ACQUIRING A BETTER UNDERSTANDING OF THE GROUNDWATER WELL INFRASTRUCTURE ON THE VALLEY FLOOR OF TEHAMA COUNTY AND NEIGHBORING COUNTIES

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Groundwater well infrastructure: What is it?

Today, in Tehama County, nearly 70 percent of the annual water demand for domestic, municipal, industrial, and irrigation is supplied by groundwater. On average about 195,000 acre-feet of groundwater is extracted annually from groundwater wells. During drought periods the volume of groundwater extracted is higher and as land uses change, the trend is towards greater reliance on groundwater in the future.

Some of the earliest groundwater wells were developed in the 1900's to supply domestic water supplies. They were shallow wells that were commonly dug by hand. Since then, the groundwater well infrastructure in Tehama County has expanded one well at a time and now includes over 13,000 wells. Most of them provide water for domestic, industrial and municipal uses, or irrigation. However, some have other purposes such as providing livestock water and some are dedicated strictly to groundwater level and groundwater quality monitoring such that little or no water is extracted.

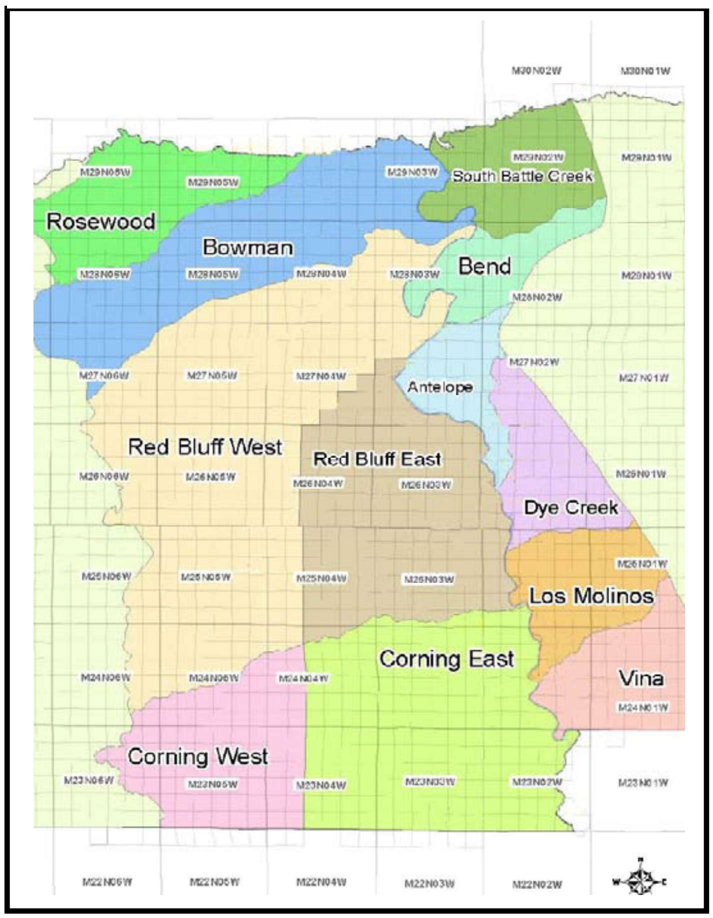
"Groundwater well infrastructure" is a term that describes the number of wells that have been constructed in Tehama County and the corresponding uses of the groundwater extracted from them. It also considers their geographic distribution throughout the county and their well depth distribution.

Where are the groundwater wells and how many are there?

Figure 1 shows twelve groundwater sub-basins on the valley floor in Tehama County. These sub-basins are recognized in the Tehama County Coordinated Groundwater Management Plan adopted in 1996 and are also recognized by the California Department of Water Resources. Each sub-basin has unique hydrologic, land use, population, and other features that distinguish them and influence how many groundwater wells have been developed.

Table 1 provides estimates of the number of groundwater wells that have been constructed between 1970 and 2006 in each of the twelve groundwater sub-basins and specifies the corresponding uses of the groundwater extracted from them. This information is based upon well construction logs that have been submitted to the California Department of Water Resources. Domestic wells are relatively shallow wells that provide water to individual households, home landscapes, and out buildings. Municipal wells may be deeper wells that provide domestic water to multiple households and landscapes. They include city municipalities and water service districts. Industrial wells are individual wells that provide water supplies for local manufacturers, processors, and distributors. Irrigation wells are

Figure 1. Map of the twelve groundwater sub-basins and corresponding townships on the valley floor of Tehama County.



