Progress with Groundwater Management in the Rural Counties of the Northern Sacramento Valley

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Introduction

Shasta, Tehama, Glenn, Butte, and Colusa Counties lie within the Sacramento River watershed which is widely recognized as a vital part of California's water system to meet agricultural, environmental, and municipal needs throughout the state. Annual water demand in this five county area is approximately 4.2 million acre-feet. Butte, Glenn, and Colusa counties each use between 1.0 and 1.3 million acre-feet while demand in Tehama and Shasta counties is about 220,000 to 380,000 acre-feet yearly. The need is greatest for agriculture, followed by domestic and industrial uses, and then public and private wetlands.

Californians are often unaware that groundwater extraction is important in supplying the annual demand in the northern Sacramento Valley. There are currently over 30,000 wells that extract groundwater from the Sacramento River Basin in this five county area and about 80 percent of the wells are either privately owned domestic wells or municipal and industrial wells. Figure 1 shows the percentage of the annual water demand supplied by groundwater and surface water in each county. Reliance on groundwater varies, being greatest in Tehama County and lowest in Colusa County. In Tehama County, about 70 percent of the annual water demand for agriculture, domestic, and industrial uses is supplied by groundwater. Figure 2 illustrates the existing density of water wells in Tehama County. Reliance on groundwater has increased in all five counties over the last two decades. For instance, in the early 1990's, only 30 percent of the annual water demand in Tehama County was supplied by groundwater. Drought, residential development, changes in water policies to address fisheries and Delta water quality issues, and shifts to orchard and vine crops that use more efficient drip and microsprinkler irrigation have contributed to increased reliance on groundwater. Attention to groundwater management is underway in these counties to ensure that the long term water needs in the area are met and sustained.

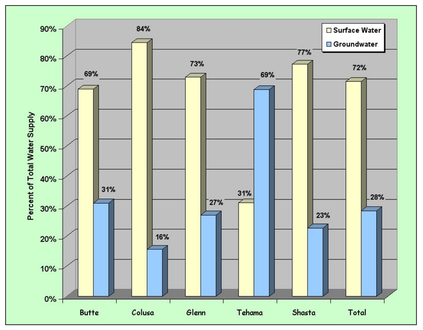

Figure 1. Proportions of annual water demand supplied by surface and groundwater in the rural northern Sacramento Valley Counties. Source: DWR, 2005.

Figure 2. Over 13,000 water wells supply water for agriculture, domestic and industrial uses in Tehama County. Well density is particularly concentrated on the valley floor. Source: DWR, 2011.

Challenges Inherent to Groundwater Management

Engaging a variety of socio-economic considerations and scientific questions are important to implement groundwater management. Some of these considerations and questions are discussed below. They are not unique to the northern Sacramento Valley.

Socio-economic considerations:

- **Diversity among local water interests** - agriculture, domestic, municipal, and environmental interests working together to implement management that balances economic vitality and resource preservation. Various water interests have different core values and capacity to engage in groundwater management. Differences often exist even within a single sector. For example, an agricultural water user who has rights to both surface water and groundwater may have different values and abilities to participate in groundwater management than an agricultural water user who is solely reliant on groundwater.
- **Local but central oversight and leadership** - the diversity among local water interests and their capacities to engage groundwater management require acceptable leadership and organization to provide coordination and oversight. Questions arise whether it is best to organize along political boundaries (e.g. as individual counties) or based upon commonalities in hydrologic and geologic conditions. Organizing to foster groundwater management is further challenged by the fact that a relatively small fraction of all water users give routine thought and attention to groundwater resource management.
- **Private property rights** - an acceptable approach to groundwater management needs to be cognizant and respectful of private property rights. This will influence the approach to groundwater management.
- **Affordability and practicality** - less populated, rural counties have relatively low public revenue to invest in groundwater management. An acceptable approach to groundwater management will be streamlined so it is possible to implement management within the framework and staffing of existing public agencies and services.
- **External regional or statewide influences** - local groundwater management needs to be in tune with regional and statewide water issues. Acceptable management will secure the long-term needs for water in the local area and seek to demonstrate to what extent it can or cannot contribute to resolving broader regional or statewide water needs.

