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April 18, 2013

Heidi Schum
Engineering Review Manager
Planning & Development Services
1739 Broadway, 3rd fl., Boulder, CO 80302
303-441-1880

Subject: McCurry Hydrology, LLC review dated April 10, 2013

Dear Ms. Schum:

The purpose of this letter is to provide response to the review commissioned by the South East Boulder Neighborhoods Association and completed by McCurry Hydrology, LLC on April 10, 2013. Specific issues raised in the review are addressed in Attachment 1. For clarity, reviewer's comments are presented in their entirety followed by the response.

Throughout his comments, the reviewer provides no data or analyses to support his claims, and the conclusion he draws from unsubstantiated claims are antithetical to the results of the independent reviews provided by the City's consultants. This makes it extremely difficult to provide clarity in response, work in partnership to solve real issues, and misleads the public from the strong scientific basis upon which the analyses were developed. It is our desire that our responses help you and the public make good decisions based on the best science available.

Sincerely,

Telesto Solutions, Inc.

Terry Fairbanks
Senior Hydrologist

Walter L. Niccoli, P.E.
Senior Engineer

Enclosure

cc: Leslie R. Ewy, PE, The Sanitas Group, LLC

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ATTACHMENT 1

RESPONSE TO:
MCCURRY HYDROLOGY, LLC
REVIEW DATED APRIL 10, 2013

General Comments

Reviewer Comment 1. *The Boulder Creek Commons Ground Water Recharge Evaluation report (Recharge Report) attempts to compare current pre-development conditions on the Hogan-Pancost property with those following its development. The Recharge Report includes numerous errors on both quantitative and conceptual levels. The errors bias the potential impacts of the proposed development by showing minimal impacts and lead to incorrect conclusions regarding the potential impacts. When these errors are corrected, the ground water impacts will be more severe after the development is constructed.*

Telesto Response 1: No data or analysis is presented to support the reviewer's claim. The analyses presented by Telesto Solutions, Inc. were performed by a highly educated group of individuals (a PhD with a Professional Engineering certificate, a Professional Engineer and a qualified hydrologist with master's degrees in the ground water field), and reviewed by two highly qualified and independent professionals. The results of the analyses are opposite of the statements made by the reviewer. Thus, the reviewer is encouraged to present the independent technical analysis, including detailed calculations and supporting documentation to substantiate this comment.

Reviewer Comment 2. *The key finding of the Recharge Report is that lining Dry Creek Ditch #2 will reduce postdevelopment recharge and will lower groundwater levels beneath the Hogan-Pancost property and beneath nearby homes. Lining the ditch will indeed reduce summer recharge. However, since this ditch is full of water only a few weeks per year, lining it does not change the finding that post-development summer recharge will be at least two and possibly up to four times larger than current recharge. The higher recharge will lead to associated increases in groundwater levels and impacts to nearby homes.*

Telesto Response 2: The reviewer concurs that piping Dry Creek Ditch No. 2 "will indeed reduce summer recharge". The independent reviewer by Anderson Consulting Engineers, Inc. dated March 11, 2013 expands on this topic:

> *"Regardless of the outcome of the concerns expressed above the piping of Dry Creek Ditch No. 2 though the BCC property is very likely to benefit those project neighbors adjacent to the ditch along Cimarron Way. Basement flooding in properties adjacent to irrigation ditches is a well known problem along the front range of Colorado. While it may not eliminate sump pumping it is likely to reduce the amount of water contributing to the problem at certain times of the year."*

However, reviewer's assertion that "*this ditch is full of water only a few weeks per year*" is inconsistent with site observations and the past 10 years diversion records for Dry Creek Ditch No. 2. The table below shows the number of diversion days (and weeks) for 2003 through 2011.

For 2011, official records show diversions to Dry Creek Ditch No. 2 for three date ranges (see table on next page). Photo documentation from 2011 show Dry Creek Ditch No. 2 was flowing along the west property line for dates ranging from May 6, 2011 to August 23, 2011. The documentation shows that there is flow in Dry Creek Ditch No. 2 for diversion rates as low as 1 cfs (8/23/11).

Year	No. of Diversion Days	No. of Diversion Weeks	Diversion Dates	Dates with photo documentation of flow in Dry Creek Ditch No. 2	Diversion Rate (cfs)
2011	112	16.0	5/2/11 to 8/9/11 8/17/11 to 8/23/11 9/8/11 to 9/12/11	5/06/11 5/16/11 5/23/11 5/31/11 6/08/11 6/14/11 6/23/11 7/12/11 8/23/11	5.05 8.43 1.81 3.78 6.66 6.5 4.67 2.36 1.0
2010	78	11.1	5/5/10 to 6/13/10 6//10 to 7//10 8/2/10 to 8/8/10	-	-
2009	75	10.7	5/10/09 to 7/24/09	-	-
2008	73	10.4	5//08 to 7/31/08	-	-
2007	59	8.4	5/22/07 to 7/19/07	-	-
2006	68	9.7	5/16/06 to 7/22/06	-	-
2005	76	10.9	5/4/05 to 7/19/05	-	-
2004	103	14.7	5/5/04 to 8/15/04	-	-
2003	130	18.6	4/1/03 to 7/17/03 9/10/03 to 10/1/03	-	-

Reviewer Comment 3. *The Recharge Report fails to consider a significant source of water that flows onto the Hogan- Pancost property from the Bodham property immediately to the south. Excluding such a large component of the water inflow to the property renders the technical assessments questionable.*

Telesto Response 3: The reviewer presents no data or analysis to support his claim and thus, is encouraged to present the independent technical analysis, including detailed calculations and supporting documentation to substantiate this comment.

