Response to Nevada Division of Environmental Protection Comments dated March 29, 2021, Shallow Groundwater Conceptual Site Model Report, Western Hook Development Area, BMI Eastside Common Area Henderson, Nevada, dated December 4, 2020

Comments

1. **Comment #1. Section 2.11, Section 4.3 and Figures 27-30**
   Sections 2.11 and/or Section 4.3 are lacking a complete description of how the arsenic, Beta-BHC, chloroform, and radium 226+228 plume contours were developed. Section 2.11 (pg 47 second paragraph) states that "the database was used to generate time-series plots of selected parameters as well as plume maps", and Section 4.3 states that the data were "posted, checked, and contoured", but details behind how the contaminant concentration data were combined with subsurface data, models, and geophysical expertise to produce the plume maps. Details behind contour development are needed to provide defensibility to the plume depictions in Figures 27-30 and the discussion of the locations of specific contour lines in the subsections of Section 4.3.

   Section 4.3.1 (p. 71, 1st full paragraph) specifically references the 50, 100, and 150 µg/L contour lines to explain plume definition and northward movement. Please provide more details behind the process of contour development for both the 2010 and 2018 contours.

Response: As stated in Section 1.2 of the CSM, Purpose and Scope, the report presents the results of groundwater studies that have been conducted at the Site and vicinity over the course of approximately 18 years, beginning in 2000. Each successive study has built upon the knowledge and data derived from the previous groundwater study. Together, that collective work is used in this report to provide the basis for articulation of the Site CSM. The methodologies utilized in the CSM are the same as those used in the previous studies and follow standard practices employed by professional hydrogeologists in the preparation of such reports.

With regard to the preparation of plots of isoconcentration contour maps for individual chemical constituents (i.e. "plume maps"), numerical modeling was not used to prepare the plume maps. Only actual data derived from samples collected in the field and analyzed at EPA-approved chemical analytic laboratories was used as the basis for the contour plots. The protocols for collection and documentation of field data are described in detail in an extensive list of Standard Operating Procedures (SOPs) previously submitted to and approved by NDEP. The processes of data generation, acquisition, review, verification for usability, and validation are described in detail in the BRC Quality Assurance Project Plan (MWH, 2006). The plots are created for each water-bearing zone by plotting individual chemical constituent data derived from field sampling onto the appropriate location on a Site base map. Since manually plotting and contouring the data is a labor-intensive and error-prone process, geographic information systems are used to automate the plotting, posting, and initial contouring of data.

Professional judgement and site knowledge are employed for final location of isoconcentration contours. All reports, including figures and tables, are subjected to quality control checks and senior review as described in detail in MWH (2006). Isoconcentration contours represent lines of equal concentration, and the contours are linearly interpolated between points of known

constituent concentration. As with all previous reports reviewed and approved by NDEP, these same methodologies were utilized for both the 2010 and 2018 contours, the only difference being the updated data set used for the 2018 contours.

Updated contour maps have been developed using the available data in the Neptune BMI database (Figures 27 to 30). The maps will be updated periodically as additional sampling is completed (including by others) and additional data are available.

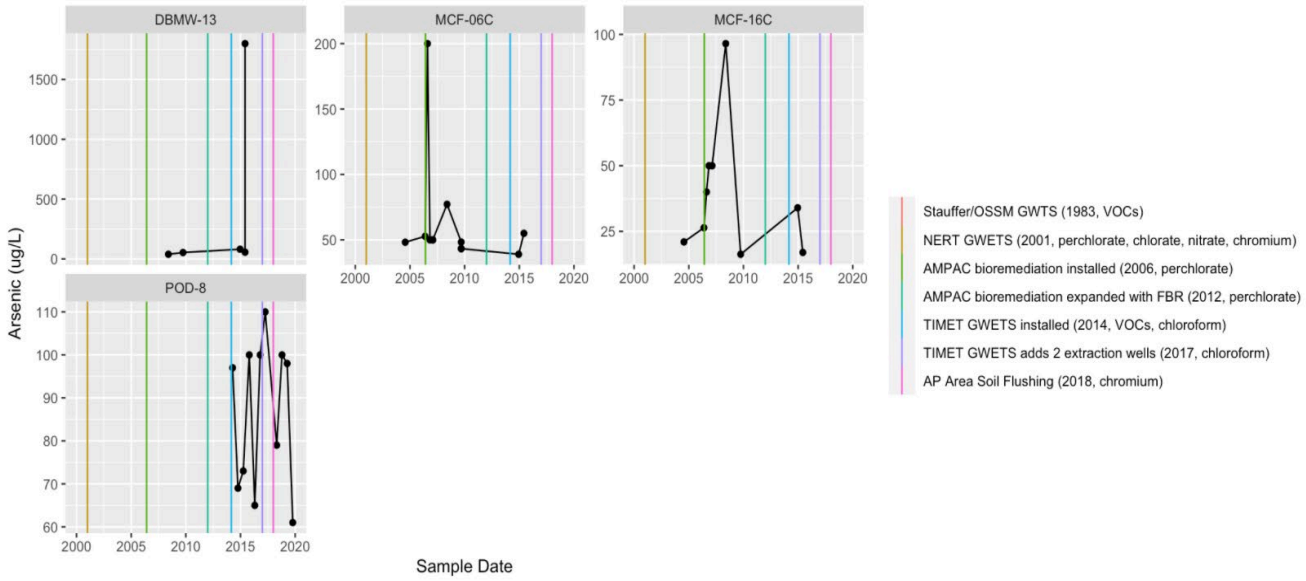
Reference:
MWH, 2006. BRC Quality Assurance Project Plan, BMI Common Areas, Clark County, Nevada, April, 2006.

