Steven F. Carle, Ph. D.
11001 Minnesota Ave.
Penngrove, CA 94951

November 4, 2003

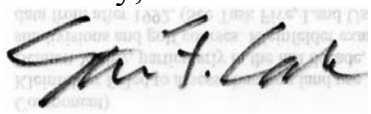
Board of Supervisors
575 Administration Drive, Room 100A
Santa Rosa, CA 95403-2887

RE: Pilot study of Groundwater Conditions in the Joy Road, Mark West Springs, and Bennett Valley Areas of Sonoma County, California (The Kleinfelder Report)

Dear Sonoma County Supervisors,

I would like to share with you my comments on Kleinfelder, Inc.'s report on water scarce areas in Sonoma County, dated September 17, 2003. Immediately below, these comments are summarized. More detailed comments follow in the order of the report. "Appendix A" gives details on easily obtainable well data that Kleinfelder did not examine.

Sincerely,



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SUMMARY OF COMMENTS

The Kleinfelder Report suffers two main problems (1) it deviates from the proposed scope of services, and (2) it deviates from basic hydrogeologic concepts by dwelling on a statistical analysis of "*depth to water trends*".

The following are deviations from the scope of services:

1. In data collection and assessment, Kleinfelder failed to collect data for two DWR monitoring wells in the Bennett Valley Study Area and 14 private water company wells in or very near Bennett Valley and Mark West Springs Study Areas. These data are easily accessible on the internet and, therefore, Kleinfelder failed to properly assess ease of data collection. (See Task Two and Task Six, item 3)
2. In relating geology and hydrogeology to water quality, Kleinfelder failed to utilize readily available water quality data from the 14 private water company wells mentioned above. (See Task Five, Technical Component; Task 6, item 5)
3. Kleinfelder did not provide any useful information on groundwater recharge. (See Task Five, Technical Component; Task 6, item 4)
4. Kleinfelder failed to assess how different entities affect each other's water availability. Specifically, Kleinfelder did not distinguish between residential usage by single-property wells and usage by private water company wells for subdivisions. Kleinfelder did not assess how usage for new developments, particularly residential subdivisions and golf courses, will affect water availability for prior users, primarily single residential units and agriculture. (See Task Five, Water Use Component)
5. Kleinfelder did not assess or address environmental constraints, such as maintaining flows in Salmon Creek and Mark West Creek, both recognized as salmonid habitat. (See Task Five, Future Demand Component)
6. Kleinfelder failed to assess changing land use in Mark West and Bennett Valley, particularly in the last decade, favoring residential subdivisions and golf courses. Kleinfelder examined no hydrology data from after 1992. (See Task Five, Land Use Component)

Kleinfelder deviated from basic hydrogeologic concepts by dwelling on a statistical analysis of "*depths to water trend*" for its primary technical contribution. This approach is fraught with errors related to:

- Topography (a major consideration for all three Study Areas),
- Development trends toward ridgetops,
- Changes in drilling technology facilitating deeper drilling,
- Trends from drilling shallow wells serving single properties to drilling deep high-capacity, public water supply wells serving subdivisions.
- Changes in land use, such as converting open space to golf courses (which Kleinfelder showed to be the largest groundwater users by far).

Kleinfelder should have focused on establishing change in water level elevations over time. Water level elevations, not depths, establish the volume of groundwater stored, which is crucial in the Joy Road area where the Wilson Grove Formation is perched on top of the Franciscan Formation. Water level elevations dictate the rate and direction of flow. If deep large capacity wells for golf courses and subdivisions drop water level elevations too much, shallow wells will go dry and summer creek flows will cease.

DETAILED COMMENTS

1. INTRODUCTION

P. 3

"*However, there are no Department of Water Resources monitoring wells near the study areas…"*

This statement by Kleinfelder is false! There are two (2) DWR monitoring wells within the Bennett Valley Study Area. Groundwater level and water quality information for these wells is easily obtainable through the DWR Water Data Library at this website:
http://wdl.water.ca.gov/gw/admin/main_menu_gw.asp