Reviewer Comment 4. *The Recharge Report suggests that neighborhood sump pumping occurs only in the summer season. This contradicts many years of winter sump pumping that has*

occurred in the neighborhood near the Hogan-Pancost property. The existence of high groundwater levels in the winter makes the approximately 50 percent increase in post-development winter recharge all the more important.

Telesto Response 4: The reviewer's comment implies that sump pumping occurs continuously year round. However, this assertion is inconsistent with field observations, and information provided by the residents on the east side of Cimmaron Way.

Date	Address	Comment	Source
4/1/13	260 Cimmaron	No sump discharge	Telesto direct observation
7/19/12	260 Cimmaron	Sump discharge	Telesto direct observation
5/19/12	260 Cimmaron	Sump discharge being used to water lawn	Telesto direct observation
5/19/12	210 Cimmaron	Sump only runs during high ground water periods (~ 1 week in 2011)	Resident
5/2/12	260 Cimmaron	Sump discharge ditch is dry, all water is infiltrating.	Telesto direct observation
4/27/12	260 Cimmaron	Sump discharge	Telesto direct observation
4/25/12	260 Cimmaron	No sump discharge	Telesto direct observation
3/22/12	260 Cimmaron	No sump discharge	Telesto direct observation
3/1/12	260 Cimmaron	Sump discharged stopped	Resident
2/26/12	260 Cimmaron Way	Sump discharged started, possible due to recent 20" snow	Resident
12/21/11	260 Cimmaron	No sump discharge	Telesto direct observation
11/21/11	260 Cimmaron	Evidence of intermittent sumps discharge (moist leaves, wet rocks)	Telesto direct observation
10/25/11	260 Cimmaron	Evidence of intermittent sumps discharge (water in ditch near outlet)	Telesto direct observation
6/14/11	260 Cimmaron	Sump discharge	Telesto direct observation
6/14/11	5395 Kewanee	Resident: "No sumping since property purchased in 1986"	Resident
5/5/11	260 Cimmaron	Sump discharge	Resident
10/21/2011	260 Cimmaron	Sump discharge	Resident
11/17/2011	260 Cimmaron	Intermittent sump discharge	Resident

Reviewer Comment 5. *The Boulder Creek Commons Ground Water Engineering Peer Review (Peer Review) identifies many errors and raises valid concerns with the Recharge Report. Unfortunately, the Peer Review misses two key flaws with the Recharge Report - the significant*

overestimate of leakage from the Dry Creek Ditch #2 during the current summer conditions and the considerable inflow of water from the Bodham property to the south.

Telesto Response 5: All independent reviews resulted in improvement to the Recharge Report and confirmed that the Recharge Report is a fair representation of the conditions expected before and after development. The reviewer presents no data or analysis to support his claim and thus, is encouraged to present the independent technical analysis, including detailed calculations and supporting documentation to substantiate this comment.

Key Issues

Reviewer Comment 1. *The Recharge Report overestimates leakage from Dry Creek Ditch #2 (Ditch) as it traverses the Property.*

Telesto Response 1: The reviewer is encouraged to present the independent technical analysis, including detailed calculations and supporting documentation of his estimate of the leakage from Dry Creek Ditch No. 2.

Reviewer Comment 1A: *The ditch is full of water only a few weeks per season as it crosses the property and receives incidental leakage from the Bodham Lateral at other times, based on personal observations of residents of neighboring properties. In contrast, the Recharge Report assumes a maximum leakage rate for the full 6-month summer season.*

Telesto Response 1A: As stated in the response to Comment #2, the reviewer's assertion that "*this ditch is full of water only a few weeks per year*" is inconsistent site observations and the past 10 years diversion records for Dry Creek Ditch No. 2.

As evidenced by the ditch records provided in Response 2, the time period used for water balance summer period (April 2nd through October 1st) is representative of the period as supported by the Dry Creek Ditch No. 2 records.

Reviewer Comment 1B: *Adjusting the reported flow by the amount of time the ditch is actually full of water results in a much smaller season-average flow compared to the 64.7 gpm presented in the Recharge Report.*

Telesto Response 1B: As stated in the response to Comment #2, the reviewer's assertion that "*this ditch is full of water only a few weeks per year*" is inconsistent site observations and the past 10 years diversion records for Dry Creek Ditch No. 2. Thus, his assertion is incorrect.

Reviewer Comment 1C: *Assuming the Ditch is full of water 2 weeks per season on average, the seasonally-averaged flow is 5 gpm (64.7 gpm * 2weeks/26 weeks per season)*

Telesto Response 1C: The reviewer's assumption that "*the Ditch is full of water 2 weeks per season on average*" is inconsistent site observations and the past 10 years diversion records for Dry Creek Ditch No. 2. Thus, his calculation is incorrect.

Reviewer Comment 1D: *Assuming the Ditch is full of water 4 weeks per season, the seasonally-averaged flow is 10 gpm*

Telesto Response 1D: The reviewer's assumption that "*the Ditch is full of water 4 weeks per season*" is inconsistent site observations and the past 10 years diversion records for Dry Creek Ditch No. 2. Thus, his assumption and calculation is irrelevant.