2. **Comment #2, Section 3.7 and Section 5.5**

   Major remediation activities conducted at the BMI complex, such as installations of interceptor well fields and trenches (as described in Section 3.7) should be related to the conceptual site model of the Western Hook. The second paragraph of Section 1 states that "the impact [on the Western Hook] of various groundwater remediation programs in the Site vicinity" is a purpose of the document.

   Section 5.5 states that remediation programs do have some effect on contaminant concentrations at the Western Hook. In particular, the OSSM GWTS is said to have kept beta-BHC concentrations in the Western Hook low, and the NERT GWETS has had the collateral effect of reducing arsenic concentrations. Additionally, the last sentence of Section 5.5 states, "With the exception of the very southeastern portion of the Western Hook, the groundwater treatment systems in place appear to be having a positive incidental effect on arsenic plume control and concentration reduction." Further explain the basis for this statement, despite the fact that only 4 wells in the Western Hook area had arsenic concentrations that decreased in time. Specifically reference figures in the explanation.

   Where possible, relate the trends observed in concentration data over time to the timing of the remediation program implementation and the affected contaminants. For example, indicate the remediation activities on the time series of Appendix B in a manner similar to the plot shown below.



Response: The comment correctly recounts that the CSM states that data from the Western Hook indicates that remediation programs do have some effect on contaminant concentrations at the Western Hook. However, the comment apparently misinterprets the phrase, "... *the groundwater treatment systems in place appear to be having a positive incidental effect on arsenic plume control and concentration reduction*.", to mean that the groundwater treatment systems in place appear to be having a positive comprehensive effect. That is not stated nor implied. It is correct to say that there are incidences of concentration declination with time, and therefore the apparent positive effect is incidental. This statement recognizes that the concentration trends in all of the Western Hook vicinity monitoring wells are not consistent. No further analysis is needed to provide the basis for the statement.

Lastly, it is beyond the scope of BRC's interest and CSM to understand and analyze the details of the upgradient plume control efforts. It is sufficient to know that: 1) there have been high concentrations of constituents located at upgradient locations which have acted as sources of contamination to groundwater that is flowing onto the Western Hook property, and 2) various responsible upgradient entities are actively remediating groundwater under the regulatory oversight of NDEP. It is assumed that, with time, contaminated groundwater originating from upgradient locations will be fully remediated to the appropriate regulatory standards.

3. **Comment #3. Section 4.1, p.75 of 93, #2**

Temporal flattening: The data used for plume map development is stated to be "the most recent sampling data for each well for each parameter that corresponded with a useable water level data point that matched the date of the most recent sampling event." This approach should be justified. Why isn't an average of the data used instead, or, better, a plume map analysis that tracks the data through time? Describe whether concentrations change markedly over the time period of sampling and whether the plume depiction is sensitive to the sampling event that is chosen for plume map development. Provide justification for pooling data over 2003-2009 to

produce 2010 maps (Appendix C) and over 2009-2018 to produce 2018 plume maps (Figures 27-30), as opposed to generating maps that show change over time.

Response: There are thousands of data points at the BRC site. The practical reality is that not every data point can be sampled on a quarterly or even semi-annual basis. This reality is recognized by NDEP in sampling work plans approved by NDEP prior to sampling work being conducted. Additionally, changes in the concentrations of constituents on the BRC property are not known to change rapidly over time. This plume stability is evidenced by the similarity of the plume shapes between the 2003-2009 and 2009-2018 plume plots on the BRC Site.

The most recent data is used to provide a picture of the most recent plume configuration. This has been the standard methodology applied in the preparation of plume maps, identical to the method used in BRC's Shallow Groundwater CSM and Remedial Alternatives Study Report for BMI Eastside Common Areas that was approved by NDEP.

Generating maps that show change over time would be subject to data sparsity in any given year, and thus lack the detail needed for CSM-level understanding. As noted in the response to Comment #1, updated maps have been provided.

4. **Comment #4, Section 5.3, 3rd paragraph, pg. 79 of 93 and Figure 29b**

The justification for no contamination in the Middle and Deep Zones is too brief given that it provides the basis for focusing this document on the Shallow Zone groundwater. Though existing wells show marked decline in concentrations with depth, provide additional geophysical justification to support this claim for the entire Western Hook, where wells are now present.

The same applies to the Chloroform plume: Figure 29b shows no wells with chloroform concentrations in Layer 2. Section 4.3.3 cites a "significant off-site source in the Plants Area where the highest posted value is 65,000 µg/L in Shallow Zone Layer 2 well MC-MW-10". Data are needed in Layer 2 of the Western Hook to justify that it is not contaminated, especially given the high concentrations in Layer 2 in the Plants area.

Please provide more documentation and explanation for the apparent lack of deeper contamination such that it supports the focus on the Shallow Zone for the sections and figures noted by this comment.

Response: The comment misstates the cited passage in Section 5.3, 3rd paragraph. The cited text does not describe "no contamination" in the Middle and Deep Zones, as indicated in the comment. Rather, in its entirety, Section 5.3 describes the high permeability Qal overlying low permeability UMCf. That, in combination, with observed marked decline in concentrations of chemicals with depth, indicate that minimal leaching has occurred. The following CSM section 5.4 Solute Fate and Transport further describes the historical preferential flow of water and contaminants in the Qal rather than migration within the underlying low permeability UMCf. Further details of the modeling efforts are referenced in DBS&A (2010d).

