5 Outreach to Potential GQRMP Members

After the initial group of entities has signed the MOU, effort to identify and recruit additional entities involved in groundwater quality monitoring will continue. Entities that are required to monitor groundwater quality will be identified and contacted about their interest in participating in the GQRMP. Representatives of the newly forming GSAs are expected to be among the initial contacts although their need for groundwater quality monitoring is required but relatively undefined at this time. However, early participation will allow them to integrate the GQRMP into their planning process and provide a jumpstart to their monitoring program. Entities responsible for implementing the monitoring of groundwater oil fields will be contacted and discussions will be initiated to determine if a nexus exists between Oil Fields Monitoring Program requirements and the GQRMP.

2.4.1.6 Coordinating Meeting with Federal, State, and Local Agencies

An informational meeting will be coordinated with federal, state and local agencies (as applicable) with mandated groundwater quality monitoring programs such as the State Water Resources Control Board's Drinking Water Program, USGS Priority Basin Project, and DPRs pesticide groundwater monitoring program. The meeting would be held for the purpose of describing the overall goals and objectives of the GQRMP, including the intent to reduce redundancies among other monitoring programs, particularly those required for regulatory compliance, identify common monitoring objectives, and enhance coordination of regional groundwater monitoring efforts.

2.4.1.7 Meeting with Regional Board

When the Program is functioning, a meeting will be requested with the CVRWQCB to provide an update on GQRMP implementation, including member participation, program implementation steps and status,

and next steps. CVRWQCB input will be sought on program elements that involve close coordination with existing regulatory compliance programs to ensure the design of the GQRMP addresses these needs.

2.4.2 Refine Conceptual Approach

After initial GQRMP Group organization matters are addressed, the first activity of the GQRMP will be to refine a Conceptual Approach to monitoring groundwater quality in the Central Valley. The Group will evaluate existing programs' monitoring and planning efforts to help structure a general approach to implementing a coordinated Central Valley groundwater monitoring program. At this time, there are many options for the development of the GQRMP. Some example elements are described below. During the development of the GQRMP Workplan, the GQRMP Group will discuss strategies for the implementation of the GQRMP.

The GQRMP preliminary Conceptual Approach envisions:

- The GQRMP would use existing data developed from existing monitoring programs whenever possible.
- The GQRMP may involve additional monitoring needed, in certain parts of the GRQMP program area, to augment existing monitoring programs and accomplish program-specific objectives. GQRMP Group members (local/regional entities) may produce their own monitoring plan and perform their own monitoring (as needed); any data generated locally would be coordinated with data collected as part of other existing monitoring programs in order to streamline related monitoring efforts. GQRMP Group members may also coordinate as a group to accomplish any additional monitoring determined to be needed to augment existing monitoring programs and accomplish program-specific objectives.
- GQRMP data will need to be received, housed and maintained. These data would be utilized by GQRMP Group members in coordination with existing data to accomplish local and/or program-specific objectives (e.g., ILRP, SGMA, etc.). Many options are available for how data storage and analysis would occur; these will be examined during early stages of the GQRMP development.
- GQRMP Group members would coordinate data analysis and reporting to periodically summarize groundwater quality conditions and trends for ILRP and other purposes as appropriate.
- The manner in which the final monitoring design is expected to fulfill the compliance requirements of each of the participating entities, and the timetable for implementation.

Potential steps to further developing and refining the Conceptual Approach include (these would be confirmed, supplemented or modified by the Group):

1. Develop an inventory of existing monitoring efforts; examples include:
    - SWRCB's Geotracker Groundwater Ambient Monitoring and Assessment Program (GAMA)
    - SWRCB's GeoTracker database for regulated facilities

- ILRP trend monitoring program
- Dairy order monitoring program
- Oil fields monitoring program
- Recycled Water Policy and salt and nutrient monitoring program
- Department of Pesticide Regulations
- Local Salt and Nitrate Management Plans
- County and/or regional programs such as Integrated Regional Water Monitoring Plan (IRWMP), Groundwater Management Plan (GMP), future Groundwater Sustainability Agency (GSA) and Groundwater Sustainability Plans (GSPs)
- State Board Division of Drinking Water (required monitoring for community water systems)

2. Assess opportunities for coordination of existing monitoring programs (e.g., GAMA, ILRP, Dairy, IRWMP, GMP) and also future GSAs, including emphasis on the design of a network at the basin/subbasin scale that can be used to assess regional groundwater quality trends while factoring in data collected under the regulatory purview of site-specific discharges (e.g., POTWs, food processors, septic systems, etc.)
3. Identify monitoring network objectives and opportunities for coordinated monitoring to accomplish objectives
4. Identify scientific methods for identifying optimal horizontal and vertical distribution of observation points (wells that are/can be monitored), as a function of key factors such as land use, hydrogeology, and other vulnerability factors, while efficiently meeting identified objectives at the least cost.

Many of the considerations in developing the conceptual approach are anticipated to be informed by the work already completed during preparation of the Groundwater Quality Assessment Reports (GARs) per ILRP requirements, work completed by the CV-SALTS program and the hydrogeologic understanding that is a necessary element of future Groundwater Sustainability Plans (GSPs).

2.4.2.1 Develop the Schedule for Refining the Conceptual Approach

A draft conceptual approach will be provided to the GQRMP for review and comments, and a final GQRMP Conceptual Approach will be submitted to the Regional

Board within six months after execution of the MOU.

2.4.2.2 Conceptual Approach Technical Memorandum

Following meetings of the GQRMP, consideration of the above factors, and performance of steps needed to refine the Conceptual Approach, a Technical Memorandum will be prepared that describes the refined approach. This Technical Memorandum will be submitted to the CVRWQCB for review and comment six months from execution of the MOU.

2.4.3 Groundwater Quality Regional Monitoring Program Workplan and Operational Workplan

Once the refined Conceptual Approach is approved by the CVRWQCB, the group will focus on preparing a draft GQRMP Workplan. The draft GQRMP Workplan will contain the details of the monitoring design including the number and location of the wells to be monitored as well as the details about the organizational management and coordination among participating entities. The draft plan will be refined into an Operational Workplan. It is expected that the Operational Workplan will be a living document that will be revised and improved as knowledge is gained through the implementation process.

The draft GQRMP Workplan will address program elements such as:

- Coordination among monitoring programs: extent of monitoring coverage by existing programs, augmentation of monitoring coverage by GQRMP Group members
- Relationship between different programs' monitoring objectives
- GQRMP monitoring network design: spatial coverage, constituents, monitoring frequency, QA/QC
- Coordination of data storage and management: it is not intended that the GQRMP would address current processes for state and federal agency data storage and management; however, with input from the State Board and DWR, the GQRMP would assess the manner in which data collected by GQRMP Group members would be standardized (reporting units, etc.), stored and managed.
- Analysis and reporting: coordination between GQRMP Group member program needs (e.g., ILRP, GSPs, etc.) and a description of how data would be periodically assessed and reported to the CVRWQCB and others
- Funding mechanisms: description of how the ongoing GQRMP will be supported and maintained
- Compliance: description of process for addressing issues arising from insufficient implementation of the overall GQRMP

2.5 Proposed Schedule

The time frame for development of the GQRMP is very aggressive given the varied time schedules of the participating entities for developing their individual groundwater quality monitoring programs.

Following is a proposed schedule for the development of the program:

Milestone Description	Timeline
1. Initial Group Meeting	2 months from Board approval of GQRMP concept
2. Recruit Members; Execute MOU	6 months from Board approval of GQRMP concept
3. Refine Conceptual Approach	12 months from Board approval of GQRMP concept
4. Draft GQRMP Workplan	18 months from Board approval of GQRMP concept
5. GQRMP Operational Workplan	26 months from Board approval of GQRMP concept

2.6 Adaptive GQRMP

The GQRMP will provide guidance that assists Group members in developing a plan to track water quality conditions (i.e., improved, declined or remained stable) and describe actions to change the monitoring network and/or program as needed. In some cases, it may be in the Group member's best interest to increase the local monitoring network to determine more accurate local conditions.

The annual updating of the database will allow for the future analyses necessary to determine basin-wide trends and potentially re-prioritize basins or areas within the Central Valley and to be used for groundwater management purposes.

The development of a Central Valley Groundwater Quality Regional Monitoring Program will result in more efficient and effective assessment and protection of groundwater quality in the Valley. The result will be more useful data gathered over a shorter period of time at significantly less cost. The organizational effort spent now will serve the Central Valley for decades.

2.7 Interaction of Participating Entities and the CVRWQCB

Each of the participating entities will be responsible for providing the details of the Final Operational Workplan to the CVRWQCB and how participation in the GQRMP will lead to compliance with their individual discharge permit requirements.

2.8 Role of the CVRWQCB

The CVRWQCB is a critical partner in the development of the GQRMP. Input from the CVRWQCB throughout the GQRMP development process is essential to the development of an effective program and to meeting the aggressive timelines. The CVRWQCB can both encourage participation of dischargers required to implement groundwater trend monitoring programs and provide regulatory incentives in the form of interim deliverables, or the ability to implement their trend monitoring program in phases until a full program is developed. The CVRWQCB will also be the entity that reviews and approves the Workplans that are developed by the GQRMP.

3 Criteria for Monitoring Network and Program Design

Design of the GQTM program takes into account multiple considerations, including hydrogeologic conditions, groundwater quality characteristics, and land use that were evaluated and summarized in the GAR and used to prioritize areas for monitoring and management. It is advantageous for the GQTM to coordinate with ongoing monitoring and utilize existing wells to meet objectives of the GQTM. As described in Section 2, it is planned that the GQTM will closely coordinate with the development and implementation of the GQRMP. An overview of the considerations and criteria for the design of the GQTM with respect to the objectives of the program and requirements of the WDRs are discussed in the following section with expanded Workplan details provided in subsequent sections.

3.1 Monitoring Objectives

The primary objectives of the GQTM are:

1) *Determine current water quality conditions of groundwater relevant to irrigated agriculture;*
2) *Develop long-term groundwater quality information that can be used to evaluate the regional effects of irrigated agricultural practices and changes in agricultural practices;*
3) *Understand long-term temporal trends in regional groundwater quality, particularly as they relate to effects from irrigated agriculture on potential sources of drinking water for communities;*
4) *Evaluate groundwater quality conditions in the Coalition area, particularly in the HVA, and identify differences in water quality horizontally and vertically within the Coalition region;*
5) *Distinguish water quality changes associated with irrigated agriculture compared to other non-agricultural factors.*

The first two objectives of the GQTM are specified in the WDRs (Attachment B, Section C) and additional objectives were developed to inform design of the GQTM specific to the Westside San Joaquin River Watershed Coalition.