Reviewer Comment 1E: *When compared to the summer post-development recharge rate of 17.8 gpm (which should be 19.2 gpm, per comment #2 below), the pre-development recharge rate is significantly less, indicating the post-development recharge will be approximately two to four times higher due to this factor alone. This will result in impacts to neighbors in the form of increased sump pumping and basement flood risks.*

Telesto Response 1E: The water balance calculations presented in the report are accurate. The reviewer is encouraged to present the independent technical analysis, including detailed calculations and supporting documentation showing his analysis of the site water balance.

Reviewer Comment 1F: *The reported diversion of this ditch is at the headgate on South Boulder Creek. Most of the usage of this ditch water is upstream (south) of South Boulder Road, south of the Property, according to Mr. Bob Crifasi, Dry Creek Ditch Company Secretary.*

Telesto Response 1F: As stated in the response to Comment #2, photo documentation from 2011 show Dry Creek Ditch No. 2 was flowing along the west property line for dates corresponding to the diversion dates and for flows as low as 1 cfs.

Reviewer Comment 1G: *Ditch loss rate is based on a highly simplified model of the site using water levels over a 2-day period from only 1 well while ignoring water levels from 5 others. Results should be considered highly speculative at best. No observations have been made of ditch flow that would validate the findings*

Telesto Response 1G: Monitoring Well B-3 was used for the analysis primarily because it is located closer to Dry Creek Ditch No. 2 (~92') and thus, it shows a more immediate response to recharge from Dry Creek Ditch No. 2. For wells located further from Dry Creek Ditch No. 2, for example Well B-1 (~158'), the response to recharge from Dry Creek Ditch No. 2 is delayed and masked by other aquifer processes. It is therefore most convenient and accurate to use the data from B-3 for model calibration.

Reviewer Comment 2A. *The Recharge Report calculates recharge incorrectly, leading to wrong conclusions*

Telesto Response 2A: The reviewer is encouraged to present the independent technical analysis, including detailed calculations and supporting documentation of his recharge estimate.

Reviewer Comment 2B: *The irrigation efficiency used in the recharge calculations may be unrealistically high at 77.5%. Any reduction in recharge efficiency would lead to much higher postdevelopment irrigation-based recharge.*

Telesto Response 2A: The 77.5% irrigation efficiency was used only to estimate the recharge from lawns during the post-development scenario. The developer has agreed to use water saving measures in the landscaping. Thus, the most likely irrigation method for lawns will be sprinkler systems. The National Sustainable Agriculture Information Service publication "Measuring and Conserving Irrigation Water" lists the Attainable Irrigation System Application Efficiency for fixed solid set sprinkler systems as ranging from 70% to 85% (average 77.5%).

Reviewer Comment 2C: *An incorrect runoff curve number is reported for runoff from impervious surfaces. A value of 61 is given; a value of 98 is more realistic. When the correct curve number is used, post-development runoff increases from 7.6 to 11.9 gpm in summer and from 4.0 to 7.0 gpm in winter. These values should be corrected on Tables 4d, 4e and 5. The result is a 50% increase in post-development winter recharge and an increase in post-development summer recharge by a factor of 2.3 to 4.7 compared to current recharge conditions based on this error alone.*

Telesto Response 2C: The SCS curve number (61) in Table 4c is a typographical error as identified by the independent reviewers. The correct curve number value is 98. The correct value was used in the calculation and the runoff is therefore reported correctly.

Reviewer Comment 2D: *The post-development summer irrigation-based recharge is too low due to a math error in Table 4a based on the methods reported in Appendix A.4 (should be 13.8 not 12.4 gpm).*

Telesto Response 2D: The tables presented in the report are accurate and no correction is required.

Reviewer Comment 2E: *When combined with the corrected values for runoff into swales (see comment in previous bullet) the resulting summer post-development recharge rate should be 23.4 gpm, not 17.8 gpm as reported in Tables 4e and 5. If the concerns raised in the Peer Review (see Peer Review page 4, comment 3) are correct, the post-development summer recharge could be considerably higher than 23.4 gpm.*

Telesto Response 2E: The tables presented in the report are accurate and no correction is required.

Reviewer Comment 2F: *The evapotranspiration rate (ET) is too high and the runoff is too low for current summer conditions. This is a result of the incorrect runoff curve number and incorrect ET rate for the mostly bare soil conditions that exist on the property for most of the year.*

Telesto Response 2F: A curve number of 61 represents a cover type of pasture, grassland, or range continuous forage for grazing, Hydrologic Soil Group B (silt loam or loam), with good hydrologic condition which is appropriate for the current land use. If the reviewer disagrees with the curve number value used, the reviewer is encouraged to present the independent technical analysis, including detailed calculations and supporting documentation to substantiate the reviewer's alternative viewpoint.

The reviewer's comment that "*mostly bare soil conditions that exist on the property for most of the year*" is inconsistent with the site conditions as shown in the aerial imagery from October 27, 2011, and observations made during multiple site visits.