Additional detailed discussion of the Site hydrogeology is given in Section 3.6, wherein the relationship between the hydrogeologic zones at the property are discussed, with supporting figures referenced. Section 3.6 also references other previous reports submitted to NDEP wherein the Site water-bearing zones are defined, details of the permeability contrast between the Qal and UMCf are discussed, and Site cross-sections are discussed and provided.

5. **Comment #5, Section 5.6**

Please explain the conceptual model behind arsenic and radium groundwater contamination. Arsenic use at the site is uncertain at best, in which case the generation of arsenic is potentially not associated with a contaminant release of arsenic. Potentially the same is the case for radium, which could be a decay product of uranium at the site.

Response: The "site" in this document is the Western Hook. The site conceptual model for arsenic is that there are high concentrations of arsenic in groundwater that have originated from upgradient locations and are migrating in groundwater that is flowing onto the Western Hook. This is plainly stated in Section 4.3.1. It is not within BRC's interest or scope to determine whether there is a primary industrial source of arsenic at upgradient locations, and therefore no comment is made as to the historical use of arsenic at any upgradient "sites".

6. **Comment #6, Section 2.10, p. 45, first paragraph and Section 5.4**

Provide a comparison of groundwater modeling results presented in Section 2.10 and plume depictions described in Section 4. For example, was a groundwater model used to inform or specifically create the contours? Please provide a supporting narrative on how the contours were defined. In addition:

- State whether arsenic groundwater model results were used to inform contours in Figures 27, 28, and 30.
- Compare groundwater model results to the spatial distribution of contaminants indicated by the data. For arsenic, Section 2.10 states that model results indicated that contamination was greatest in the upper ponds area, which seems generally consistent with the regions of higher arsenic contours in Figure 27, though the location of the upper ponds should be indicated on Figure 27.
- The second to last paragraph of Section 5.4 also states that results of arsenic modeling are also supposed to be indicative of other retarded groundwater constituents like Beta-BHC and Ra 226+228, while results of chloroform modeling are indicative of other VOCs. Compare the results of the arsenic groundwater model to the spatial distribution of beta-BHC and Ra 226+228, as depicted in Figures 28 and 30.

Response: The groundwater model was not used to inform or specifically create the contours in the plume depictions. The groundwater model was not used to inform isoconcentration contours. As discussed in Response-To-Comment No. 1, the plume contours represent interpolations of the

spatial distribution of concentrations derived from actual groundwater samples analyzed at an EPA-approved laboratory.

The contoured plumes represent different time intervals and are not comparable. The contoured plumes present actual data collected from the individual time interval of interest. The modeling results represent the groundwater conditions predicted in the future. For example, the particle tracking derived from the constituent modeling activities, represents the chemical constituent propagation and particle tracks over a 100-year simulation period.

7. **Comment #7 Sections 4.3.1, 4.3.2, and 4.3.3**

Organization of reporting concentration data: Concentrations observed at particular wells shown on the 2010 and 2018 plume maps are pointed out to explain plume location and change with time. This section would be improved with better organization of these well references and, for each well, specifically state the year the result was observed (within the range of years displayed by each map) and the depth it was observed (Shallow Zone Layer 1 or Layer 2). The Department suggests providing a table or a bulleted list within each of Sections 4.3.1, 4.3.2, and 4.3.3 with columns indicating well name, sample date, depth information, a general spatial reference, and the observed concentration, only for the particular wells that the text draws attention to. Below is the start of an example table.

Well Name	Location	Analyte	Concentration	Sample Date	Layer
AA-10	Southern portion of western arm of the Western Hook	Arsenic	44.7 µg/L	XX-XX-2009	Shallow Zone Layer 1
PC-4	Southern portion of eastern arm of Western Hook	Chloroform	100 J µg/L	XX-XX-2009	Shallow Zone Layer 1

Response: After extensive discussions with NDEP, updated plume maps have been generated as Figures 27-30 using data provided to BRC from the BMI database and the text in Section 4.3 has been revised to discuss the new maps.

8. **Comment #8 Table 2 and Appendix B**

Please include a table as an appendix that contains all the samples used in Table 2 and Appendix B. This table should include at minimum the well ID, sample ID, sample date, sample type, and whether it was used in Table 2, Appendix B, or both. It would be helpful if this was provided as an Excel file attachment as well. Below is the start of an example table.

Well ID	Sample ID	Sample Date	Sample Type	Table 2	Appendix B
AA-18	GW-AA-18	9/15/2016	Normal	X	X
AA-18	GW-AA-18(FD)	9/23/2018	Field Duplicate	X	

Response: The data in Excel format was provided April 21, 2021.

9. Arsenic plume: Arsenic concentrations at wells EC-09 and EC-06
   - In this paragraph, state the year that the results of 1,000 and 530 µg/L were observed at wells EC-09 and EC-06, respectively. The 2006 sampling event is discussed, but Figure 4 in Appendix C shows that these wells were sampled in 2008. Please resolve this discrepancy.
   - Clarify whether the results of 1,000 and 530 µg/L were observed in Layer 1 or Layer 2 of the Shallow Zone. (this may be addressed as part of the recommended table in Specific Comment #2)
   - Please provide the time series plots for arsenic concentrations at wells EC-09 and EC-06 in Appendix B or explain why they are not included.

