AECOM

**AECOM Environment**
171 Daniel Webster Highway, Suite 11, Belmont, NH  03220
T 603.524.8866    F 603.524.9777    www.aecom.com

February 19, 2009

Mr. Don Reimer
Chaffee County Director of Development Services
P.O. Box 699
Salida, CO  81201

**Subject:** AECOM's Responses to Comments Made in Wheeler's Review of NWNA 1041 Application to Chaffee County

Dear Mr. Reimer:

The following document provides responses to comments made by W.W. Wheeler in their February 4, 2009 review of the 1041 permit application submitted to Chaffee County by Nestlé Waters North America Inc. (NWNA). The responses enumerated below correspond to notes posted on a copy of Wheeler's draft review. The latter annotated document is transmitted herewith. The number referenced in a given annotation in the attached Wheeler document matches that of the corresponding response as indicated by the numbers that appear in the left-hand margin below.

1. The document entitled "*Phase 1 Hydrogeologic Report for the Buena Vista Spring Sites*" (ENSR, October 2008) which was submitted to the County in support of NWNA's 1041 application contains a considerable amount of information that relates to the temporal relationships between pumping and observed changes in spring discharge at both sites.

   During the January 2008 pumping test on RMBH-2, aggregate spring discharge measured at the Ruby Mountain weir, which is located less than 100 feet up gradient of the confluence between the spring discharge channel and the Arkansas River, "…decreased from approximately 1,665 gpm at the start of the test, to 1,468 gpm near the end of the test, or by 193 gpm…." (ENSR, October 2008, p. 4-4). (The duration of the pumping phase of this initial test was 62.25 hours.) After accounting for ambient (background) water-level recession within the source aquifer, ENSR calculated "….a test-related impact of approximately 125 gpm…" (ENSR, October 2008, p. 4-4). Twenty-four hours after pump shutdown in RMBH-2, discharge through the Ruby Mountain weir had increased by 80 gpm. "Adjusting the observed decline in discharge through the weir during the pumping test (193 gpm) yields a test-related impact of approximately 125 gpm…" (ENSR, October 2008, p. 4-4). If the rate of ambient recession observed prior to the start of pumping is projected on a linear trend out through the recovery period (on Figure 4-2b, ENSR, October 2008), then full recovery of cumulative spring discharge as measured at the Ruby Mountain weir occurred approximately 35 hours after pump shutdown in RMBH-2.

   A second pumping test was conducted on RMBH-2 in late April of 2008. The pumping phase of that test was 72.47 hours long. During the April test, "the combined flow from the site springs (including but not limited to Springs 1 through 4), as measured at the Ruby Mountain weir (Figure 4-11), decreased from approximately 965 gpm at the start of the test, to 864 gpm near the end of the test, or by 101 gpm (a 10 percent reduction in discharge)…..Adjusting the observed decline in discharge through the weir during the pumping test (101 gpm) by the reduction that would have naturally occurred in the absence of pumping (3.0 days x 4.5

gpm/day = 13.5 gpm) yields a test-related impact of approximately 87.5 gpm [after 72.47 hours of pumping]" (ENSR, October 2008, p. 4-11). "After the pump was shut down in RMBH-2, flow through the Ruby Mountain weir recovered by 68 gpm during the first 24 hours, or by 78 percent of the test-related impact. After adjusting for the observed ambient decline in composite spring discharge at the Ruby Mountain weir, 100% recovery occurred approximately 77 hours after the cessation of pumping from RMBH-2" (ENSR, October 2008, p. 4-12).