Reviewer Comment 3A: *The model used to estimate loss from the Ditch has many conceptual and quantitative errors, causing the results to be viewed with much skepticism.*

Telesto Response 3A: This comment is in stark contrast to the comment presented in the independent review by Anderson Consulting Engineers, Inc. dated March 11, 2013:

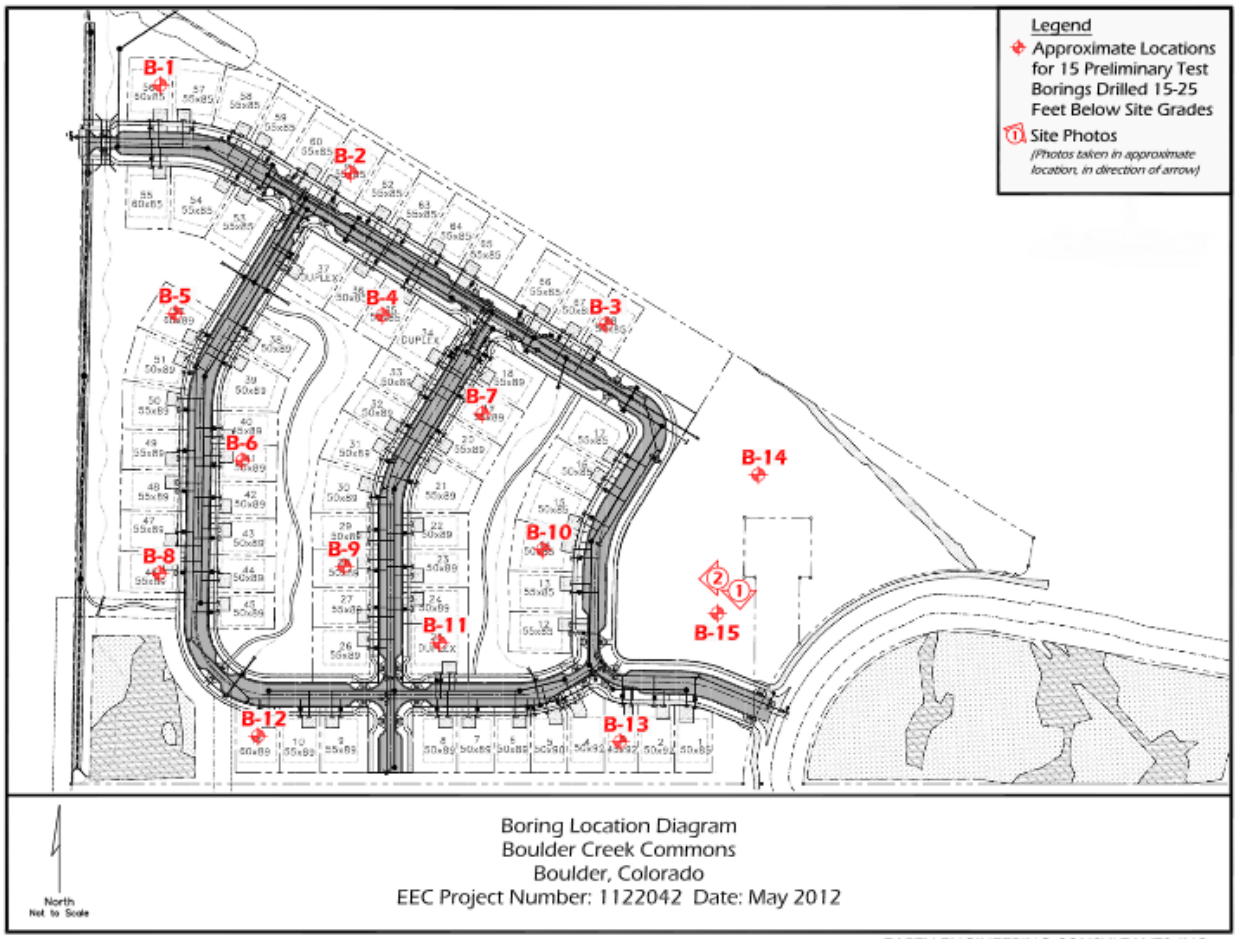
> *"The Dry Creek Ditch No. 2 recharge estimate in the 2012 Ground water Recharge Evaluation is based on measured data from monitoring wells on the BCC site. The modeling was calibrated and validated specifically to measured changes in water table elevation over time. This data driven analysis makes the findings in this report distinct from the previous studies completed for this effort. Based on the reasoning outlined in Appendices Comment 12, Appendix B of the Recharge Evaluation makes a compelling case that ditch seepage is a significant contributor to raising ground water levels at the site."*

If the reviewer disagrees, the reviewer is encouraged to present the independent technical analysis, including detailed calculations and supporting documentation to substantiate the reviewer's alternative viewpoint.

Reviewer Comment 3B: *The flat base of the model results in the aquifer being represented as a rectangular box. Borehole data reported by EEC in June 2012 in its report titled Preliminary Geotechnical Subsurface Exploration, Boulder Creek Commons, Boulder, Colorado shows the depth to bedrock varies from 2.5 to 14 feet across the Property, with thinning to the east.*

Telesto Response 3B: The reviewer's comment is misleading regarding the characteristics of the aquifer. The following table presents the approximate depth to bedrock for all borings drilled for the *Preliminary Geotechnical Subsurface Exploration, Boulder Creek Commons, Boulder, Colorado.* Locations for all borings are shown in the figure below the table. Note that only boring B-15 has a very shallow depth to bedrock. When compared to the other data obtained during the same investigation, this shallow depth to bedrock appears to be an anomaly for two reasons. First, the depth to bedrock is dramatically different than what was observed in borings B-1, B13, and B14. Second, the log for B-15 contain the note "bounce on apparent cobbles" at a depth of 5 feet. The bedrock claystone/siltstone/sandstone should not contain cobbles. This implies that the depth to bedrock at B-15 is deeper than reported on the boring log. Thus, the conceptualization using an average depth to bedrock is appropriate. If the reviewer feels that this is inadequate, he should provide his own analyses and conceptualization.

