1 July 2016

Nicole Bell
Kern River Watershed Coalition Authority
P.O. Box 151
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CONDITIONAL APPROVAL OF THE KERN RIVER WATERSHED COALITION AUTHORITY GROUNDWATER QUALITY ASSESSMENT REPORT

Thank you for the 4 February 2015 submittal of the Kern River Watershed Coalition Authority (Coalition) Groundwater Quality Assessment Report (GAR), as required by Waste Discharge Requirements General Order R5-2013-0120 (General Order). The purpose of the GAR is to identify areas within the Coalition where groundwater is vulnerable to impacts from irrigated agriculture, and to provide the foundational information necessary for design of the Management Practice Evaluation Program, the Groundwater Quality Trend Monitoring Program, and the Groundwater Quality Management Plan(s).

As outlined in the enclosed staff review, portions of the GAR pertaining to the identification of High Vulnerability Areas (HVAs) are not sufficient to meet the requirements of the Monitoring and Reporting Program (MRP). Specifically, three outstanding issues need to be addressed regarding the methodology presented in the GAR:

1. All areas identified as HVAs must be assigned a prioritization ranking, including those within the secondary coverage area of the Coalition.
2. Vulnerability to Nitrate/Nitrite contamination should be identified for areas where groundwater quality data shows concentrations of ½ the Maximum Contaminant Level or greater with a statistically increasing trend in concentration.
3. The vulnerability assessment does not incorporate an evaluation of all the relevant hydrogeologic factors that contribute to intrinsic vulnerability (e.g. hydraulic conductivity, porosity, presence or absence of confining zones, presence or absence of preferential pathways, thickness of the vadose zone, depth to first encountered groundwater, etc.).

The Coalition must continue to use the high vulnerability areas which were assigned in my 30 March 2015 letter to the Coalition, and incorporate any additional high vulnerability areas identified by the Coalition. These high vulnerability areas need to be incorporated into the Coalition's Management Practice Evaluation Program, the Groundwater Quality Trend Monitoring Program, and the Groundwater Quality Management Plan(s). Future adjustments to the assigned HVAs may be considered if data and information demonstrate that it is appropriate to do so after considering those factors and issues relating to vulnerability described in the attached review memorandum. If the Coalition chooses to revise its methodology for determining HVAs, it must address all of staff's comments at that time.

This conditional approval provides a pathway for the Coalition to address issues identified in the staff review memorandum through future work plans and the 5-year GAR update while also allowing the Coalition to expeditiously proceed with the important work of the Management Practice Evaluation Program, the Groundwater Quality Trend Monitoring Program, and the Groundwater Quality Management Plan(s). All GAR items discussed in the memorandum need to be addressed in accordance with the schedule in Table 1 - *Summary of Issues to be Addressed in Forthcoming Work Plans* (enclosed).

If you have any questions, please contact David Sholes at (559) 445-6279 or by e-mail at David.Sholes@waterboards.ca.gov.

Sincerely,

Original signed by:

Pamela C. Creedon
Executive Officer

Enclosure: Table 1 - Summary of Issues to be Addressed in Forthcoming Work Plans
Staff Review Memorandum

cc: Sue McConnell, Central Valley Water Board, Rancho Cordova

Table 1
Summary of Issues to be Addressed in Forthcoming Work Plans[1]

Staff Memorandum Item	Management Practice Evaluation Program	Groundwater Quality Trend Monitoring Program	Groundwater Quality Management Plan(s)	Groundwater Quality Assessment Report 5 Year Update
1.A		X	X	X
1.B	X	X	X	X
1.C				X
1.D		X		X
1.E		X	X	X
2.A	X[2]		X[2]	X
2.B	X[2]		X[2]	X
3.A		X		X
3.B		X		X
3.C				X
3.D		X		X
4	X			X
10		X		X
11		X		X
12.A				X
12.B				X
16.A	X[2]		X[2]	X
16.B	X[2]		X[2]	X
16.C	X[2]		X[2]	X

[1] Relevant information from reports submitted prior in sequence must be included in all subsequent workplans and reports (e.g., relevant information from GQMPs must be included in the MPEP and GQTMP).