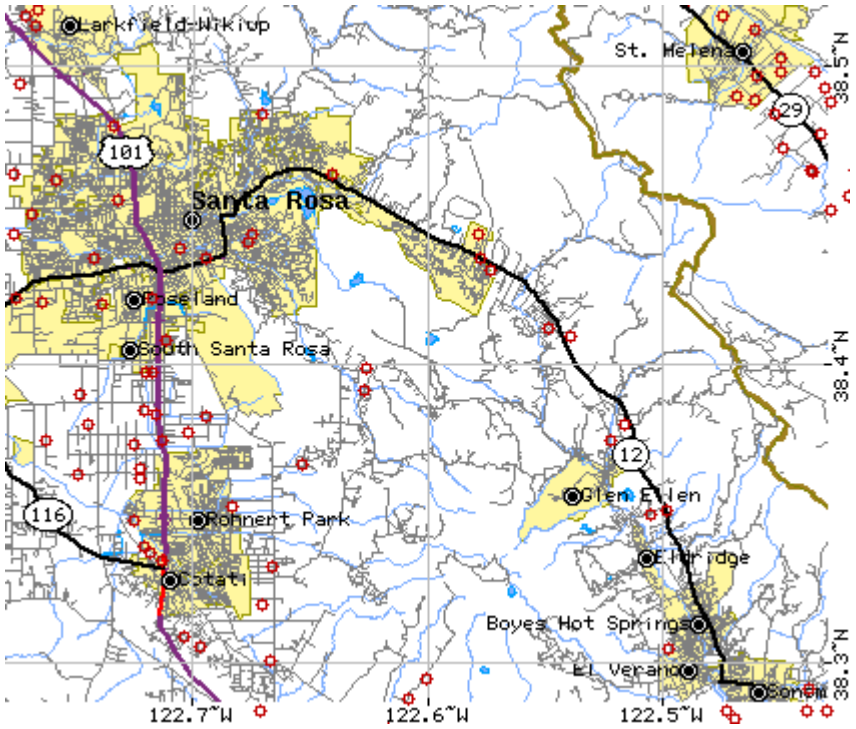
A map interface provides an easy way to find DWR monitoring wells:

Instructions (Step 4 of 4)

This map provides access to individual water well data. Click on one of the red symbols on the map below to retrieve a hydrograph and tabular listing of the data for that well. If no symbols appear on the map, then no water level data are available for that area. Data may also be obtained using our text interface.

