Comments on the AES Response to FEIR criticisms

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AES's response to the detailed criticisms of the hydrology sections contains nothing new in content. It is just a repeat of the arguments already presented in the FEIR, sometimes with different wording but identical content. The shortcomings of the DEIR that generated the criticisms have not been rectified in either the FEIR or this AES response.

A recurring commenter theme is that the criticisms of the DEIR were "dismissed". The AES Response claims this was not a dismissal, that the comments were "addressed". It is true that all the comments were "addressed", but typically by repeating the original shortcoming, not by adding new information.

The fundamental problem is this: AES has no direct evidence that prolonged industrial scale pumping at DEX-6 (the production well) will **not** have a negative impact on any residential wells in any direction from the plant. Instead, they have limited drawdown data on different pairs of wells: DEX-6 effects on DEX-3a and DEX-1; DEX-6 on itself; the domestic well (DOM) on itself and several nearly monitoring wells, etc. All of those wells are on CG property. **None** of these pairs measured the effect of DEX-6 on residential wells.

To avoid doing the actual experiment, AES instead defends the use of a theoretical model - the Theis model - as implemented by the software program PUMPIT. However, the Theis model is completely inappropriate for a volcanic region, where fractures and lava channels probably form a complex highly-sloped network that channels water in currently unpredictable directions. This unknown complexity is cited by virtually all hydrology experts we have contacted, more than a half dozen. In other words, the underground structure likely varies with location (lateral variation or "inhomogeneity") and with depth. The Theis equation does not/cannot deal with lateral variation at all, and assumes only a single homogeneous, isotropic (same in all directions) underground structure with a single aquifer layer. Any inferences drawn from the Theis analysis have no applicability here. Yet, AES relies upon it for extrapolating their data on the wrong pairs of wells because they have no actual relevant data.

In addition, the PUMPIT software very old and primitive. It is no longer publicly available because it dates back to the early 1990's and is DOS-based, produced by a company (AquaLogic) that no longer exists. It is not available for Windows/Mac/Unix, and cannot work or be checked on anything other than a computer with an operating system that is at least 20 years out-of-date. Evidently, the only modification made to the Theis model used by RCS (the consultants to AES) is the addition of a possible linear flow due to a gravitational slope, but again, with no lateral inhomogeneity considered. So AES is relying on a vastly over-simplified and inappropriate mathematical model run on an old program that is unavailable to the public, to claim that their analysis is "thorough".

That is a general observation about the AES response. Here in this document, I go through specific arguments in the AES Response, keyed by their page number.

Page 8. The FEIR does provide some interesting new data on DEX-6 pumping rates for 5 of the 10 years of bottling operations, as inferred from electric power usage. Appendix X of the FEIR attempts to correlate that rate with some other variables of interest, like levels in DEX-3A, which pulls water from the upper aquifer. AES claims that DEX-3A levels are anti-correlated with the DEX-6 pumping rates, based on Fig 3 of Appendix X; i.e., when pumping rates go up, AES claims that water levels in DEX-3A also go up. That is a bit of an overstatement, since DEX-3A water levels were about equal to their highest levels even before DEX-6 pumping began. The three year period of available data where both variables are measured (2006-2008) is not sufficient to support the conclusion of an anti-correlation. But as the AES Response correctly says (on **page 36**), the period of 2007-2017 produces a 12 foot drop in groundwater levels in DEX-3A, whereas there is only a 2-foot drop in DEX-6. It may well be that DEX-3A is much more sensitive to something, maybe precipitation amounts, maybe other users, than is DEX-6. But that is not a reason to relax any concern: the results suggest that a well in the "upper layer" may be much more sensitive to disturbance than the low aquifer production well. If, for example, the level in DEX-3A is sensitive to water pressure from the lower level, then reduction of pressure in the lower level (say, either by drought or by over-pumping) might cause a large drop in the upper level. The sensitivity of DEX-3A levels and the surrounding uncertainty about underground structure and flow patterns, argues for direct long-term tests between DEX-6A and wells of interest.

Page 19. It is claimed again that "Potential impacts to adjacent wells...were **thoroughly** analyzed...(in the FEIR)". (Emphasis added.) The commenters' criticism was that the analysis had gaping flaws, and was far from "thorough". Repeating that description does not refute the original objections.

