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August 14, 2019

Dr. Weiquan Dong, P.E.
Bureau of Industrial Site Cleanup
Nevada Division of Environmental Protection
2030 E. Flamingo Rd, Suite 230
Las Vegas NV 89119

RE: Revised Seep Well Field Area Bioremediation Treatability Study Results Report
Nevada Environmental Response Trust
Henderson, Nevada

Dear Dr. Dong:

The Nevada Environmental Response Trust (NERT) is pleased to present the Revised Seep Well Field Area Bioremediation Treatability Study Results Report for Nevada Division of Environmental Protection (NDEP) review. This revised report addresses NDEP's comments dated June 6, 2019. As requested NERT is also providing an annotated response to comments. When reviewing the changes please keep in mind that this treatability study was completed in a limited geographic area where perchlorate was entering the study area from both the NERT Site and also from the former AMPAC site. Acknowledging that the geology of the Seep Well Field Area Bioremediation Treatability Study area was more complex than originally anticipated, the objectives of this study were specifically established to demonstrate that a biologically active treatment zone could be created and maintained within the study area yet not to overcome every challenge unique to this study area nor mirror the performance of a full-scale remedial implementation. If in-situ bioremediation is ultimately selected for implementation within the NERT Remedial Investigation Study Area, a detailed design would be prepared to address all identified challenges and provisions would be made to install additional injections wells as necessary to ensure widespread distribution of carbon substrate throughout the treatment zone.

If you have any questions or concerns regarding this matter, feel to contact me at (702) 960-4309 or at steve.clough@nert-trust.com.

Office of the Nevada Environmental Response Trust

Stephen R. Clough

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1. General Comment 1: NDEP requests a summary table of the demonstration performance objectives. NDEP suggests that NERT considers organizing this information of both quantitative and qualitative parameters that are applicable for this project into tables e.g., Tables 4.1 Performance Criteria and 4.2 Performance Confirmation Methods of "In Situ Bioremediation Of Perchlorate Using Horizontal Flow Treatment Wells" (Paul Hatzinger and Jay Diebold, 2009, ESTCP Project ER-0224).	Tables have been generated as requested and have been included in Section 7 and Appendix P of the revised report.
2. General Comment 2: Lots of data collected during the site characterization and the laboratory bench-scale tests, but the report doesn't have the description how those data was used to design the screen interval, spacing of the injection wells, the rate, frequency and mass of the injection materials (EOS, phosphate, glycerin, sodium sulfite and chase water) and the layout of the monitoring wells. For example, at five of the twenty injection well locations, a paired injection well configuration was installed that consisted of two injection wells, each screened across separate treatment intervals and installed in separate boreholes, but the report doesn't discuss the advantage and disadvantage of using the paired injection well configuration from the effectiveness of monitoring results. NDEP believes that the information is very important for the full scale implementation if the in-situ bioremediation is selected for the final remedy and asks those information to be included in the revision.	The Trust agrees that the identified data is important for full-scale implementation. While Tetra Tech interpreted the identified data to complete the Phase 2 design, the process was not detailed in the Report. The additional information requested has been added as follows: • Injection well screened intervals and spacing – Text has been revised in Section 5.2.1. • Monitoring well layout – Text has been revised in Section 5.2.2. • Injections – Text has been revised in Section 5.3. • Paired injection well evaluation – Text has been revised in Section 7.1.
3. Executive Summary, "The study demonstrated the ability of ISB using a slow-release carbon substrate to achieve the Preliminary Remedial Goal (PRG) for perchlorate in groundwater of 15 µg/L within the alluvium". This statement is only true for several monitoring wells. The perchlorate concentration of groundwater in most monitoring wells screened in the alluvium is still above 15 µg/L after the third injection. It is obvious that the hydrogeology plays critical role on the radius of the injection. NDEP asks more detail discussions on why the perchlorate reduction of groundwater is dramatically different in different monitoring wells.	The heterogeneity in the treatability study area alluvial aquifer is very high, and the lithology commonly changed within spacing of less than 5 feet. Furthermore, heterogeneity is present at every scale in such geologic environments, from millimeters to kilometers. As a result, the distribution of substrate will always be heterogeneous due to micro- and macro-scale preferential flow pathways, such that strategically placed enhancement wells are commonly needed during full-scale implementation to optimize treatment performance. In addition, this particular area has the potential for upflux from the UMCf as well as impacts from the AMPAC plume which migrates across the northernmost portion of the treatability study area. If there is a contribution from the UMCf, it could pass beneath the treatment zone, and then flow upward into the alluvium downgradient of the treatment zone. It is not

