NDEP Comment	Response to Comment
1. NERT is working on the groundwater bioremediation treatability study at the Seep Well Field (SWF) area. The comments made here are required to be addressed at NERT's best effort. NDEP requires a written response to the comments made for this report. Specifically, following comments should be addressed for the SWF bioremediation treatability study: ***a.*** *Because nitrate is initially preferentially used as an electron acceptor and there appear to be upgradient sources, it would be useful to sample and map nitrate concentration in groundwater.* ***b.*** *Review groundwater monitoring for data on any other preferentially used electron acceptors.* ***c.*** *In terms of the Groundwater Bioremediation Treatability Study Results Report, map the distribution of values for:* ***i.*** *ORP* ***ii.*** *DO* ***iii.*** *TOC* ***iv.*** *Sulfate*	**a. and c.** The Seep Well Field (SWF) Area Bioremediation Treatability Study will include the collection and analysis of groundwater samples for nitrate, ORP, DO, TOC, and sulfate in both baseline and all post-injection effectiveness monitoring events. These data will be presented and discussed in the SWF Area Bioremediation Treatability Study Report, with each of these parameters provided on a map to aid in the understanding of the distribution of these parameters within the treatability study area. **b.** In addition to the electron acceptors mentioned in this comment, chlorate could be a preferential electron acceptor. As a result, chlorate will be monitored, tracked, and analyzed throughout the study to evaluate its' effect on perchlorate biodegradation.
2. Section 4.0 Laboratory Bench-Scale Studies: The experiment design should be modified to improve following errors: ***a.*** *Two column elutriate measurements (ORP and DO) were planned to occur within the columns but were found to not be feasible. These measurements were made in the container that collected the column effluent. Thus, the reported values were not deemed representative of conditions within the soil columns or comparable to field conditions.* ***b.*** *"Phosphate concentrations remained between 0.1 to 2.8 mg/L except for soil column 2 on Day 59, which might be an error. Sulfate reduction was observed in both soil columns 1 and 2 after Day 66, but not in the plastic columns."* ***c.*** *"The lower values of perchlorate concentration for microcosms E-0.01 and E-.002 on sampling Day 12 might be due to error other than analytical, since the samples were measured twice given the same results."*	**a.** Agreed, measurement of ORP and DO in the effluent were attempted, but once the water is collected in a container, ambient oxygen can influence the readings. Therefore, it was decided that these measurements were not representative of the actual DO and ORP in the columns themselves. **b and c.** Additional measures will be employed during applicable future studies to minimize analytical and human errors of phosphate and perchlorate measurements that occurred during laboratory experiments. Please note that these readings could also be minor stray anomalies or variations within a broad array of mostly precise and consistent measurements and observations that occur in the heterogeneous environment of the batch and column experiments. Future reports will also infer to these minor discrepancies as anomalies when appropriate.

NDEP Comment	Response to Comment
3. Carbon dioxide and biomass are by products of the in-situ reduction. The injection wells can be periodically be rehabilitated, however, biomass buildup in the aquifer becomes the controlling factor on the aquifer permeability. NERT should calculate appropriate amount of organic substrate needed for biodegrading targeting perchlorate and other associated chemicals based on the perchlorate mass from the site characterization and prevent addition of excess donor that can result in sulfate reduction, sulfide production and mobilization of dissolved iron and manganese. Because SWF bioremediation treatability study is planned just east of the existing capture zone of the existing SWF extraction system, which is closer to the Las Vegas Wash, particular attention should be paid to over reduction and secondary mobilization. An appropriate monitoring regime implemented during the treatability study to adequately evaluate the potential for secondary releases is required. The results for the SWF bioremediation treatability study should include the mass balance of the reactive chemicals within the injection influence zones before and after injection.	Comment noted on secondary effects and production of carbon dioxide that occurs during in-situ reduction. The slow release substrate, EOS, that was employed for this treatability study is also the substrate of choice for the upcoming SWF Area Bioremediation Treatability Study. The prime reason for using EOS is that it ferments very gradually. Therefore, EOS does not result in release of excess donor and also limits excessive sulfate reduction. The amount of EOS that is required is based on stoichiometric requirements with a suitable but minimal factor of safety to ensure efficient contaminant removal, but every attempt will be made to minimize over-addition of this reagent into the aquifer to minimize biomass buildup. Secondary impacts of in-situ reduction such as arsenic, dissolved iron, manganese, and other reactive chemicals such as sulfate will be monitored and tracked within the SWF Area Bioremediation Treatability Study area and downgradient monitoring wells.