Page 36. AES claims that their theoretical model assumed a full connection between the upper and lower aquifer. That assumption is by default, because their Theis/PUMPIT model was too simple to even include the possibility of multiple aquifers. AES reports a recent drawdown test on DOM and nearby monitoring wells that allegedly showed "limited connectivity" (although what "limited" means is left undefined) between upper and lower aquifers. They then claim that reduced connectivity means that the effect of pumping water out of the lower aquifer would only slightly affect the upper layer, even less than the Theis model would predict (because it can only deal with a single layer). There are three related problems here:

(a) The theoretical Theis model and the new test on the DOM well provides absolutely no information on lateral inhomogeneity of the underground structure or groundwater flow patterns, and that inhomogeneity can make the behavior completely different if measured at the relevant locations (residential wells) as driven by the relevant drawdown location (DEX-6).

(b) AES claims, on **page 46-47**, that other "mathematical curve-filling solutions" were tried other than the Theis equation, to fit drawdown data on DEX-1,4, and 7 (none of which involve residential wells), and none of them "fit" the data. "Therefore, the Theis equation does apply to the groundwater aquifer", says AES. Even if AES means "curve-fitting" rather than "curve-filling", this is all very vague. What other "mathematical solutions"? Did those other "mathematical solutions" include lateral inhomogeneity, even in principle, much less the actual (but unknown) lateral inhomogeneity that probably exists in the region?

(c) AES is trying to say that the Theis model is good enough and actual overstates the theoretical effect on neighboring regions, compared to any other reasonable model. This is not true. At the end of this document is a reasonable alternative model that would predict a severe depletion of residential wells given moderate over-pumping at DEX-6 that would not cause a drawdown concern at DEX-6. This alternative model is not claimed to be true, although it is possibly at least as reasonable as the Theis model. It just serves to show that effects on neighboring wells **can** be severe. In the absence of a model that correctly contains the actual complex ground layering information complete with lateral inhomogeneity, models are blindly "groping around in the dark". One can be chosen to produce any result you wish. AES wishes to see no effect on residential wells and they chose a model to satisfy that need. There is no substitute for actually doing the field test.

Page 38. In calculations, the assumed thickness of the aquifer layer was varied between 100 and 450 feet, depending on which set of data is being analyzed. That by itself may not be a problem except for the statement, "Use of the 100 foot thickness was not possible in calculating those values". This vague statement illustrates either a lack of actual information about the actual ground structure or the possible inadequacy of the programs to work for all conditions, or both.

Page 38. Residential wells within a mile of CG that do NOT have city water exist in the following directions: E, S, SE, and NW directions. The AES statement is misleading since the S, SE, and NW directions do have some city water coverage, but it is mixed. All directions that contain well water users need to be included in actual drawdown testing, even if city water usage in those directions is mixed in.

Page 38. AES lists "logistical and legal issues" with regard to monitoring water levels in residential wells. None of these "issues" are insurmountable, certainly less problematic than possible issues arising from damage later that could have been avoided with proper hydrological mitigations set in advance. It is more likely that CG does not want to set a precedent of having to worry about effects on residential wells.

Page 39. AES argues that the onsite data used to validate the PUMPIT model is just as good as obtaining and using offsite (residential area) data. For reasons stated above, the PUMPIT model is too simple to account for lateral variability, especially in volcanic zone. Validation of a model on the wrong set of data has no scientific meaning.

Page 39. AES says that "No significant impacts to neighboring wells were identified; therefore no mitigation is required". No significant impacts were identified simply because they did not look for them: they ignored historic complaints during the Dannon/CocaCola days; they did not measure anything at residential wells, and they used an inappropriate theory to extrapolate their on-site results. Mitigation could involve setting up residences with depth monitors and then responding to problems if and when they arise, by cutting back on production.

CG does not want that kind of mitigation and that is why they incorrectly conclude that "no mitigation is required".

Page 46. Aside from the problems on this page mentioned above, there is this: AES claims that the years with Dannon/CocaCola were already an actual 10 year field "test", with presumably no real problems. This ignores the following: (a) Neighbors *did* complain about problems with quantity and quality of their well water, and these complaints were ignored. They are now dismissed by AES as "anecdotal"; (b) Any "test" would need to correlate DEX-6 pumping rate with well response, but records of DEX-6 pumping rate are incomplete; based on electrical power usage for only the last 5 of those 10 years; (c) Scientific monitoring of residential wells was not done during those years. A "test" in which either the input variables and the output variables (or both) are unknown is hardly a "test".