Boring ID	Approximate Depth to Bedrock (ft)
B-1	13.5
B-2	14.0
B-3	10.0
B-4	13.0
B-5	12.0
B-6	14.5
B-7	13.0
B-8	8.5
B-9	12.0
B-10	8.0
B-11	11.0
B-12	10.5
B-13	7.0
B-14	9.0
B-15	2.0



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Reviewer Comment 3C: *The primary source of inflow into the property, recharge from the CD Bodham property immediately to the south is not included. This groundwater inflow has a dominating effect on water levels on the Property.*

Telesto Response 3C: The irrigation practices by the neighbor located to the immediate south will continue to contribute to a seasonal local rise in ground water levels. Although these irrigation practices contribute to ground water flow beneath the project area (both into and out of), they do not contribute the recharge occurring within the project area. It is only the changes in the hydrologic system components (i.e., recharge) influenced by the development that need to be accounted for in the water balance approach. The Hogan-Pancost property owners can only control recharge occurring on their property.

Reviewer Comment 3D: *The model assumes that 5 sump pumps operate in the neighborhood west of the Property. There are six homes on Cimmaron Way with sump pumps and most have two sumps. It is not known whether these pumps were operating during the April 25-27, 2012*

period simulated, but it would not be expected for pumps to be operating during a period of no rain and before regional ditch operations began. Assuming no sump pumping would reduce the ditch leakage by more than 10 percent of the estimated rate.

Telesto Response 3D: Initially, on April 25th, there was no discharge from sumps at 260 Cimmaron Way. However, sump discharge was observed on April 27th. This sudden change in the sumping at 260 Cimmaron Way implies a strong connection between flows in Dry Creek Ditch No. 2 and increased water levels at 260 Cimmaron Way.

Reviewer Comment 3E: *A fine grained clay-rich soil exists in the upper several feet throughout the site and extends into the water table in many locations on the Property at times of the year (see Groundwater Hydrology Monitoring & Wetland Delineation Report, Hogan Pancost Property, Boulder County, Colorado by Western Ecological Resource, Inc, May 2010). This soil consistency is likely to cause a rapid water level response to recharge events (as observed) due to confined aquifer conditions that would occur when water levels rise to or above its base. When confining aquifer conditions occur, relatively little recharge water would be needed to generate the response seen in the wells. The model did not consider this possibility, instead simulating the aquifer as if it were uniformly sand and gravel. The result is a higher modeled ditch seepage rate than could be explained by incorporating the fine-grained soils into the model.*

Telesto Response 3E: According to the Monitoring Well B-2 well log, The fine grained soil described by the reviewer is present at a depth of 0 to 3 feet. ("CL Clay, Sand, Find Grained, Stiff, LT moist, brown"). During the study period the measured depth ranged from 5.03 feet on 4/25/12 to .45 feet on 4/27/12. Thus, the maximum measured water level is approximately 1.5 feet below the fine grained layer and the scenario described by the reviewer did not occur during the study period.

Reviewer Comment 3F: *The Recharge Report (Appendix B, pages B-2 to B-3) indicates that the model includes both the fine grained shallow soils and the deeper sand and gravel. However, Table B-2 indicates that only a single value is used to represent the aquifer permeability, and this value is for the sand and gravel deposits (Transmissivity of 1150 ft2/day, the product of the hydraulic conductivity for the sand and gravel of 100 ft/day and the total saturated thickness of 11.5 ft). The report is highly misleading in this regard.*

Telesto Response 3F: The reviewer's comment is inconsistent with the information presented in Table B-2. The following excerpt from Table B-2 clearly indicates that separate values were used to represent the hydraulic conductivity for each model layer.

	Units	Steady-State Calibration	Transient Calibration	Transient Validation
Aquifer				
Layer 1 Thickness	ft	1.167	1.167	1.167
Layer 1 Hydraulic Cond.	ft/day	12	12	12
Layer 2 Thickness	ft	9.5	9.5	9.5
Layer 2 Hydraulic Cond.	ft/day	100	100	100

Reviewer Comment 3G: *The model bases its ditch leakage on results from a single well, even though data for 6 wells are available. The selection of water level data from a single well (well B-3) is justified because it is close to the Ditch and away from sump pumps. However, well B-1 would have been a more logical choice since it is equally close to the ditch and much farther from any sump pumps (see Figure B-1 in the Recharge Report). The model overestimates water levels in well B-1 by 0.56 feet on average over the three days of simulating ditch loss (see Table B-4d of the Recharge Report). This is a very large overestimate in the context of the water level variation across the site and is a result of too large a ditch recharge rate. The poor match to the other 4 wells on-site (ranging from - 1.0 to 0.5 feet; see Tables B-4a through B-4c of the Recharge Report) indicate that the model is a very poor match to site conditions during the period evaluated. Therefore the model as it is currently constructed is not an adequate tool to evaluate ditch loss.*

Telesto Response 3G: Monitoring Well B-3 was chosen for the analysis primarily because it is located closer to Dry Creek Ditch No. 2 (~92') and it shows a more immediate response to recharge from Dry Creek Ditch No. 2. Because Well B-1 is located further from Dry Creek Ditch No. 2 (~158'), the response to recharge from Dry Creek Ditch No. 2 is delayed and using the data for model calibration is more difficult and less reliable. The reviewer confirms this view by his statement in Comment 3C that says ground water inflow dominates the ground water system. Thus, to measure influences from other sources, such as ditch leakage, one needs to be close to the source to minimize these influences (i.e., using B-3 verses the other 6 wells).