Scientific questions:

- **Groundwater aquifer systems** - the geologic and hydrologic features of the aquifers from where groundwater is extracted are usually complex. Understanding these characteristics are fundamental to managing groundwater.
- **Groundwater conditions** - establishing a monitoring network to track temporal and spatial trends in groundwater conditions is a vital element of management. What constitutes adequate monitoring is a re-occurring question.
- **Water well infrastructure** - the existing water well infrastructure in the northern Sacramento Valley has been established over several decades by the investment of thousands of northern Californians. Characterizing the infrastructure and relating it to groundwater conditions is important. Anticipating future well infrastructure needs may also be important to manage groundwater.
- **Surface hydrology and sources of groundwater recharge** - understanding the pathways for natural recharge of the groundwater aquifers is important to management. Characterization of the surface geology improves understanding and assists with planning active recharge efforts and may guide land use planning decisions.
- **Economic vitality** - growth and changes in land use can be anticipated in the future. Opportunities exist to develop and implement "smart" planning tools to assist groundwater management. This may include groundwater, land use, population, economic, and climate change modeling.

Northern Sacramento Valley Experience

Water users and county governments in the northern Sacramento Valley have been working to manage groundwater since the late 1980's. The primary forms of management undertaken have involved county ordinances and AB 3030 groundwater management plans (Water Code §10750). These forms of management were preferred to court ordered adjudications or legislated "special districts" which usually specify how much groundwater each landowner can extract and how many wells can be constructed in a basin. Adjudication and special districts were viewed as less adaptive to changing circumstances, increasing knowledge, and not necessarily founded on principles of local management.

Elements of Groundwater Management

- Leadership, administration, and enforcement
- Monitor groundwater conditions
- Evaluation of data
- Collaboration and adaptive management
- Special projects
- Long-term planning
- Regional coordination
- Broad-based education

Leadership, administration, and enforcement:

A specific department within each county's government administers the groundwater management efforts. The department varies between counties. The Department of Agricultural Commissioner and Sealers oversees management in Glenn County, the Department of Public Works provides oversight in Tehama County, and Butte County has established the Department of Water and Resource Conservation. The choice of the administering department may reflect the county setting and existing capacity and staffing. Each of the departments are responsible to the County Board of Supervisors, who in turn provide leadership, accountability, and enforcement as groundwater management is implemented. Voter approved, county ordinances play an important role to provide each of the Board of Supervisors with authority to enforce policies on groundwater management. The Board of Supervisors hold an important role in conflict resolution when contentious issues arise. While the administrative approach is slightly different in each county, they each rely on formal advisory committees to regularly involve various stakeholders and in some cases form collaborative agreements with other water interests in the county who also have legal authority in water resource management.

Monitoring groundwater conditions:

Monitoring is a core element of groundwater management in the northern Sacramento Valley. Each county has a network of key monitoring wells. Initially, they consisted of domestic and irrigation wells but over time investments are being been made to improve the network by constructing dedicated monitoring wells. Small diameter monitoring wells are constructed at multiple depths that are associated with key water bearing strata and correspond to depths where water wells have been constructed or may be constructed in the future. Figure 3 shows the current groundwater level monitoring network in Tehama County. Groundwater levels are measured in 45 key wells in 9 of the 12 groundwater sub-basins, each with uniquely different hydrologic features and water demands. Eight of the 45 key wells are dedicated, multi-completion monitoring wells. The other 37 key wells are either irrigation or domestic wells with a long history of monitoring and where well logs are available to provide information about their construction and whether they represent other surrounding wells. Groundwater levels are measured in the spring before the most intensive season of extraction and in the fall after the most intensive period of extraction but before the winter season and when recharge occurs. Similar networks exist in Glenn and Butte Counties and are in development in Colusa and Shasta Counties. County staff from the respective administrative departments oversee data collection and inputting into databases. Staff also work collaboratively with the California Statewide Groundwater Elevation Monitoring (CASGEM) program.

