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MEMORANDUM

TO: Aaron Yue
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FROM: Chris Guerre, PG, CHG
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PROFESSIONAL GEOLOGIST
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DATE: March 13, 2017

SUBJECT: WELL SALINTY STRATIFICATION IDENTIFIED BY CONDUCTIVITY PROFILING AND POTENTIAL IMPACTS TO GROUNDWATER SAMPLING RESULTS. PACIFIC GAS AND ELECTRIC COMPANY (PG&E), TOPOCK COMPRESSOR STATION SITE, NEEDLES, CALIFORNIA (EPA ID NO. CAT080011729)

PCA 22120 SITE CODE 540015 WP 48

BACKGROUND

Groundwater salinity stratification occurs at the PG&E Topock Compressor Station site (site) and generally increases with depth within the aquifer as noted at many monitoring well clusters across the site. Less often, monitoring well clusters indicate that salinity may also decrease with depth within the aquifer. Finally, salinity/total dissolved solids also varies laterally across the site. Due to the variable salinity and associated variable water densities that occurs within the aquifer at the site, additional effort is required to properly assess groundwater flow conditions. Water level measurements across the site are mathematically adjusted to “equivalent fresh water heads” to account for the variable water density and to allow proper comparison and evaluation of gradients and flow directions. Based on historic data discussed further below, salinity stratification has been identified inside individual groundwater well casings. The GSU is uncertain why this stratification exists, but is concerned that the dissimilar water types contained within a well could affect the representativeness of the sample obtained during routine sampling events.

Illustrations of specific conductivity (SC) profiles collected in 2004/2005 for select Topock wells are attached (Figures 3 and 4) and were obtained from the June 23, 2005 Technical Memorandum titled, "*Groundwater Elevation and Hydraulic Gradient Error Analysis, Interim Measures No. 2 Pacific Gas and Electric Company, Topock Project*" (Tech Memo). The figures illustrate distinct conductivity contrasts between the shallow and deeper portion of the water column inside individual well casings at the site. The Tech Memo stated that the lower portion of the water column near the well screen was representative of the aquifer, while the upper portion of the well represented stagnant water that was not otherwise circulated during three volume purging and sampling events. Figure 3 also shows post-purge efforts to intentionally mix the entire water column as illustrated by intermediate conductivity values. Please note that the conductivity values displayed for wells MW-34-80 and MW-34-100 on Figure 4 were measured after the water columns were intentionally mixed and homogenized and that the Tech Memo did not evaluate any wells where salinity decreased with depth.

GSU CONCERNS

The Geological Services Unit (GSU) is concerned that the dissimilar, stagnant water column has been documented as not being representative of the aquifer screened and that it can be mixed (e.g., via emplacement of a groundwater pump) and was intentionally mixed in the past using a "mixing protocol" as described in the Tech Memo. Overall, this could result in collection of laboratory samples that are not representative of the zone monitored and could be a factor when transitioning to and employing no flow or low flow purge methods. Eliminating or minimizing the amount of non-representative stagnant water in monitoring well casings can only ensure that better sampling data will be obtained.

The GSU is puzzled that the variable conductivity profiles existed at all. It is assumed that proper well development would have removed any conductivity stratification inside the well casing that could have been created during well installation, construction, and/or development. Additionally, as the Topock wells were repeatedly sampled using a three-volume purging method in the past, one would expect that all stagnant water within the well casing would be removed and repeatedly replaced with representative water from the screened portion of the aquifer. For example, if well MW-34-80 received all its water from the portion of the aquifer screened at approximately 68 to 78 feet below the water table (bwt), then the entire water column from 0 to 80 feet bwt would exhibit a constant specific conductivity value at or greater than approximately 20,000 uS/cm (see Figure 3 for reference). This type of constant SC value was not exhibited throughout the well casing as illustrated in well MW-34-80 SC measurements presented in Figures 3 and 4. Figure 3 shows 2004 SC profiles with values around 20,000 uS/cm, but the values only persist from 40 to 80 feet bwt, not the anticipated 0 to 80 feet bwt. Figure 4 shows a SC profile for MW-34-80 that is more constant from 0 to 80 feet bwt since the water column was mixed, but the SC value averages around 14,000 uS/cm instead of the 20,000 uS/cm expected from the screened zone. 2004/2005 SC data from sampling events as well as from profiling are summarized in Table 2 (attached) from the Tech Memo. SC data obtained from sampling events indicate that MW-34-80 averaged 14,600 uS/cm (well below an anticipated 20,000 uS/cm), but had ranged from 10,400 uS/cm up to a maximum of 26,900 uS/cm. This wide range from 10,000 to 26,000 uS/cm is consistent with the data illustrated in Figure 3, but the 10,000 uS/cm data point is alarming as it suggests that only stagnant water was sampled and not the intended deeper aquifer zone which should yield more saline water. Both Table 2 and Figure 4 indicate that MW-34-80 SC values are less than anticipated and are likely influenced by less saline, non-representative, waters occurring in the upper blank well casing.