Characterization of the current groundwater quality conditions relevant to irrigated agriculture was previously accomplished as part of the GAR through the assembly and evaluation of extensive current and historical groundwater quality information for the Coalition region. Detailed documentation and summarization of the groundwater quality characterization for the Coalition region are contained within the GAR.

The GQTM places primary focus on establishing temporal trend monitoring of groundwater quality for the purposes of evaluating long-term regional effects of agricultural practices. Of particular focus are locations, and within vertical horizons, where groundwater represents a significant source of drinking water supply for communities within the Coalition region. Municipal and domestic water supplies represent an important beneficial use for groundwater in parts of the Coalition region and the protection of this beneficial use is a key goal of the ILRP. The GQTM will incorporate data collected from public supply wells as part of the monitoring program.

Implementation of the GQTM will further the understanding of long-term temporal trends in regional groundwater quality. The regional-scale and long-term trend monitoring program outlined in this Workplan Phase I involve establishing a system through which the groundwater quality within the Coalition region will be monitored on a long-term basis in order to evaluate regional temporal trends and their relationship with irrigated agriculture. In contrast to the Management Practice Evaluation Program (MPEP), which will track the response of groundwater to changing agriculture management practices at a local and site-specific scale, the intent of the GQTM is to evaluate long-term changes in groundwater quality conditions at a regional scale as they relate to aggregated effects of irrigated agriculture and changes in agricultural practices. The proposed GQTM has objectives, methods, and reporting elements that are consistent with and complement the GQMP and are coordinated with the GQRMP. Distinguishing groundwater quality trends related to irrigated agriculture from non-agricultural factors may involve other recommendations should this need arise.

3.2 Spatial Considerations

Various spatial considerations exist in designing the GQTM network. These considerations focus on where and how to representatively monitor groundwater quality trends relative to agricultural activities. Spatial factors relating to the GQTM design include delineation of areas to monitor and specific sites (wells) suitable for use in monitoring.

3.2.1 Prioritization of Monitoring Areas

As part of development of the GAR, the entire Coalition region was evaluated with respect to the vulnerability of groundwater to contamination. That assessment identified high vulnerability areas (HVAs) where physical conditions make groundwater more vulnerable to impacts from overlying land use activities. The spatial distribution of HVAs is shown on **Figure 1**. HVAs were prioritized in the GAR for the purpose of focusing management efforts related to agricultural practices. The prioritization of HVAs was based on multiple considerations relating to the intrinsic hydrogeologic characteristics that affect groundwater vulnerability, existing groundwater quality conditions, land use and associated agricultural practices, and other factors, including proximity to areas contributing recharge to communities reliant on groundwater. The prioritization system implemented in the GAR involved a quantitative method of weighting and ranking of factors as illustrated in **Table 2**. The calculated priority values derived from this system are illustrated in **Figure 2** and were used as the basis for identification of areas of focus for trend monitoring for the GQTM. As exhibited in **Table 2**, areas in proximity to and contributing recharge to communities reliant on groundwater were weighted highest in the prioritization of HVAs. A detailed description and discussion of the process for determination and prioritization of HVAs into Priority 1, 2 and 3 is included in the GAR. Lower vulnerability areas were not prioritized in the GAR. In identifying appropriate areas for trend monitoring, additional factors were also considered including the proximity and density of irrigated agriculture and potential for constituent transport both laterally and vertically.

The approach to monitoring for long-term regional groundwater quality trends in the GQTM emphasizes evaluation of trends in wells that are believed to provide a representation of regional trends in areas dominated by irrigated agriculture. The spatial distribution of the monitoring network across the

Coalition region will be variable based on the prioritization of HVAs. Areas of generally higher priority (in the HVAs identified in the GAR) will have more long-term trend monitoring locations than areas of relatively lower priority. Furthermore, areas of relatively lower vulnerability (those areas not identified as HVAs in the GAR) will have fewer trend monitoring locations because hydrogeologic conditions suggest these areas are less vulnerable to contamination. More detail relating to the GQTM design and approach are provided in **Section 4**.

3.2.2 Well and Aquifer Characteristics

Well characteristics (pumping rate and depth) and the aquifer properties in the area also are important considerations in understanding the appropriate spatial distribution and depth for monitoring of regional trends. Larger-capacity (higher pumping rates) wells such as irrigation wells and public water supply wells, provide a better representation of regional groundwater conditions because these wells have relatively larger groundwater capture zones drawing groundwater from a greater contributing area and minimizing the degree to which a well reflects highly localized groundwater conditions. Groundwater produced from large-capacity wells represents a composite of groundwater from within the larger well contributing area and changes in groundwater quality exhibited by such wells indicate effects on groundwater across the entire contributing area. Smaller-capacity wells will have a smaller capture zone and therefore will be representative of groundwater conditions within a smaller contributing area (i.e., local rather than regional conditions). Well depth is another key element relating to the contributing area for wells and potential time lag associated with groundwater quality observations. Together, these factors associated with the construction and operation of wells in conjunction with the aquifer properties comprise the primary criteria for evaluating the degree to which potential candidate wells are likely to represent regional groundwater quality trends. The characteristics of candidate well capture zones and depth zones and the land uses represented within the contributing area are critical elements in selection of wells for a regional monitoring program.

3.2.3 Staged Implementation

Monitoring conducted as part of the GQTM will be implemented in a staged approach using an initial network of wells selected in Phase II of the Workplan. Subsequent modifications to the monitoring network will be made as needed based on information acquired relating to the characteristics of potential monitoring well candidates and any identified need for additional monitoring of groundwater quality trends. An initial pool of potential candidate wells for monitoring are identified within Phase I of this Workplan. Only a subset of these wells will ultimately be selected for implementation of initial monitoring conducted as part of the GQTM, pending the outcome of the evaluation of well construction characteristics (e.g., well completion reports), the accessibility of wells and willing cooperation of well owners for inclusion in the monitoring program, and the desired spatial distribution and adequacy to provide the information needed to fulfill the objectives of the GQTM. Phase II of the Workplan development will involve investigating candidate wells to determine their suitability for inclusion in the GQTM network. A final list of monitoring network wells will be proposed in the Workplan Phase II. During the implementation of the GQTM, the need for additional monitoring locations will be assessed on an annual frequency as part of the annual evaluation and reporting of the trend monitoring results.

3.3 Well Construction Requirements

In accordance with the requirements specified in the WDRs, information relating to wells selected for inclusion as part of the GQTM will be submitted to the CVRWQCB as part of Phase II of the GQTM Workplan development prior to initiation of monitoring. As indicated above, details relating to the construction of wells included in the GQTM are highly important. These well information data will include the well location (GPS coordinates and physical address); State Well Number, if known; well construction details (total depth, top perforation depth, bottom perforation depth, as available); well drillers log (well completion report), if available; well seal information; and measured depth to water at the time of monitoring implementation. Because of limitations relating to the accessibility and availability of well construction records and the time required to review and coordinate with prospective monitoring network well owners, some of these required details have not yet been determined or acquired for candidate wells. Consequently, these data will be forthcoming in Workplan Phase II as wells selected for inclusion in the GQTM are confirmed and cooperative agreements with well owners are secured. Information relating to well details will be provided for wells selected for the trend monitoring. Required and optional well reporting information is listed by category in **Table 3**.

3.4 Field and Laboratory Methods

Wells selected for trend monitoring will be sampled and tested at an annual frequency for water quality parameters including nitrate as nitrogen (as N), electrical conductivity at 25 °C (EC), pH, dissolved oxygen (DO), and temperature. EC, pH, DO, and temperature will be measured in the field whereas nitrate concentration will be analyzed by a certified laboratory. Every five years, starting with the first monitoring event, wells selected for inclusion in the GQTM will be sampled and tested for additional water quality constituents including total dissolved solids (TDS), major anions (carbonate, bicarbonate, chloride, sulfate), and major cations (boron, calcium, sodium, magnesium, potassium). The testing parameters and monitoring frequency for the GQTM are outlined on **Table 4** and are in accordance with the requirements of the WDR. Although not required by the WDRs, additional potential water quality parameters including oxidation-reduction potential (ORP) and turbidity will be considered for testing when possible, pending the access to these data in cases where wells are being monitored through cooperative arrangements. Field and laboratory methods are described in the Groundwater QAPP.

4 Trend Monitoring Network Design

The GQTM design recognizes that a critical aspect of monitoring involves establishing a monitoring program that can evolve through time based on consideration of data derived through implementation of the program. Alley (1993) emphasizes this approach in describing the importance of a dynamically evolving design: "A characteristic of virtually all water-quality sampling programs is that knowledge is attained about a more efficient design after sampling is completed and the results are analyzed. For long-term studies, the anticipation that modifications may be made to the network at a future date favors the utilization of fairly simple designs at the outset."

4.1 Delineation of Monitoring Areas

The primary objective of the GQTM is to monitor long-term trends in regional groundwater quality as they relate to influences from irrigated agriculture and changes in agricultural practices at a regional scale. In designing the initial monitoring network for the GQTM, factors relating to the vulnerability of groundwater and prioritization of HVAs represent important considerations for focusing locations for groundwater monitoring. The HVAs represent areas where the intrinsic physical properties make groundwater more vulnerable to influences from overlying land use activities; the prioritization of the HVAs considers the relative vulnerability within the HVAs along with additional factors including existing groundwater quality conditions, land use, and other factors such as proximity to communities reliant on groundwater. The prioritization of HVAs conducted as part of the GAR represents the foundation for targeting areas for monitoring as part of the GQTM.

As outlined above and described in detail in the GAR, the prioritization of HVAs accounts for multiple factors of interest for planning of future monitoring and management efforts. The WDR (Attachment A, Section IV, B) identifies several factors to be considered in prioritizing high vulnerability areas, including:

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

In an effort to objectively incorporate the many factors identified for consideration as part of the prioritization, a numeric system of ranking and weighting of factors was utilized to calculate priority values across the entire HVA. **Table 2** summarizes the system used to prioritize HVAs. Key among the elements incorporated in the prioritization system are factors relating to intrinsic physical vulnerability, existing groundwater quality conditions and temporal trends, land use and associated agricultural

practices, and areas contributing recharge to communities reliant on groundwater, including disadvantaged communities.

As part of identifying the most beneficial and representative areas for groundwater quality trend monitoring, generalized areas of relatively higher and lower emphasis for monitoring will be identified from the priority calculations to inform the locations selected for groundwater trend monitoring. To produce a regional trend monitoring network with representative wells distributed throughout the Coalition region and to assist in identifying trend monitoring wells to fulfill the objectives of the GQTM, the Coalition region will be divided into monitoring subareas based on the vulnerability designation and prioritization of HVAs previously completed as part of the GAR. In delineating the monitoring areas, the prioritization scheme from the GAR will initially be used to subdivide the Coalition into monitoring subareas in general accordance with varying monitoring emphases:

1) HVA priority 1,
2) HVA priority 2,
3) HVA priority 3,
4) HVA priority 4, and
5) Lower vulnerability areas.