Reviewer Comment 3H: *The model validation (see page B-7 of the Recharge Report) is based on two key assumptions that are unsupported by the data, and therefore does not validate the findings of the model. The first assumption is when the ditch started flowing during the 2011 period used for model validation; there is no evidence presented to support this. The second assumption is the 'observed' water level in well B-3; this well was not measured at the critical starting time during the model validation period but was estimated from measurements in a well hundreds of feet away. During the April 2012 results this same well had no correlation whatsoever to the water levels in well B-3. Excluding the first estimated water level for this well results in essentially no change in measured water levels during the model validation period, even though the model shows a large increase in water levels. Perhaps the more realistic finding*

from the 2011 period is that the ditch losses are very small (less than a foot, according to Figure B-6 of the Recharge Report) and have a small effect on water levels at well B-3.

Telesto Response 3H: The start date of May 6, 2011 is supported by the Dry Creek Ditch No. 2 diversion records which show that the first day of use for the Dry Creek No. 2 Ditch in 2011 was May 2nd. Flow was observed in Dry Creek Ditch No. 2 on May 6, 2012 so it is likely that the ditch flow initiated on the property between May 2, 2012 and May 6, 2012.

The water level estimated for Well B-3 on May 6, 2011 is non-critical because the model validation period is from June 8, 2011 through July 12, 2011. The water level estimated for Well B-3 on May 6, 2011 is only used to illustrate that water levels were initially lower and then increased.

Reviewer Comment 3I: *The model does not include a sensitivity analysis of key model inputs. This is a standard component to any modeling exercise in which model inputs are varied over reasonable ranges and the resulting effect on water levels is presented. Given the large uncertainty in variable aquifer thickness, aquifer hydraulic conductivity, sump pump usage, recharge from the property to the south, and effect of the shallow low-permeability confining soils on ditch leakage rates, evaluating the validity of the model results is not possible. Instead, one questions whether the combination of model inputs was created to cause the largest possible ditch leakage rate in the pre-development scenario. Other comments provided in this Memorandum support that question.*

Telesto Response 3I: The reviewer's premise that there is a large uncertainty in key parameters to the water balance is misleading. The only component of the ground water balance that will be affected by the development is the recharge. The aquifer thickness, sump pumping rates and so – called confining effects have nothing to do with recharge.

Reviewer Comment 3J: *The model does not place the post-development recharge from runoff into the detention basin locations where the current Site Development Plan indicates it will go into. Several of these detention basins are located along the western edge of the property. Focused recharge into these basins will amplify impacts of runoff-based recharge, which is nearly half of the total estimated post-development summer recharge and over half the post development winter recharge.*

Telesto Response 3J: As noted by the reviewer from Anderson Consulting Engineers, Inc.:

> *"(4)Page 9 of the report discusses assumptions concerning recharge from storm water runoff and states: "for the purposes of this evaluation it was assumed that 100% of the storm water runoff entering the swales from irrigated, non-irrigated, and impervious areas will percolate downward and provide seepage recharge to ground water." As it is stated in the report, from the standpoint of comparing pre-development to post-*

> *development recharge this is a conservative assumption. It should be noted that it is not a realistic one. The soils in this swale will have an infiltration capacity that will be exceeded by the storms of a certain intensity and duration. The infiltration capacity is unknown, but is likely much lower than the native soils. When the infiltration capacity is exceeded there will be runoff from swales and detention ponds."*

Thus, the ACE reviewer agrees assuming 100% of the storm water runoff entering the swales becomes recharge to ground water is a conservative assumption in that it over estimates the amount of post development recharge.

According to Appendix C of the Conceptual Storm Water Management and Floodplain Mitigation Report (Section 10.5, item 6), bioswale vegetation will conform to the following recommendation:

> *"6. Vegetation - Vegetate the channel bottom and side slopes to provide solid entrapment and biological nutrient uptake. Cover the channel bottom with loamy soils upon which cattails, sedges, and reeds should be established. Side slopes should be planted with native or irrigated turf grasses."*

Per the recommendation, the channel bottom will be covered with loamy soils to retain water and facilitate vegetative growth. Because the hydraulic conductivity of a loamy soil (0.055 ft/day to 11.5 ft/day, [Leij et. al., 1996]) is significantly lower than the estimated native soil hydraulic conductivity (100 ft/day), recharge to the aquifer in the bioswale area will be limited.

Reviewer Comment 4: *The Recharge Report misrepresents neighborhood sump pump usage.*

Reviewer Comment 4A: *There are dozens of homes with sump pumps in the neighborhoods to the south, southwest, west and northwest of the Hogan-Pancost property. Focusing the evaluation on only a few homes immediately west of the property is grossly inadequate.*

Telesto Response 4A: The evaluation is focused on the neighbors immediately to the west of the property because they are the only ones who could be potentially affected by changes in recharge on the property. Other homes are located too far from the property to be affected. If the reviewer disagrees, the reviewer is encouraged to present the independent technical analysis, including detailed calculations and supporting documentation to substantiate the reviewer's alternative viewpoint.

Reviewer Comment 4B: *There has been a long history of winter use of sump pumps in many homes. Assuming sump pumping occurs only in late summer is wrong.*

Telesto Response 4B: The reviewer's comment implies that sump pumping occurs continuously year round. However, this assertion is inconsistent with field observations and information

provided by residents on the east side of Cimmaron Way (see previous response on this topic).

Reviewer Comment 4C: *The 25 percent increase in winter recharge at the property in post-development compared to current conditions, as reported in the Recharge Report, results in unequivocal impacts that existing homeowners will be faced with.*

Telesto Response 4C: The reviewer's comment refers to Table 5 (reproduced below). According to the results presented in Table 5, post-development winter recharge rates will increase by 2.3 gpm over pre-development conditions. Although there is estimated to be a slight increase during the winter, this is offset by the substantial reduction in the summer recharge rate.