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	possible to assess definitively whether upward flow of untreated water from the UMCf is occurring because there are only two paired UMCf well locations. In addition, the small east-west paleochannel is not fully targeted by an injection well transect, because it was identified during the drilling of the injection and monitoring wells and not during the initial pre-design efforts. Additionally, the AMPAC plume migrating at the northern end of the treatability study area may have impacted water quality at some of the downgradient performance monitoring wells. It is critical to note that it was not the objective of the treatability study to overcome all of these challenges but to demonstrate that a biologically active treatment zone could be created and maintained within the alluvium. Furthermore, it should be noted that the upflux of perchlorate from the UMCf will be evaluated from a remedial perspective in the forthcoming Las Vegas Wash Bioremediation Pilot Study and discussed in much greater detail in the forthcoming Remedial Investigation (RI) Report for Operable Unit (OU) 3. Sections 6.1.2 and 6.2.1 of the revised report have been expanded to discuss the hydrogeology and perchlorate distributions with respect to hydrogeology in the area including preferential flow pathways, location of paleochannel, and heterogeneity of the alluvium.
4. Executive Summary, Treatability Study Findings and Conclusions, third bullet point-The text states that "the maximum first-order perchlorate biodegradation rates in groundwater were determined to range from -0.09 day-1 and -0.25 day-1." The text in this section should specify that the presented values are perchlorate biodegradation rate constants. The same comment applies to Section 7.1 Treatability Study Summary.	Text has been revised as requested in both the Executive Summary and Section 7.1 of the revised report.
5. Executive Summary, approximately 2,748 pounds of perchlorate were destroyed by ISB during the 14-month treatability study time frame. This number seems overestimated. NDEP asks details how the 2,748 pounds of perchlorate destroyed was calculated.	Complete details of how the perchlorate mass estimates were calculated are provided in Section 6.2.1.4 of the report. This section includes a summary of the data sources, procedures, and results. It should be noted that as expected, a large initial mass of perchlorate was destroyed because the aquifer within the entire study area contained perchlorate-impacted groundwater in its pore spaces, which was degraded by ISB. However, subsequent injection events only target the mass that entered the system after the first injection event. In other words, the mass flux into the system limits the

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	amount of treatment during subsequent events and allows ISB to target the progressively smaller quantities of the remaining smaller incoming concentrations. In order to achieve a comparably large mass destroyed in any subsequent event, it would be necessary to allow the system to “refill” with perchlorate entering from upgradient, to the point where concentrations rebounded back to the initial baseline perchlorate values. It should be noted quantification of the mass destroyed in this study was estimated as requested by NDEP; however, such calculations are presented as estimates and are not critical to the outcome of the study or the forthcoming FS.
6. Section 3.4.2.1 Soil Analytical Results, first paragraph -Is the sample detection limit 0.010 mg/kg, or 0.012 mg/kg? Please clarify.	The laboratory reports perchlorate detection limits specific to each sample. The base detection limit for each sample is adjusted for its specific moisture content and dilution, if applicable, leading to a low-level variability in individual sample detection limits. Detection limits for the soil samples collected during the pre-design activities ranged from 0.010 to 0.014 mg/kg.
7. Section 3.4.2.1 Soil Analytical Results, third paragraph -The sum of the reported microbial population bacteria percentages (58, 16, 15, 7) is 96%. Should the sum be equal to 100%? If so, identify the remaining 4%.	The remaining microbial population is made up of the eukaryotes. Section 3.4.2.1 of the revised report has been updated to provide additional clarification.
8. Section 5.4 Effectiveness Monitoring Program, second bullet point -The text should explain why the number of groundwater sampling locations for the listed constituents was reduced.	Section 5.4 of the revised report has been updated to provide additional clarification.
9. Section 5.4 Effectiveness Monitoring Program, the magnitude of the perchlorate reduction in many monitoring wells is much less after the injection event 2 compared to after the Injection event 1, please explain why.	Section 6.2.1.1.3 provides a summary of the perchlorate degradation response following the second injection event and the likely reasons why the magnitude of perchlorate reduction was lower in several monitoring wells. Intentional manipulation of the injection quantities during subsequent injection events are typically performed in treatability studies to provide valuable data on carbon substrate dosing. As noted in Sections 5.3.2 and 6.2.1.1.3, carbon substrate quantities were intentionally reduced during the second injection event and therefore, is the likely reason for the lessened perchlorate degradation following the second injection event.
10. Section 5.4 Effectiveness Monitoring Program, the perchlorate reduction of groundwater from monitoring well SWFTS-MW14 is one of the best among all monitoring wells but the concentration of As, Mn, CH4 and Se substantially increased from the baseline condition. Please explain if the best perchlorate	Section 6.2.6.4.1 provides a discussion of arsenic concentration trends for monitoring well SWFTS-MW14.