Monitoring subareas will be delineated to generalize the priority values calculated in the GAR and recognize different monitoring emphases and objectives in the GQTM. Consideration of other characteristics and conditions such as prevailing regional groundwater flow direction and extent and density of irrigated agriculture will also be given in the delineation of monitoring subareas. Delineation of the monitoring subareas focusses on areas within the Coalition region where irrigated agriculture represents a dominant land use. As a result, no GQTM monitoring is planned for the major non-agricultural areas within the Central Valley Floor of the Coalition region in the vicinities north of Los Banos and east of Gustine and also between Los Banos and Dos Palos, as presented in the GAR. Additionally, no GQTM monitoring is planned in peripheral areas of the Coalition region, outside of the Central Valley Floor. These areas are identified as lower vulnerability and have no or very little irrigated agriculture. Consequently, groundwater quality trend monitoring in these areas is not in alignment with the goals and objectives of the GQTM relating to regional influences from irrigated agriculture.

The proposed initial GQTM program consisting of wells to be identified as part of Phase II of the Workplan, will incorporate trend monitoring within each subarea, although the nature of this trend monitoring will vary in design depending on the monitoring objectives and prioritization for the subarea. With the development of the GQRMP, additional monitoring will be coordinated with cooperative entities to ensure that monitoring is conducted in a manner that is consistent with the objectives of the GQTM.

The size of subareas will be based on land use and hydrogeologic considerations. These delineations will consider factors associated with representative monitoring around disadvantaged communities (DUCs and DACs) and other communities.

The proposed approach to the initial trend monitoring network in the Westside Coalition region is anticipated to include about 10 to 15 wells to be monitored by the Coalition to augment ongoing monitoring being conducted by others, including monitoring of Public Water Supply (PWS) wells for DDW and other groundwater monitoring programs. The adequacy of the initially proposed monitoring well distribution and specific monitoring site selection will be reviewed in coordination with development of the GQRMP and subsequently on an annual basis through inspection and qualitative assessment of the time-series monitoring data. Initial review of time-series data will focus on wells with historical data records as additional data from the GQTM are developed. Further review of the monitoring program design and adequacy will occur in coordination with the GQRMP.

4.2 Selection of Monitoring Sites

Existing larger-capacity wells that are relatively shallow, but not completed in the zone of first-encountered groundwater, will be targeted as the main candidate monitoring wells for the GQTM. First-encountered groundwater is likely to reflect local conditions and influences rather than those at a regional-scale which are of interest in this program; therefore, monitoring within the zone of first-encountered groundwater is not an objective of the GQTM. Relatively shallow wells constructed below the zone of first-encountered groundwater are more likely to exhibit regional groundwater trends that are relevant to agricultural operations on a regional scale because of the greater potential for lateral and vertical constituent transport along longer flow paths with the increased depth. Groundwater produced from wells represents a composite of groundwater from within the well capture zone or contributing area and changes in groundwater quality exhibited in such wells indicate influences on groundwater across the entire contributing area. Therefore, in order to represent trends in regional groundwater conditions, larger-capacity (higher pumping rates) wells such as irrigation wells and public water supply wells, will be preferentially selected for inclusion in the GQTM network. Such wells have relatively larger groundwater captures zones drawing groundwater from more regional contributing areas and minimizing the degree to which selected monitoring wells reflect only localized groundwater conditions around a well. Relatively shallow higher-capacity wells completed below the zone of first-encountered groundwater are the preferred wells for inclusion in the GQTM, although relatively shallow lower-capacity wells such as domestic wells may also be considered for monitoring while recognizing the potential for differences in contributing areas for domestic wells when compared with production wells.

4.2.1 Candidate Well Identification Criteria

There are numerous considerations and criteria involved in identifying existing wells to utilize for regional trend monitoring. In accordance with the WDRs, required information for wells in the GQTM network include accurate locational information; well construction details including depth, perforated interval, and seal characteristics, and an accompanying DWR Well Completion Report, when available. **Table 3** outlines required information relating to GQTM network wells. The required criteria define important considerations in well selection, although additional criteria included in **Table 3** are also important factors for selection of wells. Some exceptions to these requirements will be considered with respect to known information associated with wells (e.g., well construction) recognizing that historical

water quality record and other factors associated with a well may make a well a particularly informative trend monitoring well.

4.2.1.1 Location

As described above, monitoring subareas were delineated to assist in targeting locations for regional trend monitoring. The locations of existing Coalition member District wells relative to the identified monitoring subareas provide the first indication of potential monitoring well candidates. The locations of known District production wells (irrigation or public supply) previously monitored for groundwater levels or quality were used as a starting point for identification of potential candidate GQTM network wells. Wells ultimately selected for inclusion in the GQTM network will require accurate and precise locational information in the form of GPS coordinates and a physical address, if appropriate. Determining an accurate location for wells being considered or selected for inclusion in the GQTM program will be conducted as part of the well vetting process which will occur prior to submitting Phase II of the GQTM Workplan.

4.2.1.2 Land Use

The location of wells relative to overlying land uses is also an important factor as it relates to the monitoring objectives of the GQTM and the groundwater conditions and influences reflected in a well. Groundwater quality measured in a well represents the combination of ambient groundwater conditions and influences from land uses present within the contributing recharge area to the well. Consequently, groundwater quality samples collected from wells will reflect both current and historical land uses as well as management practices implemented to reduce the leaching of nitrate to groundwater. Because the objective of the GQTM is to understand and monitor groundwater quality trends relevant to irrigated agriculture and regional changes in agricultural practices, the type of agricultural land around a well is an important consideration for selection of monitoring wells. The top agricultural categories make up the dominant fraction of agricultural land within the higher priority (Priority 1 and 2) areas as identified in the GAR and will be a focus for education and outreach with the goal of improving groundwater quality.

4.2.1.3 Construction

Characteristics related to the construction of wells are a highly important consideration in identification of wells suitable for use as part of the GQTM network. Knowledge of well construction characteristics is important for wells selected as part of the GQTM network. Important information relating to well construction include well depth, perforated interval (depth to the top and bottom of perforations), and seal depth and material. Some of these well details are available in public well databases; however, well details should be confirmed through association of a DWR Well Completion Reports with GQTM network wells, whenever possible, or through other reliable means as appropriate. As indicated in **Table 3**, important details related to well construction should be provided for selected network wells, whenever possible, although some exceptions to the requirements specified in the WDRs (**Table 3**) should be considered for wells with characteristics making them particularly beneficial trend monitoring wells (e.g., with long historical water quality record).

The objective of the GQTM is to monitor regional groundwater quality trends. Wells completed in the upper part of the groundwater system, but not necessarily the first-encountered groundwater, are more likely to reflect regional groundwater conditions that enables the evaluation of influences from land use practices occurring on the surface over the long term. The water table is very shallow in large parts of the Coalition region, especially within the central portion where the water table is less than 20 feet below the ground surface in many areas. In the adjoining subbasins to the east, Burow et al. (2008) found that groundwater in wells completed at the water table reflected groundwater generally less than five years old and sometimes less than one year old. Slightly deeper, but still relatively shallow, wells between approximately 100 and 200 feet deep, exhibited groundwater that was generally about 20 to 50 years old (Burow et al., 2008). The positive relationship between well depth and groundwater age observed by Burow et al. (2008) suggests the flowpaths and travel time for groundwater measured in wells increases with well depth and therefore deeper wells produce water from a larger area.

The Corcoran Clay is a notable fine-grained geologic unit present across most of the Central Valley Floor area of the Coalition region. Within the Coalition region the Corcoran Clay is mapped at depths between 150 feet and 300 feet with thicknesses typically greater than 50 feet across most of the Coalition region. Because of its considerable lateral and vertical extent and fine-grained texture (and resulting low hydraulic conductivity), it is believed to present a significant barrier to vertical movement of groundwater and separates the Upper and Lower Aquifer zones within the area. Data provided by DWR (personal communication) for areas directly north of the Coalition region and from professional experience relating to wells and groundwater conditions within the Coalition region suggest that many of the wells (domestic, irrigation, and public supply) across the Coalition region are perforated within the Upper Aquifer, especially in the central and southern parts (LSCE and LWA, 2016).

During the implementation of initial monitoring within the Westside Coalition, relatively larger-capacity wells with perforated intervals within the Upper Aquifer and spanning the zone of relatively shallow groundwater, but not first encountered groundwater, will be targeted for inclusion in the GQTM network. Such wells will provide a representation of groundwater within the upper part of the aquifer system at depths which are also consistent with the primary zone of production for groundwater supply for most of the Coalition region. These wells are more likely to have contributing areas that represent regional conditions and enable long-term monitoring of groundwater quality trends relevant to irrigated agriculture at an aggregated scale as opposed to site-specific scale. Although wells with longer perforated intervals extending to greater depth may produce a small fraction of older water from deeper zones, a dominant fraction of water produced by wells perforated across the Upper Aquifer is likely to be relatively young (<60 years) because of the higher productivity of shallower coarse-grained aquifer materials throughout much of the Coalition region. This is consistent with observations made by others for wells in the area (Burow et al., 2008; Landon et al., 2010; Shelton et al., 2013). For the purposes of monitoring of relative changes in groundwater quality related to irrigated agriculture, some wells of deeper construction may be considered as long as the well construction does not exclude water from the upper part of the aquifer system.

4.2.1.4 Historical Water Quality Record

The existence and duration of historical water quality data are important factors in considering candidate trend monitoring wells because such data provide a foundation with which to evaluate long-term trends in concentrations especially as they relate to legacy conditions and changing trends and concentrations resulting from agricultural practices. Primary considerations relating to the historical water quality record for a well consist of the time period (range of dates) and the total number of available water quality results. For the purpose of identifying potential candidate monitoring wells, the availability of historical nitrate and TDS concentration data are considered because these parameters are useful indicators of influences from irrigated agriculture and because they are more widely available than many other water quality parameters.

4.2.1.5 Monitoring Status

Cooperative opportunities with ongoing monitoring already being conducted by others is another important consideration in design of the GQTM and is the basis and rationale for the proposed GQRMP approach. Existing monitoring activities by other entities provide an opportunity to incorporate monitoring locations with more extensive historical water quality data to enable a better understanding of long-term groundwater quality trends. In accordance with the intent of the GQRMP, utilizing monitoring by others also minimizes unnecessary redundancy in groundwater monitoring, resulting in reduced overall cost of the GQTM or the monitoring being conducted by cooperating entities, which potentially allows the Coalition and other cooperating entities to direct additional resources towards addressing and implementing improvements across other elements of the ILRP or other groundwater management programs.