Similar data have been presented for BHBH-2 and the Bighorn Springs in the *Phase 1 Hydrogeologic Report.* The pumping phase of the January 2008 pumping test on BHBH-2 lasted 63.3 hours. During that period, "the rate of flow at Parshall 1 [which is located roughly 500 feet upstream of the confluence of the spring discharge channel and the Arkansas River]…decreased from approximately 245 to 224 gpm near the end of the test, or by 21 gpm (9 percent) … After adjusting the decrease in flow by the amount that would have been expected to occur naturally during the 63-hour test, the pumping of BHBH-2 is estimated to have impacted flow through Parshall 1 by approximately 8 gpm…..at the end of the test" (ENSR, October 2008, p. 4-6). A more dramatic response was observed at Parshall 2 which was installed about 150 feet down gradient of Parshall 1 to monitor discharge from a smaller, ancillary spring at the Bighorn site. "After adjusting for [the rate of] ambient decline, the pumping of BHBH-2 is estimated to have impacted flow at Parshall 2 by 11.0 gpm or 73 percent of the rate of flow anticipated at the end of the test. The rate of flow recovered by 7.3 gpm (to 14.5 gpm) after the pump was shut off, which represents full recovery at that monitoring station. The total observed response of spring discharge during the pumping test on BHBH-2 was 19 gpm (8 gpm at Parshall 1 and 11 gpm at Parshall 2), or 27 percent of the 70 gpm pumping rate. After accounting for ambient declines in flow, the rates of discharge at both stations are thought to have experienced complete recovery following cessation of withdrawals from BHBH-2" (ENSR, October 2008, p. 4-6 and 4-7). If the rate of ambient recession observed prior to the start of pumping is projected on a linear trend out through the recovery period (on Figure 4-3c, ENSR, October 2008), then full recovery at the Parshall 1 flume occurred approximately 4 hours after pump shutdown in BHBH-2. Interpretation of spring discharge data from Parshall 2 is complicated by the fact that no automated antecedent data are available for this monitoring station. Nonetheless, if a similar rate of ambient decline in spring discharge is assumed (relative to Parshall 1), then full recovery at Parshall 2 occurred within about 5 hours of pump shutdown.

As in the case of RMBH-2, a second pumping test was performed on BHBH-2 under low-water-table (and low-flow) conditions in the spring of 2008. The pumping phase of the May 2008 test was 51.7 hours long. At the time of the test, the smaller spring up-gradient of Parshall 2 was not flowing and therefore no discharge data exist for that monitoring station. Analysis of pumping test data show that "at Parshall 1, …..the rate of flow decreased from 97 gpm to a low of 87 gpm during the final 37 gpm step, for a total test-related impact of 10 gpm (10%)" (ENSR, October 2008, p. 4-15). Following pump shutdown in BHBH-2, spring discharge measured at Parshall 1 gradually increased to 95 gpm over a two-day period. The 2 gpm difference between spring discharge rates observed prior to pumping and after two days of recovery is attributed to the ambient decline in discharge within the outwash aquifer during early May of 2008. Therefore ENSR concludes that full recovery of spring flow occurred within the 48-hour period following pump shutdown in BHBH-2.

When all pumping test data are considered objectively in the context of hydrogeological conditions prevailing at the time of the tests, full recovery of spring flow (following a protracted period of pumping) appears to occur within 35 to 77 hours of the cessation of pumping at the Ruby Mountain site and within four and one half to 48 hours of pump shutdown at the Bighorn site. These observations contradict the notion that “the discharge rate of the springs will presumably not fully recover for a substantial period of time after the pumps are shut off” (W.W. Wheeler, 2009, p. 1).

2. Although AECOM agrees that the response of spring discharge to changes in the rate of groundwater withdrawal from the production boreholes will not be instantaneous at the Ruby Mountain and Bighorn sites, it is not clear why “…the net reduction of spring discharge at the two sites will presumably be a similar amount” (W.W. Wheeler and Assoc., 2009, p. 3) when pumping-test data indicate otherwise. During the January 2008 pumping test on RMBH-2, the borehole was pumped for a period of 62.25 hours at an average rate of approximately 190 to 195 gpm. The measured reduction in spring flow at the Ruby Mountain weir was 125 gpm (66 percent of the average pumping rate) after correcting for the rate of ambient decline is spring discharge observed at the time of the test. During the April 2008 pumping test at Ruby Mountain, RMBH-2 was pumped for 72.47 hours at an average rate of 136.7 gpm. At the conclusion of the pumping phase of that test, spring discharge through the weir had declined by 87.5 gpm after accounting for ambient trends (which equates to 64 percent of the average pumping rate).