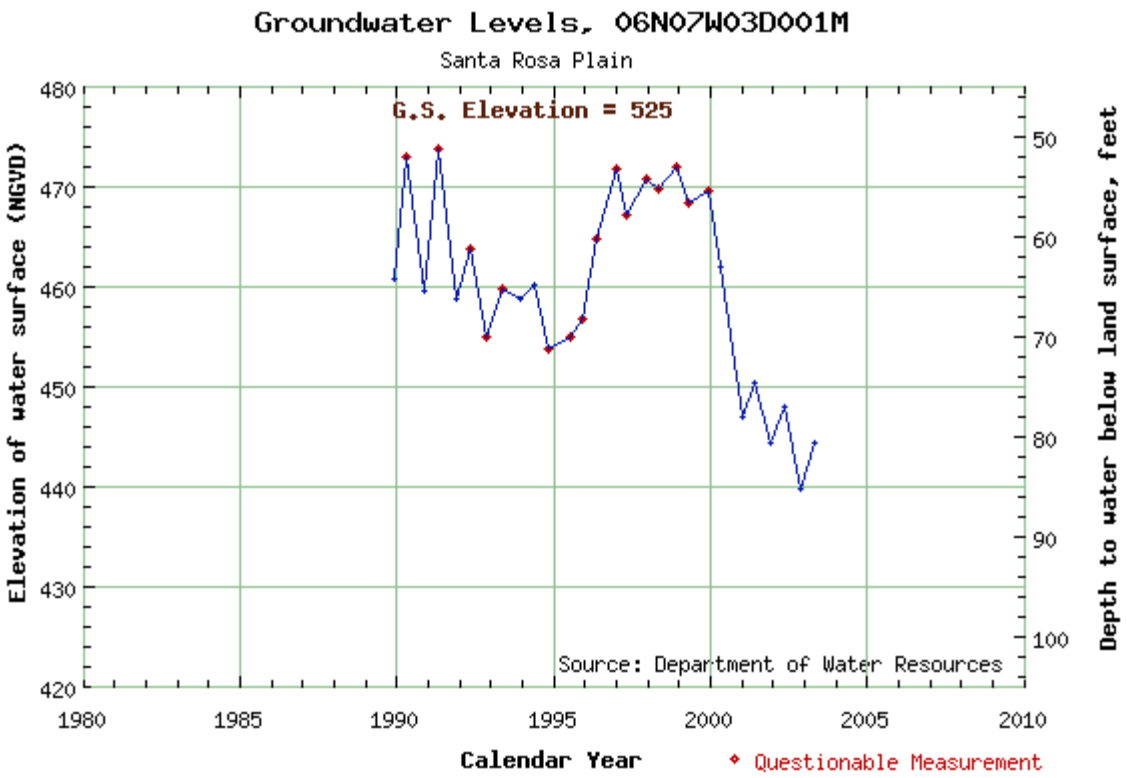
NW North NE

West East

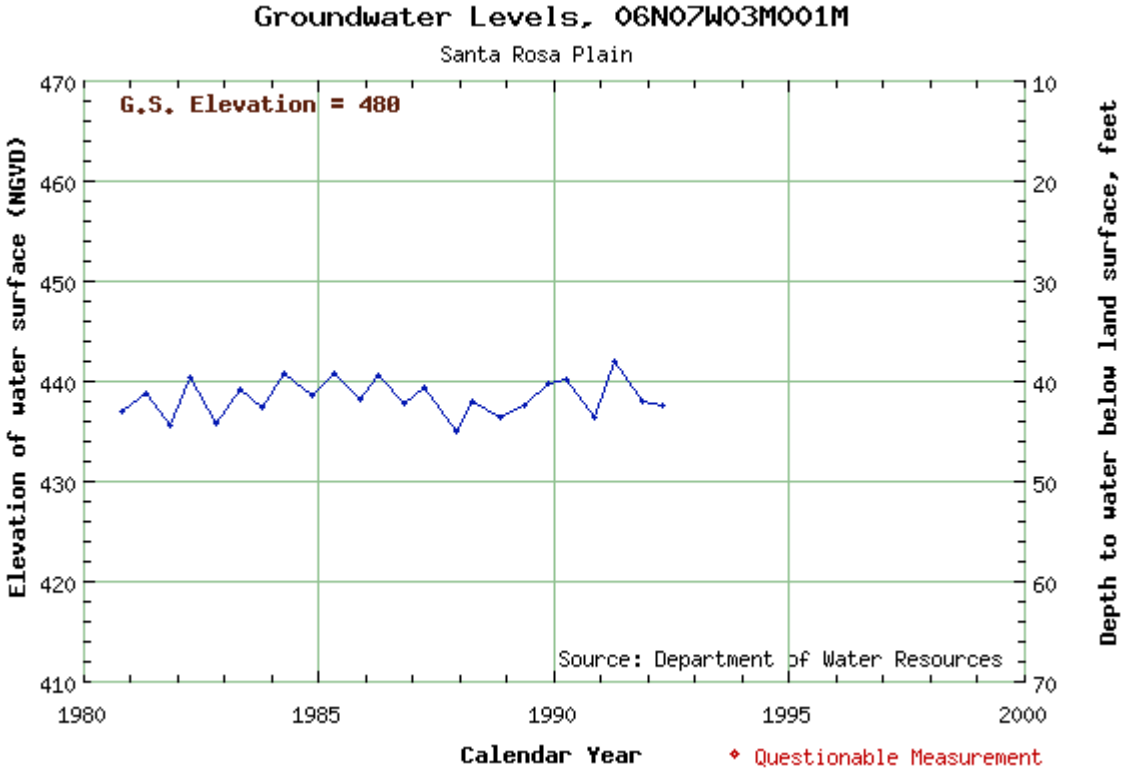


SW South SE

Water level elevations in DWR well 06N07W03D001M indicate an approximate 30 foot water level decline between 2000 and 2003:



Water level elevations in DWR well 06N07W03M001M appear stable over time. However, no water level data are available after 1992:



P. 3

"…monitoring of private wells is not required in Sonoma County so, unfortunately, no such data is available."

This statement is false. Water quality monitoring is required of private water companies that are public water suppliers. The California Department of Health Services (DHS) keeps records that are publicly accessible through the "Geotracker" web site:

http://www.geotracker.swrcb.ca.gov/

I found water quality information for 6 public water supply wells in or near the Bennett Valley study areas and 8 public water supply wells in the Mark West Creek study area.

See Appendix A for a list of names and web addresses for these wells obtained from the Geotracker website.