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reduction is likely associated with the secondary mobilization of some unwanted chemicals.	A similar concentration trend was observed for manganese at monitoring SWFTS-MW14 in which groundwater samples initially showed a slight increase in manganese concentrations, followed by several consistent decreases when the final sampling event during the reporting period indicated groundwater concentrations less than those observed during baseline. In geochemical terms, the behavior of selenium is similar to arsenic. Although selenium concentrations increased in groundwater samples collected from SWFTS-MW14, concentrations were reducing towards the end of the reporting period. Recent data collected for selenium as part of the study extension indicate that these concentrations continue to reduce, with a selenium concentration of 89 μg/L in the groundwater sample collected from SWFTS-MW14 during the May 2019 sampling event. Text has been updated in Sections 6.2.6.4.3 and 6.2.6.5 to discuss concentrations trends for monitoring well SWFTS-MW14 for manganese and selenium, respectively. Methane concentrations are discussed in the fourth bullet in Section 6.2.6.5, which describes that the methane concentration increases observed are indicative of the level of reducing conditions that were established following injections and notes that the only noteworthy methane concentration increases were observed in monitoring wells located immediately in between the injection well transects, while groundwater samples collected from the farther downgradient monitoring wells did not observe these same level of increases. Finally, any methane that is produced at the depth at which groundwater is being addressed is very likely to be rapidly oxidized to harmless carbon dioxide in the gravelly and sandy alluvium. In conclusion, there is no location-specific correlation that is of value when analyzing perchlorate decrease with changes in secondary constituents. The onset of perchlorate biodegradation is likely to be dependent on geochemical and biochemical conditions (including microbial factors), whereas that of ionic changes in secondary elements is more chemical dependent. Therefore, tracking secondary parameters has the sole objective of making sure these don't persist long-term temporally and more importantly, spatially in downgradient locations.