   During the January 2008 pumping test on BHBH-2, the borehole was pumped for 63.3 hours at an average rate of 69.7 gpm. Near the conclusion of the test, the combined reduction in spring discharge from the site as measured at the Parshall 1 and Parshall 2 flumes was 19 gpm after adjustments for the ambient decline in spring flow were made, which is approximately 27 percent of the sustained rate of withdrawal from BHBH-2. Later in the spring of 2008, when BHBH-2 was pumped at an average rate of 46 gpm over a 51.7-hour-long period, there was no measurable flow through the Parshall 2 flume, but the reduction in spring discharge measured at Parshall flume 1 was 10 gpm after allowances for ambient trends in spring flow were made. This represents roughly 22 percent of the average pumping rate during the test.

   Therefore the pumping test data suggest that the observed reduction in aggregate spring flow leaving the Ruby Mountain site through the weir is 64 to 66 percent of the average rate of withdrawal from RMBH-2. In the case of BHBH-2 the observed decline in spring flow leaving the site is on the order of 22 to 27 percent of the average pumping rate in the borehole. In terms of absolute magnitude, observed reductions in spring discharge at the Ruby Mountain site have been 87.5 to 125 gpm under test pumping conditions. The pumping induced reductions in spring flow at the Bighorn site have been in the range of 10 to 19 gpm. Because the amount of spring flow reduction appears to be roughly one quarter of the pumping rate at Bighorn and two thirds the pumping rate at Ruby Mountain, the actual reduction in spring discharge (in gpm) at each site will be determined by the rate of withdrawal from the borehole which will in turn be limited, at any given time, by the amount of available drawdown, the specific capacity of the borehole, and the long-term constraints in withdrawals (200 acre-feet annually).

3. This statement presumes a one-to-one relationship between the rate of withdrawal from the borehole being pumped and the consequential reduction in spring discharge. In other words, the underlying assumption is that if the borehole is pumped on a sustained basis at 120 gpm, then the cumulative reduction in spring discharge on the site will be equivalent (i.e., a loss of 120 gpm in aggregate spring flow). Results from all pumping tests conducted to date, however, indicate that this is not the case. During the January 2008 pumping test on RMBH-2, it was determined that discharge through the Ruby Mountain weir declined by 125 gpm after accounting for the ambient (background) trend in water-level recession within the source aquifer (ENSR, 2008, p. 4-4). This corresponds to “a test-related impact of approximately 125 gpm or roughly 83 percent of the pumping rate during the last phase of the test” or 65 percent of the average rate of pumping (~ 193 gpm) during the testing period.

In late April of 2008, under low-water-table conditions, RMBH-2 underwent a 72-hour-long pumping test at an average withdrawal rate of 136.7 gpm. During the final 9.47 hours of the test, the pumping rate was maintained at a constant 169.5 gpm. During the pumping phase of the April 2008 test, flow through the Ruby Mountain weir declined from 965 to 864 gpm (ENSR, 2008, p. 4-11). "Adjusting the observed decline in discharge through the weir during the pumping test (101 gpm) by the reduction that would have naturally occurred in the absence of pumping (3.0 days x 4.5 gpm/day = 13.5 gpm) yields a test-related impact of approximately 87.5 gpm or 64 percent of the average rate of withdrawal during the pumping phase of the test" (ENSR, 2008, p. 4-11) or 51.6 percent of the pumping rate during the last step in the test.