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individual wells that supply water to grow the wide variety of field, forage, and orchard crops in Tehama County.

Domestic wells appear most abundant in each sub-basin, followed by irrigation wells, and then industrial and municipal wells. The Red Bluff West and Corning East sub-basins had the highest total number of wells, both surpassing 2000 groundwater wells. However, the Corning East sub-basin had a notably higher proportion of irrigation wells (31 percent) than the Red Bluff West sub-basin (3 percent). The Red Bluff East sub-basin had the third highest total with over 1400 groundwater wells and 18 percent of them as irrigation wells. The Bowman sub-basin had the fourth highest total with just over 1100 wells with about 3 percent for irrigation. The other seven sub-basins have fewer groundwater wells. Most notably, the South Battle Creek sub-basin had the fewest groundwater wells (only 17) of any area in Tehama County.

Table 1. Overview of the number groundwater wells in each groundwater sub-basin of Tehama County and the corresponding uses of the water extracted from them.[1]

Groundwater sub-basin	Number of domestic wells	Number of industrial and municipal wells	Number of irrigation wells	Total number of groundwater wells
Antelope	770	11	112	**893**
Bend	144	0	19	**163**
Bowman	1051	14	37	**1102**
Corning East	1377	26	630	**2033**
Corning West	60	1	14	**75**
Dye Creek	314	2	50	**366**
Los Molinos	303	6	38	**347**
Red Bluff East	1137	37	254	**1428**
Red Bluff West	2119	7	63	**2189**
Rosewood	196	1	13	**210**
South Battle	12	0	5	**17**
Vina	115	4	66	**185**
TOTAL	**7598**	**109**	**1301**	**9008**

[1] Source: Tehama County AB-3030 Groundwater Management Plan Technical Memorandums. July 1, 2008. Tehama County Flood Control and Water Conservation District.

Undoubtedly, the information provided in Table 1 has changed since it was summarized in 2006 and will continue to change with time. In a public presentation given December 2009, the California Department of Water Resources Northern Region office reported a total of 8728 domestic wells, 115 industrial and municipal wells, and 1340 irrigation wells for a total of 10,183 groundwater wells in Tehama County.

What is known about the distribution of groundwater wells by depth?

The well construction log data in Tehama County has also been evaluated from the perspective of well depth distribution in addition to geographical distribution. Figure 2 below illustrates estimates of the well depth distribution of domestic groundwater wells in Tehama County prior to 2003. It shows 7801 domestic wells existed in Tehama County with 50 percent of them (3901 wells) being 150 feet or less in depth. Similarly, Figure 3 shows the depth distribution of the irrigation wells in Tehama County prior to 2003. It shows 1307 irrigation wells existed in Tehama County with 50 percent (654 wells) 225 feet or less in depth. Similar data for industrial and municipal wells was also reported in the 2003 Tehama

County Water Inventory and Analysis but are not shown in this article. A total of 132 industrial and municipal wells existed in Tehama County with 50 percent (66 wells) 175 feet or less in depth. Slight differences in the number of total wells and different types of groundwater wells are recognized between those reported in Table 1 and Figures 2 and 3. These differences most likely reflect slightly different designations in the types of wells when the construction well logs were analyzed on two different occasions. The discrepancies are minor and overall trends are in agreement in the context of the broader question of "what is known about the distribution of groundwater wells by depth".