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11. Section 5.4 Effectiveness Monitoring Program, monitoring wells of PC-91 (screened from 26.5-36.5 feet) and PC-92 (Screened from 11.5 to 21.5) are close each other and are about the same distance from the injection wells of SWFTS-IW11 (Screened 17.3 to 37.1 feet) and SWFTS-IW12 (Screened 14.3 to 39.1 feet), but the perchlorate reduction is very different from each other and the perchlorate of groundwater rebounded after 2nd injection and stayed high after 3rd injection in shallow screened PC-92 . The less effective perchlorate reduction is also observed in other shallow screened monitoring wells. Please explain why this difference happened.	Tetra Tech agrees that the response between monitoring wells PC-91 and PC-92 is different as presented. However, after comparison of original boring logs to survey data and recent video logging, it was confirmed that that the historical PC-91 and PC-92 logged well construction information was originally switched at installation. The well labeled PC-91 in the field is the shallower, western well and is screened from 11.5 to 21.5 feet bgs. PC-92 is the eastern well and is screened from 26.5 – 36.5 feet bgs. The update to the well depths and screened intervals was part of NERT's recent update to the AllWells Database in late July. The Ramboll and Tetra Tech cloud databases have been updated to match the field reality of the well construction. The appendix tables have been updated in the revised report and the revised DVSR submitted on June 26, 2019 included this correction. With regards to perchlorate concentration reductions, groundwater samples collected from both monitoring wells have indicated perchlorate reductions throughout the duration of the treatability study. Groundwater samples collected from monitoring well PC-91 achieved a reduced perchlorate concentration of 160 μg/L during the reporting period (approximately 93 percent decrease compared to baseline concentrations), while groundwater samples collected from monitoring well PC-92 achieved a reduced perchlorate concentration of 2,100 μg/L (approximately 52 percent decrease compared to baseline concentrations). As observed in Figure 7, PC-91 and PC-92 are slightly downgradient of injection well IW-11 but are likely not influenced by injection well IW-12. Although groundwater samples collected from both PC-91 and PC-92 have indicated perchlorate reductions following the injections, the following should be noted: • The proximity of the east-west paleochannel in this vicinity likely contributes to the varying effects on perchlorate concentrations between PC-91 and PC-92. It is likely based on the groundwater flow patterns that both PC-91 and PC-92 are impacted by injections but PC-91 more so due to its proximity to IW-11 and the paleochannel. • As discussed in Section 6.2.1.1.3, the perchlorate degradation response observed in groundwater samples collected following the second injection event was not as great as the first injection event likely due to the change in injection strategy.

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	• Following the third injection event, groundwater concentrations at PC-92 began to reduce again (9,200 µg/L prior to the third injection event and 4,100 µg/L following the third injection event). As part of the extension of this study (i.e. NERT's Treatability Study Modification No. 6), groundwater samples collected from this well continue to reduce to concentrations similar to the results observed following the first injection event. • Response variations are not uncommon during treatability studies and such variations provide useful information for remedy design. Tetra Tech will continue to monitor the on-going response at monitoring wells PC-91 and PC-92.
12. Section 5.4 Effectiveness Monitoring Program, the perchlorate decreases observed in the monitoring wells of PC-88 and PC-97 are likely caused by the dewatering during the Sunrise Mountain Weir construction, because they are located at the upper gradient and distant areas of the injection wells and the timing of the perchlorate dropping and rebounding is consistent with the starting and stopping dewatering. NDEP suggests scrutinizing the effectiveness monitoring results and making sure that only true effectiveness caused by the injections is credited to the in-situ bioremediation treatability study.	Comment noted. PC-88 and PC-97 are upgradient monitoring wells for purposes of this treatability study and were not included in the discussion of perchlorate degradation response associated with injections. Additionally, because PC-88 and PC-97 are located upgradient of the treatability study, the concentration decreases observed at these wells during construction of the Sunrise Mountain Weir were accounted for in mass estimate calculations as a decrease in the incoming perchlorate mass into the study area. As stated in Section 6.2.1.4.2, "A multiplier was developed to adjust incoming mass by the overall change in concentration in each sampling event observed at the Seep Well Field area, which is located just upgradient of the treatability study area."
13. Section 6.2 Effectiveness Monitoring Results, Figures 8a to 8c (Perchlorate Distribution In Groundwater During the Treatability Study. Please provide a three-dimensional picture of perchlorate and TOC distribution for Baseline Conditions, Week 6, Week 33, Week 56 and the difference of Baseline Conditions and Week 56 (Subtract Week 56 from Baseline Conditions).	Figures for perchlorate have been added to the revised report as requested, with additional text references included in Section 6.2.1.2. TOC concentration figures have not been generated due to the potential for misinterpretation of the results. While elevated TOC concentrations do suggest that biological degradation is occurring, the design of this treatability study was focused on creating a carbon substrate-filled biologically active zone within the vicinity of the injection wells and not to distribute TOC throughout the study area. Although there were some periodic increases of TOC in downgradient monitoring wells, the three-dimensional visualization of TOC in groundwater does not accurately identify the area where biological degradation is occurring within the subsurface since the goal of the injectate was for the elevated TOC to remain within the biologically active zone. As