4. <u>Specific Comment #1 Comparison of proposed plan to actual plan</u>: Comparison of the NDEP approved Conceptual Pilot Test Layout (Figure 2 – attached) to the actual implementation of the well network as depicted on Figure 2 Treatability Study Layout the following observations are noted: • *Number of injection wells reduced from fourth to three* • *Number of downgradient monitoring wells reduced from 11 to 7* • *Distance in between injection wells and closest downgradient monitoring wells increased from proposed to actual* *The NDEP acknowledges that the entire network was modified due to its relocation 700 feet upgradient. However, it is not clear that the relocation entirely accounts for the reduction and reconfiguration of the monitoring well network.* *(Continued on next page)*	Comment noted. In future studies, NDEP will be advised of the latest findings and resulting changes in real-time through submittal of detailed monthly progress updates and additional technical memorandums as required. In regards to observations noted: - Number of injection wells reduced from four to three: This is correct. The reasons for the modification are outlined in Section 5.2.1. - Number of downgradient monitoring wells reduced from 11 to 7: The number of newly installed downgradient monitoring wells was 8 (BP-MW02 – BP-MW09). However, because the location of the treatability study was moved upgradient to the bermed location due to a conflict with COH's aboveground water discharge permit area, three existing downgradient monitoring wells (PC-98R, MW-K5, and BHW-1) became available for monitoring purposes and were incorporated into the monitoring program, bringing the total number of available downgradient wells to 11. Section 5.2.2 discusses the monitoring well network. *(Continued on next page)*

NDEP Comment	Response to Comment
Section 4.3.2 Monitoring Well Network of the Work Plan (Tetra Tech 2015) states, *"The exact number and location of effectiveness monitoring wells may be modified based on the results of the slug tests and the single borehole test, estimations groundwater velocity, and other geological characteristics in the area, and will be detailed in the technical memorandum prepared at the beginning of the field pilot testing phase."* *If a technical memorandum was prepared, it is recommended that this be included as an appendix to the report for clarity. Otherwise, it is recommended that the report be revised to further elaborate as to the rationale justifying a reduction in the number of monitoring wells and their subsequent reconfiguration. An evaluation as regards "lessons learned" should also be included so this information can be carried forward into the planning and implementation of the SWF Treatability Study.*	- Distance in between injection wells and closest downgradient monitoring wells increased from proposed to actual: The WP presented the conceptual design based on preliminary flow velocities reported in the previous ENVIRON Treatability Study Work Plan, Permeable Reactive Barrier, Revisions 1 and 2 (December 2013 and May 2014). However, on-site field testing via borehole dilution and slug testing indicated that groundwater flow rates were much higher than originally anticipated. Therefore, the distances between the injection well transects and monitoring wells were expanded to account for higher flow velocities. Following completion of the SWF Area Treatability Study, the results report will include text that specifically outlines any differences between the WP and final treatability study and the appropriate reasoning for these adjustments. Consistent with the NDEP comment letter, a revised deliverable will not be submitted and the lessons learned from this groundwater bioremediation treatability will be incorporated into the planning, design, and implementation of the SWF Area Bioremediation Treatability Study, other applicable future treatability studies and all related reporting.
5. Specific Comment #2 Executive Summary Preliminary Field Activities, first sentence, page 1: Both values are reported on Table 1, page 8, yet throughout the remainder of the document the geometric mean value of 32 ft/day is referenced. Suggest revision to the statement in Section 3.3.1 to reflect the geometric mean value for consistency.	The geometric mean of the groundwater flow velocity that has been reported throughout the document was determined to be 32 ft/day, while the arithmetic mean was 33 ft/day. Future testing and reporting of groundwater flow velocity related to treatability studies will clarify the nomenclature, units, and measurements throughout the report for consistency.