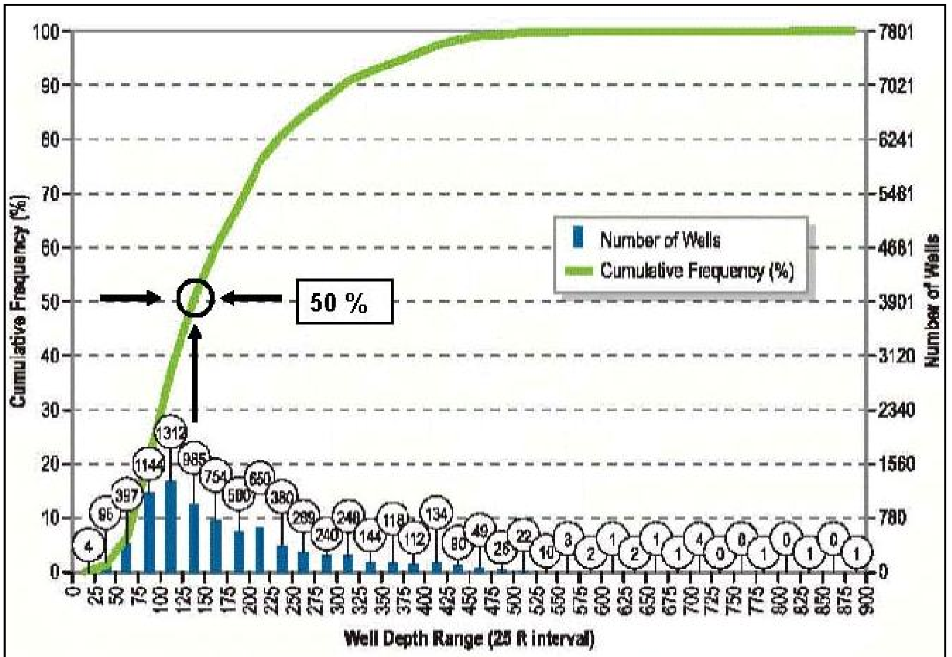


Figure 2. **Depth Distribution of Domestic Wells in Tehama County**

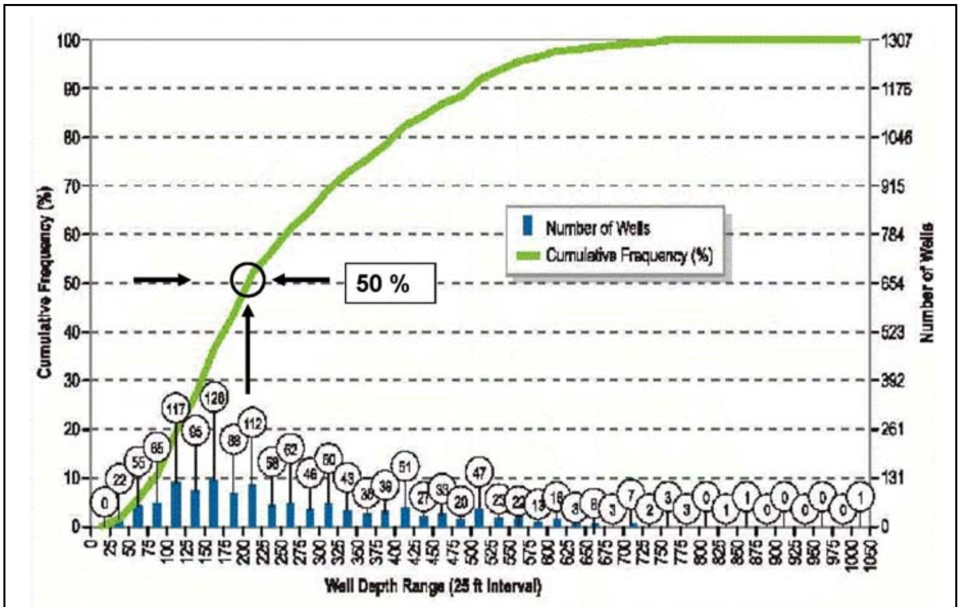


Figure 3. **Depth Distribution of Irrigation Wells in Tehama County**

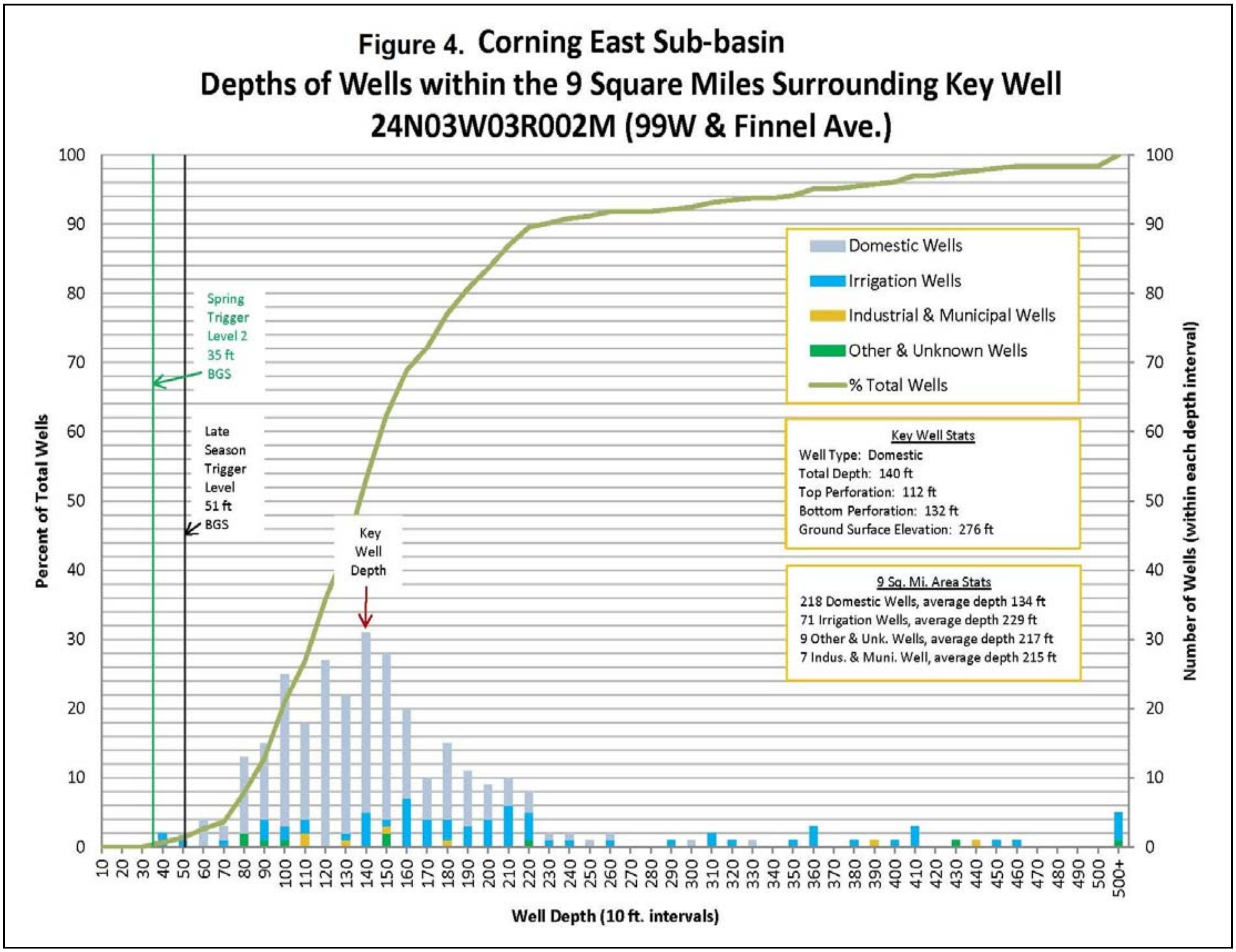
[2] Source: 2003 Tehama County Water Inventory and Analysis. Tehama County Flood Control and Water Conservation District.

How does information on groundwater well depth distribution relate to groundwater levels?

Currently, there is an effort underway in both Tehama and Glenn Counties to relate historic groundwater level measurements collected from key monitoring wells to information about the well depth distribution of groundwater wells within the various groundwater sub-basins of each county. This assessment will require time to complete and information from this analysis will be shared as it becomes available. An example for Tehama County is described below to demonstrate how the assessment is being conducted.