Response: As noted in the response to Comment #7, after extensive discussions with NDEP, updated plume maps have been generated as Figures 27-30 and the text in Section 4.3 has been revised to discuss the new maps using data provided to BRC from the BMI database.

As stated in Section 4.2, "Time-series plots were constructed to provide a historical reference as needed for the evaluation of analyte concentrations over time at individual Eastside locations and in individual Western Hook Shallow Zone monitoring wells." EC-06 and EC-09 are in the Plants Area, not the Western Hook or Eastside.

10. **Comment #10, Section 4.3.1, p. 72 of 93, last two paragraphs**

Arsenic plume: Arsenic concentrations at wells in the Western Hook.

- PC-108 increased from 112 to 150 ug/L from the 2010 to the 2018 plume maps. Arsenic concentrations at well PC-2 increased from 51.1 to 103 from the 2010 to the 2018 plume maps.

- Explain why well PC-2 is not mentioned in Section 4.3.1 despite its relevancy.
- Provide a time series plot in Appendix B for arsenic concentrations at wells PC-108 and PC-2 or explain thoroughly why it is missing.

- Arsenic concentrations at wells AA-08, AA-10, PC-4, and PC-94 appear be relatively stable from the 2010 to the 2018 plume map.
  - Discuss whether these changes are supportive of the hypothesis of an arsenic plume propagating in a north, north-easterly trend, and speculate why these concentrations remained stable while PC-2 and PC-108 increased.

Response: As noted in the response to Comment #7, after extensive discussions with NDEP, updated plume maps have been generated as Figures 27-30 and the text in Section 4.3 has been revised to discuss the new maps using data provided to BRC from the BMI database.

There are many complex variables that can affect the distribution of As concentrations and time-trends at the various wells. Factors that affect As chemistry and its mobility in soils and groundwater included soil solution chemistry (pH and redox conditions), biological transformations, adsorption, and desorption. Escobar et al. (2007) report that it is the chemical forms of As associated with various soil phases, rather than its total concentration, that affects its mobility. They cite a number of studies that reported the mobilization and attenuation of As in the fine and coarse soil fractions. They cite a study wherein it was determined coarse-textured soils are likely to yield a higher fraction of readily mobile As, while As in the fine-textured soils is relatively immobile, but can be released upon changes in the subsurface geochemical environment. In addition to the fate and transport variables that affect As migration at the Site, there are also hydraulic influences on the flow of As-impacted groundwater in the form of the remediation systems that are in place along the flow path between the higher-concentration wells and the Western Hook wells (see CSM Section 5.5).

In summary, in view of the many complex variables affecting As fate and transport along the flow path from the higher-concentration wells in the plants area to the Western Hook, the monitoring well data are consistent with an arsenic plume propagating in a north, north-easterly trend. Reference: Escobar, Maria E., N. Hue, and W. Cutler, 2007. Recent developments on arsenic: contamination and remediation. *In* (S.G. Pandalai, ed.) Recent research developments in bioenergetics, Transworld Research Network.

11. **Comment #11 Section 4.3.3 and Figures 29a, 29b**

Chloroform map clarification: The text in Section 4.3.3 references a 2010 chloroform plume map (shown in Appendix C), a 2017 NERT map, a 2018 NERT map, and an updated 2020 map, yet Figures 29a and 29b indicate 2019 in the bottom right corner of the page ("Chloroform Shallow Zone Layer 1 or 2 (2019)). Clarify which map is shown in these figures.

Response: As noted in the response to Comment #7, after extensive discussions with NDEP, updated plume maps have been generated as Figures 27-30 and the text in Section 4.3 has been revised to discuss the new maps using data provided to BRC from the BMI database.

12. Comment #12 Sections 4.3.3, last paragraph on p. 73 of 93

Chloroform plume: Chloroform concentrations at wells MC-MW-10 and AA-MW-07

- In this paragraph, state the year that the results of 65,000 and 21,000 µg/L were observed at wells MC-MW-10 and AA-MW-07. (this may be addressed as part of the recommended table in Specific Comment #2)
- Please provide the time series plots for chloroform concentrations at wells MC-MW-10 and AA-MW-07 in Appendix B or explain why they are not included.

Response: As noted in the response to Comment #7, after extensive discussions with NDEP, updated plume maps have been generated as Figures 27-30 and the text in Section 4.3 has been revised to discuss the new maps using data provided to BRC from the BMI database. As discussed for Comment 9, time series plots are generated for wells in the Western Hook and/or Eastside. MC-MW-10 and AA-MW-07 are located in the Plants area.

13. **Comment #13 Section 4.3.3, p. 73 and 74 of 93**

Chloroform plume: Chloroform concentrations at wells in the Western Hook.

- The last sentence of p. 74 of 93 states that chloroform concentrations of 790 µg/L were observed at well AA-10 in the western arm of the Western Hook, though the 2019 map (Figure 29a) shows a result of 4.1 µg/L at well AA-10. Please resolve this discrepancy. PC-94 in the northeast arm region of the Western Hook decreased from 41 µg/L in the 2010 map (Appendix C) to 1.6 µg/L in the 2019 map (Figure 27a).
    - Explain this decrease and why it is not mentioned in Section 4.3.3.
    - Provide a time series plot in Appendix B for chloroform concentrations at well PC-94.

Response: As noted in the response to Comment #7, after extensive discussions with NDEP, updated plume maps have been generated as Figures 27-30 and the text in Section 4.3 has been revised to discuss the new maps using data provided to BRC from the BMI database.