[2] The high vulnerability areas which were assigned to the Coalition by the Executive Officer (30 March 2015 letter) and any additional high vulnerability areas identified by the Coalition must be used.

TO: Douglas K. Patteson, P.E.
Supervising Water Resource Control Engineer

FROM: David Sholes, C.E.G.
Senior Engineering Geologist
Irrigated Lands Regulatory Program

DATE: 1 July 2016

SUBJECT: **REVIEW OF 4 FEBRUARY 2015 GROUNDWATER QUALITY ASSESSMENT REPORT FOR THE KERN RIVER WATERSHED COALITION AUTHORITY**

On 4 February 2015, the Kern River Watershed Coalition Authority (KRWCA or Coalition) submitted a Groundwater Quality Assessment Report (GAR) in accordance with the Monitoring and Reporting Program (MRP) for Waste Discharge Requirements General Order R5-2013-0120 (General Order). The GAR provides the foundational information necessary for design of the Management Practices Evaluation Program (MPEP), the Groundwater Quality Trend Monitoring Program, and the Groundwater Quality Management Plan(s) (GQMPs).

Prior to submission of the GAR, Central Valley Regional Water Quality Control Board (Central Valley Water Board) staff met with the Coalition to discuss the proposed methodology for determining vulnerability. During the meeting, the Coalition indicated that they planned to apply the Nitrate Groundwater Pollution Hazard Index (NHI) on a parcel by parcel basis, in addition to detections of nitrates and pesticides in wells above Maximum Contaminant Levels (MCL) to determine vulnerability. Water Board staff informed the Coalition that this was not an adequate methodology for determining vulnerability, and that the methodology did not meet the requirements of the General Order. The Coalition used the NHI and nitrate and pesticide detections above MCLs for the vulnerability analysis contained in the GAR. By letter dated 30 March 2015, the Executive Officer assigned High Vulnerability Areas (HVAs) in the Coalition's area, noting that those near disadvantaged communities reliant on groundwater must be the highest priority and that adjustments to the assigned high vulnerability areas may be considered if future data collected demonstrates that it is appropriate to do so.

Central Valley Water Board staff's review of the GAR concluded that modifications and additions are necessary to the GAR to meet the terms and conditions of the General Order; however, provided the HVAs assigned by the Executive Officer are used, many of the required modifications can be included in subsequent work plans or GAR updates, making submission of a revised GAR unnecessary at this time. Table 1 provides descriptions of the required GAR components from the General Order and MRP and lists the section in the GAR that addresses each component. Recommended revisions/additions for incomplete items are provided below. The memorandum item numbers correspond to item numbers on Table 1.

Item 1. Assessment of Readily Available, Applicable, and Relevant Data and Information to Determine High and Low Vulnerability Areas

The General Order (Section VIII.D.1) requires that the GAR provide an assessment of all readily available, applicable, and relevant data and information to determine the high and low vulnerability areas where discharges from irrigated lands may result in groundwater quality degradation. While a portion of the available data was identified and discussed in the GAR, a large quantity of available information was ultimately not utilized. This has given rise to a variety of assumptions that have affected the interpretation of the water quality data present within and adjacent to the Coalition's boundaries. Recommended revisions include the following:

A. The GAR references many published sources related to components, development, and application and support of the NHI, but does not include many studies documenting investigations of actual impacts to groundwater quality from farm to regional scale. Much research has been done in this field, often specific to Kern County or the San Joaquin Valley. Several studies specific to Kern County document how wells distribute poor quality water in upper zones to lower zones or aquifers with better water quality. A list of publications is attached to this memo. The Coalition should consider these, and others that describe the processes of vadose zone transport of irrigation waters, and actual case studies when considering future revisions to the GAR and during the preparation of future work plans and reports. These resources and others should be used to broaden the Coalition's approach to determining HVAs, which should also include intrinsic factors now only considered as criteria when prioritizing HVAs.

