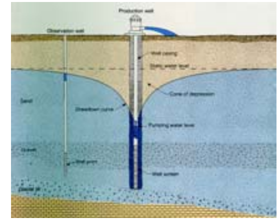
This article is the fourth in a series of five to be published in 2005/06 discussing topics related to groundwater and water wells in the northern Sacramento Valley.

Article No. 4 – September, 2006



MONITORING GROUNDWATER QUALITY: AN IMPORTANT ASPECT OF GROUNDWATER MANAGEMENT

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This Outreach is funded by the "Four County Drinking Water Quality Program" – Butte, Glenn, Tehama, and Colusa Counties

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INTRODUCTION

Past articles in this informational series on groundwater management and well water topics have highlighted understanding the valley geology, monitoring groundwater levels, and monitoring land subsidence as important components of protecting and utilizing the groundwater aquifer systems in the northern Sacramento Valley. Copies of past articles in this series can be downloaded at http://www.glenncountywater.org (select water education, bottom left menu). This article focuses on groundwater quality, an equally important component of groundwater management, by discussing basic principles pertaining to groundwater quality and by providing an overview of current groundwater quality monitoring activities underway in the north valley.

AN IMPORTANT CHARACTERISTIC OF GROUNDWATER

One of the most unusual characteristics of water is its ability to dissolve a wider range of substances than any other liquid. What gives water this unusual dissolving capacity? The water molecule is formed from the bonding of two hydrogen atoms to one oxygen atom (Figure 1). The negatively charged oxygen atom attracts and bonds to the positively charged hydrogen atoms in a unique V-shape. This unique shape and distribution of charges creates a positive and negative end, which results in a highly polar character that behaves like an electromagnet. The strong polar nature of water allows it to attract both positive and negative charged ions and molecules from other substances, and gives water the unique ability to dissolve a large number of substances.

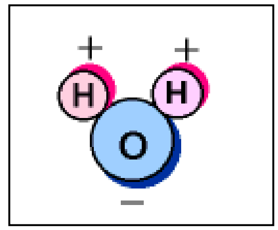

Figure 1. The water molecule.

The combination of the unusual dissolving capacity of water and its slow percolation through the ground, results in the addition of natural minerals and other human-induced substances into the groundwater. Changes in chemical character of the groundwater occur, subtle or pronounced, producing a unique chemical signature of the groundwater that reflects the aquifer geology and human-related influences encountered along its flow path.

OVERALL GROUNDWATER QUALITY

Currently, about 1.2 million acre-feet of groundwater are withdrawn during an average year in Tehama, Glenn, Butte, and Colusa counties. In general, the quality of groundwater is quite high. However, localized areas of lower quality groundwater do exist. In some areas, naturally occurring constituents associated with local aquifer geology, such as salinity, boron, and trace metals may affect uses of groundwater. In other areas, human-induced constituents from a wide variety of sources such as leaky fuel tanks, septic systems, waste disposal facilities, homeowner activities, agricultural activities, and industrial processes may contribute to a decline in groundwater quality (Figure 2).

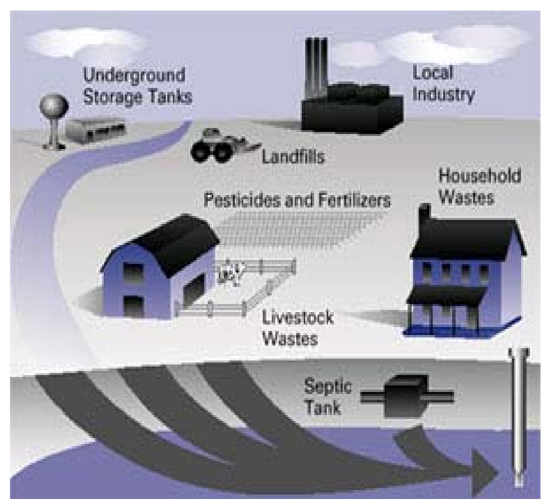

Figure 2. Potential human influences on groundwater quality.

HOW IS GROUNDWATER QUALITY DEFINED?