14. Comment #14 Section 5.5, last paragraph, p.83

Arsenic plume, time series analysis: The text states that seven wells have sufficient data to represent multiple years (10 years) but they are all located on the eastern half of the Western Hook area, where concentrations are higher than on the west. Specify the names of the wells that had stable, increasing, and declining concentrations so that the reader can spatially reference the trends on Figure 27.

Response: This paragraph has been deleted as the arsenic plume maps have been updated using data provided to BRC from the BMI database.

15. Comment #15 Section 2.7

Vertical gradients are discussed in this section with callouts to Figures 7 and 8, which show the locations of the well pairs used to evaluate the vertical gradient. The text then provides lists of well pairs that showed upward and downward gradients. In addition to these lists, an additional figure

could be added that shows the calculated vertical gradient for each well pair. This would greatly ease evaluation of statements later in the document that make reference to vertical flow and transport.

Response: These data are presented in the separate referenced report from 2008 entitled, DBS&A, 2008, Revised Vertical Gradient Submittal, prepared for BRC, dated September 10. Figure 8 was revised to post vertical gradient data available when the vertical gradient submittal was last prepared (DBS&A, 2008c).

16. **Comment #16, Section 4.3.2 and Figure 28**

Plume movement: Elevated beta-BHC concentrations seem to migrate in a northerly direction from the Plant area, and then north-easterly through Western Hook, in contrast to arsenic and chloroform which seems to migrate more northeasterly and then northerly through the Western Hook. Explain these differences.

Response: The difference in the shape of the beta-BHC plume as compared to the plumes of arsenic and chloroform is explained by the physiochemical properties of the respective chemicals. The solubility of b-BHC is 5 mg/L and the logarithm of the organic carbon partition (Log Koc) coefficient is 3.57 (ASTDR, 2005). By comparison, the solubility of chloroform is 8,000 ppm and the Log Koc is 1.64. The partitioning coefficient (Kd) for As was estimated by Baes and Sharp (1983) to be 6.7 mg/L as a default value. The solubility of As varies with the form in which As exists and temperature. For example, the solubility of arsenic trioxide at 25 C is 2,100 mg/L. Because of these physiochemical parameters, the b-BHC plume is highly retarded as compared to the chloroform and As plumes. b-BHC is highly adsorbed on soil and the result is that concentrations decline rapidly with distance from the plume. When historic groundwater conditions were at higher levels, the gradient and groundwater flow were to the northeasterly direction, consistent with the natural slope of the landscape. During periods of low groundwater, the gradient and direction of groundwater flow is controlled by preferential flow in paleochannels. The shape of the b-BHC plume is largely consistent with the direction of paleochannels in the plume vicinity, indicating the b-BHC has been dominated by periods of time when flow was controlled by paleochannels.

References:

Agency for Toxic Substances and Disease Registry (ATSDR), 2005. Toxicological Profile for alpha-, beta-, gamma- and delta-hexachlorocyclohexane. US Department of Health and Human Services.

Baes, C. F., III, and R. D. Sharp. 1983. “A Proposal for Estimation of Soil Leaching and Leaching Constants for Use in Assessment Models.” Journal of Environmental Quality, 12:17-28.

17. Comment #17 Section 3.6, 5th paragraph, pg. 58 of 93

The following sentence is missing a clause regarding details about the groundwater elevation data.

Groundwater elevation data from [reference missing] show that Deep Zone groundwater is confined, and that the potentiometric surface of Deep Zone groundwater is oriented generally north toward Las Vegas Wash.

Response: The text will be revised to omit "from" in this sentence to clarify.

18. **Comment #18 Appendix C, Figure 4**

Arsenic concentrations with depth: Explain whether arsenic concentrations in Shallow Zone Layer 1, Layer 2, or a summary of both are shown. Explain how the results are summarized for each well with depth. Is it the mean, maximum, or other concentration that is shown in Figure 4?

Response: As depicted in Figure 22, layer designations for the plants area differs slightly from the BRC properties. Appendix C Figure 4 depicts wells in the Plants Area Shallow Zone and BRC Shallow Zone Layer 1 or 2.

19. **Comment #19 Section 4.3.4**

Technical comment, radium plume: Ra 226+228 concentrations at wells in the Western Hook.

- Explain the decrease in Ra 226+228 concentration at well DBMW-3 from the 2010 map (7.04 pCi/L) to the 2018 map (5.1 pCi/L).
- Explain the break in the plume between the Plants Area and the Eastside properties.

Response: BRC views the activities of 7.04 and 5.1 pCi/L as within the range of normal sampling variability and not substantially different. The data merits continuing observation and scrutiny. This CSM is written with the Western Hook in mind. Please see the document, "Shallow Groundwater Conceptual Site Model and Remedial Alternatives Study, BMI Eastside Common Areas, Clark County, Henderson, Nevada" report dated March 14, 2019 for a complete discussion of the Eastside CSM and related NDEP comments dated June 6, 2019. Ra 226+228 activities on the Eastside are mostly below the USEPA MCL of 5 pCi/L. The break in the plume between the Plants Area and the Eastside properties is most likely explained by the remediation activities discussed in CSM Section 5.3.

20. **Comment # 20 Appendix B**

In the data file provided for the time series in Appendix B, two sample results were missing from the BMI Regional Database.

As part of the report review, data used in the report were checked against data in the BMI Regional Database. This was done to make sure the database contains what it should, but also to make sure data used in the report has been approved by NDEP. The two results missing from the BMI Database but present in the data in Appendix B were:

- Well: POU3, Sample Date: 9/15/2016, Result: 1,200 µg/L

- Well: POU3, Sample Date: 9/23/2018, Result: 340 µg/L:

Please identify the DVSR ID from which the above two data points should originate.