B. The GAR lacks a discussion/acknowledgement that well bores may provide potential preferential pathways for vertical migration between aquifers and how this may reflect on groundwater chemistry. As stated by a variety of USGS investigators (Lofgren and Klausing 1969, Williamson et al. 1989, Bertoldi et al. 1991, Burow et al. 2012), the high density of wells constructed with long perforated sections or multiple well screens provides vertical hydraulic connections within the aquifer system. The presence of tens of thousands of irrigation wells perforated at various levels (Harou and Lund 2008) has lead USGS investigators and modelers to the concept of a single heterogeneous aquifer within the Central Valley with varying vertical leakage and confinement. Publications specific to Kern County state that nitrates in affected aquifer zones can pollute unaffected aquifer zones through existing wells. This concept/discussion should be included in Section 5 of the GAR, carried forward into the groundwater discussions presented in the GAR, and be used when assessing the causes and existence of HVAs in the Coalition area (Section 10 of the GAR).

C. Section 6.2 of the GAR includes a list of the readily available sources of groundwater quality data used by the Coalition to evaluate water quality within the KRWQA area; however, it does not provide the actual data set or identify a method for reproducing the data set used for GAR evaluations. Access to this data set is necessary for Central Valley Water Board staff review of the GAR and to determine if all the readily available data were evaluated. Based on the review of the reference section of the GAR, it appears that a number of relevant documents (some of which contain groundwater data that does not appear to have been included in the GAR data set) were not evaluated as part of the GAR (see Attachment B, Additional References to this memorandum).

D. The GAR should include a discussion of the Friant-Kern Canal and the California Aqueduct and their role in providing surface water to area streams and irrigation canals and water for groundwater banking/recharge. Additionally, nitrate groundwater data from

the irrigation districts Pump-in Program (wells discharging into the Friant-Kern Canal, California Aqueduct, Cross Valley Canal) should be obtained, evaluated and included in the GAR's discussion of groundwater quality (Section 6) and should be included in the evaluation of HVAs (Temporary Change in Water Quality Requirements for the Friant-Kern Canal Groundwater Pump-in Program, 2014, U.S. Department of the Interior Bureau of Reclamation, Draft Finding of No Significant Impact, October 2014, FONSI-14-043, and Water Quality Assessment of Non-Project Turn-ins to the California Aqueduct, 2014, Technical Memorandum Report, State of California Natural Resources Agency, Department of Water Resources, October 2015).

E. Section 6.2 of the GAR states "It is assumed for the sake of this evaluation that all groundwater quality results represent first encountered groundwater." However, well construction details for wells that yielded groundwater analytical data were not evaluated as part of the GAR. Without knowledge of well construction details it is unclear what depths the groundwater samples were collected within the aquifer. Evaluating groundwater quality data without knowing the depth within the aquifer from which the sample was obtained provides an incomplete picture for purposes of assigning vulnerability. Well construction information should be utilized in the evaluation of water quality data (e.g., well construction details should be compared to the depth to groundwater maps contained in the GAR and the historical maps presented on the California Department of Water Resources website to determine potential differences between shallow and deeper groundwater quality).

   Well construction in relation to the depth of first encountered groundwater is particularly important as it has been established by a variety of USGS investigators and academics that nitrate concentrations decline with depth below first encountered groundwater (Burow et al. 1998; Burow et al. 2012; Fuhrer et al. 1999, Rupert 1999). Therefore, areas for which only deep groundwater quality data are available cannot be assumed to be low vulnerability based solely on this data. Additional efforts need be made to obtain shallow groundwater quality data to comply with the requirements of the General Order (MRP Section IV. A. 2). A discussion should be developed regarding differences in shallow groundwater concentrations of constituents of concern (COC's) and deeper groundwater chemistry obtained from the same region.

   In June 2015, subsequent to the GAR submittal, Senate Bill 83 amended California Water Code §13752 to allow public access to well completion reports. The Department of Water Resources is currently in the process of redacting personal information from the reports, which are expected to become available online within the next year and are currently available upon request. The Coalition should utilize the available resource during the development of future work plans and reports, and in future updates to the GAR.

Item 2. Establish Priorities for Implementation

The General Order (Section VIII.D.1) requires that the GAR establish priorities for the implementation of groundwater studies within high vulnerability areas. To meet the prioritization requirements of the General Order, the GAR prioritizes efforts in HVA areas using three parameters; hydrologic (intrinsic sensitivity), the relationship between high vulnerability lands and public groundwater supply wells, and the NHI. The GAR assigns numeric values to these parameters, and creates an additive overlay, which is divided into three tiers (depicted on Figure 11-11) with Tier 1 being the highest priority and Tier 3 being the lowest priority.