6. Specific Comment #3 Section 3.1 Soil Boring and Monitoring Well Installation, fourth sentence, page 7: Review of Table A.1 and Section 4.2 Collection and Evaluation of Soil and Groundwater suggests soil samples were not collected at a discrete depth of 25-feet potentially from the soil cuttings which were collected and sampled from 0 to 25 feet bgs. Please clarify. *(Continued on next page)*	A composite soil sample was collected from the unsaturated zone from 0 to 25 feet below ground surface (bgs). Appendix A.1 presents these soil results from the field sampling during the installation of BHW-1. It should be noted that Section 4.2 presents the soil depth ranges (20 - 40 feet bgs) from where soil was collected and transferred to sterile plastic buckets that was used for purposes of the UNLV-conducted bench-scale studies. *(Continued on next page)*

NDEP Comment	Response to Comment
In addition, the second to last sentence states, *"In particular, the slug tests performed in wells MW-K5 and PC-98R were difficult to interpret due to a combination of low slug displacement and very fast response times, and therefore, the results are considered uncertain."* *Additionally, in Section 6.9.1 Slug Tests, the Deliverable again notes (page 41) that* *"A number of slug tests had an inadequate number of data points for analysis due to the rapid aquifer response. However, the large number of tests performed allowed analysis of between two and four tests at each well during each event."* *It appears that the numbers of tests were increased between slug tests performed on the preliminary monitoring wells and subsequent testing during the treatability study. However, this "lesson learned" is not highlighted in the subsequent Finding and Conclusions sections. Since additional bioremediation studies are planned, it is suggested that the authors make note of this finding for future work plan development.*	Aquifer testing performed as part of future bioremediation studies will incorporate the lessons learned from aquifer testing in this treatability study.
7. <u>Specific Comment #4 Section 3.3.2 Slug Testing, page 8:</u> The Deliverable states that "A number of the slug tests had an inadequate number of data points for analysis due to the rapid aquifer response." Out of 16 slug tests reported in Appendix H Treatability Study Slug Test AQTESOLV Plots only three plots of the 16 tests had four or more straight line match points, while nine had two or fewer point falling on a straight line. Please clarify whether well design and/or slug test design met the assumptions for the Bouwer and Rice (1976) method for analyzing slug tests.	The slug tests and well design did acceptably meet the Bouwer and Rice (1976) method assumptions. However, when the hydraulic conductivity is quite high, actually measuring the aquifer response can be a challenge. During these tests, the aquifer responded so rapidly that the transducer's minimum measurement interval could only record a few data points before the majority of recovery was complete. Under such circumstances, the analyst can be confident that the hydraulic conductivity is very high, but the numerical estimate of hydraulic conductivity is less accurate due to the smaller number of data points. Also, it is unusual to have large numbers of data points fall directly on a straight line during analysis. Instead, most slug tests tend to have significant scatter around the line.
8. <u>Specific Comment #5 Section 4.2.1 Geotechnical Analysis of Aquifer Solids, page 10:</u> *Please define "aquifer physical parameters of significance."*	The aquifer properties of significance include soil grain size analyses, specific gravity, bulk density, moisture content, and porosity, which are presented in Appendix D - UNLV Bench-Scale Study Report. For future reports, parameters that are measured or estimated will be listed at the beginning of the section.

NDEP Comment	Response to Comment
9. Specific Comment #6 Section 4.2.1 Geotechnical Analysis of Aquifer Solids, page 11, bottom of page: The Deliverable states that "Measurements of effective porosity within the study area are typically ~10%." Please specify how effective porosity was determined and provide reference.	A value of 10 percent for effective porosity was based on a previous study in the area performed by Errol L. Montgomery & Associates (2000) titled, "Final Report, Analysis of Rate of Groundwater Movement Based On Results of Tracer and Hydraulic Tests Conducted Between Pittman Lateral and Seep Area", Henderson, Nevada, prepared for Kerr-McGee Chemicals, LLC, December 2000.
10. Specific Comment #7 Section 4.3.2 Results, second bullet, page 12: The second sentence states, "The relatively higher TDS in groundwater at the Site (greater than 6,000 mg/L)…" (emphasis added). The "Site" is defined as the NERT site in Section 1.0 Introduction. The Deliverable's reference to the "Site" appear to refer to the "treatability study area" more so than the NERT Site. Suggest revision to this term for clarity. It should be noted there are eight instances where this occurs between Sections 4.3.2 to 4.4.2 and two instances in Section 6.6.1 and 6.6.2.	Comment noted. The language in future reports will be adjusted for clarity.
