Data Necessary to Address the Questions to be Addressed by Groundwater Monitoring in the Long-Term Irrigated Lands Regulatory Program

The Groundwater Monitoring Advisory Workgroup (GMAW), the Stakeholder Advisory Workgroup (SAW), and the staff of the California Regional Water Quality Control Board, Central Valley Region (Central Valley Water Board) have identified seven questions (bolded questions below) as critical questions that should be answered by groundwater monitoring conducted to comply with the Long-Term Irrigated Lands Regulatory Program (ILRP). These questions are meant to assist Central Valley Water Board staff, stakeholders and Third-Party Groups in identifying how groundwater monitoring will be integrated into the long-term irrigated lands regulatory program (ILRP). Groundwater requirements developed for the ILRP will be incorporated into monitoring and reporting programs prepared for coalition waste discharge requirements general orders.

A second meeting of both the GMAW was held on 25 August 2011 to identify the data/processes necessary to answer the critical groundwater monitoring questions. The information provided by the workgroup is summarized below the bolded critical question to which they refer.

1. What are irrigated agriculture's impacts to the beneficial uses of groundwater and where has groundwater been degraded or polluted by irrigated agricultural operations (horizontal and vertical extent)?

- Primary constituents of concern: Consensus was reached between workgroup members that the primary constituents of concern (COCs) related to agricultures impacts to the beneficial uses of groundwater are nitrate and salinity. Several of the workgroup members agreed monitoring for the primary COCs should consist of analysis for nitrate (NO_3-N), total dissolved solids (TDS), and electrical conductivity (EC). Some members of the workgroup suggested that it would be beneficial to analyze for all species of nitrogen (total nitrogen, nitrate, nitrite, ammonium, and total Kjeldahl nitrogen). Some workgroup members suggested analyzing for the major cations/anions (sodium, potassium, calcium, magnesium, chloride, bicarbonate, carbonate, and sulfate) at a lesser frequency than other monitoring.

- Other potential COC's: There was discussion within the group regarding the addition of the following COCs; pH, phosphate, dissolved/trace metals (primarily a concern with regards to redox conditions), some pesticides (if there are pesticides with low adsorptivity, high solubility, and slow degradation rate that aren't currently being monitored for by the Department of Pesticide Regulations [DPR]), total organic carbon, and toxicity.

- Unnecessary COC's for ILRP groundwater monitoring: It was suggested that monitoring for bacteria is not necessary, as bacteria is primarily a concern at confined animal feeding operations (CAFO) and wastewater treatment facilities. Some workgroup members suggested that phosphate is only a concern in surface waters and should not be analyzed for in the ILRP groundwater monitoring program.

- Extent of impact: The workgroup came to a consensus that when possible, existing water quality data should be used to identify where impacts have already occurred. It was recommended by some workgroup members that geographical information systems (GIS) software be utilized to plot exiting water quality data to help answer this question. Some workgroup members suggested that existing data alone are insufficient to identify where impacts have already occurred and that additional data collection will likely be needed to identify the extent of irrigated agricultures impacts to groundwater quality.

2. Which irrigated agricultural management practices are protective of groundwater quality and to what extent is that determination affected by site conditions (e.g., depth to groundwater, soil type, and recharge)?

- What management practices are currently be used: It was suggested that data collected by the Agricultural Sustainability Institute at UC Davis as part of the California Nitrogen Assessment, which will soon be publicly available, may help identify what current management practices are being used for the key crops grown in the Central Valley. There was a general consensus from the group that academic and commodity research groups should be utilized to identify existing management practices.

- What management practices are protective of groundwater quality: Some workgroup members identified the need to collect shallow groundwater data (from domestic wells where appropriate and from monitoring wells in areas where no appropriate sited and screened domestic wells exist) to identify if individual management practices are protective of groundwater quality. It was suggested that other shallow monitoring techniques (suction lysimeters, soil sampling, or tile drain water samples) could be used to collect these data. Some workgroup members suggested that modeling (mass balance estimates) could predict if a management practice would be protective; however, several members of the workgroup agreed that some groundwater monitoring would still be needed to verify the models assumption and conclusions. Many workgroup members suggested that special studies targeted around individual management practices would likely be needed to answer this question. These workgroup members also recommended that these special studies be completed by either academic or commodity research groups. It was also suggested that the Central Valley Water Board ask agricultural researchers to include a "groundwater emissions" component to their existing and/or future research projects.

- Site conditions and their effects on management practices: The workgroup discussed that site conditions (such as depth to groundwater and soil type) play a role in how quickly impacts to groundwater caused by various surface activities would be observed at the water table. Several workgroup members agreed that the these site conditions should be considered when evaluating the effectiveness of a management practice, particularly given that at some point the available ion exchange sites will be filled and that the discharge will eventually reach the groundwater table.