Response: Well POU3 was sampled in 2016 as part of a supplemental chloroform characterization in this well area. BRC will follow up to identify the DVSR that posts these data.

21. **Comment #21 Appendix B**

An arsenic result appears to have either the wrong sample date or the wrong result value. The arsenic result of 26.1 for the sample taken on 7/22/2004 at well AA-18 does not match records in the BMI Regional Database uploaded from BRC Dataset 27 via file 'BRC_DB_20091201.mdb.' Please resolve this discrepancy.

For some extra context and information, in the BMI Regional Database there is a field duplicate with sample id of 'GW-AA-18(FD)', a sample date of 7/22/2004, and a result value of 24.3 µg/L (sample date matches, result does not). There is also a sample id of 'GW-AA-18' with a sample date of 2/6/2007 with a result value of 26.1 (sample date does not match). One might assume the 2/6/2007 sample date is no longer correct for the sample with id GW-AA-18. Please check and verify that this data point in the report is correct.

Response: BRC will look into the available records to attempt to resolve the database information regarding well AA-18 data. The report text will be clarified as needed. The arsenic dataset will be updated as additional sampling is completed (including by others).

	A	B	D	E	G	H	P	Q	R	S	T	AJ	AK	AL	AQ	AR	AU
1	sample_id_field	data_sc	dvsr_id	sub_are	sample	locatio	hydro	matrix_	matrix	sample	sample_date	analysis_date	analysi	analyst_name	analyte	result_	result_
109	GW-AA-18[FD]	BRC	BRC_27	Upper Por	AA-18	AA-18	Shallow	WG	Ground W	FD	7/22/2004	8/13/2004	11:04:00	Laurie Baumgartner	Arsenic	24.3	ug/L
110	GW-AA-18_0406	BRC	BRC_37	Upper Por	AA-18	AA-18	Shallow	WG	Ground W	NORM	5/19/2006	6/2/2006	19:20:00	Fernando Cruz	Arsenic	38.9	ug/L
111	GW-AA-18 [FD]_0406	BRC	BRC_37	Upper Por	AA-18	AA-18	Shallow	WG	Ground W	FD	5/19/2006	6/2/2006	19:26:00	Fernando Cruz	Arsenic	40.3	ug/L
112	GW-AA-18_0806	BRC	BRC_38	Upper Por	AA-18	AA-18	Shallow	WG	Ground W	NORM	8/10/2006	8/17/2006	17:16:00	Fernando Cruz	Arsenic	30.6	ug/L
113	GW-AA-18_1006	BRC	BRC_42	Upper Por	AA-18	AA-18	Shallow	WG	Ground W	NORM	10/31/2006	11/10/2006	19:35:00	Fernando Cruz	Arsenic	36.1	ug/L
114	GW-AA-18 [FD]_1006	BRC	BRC_42	Upper Por	AA-18	AA-18	Shallow	WG	Ground W	FD	10/31/2006	11/10/2006	19:42:00	Fernando Cruz	Arsenic	32.3	ug/L
115	GW-AA-18	BRC	BRC_27	Upper Por	AA-18	AA-18	Shallow	WG	Ground W	NORM	2/6/2007	8/13/2004	11:00:00	Laurie Baumgartner	Arsenic	26.1	ug/L
116	GW-AA-18-0107-N	BRC	BRC_44	Upper Por	AA-18	AA-18	Shallow	WG	Ground W	NORM	2/6/2007	2/15/2007	18:22:00	Fernando Cruz	Arsenic	29.9	ug/L
117	GW-AA-18[FD]-0107-N	BRC	BRC_44	Upper Por	AA-18	AA-18	Shallow	WG	Ground W	FD	2/6/2007	2/15/2007	18:28:00	Fernando Cruz	Arsenic	29	ug/L
118	AA-18	BRC	BRC_51	Upper Por	AA-18	AA-18	Shallow	WG	Ground W	NORM	5/13/2008	5/31/2008	19:33:00	Kristen Ely	Arsenic	28.1	ug/L
119	AA-18_6Q09	BRC	BRC_58	Upper Por	AA-18	AA-18	Shallow	WG	Ground W	NORM	8/11/2009	8/17/2009	20:26:00	Thomas Lill	Arsenic	31.5	ug/L

22. **Comment #22 Figure 11**

The particle tracking analysis indicates preferential flow in the paleochannels, and various places in the text make clear that these are important geologic features with respect to both groundwater flow and contaminant transport. Some additional discussion of the uncertainty associated with the paleochannel locations and properties seems warranted. Some questions that might be addressed include:

- Are the locations of the paleochannels at the site more uncertain in some areas compared to others? Does this uncertainty have any impact on the shallow groundwater conceptual model? For example, does the uncertainty in upgradient areas have implications for the interaction of the site with neighboring, upgradient contamination?

- Do isocontours derived from water level measurements in the vicinity of the paleochannels compare well with those predicted by the flow model? Were the flow model results used to quantify the importance of the paleochannels in some fashion?
- How would fluctuations in the water table elevation impact the relative importance of the paleochannels to the shallow groundwater flow?

Response: The locations of the paleochannels have been developed over nearly 20 years of study by multiple entities with numerous reviews by NDEP. The development started with geophysical surveys and has been refined over the years by the incorporation of borelog data from over 500 borings. At this point, the locations of the paleochannels are reasonably well known. It is BRC's position that paleochannel location does not represent a point of significant uncertainty.