An assessment is being conducted for each groundwater sub-basin within Tehama County because of their unique hydrologic, land use, population, and other features. Efforts have been made to select key wells within each sub-basin with construction features (i.e. well depth and screening depth) that represent other groundwater wells in the surrounding area. They have also been selected based upon their accessibility so that static spring and fall groundwater levels can continue to be measured annually to track long term trends. The historic groundwater levels measured in these key wells within each groundwater sub-basin can then be compared to the depth distribution information of groundwater wells surrounding each key well. Groundwater well construction logs are being analyzed to assess the number of domestic, industrial and municipal, and irrigation wells and their depth distribution within the nine square miles surrounding each key well. The analysis of groundwater well infrastructure surrounding each key well is limited in area to recognize a primary sphere of influence of several potentially localized variables on groundwater levels. Some of the variables that may influence groundwater levels are pumping drawdown of surrounding wells, recharge from nearby surface water sources, and variations in land use and population.

Figure 4 below provides an example to demonstrate the type of results attained from comparing historic groundwater levels to well depth distribution information. The results are for a key well in the Corning East Sub-basin located near Highway 99W and Finnel Avenue in Tehama County and the surrounding groundwater well infrastructure.



The results show there are 218 domestic wells, 71 irrigation wells, and 7 industrial and municipal wells within the 9 square mile area surrounding this key well. Fifty percent of all of the wells constructed in the area are about 130 feet or less in depth. The vertical lines (green and black) near the left vertical axis of Figure 4 represent Spring, Stage 2 and Late Season groundwater level triggers which have been defined according to the 1996 Tehama County Coordinated AB 3030 Groundwater Management Plan. They are also referred to as basin management objectives (BMO's) in Glenn County and other neighboring counties. The linkage between the trigger levels or BMO's and the groundwater well depth distribution in the surrounding area is an important means of relating the groundwater well infrastructure to groundwater levels. In this example, the Spring Trigger Level 2 of 35 feet below ground surface (BGS) is the historically lowest static groundwater level measured in this key well during the Spring (March/April) timeframe. Similarly, the late season trigger level of 51 feet BGS represents the historically lowest static groundwater level in the late Summer/early Fall (August-October). These results suggest that all but two of the groundwater wells constructed in the 9 square mile area surrounding this key well are constructed to depths that are deeper than these trigger levels. It also shows the key well provides satisfactory representation of the surrounding wells in the area.

How can an analysis of well depth distribution in relation to groundwater levels help?

This type of analysis is relatively new and still underway in both Tehama and Glenn Counties. Its usefulness and limitations will become more apparent as experience is gained.

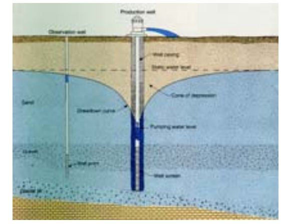
Some potential benefits to the broader community include:

1. Helping to understand important differences in groundwater levels and groundwater well infrastructure among the different groundwater sub-basins and how groundwater management may need to be implemented differently depending on the unique features of each sub-basin.
2. It provides a procedure to evaluate current trigger levels or BMO's and affirm that historically low Spring and Late Season groundwater levels provide rational trigger levels or BMO's to ensure that the existing groundwater infrastructure remains operational in the future. This type of analysis may point to opportunities to improve existing trigger levels or BMO's for some key wells.
3. It allows a means of evaluating current countywide groundwater monitoring networks to ensure that each key well adequately represents the surrounding groundwater well infrastructure. It may point out deficiencies and opportunities to improve the current groundwater monitoring network.
4. It may serve as a risk assessment tool by providing a way to estimate the extent that the existing groundwater well infrastructure may be at risk of dewatering if groundwater levels are lowered by drought and other variables.
5. It provides a method to understand future expansion of the groundwater well infrastructure.

Some potential benefits to individual, private landowners include:

1. Whether the interest is in drilling a domestic, industrial or municipal, or irrigation well, this analysis should provide additional information about the existing water well infrastructure surrounding their property and how it relates to the localized groundwater conditions.
2. It may influence individual decisions on how deep to drill a new well and how deep to set the pump bowls to secure a reliable supply of groundwater for the long term.
3. It may also influence the design and construction of new groundwater wells to lessen interference and competition with pre-existing groundwater wells.

October 2011



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This Outreach is funded by the Tehama County Flood Control and Water Conservation District (TCFCWCD) and the Glenn County Water Advisory Committee.

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