Groundwater quality and land subsidence are also monitored. Whenever possible, due to a wide array of possible constituents of concern and related costs, groundwater quality monitoring is accomplished through collaborative efforts. Examples include past cooperation with the USGS Groundwater Ambient Monitoring and Assessment (GAMA) program and potential cooperation with the Sacramento Valley Water Quality Coalition. A network of GPS land surface elevations was established in the northern Sacramento Valley counties in 2008 to provide benchmarks to detect land subsidence. Plus, cable extensometers have been constructed as part of two dedicated monitoring wells located in Butte and Glenn counties to detect early signs of land subsidence.

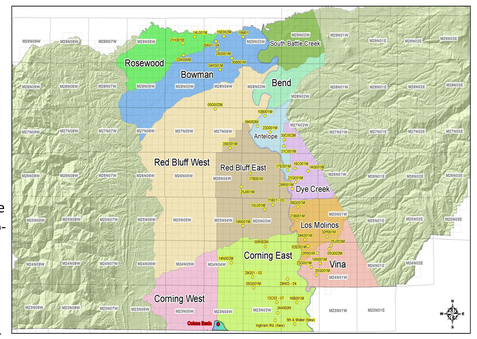

Figure 3. Locations of key monitoring wells for groundwater management in Tehama County (denoted by yellow symbols and state well identification numbers).

Data evaluation:

Groundwater monitoring data provides a basis for establishing management objectives and provides feedback as to whether they are being achieved. Figure 4 illustrates the long term trends in spring groundwater levels (a hydrograph) for one key well in the Tehama County monitoring network after most of the recharge has occurred and before the next season of intensive extraction begins. Each key well has a specific hydrograph that reflects uniquely different groundwater conditions. The hydrograph indicates the extent that groundwater levels recovered from the previous year of groundwater extraction and whether the levels are within normal ranges (43 to 61 feet below ground surface). A similar hydrograph is also developed for fall groundwater levels (not shown) after the most intensive season of groundwater extraction to evaluate whether groundwater drawdown levels are within normal levels. These management objectives are defined for each key well and identify groundwater levels that surpass historic lows (63 feet for this key well) and provide management alerts. Groundwater quality and land subsidence data are also included in the evaluation and part of the overall management objectives.

Assessment of the water well infrastructure surrounding each key well is also part of the data evaluation. Aggregate analysis of the well logs filed with the California Department of Water Resources (DWR) have been queried for the nine square mile area surrounding each key well (approximate common area of influence). Figure 5 shows the distribution frequency of the wells by depth for 571 privately owned domestic wells, 25 irrigation wells, and 8 industrial or municipal wells operating in the nine square miles surrounding the key well. The spring and late season management objectives (trigger levels) are also denoted on the graph along with the well construction depth of the key well. The analysis shows the management objective for groundwater levels for this key well and the surrounding area have been defined at levels that should protect over 90 percent of the existing well infrastructure from dewatering. It also suggests that the key well construction is representative of many of the wells in its vicinity and lends insight to the potential risk of more wells dewatering and impacts upon people if groundwater levels were managed such that they decline further.

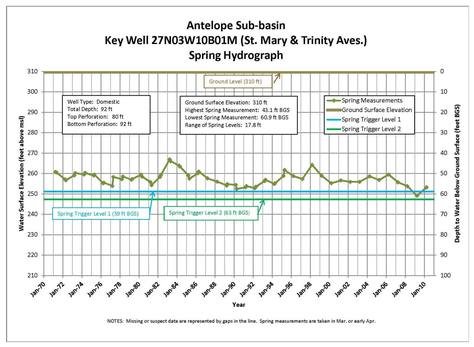

Figure 4. Example hydrograph for a key well in Tehama County showing historic trends in spring groundwater levels and specific management objectives.