Recent and/or ongoing monitoring of wells is a helpful indicator of wells that are potentially available and accessible for monitoring as part of the GQTM. Wells throughout the Coalition region have historically been monitored for groundwater quality by various entities including Coalition member districts, municipalities and public water systems, and governmental entities such as the USGS, DWR, DPR, and counties. Monitoring entities that have conducted recent groundwater quality monitoring are summarized in the GAR. Numerous wells recently monitored for groundwater quality are dispersed across much of the Coalition region as shown in **Figure 3**. The suitability of wells being monitored by others for inclusion in the GQTM network, through evaluation of the nature of ongoing monitoring efforts and potential for a cooperative arrangement with the Coalition as part of the GQTM, will be assessed individually for candidate wells as part of Phase II of the Workplan. Wells monitored by Coalition member districts represent potential candidate wells for the initial GQTM network.

4.2.1.6 Identification of Candidate GQTM Network Wells

To determine their potential suitability as wells for monitoring as part of the GQTM, all known locations for wells monitored for groundwater quality (candidate monitoring wells) will be evaluated with respect to their individual characteristics. The initial evaluation of candidate GQTM network wells will focus on Coalition member district wells and public water supply wells with known perforated intervals in the

Upper Aquifer. The preliminary assessment of candidate wells as part of the Workplan Phase II will include the following:

- Type of agricultural land within a specified distance of the well;
- Availability of well construction information and interpreted aquifer zone;
- Well type;
- Length of the historical period of record for nitrate and TDS tests;
- Recent historical groundwater quality data availability; and
- The number of historical water quality sample events for the well.

Figure 3 shows the initial candidate wells historically monitored by Coalition member districts and public water suppliers. As part of Workplan Phase II, these candidate wells will be evaluated for potential consideration as part of the GQTM network. Before including a well in the GQTM network, additional investigation of candidate wells must be also be undertaken to confirm and evaluate location, condition, construction, accessibility, and other details that should be accounted for in determining the suitability for inclusion in the GQTM network. The number of wells included in the initial group of GQTM network wells has not been defined although it is anticipated to be between 10 and 15 wells. The initial GQTM network wells will augment ongoing monitoring currently being conducted by others, including monitoring data collected for PWS wells, and will eventually become part of the Central Valley wide coordinated efforts of the GQRMP. Many of the public water supply wells represent the longest historical periods of record for groundwater quality data. These wells potentially represent the most meaningful monitoring sites for understanding regional and long-term trends in groundwater quality.

4.2.1.7 Vetting of Candidate Wells

As mentioned above, a process of vetting candidate wells to identify suitable wells for inclusion in the GQTM network will be conducted during development of Phase II of the Workplan. This vetting process will include confirming individual well location and existence, evaluating well construction information through review of a DWR Well Completion Report or other comparable documentation of the well construction, determining well accessibility and means of collecting groundwater quality samples and water level measurements, and acquiring permission, as necessary, for inclusion of the well in the GQTM network. Exploration of coordination opportunities with other monitoring entities regarding currently monitored wells will also be conducted as part of the GQRMP development. Information obtained through evaluation of coordinating opportunities will ensure that the well location and construction and monitoring activities (timing, frequency, measurements) are sufficient to satisfy the objectives and design of the GQTM. Complete vetting of wells for the GQRMP will be a considerable undertaking and will require access to information that may only be available through data sources maintained by the coordinating entities and well owners. In many cases, a site visit may also be required to determine if a well satisfies the criteria for use in the GQTM network or other monitoring program. The complete list and details relating to proposed wells for the initial Westside GQTM monitoring network will be included in the GQTM Workplan Phase II. Finalization of wells to be included in the GQRMP will be completed in accordance with the GQRMP Workplan to be developed at a later date.

4.2.2 Rationale for Specific Site Selection and Monitoring Network Design

During the evaluation of initial GQTM candidate wells described above, specific characteristics of Coalition member district wells will be further evaluated as part of Phase II of the Workplan. However, regional conditions and characteristics as they relate to well locations are also an important consideration in selection of the initial GQTM network wells.

4.2.2.1 Site Selection Considerations

Factors related to hydrogeologic and land use conditions will be incorporated in the process of delineating monitoring subareas, as discussed above. The intent of defining subareas is to focus monitoring efforts to ensure regional representation of groundwater quality trends by the GQTM. The delineation of the monitoring subareas will consider conditions related to the hydrogeologic vulnerability of groundwater, land use composition and practices, existing groundwater quality conditions and trends, and regional groundwater gradient in relation to communities reliant on groundwater, all of which are factors used during the prioritization process for the GAR. However, it is important to also evaluate specific well locations with respect to additional regional hydrologic conditions such as regional groundwater flow conditions and flowpaths. These specific details will also be evaluated as they relate to potential candidate wells within monitoring subareas to ensure that wells selected for the GQTM network help fulfill objectives specific to the monitoring subarea and the overall GQTM. Concurrent consideration of well and land use characteristics, hydrogeologic conditions, historical data record, and other factors listed in **Table 2** will be important in selecting initial monitoring sites. This approach is more appropriate than a random network design because it will focus monitoring effort in areas where impacts from agricultural activities are more likely to manifest in the groundwater because of physical conditions or land use conditions or where there is a heightened interest in monitoring because of the greater reliance on groundwater for beneficial uses. Furthermore, the initial GQTM network wells will be selected with consideration to additional monitoring objectives of the GQRMP.

4.2.2.2 Monitoring Representation

In addition to site-selection considerations, wells included in the GQTM network should also provide a representative indication of groundwater conditions within delineated monitoring subareas. Larger-capacity wells are more likely to represent regional groundwater conditions and trends that are the focus of the GQTM. Large contributing areas are suggested by basic hydrologic analytical modeling using groundwater flow equations under different scenarios of well operation (pumping capacity and duration) and aquifer properties and configuration (hydraulic conductivity, specific storage, saturated thickness).

Public supply wells and irrigation wells which tend to pump higher volumes of water are the preferred well type for the GQTM network because they are more likely to indicate regional conditions and trends in groundwater quality. Such wells completed in the upper part of the aquifer system are likely to provide more regional representation of groundwater quality within a time frame that enables the evaluation of trends in groundwater quality resulting from changes in past and current land use

practices. To further ensure that wells selected for the initial GQTM network provide reasonable indications of regional trends, the degree to which the land use composition within the vicinity of wells represents regional land uses and top agricultural land uses will also be considered.

4.2.2.3 Stage Implementation

Initial monitoring will utilize existing Coalition member district wells identified to meet required criteria for the GQTM network while development of the GQRMP is conducted. Identification and vetting of potential initial GQTM network wells will focus on higher priority monitoring subareas. A timeline for implementation of the GQTM is discussed in **Section 6** of this Workplan. Scheduling details relating to the timing of monitoring will be provided as part of Phase II of the Workplan. Upon implementation of trend monitoring, the spatial representation and sufficiency of the GQTM network will be evaluated on an annual basis with respect to the objectives of the program and recommendations regarding potential additional wells or elimination or substitution of wells will be provided. The adequacy of the initially proposed monitoring well distribution and specific monitoring site selection will be reviewed in coordination with development of the GQRMP and subsequently on an annual basis through inspection and qualitative assessment of the time-series monitoring data. Initial review of time-series data will focus on wells with historical data records as additional data from the GQTM are developed.

4.3 Groundwater Quality Sampling

Wells selected for inclusion in the initial GQTM network will be sampled on an annual interval for select water quality parameters and will also be sampled every five years for a more extensive set of parameters. **Table 4** summarizes the testing and analyses to be conducted and the frequency of testing for each water quality parameter.

4.3.1 Groundwater Quality Analyses

4.3.1.1 Annual Sampling

Annual monitoring of GQTM network wells will include sampling and laboratory analysis of nitrate concentration in well water. Nitrate concentrations will be reported in units of milligrams per liter (mg/L) as nitrogen. Additional measurement of select water quality parameters will take place in the field at the time of sampling. Field parameters that should be measured at an annual frequency include electrical conductivity at 25 °C (EC) in µS/cm, pH, temperature (in °C), and dissolved oxygen (DO) in mg/L. The annual testing of wells for these water quality parameters is consistent with sampling requirements specified in the WDRs, as summarized in **Table 4**. Additional field testing for oxidation-reduction potential (ORP or redox potential) may provide information relating to the groundwater quality that is helpful in understanding existing influences on groundwater quality from agricultural operations and potential for future impacts that may impact beneficial uses. Field turbidity in sampled water may indicate issues associated with the sample collection (suspended solids) or other characteristics of the water being tested that may affect the results of laboratory analyses. Although not required by the WDRs, field testing of samples for ORP and turbidity, when possible through coordination with monitoring entities or through sampling by the Coalition, will be included in the

annual testing procedures. Public water supply wells represent additional ongoing monitoring wells throughout the Coalition region. Although public supply wells are not envisioned for inclusion as initial GQTM network wells, continued monitoring of these wells will be performed by the water supply system operators in accordance with Division of Drinking Water (DDW) requirements. Although the annual sampling of the initial GQTM network wells conducted by the Coalition will include collection of the field parameters identified above, monitoring of additional wells by other monitoring entities may not include testing of all of the identified field parameters.

4.3.1.2 Every Five Years

Every five years GQTM network wells will be tested for a more extensive set of groundwater quality constituents in addition to the laboratory and field water quality parameters included as part of the annual testing. The constituents to be tested for and analyzed in a laboratory every five years include total dissolved solids (TDS) and major cations such as boron, calcium, sodium, magnesium, and potassium and anions including carbonate, bicarbonate, chloride, and sulfate (**Table 4**). Results from analyses of cations and anions will be reported in mg/L. Groundwater quality testing in additional wells monitored by others may not align exactly with the frequency of testing for all water quality parameters specified in the WDRs, although coordination efforts with cooperating monitoring entities will focus on establishing a testing program that is consistent and compatible with the monitoring objectives for the GQTM.

4.3.2 Network Well Sampling Protocols and Procedures

Sampling of wells as part of the trend monitoring network should follow established protocols and procedures relating to sample timing, well purging, sample collection and handling, and field observations and measurements, to the extent possible, as outlined in the standard operating procedures (SOP).