2. JOY ROAD STUDY AREA

P. 9

"(52 to 156 million gallons)"

Incorrect conversion: should be "(52 to 104 million gallons)."

"*Increase in water demand should be proportional to residential growth*."

This statement should be qualified to assume similar residential water demand for new development." Much new development consists of luxury homes.

3. MARK WEST STUDY AREA

P. 18-19

There is no discussion comparing residential wells and public water company wells within the Mark West Study Area. Clearly, Kleinfelder did not investigate readily accessible information on private water companies, including how many customers these private water companies serve. See Appendix A. This topic should have been investigated as specified in "Water User Component, Task Five."

P. 21

Kleinfelder estimates golf course groundwater usage at 660 acre feet per year and residential groundwater usage at 269 acre feet per year for 537 households (p. 18). If up to 206 units can still be built (p. 19), residential water usage could rise to 372 acre feet based on Kleinfelder's estimated annual water consumption figures shown in section 3.18.

On p. 21, Kleinfelder states:

"Both (golf) courses are irrigated with well water; although, development plans call for use of reclaimed water from future homes to water the Mayacama course."

"…irrigation of the Mayacama course is expected to require about 330 acre feet per year.

Based on Kleinfelder's statements and figures, reclaimed water from future homes could irrigate only a small fraction (10-20%) of the Mayacama golf course, considering that much of residential water usage is devoted to outside irrigation and, for some residents, swimming pools.

Based on Kleinfelder's statements and figures, the Mayacama and Fountaingrove golf courses will continue to be the dominant groundwater users (approximately 660 acre feet per year) in the Mark West Study Area. As is, Kleinfelder implies that the golf course groundwater usage will be entirely replaced by reclaimed wastewater in the future.

P. 21-22

In Section 3.19 "CONSTRAINTS ON GROUNDWATER AVAILABILITY," no mention is made of the potential impacts of increased

groundwater extraction in the Mark West Study Area on stream flows in Mark West Creek. Mark West Creek is one of the few remaining tributaries to the Russian River that is known to support salmonid reproduction.

4. BENNETT VALLEY STUDY AREA

P. 25-27

Similar to the Mark West Study Area, there is no discussion comparing water supplies from residential wells and public water company wells within the Bennett Valley Study Area. Clearly, Kleinfelder did not investigate readily accessible information on private water companies, including how many customers the private water companies serve. See Appendix A. This topic should have been investigated as specified in "Water User Component, Task Five."

This topic of water supply differences between residential wells and private water company wells should have influenced Kleinfelder's discussion on "RESIDENTIAL LAND USE", "HISTORICAL RESIDENTIAL USE", "CURRENT RESIDENTIAL WATER DEMAND," and "HISTORICAL RESIDENTIAL WATER DEMAND," and "FUTURE RESIDENTIAL USE TRENDS". A centralized water supply makes obtaining water from deeper wells more economical. Furthermore, metering of water usage is typical for a private water company. Pumping from deeper private water company wells also may dry up shallower residential wells.

5. STATISTICAL EVALUATION OF WELL LOG DATA

P. 32 (DATA SET PREPARATION)

No effort was made to determine water level elevation. This is a fundamental error. Depth to water is the wrong parameter to analyze in a hydrogeologic study.

Water level <u>elevation</u>, not depth, should have been studied.

Water level elevation, or the "potentiometric surface", is the most important parameter for determining changes in groundwater supply. See attached excerpt from "Chapter 6, Basic Groundwater Concepts, California's Groundwater Update 2003, Bulletin 118, DWR." The Bulletin 118 Update explains how flow of groundwater is determined by the potentiometric surface.

The statistical analysis of depth to water is fraught with difficulties related to topography, which is an obvious issue in all three study areas. Kleinfelder had access to topographic information (see Plates 1, 9, and 17) and, thus, could have easily estimated the elevations of the wells evaluated in the study.

P. 32 (INITIAL DATA SCREENING)

"The goal of the initial (a priori) data screening process was to identify and remove unwanted, irrelevant, and unusable data from each data set. For example, 13 records (1 Joy Road and 12 Bennett Valley records) with depths. Of water values of "0" were removed. Zeros were used for wells where water flowed freely from the casing."

Kleinfelder "*removed*" all data indicating artesian conditions, labeling it as "*unwanted, irrelevant, an unusable data*". Location of historical artesian flow conditions is vital hydrogeologic information. Locations of historical artesian conditions should have been mapped.