From these observations it is reasonable to conclude that for a given rate of withdrawal from RMBH-2, the corresponding reduction in aggregate spring flow from the Ruby Mountain site is approximately half to three quarters of the pumping rate. Analysis of available pumping test data "…suggests that during active pumping, a portion of the withdrawals from the borehole would not otherwise immediately discharge at the monitored springs under non-pumping conditions" (ENSR, 2008, p. 4-11). If a proportionality of 50 to 75 percent is applied to a scenario involving sustained pumping at a rate of 124 gpm (as suggested by Wheeler, 2009, p.3), then the resultant reduction in spring flow at the Ruby Mountain site would be 62 to 93 gpm or 7 to 10 percent of aggregate spring flow (900 gpm) under seasonal low-flow conditions.

4. As a matter of clarification, the low-flow spring discharge of 90 gpm cited by Wheeler (2009, p. 3) does not come from the monitoring station "located immediately upstream of the [Bighorn Springs] discharge into the Arkansas River." The monitoring location they describe is Parshall flume 3, where low-flow discharges to the river are significantly greater. Parshall flume 1 is situated approximately60 feet down-gradient of Bighorn Spring 1 and roughly 300 to 350 feet upstream from Parshall flume 3, along the Bighorn Springs discharge channel; it is at this monitoring station where a low-flow spring discharge of approximately 90 gpm was documented between September of 2007 and May of 2008. It is important to note that in between Parshall flumes 1 and 3, the spring discharge channel is a gaining stream due to streamflow contributions from areas of diffuse spring discharge and groundwater seeps, primarily within the area encompassed by Wetland 2.

5. The important point to recognize in this instance is that the production capacities of the boreholes are constrained by their respective specific capacities and the amount of available drawdown (i.e., static water level elevation minus the elevation of the top of the well screen). The maximum amount of water that is feasible to pump from the borehole is roughly equivalent to the borehole's specific capacity (gpm/ft) multiplied by the amount of available drawdown (in feet). Under low-flow conditions, when spring discharge is at a seasonal minimum, water levels within the host aquifer are typically at their annual lows. The consequential reduction in the amount of available drawdown will ultimately limit the production capacity of the borehole. The 70 gpm withdrawal rate cited by Wheeler (2009, p. 3) is only achievable under the most favorable hydrogeological conditions which usually occur between late October and early December of a given year. Under low-flow (low-water-table) conditions, the amount of water that can be pumped from the borehole on a sustainable basis will be much lower. In the case of the most recent test conducted on BHBH-2 (in early February of 2009), the amount of available drawdown was 3.31 feet; given a specific capacity of 18.4 gpm/ft, the maximum pumping rate that could be sustained during a 72-hour constant-rate test was 40 gpm. (This pumping rate incorporates a one-foot safety factor whereby the lowest pumping water level within the borehole remains at least one foot above the top of the screened interval.) Under such

conditions the rate of withdrawal equates to roughly 44 percent of the spring discharge measured at Parshall flume 1 (not the 78 percent calculated by Wheeler).

6. The assertion that lowering of the water table due to pumping of the Ruby Mountain and Bighorn boreholes “may have a lasting effect on the streamflow for several years, even if pumping does not continue to occur” is inconsistent with available pumping test data. The rapid recovery of springs in the study area following pump shutdown in the production boreholes has already been discussed in some detail under Item 1 above. Rapid recovery upon termination of pumping is also evident in water-level data from RMBH-2 and BHBH-2.

   In January of 2008, RMBH-2 was pumped for a period of 62.25 hours at an average rate of approximately 190 to 195 gpm; during the final 17.5 hours of the test, a constant pumping rate of 150 gpm was maintained. At the end of the pumping phase of the test, there was a total drawdown of 11.26 feet in the pumping borehole. Following pump shutdown, RMBH-2 experienced 93 percent recovery (relative to pre-pumping, static conditions) within 15 minutes. The fact that no measurable recovery was observed over the ensuing two-hour period is attributed to a background recession of water levels throughout the host aquifer. During the January test, the maximum amounts of drawdown in RMBH-1 and the Hagen domestic water supply well were 0.79 and 0.68 feet, respectively; these overburden observation wells are located 196 and 90 feet, respectively, from the pumping borehole. The minimal drawdown in RMBH-1 and the Hagen well attest to the highly transmissive character of the aquifer and the very localized cone of depression induced by pumping.