Most puzzling is the SC differences noted between the October 2004 and February 2005 data pictured in Figure 3 for well MW-34-80. As illustrated in this figure, the water column was mixed and homogenized in October 2004 and an average SC value of approximately 14,000 uS/cm resulted in the upper portion of the well casing. Strikingly, by the February 2005 monitoring event, low SC values around 10,000 uS/cm were reestablished in the upper blank casing well above the screened zone. The reestablishment of the conductivity stratification in February 2005 cannot be explained easily and might suggest that the blank casing is leaking (Michalski, 1989) allowing the well water to be in communication with the surrounding shallow aquifer.

The GSU recognizes that the potential concerns described above are based on older data. However, as part of the Response to Comment (RTC) process for the 90% Design Document, comments on the procedures for calculating freshwater equivalent heads due to variable salinity across the Topock site were identified. In response to comment RTC # 733, PG&E stated, "*The conductivity profiles in the floodplain wells typically show a relatively uniform conductivity within the casing above the screen and a zone of significantly higher conductivity within the well screen or in the lower section of the well screen (generally 20 foot screens). The single-point samples tend to have an intermediate value between the higher conductivity observed in the deeper screened interval and the lower conductivity within the blank well casing. This results in single-point conductivity measurements from samples collected after pumping being comparable to the average well profile conductivity that is calculated from conductivity profiling.*" This statement confirms that conductivity stratification within some Topock wells still occurs today at the site.

GSU REQUESTS

The nature and prevalence of the conductivity stratification needs to be further evaluated as it is a potential issue related to groundwater sample quality. The GSU wants to ensure that the most representative groundwater samples are collected at the site. Discussion above suggests that stagnant, nonrepresentative water has mixed with formation water resulting in compromised data. The GSU requests that any previous documents related to this SC issue be provided to the GSU for review as well as any undocumented data and assessments. PG&E should indicate which wells have been profiled for SC and which are known to have exhibited conductivity stratification. The SC data should be compiled in an easily reviewable format.

For those individual wells that have exhibited SC stratification, PG&E should state why it is believed to have occurred within each well (e.g., Where is the fresher water coming from?).

Without any further input, the GSU would require PG&E to profile most site wells for conductivity to see how prevalent this issue is and attempt to determine what is causing the water column conductivity stratification.

For those wells exhibiting unnatural conductivity profiles, procedures should be considered and implemented to eliminate it. For instance, if it is believed that stagnant water is contained in the upper portion of the blank well casing, then the well should be purged/evacuated with a specific procedure (e.g., by placing the pump in a shallow position in the well casing and potentially lowering it during pumping). Conductivity profiling would then be conducted after this purge/evacuation event to see if fresh, representative groundwater is contained within the entire length of the well casing. A follow up profiling event should be planned to ascertain if stratification reappears again with time.

This issue of stratified conductivity within a well column and potential non-representative sampling complicates PG&E's proposed alternative sampling trial. It potentially corrupts the historical data base that would be used for comparing alternative sampling methods and places greater importance on where and how to place low flow pumps/no flow HydraSleeve samplers as well as how long one should wait after pump/equipment emplacement to minimize any effects of unavoidable mixing. GSU comments on PG&E's proposed alternative sampling trial are forthcoming, but the issue of SC stratification within individual wells needs to be evaluated to ensure quality samples are being collected.

PG&E should address the requests noted in this memorandum.

The GSU notes that the comments and recommendations presented in this memorandum are facility specific and should not be applied to other projects without consultation with the Project Geologist. If you have any questions or comments please telephone me at (714) 484-5422, or e-mail me at christopher.guerre@dtsc.ca.gov.

Peer reviewed by: Wendy Arano, P.G.

cc: Alfredo Zanoria, C.E.G., CH.G

REFERENCES

CH2MHill, June 23, 2005. *Groundwater Elevation and Hydraulic Gradient Error Analysis, Interim Measures No. 2 PG&E Topock Compressor Station*.

Andrew Michalski, Summer 1989, Ground Water Monitoring Review. *Application of Temperature and Electrical Conductivity Logging in Ground Water Monitoring*.