Kleinfelder could have compared locations of artesian conditions relative to locations of non-artesian conditions at similar times to infer probable pressures (potentiometric surfaces) for the artesian wells. In this way, the artesian well data could have been included in the analysis of water level trends. Instead, Kleinfelder biased its analysis by "removing" all data with water level depths greater than zero.

P. 33-34 (OUTLIER TESTING)

"Grubb's test assumes that the parent population follows a normal distribution."

Kleinfelder never shows or mentions the shape of the parent population distribution. Therefore, use of the Grubb's test is not validated in the report.

"If Tn > Tc this is statistical evidence that the data point is an outlier."

What values of Tc were used? The reader has no idea what liberties were made in removing "*outlier*" data.

P. 34

"Information regarding location of each well and intended use of that well were not consistently available but variation due to these factors is to be expected."

The DWR well naming scheme indicates its location. The locations could also be inferred from addresses. Well locations and well top elevations can be estimated with reasonable effort.

P. 35-36 (DEPTHS TO WATER TREND)

"The variation (in mean depth to water) appears to be correlated with variation in precipitation."

Why didn't Kleinfelder <u>calculate</u> (instead of inferring) correlations between precipitation and depth to water since Kleinfelder obviously has the capacity to carry out a statistical analysis? The discussion in this paragraph sounds like hand-waving.

"These plots show that the mean depth-to-water in new wells generally correspond to the amount of precipitation from the preceding year."

Kleinfelder misinterprets the relationship between precipitation and water levels shown in its own graphs. Kleinfelder never asks why depth to water would <u>increase</u> following increased precipitation?

For example, let us examine Figure 1 for Joy Road. The most prominent precipitation peak occurs in 1983. Notably, a depth-to-water (DTW) peaks at about 70 feet in 1984. Why should depth to water <u>increase</u> following greater precipitation? This is hydrogeologically implausible. Kleinflelder

never probes into this odd relationship evident in its "*depth to water trends*" approach to analyzing water levels.

"The nature and rate of development has been different in each of the Study Areas; but, in every case it is far greater than the rate of declining depth to water in new wells."

Here Kleinfelder implies that groundwater supply is keeping up with the rate of development. With this statement, Kleinfelder reveals serious misconceptions on how to perform a hydrogeologic study.

- The "*rate of declining depth to water*" is not an appropriate hydrogeologic measure to compare to the "*rate of development*."
- Kleinfelder never formally defines the "*rate of declining depth to water*".
- Kleinfelder shows no indication that it understands the basic concepts of a water budget:

  Inflow – Outflow = {Change in Storage}

  The primary inputs are recharge from percolation of rainfall and stream flow into the watersheds.

  The primary outputs are groundwater pumping and stream flow out of the watersheds.

  Change in water level elevation (the potentiometric surface) is an appropriate hydrogeologic measure for evaluating change in storage. Kleinfelder never mentions this basic hydrogeologic concept.

P. 35-36

"*Since 1951 the number of residences in the Study Area has increased by at least 2000 percent. In the same period, the mean depth to water in new wells has deepened by a little less than 100 percent. Such a marked difference between the rate of increase in water consumption and the rate of lowering average water levels in new wells suggests that the effect of increased extraction on water levels is being buffered by annual recharge from precipitation*."

As discussed above, Kleinfelder never determined the "*rate of lowering average water levels*" (as written above) because it evaluated depth information only. Furthermore, Kleinfelder has not linked its "*depth to water trends*" analysis to a hydrologic budget and, therefore, is not in position to make any interpretation of the sustainability of the groundwater resource in either of the three study areas.

P. 36-37 (DEPTH OF WELLS TREND)

"*There is a clear trend of increasing well depths over time."*

This statement is true, but reflects an important issue that Kleinfelder failed to recognize: new residential developments in the Mark West and Bennett Valley study areas are relying on deeper private water company wells for water supply. The private water company wells are usually deeper and of higher capacity than residential wells. Kleinfelder failed to recognize the existence of private water company wells in the Mark West and Bennett Valley Study Areas even though information on these wells are readily accessible through the Geotracker web site.

In not recognizing the trend toward centralized water supply systems in the Mark West and Bennett Valley Study Areas, Kleinfelder failed to recognize the potential issue of shallow residential wells going dry as a result of deep, high-capacity pumping by new residential development (and golf courses). This issue is well known in other areas of Sonoma County, such as Penngrove and Valley of the Moon.