   The Hagen well achieved 65 percent recovery within 7 hours of pump shutdown in RMBH-2; the *Phase 1 Hydrogeologic Report* concludes that “…the lack of complete recovery in the domestic well is mostly attributable an ambient, background water-level decline throughout the aquifer” (ENSR, October 2008, p. 4-3). RMBH-1 achieved 48 percent recovery within 7 hours of pump shutdown and 62 percent roughly 17 hours later.

   During the subsequent pumping test on RMBH-2 conducted in late April of 2008, the borehole was pumped for a period of 72.47 hours at an average withdrawal rate of 136.7 gpm; for the last 9.47 hours of the test, a constant pumping rate of 169.5 gpm was maintained; the maximum observed drawdown at the conclusion of the pumping phase was 7.91 feet. “Within 1 minute of shutting off the pump in RMBH-2, water levels had recovered …by 6.15 feet (77.7 percent recovery relative to static conditions at the start of the test). After 15 minutes of recovery, water levels had recovered by a total of 7.42 feet (93.8 percent recovery) and after one hour, they recovered a total of 7.55 feet (95.4 percent recovery). Full recovery was achieved about 49 hours after the pump was shut off….” (ENSR, October 2008, p. 4-10).

   At the conclusion of pumping, a total test-related drawdown of 0.48 feet was observed in the Hagen well; 95 percent recovery was achieved within 21 hours of pump shutdown in RMBH-2. In comparison, the total drawdown measured in RMBH-1 was 0.43 feet, roughly comparable to that observed in the Hagen well; 58 percent recovery was observed 10 hours after pump shutdown in RMBH-2 and full recovery occurred approximately 71 hours later (less than three and one half days after the cessation of pumping).

   The pumping tests conducted to date on BHBH-2 also provide evidence of minimal drawdown and rapid water level recovery within the outwash aquifer following the cessation of pumping. In January of 2008, BHBH-2 was pumped for a period of 63.3 hours duration; during the last 61.13 hours of the test, the borehole was pumped at a constant rate of 70 gpm. BHBH-2 experienced a total pumping-induced drawdown of 3.81 feet. Following pump shutdown, water levels in BHBH-2 recovered by 3.20 feet or 83 percent within 15 minutes; after only 5.58 hours, 90 percent recovery had been achieved. After approximately 24 hours of recovery, the water level in the pumping borehole had risen to within 0.28 feet of static, thereby attaining 91 percent recovery relative to pre-pumping conditions. As in other cases that have been described, the lack of additional recovery is attributed to a background recession of water levels throughout the aquifer that was observed during the antecedent period of the test.

During the January 2008 test, BHBH-1, which is 94 feet away from BHBH-2, was utilized as an observation well. The maximum drawdown in BHBH-1, measured just before pump shutdown, was 0.61 feet. "Within 5.58 hours of pump shut off, water levels in BHBH-1 recovered by 0.36 feet, achieving 41 percent recovery relative to static [conditions]. BHBH-1 recovered an additional 0.04 feet after 23.25 hours, corresponding to 48 percent recovery….The lack of additional recovery is attributed primarily to a ubiquitous reduction in water levels throughout the aquifer" (ENSR, October 2008, p. 4-6).

In May of the same year, the second hydraulic performance test conducted on BHBH-2 involved pumping the borehole under low-water-level conditions for a period of 51.7 hours at an average withdrawal rate of 46 gpm. A nearly constant pumping rate of 37 gpm was maintained for the final 19 hours of the test. The total amount of drawdown measured just prior to pump shutdown was 5.03 feet. Following pump shutdown, water levels in the pumping borehole rebounded 3.10 feet within two minutes corresponding to 62 percent recovery (relative to static conditions at the start of the test). "Within 10 hours, water levels had recovered 4.52 feet, or by 90 percent…..One hundred percent recovery was attained approximately 40 hours after the cessation of pumping" (ENSR, October 2008, p. 4-14).

