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Joan Stormo, Senior Environmental Geologist
Colorado River Basin Regional Water Quality Control Board
73-720 Fred Waring Drive, Suite 100
Palm Desert, CA 92260
Email: jstormo@waterboards.ca.gov

Dear Ms Stormo:

I am pleased to provide the requested review of the staff report in support of a basin plan amendment to prohibit wastewater discharges from septic tank sub-surface disposal systems in the town of Yucca Valley, California.

1. USGS report of 2003. This study is a detailed analysis of exiting groundwater elevation data as well as nitrate levels in well waters within the Warren Subbasin. It is clear from this study that nitrate is coming from septic tank discharges.

2. USGS modeling. The USGS report adopts a number of modeling approaches that support the analysis that septic tank discharges are the main source of nitrate in pumped groundwater. Mixing models are used to compare groundwater nitrate levels with nitrate levels in various source terms including natural recharged groundwater, artificially recharged groundwater, and septic tank discharges. While not strictly predictive, mixing models are very powerful in demonstrating with measurements the dominant source of contamination when there are multiple sources. The use of isotopic analysis for the nitrogen atoms present in the groundwater nitrate provides additional supporting information that the source of the nitrate is septic tank discharges. Computer modeling of groundwater flow and nitrate transport quantify nitrate sources and their transport, but at a much more complex level. The water flow in the subsurface must first be simulated using the commonly accepted MODFLOW package. Water flow predictions from MODFLOW are then used to drive a solute transport, MOC3D, suitable for nitrate transport assuming nitrate is a conservative, nonreactive compound. Flow and transport models require a representation of the subsurface geometry that is only poorly known from well logs and local geologic information, including the presence of faults that can act as barriers to groundwater migration. These uncertainties in the subsurface lead to extensive model calibration to identify appropriate parameter values related to subsurface transport properties and nitrate release rates. Once the model is calibrated then sensitivity studies are undertaken to identify what parameters are critical, and in this case the USGS report provided a detailed analysis of model uncertainty.

3. USGS data adequacy. There is generally never enough data, but professional judgment is required to utilize the available historical data and recently collected data to move forward with more informed decisions. The historical data was adequate and new data collected from existing

wells in the basin was a reasonable approach to undertake groundwater flow and solute transport modeling.

4. Septic tank discharges and groundwater recharge. The multiple models evaluated in the USGS report ranging from mixing models to numerical groundwater and solute transport models support the conceptual model that the increase in nitrate in well water came from a rise in the water table caused by the importation of water into the basin. There is an alternative explanation that was not discussed in the USGS report. Prior to artificial recharge into the basin, the overdrafting of the groundwater basin provided a very thick vadose zone where septic tank nitrogen compounds probably encountered partially oxidizing conditions. Under those conditions ammonia and organic nitrogen can be oxidized to nitrate. If that nitrate is then mixed with high organic content septic tank water, nitrate reduction to nitrogen gas is possible via denitrification. When the artificial recharge was initiated, this possible soil-aquifer treatment system could have been arrested by water flooding. Since denitrification can cause a shift in the isotopic composition of the remaining nitrate, and perhaps there is a detectable shift in the nitrate isotopic composition to support or dismiss this alternative explanation. Nitrogen isotope geochemistry under denitrification conditions is not something I had time to investigate within the time constraints of this review.

5. Groundwater data from 2002 – 2010. Appendix D of the staff report with recent nitrate and groundwater elevation data demonstrate continued high levels of nitrate in the groundwater even though they do not exceed drinking water standards. Levels reported are in the range of 10 to 30 mg/L and that level might represent some steady state value of septic tank discharges and groundwater recharge, but such an analysis does not appear in the staff report and the USGS report does not consider that situation. In the USGS 2003 report, Figure 15 (page 42) shows nitrate concentrations increasing over time in the deepest groundwater sampling interval (YV2-570) over the period of artificial recharge with SWP water. Additionally, groundwater from this deepest sample with the highest nitrate concentrations has a mixing curve of Delta Oxygen-18 water and nitrate in Figure 18 (USGS page 55) that indicates there has been no dilution of that water with imported SWP water. These results suggest that septic tank discharges are possibly denser than ambient groundwater and artificially recharged SWP water causing the waste to sink to the lower levels of the aquifer. Appendix D in the staff report does not include nitrate concentrations in that well in the 2003 to 2010 period to evaluate if deeper groundwater could be a reservoir of nitrate contamination for the whole aquifer.

Bigger Picture:
The USGS report and the staff report on the Yucca Valley water supply did not start off with an analysis of the aquifer storage, the town's water pumping, and septic tank discharges to quantify the waste load being added to the subsurface. Under natural conditions the inflow and outflow were estimated by USGS at less than 100 ac-ft/yr, and as a consequence, the water in the basin is old based on radiocarbon dating with estimates of 2000 to 3000 years (page 14). Water pumping prior to the importation of State Water Project water was mining the groundwater aquifer with well pumping far exceeding inflows and septic tank discharges. While there is considerable consumptive use of Yucca Valley water reported for a golf course, there is no consideration of landscape irrigation by households and the corresponding nutrient loads associated with those practices. A Google Earth image of the town of Yucca Valley in February 2009 indicates limited landscaping, but this is the middle of winter. There should be an analysis of actual consumptive use with an overall water balance for the basin. Prior to the importation of SWP water the groundwater aquifer was being used as the sole source of drinking water and the sole recipient of wastewater. That circumstance resulted in the long term buildup of wastewater components in the

groundwater basin and would not be viewed as sustainable either from a water supply or a waste management perspective.

The installation of a sewer during Phase I implementation is justified by the annual rate of failure of septic systems within Yucca Valley. Septic systems for residential development at that density along with commercial establishments exceed waste accommodation rates and the soil's infiltration capacity. Separate from the documents presented for this review was a description of the Water Reclamation Facility being planned for Yucca Valley present on the Hi-Desert Water District website. The proposed plant will utilize secondary treatment with filtration to achieve 10 mg/L BOD (organic matter), 10 mg/L suspended solids, and 8 mg/L total nitrogen. With extended aeration it is likely the wastewater effluent will be nitrified and all the nitrogen will be present as nitrate. Since this effluent will be infiltrated on site, the groundwater basin will again be subject to increased nutrient loading along with the accumulation of salts within the aquifer. While the sewer collection system and treatment plant will be an advance over a poorly functioning diffuse septic system, will the solution being proposed ultimately improve the nitrate loading to the groundwater basin?

I hope these comments are useful to you in your deliberations.

Sincerely,

James R. Hunt

James R. Hunt
Lawrence E. Peirano Professor of Environmental Engineering
Co-Director, Berkeley Water Center