Table 5 Recharge Summary

	Developed (gpm)	Current Non-irrigated (gpm)	Flood Irrigation (gpm)
Summer			
Areal Recharge	17.8	0	51.3
Dry Creek Ditch No. 2 Leakage	0	64.7	64.7
Summer Total	17.8	64.7	116.0
Post- minus pre-development	-	-51.0	-102.3
Winter			
Areal Recharge	12.5	10.2	10.2
Dry Creek Ditch No. 2 Leakage	0	0	0
Winter Total	12.5	10.2	10.2
Post- minus pre-development	-	+2.3	+2.3
Annual Total	30.3	74.9	126.2
Post- minus pre-development	-	-48.7	-51.3

If the reviewer disagrees the slight increase in winter recharge rates is not outweighed by the significant decrease in summer recharge rates, the reviewer is encouraged to present the independent technical analysis, including detailed calculations and supporting documentation to substantiate the assertion that an increase in the winter recharge rate of 2.3 gpm "results in unequivocal impacts that existing homeowners will be faced with [sic]."

Reviewer Comment 5. *There are fundamental conceptual errors in the depiction of seasonal changes in groundwater levels at the site.*

Reviewer Comment 5A: *The reported conceptual model does not consider the effect of significant recharge from the CD Bodham property located immediately to the south. Any*

assessment of hydrologic changes on the property must incorporate this aspect.

Telesto Response 5A: The irrigation practices by the neighbor located to the immediate south will continue to contribute to a seasonal local rise in ground water levels. Although these irrigation practices contribute to ground water flow beneath the project area, they do not contribute the recharge occurring within the project area. The Hogan-Pancost property owners can only control recharge occurring on their property.

The reviewer is encouraged to present the independent technical analysis, including detailed calculations and supporting documentation to substantiate this comment.

Reviewer Comment 5B: *The Recharge Report overly simplifies the description of groundwater flow through the portion of the South Boulder Creek valley that includes the Hogan-Pancost property. The simplifications include:*

Exaggerating the aquifer thickness by stating it is 10-30 feet when the actual aquifer thickness is 2.5 -14 feet based on numerous soils borings in and near the property.

Telesto Response 5B: As shown by Response 3B, the reviewer's assertion that "the actual aquifer thickness is 2.5 -14 feet based on numerous soils borings in and near the property" fails to mention that only boring B-15 has a very shallow depth to bedrock. When compared to the other data obtained during the same investigation (see Response 3B), this shallow depth to bedrock appears to be an anomaly. Excluding B-15, the average depth to bedrock is 11.4 +/- 2.4 feet.

Reviewer Comment 5C: *Ignoring the fact that the entire South Boulder Creek watershed alluvial aquifer constricts near the property so that the width of the property represents approximately 25 percent of the entire aquifer width at that location. This constriction of the groundwater basin helps explain why water levels are so shallow at the site, and suggests that small changes in recharge beneath the property could result in large impacts to nearby neighbors.*

Telesto Response 5C: The 22-acre Hogan-Pancost property covers only 0.04 square miles which is 0.03% of the 132 square mile (84,480 acres) South Boulder Creek watershed. Although small changes in recharge occurring throughout the entire watershed do result in changes in ground water levels, small changes in recharge occurring on the project area are insignificant by comparison and cannot have a dramatic effect on ground water levels.

Reviewer Comment 5D: *The discussion of seasonal changes in groundwater levels relates the spring/summer high groundwater levels to neighborhood sump pump usage. These seasonal fluctuations have always existed yet neighborhood sump pumping has been a recent phenomenon, starting in about the mid-1990's. The basement flooding is correlated instead to development activities including the raised soccer fields at East Boulder Community Center.*

Telesto Response 5D: The reviewer's statement that "*neighborhood sump pumping has been a recent phenomenon, starting in about the mid-1990's*" is incorrect. According to information contained in a letter written former 220 Cimmaron Way resident Dennis Irwin water levels "Construction of the soccer fields was completed during the winter of 1989…" (5/9/92 letter) and the water levels started to rise at 230 Cimmaron Way on July 6, 1990.

Although the rise in water levels followed construction of the soccer fields, there is no causal relationship between the two events. If the reviewer disagrees, the reviewer is encouraged to present the independent technical analysis, including detailed calculations and supporting documentation to substantiate the reviewer's alternative viewpoint.

It is Telesto's professional opinion that ground water levels increased in response to: 1) increased recharge from precipitation, and 2) increased recharge from lawn irrigation due to residential development in south Boulder. In 1990, the ground water levels reached a level that required basement sumps and pumping at these addresses.

The homes along Cimmaron Way were constructed in 1966 with basements and without basement sumps. From 1960 through 1968 the City of Boulder, and the South Boulder Creek watershed, had 6 of 9 years with below average precipitation (Figure 2). This is reflected in the spring flows (March-June) in South Boulder Creek which were 22% lower than average during the same period. At the time the homes were constructed, it is hypothesized that the ground water levels were low due to the multiple years of below average precipitation. In 1969, precipitation was significantly higher and South Boulder Creek flooded. Water from the flood recharged ground water but it was not enough to raise the ground water to a level that required sumps and pumping. Precipitation in 1970 was below average, 1971 and 1972 were near average and 1973 was above average. From 1974 through 1977 precipitation was below average and the ground water levels remained low. From 1978 to 1990 there was a trend of increasing precipitation with 8 of 13 years having higher than average precipitation.