A detailed description of the model calibration process was presented in (DBS&A, 2009b). Briefly, model calibration was conducted for both the current (then 2007) and historical time periods, although most of the calibration effort was spent on the current time period, because the amount of observed available data for 2007 was far greater. Model calibration results were presented in terms of several statistical measures, including mean absolute error (MAE), mean error (ME), and root-mean-squared error (RMSE). Analysis of the calibration for the current period indicated good agreement between simulated and observed water levels, with an MAE of 5.7 feet, an RMSE of 7.1 feet, and an RMSE divided by the range in observed water levels of 3 percent.

Model calibration to the historical period was not as detailed as that conducted for the current period because water level measurements and other information for the historical time period (mid- to late 1960s) were generally lacking. The historical period simulation consisted of adjusting model recharge in an attempt to generally match observed groundwater outflow conditions believed to be captured in a series of aerial photographs from the mid- to late 1960s. The resulting flow and transport models demonstrated that paleochannels were a primary mechanism for northerly transport of contaminants and that transport within and the UMCf was of far less significance.

It is a feature of BRC's CSM for both the Eastside and the Western Hook that in historic times when groundwater levels were higher, as evidenced by recharge activities, limited data, and aerial photographic documentation, the groundwater gradient and direction of flow was primarily controlled by hydraulic forces. The simple meaning of this is that groundwater was above the "banks" of the paleochannels and the gradient and direction of flow was primarily to the northeast. During this time contaminants within the Qal groundwater also impacted the underlying UMCf. It is likely that more soluble chemicals, for example perchlorate, flushed through the system under the driving force of historic recharge features, including the Rapid Infiltration Basins (RIBs).

As recharge activities were significantly reduced, groundwater levels declined such that flow was contained within the "banks" of the paleochannels and the gradient and direction of flow was directed within the paleochannels. Remnants of the impacts to the UMCf remain. However,

because of its much lower hydraulic conductivity, flow and contaminant transport within the UMCf is much reduced.

23. **Comment #23, Section 4.5**

The text states that the flow and transport model was used to the support conclusion that, "the observed distribution of various constituents in the UMCf at many locations is likely a product of historical groundwater flowpaths in the Qal, rather than the direct migration of constituents from a given source area along groundwater flowpaths within the UMCf itself." How was this conclusion reached? For example, were simulations performed with an elevated water table that were better able to predict historic migration patterns compared to simulations performed with prevailing current conditions? Were historic groundwater level data used to inform this conclusion?

Response: The cited text in the comment represents a portion of the summary from the report entitled "Technical Memorandum on Predictive Solute Transport Simulations BMI Upper and Lower Ponds Area" dated May 28, 2010 that was submitted to and approved by NDEP. Details of the modeling were discussed in that report and referenced for the CSM. As discussed in the response to Comment #22, the lack of historical data prevented quantitative calibration of the historical scenario wherein groundwater water levels were higher.

Also discussed in response to Comment #22, the flow model was calibrated to the 2007 current scenario. In order to constrain and test the transport modeling results, sensitivity analyses were performed on the transport modeling scenarios. This is discussed in detail in the 2010 modeling tech memo referenced above. A copy of the complete report summary is included herein below for convenience.

8. Summary and Conclusions

A series of predictive solute transport simulations were conducted for perchlorate, arsenic, chromium VI, and selenium. Simulation results indicate that perchlorate is readily flushed from the Qal within a period of 10 to 20 years, depending on the value of Qal hydraulic conductivity. However, perchlorate in the UMCf that exists under current observed conditions or that enters the UMCf during the predictive simulation period is less easily flushed and serves as a long term continuing source of perchlorate mass transfer to the Qal. For this reason, long-term simulated concentrations of perchlorate are lowest in the Qal, and increase with depth through the UMCf. In addition, the geographic distribution of simulated future perchlorate concentration in the Qal is closely correlated with regions of significant perchlorate concentration in the UMCf.

Simulations with three assumed groundwater inflow boundary conditions were run for each constituent (except for selenium, which has boundary concentrations that are small or zero). The simulations are (1) assumed boundary concentrations of zero (no mass inflow), (2) assumed boundary concentration equal to current conditions (current scenario assumed for 100 years), and (3) assumed reductions in constituent concentrations through time. For perchlorate, simulated values within and south of the Western Hook area are sensitive to the

assumed perchlorate concentration of groundwater inflow. However, simulated perchlorate concentrations in the Upper Ponds area are similar among the three simulations conducted, indicating that simulation results in this area are not significantly influenced by assumed boundary concentrations. This result is due primarily to the limited volume of groundwater inflow that occurs to the Upper Ponds portion of the model domain.

Predicted solute concentrations for arsenic, chromium VI, and selenium are influenced more by the initial concentration than by the assumed boundary conditions. Due to retardation processes, simulated changes in these constituents through time are much slower (take more time) as compared to perchlorate. Even with the effects of retardation, however, trends in simulated concentrations for these constituents are observed over time periods of 40 to 50 years. Selenium is of concern due to potential loading to Las Vegas Wash. The simulation results indicate that the selenium loading to the wash is about 0.02 lb/d. As noted earlier in the report, the selected retardation factors for each of these constituents (arsenic, chromium VI, and selenium) are on the low end of possible values based on the literature; therefore, in reality the migration of these constituents may be significantly slower than that simulated herein.