Page 47. AES finally says something true: "Long term groundwater level monitoring data...provides more substantial evidence regarding the effects to groundwater levels...than a short term pump test would achieve." The only deliberate pump tests that were done, all at on-site wells, lasted from 5 to 72 hours, hardly long-term. It is nice to see that AES admits that their short term tests (albeit done on the wrong wells) are not very substantial for predicting long-term effects.

Page 48. This is not a hydrology point but it is important. The City says that wastewater options must be chosen prior to project approval. The FEIR uses different words, quoted here, but they mean essentially the same thing.

Page 48. Back to hydrology. The City requests a data collection program to resolve "conflicting expert opinions". For AES to focus on that phrase is a red herring. This is not a disagreement among experts. It is a lack of data. To cover for the lack of data, an inadequate theory is used, and the "less-than-significant" conclusion is entirely based upon that.

The City's position on the hydrology is clearly stated in their NOP comments and their response to the DEIR, the latter quoted in full here:

SECTION 4.8 HYDROLOGY AND WATER QUALITY

NOP Comment Letter:

The City's NOP comment letter stated that in addition to its spring-fed water source, the City's municipal water supply is provided in part by groundwater wells. The City's Master Water Plan, identifies a future well site in the vicinity of the Crystal Geyser facility. The City requested the EIR include a comprehensive hydrologic study sufficient to evaluate potential impacts of the proposed project on existing and planned municipal wells.

City's Comments on DEIR

Municipal Water Supply; Cumulative Impacts

Page 4.8-30 of the DEIR states, "*Due to the local topography and residential zoning of adjacent properties to the northeast, there are no other reasonably foreseeable developments that would significantly utilize the groundwater aquifer for water supply. Therefore, cumulative impacts associated with groundwater supply are **less than significant** and no mitigation is required.*

The City's 2010 Water Master Plan identifies development of a new well at the base of Spring Hill and the addition of an additional 1.0 million gallon reservoir on Spring Hill. These improvements are also identified in the 2011 City of Mt. Shasta Municipal Services Review Report. In addition, the City's General Plan Land Use Element (2007) identifies the Spring Hill Area, north of the Crystal Geyser facility, as a special planning area in the City because of its unique development opportunities as well as the challenge of infrastructure limitations and development constraints. The City's General Plan calls for a Specific Plan that would set the proposed density.

The City's Impact Fee Report (2009), which identifies the Spring Hill area as the primary growth area for the City, states it is reasonable to assume approximately 2,585 dwelling unit equivalents (DUEs) within the vacant 341 acres. This could result in approximately 4,373 new residents, essentially doubling the population of the City.

The City's water system does not currently extend to or serve the Spring Hill Area. Consequently, commercial uses have been approved and developed with private systems. This is generally contrary to the City's policies concerning water service for commercial uses and may complicate the development of a more efficient public water system in the future.

It does not appear the DEIR addresses potential impacts of the Project on the City's future municipal well or cumulative impacts associated with future well and residential development as described above. The DEIR's conclusion that cumulative impacts to groundwater supply are less than significant is not supported, and the DEIR needs to be amended accordingly.

Requested Mitigation Measures:

Appropriate Mitigation Measures should be considered based on additional analysis as described above.

Aside from AES' misjudging where potential impacts should be investigated, the key point is this sentence from the City: "The DEIR's conclusion that cumulative impacts to groundwater supply are less than significant is not supported, and the DEIR needs to be amended accordingly." In fact, an addition to the FEIR not in the DEIR, the drawdown test on the DOM well, is completely irrelevant for the reasons reviewed above. The FEIR proposes absolutely NO mandatory mitigations with regard to hydrology, and the City's concerns have not been addressed, much less satisfied.

