



May 3, 2007

7-61M-11202-N

Ms. Lisa Milliman
Marion County Planning Division
P.O. Box 14500
Salem, Oregon 97309-5036

Dear Ms. Milliman:

Re: AMEC Peer Review of "Hydrogeologic Review For A Subdivision, T.9S. R.3 W. Sect. 3 Parcel Nos. 400 and 500, Marion County" by Pacific Hydro-Geology, Inc.

At the request of Marion County, AMEC Earth & Environmental, Inc. (AMEC) reviewed the referenced report (dated March 12, 2007) by Pacific Hydro-Geology, Inc. (PHG). The report was submitted by PHG to meet the requirements of the County's sensitive groundwater overlay (SGO) ordinance.

AMEC's review of this report was based on the SGO ordinance and on Marion County's October 2005 manual for completing hydrogeology reviews and studies in compliance with the SGO. Specifically, AMEC verified that the report contained the information required by Section 181.100(A) of the SGO and that it demonstrated all items required by Section 181.100(B). The work was performed under the terms and conditions (including limitations of liability) specified in the contract between AMEC and Marion County.

REPORT SUMMARY

The proposed development is a partition of parcels 400 and 500 into a total of 43 residential lots, which would result in 43 additional domestic wells. The report reviewed the hydrogeologic setting in the project area and provided a water use inventory and water budget. The target aquifer for the proposed development is the Columbia River basalt. Within the study area, another aquifer – the marine sediments – lies stratigraphically beneath and topographically downslope of the basalt.

A water budget prepared by Marion County and included in the PHG report as Figure 2 estimated that approximately 25% of the estimated available groundwater recharge in the study area would be used if the study area were underlain entirely by the basalt, or that approximately 74% of the estimated available recharge in the study area would be used if the study area were entirely underlain by the marine sediments aquifer. However, the location of the proposed development was revised, invalidating the County water balance. PHG therefore developed a revised water balance, but on the assumption that the only relevant recharge and discharge in the study area occurred in that part of the study area that is underlain only by the basalt. PHG did not develop a water balance for the entire study area. For the basalt area, PHG developed primary and supplemental water balances. The primary balance estimated that 29.9% of the



recharge in the basalt area would be used, whereas the supplemental balance estimated that 63.9% of the recharge within only the area of the proposed subdivision would be used.

PEER REVIEW FINDINGS

The above-referenced report included the elements required by Marion County's Chapter 181 SGO ordinance. There are two critical issues in the report: 1) the water balance and 2) whether well deepenings/replacements and water level data indicate problems obtaining groundwater in the study area.

Water Balance. PHG presented two water balances, a primary balance that addressed only that part of the study area underlain by basalt and a supplemental balance for only the area of the proposed development. The assumption upon which both water balances rest – that there is no connection between groundwater in the basalt and groundwater in the underlying marine sediments – is discussed at the end of this review.

A minor problem with the primary water balance is that the boundaries of the basalt aquifer, as opposed to the basalt geologic map unit, are not clear. PHG correctly notes that the location of the mapped edge of the basalt can be revised on the basis of well log data, but it is not clear that this was done for the purpose of estimating recharge. Nor is it clear that the edge of the basalt aquifer has been adjusted to include only those areas where groundwater is actually present in the basalt, an issue PHG discussed (page 6, paragraph 3) with respect to an earlier hydrogeologic review.

A larger problem with the estimated primary water balance, however, is that it does not account for existing water rights. PHG is correct in stating that no groundwater rights are present in the study area but there are three other rights in the study area that are relevant because they tie to water that originates, at least in part, from springs. In contesting an interpretation in a report prepared by Groundwater Solutions, Inc. (GSI) (Hydrogeologic Assessment of the Seeps and Springs at Spring Lakes Estates, Salem, Oregon, October 4, 2006), PHG seems to describe the springs as issuing from the basalt aquifer. The three rights (R 79830 – Snively, R 7770 - Kubena, and R 5869 – Thompson) allow for reservoir storage of 104.56 acre-feet (AF) of water per year.

How much of the reservoir storage derives from groundwater via spring discharge is uncertain; we estimate that the average discharge would be approximately 60 gallons per minute if all the water in storage came from the springs. This seems too large, on the basis of photographs of the springs presented in the GSI report. Our crude estimate suggests that local surface water runoff might provide approximately 50 AF of water for annual storage, leaving approximately 54 AF of water for the springs to supply.

On the basis of this simplistic rough estimate, the proposed development's annual use of 25 AF of groundwater could amount to 46% of the estimated annual discharge from the springs. Whether and to what degree the proposed development might affect spring flow is not evaluated in the report except for speculative discussion on page 17, paragraph 2.



Well Deepenings/Replacements and Water Level Declines. As with the water balance, PHG limited its analysis to well deepenings/replacements and water levels in the basalt aquifer. The report does not specifically state the percentage of deepened/replacement basalt wells in the study area, but working from information presented in the report text and its Table 1, it appears that PHG located 63 basalt wells in the study area, of which 4 represent deepenings or replacements. The apparent deepening/replacement statistic is therefore 6.3%.

However, this statistic needs to be modified on the basis of additional information provided to Marion County by the "Keep Our Water Safe Committee;" this information was provided to AMEC by Marion County on April 11, 2007. The additional information indicates that three other basalt wells have been deepened or replaced, of which AMEC considers two (PHG wells 91 and 94) to be relevant to potential water level declines. (We do not consider the third basalt well, PHG well 96, to be relevant because the original 320-foot-deep well was replaced in October 2003, only three months after its completion, by a shallower (245 foot) well that yielded more water.)