"*The location of each well in the data set and further analysis of the data would be needed to evaluate the potential correlation between well depth and elevation over time.*"

Why couldn't Kleinfelder determine well locations? The DWR naming scheme indicates the approximate well location. Given all the GIS work Kleinfelder performed, including plotting lots lines, why couldn't well locations be further refined according to property address. Weren't citizens of the Joy Road study area willing to provide well location information?

The proper hydrogeologic approach would not be to "*evaluate the potential correlation between well depth and elevation over time*" but, rather, to evaluate the change in water level elevations (potentiometric surface) over time. Kleinfelder seems possessed with indirect statistical analysis instead of embarking on the standard methods of the hydrogeology profession.

6. CONCLUSIONS

"*1. Geologic Conditions Are the Principal Constraint On The Availability of Groundwater*"

This statement is correct (and obvious). However, Kleinfelder did very little to address this issue. Of key importance would have been to estimate the volume of the water bearing rocks (total storage) in the study areas. Kleinfelder did not do this even though it had much geologic information at its fingertips. A lower limit on storage for the Joy Road and Mark West Creek Study Areas could have been established relative to the elevation of Salmon and Mark West Creeks. Additionally, the Joy Road groundwater storage is limited by the volume of the Wilson Grove Formation perched on top of the Franciscan Formation.

Once total storage is established, the change in storage over time could have been evaluated by estimating change in water level elevations (peizometric surface) over time. Kleinfelder elected instead to evaluate "*depth to water*" which, as discussed above, is fraught with error from topography, development trends toward ridgetops, changes in drilling technology, and changes in land use.

"2. *Changes In The Depth To Water In New Wells Are Trending Downward*"

For reasons that are not adequately explained, Kleinfelder chose to evaluate "*depth to water*" instead of water level elevations. As mentioned above, this approach is fraught with error from topography, development trends toward ridgetops, changes in drilling technology, changes from residential to public water supply wells, and changes in land use (e.g. open space to golf courses). The Kleinfelder interpretations of water level trends are unnecessarily nebulous and uninformative given the available hydrogeologic information.

"3. The Trend In Depth To Water In New Wells Shows Evidence Of An Overdraft Condition"

Finally, Kleinfelder discusses the concept of inflow and outflow and its relationship to groundwater overdraft. However, the "*depth to water*" approach used by Kleinfelder is inadequate for making judgment on whether or not overdraft conditions exist. Dropping depths to water do not necessarily mean overdraft conditions exist.

"However, comparison of the actual volume of groundwater extracted with reliable estimates of annual groundwater recharge would be needed to determine if overdraft conditions actually exist. Determination of the actual volume of water extracted would require monitoring of total volume of water produced by a representative number of wells in each Study Area."

These statements are partially misleading because a careful hydrogeologic study of water level elevations (potentiometric surface) can avoid need for recharge estimates and pumping rates at individual wells. Granted, good data on pumping and recharge rates are very useful. However, not having such data does not rule out evaluation of groundwater quantity change over time. Change in storage can be evaluated directly through the geology, specific yield (or effective porosity), and water level elevation changes.

"*4. Lower Depths To Water In New Wells Correlates With Development.*"

Again, why did Kleinfelder choose a nebulous statistical approach applied to "*depth to water*"? Why didn't Kleinfelder try to evaluate water level elevation (potentiometric surface) changes, which is a basic hydrogeologic concept? Granted, Kleinfelder can maintain that well elevations are difficult to determine. However, other studies manage to obtain this information, which seemed to be available to Kleinfelder.

"*5. Additional Development Will Likely Increase Overdraft*"

Although this statement may be correct, Kleinfelder did not do the proper hydrogeologic analysis to make such a determination.

7. QUESTIONS FOR FURTHER STUDY

P. 41

"...much of the needed information is not currently available."

This statement sounds like an excuse. More information will always be needed. The measure of success is how well available information is collected and used. By combining all available information – hydrologic, hydrogeologic, geologic, geographic, topographic, etc. - with County and DWR records, there is plenty of information available to better quantify groundwater supply in the Study Areas.

P. 41

"*This study has shown that groundwater conditions are changing in the Study Areas and that there are geologic, physiographic, and competitive constraints on the availability of groundwater."*

The Kleinfelder report only showed changes in "*depth to water*", an indirect and nebulous approach to evaluating groundwater conditions in hilly and mountainous terrain. The "*geologic, physiographic, and competitive constraints*" were never quantified. What are the "*constraints"* anyway?