11. Specific Comment #8 Section 4.3.2 Results, page 12 fourth bullet point and page 13 seventh bullet point: The Deliverable states that "Because of the high nitrate concentrations in groundwater (ranging from 8.3 to 15 mg/L), it was not deemed necessary to augment the system with nitrogen micronutrients." Nitrate has never been analyzed/mapped at the site. There are three potential sources COH wastewater, NERT, and TIMET. Please provide data summary and map for nitrate distribution.	The results ranging from 8.3 to 15 mg/L were based on the results of the April 2015 groundwater sampling event in which samples were collected from wells BH-01, MW-K5, and PC-98R. At the time of the bench-scale study, these were the only monitoring wells installed within the general treatability study area as the more extensive treatability study injection and monitoring well network was not installed until August 2015. Therefore, it was these results that were used to determine the appropriate amendment(s) required for the bench-scale testing. The nitrate data collected in April 2015 can be found in Appendix A.2. Nitrate data collected during the treatability study can be found in the data summary table presented as Table 7, located in Section 6.2, as well as Appendix A.3. For the forthcoming SWF Treatability Study, a map of nitrate distributions within the SWF treatability study area will be included in the final report.

NDEP Comment	Response to Comment
12. Specific Comment #9 Section 5.1 Treatability Study Location, first paragraph, page 16: The second sentence states, "This area is slightly different from the location presented in the Groundwater Bioremediation Pilot Test Work Plan (Tetra Tech, 2015) as the location was moved approximately 700 feet upgradient to reduce interference from the COH operations….". Should the Deliverable include an acknowledgment that all the bench-scale testing and geotechnical analysis was conducted from boring BH-01 which was Not located within the field treatability study area? If this discrepancy was not deemed to a have material impact on the results then the report would benefit by inclusion of such an analysis. Otherwise, an acknowledgement of the uncertainty associated with this discrepancy should be included. In addition, the term "interference" should be defined; for example, 1) interference from current COH operations, or 2) interference as caused by the operation of COH RIBs. Please clarify accordingly.	The area originally slated for the treatability study (immediately adjacent to the area officially known as Pond 13) was within the region that COH periodically employs for surface water discharge of excess treated effluent from their treatment plant, which would have interfered with their operations as well as treatability study operations. As described in Section 5.2.3 (Geology of Treatability Study Area), there appear to be three defined layers in the alluvium (silt with gravel, sandy gravel, and sandy silt) in the overall study area; any or all three may exist within one well, and they are often observed at different depth intervals from one well to another that are in close proximity. This variation in lithology was noted in all treatability study wells as well as BH-01, and therefore is a natural feature of the indiscriminate manner in which geological erosions and depositions occurred in the alluvium. Given this lithological variability in the vicinity, it is not expected that there would have been a material impact on the results of the bench-scale tests and the soil analyses pertaining to the treatability study.
13. Specific Comment #10 Section 5.2.1 Injection Well Transect, page 16: The Deliverable states that "Based on the hydrogeological characteristics and higher than expected permeability in the alluvium, it was estimated that 30 feet was a likely lateral influence that can be expected with a sufficient degree of overlap..." Please clarify how the estimate was made.	The spacing of injection wells is generally based on several factors including groundwater velocity flow rates (very conductive within the treatability study area), the amount of chase water or distribution water that is used, the lithological heterogeneity in the aquifer (which impacts transverse and vertical dispersion), the type of substrates (in this case, slow release EOS), and screening-level modeling using Groundwater Vistas software (which indicated that minimal dispersion would essentially result in lateral movement of substrate and an overlap if wells were spaced 60 ft apart). Bioremediation protocol and guidance documents support this design as well and have been referenced in this section (AFCEE, 2004). Based on all of this information, a 60-ft spacing with 30 feet of lateral influence was adopted for the injection well transect for treatability testing.
14. Specific Comment #11 Section 5.2.1 Injection Well Transect (page 17) and Section 5.2.2 Monitoring Well Network: The Deliverable notes "soil samples were collected…and analyzed for…as well as grain size analysis." The NDEP could not locate these results in tabular not raw format within the report. Please advise as regards location or include in revision.	Grain size analysis results were inadvertently omitted from the report and have been included as an attachment to this response to comments. All future treatability studies will include all geotechnical results in an appropriate location within the report.