During the May 2008 test, BHBH-1 was again used as an observation well. The total drawdown measured in that well was 0.63 feet just before the end of the pumping phase of the test. "During the first 24 hours of recovery, water levels in BHBH-1 recovered by 0.58 feet, for 92 percent recovery relative to static (pre-test) conditions. One hundred percent recovery was achieved within 32 hours of the end of the pumping phase. Water levels in BHBH-1 continued to rise, reaching 0.10 feet above static later in the recovery period" (ENSR, October 2008, p. 4-14).

Several other observation wells were monitored during the May 2008 test on BHBH2; of these, BHMW-1, which is 1,364 feet east-northeast of BHBH-2, is the most proximal to the pumping center. The observation wells were monitored twice daily using automated equipment (pressure transducers and data loggers) and manual readings (with a hand-held electronic water-level probe). No pumping-related effects were observed at any of these stations over the course of the test.

In summary, RMBH-2 and BHBH-2 have each undergone two pumping tests. During these tests, maximum drawdown in the pumping boreholes has ranged from 7.91 to 11.26 feet in the case of RMBH-2 and 3.81 to 5.03 feet in the case of BHBH-2. At Ruby Mountain, the maximum amount of pumping-induced drawdown in observation wells located between 90 and 200 feet from RMBH-2 was on the order of 0.43 to 0.79 feet. During the pumping tests conducted on RMBH-2, 93 percent recovery in the pumping borehole was achieved within 15 minutes of pump shutdown. At the Bighorn Springs site, the maximum amount of pumping-induced drawdown in an observation well located 94 feet from BMBH-2 varied from 0.61 feet (in January) to 0.63 feet (in May). In both tests conducted on BHBH-2, 90 percent recovery in the pumping borehole was achieved within five and one half to 10 hours following pump shutdown. These empirical data do not support Wheeler's assertion (W.W. Wheeler and Assoc., 2009, p. 4) regarding potential long-term impacts to water-table elevations and streamflow following the cessation of pumping at the Bighorn and Ruby Mountain sites.

7. This is an apparent misunderstanding by Wheeler with respect to the last sentence of the first paragraph in Section 11.0 of the Groundwater Investigation module in the 1041 application. Specifically, that sentence states that "given the physical limitation of the production borehole design, water levels cannot be drawn down to levels that would induce surface-water infiltration from the Arkansas River." In other words, the pertinent section of the Groundwater Investigation concludes that "a scenario in which the groundwater level could be pumped down to the level of the Arkansas River, causing water to be extracted from the Arkansas River to replenish the groundwater" (Wheeler, p. 4) is not possible under anticipated operating conditions by virtue of production borehole design details. The elevation relationships between the screened intervals in RMBH-2 and BHBH-2 and stage in the river provide some insight in this matter.

   The 15-foot screened interval in borehole RMBH-2 extends from 7,623 to 7,638 feet above mean sea level (ft msl). The stage elevation along the adjacent reach of the Arkansas River (as determined from a 2007 site survey map compiled at two-foot contour intervals) is 7,628 to 7,632 ft msl. Therefore, the pumping water level in RMBH-2 could not be depressed to the elevation of the river without dewatering the upper several feet of screen. (Dewatering of the screen is to be avoided under any circumstance as this would result in damage to the gravel-developed annulus surrounding the well screen and a significant reduction in borehole efficiency, long-term sustainable yield, and specific capacity.) Under operating conditions, the pumping water level in the production boreholes will remain at least one foot above the top of the screen at all times; the one-foot safety margin is intended to safeguard against dewatering of the screen and prevent costly, and potentially irreparable, damage to the production borehole.