4.3.2.1 Timing

Consistent timing of sampling of GQTM network wells (to the extent possible) will be coordinated taking into consideration the timing of existing ongoing monitoring by others, timing of historical monitoring of network wells and other wells in the Coalition region, and the seasonality of hydrologic conditions and influences from irrigated agriculture. The approximate timing of sampling is likely to be either in the spring or fall seasons and will be constrained within a designated range of months to ensure temporal consistency.

4.3.2.2 Sample Collection

Wells will be sampled in accordance with the Groundwater QAPP (Summers Engineering, 2016). Wells will be appropriately purged in accordance with their type and operational history to ensure that a representative groundwater sample is collected from the well. Wells will be purged for a sufficient time to evacuate water held in casing storage before collecting the water sample. This is important to ensure that water collected from a well is representative of groundwater in the aquifer formation outside the well bore. If possible, three casing volumes will be purged from the well prior to sample collection.

Larger-capacity wells may not need purging (or may need more pumping) depending on their operational history. For smaller-capacity wells, such as domestic wells, achieving a three-casing volume purge may not be practical because of operational constraints relating to the well and water distribution system. For domestic wells currently in operation, lengthy purging may not be necessary because wells used for domestic supply typically experience frequent and short pumping cycles that serve the same purpose as purging. In cases where a three-casing volume purge is not achievable, field parameters (EC, pH, temperature, etc.) of the water will be monitored during pumping/purging and a sample will not be collected until the field parameters have sufficiently stabilized in accordance with the sampling SOP.

Well water samples will be collected from a point in the distribution system as near to the wellhead as possible and prior to any filtration or pressure tank, if possible. Water samples collected for laboratory analytical testing will be collected in appropriate laboratory-provided sample containers and stored on ice or in accordance with recommended sample handling procedures indicated by the laboratory and established in the Groundwater QAPP. The sample identification, time, date, and any other informational fields indicated on the sample container label will be clearly provided. The associated laboratory chain of custody for samples will be completed and signed and provided with the samples at the time of delivery of samples to the laboratory for analysis. It is important to verify that sample holding times are not exceeded.

4.3.3 Field Observations and Measurements

Prior to sampling of a well, the depth to the water in the well will be measured, if possible, and recorded. It may not be possible to measure the water level due to wellhead accessibility or because the well is actively pumping. The well operational status prior to and at the time of sampling will be noted and any other observations at a well site that may potentially relate to the well or groundwater sampling will be described. Field water quality parameters including EC, pH, temperature, and DO, and possibly ORP and turbidity, will be tested during sampling; field parameters should be stable prior to collecting a well water sample. Field parameters will be monitored and recorded at least three times during well pumping/purging. Observed characteristics of the water during sampling such as color, smell, or other visual observations will be documented, if possible. All instruments used to measure field conditions during sampling will be calibrated on a regular basis in accordance with manufacturer guidelines and recommendations or otherwise established in the Groundwater QAPP.

4.3.4 Quality Assurance/Quality Control Protocols and Procedures

To ensure the quality and consistency of data collected as part of the GQTM, specific protocols and procedures relating to well sampling and analytical testing will be adhered to in accordance with the Groundwater QAPP (Summers Engineering, 2016). Data assembled by the Coalition as part of the GQTM will be evaluated through a quality assurance/quality control (QA/QC) procedure involving review of results and data formatting to verify reasonableness and accuracy. Analytical and field data collected by the Coalition through sampling of wells will be evaluated with respect to laboratory and analytical QA/QC metrics. Data collected by others and incorporated as part of the GQTM will undergo a more general QA/QC review to identify potentially erroneous data. More details regarding the QA/QC of

GQTM data are included in the QAPP. Adherence to procedures that are aligned with the established protocols and procedures in the SOP and QAPP will be emphasized as part of coordination with cooperating monitoring entities collecting additional groundwater quality data within the Coalition region.

4.3.5 Data Management

Data generated or acquired as part of the GQTM will be assembled within a data management system to facilitate organization, analysis, and display of the data and to assist the Coalition with meeting objectives of the GQMP. All wells in the data system will be attributed with a unique well identification (ID) and information associated with wells, such as well characteristics and historical hydrologic observations, will be compiled and maintained within the data management system. The structure of the data management system will be compatible with geographic information systems (GIS) and other data formats and will also facilitate submittal of the GQTM data to the CVRWQCB via uploading of data to Geotracker or otherwise providing the data in accordance with the WDRs.

5 Reporting

5.1 Report Content

Reporting of results of the GQTM will be provided on an annual basis in accordance with the WDRs. The annual reporting will consist of increased compilation and analysis of results as part of the GAR update. Reporting elements for the annual reporting and reporting as part of GAR updates are shown in **Table 5**.

5.1.1 Annual Report

Annual reporting of results related to the GQTM will focus on visual and tabular presentation of data with limited representation of data interpretation. Additional interpretations and conclusions relating to trends and relationships in trends will be conducted as part of reporting for the GAR update. The GQTM network will be reviewed and recommendations for modifications will be provided as needed.

Annual reports will include a map or maps of the wells sampled and monitored as part of the GQTM network. Results from sampling will be provided in a tabulated format consisting of a summary of the results using statistics such as recent, minimum, maximum, and mean result, in addition to a table providing all field and analytical results. Visual presentation of results with some limited interpretation will be provided in the form of maps of patterns in groundwater quality within the aquifer system. These maps will separately present water quality patterns within the shallower part of the aquifer system and patterns in deeper parts of the aquifer system based on observed groundwater quality in the GQTM network wells. These maps are envisioned to be in the form of color gradient maps or similar displays intended to illustrate observed groundwater quality in GQTM network wells.

Graphs of time-series groundwater quality data for all of the wells in the GQTM network will be included in the annual reports. Time-series graphs will include all available historical water quality data relevant to potential influences from irrigated agriculture for network wells, including data that pre-date the GQTM. Finally, groundwater level contours and other representations of groundwater levels within select areas of the Coalition region, as applicable and appropriate relative to the regional monitoring network design, will be generated and provided as part of the annual report. Groundwater level data will be presented as depth to water and groundwater elevation to inform hydrogeologic understanding of areas with shallow groundwater and also regional groundwater flow directions.

5.1.2 GAR UPDATE

Reporting related to the GQTM will include more extensive analysis as part of the GAR update. The more extensive analysis will include all elements in the annual report, as described above, with the additional analyses and presentations.

5.2 Report Discussion

The annual report and the GAR update will include discussion of results and findings from the GQTM. As described above, the annual report will focus on graphical and tabulated presentation of monitoring results. The GAR update will incorporate additional data acquisition beyond the sample data collected

from GQTM network wells and these data will be 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 will be the focus of discussion in the GAR update. A discussion of findings related to data gaps will be included and recommendations regarding addressing data gaps will be provided. The need for refinements to the GQTM design will be assessed and discussed in the report and associated recommendations on modifications to the program design will be provided. Recommendations will be made to improve coordination of the GQTM design with education and outreach efforts being conducted by the Coalition as part of their GQMP.

5.3 Schedule and Report Submittal

Annual reporting of GQTM results and interpretations will be submitted electronically in accordance with requirements specified in the WDRs. Annual reporting will include data submittals to Geotracker in combination with other report submittals. Implementation of the GQTM will be done in stages as suitable wells are identified and incorporated into the GQTM network. Because of limitations in access to available well construction information and time required to appropriately investigate potential wells for trend monitoring, initial monitoring will utilize existing wells identified to meet required criteria for the GQTM while additional network wells are identified. Identification and vetting of potential network wells will focus initially on higher priority monitoring subareas. The timing of the initial monitoring will largely be governed by the timing of coordination and sampling agreements.

6 Workplan Phase II – Determination of Specific Wells for GQTM

Following submittal of this Workplan Phase I, the Coalition will undertake activities related to completion of the Workplan Phase II and implementation of the Westside Coalition GQTM network. Workplan Phase II efforts will focus on the work needed to select the wells that will compose the initial GQTM network. Outreach and Coordination with CVRWQCB

Prior to actual monitoring network well selection, the Coalition will be informing its member districts of the GQTM process and the potential for recruitment of member districts' wells for inclusion in the program in some areas. Additionally, the Coalition will plan to meet with the CVRWQCB to receive feedback on the Workplan Phase I – Monitoring Design Approach.

6.1 GQTM Well Selection

The Phase II well selection process involves vetting the candidate wells identified in Phase I to ensure that the required criteria specified in the WDRs (e.g., well construction, location coordinates, etc.) and additional objectives associated with coordinating monitoring programs are satisfied. Some wells to be used as part of the GQRMP may already have a long period of record and because the existing monitoring entity may have its own program and set of routine constituents that are regularly monitored, there may be some parameters (particularly field parameters) that may not be monitored at these locations. The Coalition will coordinate with existing monitoring entities to ensure that the arrangement is mutually beneficial to various parties relying on the data collected for the GQRMP.

The Phase II selection process also entails site visits and setting up coordination agreements with the authorized party. Once it is determined which wells are suitable for inclusion in the GQTM network, Phase II of the Workplan will be completed and submitted to the CVRWQCB. **Figure 4** indicates the timelines accompanying the Phase II well selection process, completion of the Workplan Phase II, and implementation of the monitoring program. It is proposed that a two-month period be allotted for CVRWQCB review of the Workplan Phase I. Concurrent with the CVRWQCB review of Workplan Phase I, the Coalition will begin implementing initial steps for Phase II. The proposed deadline for submittal of the Workplan Phase II to the CVRWQCB, including the selection of the wells to be monitored, will be implemented on approval of Workplan Phase I.

6.2 Proposed Monitoring and Reporting Schedule

The Coalition's WDRs require an Annual Monitoring Report be submitted on November 30 of each year with a data submittal on June 30. The June 30 data submittal will include data collected for the prior water year, from October 1 to September 30. Since groundwater trend monitoring is not planned to begin until the Phase I and Phase II GQTM Workplans have been approved, the November 30, 2017 report will include at least a status report on the implementation of the GQTM program (i.e., the selected network, wells sampled and/or about to be sampled, and other pertinent information).

7 Future Design Considerations

A fundamental element of the GQTM is the initiation of the monitoring program with ongoing review and assessment of trend monitoring data and consideration of results in relation to the GQTM design.

7.1 Adaptive Phasing and Modification

Design of the GQTM and selected network wells is intended to be dynamic and closely coordinated with the implementation of the GQRMP. The GQTM Workplan approach envisions a process for revisiting and modifying design elements to address evolving questions relevant to the trend monitoring program. This is an important part of long-term water quality monitoring programs (Alley, 1993). The initial design and implementation of the GQTM will be reviewed during the course of annual reporting and analysis of results of the GQTM. This review will assess the adequacy of the GQTM network and design to meet the objectives of the program. An initial period of baseline GQTM data collection will be required before meaningful conclusions can be developed regarding the adequacy of the GQTM design. Emphasis will be placed on the review of regional groundwater quality trends, as evaluated in coordination with the GQRMP, to identify temporal or spatial data gaps that warrant addressing through modification of the GQTM design. Specific attention will focus on the adequacy of monitoring in areas where the direction and magnitude of temporal trends in groundwater quality suggest a consistent pattern that is likely to be attributable to influences from irrigated agriculture.