NDEP Comment	Response to Comment
15. Specific Comment #12 Section 5.2.1 Injection Well Transect, page 17: The Deliverable states that "Finally, a screening-level hydrogeological model was used to assess the appropriate spacing for the injection and monitoring well array." Please identify the model employed for this evaluation, and include a discussion of limitations associated with this model.	The modeling codes MODFLOW2000 and MT3D were used to create a simplified model of the injection area to assess the planned layout of the injection and monitoring wells prior to well installation. Basically, the model represented the injection area as a homogeneous box of saturated material measuring 800 feet long, 400 feet wide, and 15-20 feet thick. Because the model was only a screening-level tool, no calibration was performed. Instead, the locally-measured hydraulic gradient was combined with reasonable estimates of aquifer properties from previous aquifer and soil testing to represent the local hydraulic conditions. The planned injection and monitoring well network tested in the model was augmented with real-world experience of the treatability study engineers. The model was then used as a simple tool to test the effects of a reasonable range of hydraulic conductivity and dispersivity values on the movement of dissolved organic carbon, confirming that the dissolved organic carbon would be detectable by the monitoring network that was laid out. The modeling also has limitations in that it does not account for aquifer heterogeneity and the adsorption and desorption characteristics of the EOS that was injected. The EOS is also an emulsion and not a truly soluble substrate and would in reality be more amenable to a multi-phase model; however, such a model is quite complex and also has assumptions and limitations.
16. Specific Comment #13 Section 5.2.1 Injection Well Transect, page 17: The Deliverable states that "Soil samples were collected from location BP-IW02 during installation and analyzed for native chemical characteristics, including TOC, iron, and calcium as well as grain size analysis. Please identify where in the Deliverable these data are presented.	TOC, iron, and calcium data are provided in Appendix A.1. Grain size analysis results were inadvertently omitted from the report and are attached to this response to comments.
17. Specific Comment #14 Section 5.3.2 Geology of Treatability Study Area, page 18: The second paragraph, last sentence states, "Finally, the paleochannel that has been previously mapped in this area [Plate 2 in the 2015 Annual Remedial Performance Report (Ramboll Environ, 2015)] was encountered during well installation for the treatability study as expected." The Deliverable would be benefit by inclusion of this feature on the report Figures, where applicable. Please revise accordingly.	Comment noted. For the future SWF Area Bioremediation Treatability Study Report, or other applicable future treatability study reports, paleochannel(s) will be mapped if sufficient data is present.

NDEP Comment	Response to Comment
18. Specific Comment #15 Section 6.1 Perchlorate, last paragraph and Page 16, Section 5.2.1 Injection Well Transect, page 25: Section 6.1 presents the potential factors for why BP-MW09 did not report a favorable response to the carbon substrate injection events. However, the investigators do not note that in Section 5.2.1 a fourth injection well was removed from the study. It should be noted that the fourth injection well was proposed as the furthest west injection point and was more conceptually located hydraulically upgradient from BP-MW-09 (refer to Figure 2 Conceptual Pilot Test Layout [Tetra Tech 2015], attached herein for reference). Suggest revision to the text to note this discrepancy between the approved Work Plan and field implementation.	We acknowledge as stated in the last sentence in the text on Section 6.1 that if an additional injection well was located to the east of injection well BP-IW03 and in a hydraulic flow line towards BP-MW09, it is possible and perhaps likely that a more favorable response would have occurred at this location. This fourth injection well that was proposed in the original approved work plan was removed from the study because of the modified injection well spacing based on the higher than expected permeabilities and the relocation of the study within a space-restricted bermed area upgradient of the originally slated testing area. Future treatability studies to be performed in the SWF area will comprise longer transects that will incorporate several injection wells that provide a greater understanding of the impacts of hydraulic flow on perchlorate biodegradation in downgradient wells.
19. Specific Comment #16 Section 6.5 Oxidation Reduction Potential, page 33, 1st paragraph: Please provide spatial distribution of parameters including ORP, especially relative to injection points to provide information on the nature and extent of the redox environment.	As discussed in response to comment 1, for the future SWF Area Bioremediation Treatability Study, ORP will be mapped to demonstrate the nature and extent of the redox environment within the study area.