A. While the GAR's approach to prioritize work in HVAs appears largely appropriate, it does not provide highest priority to HVAs near disadvantaged communities reliant on groundwater. The prioritization methodology should be revised to ensure that addressing the agriculture related issues affecting the water supply of these communities is the highest priority. This revised priority must be applied when preparing future work plans and reports.

B. As stated in Section IV.A. of the MRP, the GAR must provide a ranking of high vulnerability areas to provide a basis for future work plan activities. The GAR identifies HVAs within the secondary areas of the Coalition; however, it does not assign a priority to these HVAs. The HVAs in secondary areas must be assigned a priority ranking to meet the requirements of the MRP. These must be considered when updating the GAR, and in all future work plans and reports.

Item 3. Basis for Establishing Monitoring Work Plans Developed to Assess Groundwater Quality Trends

The General Order (Section VIII.D.1) requires that the GAR provide the basis for establishing work plans to assess groundwater quality trends. The GAR (Section 13.2) proposes to monitor one or more wells in each township, with the number proportional to the percentage of HVA land within each township; the Coalition estimates that one to three wells per township will be monitored. The Trend Monitoring Work Plan will be reviewed separately, and only general comments on the basis for monitoring are included here. These comments should be addressed and included in evaluations of HVAs and priorities when preparing future work plans and reports, including the Trend Monitoring Work Plan.

A. The GAR did not include a complete review of available information regarding known agricultural impacts to groundwater quality, or methods by which those impacts may occur. Multiple studies have shown correlation between groundwater vulnerability and intrinsic hydrogeologic factors other than those addressed by the NHI (see Attachment B). The findings of these studies should be incorporated into the GARs approach to assess vulnerability within the Coalition area.

B. The GAR only evaluated pesticides with a numeric MCL, however an MCL or other water quality criteria has not been established for a large number of the pesticides (or their associated transformation products) applied within the Coalition's area. This approach of only evaluating pesticides with a MCL does not account for the possible cumulative effects on water quality if multiple pesticides are present in groundwater. The *Water Quality Control Plan for the Tulare Lake Basin*, Second Edition, revised January 2004 (Basin Plan) states that no individual pesticide or combination of pesticides shall be present in concentrations that adversely affect beneficial uses. While the detection of a pesticide below its respective MCL or the detection of a pesticide without a numeric MCL may not merit a high vulnerability designation, at a minimum the GAR should evaluate this data in parallel with the other water quality and hydrogeologic data.

C. The GAR did not address nitrates detected in groundwater at half the MCL and showing a statistically significant increasing trend (see Item 16.B. below).

D. The GAR did not discuss using well construction information to choose an appropriate groundwater monitoring well network. Well construction information needs to be used to identify suitable wells within existing groundwater monitoring networks for the Coalition's Groundwater Quality Trend Monitoring Program. Well construction details will allow the

Coalition to choose appropriate wells to obtain groundwater quality data from first encountered groundwater. The Coalition should explore the option of using existing domestic supply wells for the Groundwater Quality Trend Monitoring Program, as these may be suitable (proper well screen length and placement with respect to the water table) for obtaining groundwater samples that would be consistent with the groundwater monitoring provisions of the General Order.

Item 4. Basis for Establishing Management Practices Evaluation Program
Section 13.1 of the GAR describes the MPEP group with which the KRWCA coordinates and which now includes all coalitions enrolled in the General Order. The MPEP work plan will be reviewed separately, and only general comments affecting the basis for establishing the MPEP evaluation criteria are included here. Comments for Item 3 above apply. These comments should be addressed and included in evaluations of HVAs and priorities when preparing future work plans and reports, including the MPEP Work Plan.