3. To what extent can irrigated agriculture's impact on groundwater quality be differentiated from natural sources or other anthropogenic sources of impact (e.g., nutrients from septic tanks or dairies)?

- Some workgroup members suggested that the biggest and least expensive step to addressing the issues associated with natural or other anthropogenic sources of COC's would be to have site groundwater monitoring wells (or find appropriate domestic supply wells) in areas with a known source of the recharge to the well. The workgroup also discussed co-contaminants, tracers, isotope analyses, and various other forensic tools to differentiate between irrigated agricultures impacts and impacts caused by natural sources or other anthropogenic sources. Several workgroup members suggested that this data would not be necessary for all areas covered by the monitoring program. The data may be needed in cases where other sources could be responsible for causing or contributing to groundwater impacts.

4. What are the trends in groundwater quality beneath irrigated agricultural areas (getting better or worse) and how can we differentiate between ongoing impact, residual impact (vadose zone) or legacy contamination?

- What are the trends in groundwater quality beneath irrigated agricultural areas: Consensus was reached that the only way to identify trends in groundwater quality was to conduct some type of long-term trend monitoring. Some workgroup members suggested that this monitoring also include the collection of groundwater elevation data. The workgroup came to consensus that no matter what frequency groundwater samples are collected, they should be collected on roughly the same date each year. Some workgroup members suggested that annual sampling would be adequate. Other workgroup members suggested that more frequent sampling should be conducted to identify the effects of seasonality and irrigation pumping on groundwater quality. It was also recommended that if statistical analyses were be used to identify trends in groundwater quality, seasonal trends must be considered.

- How can we differentiate between ongoing impact, residual impact (vadose zone) or legacy contamination? The workgroup discussed the use of co-contaminants. Specifically, it was recommended that constituents that were applied in the past that are currently not being applied, be used as indicator of legacy or residual impacts. The workgroup discussed how conducting studies in areas with coarse grained soils and shallow groundwater could remove many of the complexities associated with residual impacts and legacy contamination. Some workgroup members suggested that this approach be taken when conducting special studies to evaluate individual management practices.

5. What properties (soil type, depth to groundwater, infiltration/recharge rate, denitrification/nitrification, fertilizer and pesticide application rates, preferential pathways through the vadose zone [including well seals, abandoned or standby wells], and contaminant partitioning and mobility [solubility constants] are the most important factors resulting in degradation of groundwater quality due to irrigated agricultural operations?

- Several workgroup members agreed that soil type and depth to groundwater are two critical hydrogeologic properties that make an area vulnerable to experiencing groundwater degradation due to irrigated agriculture. Some of the workgroup members suggested that groundwater pumping is a critical factor resulting in groundwater degradation due to mixing shallow groundwater with the deep high quality groundwater. The workgroup discussed how redox conditions and how that may affect the concentration of nitrate and dissolved/trace metals. It was recommended by a member of the public that cation exchange capacity of the soil is also an important property.

6. What are the transport mechanisms by which irrigated agricultural operations impact deeper groundwater systems? At what rate is this impact occurring and are there measures that can be taken to limit or prevent further degradation of deeper groundwater while we're identifying management practices that are protective of groundwater?

- What are the transport mechanisms by which irrigated agricultural operations impact deeper groundwater systems: The workgroup discussed how abandoned wells, dry wells, and poorly sealed wells may act as direct conduits for irrigation water to reach deeper groundwater. Some members of the workgroup suggested that the lack of backflow prevention devices on many fertigation systems is a significant transport mechanism for irrigation water containing agricultural chemicals to reach deeper groundwater. It was recommended that permits contain a requirement that all fertigation systems be fitted with backflow prevention devices. It was suggested by some members of the workgroup that drainage wells are also an important transport mechanism for irrigation water to the subsurface.

- At what rate is this occurring: The topic of rate was not discussed by the workgroup.

- Are there measures that can be taken to limit or prevent further degradation of deeper groundwater while we're identifying management practices that are protective of groundwater: Consensus was reached between workgroup members that this portion of the question was not appropriate for the discussion of how to implement a groundwater monitoring program under the long-term ILRP.

7. How can we confirm that management practices implemented to improve groundwater quality are working?

- Several of workgroup members recommended that a properly designed and constructed groundwater monitoring network would be needed to answer this question. It was suggested that this type of monitoring well network could be used as part of a special study to evaluate individual management practices. Several members of the workgroup recommended the use of modeling combined with some groundwater monitoring to validate the models assumptions and conclusions.