

LONG VALLEY HYDROLOGIC ADVISORY COMMITTEE

MEETING NOTES

August 10, 2016

(Adopted February 1, 2017)

THERMAL SUBCOMMITTEE ATTENDEES

Ormat: Janice Lopeman, Steve Henricksen, Mark Hanneman, Rahm Orenstein, Cheryl Eanes, Edward Pozek & Patrick Walsh (via phone). **USGS:** Jim Howle, Bill Evans & Deborah Bergfeld. **BLM:** Steve Nelson, Dan Munger & Dale Johnson. **EGS:** Gene Suemnicht. **CA DOGGR:** Jack Truschel, Matt Cochrane & Charlene Wardlow. **USFS:** Margie DeRose. **Mono County:** Nick Criss & CD Ritter

PUBLIC MEETING ATTENDEES

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1. **Call to order & introductions:** Nick Criss called the meeting to order at 10:13 a.m. in Town/County Conference Room at Minaret Village Mall, Mammoth Lakes. Attendees introduced themselves and their agencies.
2. **Public comment:** None
3. **Meeting notes:** Approve meeting notes of Feb. 10, 2016. (*Criss/Hayes. Ayes: All.*)
4. **Subcommittee status reports:** Discussed monitoring wells, noted well 14.25 temperatures higher. Discussed water level data in 2015. New wells support Ormat's model. BLM has what's needed to come up with new monitoring plan, adjust to fit needs.
What does BLM consider OK? Dale Johnson recalled BLM held series of facilitated meetings, worked through issues MCWD had mentioned in letter. BLM staff geologist unexpectedly left – expertise in geology is needed.
Information from subcommittee today? Nick Criss indicated no other data presented.
Monitoring data show higher temps at new monitoring well? Johnson confirmed.
5. **USGS monitoring data:** Jim Howle discussed wells in Long Valley, Sherwin Creek, and Shady Rest.
Bill Evans' map showed areas of discussion, such as Long Valley Caldera, MCWD wells, and resurgent dome. Hot water flows all way to Hot Creek, even beyond. Areas exist where medium-deep wells hit warm water. Dry Creek wells were drilled earlier by MCWD.
Hot water was sampled and studied by many over time. Looking for mixing, consider chloride/boron, the gold standard for Long Valley. Waters around Mammoth were characterized. Analyze many different things in waters to spot outlier. Two sources of salt (ski area and natural in geothermal system). No Mammoth Basin groundwater sources move horizontally along the ski area salt line, but a few follow without invoking thermal water input line.
Another chart showed most wells plot near origin. Normal to show variation over time, tap different water seasonally. All data came from central lab except Menlo Park in 2011.
Why changed? Drought is favorite scapegoat. Decrease in availability of cold and thermal water. Hayes thought a change in relative proportion of cold and thermal water had occurred.
Gene Suemnicht mentioned groundwater data shown on MCWD website. Evans indicated data needed to be checked. Bromide is another conservative species. Ratio chlorine/bromine (Cl/Br) has little bit of range. No outlier,

all new P17 wells plot together. Similar to chlorine/boron (Cl/B). Non-thermal groundwaters of different ages/sources. Vertical trend near origin. No Br data prior to drought. Menlo sees lower Br than central lab. Change is huge compared to lab offset. Important to stay with a lab, use its data. Check vs. other labs, but reduce scatter.

How to explain change? Evans indicated two types of groundwater, could be drought-related. Important to recognize variations that occur over time, not attribute them to changes in geothermal development. Hanneman saw similarity to Steamboat Hot Springs in Reno. Response due to climate.

Evans noted most responses on different slope than geothermal fluid line. Orenstein recalled 2011-16 was historic drought. No change in production. Evans concurred that drought was possibly responsible, but not the only possibility. Chlorine/lithium (Cl/Li) = ~89. 14-25 plots well off geothermal line. 14-25 water has unusual chemistry, with potassium. Still not fully sampled. Analyses only for deep part of well. Bit of wildcard in chemistry, unlike other wells. Arsenic (As) extremely non-conservative in solution. Sources for As exist, not only on geothermal activity. Isobutane, working fluid at Casa Diablo, not detectable in P17, M26.

How far back are other chemicals seen? Evans indicated 2011 analysis. The Cl anomaly there long time. P17 sure bet if it had Cl, same reason for today.

Lithium? Evans stated rocks 1,000-10,000 years old, good source of thermal elements. Good source of Cl mostly leached out. Non-thermal waters don't get a lot of Cl. Ski area waters have nice source of Cl. Shallow groundwaters around Mammoth Lakes don't have Cl in them, looks like highly enriched in Li, but function of Li is out of volcanic rocks that lost Cl.

Higher Cl and B in drought years? Mark Hanneman stated concentration rises.

Pat Hayes indicated MCWD has been collecting water quality samples from its wells. Status of available results? Howle stated May data still not released. Hayes thought July 19 presentation to BOS seemed to advocate additional monitoring. Correct, said Howle.

Discovery of hot water in ~~14-25A~~ 14A-25 not expected? Howle indicated it ~~might have been~~ expected by Ormat, but not by USGS. Need additional data for conclusions about difference with other wells. Pump plugged with rock flour in February 2016, so one sample in deep piezometer anomaly. Dissolved samples get filtered.

Evans indicated wells get lots of crushed rock in drilling process. Water was sampled during drilling. Analysis has weird chemistry, high potassium (K). Not lot of groundwater throughflow, stagnant water around well.