The simulation results summarized above, in addition to providing some insights about potential future constituent concentrations and solute transport behavior, have significant implications regarding site conceptual model issues. Specifically, the simulation results indicate that the magnitude and extent of current observed solute concentrations in the aquifer system beneath the site are likely a highly complex result of historical source locations and strengths, historical groundwater flow conditions, and the degree of hydraulic communication between the Qal and the UMCf. For example, the observed distribution of various constituents in the UMCf at many locations is likely a product of historical groundwater flowpaths in the Qal, rather than the direct migration of constituents from a given source area along groundwater flowpaths within the UMCf itself.

Finally, it should be noted that observed constituent concentrations from UMCf monitor wells with limited screen lengths (generally 20 feet, all of which may not be saturated) were used to estimate initial solute concentrations across the entire simulated thickness of UMCf in the model of 50 feet. This approach likely increases the assumed mass of a given constituent within the simulated portion of the UMCf, since observed data indicate that the concentrations of solutes in the UMCf generally decrease with increasing depth. Consequently, simulated mass in the UMCf for the constituents considered in this report are in all likelihood greater than that which actually exists.

In addition to the base case simulations summarized above, a series of worst case source area leaching scenarios were considered for perchlorate, arsenic, and chromium VI. In these model runs, the entire estimated mass of the given constituent in each source area was assumed to enter groundwater in the Qal over a 3.5-year period at the beginning of the predictive simulation. For source areas that have not yet been characterized, constituent mass was estimated based on the soil concentrations measured for adjacent areas. For arsenic and chromium VI, it is likely that a significant portion of the mass in soil will never reach groundwater. For perchlorate it is likely that the mass that leaches to groundwater will do so over an extended period of time much longer than 3.5 years.

The results of these simulations indicate that for perchlorate, elevated solute concentrations are concentrated along the northern site boundary of the Upper Ponds area, in the former CoH Northern RIBs area, and west of Tuscany Village. As noted for previous perchlorate simulations, simulated concentrations are lowest in the Qal and increase with depth through the UMCf. For arsenic and chromium VI, the greatest simulated long-term concentrations in groundwater occur in the Upper Ponds area and beneath the former CoH Northern RIBs (there is a paleochannel that passes beneath the former RIBs area). In the vertical dimension, the simulated long-term concentrations are significantly different than those of perchlorate in that there is less mass (lower concentrations) in the top of the UMCf, and almost no constituent mass that reaches the base of the UMCf that is simulated in the model (depth of 50 feet). This result is due to the significant retardation factors applied for these constituents, which tends to limit vertical migration (as compared to perchlorate) due to the smaller magnitude of advection and hydrodynamic dispersion, which is velocity dependent. BRC expects to conduct more detailed source area simulations in the future based on the results of leaching models completed for each source area. The results of these future source area simulations will likely indicate substantially lower predicted solute concentrations than those presented in this report.

24. **Comment #24 Page 72 of 93, 2nd paragraph**

Arsenic plume: The text states, "Detected concentrations in the Western Hook Shallow Zone posted on the 2010 groundwater maps ranged from <11 µg/L to 250 µg/L", but the previous sentence states that the maximum concentration on the 2010 maps was 240 µg/L in well MW-S. Reconcile this discrepancy.

Response: The text will be updated as follows to clarify: "The maximum concentration detected in Western Hook area groundwater posted on the 2010 maps was 250 µg/L near the property boundary between the Western Hook and the western margin of the City of Henderson wastewater treatment plant in well MW-S…"

25. **Comment #25 Section 4.1, Table 2, Appendix B, Plume maps**

Field duplicates are not used consistently throughout the data. They are used for some samples and not used for others. In Section 4.1 (or in another section you find more appropriate) please use field duplicates consistently and describe how field duplicates are incorporated into Tables 2 and 3 as well as any figures that use the master analytical database described in sections 2.11 and 4.1.

Response: Field duplicates in the analytical database are evaluated in the same manner as other field samples. As stated in the April 206 BRC Quality Assurance Project Plan, "According to the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (USEPA 2004a), data are not qualified on the basis of field duplicate imprecision. However, field duplicate analysis results may be used in conjunction with historical or other mitigating data to support field decisions…". The text has been updated in Section 4.1.

26. **Comment #26 Appendix B**

Time Series plots in Appendix B extend beyond the data summaries in Table 2 and Table 3 (i.e. beyond 2004-2016 sampling events). Please acknowledge this in the text of Section 4.2 and explain why.

Response: The text will be revised as suggested. Times-series plots for the Western Hook area include recent data while Table 2, for Eastside data, is presented for context in Section 2.11 describing Eastside groundwater monitoring.

27. **Comment #27 Appendix B**

Please add text in either Appendix B or Section 4.2 (or both) explaining that the un-filled diamonds on the time series plots in Appendix B represent non-detects.

Response: The Section 4.2 text will be updated to include the note posted on the plots: "All non-detect values are plotted as an open symbol at the Reporting Limit for the sample."

28. **Comment #28 Figures 27-30**

On Figures 27-30 and any other relevant figures, please indicate the meaning of data qualifiers (such as "J") shown next to the sample result.

Response: A note explaining the use of standard data qualifiers (such as "J") will be added to the text Section 4.1.

29. **Comment #29 Section 4.3, 1st paragraph**

In this sentence, "through" should be replaced by "thorough". "The maps were refined until final thorough quality control checks to reassign wells by layer, if needed, according to newly received well construction data.

Response: The text reads correctly as originally drafted: The maps were refined until final through quality control checks to reassign wells by layer, if needed, according to newly received well construction data.