COMMENTS ON SCOPE OF WORK

Task Two

"*We will obtain readily available information…*"
Kleinfelder failed to check the DWR Water Library and the Geotracker web sites for publicly accessible water level and water quality data.

"*We will assess the availability and ease of data collection regarding groundwater quantity and quality… to the general County area*"
Kleinfelder failed to check the DWR Water Library and the Geotracker web sites for publicly accessible water level and water quality data.

Task Five

Technical Component
"We will discuss the specific geology and hydrogeology of each area as it relates to water quantity and quality."

Kleinfelder failed to properly relate groundwater quality to the geology and hydrogeology by ignoring readily available DHS water quality data for wells within the Mark West Creek and Bennett Valley watersheds.

Water User Component.
"We will discuss the different entities that use water within each key water-scarce area, and how their current usage affects water availability and quality."

Kleinfelder failed to assess publicly available data on private water companies within the Mark West and Bennett Valley study areas. These data contain valuable information that on water quality and number of residences supplied by private water companies. These data could have been used to assess how recent development potentially affects water availability for prior users and flows in Mark West Creek.

Task Six

"*Our recommendations will include, but not necessarily be limited to the follow:*"

"*sources of readily available data*"

Kleinfelder failed to access readily available data in the study areas provided by the DWR Water Data Library and Geotracker websites. Kleinfelder also fails to mention these data resources

APPENDIX A – List of Public Water Supply Wells Within or Near Study Areas

BENNETT VALLEY

BENNETT RIDGE MUTUAL WATER COMPANY (SANTA ROSA)
WELL 01
State Well Number: 06N/07W-02J02 M
http://www.geotracker.swrcb.ca.gov/reports/well.asp?global_id=W0609700585&assigned_name=06N/07W-02J02_M

BENNETT RIDGE MUTUAL WATER COMPANY (SANTA ROSA)
WELL 02
State Well Number: 4900585-002
http://www.geotracker.swrcb.ca.gov/reports/well_geo.asp?global_id=W0609700585&assigned_name=4900585-002

MATANZAS CREEK WINERY (SANTA ROSA)
Well 01
State Well Number: 4901248-001
http://www.geotracker.swrcb.ca.gov/reports/well_pws.asp?global_id=W0609701248&assigned_name=4901248-001

SONOMA MOUNTAIN COUNTY WATER DISTRICT (SANTA ROSA)
WELL 01
5438 ALTA MONTE DR
SANTA ROSA, CA 95404-9728
State Well Number: 06N/07W-16C02 M
http://www.geotracker.swrcb.ca.gov/reports/well_pws.asp?global_id=W0609700580&assigned_name=06N/07W-16C02_M

SONOMA MOUNTAIN COUNTY WATER DISTRICT (SANTA ROSA)
WELL 02
State Well Number: 4900580-002
http://www.geotracker.swrcb.ca.gov/reports/well_pws.asp?global_id=W0609700580&assigned_name=4900580-002

SUMMIT VIEW RANCH MUTUAL WATER CO (SANTA ROSA)
WELL 01
State Well Number: 06N/07W-15K02 M
4100 SUMMIT VIEW RANCH RD
SANTA ROSA, CA 95404-9562
http://www.geotracker.swrcb.ca.gov/reports/well_pws.asp?global_id=W0609700892&assigned_name=06N/07W-15K02_M

MARK WEST CREEK

HEIGHTS MUTUAL WATER COMPANY (SANTA ROSA)
WELL 01A
State Well Number: 4900612-002
http://www.geotracker.swrcb.ca.gov/reports/well_pws.asp?global_id=W0609700612&assigned_name=4900612-002

HEIGHTS MUTUAL WATER COMPANY (SANTA ROSA)
WELL 02
State Well Number: 4900612-003
http://www.geotracker.swrcb.ca.gov/reports/well_pws.asp?global_id=W0609700612&assigned_name=4900612-003

HEIGHTS MUTUAL WATER COMPANY (SANTA ROSA)
WELL 04 - STANDBY
State Well Number: 4900612-005
http://www.geotracker.swrcb.ca.gov/reports/well_pws.asp?global_id=W0609700612&assigned_name=4900612-005