Also, from the time the homes were constructed in 1966 through the 1980's, a significant amount of development occurred in Boulder south of Baseline Rd. By 1990, development in south Boulder covered approximately 3.7 square miles. With the change in land use, lawn irrigation increased and the amount of recharge to ground water also increased.

The combination of increased recharge from precipitation, and increased recharge from lawn watering caused ground water levels to rise. In 1990, the ground water level rise was enough to require basement sumps and pumping.

Also, in the independent review by Anderson Consulting Engineers, Inc. dated March 11, 2013 the reviewer comments:

> "Table B.1 (Attachment D) shows a steep gradient in the water table from south (high) to north (low). Without a larger field of data it is not possible to tell what all the influences on this gradient may be, but it is not indicative of a water table that is being controlled by down gradient processes, like impeded flow to the north. The tendency is consistent throughout the 2006 to 2012 time period captured in the data."

Additionally, the reviewer for Anderson Consulting Engineers, Inc. noted:

> *"COB staff have discovered that an original Street and Utility Plans for Keewaydin Meadows Subdivision included a 6" drain tile installed below the sanitary sewer in the same trench. This indicates that the possibility of high ground water was known to the original developer. The condition of this drain tile may have bearing on the problems experienced by the homeowners on Cimarron Drive. Drain tiles of this type can have service lives of over 100 years if protected, but they are subject to damage from overhead construction and tree roots. If the existence of the tile was unknown to later utility crews it may have been damaged inadvertently. The location and condition of the outlet for the drain tile is also of interest."*

Reviewer Comment 5E: *The discussion of seasonal changes in groundwater levels does not mention the significant variability that occurs in precipitation, stream flow, agricultural irrigation, residential lawn water and ditch flow across the site. All of these can affect groundwater levels at the property so ignoring these is misleading, at best.*

Telesto Response 5E: As stated by the reviewer, precipitation and other hydrologic processes occurring within the watershed are variable from year-to-year. As clearly described in the report, it is the annual variation in these processes that causes ground water levels to rise and fall throughout the watershed.

Reviewer Comment 5F: *The report assumes that the baseline condition at the property is flood irrigation. This assumption has not been valid for over 6 years, since flood irrigation on the property ceased in 2007. Any analyses of pre- and post-development effects should not consider this dated and unjustified assumption.*

Telesto Response 5F: The report assumes two valid baseline conditions: 1) Flood irrigation, and 2) current conditions. As shown by the results in Table 5, post-development recharge will be lower than either of the pre-development conditions.

Additionally, flood irrigation was voluntarily temporarily discontinued at the request of the adjacent neighbors. The water right associated with the project area is still active and thus flood irrigation may be restarted at any time.

Reviewer Conclusions

Reviewer Comment C1: *The Ground Water Recharge Evaluation report (Telesto Solutions Inc, June 2012), as with its 2011 Ground Water Evaluation report, includes numerous errors and inconsistencies that lead to incorrect conclusions regarding the potential impacts of developing the Hogan-Pancost property on ground water levels in surrounding neighborhoods. The errors include both the water balance and ground water modeling portions of the report. When these errors are corrected, the ground water impacts will be more severe after the development is constructed compared to current conditions.*

Telesto Response C1: Responses provided for each of the reviewer's comments demonstrate the analysis presented in the Telesto report is accurate.

Reviewer Comment C2: *The assessment also fails to include an analysis of the effects of likely site construction activities on local groundwater flow, including the focusing recharge in the drainage swales and wetlands, and the decrease in aquifer area due to soil compaction, installation of foundation footers, and low-permeability materials placed in utility corridors trenches.*

Telesto Response C2: The reader is directed to the review by Anderson Consulting Engineers, Inc. dated March 11, 2013 which provides context and responses to each of these issues.

Reviewer Comment C3: *There are many reasons for the high ground water levels that exist beneath and in the vicinity of the Hogan-Pancost property. The proposed development of this property is very likely to increase ground water levels in both summer and winter seasons, with the associated impacts to nearby homeowners including increased sump pump usage and greater risks to basement flooding.*

Telesto Response C3: As noted by the reviewer above *"there are many reasons for the high ground water levels beneath and in the vicinity of the Hogan-Pancost property."* The Hogan-Pancost property owners can only control recharge occurring on their property.

The reviewer is encouraged to present the independent technical analysis, including detailed calculations and supporting documentation to substantiate this conclusion.

Reviewer Comment C4: *The Peer Review report identifies many concerns that must be addressed in order to justify the conclusions made in the Recharge Report. It also identifies the need to install low-permeability backfill materials in the utility corridor trenches that could impede the flow of groundwater beneath the site. The Peer Report, however, fails to note that summer recharge under current conditions is overestimated by a factor of 6-11 due to a significant conceptual error in how long Dry Creek Ditch #2 actually flows across the property. Once corrected, the post-development recharge is approximately two to four times greater in summer and 50% greater in winter than current recharge. These increases in post-development*

recharge are likely to lead to higher groundwater levels and adverse impacts to neighboring homeowners.

Telesto Response C3: The reader is directed to responses contained in this document, and the review by Anderson Consulting Engineers, Inc. dated March 11, 2013 which combined, provide responses to each of these issues. If the reviewer disagrees with the responses and conclusions, reviewer is encouraged to present the independent technical analysis, including detailed calculations and supporting documentation to substantiate this conclusion.