An alternative reasonable hydrodynamic model producing opposite conclusions from Theis

The main theme of the FEIR hydrology section is that a direct test of the DEX-6 effect on residential wells is not necessary because

(1) Recent pumping tests of the DOM well showed only a small drawdown on that same well; and

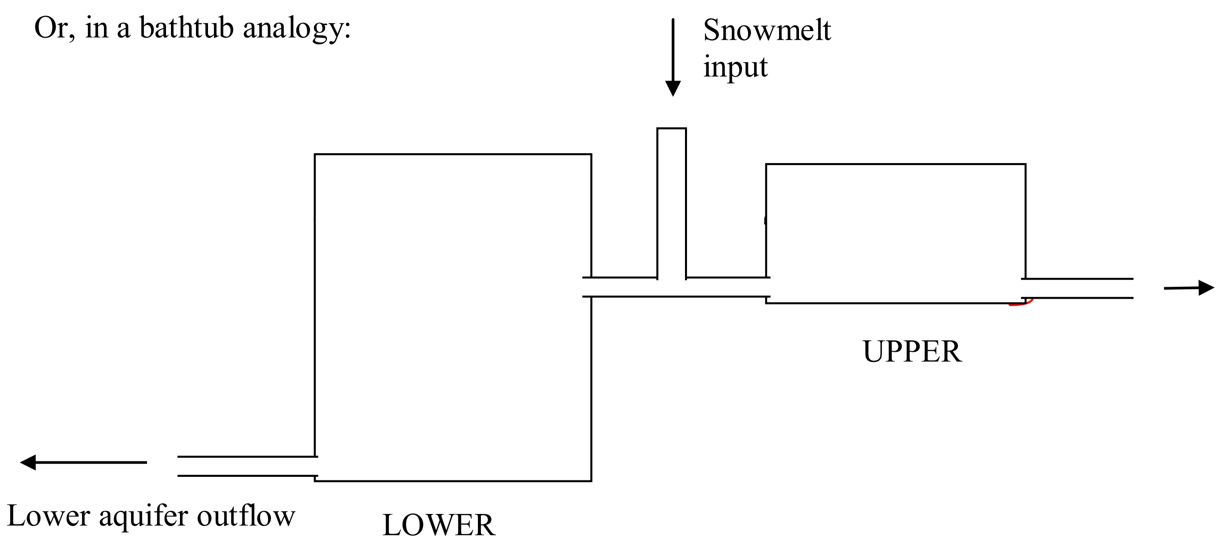
(2) Extrapolating this result via the Theis/PUMPIT-based model suggests that DEX-6 pumping will draw down neighborhood residential wells even less than the self-drawdown of the domestic well. In other words, results on self-drawdown at one well (DOM) can be extrapolated to cross-drawdown at two different sets of wells (DEX6 and residential wells)

This argument might be valid if there were no other reasonable models. But is not the following model reasonable? This made-up non-Theis model is intended to show that increasing the flow into the "lower aquifer" (which DEX-6 and the domestic well are presumed to draw upon) by pumping may reasonably decrease the flow into the upper aquifer (residential wells).

Assume both aquifers draw upon the same source, snowmelt on Mt. Shasta. The average flow rate is fixed, limited by the average melt rate. At some point on the underground journey downhill, that fixed flow is apportioned between upper and lower aquifers. Pulling the lower aquifer down by pumping will decrease its pressure and thereby increase flow into that route, at the expense of the upper route. It is even conceivable (in principle) that the lower aquifer pumping may completely deplete the upper aquifer. For example, say that 90% of the water goes into the lower and 10% into the upper. Increasing the flow in the lower by 10 % (say, by DEX-6 pumping) will increase its % to 99% and rob the upper down to 1%. The change is near-negligible for lower aquifer levels but catastrophic for upper aquifer levels.

An electric circuit analogy is a constant-current source feeding into parallel resistors to ground. If one of those resistors drops in ohmage, the other resistor will see a decrease in current going through it.

Or, in a bathtub analogy:



Pumping on the "lower aquifer" brings the level down in the left bathtub from the black squiggly line to the red. This does not seriously deplete the lower outflow. But the upper outflow is sharply reduced.

Another way of looking at this is that the level in the upper aquifer is supported by hydrodynamic pressure from below, even if the hydrodynamic connection is "limited". If that pressure from below is reduced by industrial-scale pumping, the level in the upper will drop.

These alternative views could be criticized as having no experimental basis in the actual Mt. Shasta region. Neither does the simple Theis model. Again, the only way to resolve the uncertainty is to do testing. Or, if CG operations begin, to install a system of residential area monitoring, coupled with a mandatory agreement to slow production if problems develop.