Does deeper geothermal have K? Evans noted not acid sulfate water.

Janice Lopeman showed pole magnetic map from USGS air map survey.

Rahm Orenstein noted models show if deep enough, hot enough for electricity. Steamboat Hot Springs in Reno is much bigger. In known geothermal area, elevated temperature or chemicals are unlike Reno water sources.

Evans suggested releasing temperature profiles from deep wells to make better sense of it. Orenstein stated it's usually confidential due to competitive landscape.

Background from USGS? Evans stated dark blue is demagnetized rock, long-term high temp system.

Evans asked what happens west of 14-25. Hot water is there.

Hayes asked if it was discussed at "secret" geothermal subcommittee today. Seeing it first time himself, no chance to study it, but suspect not necessarily represent hotter waters to west. Evans indicated they have been found. Lopeman confirmed depths much greater.

Data from BLM in 2014? Lopeman indicated no. USGS in 2013 published poster on it.

Tom Cage stated geothermal water exists west under Knolls, east of scenic loop. If Ormat stated that, why not show area of hotter water to west? Ormat was not surprised water was hot in ~~14-25A~~ 14A-25, and brought core samples indicating protective dome to keep geothermal from intermingling with fresh water.

Suennicht indicated no dome, but core illustrated alteration. Clay seals around water wells. Altered rock 1600' thick in area. Water + clay = high conductivity. Continuous horizontal.

Deborah Beryfeld asked for explanation. Lopeman explained different surveys are needed to show hot zone. Exact up-flow zone is not defined. Several people studied, reported up-flow zones. Only a few wells to northwest, cannot characterize. Only goes so deep. Pure geophysics of USGS survey. Low vs. higher resistivity zones.

Hot water up to surface? Dan Munger explained it shows process in degradation/weathering cycle. Blue area shows hot source that alters it. Does not show flow, only that rock changed due to hot source.

Does blue area expand? Lopeman stated Ormat didn't expect to have cold temps at ~~14-25A~~ 14A-25, but USGS did. Cage thought Ormat expected it to be dry. Evans confirmed ~~it's~~ well RD08 is not a static well, but continuous flow, reason why it was abandoned.

Orenstein found it interesting to speculate, but salient point is data collected after drilling did not change perception. CD IV is another monitoring point. Commercial geothermal around 100 years ago. First Ormat well in 1983 is still running.

7. Update on MCWD/Ormat meetings: Dale Johnson stated on May 26 talks were at point of working toward monitoring plan. Completion slowed down by departure of geologist, BLM is advertising now.

Irene Yamashita inquired about progress. Johnson indicated it's difficult without geologist. Yamashita asked about communications on plan. Johnson indicated no review, not there.

As of May 26, Hayes confirmed MCWD's position to maintain no clear delineation of what's going on underground. Data should drive undertaking. USGS points show intermingling of geothermal at P17 and 26 with groundwater. Need two deep geothermal monitoring wells. Ormat has not agreed to drill second well to provide vital information on gradients between two systems. Gradient changes with pumping. Lots of speculation at meetings. He thought Steve Nelson couldn't require Ormat to drill second well unless new data became available.

Howle indicated data seem to indicate mingling of fluids. Need more monitoring before project proceeds. Jointly agree to apply for 80/20 grant, with MCWD lead agency. Application from Ormat is due in October. New information from water sampling (\$120,000 to protect water supply). Need data and wells in place. Didn't say required, was suggested. Coldwater production could also influence.

Nelson cited no change in MCWD position. Key points: If BLM had not required monitoring plan (against advice of different counsels), couldn't be having these discussions. Both wells located at good sites, with different information at different spots, so big progress. It was BLM's decision, the only entity that could require such a plan. Worked hard to get as close as possible between parties. But, cannot get completely agreeable plan to sign unless geologist is on staff and experts can review. Will be best plan with what is known today. Not get perfect monitoring plan right off, not easy. BLM took responsibility for monitoring plan, is committed to doing it, or would have folded it in a long time ago. However, no ink on paper until geologist is available.

Orenstein stated Ormat takes pride as world's most successful geothermal developer and being good neighbors to Mammoth Lakes, Reno, and Hawaii communities. Disagreed on insufficient data: see 30-year Casa Diablo monitoring response plan. Want to move forward, as fossil fuels provide jobs.

Nelson indicated important discussions are taken to heart. Two huge priorities – water and clean energy.

8. CD IV update: On hold for monitoring plan and BLM to acquire staff geologist. Yamashita inquired about flow tests. Johnson cited sundry notice from Ormat, similar to 2012 proposal. Ormat now wants 30-day test, beginning around Aug. 24-25. Not yet signed, but close.

Yamashita questioned change from seven-day to 30-day test. Nelson indicated it was to take advantage of where monitoring plan is heading.

Lopeman asked if flow data would be shared. Suemnicht confirmed flow test completed, submitted to Ormat, not yet to BLM. Johnson indicated test preceded CD IV. Orenstein recalled it was explored before building plant. 2011-12 flow test was CD IV. Lopeman indicated long-term test will show how reservoir reacts over longer time.

Wardlow recalled well 14-25 was drilled in 2010. Took USFS over a year, plus other delays. Orenstein stated that after delays, finally seeing light at end of tunnel.

9. Adjourn at 12:11 p.m. to Feb. 1, 2017, same time. Data available in March? Howle indicated a typical six-month schedule, hard to anticipate return times. Hayes thought Ormat/BLM/MCWD could continue separately when data are available.

Prepared by CD Ritter, LVHAC secretary