Groundwater quality is defined based on a set of health and safety regulations for domestic use. Similarly, the quality of groundwater is analyzed and evaluated for other uses (Figure 3). Groundwater used for public domestic supply must adhere to a more rigorous set of regulatory objectives for health and safety than groundwater used strictly for irrigation needs. The quality of public water systems must fall below the maximum contaminant levels (MCL's) for a standard set of constituents. No adverse human health effects are known to exist at the recommended MCL's. Presently, MCL's have been determined and recommended for: inorganic

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chemicals such as arsenic, mercury, and nitrate; for optimal fluoride levels; natural and man-made radioactive substances; man-made, volatile organic carbon compounds typically associated with industrial activities; non-volatile, synthetic organic chemicals associated with past or present agricultural and urban pesticide use; and for other parameters such as color, odor, corrosion, turbidity, bacteria, and salinity. The MCL's can be viewed at: http://www.dhs.ca.gov/ps/ddwem/chemicals/MCL/EPAandDHS.pdf. They are under continual review by the Department of Health Services (DHS) Drinking Water Program to enforce the Federal and California Safe Drinking Water Acts (legislation dating back to 1946, 1974 and 1975). The State Water Resources Control Board (SWRCB) and the Regional Water Quality Control Boards (RWQCB) also enforce and review these drinking water objectives according to the *Porter-Cologne Water Quality Control Act* (1969 legislation).

Figure 3. Adjectives like "high" or "low" and "good" or "poor" are often used to describe groundwater quality. Regulatory and non-regulatory criteria exist to define groundwater quality based upon health and safety concerns and a variety of potential uses.

Non-regulatory guidelines exist to assess groundwater suitability for a wide variety of different uses. For example, guidelines exist to evaluate groundwater suitability for irrigation of ornamental landscape plants and agricultural crops. Groundwater quality for irrigation is generally evaluated for potential to accumulate salts in soils, specific types of toxicity from root and foliar absorption, adverse affects on soil physical properties, and for plugging of irrigation filters and drip or microsprinkler emission devices. Other examples for assessing groundwater quality include guidelines for well water design, construction, and maintenance, and criteria to determine suitability of groundwater for specific industrial processes such as cooling, boilers, and food processing.

CURRENT GROUNDWATER QUALITY MONITORING

Groundwater quality sampling and testing can be time consuming and expensive. As such, the sampling and testing programs are tailored to meet specific water quality questions. In the case of wells providing domestic water, the focus is on fulfilling the regulatory requirements for health and safety. In the case of non-regulatory groundwater quality monitoring, the focus can vary, but often stems from a need for further knowledge. These activities provide baseline water quality data, help characterize the physical distribution and source of recharge for specific aquifer systems, assist with evaluating an aquifers potential vulnerability to contamination, and help assess the potential uses and limits of specific groundwater supplies.

REGULATORY MONITORING ACTIVITIES, At the local level, the Department of Health Services (DHS) works with county health and planning departments to help protect local domestic sources and, in the case of Butte and Tehama Counties, provide regulatory oversight of some of the smaller public water supply systems. The California Department of Pesticide Regulation (DPR) works with the county agricultural commissioners to determine where and how pesticides are contaminating groundwater, identify areas sensitive to pesticide contamination, develop mitigation measures and implement best management practices to prevent pesticide movement, and adopt regulations to carry out mitigation measures. In addition, some counties have adopted groundwater management ordinances, which incorporate groundwater quality sampling to protect against future degradation of the resource. Overall, these regulatory activities serve to protect California's groundwater quality by developing standards for well construction, wellhead protection, public water supply monitoring and reporting, underground storage of hazardous substances, and a number of other activities which have the potential to impact water quality. Groundwater quality data and additional information regarding these regulatory programs can be accessed at the following websites:

SWRCB Division of Water Quality: http://www.waterboards.ca.gov/quality.html?counter=14514
DHS Drinking Water Program: http://www.dhs.ca.gov/ps/ddwem/technical/dwp/dwpindex.htm
DPR Groundwater Protection Program: http://www.cdpr.ca.gov/docs/gwp/index.htm

NON-REGULATORY MONITORING ACTIVITIES, A number of local interest groups, private and public water purveyors, and county, state, and federal agencies participate in groundwater quality monitoring outside the required regulatory programs. A summary of some of these monitoring activities is provided in the remainder of this article.