7.2 Coordination

The GQTM will benefit from cooperation and coordination with monitoring entities and stakeholders throughout the Coalition and also at the greater regional scale of the GQRMP. Coordinated efforts related to data sharing will benefit the GQTM and the ILRP. Data sharing will minimize unnecessary redundancy in groundwater monitoring efforts within the Coalition region, keep stakeholders informed of groundwater quality conditions and trends, and enable a better understanding of relationships between land use practices and groundwater quality conditions.

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TABLES

TABLE 1
Groundwater Quality Trend Monitoring (GQTM) Workplan Items Identified in WDRs

GQTM Workplan Items Identified in Monitoring and Reporting Program (Appendix B) of the WDR General Order	Where Addressed		How Addressed
	GQTM Workplan Phase I	*GQTM Workplan Phase II/ GQRMP Workplan*	
1. Workplan Approach			
Discussion of the rationale for the number of proposed wells to be monitored and their locations	X	x	Workplan Phase I: Rationale monitoring approach, guidelines for target well depth, and proposed monitoring emphasis and approach based on numerous factors considered in GAR prioritization; initial candidate wells identified considering additional factors Workplan Phase II/GQRMP Workplan: Specific site selection depending on candidate well vetting process
A. Consideration of variety of agricultural commodities produced within the third-party's boundaries	X	x	
B. Consideration of conditions discussed/identified in the GAR related to the vulnerability prioritization	X	x	
C. Consideration of areas identified in GAR as contributing significant recharge to urban and rural communities where groundwater serves as a significant source of supply	X	x	
2. Well Details			
Details for well proposed for trend monitoring		X	Workplan Phase II/GQRMP Workplan: Vetting of candidate wells and selection of wells for monitoring network
A. GPS coordinates		X	
B. Physical address of the property on which the well is situated (if available)		X	
C. California State well number (if known)		X	
D. Well depth		X	
E. Top and bottom perforation depths		X	
F. Copy of DWR Well Completion Report (water well drillers log), if available		X	
G. Depth of standing water (static water level), if available (may be obtained after implementing program)		X	
H. Well seal information (type of material, length of seal)		X	
3. Proposed Sampling Schedule			
Trend monitoring wells to be sampled, at a minimum, annually at the same time of year for indicator parameters (parameters identified in Table 3 of WDRs, Att. B).	X	X	Workplan Phase I: Proposed approach and initial GQTM network well selection considers prioritization and ongoing monitoring by others Workplan Phase II/GQRMP Workplan: Specific timing of sampling to depend on vetting of wells and determined in conjunction with existing monitoring by others; timing associated with monitoring implementation
4. Workplan Implementation and Analysis			
Proposed methods to be used to evaluate trends in the groundwater monitoring data over time.	X	X	Workplan Phase I: Discussion of methods proposed to present results and evaluate temporal trends and spatial patterns in trends Workplan Phase II/GQRMP Workplan: Completion of monitoring network design; finalize monitoring and reporting schedule

Table 2
Matrix for Prioritization of Westside High Vulnerability Area

Prioritization Component Category	Prioritization Component Identified in the Order (Att. B)	Description of Component Used in Prioritization Method	Ranking Factors		Component Weighting	
			Ranking Metric	Range of Ranking	Percent	Comments
Hydrogeologic Groundwater Vulnerability	Additional component not directly specified in order for prioritization purposes	**Soil Vulnerability** Includes ranking of the vulnerability based on soil hydraulic conductivity.	Soil drainage class	0 to 10 (low to high) based on soil drainage class; (drainage class: very poorly drained=0, poorly drained=2, somewhat poorly drained=4, moderately well drained=6, well drained=8, somewhat excessively drained=9, excessively drained=10)	7.5%	High - Collectively represents weighting of importance of hydrogeologic characteristics
		Subsurface Sediment Vulnerability Includes ranking of the vulnerability based on subsurface sediment texture.	Average percentage of coarse sediments indicated for the upper 200 feet, based on CVHM sediment texture model	0 to 10 (low to high) based on average percent coarse for 0 to 200 feet (AVG PC 0-200); 5 (neutral) for locations outside Central Valley Floor; (AVG PC 0-200: <30 = 0, 30-35=1, 35-40=2, 40-45=3, 45-50=4, 50-55=5, 55-60=6, 60-65=7, 65-70=8, 70-75=9, >75=10)	7.5%	
Existing Groundwater Quality Conditions	Legacy or ambient conditions of the groundwater.	**Observed Groundwater Quality Concentrations** Includes an evaluation and ranking of areas based on recent observed groundwater NO3 concentrations.	Average concentration for location based on wells within 1/2 mile	0 to 10 (low to high) based on average concentration; 5 (neutral) for locations without any concentration data within 1/2 mile; (NO3 [mg/L as N]: <1=0, 1-2=1, 2-3=2, 3-4=3, 4-5=4, 5-6=5, 6-7=6, 7-8=7, 8-9=8, 9-10=9, >10=10)	15%	High
		Temporal Trend in Groundwater Quality Includes evaluation and ranking of areas based on recent trend (degrading, improving, etc.) in groundwater NO3 concentration.	Average trend for location based on wells within 1/2 mile	0 to 10 (low to high) based on average water quality trend; 5 (neutral) for locations without any trend data within 1/2 mile (mg/L/yr: <-1=0, -1--0.5=1, -0.5--0.1=2, -0.1-0.1=5, 0.1-0.5=8, 0.5-1=9, >1=10)	10%	Moderate
	Identified exceedances of water quality objectives for which agricultural waste discharges are the cause, or a contributing source.	**MCL Exceedances** Includes evaluation and ranking of areas according to presence/absence of NO3 concentrations observations that are above the drinking water MCL.	Distance from nearest NO3 MCL Exceedance	0 to 10 (low to high) inversely related to distance from nearest NO3 exceedance; 5 (neutral) for locations without any WQ observations within specified distance; (miles: >2=0, 1.5-2=2, 1-1.5=4, 0.5-1=6, 0.25-0.5=8, <0.25=10)	2.5%	Low - weighting is low to avoid double-counting since measured concentration is considered in ambient water quality component
	Identified constituents of concern.	**Pesticide Detections** Includes evaluation and ranking of areas based on presence/absence of detectable concentrations of pesticides in groundwater samples.	Percent of wells with a pesticide detection within a section	0 to 10 (low to high) based on percent of wells with a pesticide detection; 5 (neutral) for sections without any pesticide observations; (percent: 0%=0, 0.1-10%=2, 10-20%=4, 20-30%=6, 30-40%=8, >40=10)	2.5%	Low - Pesticide detection data from DPR are at coarse spatial accuracy
Land Use	Existing field or operational practices identified to be associated with irrigated agriculture water discharges that are the cause, or a contributing source.	**Typical Nitrogen Application Rate** Includes evaluation and ranking of areas based on typical nitrogen application rates for land uses (Rosenstock and others, 2013; Viers and others, 2012) using 2013 USDA land use designation.	Typical nitrogen application rate for land use	0 to 10 based on typical nitrogen application rate; (lbs/ac/yr: <50=0, 50-100=3, 100-150=7, >150=10)	7.5%	Low-Moderate
		Typical Irrigation Method Includes ranking of areas based on typical irrigation method for land uses (using 2013 USDA land use designation) in accordance with irrigation method statistics derived from circa-2000s DWR land use survey irrigation method data.	Typical irrigation method for land use	0 to 10 based on typical irrigation method; (micro=3, sprinkler=6, gravity=10)	12.5%	Moderate-High
	The largest acreage commodity types comprising up to at least 80% of the irrigated agricultural acreage in the Coalition region and the irrigation and fertilization practices employed by these commodities.	**Top Commodities** Includes evaluation and ranking of areas based on percent of land area that is of a land use category comprising 80% of the irrigated acreage within Coalition region (based on 2013 USDA land use designation).	Presence/absence of top 80% land use category	0 = Absent 10 = Present; (Top 80% land use category=10, Other land use category=0)	2.5%	Low
Other Factors	Proximity of high vulnerability areas to areas contributing recharge to urban and rural communities where groundwater serves as a significant source of supply.	**Proximity to Public Groundwater Supply** Includes evaluation and ranking of areas by proximity to public water systems and communities reliant on groundwater.	Distance, within 1 mile, from public water system or community reliant on groundwater Within Contributing Area/Not Within Contributing Area	0 to 10 (low to high) inversely related to distance from public supply system reliant on groundwater; multiplier of 1 for locations within contributing area and multiplier of 0.5 for locations outside of contributing area; (miles: >2=0, 1.5-2=2, 1-1.5=4, 0.5-1=6, 0.25-0.5=8, <0.25=10)	30%	High
	Groundwater basins currently or proposed to be under review by CV-SALTS.	**CV-SALTS Priority Areas** Includes Initial Analysis Zones (IAZ) that were identified by CV-SALTS as being high priority with respect to nitrate in groundwater.	Location within or not within IAZ identified as high priority by CV-SALTS	0 = Not within priority IAZ 10 = Within priority IAZ	2.5%	Low

TABLE 3
Well Detail Reporting Information

Category of Well Information	Description of Well Detail	Required[1] or Optional	Comment
Unique Well Identification	State well number	Required	If known
	GQTMP well ID	Optional	
	Monitoring entity	Optional	
Well Location	GPS coordinates	Required	Latitude and longitude in decimal degrees (datum NAD83, minimum of five decimal places
	Physical address	Required	As applicable or available
	PLSS coordinates (T/R/S)	Optional	
Well Construction	Total well depth	Required	
	Depth to top of perforations	Required	
	Depth to bottom of perforations	Required	
	Well seal depth/length	Required	
	Well seal material	Required	
	DWR Well Completion Report (water well drillers log)	Required	Provide copy, if available
	Well construction date	Optional	
Well Characteristics	Depth to standing water (static water level)	Required	Collected annually at time of well sampling, if available/accessible
	Estimated ground surface elevation	Optional	Feet above mean sea level from National Elevation Dataset (NED) digital elevation model (DEM)
	Water level measurement reference point	Optional	Feet above ground surface
	Well pumping rate	Optional	
	Well operation	Optional	Typical pumping cycles; annual pumping duration
Historical Well Testing	Period of available historical water quality record	Optional	Range of years (first/last year)
	Number of historical water quality tests	Optional	
Characteristics of Well Vicinity	Land use composition in vicinity of well	Optional	Percent agriculture by commodity

[1] Required well construction details will be included for wells selected for trend monitoring conducted by the Coalition. Some cases may exist where well construction information is not available for a well determined to represent a particularly informative monitoring site for various other reasons (e.g., historical period of record). Detailed well construction information will likely not be available for wells monitored in low vulnerability areas, which will rely on available public monitoring data.