MARK WEST ACRES (SANTA ROSA)
WELL 01
State Well Number: 08N/08W-26F03 M
http://www.geotracker.swrcb.ca.gov/reports/well_pws.asp?global_id=W0609700605&assigned_name=08N/08W-26F03_M

MARK WEST MEADOWS MUTUAL WATER (SANTA ROSA)
WELL 01
State Well Number: 08N/08W-22R01 M
http://www.geotracker.swrcb.ca.gov/reports/well_geo.asp?global_id=W0609700905&assigned_name=08N/08W-22R01_M

MICHELE MUTUAL WATER COMPANY (SANTA ROSA)
WELL 01
State Well Number: 08N/08W-26D01 M
http://www.geotracker.swrcb.ca.gov/reports/well_pws.asp?global_id=W0609700552&assigned_name=08N/08W-26D01_M

RIEBLI MUTUAL WATER COMPANY (SANTA ROSA)
WELL 03
State Well Number: 4900603-003
http://www.geotracker.swrcb.ca.gov/reports/well.asp?global_id=W0609700603&assigned_name=4900603-003

WILSHIRE HEIGHTS (SANTA ROSA)
WELL 02
State Well Number: 08N/08W-26B02 M
http://www.geotracker.swrcb.ca.gov/reports/well.asp?global_id=W0609700573&assigned_name=08N/08W-26B02_M

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Unconfined and Confined Aquifers

In most depositional environments, coarser-grained deposits are interbedded with finer-grained deposits creating a series of aquifers and aquitards. When a saturated aquifer is bounded on top by an aquitard (also known as a confining layer), the aquifer is called a confined aquifer (Figure 14). Under these conditions, the water is under pressure so that it will rise above the top of the aquifer if the aquitard is penetrated by a well. The elevation to which the water rises is known as the potentiometric surface. Where an aquifer is not bounded on top by an aquitard, the aquifer is said to be unconfined. In an unconfined aquifer, the pressure on the top surface of the groundwater is equal to that of the atmosphere. This surface is known as the water table, so unconfined aquifers are often referred to as water table aquifers. The arrangement of aquifers and aquitards in the subsurface is referred to as hydrostratigraphy.

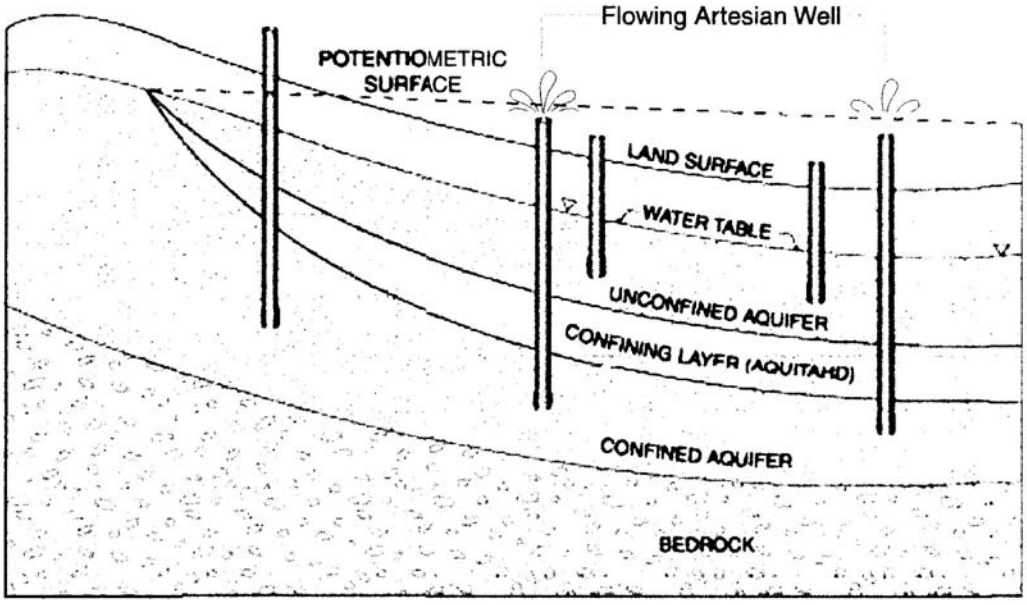

Figure 14 Interbedded aquifers with confined and unconfined conditions

(From DWR-BULLETIN 118, California's Groundwater, UPDATE 2003, p. 87).