DWR Monitoring, Northern District DWR conducts monitoring of groundwater quality in domestic, irrigation, and dedicated monitoring wells throughout the Northern Sacramento Valley. Some of the wells are monitored annually and others are monitored on a three or four year rotation. The monitoring focuses on collection of long-term baseline data, analyzing for naturally occurring indicators of groundwater quality such as minerals (salinity), metals, and nutrients. The monitoring also seeks to delineate natural from human-induced impacts on groundwater quality such as nitrate contamination. Figure 4 shows, at present, 45 dedicated monitoring well locations in the north valley. Sampling is often performed using dedicated monitoring wells to isolate discrete aquifer intervals (Figure 5). DWR also collaborates with counties, water purveyors, Lawrence Livermore National Laboratory (LLNL), and the United States Geological Survey (USGS) to provide a more detailed analysis of groundwater chemistry. The more extensive analysis commonly includes testing volatile organic compounds (VOC's), isotopes, and age dating. These data are available on the internet at DWR's Water Data Library: http://wdl.water.ca.gov

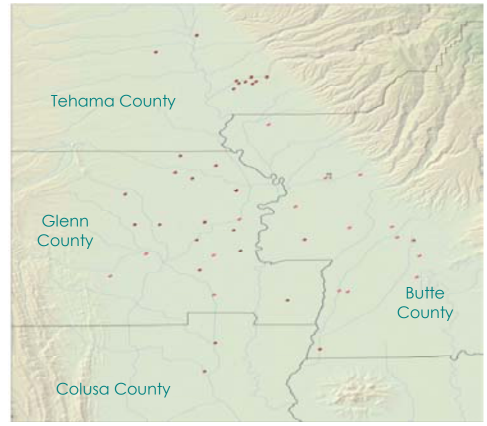

Figure 4. Dedicated monitoring wells in the northern Sacramento Valley sampled for water quality.

County Monitoring, Butte, Colusa, Glenn, and Tehama counties have developed the *Four County Drinking Water Quality Program,* which promotes collaboration in the north valley for effective monitoring and analysis of shared drinking water resources, and contributes to local, regional, and statewide water quality goals. Part of this program includes an ongoing assessment of current groundwater quality. Many of the dedicated monitoring wells currently sampled by DWR have been authorized and established by local entities and, thus, contribute to local groundwater quality assessment. A number of counties also incorporate groundwater quality sampling as part of the local groundwater management ordinances or management plans. For example, Butte and Glenn Counties have been collecting baseline data on temperature, pH, and electrical conductivity (Figure 6). Water quality information collected as part of these management activities may be obtained through the respective counties.

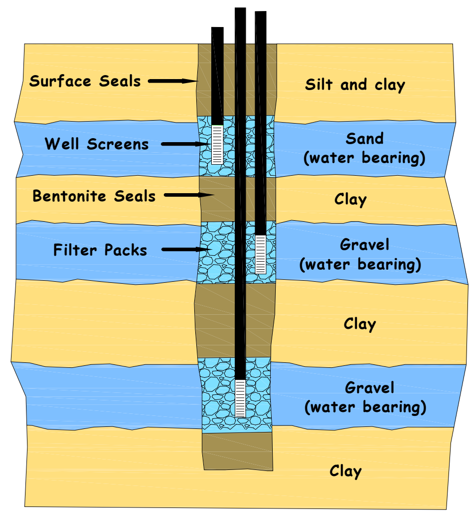

Figure 5. Example of discrete aquifer sampling with dedicated monitoring wells.

Groundwater Ambient Monitoring and Assessment (GAMA) program is a comprehensive statewide monitoring activity. The GAMA Program monitors groundwater for a broad suite of chemicals. The program was developed in response to the Groundwater Quality Monitoring Act of 2001 (AB 599), and is implemented by SWRCB in coordination with the USGS and LLNL. Local participation in the GAMA program is entirely voluntary. Monitoring and assessments for priority groundwater basins are to be completed every ten years, with trend monitoring every 3 years. A portion of the Northern Sacramento Valley was sampled during July and August, 2006. Local counties, public water supply purveyors, and DWR assisted USGS by helping select sampling wells, providing site access, and additional equipment. More Information on the GAMA program is available at: http://www.swrcb.ca.gov/gama/index.html

CAS Monitoring Program: Prior to 2003, the California Aquifer Susceptibility (CAS) Assessment Program was conducted. The CAS Assessment addressed the relative susceptibility of public wells to contamination. This effort was the foundation for the GAMA Program. As part of this effort, DWR coordinated with LLNL to sample numerous public supply and dedicated monitoring wells in Butte, Glenn, Tehama, Modoc, Siskiyou, Plumas, and Shasta counties. A 2005 report by LLNL assessing this data is available on the internet at: http://www.waterboards.ca.gov/gama/cas.html.

Figure 6. Groundwater quality sampling and monitoring at a dedicated monitoring well in Butte County.

NEXT ISSUE

The next issue of this informational series will discuss findings from ongoing groundwater quality monitoring efforts in the north valley. It will also discuss how the understanding gained can assist local and regional groundwater management efforts.