TABLE 4
Water Quality Testing Requirements

Water Quality Constituent	Reporting Units	Testing Frequency	Required or Optional[1]	Field or Laboratory Analysis	Comment
Nitrate as nitrogen	mg/L (as N)	Annual	Required	Laboratory	Should be part of trend monitoring in Tier 1-3 monitoring subareas
Electrical conductivity (EC)	µS/cm	Annual	Required	Field	at 25 °C
pH	pH units	Annual	Required	Field	
Dissolved oxygen (DO)	mg/L	Annual	Required	Field	
Temperature	°C	Annual	Required	Field	
Oxidation-reduction potential (ORP)	mV	Annual	Optional	Field	
Turbidity	NTU	Annual	Optional	Field	
Total dissolved solids (TDS)	mg/L	Five years	Required	Laboratory	Should be part of trend monitoring in Tier 1-3 monitoring subareas
Anions					
Carbonate	mg/L	Five years	Required	Laboratory	
Bicarbonate	mg/L	Five years	Required	Laboratory	
Chloride	mg/L	Five years	Required	Laboratory	
Sulfate	mg/L	Five years	Required	Laboratory	
Cations					
Boron	mg/L	Five years	Required	Laboratory	
Calcium	mg/L	Five years	Required	Laboratory	
Sodium	mg/L	Five years	Required	Laboratory	
Magnesium	mg/L	Five years	Required	Laboratory	
Potassium	mg/L	Five years	Required	Laboratory	

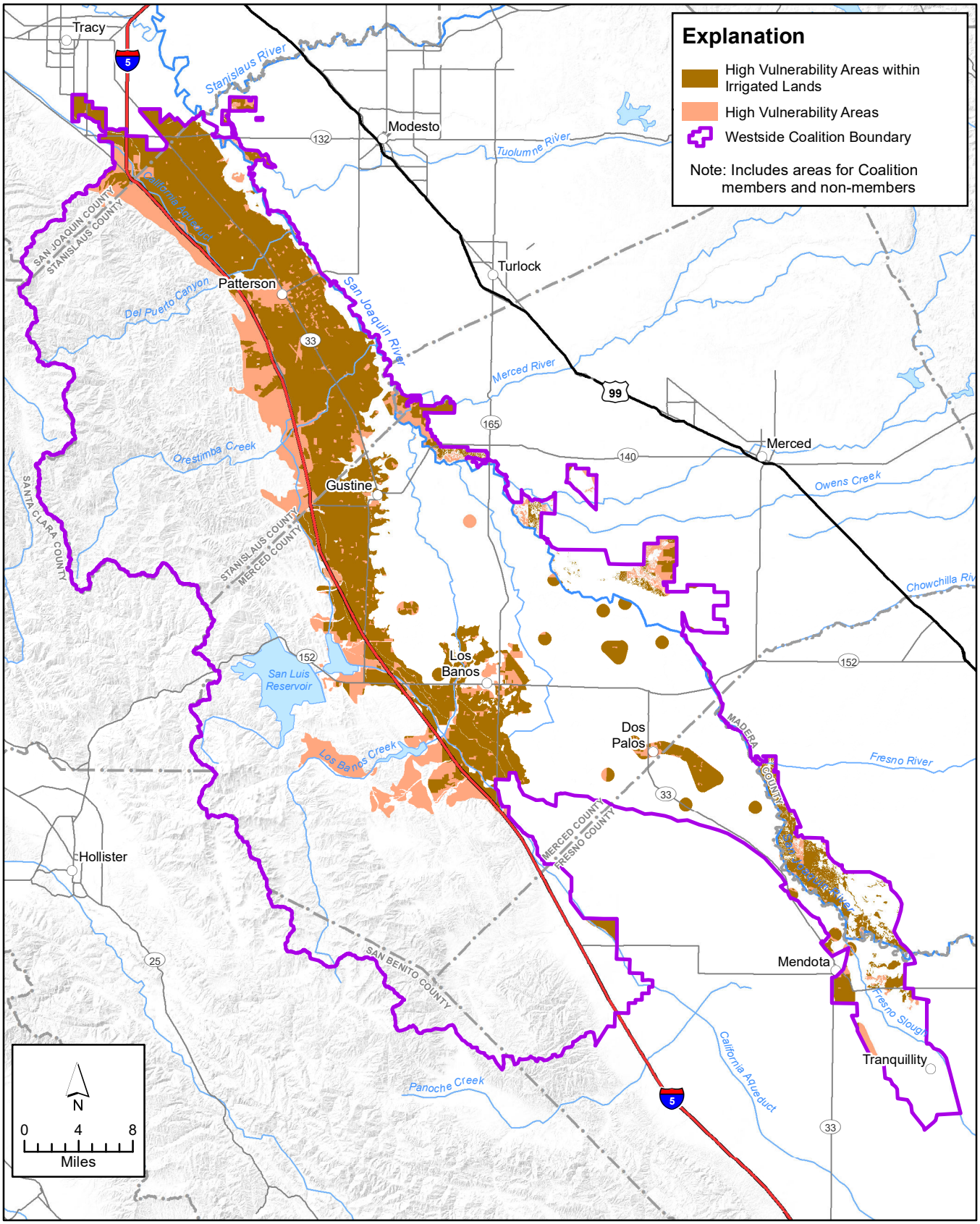
[1] Required Water quality constituents will be included in trend monitoring of Tier 1 and Tier 2 monitoring subareas. Not all required constituents will necessarily be included in trend monitoring in Tier 3 monitoring subareas depending on the cooperation with existing monitoring entities in these Tier 3 subareas. Groundwater analyses in Tier 4 monitoring subareas will be based on available public monitoring data.

TABLE 5
Reporting Elements

Reporting Element	Description of Reporting Method	Reporting Frequency
GQTM data submittal	Upload data to Geotracker database or in accordance and coordination with GQRMP data submittal	Annual
Report Content		
Design of trend monitoring program	Map(s) of monitoring subareas	Annual/GAR Update*
	Map(s) of sampled wells	Annual/GAR Update*
Tabulation of results	Summary statistics	Annual/GAR Update*
	Complete analytical results	Annual/GAR Update*
	Analytical reports	Annual/GAR Update*
Visual presentation and interpretation of results	Map(s) of patterns within aquifer system (e.g., color gradient symbols)	Annual/GAR Update*
Graphic presentation of time series data	Graphs of time series data illustrating temporal changes	Annual/GAR Update*
Groundwater levels	Map(s) of groundwater elevations (e.g., contours) within select areas as applicable to regional monitoring	Annual/GAR Update*
Update regional groundwater quality characterization (using all readily available groundwater quality data)	Map(s) and tabulation of groundwater quality data relevant to irrigated agriculture	GAR Update*
	Map(s) and tabulation of DPR groundwater pesticide monitoring data	GAR Update*
Comparison of regional groundwater quality trends (using all readily available groundwater quality data)		
Temporal trends analyses	Non-parametric statistical analyses of trends (e.g., Mann-Kendall test)	GAR Update*
	Parametric statistical analysis of trends (e.g., linear regression)	GAR Update*
Presentation of spatial patterns in trends (i.e., maps showing trends)	Statistical summary of conditions and trends relative to monitoring subareas	GAR Update*
	Analyses of groundwater quality trends by depth zone	GAR Update*
	Analyses of groundwater quality trends by location and locational characteristics (e.g., land use composition)	GAR Update*
Report Discussion		
Rationale for trend monitoring program design	Discussion of basis for trend monitoring well selection	Annual/GAR Update*
Synthesis of findings	Discussion of findings relating to groundwater quality trends and patterns	Annual/GAR Update*
	Evaluation of relationships between groundwater quality trends and land use	Annual/GAR Update*
Evaluation of uncertainty and data gaps	Evaluation of representation of GQTM well network in relation to trends and patterns observed across Coalition region	Annual/GAR Update*
Assess need to future GQTMP refinements	Provide recommendations regarding monitoring network	Annual/GAR Update*
Coordination with education and outreach efforts	Evaluation of GQTM design in relation to Coalition education and outreach efforts	Annual/GAR Update*

* Will include reporting in five-year GAR Update or other five-year reporting submittal.

FIGURES



X:\2016\16-049 Westside Coalition - GW Quality Trend Monitoring Workplan\GIS\Workplan Figures\Figure1 Map of Westside High Vulnerability Area within Irrigated Lands.mxd