Item 10. Shallow Groundwater Constituent Concentrations from Existing Monitoring Networks
Section IV.A.2 of the Monitoring and Reporting Program requires that the GAR include information and data on shallow groundwater constituent concentrations that could be related to agricultural activities. The GAR evaluates nitrates, salinity, and pesticides that are monitored by the California Department of Pesticide Regulation (DPR) and have a MCL. Detection of any pesticide in groundwater is an indication of vulnerability. Exceedance of a water quality objective is an issue of public health. All available pesticide data should be evaluated, and additional discussion should be provided regarding the occurrence/detections of pesticides in groundwater as an indicator of vulnerability. This evaluation should be included in future work plans and reports, and updates of the GAR.

Item 11. Information on Existing Groundwater Data Collection and Analysis Efforts
The GAR provides an extensive list of agencies and entities that collect groundwater information but does not identify any shallow groundwater quality data or any information regarding existing groundwater monitoring networks. The GAR assumes all groundwater quality data obtained from wells represents first encountered groundwater. For various reasons, documented by multiple studies, this assumption biases the review of these data in the direction of underestimating the extent of HVAs (see discussion for Item 1 above). Future work plans and reports should include a discussion of existing shallow groundwater monitoring networks and an explanation of where data gaps exist with respect to what is known about agriculture's effects on shallow water quality. HVAs may need to be revised upon completion of this effort, which may also affect the MPEP Work Plan, GQMPs, and the Trend Monitoring Work Plan.

Item 12. Existing Water Quality Impacts and Vulnerable Conditions
Section IV.A.3 of the Monitoring and Reporting Program requires that the GAR identify known groundwater quality impacts for which irrigated agricultural operations are a potential contributor or where conditions make groundwater more vulnerable to impacts from irrigated agricultural activities. Review of the GAR has identified the following concerns regarding existing groundwater quality impacts and data/information not included. Future work plans and reports should address these concerns.

A. As described above (see Items 1.A, 1.B, 1.C), additional readily available data exist that has not been evaluated by the GAR. These data need to be reviewed and the GAR updated to reflect the results of the new information.

B. If any readily available nitrite data are available in the data sets utilized by the GAR, this information should also be evaluated relative to the nitrite MCL (2 mg/l).

Item 16. Groundwater Vulnerability Designations

The General Order requires that the GAR designate high/low vulnerability areas for groundwater where known groundwater quality impacts exist for which irrigated agricultural operations are a potential contributor or where conditions make groundwater more vulnerable to impacts from irrigated agricultural activities. The vulnerability designations are to be made using a combination of physical properties (soil type, depth to groundwater, known agricultural impacts to beneficial uses, etc.) and management practices (irrigation method, crop type, nitrogen application and removal rates, etc.).

The GAR uses three criteria to establish HVAs. Section 10, Groundwater Vulnerability Areas states: *Areas which have a high nitrate leaching risk from the land surface, are designated as a Groundwater Protection Area (GWPA) for leaching by the California Department of Pesticide Regulation (DPR), or have underlying water quality exceedances, were identified as high vulnerability lands.* With respect to why intrinsic geologic characteristics were not considered, the GAR states: *The assessment of vulnerable areas in this section does not include any intrinsic hydrogeology component. …there is no combination of hydrogeologic conditions which indicate absolute vulnerability to contamination.*

Staff's review of the GAR's approach to determining vulnerability (Section 10 of the GAR) is described below followed by issues that need to be addressed.

A. The method for designating HVAs does not meet the minimum requirements specified in Section IV.A.4 of the Monitoring and Reporting Program. Specifically, the proposed method does not include an evaluation of all the relevant hydrogeologic factors that contribute to intrinsic vulnerability (e.g. hydraulic conductivity, porosity, presence or absence of confining zones, presence or absence of preferential pathways, thickness of the vadose zone, depth to first encountered groundwater, etc.).

B. Section 6.6.6 Nitrate, of the GAR states: *For this study the 45 mg/l nitrate as nitrate MCL has been used as the basis for identifying areas of existing nitrate impacted groundwater.* The vulnerability assessment did not include areas identified as having statistically significant increasing nitrate trends. At a minimum, high vulnerability needs to include all areas where nitrate and EC concentrations in groundwater are at 50% of the MCL or higher and have a trend indicating a statistically significant increasing concentration.

C. As indicated in Item 1.A., above, the GAR does not appear to make use of all available information (see comment Items 1.A and 1.B., above). Other pathways of contamination such as through wells, and between aquifer zones due to well construction issues, are described and should be included in the vulnerability determination methodology.