   At the Bighorn site, the 15-foot screened interval in BHBH-2 spans elevations between 7,664 and 7,679 ft msl. According to the 2007 site survey, the stage elevation in the adjacent reach of the river falls in the range of 7,652 to 7,654 ft msl. In this case, it is impossible to drop the pumping water level in the borehole to the elevation of the Arkansas River, even if the entire screen is dewatered: the elevation of the bottom of the screen (7,664 ft msl) is approximately 10 feet higher than river stage.

   Given these elevation relationships and the fact that operating practices will not allow for dewatering of any portion of the well screens under pumping conditions, it will be impossible to induce surface water infiltration from the Arkansas River.

8. Please note that NWNA is proposing a long-term wetlands monitoring program to address this concern. In addition, the project proponent is also proposing to undertake a wetlands habitat restoration project at the Ruby Mountain site. The restoration program will dramatically increase the size of high-quality wetland habitat in the project area.

9. It is AECOM's contention that the pumping tests performed on RMBH-2 and BHBH-2 were of sufficient duration to determine the long-term sustainable yield of the boreholes under the hydrogeologic conditions prevailing at the time of the tests. In cases where there are regulatory requirements that pertain to the minimum acceptable duration of a pumping test, 48 to 72 hours is a commonly prescribed value. As summarized in Table 1 (below), the lengths of the pumping tests performed to date have varied between 62.25 and 72.47 hours in three out of four cases, the one exception being the May 2008 pumping test on BHBH-2 which was 51.7 hours long. At

the conclusion of the pumping phase of each test, observed rates of drawdown in the pumping borehole varied between 0.002 and 0.006 feet per hour.

Table 1: Summary of Pumping Tests Conducted to Date at the Ruby Mountain and Bighorn Sites

| **Borehole & Pumping Test Date** | **Total Length of Pumping Period (hours)** | **Pumping Rate During Last Step (gpm)** | **Rate of Drawdown During Last Step (feet/hour)** | **Length of Time (hours) Over Which Average Rate of Drawdown is Computed** |
|---|---|---|---|---|
| RMBH-2 0108 | 62.25 | 150 | 0.002 | 14.5 |
| RMBH-2 0408 | 72.47 | 169.5 | 0.006 | 8 |
| BHBH-2 0108 | 63.3 | 70 | 0.004 | 18.4 |
| BHBH-2 0508 | 51.7 | 37 | 0.006 | 4.68 |

Part of the analysis and presentation of pumping test data has involved making long-term projections of water levels in the pumping borehole under a scenario that involves continued pumping for a protracted period of time without recharge from precipitation. This was done by extrapolating or projecting out the water level in the pumping borehole for 180 days on a semi-logarithmic plot of time versus drawdown. In three out of four cases, the pumping water level in the borehole remained above the top of the screen after 180 days. (In the analysis of the May 2008 pumping test on BHBH-2, a 180-day no-recharge projection was not attempted because of adjustments in the pumping rate during the last few hours of the test and the fact that the uppermost four feet of the well screen were intentionally packed off during the test.)

Conclusions derived from a 180-day projection of water-level data admittedly ignore the possibility of encountering a recharge boundary during the period of prolonged pumping. This type of recharge boundary, for example, could result if the outward-propagating cone of depression intersects the bedrock surface at some distance from the borehole. It is generally acknowledged that the only reliable way of demonstrating sustainable well yield is to monitor water levels in the pumping borehole and outlying observations wells over a prolonged period of operation. This is exactly what NWNA will do as part of the best resource management practices at the spring sites. Nonetheless, available pumping test data strongly suggest that the long-term sustainable yields of RMBH-2 and BHBH-2 are approximately 170 gpm and 40 to 70 gpm, respectively. This will be more than adequate to meet a water supply demand of 200 acre-feet per year (or a constant, sustained withdrawal of 124 gpm).