20. Specific Comment #17 Section 6.6.5 Additional Parameters, sixth bullet, page 37: ***a.*** *The investigators acknowledge that "reducing conditions appear to have solubilized resident manganese in the treatability study area." However, the investigators point to results from the "farthest downgradient monitoring wells (which are discussed in Section 6.6.3) did not show significant manganese concentrations." It should be noted Section 6.7.3 Downgradient Monitoring Outside of the Treatability Study Area presents a definitive case that operations at the City of Henderson Pond 13 likely influenced monitoring results in these wells and was the primary driver behind relocation of the treatability study 700 feet upgradient. It seems reasonable that interpretation of data from these wells should be done with caution and noted as uncertain. As such, it is suggested that reference to the monitoring results from the "farthest downgradient monitoring wells" as regards potential secondary releases of solubilized manganese be qualified or removed. Additionally, the text refers reader to Section 6.6.3 for a discussion of downgradient monitoring wells. It should be noted that Section 6.6.3 appears to be an incorrect reference.* *(Continued on next page)*	**a.** Comment noted. *(Continued on next page)* **b.** Comment noted.

NDEP Comment	Response to Comment
b. *Page 46, Section 7.0 Summary of Overall Findings, last bullet states, "Groundwater at downgradient monitoring wells BH-01, MW-K5, and PC-98R…did not exhibit any direct geochemical impacts from the injections. No other secondary effects…were observed in these wells." Again, the investigators should qualify this statement since the area was generally under the influence of COH Pond 13 discharges during the treatability study.*	
21. Specific Comment #18 Section 6.9.1 Slug Tests, 3rd paragraph, page 42: The discussion of decreases in hydraulic conductivity does not consider that carbon dioxide and biomass are by products of the in-situ reduction, both trapped carbon dioxide and biomass buildup could contribute to the decrease in hydraulic conductivity.	Gas production via denitrification has been noted and stated to be a potential cause of decreases in hydraulic conductivity. In addition, carbon dioxide that is generated during microbial respiration could also contribute to overall gas production and decreased hydraulic permeability, even though carbon dioxide is much more soluble in water compared to nitrogen. Biomass is also noted to be a contributing factor as stated in the last paragraph of this section.
22. Specific Comment #19 Appendix C Preliminary Field Activities – Borehole Dilution and Slug Test Summary: Review of the Bouwer and Rice data plots shows that in only three of the 16 data plots were there four or more data points on a best fit straight line, over half of the plots had two or fewer data points on a best fit line. Results from these tests need to be reviewed for future test and/or well design.	Please see response to comment 7. Additionally, future test design and implementation will incorporate lessons learned from these slug tests.
Minor Corrections/Editorial:	
23. Specific Comment #20 Section 3.3.1 Borehole Dilution Testing, page 8: The text discusses groundwater velocity testing and references to Errol L. Montgomery & Associates, Inc. (2000) but does not provide the value being compared.	The groundwater velocity for Site B (which is near PC-98R and MW-K5) was estimated to be 30-45 ft/d by Errol L. Montgomery & Associates, Inc. (2000).
24. Specific Comment #21 Appendix D UNLV Bench-Scale Report, Table 4.3: Dissolved metals analysis for the effluent from the columns from Test America. Please explain color coding in Table 4.3.	The color coding in Table 4.3 signifies measurements that exceeded EPA's MCLs.
25. Specific Comment #22 Executive Summary, Bench-Scale Studies, fourth sentence states, page 1: Suggest revision to the last phrase "this was also to likely to occur during field injection wells" for clarity.	Comment noted.

NDEP Comment	Response to Comment
26. Specific Comment #23 Section 4.2.1 Geotechnical Analysis of Aquifer Solids, third paragraph, last sentence, page 11: The borehole dilution testing results are discussed in Section 3.3.1, not 4.3.1 as stated here. Please revise accordingly.	Comment noted.
27. Specific Comment #24 Section 6.1 Perchlorate, fifth paragraph, seventh and eighth sentences, page 23: Monitoring wells BP-MW03 and BP-MW04 are cited as MW-03 and MW-04 within the text. Please revise accordingly.	Comment noted.
28. Specific Comment #25 Section 6.6.1 Chlorate, first paragraph, third sentence, page 11: Suggest revision of the term "background" to "upgradient".	Comment noted.