Table 1. Components of the Groundwater Assessment Report

Item No.	Required Component	Location in GAR	Item Complete
GAR Objectives – MRP section			
1	Provide an assessment of all readily available, applicable and relevant data and information to determine the high and low vulnerability areas where discharges from irrigated lands may result in groundwater quality degradation.	Throughout	N
2	Establish priorities for implementation of monitoring and studies within high vulnerability or data gap areas.	Chapter 11	N
3	Provide a basis for establishing Monitoring work plans developed to assess groundwater quality trends.	Throughout	N
4	Provide a basis for establishing Management Practices Evaluation Program (MPEP) work plans and priorities developed to evaluate the effectiveness of agricultural management practices to protect groundwater quality.	Throughout	N
5	Provide a basis for establishing groundwater quality management plans in high vulnerability areas and priorities for implementation of those plans.	Throughout	N
Required GAR Components – MRP section			
6	Detailed land use information with emphasis on land uses associated with irrigated agricultural operations. The information shall identify the largest acreage commodity types in the third-party area, including the most prevalent commodities comprising up to at least 80% of the irrigated agricultural acreage in the third-party area. If the third-party manages the area through sub-watershed groups, the GAR information should be developed for each sub-watershed.	Chapter 2	Y
7	Information regarding depth to groundwater, provided as a contour map(s), if readily available. Tabulated and/or graphical data from discrete sampling events may be submitted if limited data precludes producing a contour map.	Chapter 7	Y
8	Groundwater recharge information, if readily available, including identification of areas contributing recharge to urban and rural communities where groundwater serves as a significant source of supply.	Chapter 8	Y
9	Soil survey information, including significant areas of high salinity, alkalinity and acidity.	Chapter 3	Y
10	Shallow groundwater constituent concentrations from existing monitoring networks (potential constituents of concern include any material applied as part of the agricultural operation, including constituents in irrigation supply water [e.g., pesticides, fertilizers, soil amendments, etc.] that could impact beneficial uses or cause degradation).	Chapter 6	N

11	Information on existing groundwater data collection and analysis efforts relevant to this Order (e.g., Department of Pesticide Regulation [DPR], United States Geological Survey [USGS], State Water Board Groundwater Ambient Monitoring and Assessment [GAMA], California Department of Public Health, local groundwater management plans, etc.). This groundwater data compilation and review shall include all readily accessible information relevant to the Order on existing monitoring well networks, individual well details, and monitored parameters. For existing monitoring networks (or portions thereof) and/or relevant data sets, the third-party should assess the possibility of data sharing between the data-collecting entity, the third-party, and the Central Valley Water Board.	Chapter 6	N
GAR Data Review and Analysis – MRP section			
12	Determine where known groundwater quality impacts exist for which irrigated agricultural operations are a potential contributor or where conditions make groundwater more vulnerable to impacts from irrigated agricultural activities.	Chapter 6	N
13	Determine the merit and feasibility of incorporating existing groundwater data collection efforts, and their corresponding monitoring well systems for obtaining appropriate groundwater quality information to achieve the objectives of and support groundwater monitoring activities under this Order. This shall include specific findings and conclusions and provide the rationale for conclusions.	Chapter 12	Y
14	Prepare a ranking of high vulnerability areas to provide a basis for prioritization of work plan activities.	Chapter 11	N
15	Describe pertinent geologic and hydrogeologic information for the third-party area(s) and utilize GIS mapping applications, graphics, and tables, as appropriate, in order to clearly convey pertinent data, support data analysis, and show results.	Throughout	Y
Groundwater Vulnerability Designations – MRP section			
16	The GAR shall designate high/low vulnerability areas for groundwater in consideration of high and low vulnerability definitions provided in Attachment E of the Order. The vulnerability designations will be made using a combination of physical properties (soil type, depth to groundwater, known agricultural impacts to beneficial uses, etc.) and management practices (e.g., irrigation method, crop type, nitrogen application and removal rates, extent of implementation, etc.). The third-party shall provide the rationale for proposed vulnerability determinations.	Chapter 10	N

Attachment B
Additional References

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