10. Wheeler's assumed impacts to spring discharge due to pumping appear to be significantly higher than what would be anticipated based on a careful examination of the pumping test data. (Please also refer to Items 1 and 2 for related analyses that have direct bearing on this matter.) First, it is important to reemphasize that the relationships between borehole pumping rates and consequential reductions in spring flow do not reflect a one-to-one proportionality. In other words, if a borehole is pumped at 60 gpm then the resultant reduction in spring discharge in not 60 gpm, but something less. The proportionality between pumping rates and spring flow diminution has been empirically derived for RMBH-2 and BHBH-2 in Item 2 based on available test data. Second, under low-flow conditions, the maximum tested withdrawal rate of 70 gpm from BHBH-2 will not be possible given limitations in the amount of available drawdown.

    For the purposes of this analysis, one can initially assume that all of the maximum withdrawal (124 gpm) will come from RMBH-2 as pumping test data indicate that the borehole will be capable of sustaining well in excess of this amount even under seasonal low-flow conditions. As shown in Table 2 (below), the percent reduction in aggregate spring flow at the Ruby Mountain weir (top two unshaded rows in Table 2) will vary from 4.9 percent under moderate- to high-flow conditions in late fall and early winter, to 8.6 percent under typical low-flow conditions in spring time.

Table 2: Observed and Predicted Reductions in Spring Flows Caused by Pumping

| Borehole & Pumping Test Date | Spring Discharge at Start of Test (gpm) | Observed Reduction in Spring Flow Due to Pumping (gpm) | Reduction in Spring Flow as a Percentage of Pumping Rate | Observed/Predicted Reduction in Spring Flow at Specified Pumping Rate | Percent Reduction in Spring Flow at Specified Pumping Rate |
|---|---|---|---|---|---|
| RMBH-2<br>0108 | 1,665 | 125 | 66% | 82 gpm @ 124 gpm | 4.9% @ 124 gpm |
| RMBH-2<br>0408 | 965 | 87.5 | 64% | 82 gpm @ 124 gpm | 8.6% @ 124 gpm |
| BHBH-2<br>0108 | 260 | 19 | 27% | 19 gpm @ 70 gpm | 7.3% @ 70 gpm |
| BHBH-2<br>0508 | 97 | 10 | 22% | 9 gpm @ 40 gpm | 9.3% @ 40 gpm |

At the Bighorn site, the amount of water that can be withdrawn for bottling purposes will be limited by the specific capacity of the borehole and the amount of available drawdown; for this part of the analysis, we have again used observed spring flows under moderate- to high-flow conditions and the maximum sustainable pumping rates under those same two conditions (bottom two rows to Table 2). We have assumed that in the late fall and early winter, BHBH-2 will be able to contribute up to a maximum of 70 gpm to the 124-gpm combined rate of withdrawal from both sites, while during a typical spring, a maximum of only 40 gpm will be available from that borehole. Applying the proportionality factors derived in Item 2 (and listed in the fourth column from the right in Table 2) we conclude that anticipated reductions in spring flow at the Bighorn site will vary between 7.3 percent under moderate- to high-flow conditions and 9.3 percent under seasonal low-flow conditions. These estimates are significantly less than the 78 percent maximum reduction in spring flow cited by Wheeler (p. 6, Item 3). The value of 78 percent appears to be based on the erroneous assumptions that (1) BHBH-2 will be capable of producing a sustainable 70 gpm under seasonal low-water-table conditions and (2) a one-to-one ratio exists between the rate of withdrawal from the borehole and the resultant reduction in spring discharge.

I hope you will find this information useful as you proceed with your evaluation of Nestlé's 1041 permit application. If I can be of further assistance or should you have any questions regarding the explanations presented herein, please feel free to contact me at your convenience.

Yours very truly,

Dennis S. Albaugh

DENNIS S. ALBAUGH
Director, Hydrogeology & Water Supply

cc: Gary Thompson, P.E., W.W. Wheeler and Associates, Inc.
Danielle R. Tripp, E.I., W.W. Wheeler and Associates, Inc.