The revised statistic for the basalt aquifer is therefore 9.5%, which is below the 12.6% deepening/replacement threshold taken by Marion County as signifying potential issues with groundwater availability. However, AMEC feels that further consideration of well deepenings/replacements would be prudent because 1) only two more deepenings/replacements would cause the threshold value to be exceeded, 2) most of the existing deepenings/replacements appear to be located near the proposed development, and 3) it is not clear whether the deepenings/replacements are due to natural factors such as transmissivity that may vary from location to location, or whether they are due to well interference or declining groundwater levels resulting from aquifer overuse.

As a cross check on the information provided by the logs of well deepenings/replacements, PHG also compiled water level data. The nearest basalt well having a water level record is MARI 15000, which is located in the study area at a point approximately 1,500 feet south of the proposed development. The available data for MARI 15000 do not indicate a long-term groundwater level decline, because the maximum difference in measured water levels between 1975 and 2005 is 1.1 foot. However, no post-2005 data are available and it is uncertain if the water level in the well has since changed.

The other groundwater level data presented in the PHG report are from wells located approximately 3,500 to 10,000 feet outside of the study area. In our opinion, this means that such data are not useful in evaluating conditions in the study area, because in the absence of documentation, the conditions of groundwater recharge and usage at these locations may vary from those in the study area. However, assuming for the moment that this is not a valid concern, the presentation of water level data from wells outside of the study area does not paint a complete picture. Specifically, PHG noted that a water level record was available for well MARI 51445, which is located at Chinook Estates, a development several miles to the west-northwest of the study area. Using Chinook Estates as a hydrogeologic analog for the proposed development, PHG noted that the water level in the Chinook Estate basalt well was stable from 1998 through 2004, the period of record. However, water level records for other wells completed in the marine sediments aquifer at Chinook Estates were not presented, making it



impossible for the reviewer to assess whether groundwater withdrawal from the basalt has or has not affected water levels in the underlying marine sediments aquifer.

Other available information concerning water levels in the study area is only anecdotal, not empirical. The GSI report states that in September 2006, the springs were dry for the second summer in a row after running continuously for 40 years. Also, a letter from Thomas Bass attached to the "Keep Our Water Safe Committee" document states that the ability of his well (PHG well 98) to provide water has decreased, especially in the past ten years. The Bass well is completed in basalt and according to Figure 5 in the PHG report, is located near the southwestern corner of the proposed development.

Discussion. Beyond the issues raised above, the largest issue in the PHG report is the assumption that the proposed development needs to consider only groundwater recharge and usage in the basalt aquifer, and not also in the marine sediments aquifer. The basis for this assumed conceptual model is not stated and it is obvious that the review attempts to consider the basalt aquifer as a closed system, as shown by the supplemental water balance. While we appreciate that the supplemental balance can be taken as an attempt to show that the proposed development "stands on its own legs," it is clear from consideration of potential spring discharge alone that the conceptual model for groundwater recharge and discharge in the study area cannot be isolated to just the proposed development. Furthermore, it is not certain that the conceptual model of an isolated basalt aquifer pertains to the proposed development, because no hydrogeologic cross sections transecting the proposed development have been provided. Review of aerial photographs on the Marion County Internet Mapper indicates that homes, and thus wells, are located immediately north of the proposed development. Well logs from these locations could be used in cross sections drawn through the proposed development.

The conceptual model for the proposed development should consider that the proposed development is in a groundwater recharge zone, because the proposed development straddles a ridge. In recharge areas, water soaks into the soil, eventually reaches the water table, and migrates toward one or more discharge areas. PHG apparently believes that this movement is restricted to the basalt. However, in recharge areas a vertical component of groundwater movement is common, and this can cause groundwater to migrate vertically from a shallow aquifer to a deeper aquifer, regardless of the aquifers' individual water-bearing properties. Such vertical movement is necessary to explain the presence of groundwater in the marine sediments at hilltop locations where the marine sediments are covered by basalt that also contains groundwater. This can be seen in the logs for PHG wells 21a and 131. In our opinion, this means that the impact of the proposed development on the entire hydrogeologic system – including the marine sediments – should be evaluated.

Conclusion. No evidence is presented that the basalt and marine sediments aquifers in the study area are not interconnected. On this basis, as well because of the detailed points raised above, the reviewer finds that the information in the report is not adequate to demonstrate that the proposed development would not adversely affect the availability of groundwater for other existing users in the entire hydrogeologic system.



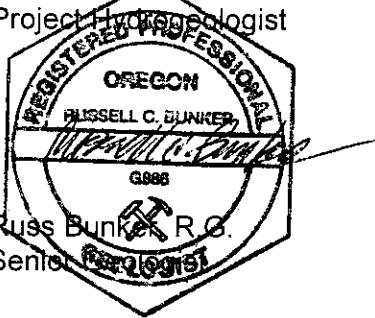
Please contact the undersigned at (503) 639-3400 if you have any questions.

Sincerely,

AMEC Earth & Environmental, Inc.

A handwritten signature in black ink that reads "Matt Kohlbecker".

Matt Kohlbecker
Project Hydrogeologist



Russ Bunker, R.G.
Senior Geologist

RB/jm