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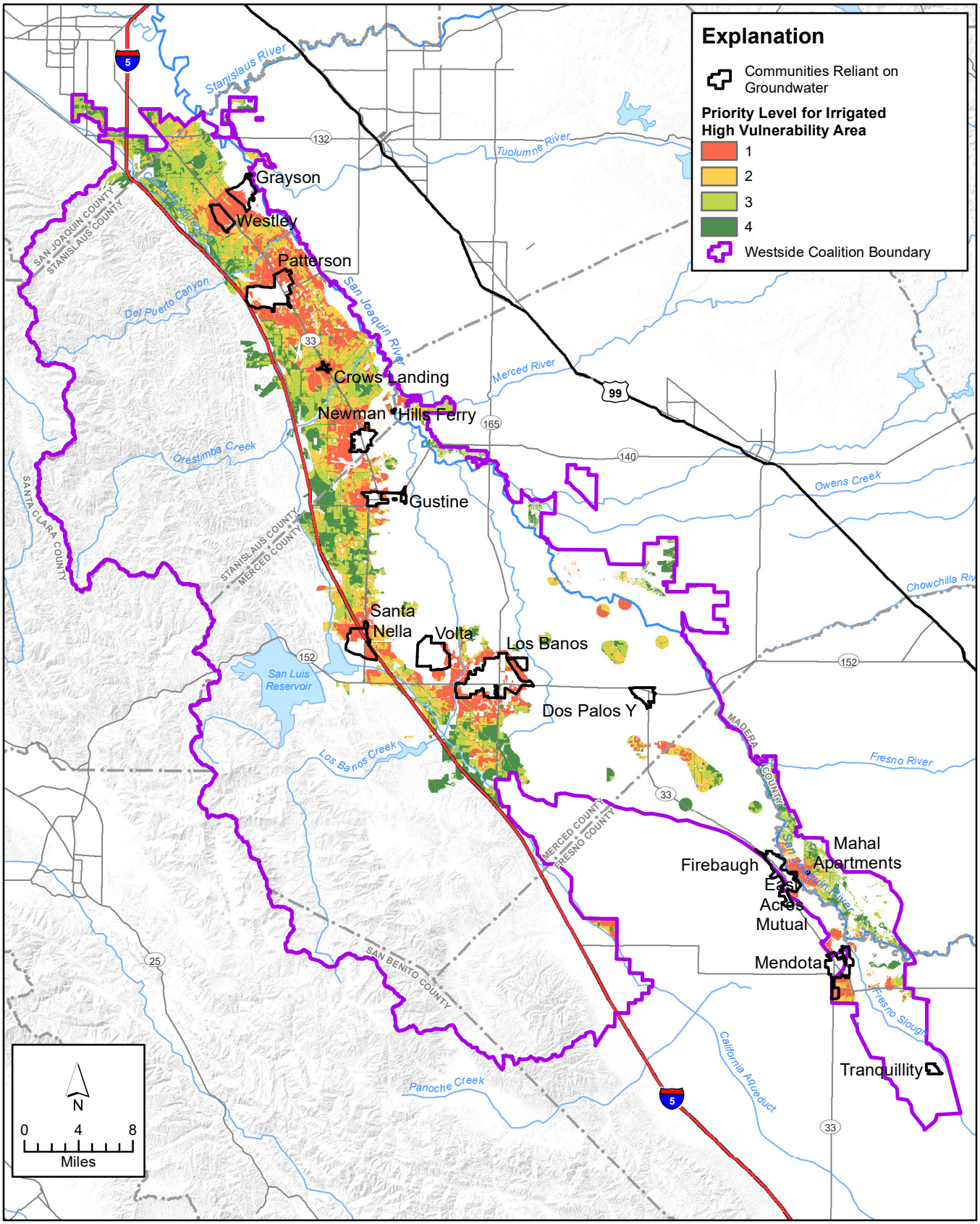
FIGURE 1

Map of Westside High Vulnerability Area

Westside San Joaquin River Watershed Coalition
Groundwater Quality Trend Monitoring Workplan



X:\2016\16-049 Westside Coalition - GW Quality Trend Monitoring Workplan\GIS\Workplan Figures\Figure 2 Map of HVA Priority Areas and Communities Reliant on Groundwater.mxd

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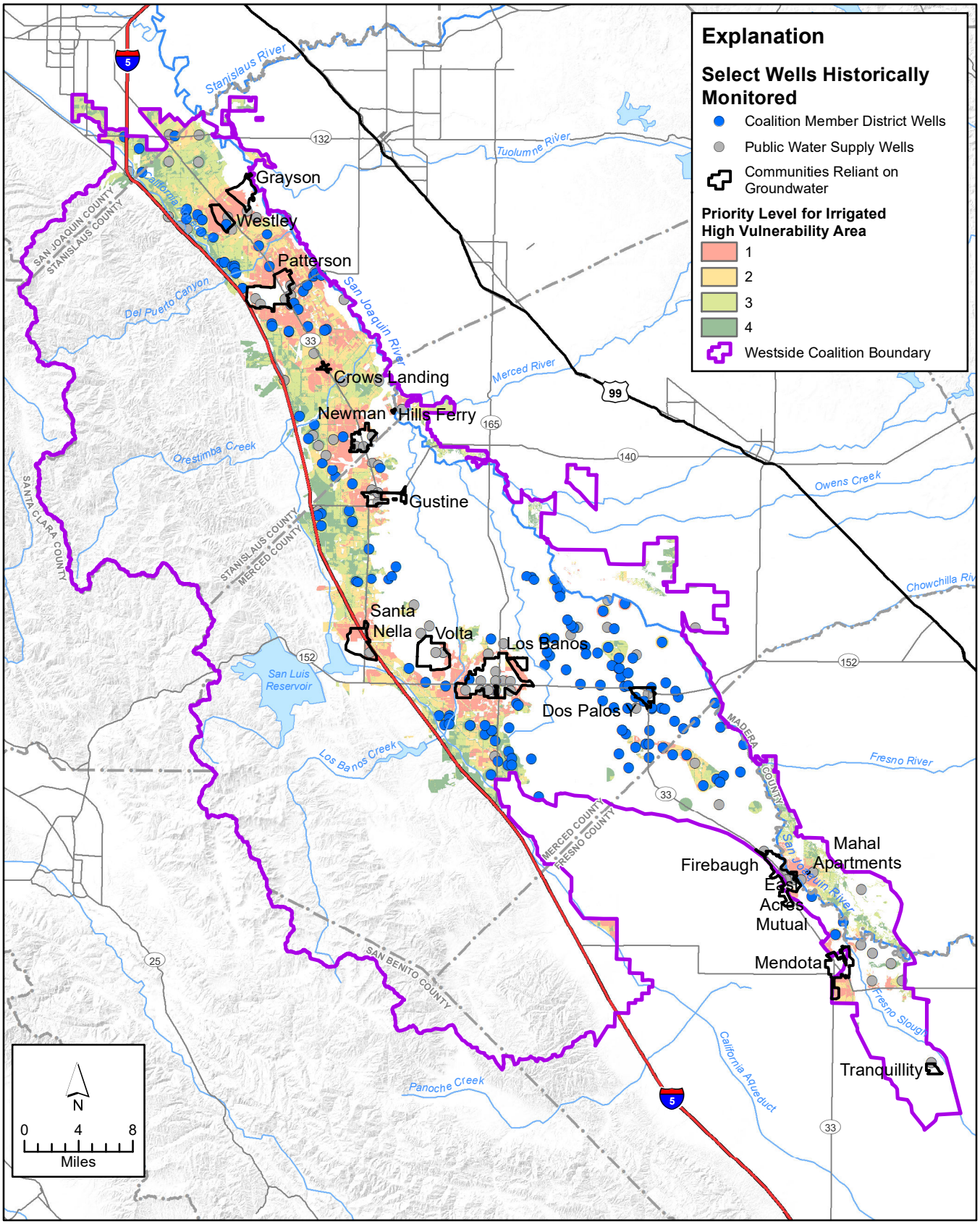
FIGURE 2
Map of High Vulnerability Priority Areas and Communities Reliant on Groundwater

Westside San Joaquin River Watershed Coalition
Groundwater Quality Trend Monitoring Workplan



X:\2016\16-049 Westside Coalition - GW Quality Trend Monitoring Workplan\GIS\Workplan Figures\Figure 3 Map of Coalition Member District Wells and Monitored PWS Wells.mxd

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FIGURE 3
Map of Monitored Coalition Member District Wells and Public Water Supply Wells

Westside San Joaquin River Watershed Coalition
Groundwater Quality Trend Monitoring Workplan

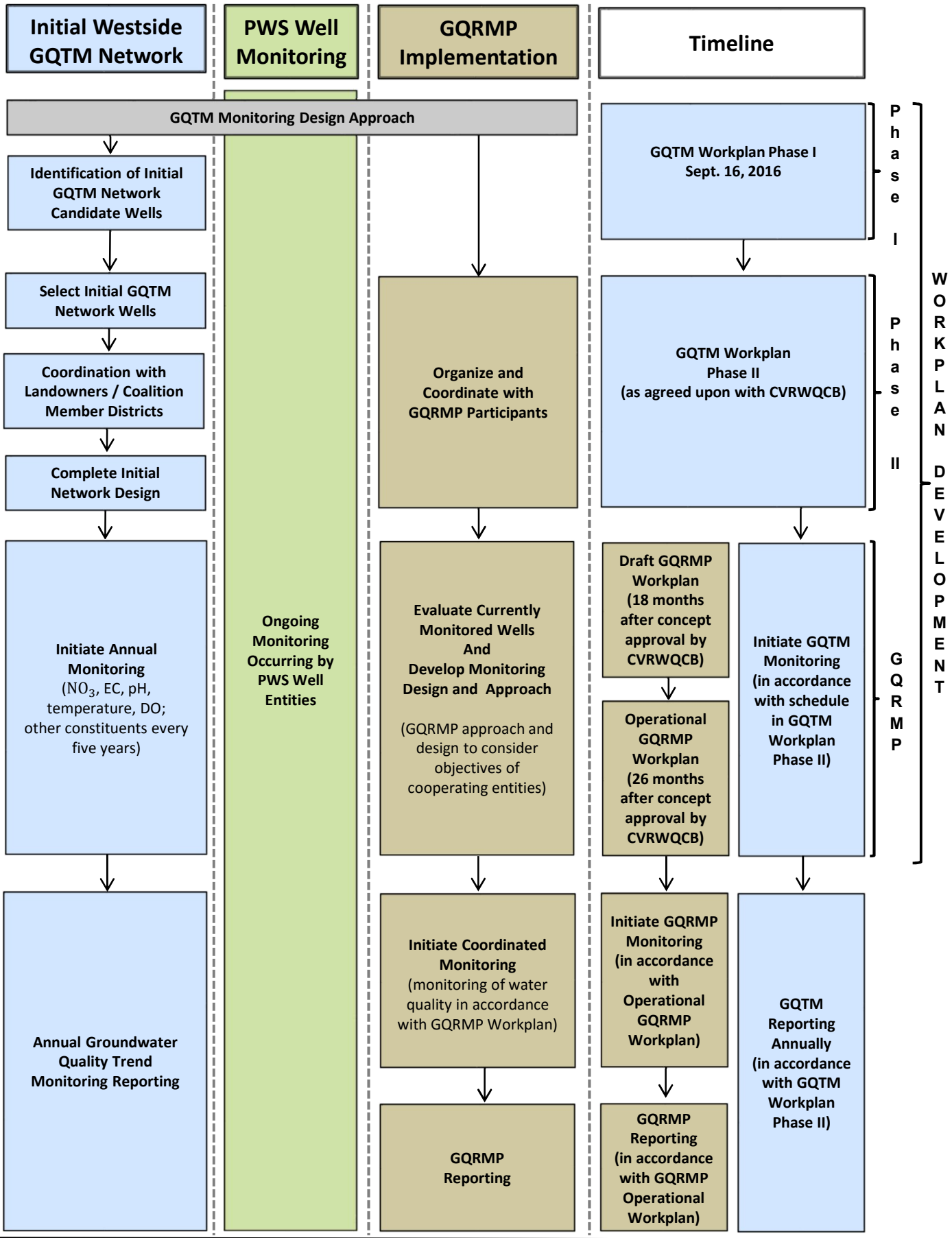

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FIGURE 4

Timeline for Trend Monitoring Elements

Westside San Joaquin River Watershed Coalition
Groundwater Quality Trend Monitoring Workplan