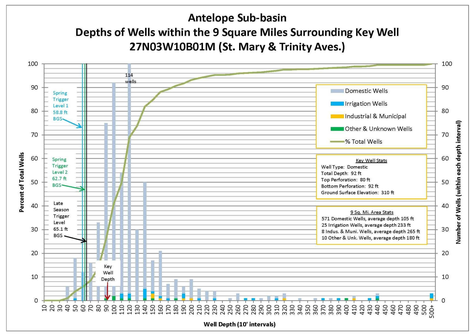

Figure 5. Example frequency distribution chart showing well construction depths in relation to groundwater level management objectives.

Adaptive management and collaboration:

Management is flexible and dependent upon regularly updated information on the groundwater conditions and the management objectives. The management objectives are in place to determine when to initiate a management response to an apparent need (Figure 6). Depending upon the scope of the issue the response may range from improving communication, increased monitoring and investigation, or pursuing a specific action to resolve or curtail the matter. Collaboration among all of the water interests in the county and perhaps among water interests in neighboring counties is foundational to achieving creative and effective management of specific issues. In the event widespread and extraordinarily poor groundwater conditions were to develop, each county, either by way of ordinances or adopted management plans, has an established priority of beneficial uses to guide more extreme management measures such as rationing or giving priority to one use over another.

Special Projects:

Special projects or investigations are undertaken that go beyond routine monitoring of groundwater conditions and evaluation of management objectives. They may add technical understanding about groundwater resources, add capabilities to evaluate data, or assess future needs and initiate planning to fulfill them. Numerous special projects have been completed over the past two decades or more. Some of the more recent completed projects include:

- The Tuscan aquifer project - Butte and Tehama Counties (2012)
- Feasibility study - inlieu recharge in the Capay area of Glenn and Tehama Counties (2012)
- Tehama County groundwater recharge area location study (2011)
- Development of the Basin Management Objective Information Center (BMOIC) - Butte, Glenn, Tehama, and Colusa Counties (2006)

Long term planning and regional coordination:

Groundwater management is ongoing and its importance is only going to increase in time. Long term planning is a vital part of management to anticipate future needs and to be prepared to engage them. Each of these northern Sacramento Valley counties has an existing groundwater management plan which they are currently implementing. These plans undergo reviews and updates as appropriate. In addition, the individual counties realize that groundwater resources are not bound by political boundaries and so coordination among counties has become common practice. Butte, Colusa, Glenn, Shasta, Sutter, and Tehama Counties have joined to form the Northern Sacramento Valley Integrated Regional Water Management Plan group and they are in the process of developing a long range plan for water resources management in this region.

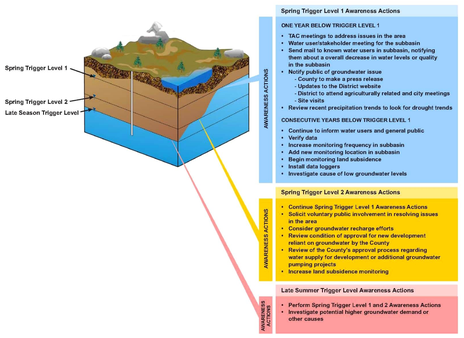

Figure 6. Conceptual illustration of groundwater level management objectives and corresponding awareness stages and possible actions that may be exercised.

Broad-based education:

The idea of groundwater management conjures many thoughts among water users and in some cases creates angst. Efforts to educate the broader public is important. It can convey its importance and teach concepts that employ objective, science based approaches to management. In due course, education can help build collaboration and improve management.

Broad-based education is an aspect of groundwater management that the University of California Agricultural and Natural Resources (UC ANR) has been contributing. Examples of educational materials that have been written in the past to specifically support groundwater management in the northern Sacramento Valley are displayed at the right. Other possible avenues to contribute include:

- Participation is special projects and scientific investigations
- Technical advisory roles in planning and scoping tasks
- Assistance with adapting science-based knowledge into management methodologies