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	described in Section 6.2.4, TOC was not regularly sampled at the injection wells because TOC measurements at the actual points of injection may not be particularly helpful or subject to useful interpretation as they could include biomass and organic particulates which tend to linger around the well screen and around the immediate formation itself, but may not accurately reflect biochemical conditions outside that immediate vicinity. Per Section 8.0, a modification will be prepared to study the distribution of emulsified vegetable oil within the subsurface along the injection well transects and include the installation of soil borings and collection of soil samples to better understand carbon substrate movement and influence in the aquifer.
*14. Section 6.2 Effectiveness Monitoring Results, NDEP suggests calculating the targeted radial distance based on amendment volume, effective porosity, screen intervals of the injection wells with the equation of V=n*r2*h*0e (Payne 2008*, where: r is the injection radius of influence, h is the height of the well screen, and 0e is the effective porosity) and comparing the calculated radial distance to the concentrations of TOC and perchlorate.*	Section 5.3 of the revised report has been updated to include the injection calculations used for the injection process, including the use of the equation specified in this comment. Perchlorate concentration reductions were measured at varying distances within and downgradient of the estimated (targeted) carbon substrate injection influence in order to provide the degree of effectiveness of the entire biologically active zone that was created. This includes wells varying from 45 feet to 600 feet downgradient of the injection well transects. As explained in the previous response, the goal of the injections is to create a carbon substrate-filled biologically active zone within the vicinity of the injection well transects and not to distribute TOC throughout the study area. Therefore, a correlation of the desired ROI and perchlorate and TOC concentrations at downgradient monitoring wells is not applicable. However, as part of the extended study (i.e. NERT's Treatability Study Modification No. 6), soil borings will be installed to further evaluate the distribution of organic carbon and/or chemical signatures of emulsified vegetable oil within the targeted radius of influence of the injection wells.
15. Section 6.2.4 Total Organic Carbon, last paragraph - The text states that "it is not always possible to use [TOC] as a quantitative indicator parameter for rejuvenation of EVO or to assist in the determination of the quantities of EVO that need to be periodically injected." If that is the case, what parameter(s) will be used to determine the injection frequency and substrate quantity? NDEP noticed that TOC was used to determine which injection wells	If ISB is selected as part of the full-scale remedy, it is anticipated that a screening process will be developed as one of the tools to determine the optimal timing of subsequent injection events. Specifically, this screening process would give guidance on the timing of substrate injections as well as the potential number of injection wells requiring reinjection by taking into account data collected during the effectiveness monitoring program primarily for the main contaminants of potential concern

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were injected during the 2nd injection event. Please define the numeric value of TOC at which the injection is not needed.	(COPCs), namely, perchlorate and chlorate, other electron acceptors (such as nitrate, dissolved oxygen, and sulfate), TOC, and potentially oxidation reduction potential. A numeric value for TOC to determine injection frequencies has not been determined and is not recommended. TOC comprises many components of organic carbon including the original substrate, breakdown products such as long-chain, medium-chain, and small-chain fatty acids, as well as both living and dead biomass. Therefore, it is difficult and impractical to use it solely to predict the need for carbon substrate rejuvenation. TOC was measured in the injection wells at this site five months following injections, with concentrations varying widely from 220 mg/L to 6,500 mg/L. Preliminary evaluation of the groundwater and material collected from the injection wells indicated the presence of organics (biomass and remnants of carbon substrate) along with inorganic salts, for example salts of calcium such as calcium carbonate. As described in Section 6.2.4: *"In conclusion, although TOC is sometimes a useful indicator to determine the arrival of carbon substrate from injections, it is not always possible to use it as a quantitative indicator parameter for rejuvenation of EVO or to assist in the determination of the quantities of EVO that need to be periodically injected. In particular, for ISB systems that involve transects or barriers via injection wells, TOC measurements at the actual points of injection may not be particularly helpful as they could include biomass and organic particulates which tend to linger around the well screen and around the immediate formation itself, but may not accurately reflect biochemical conditions outside that immediate vicinity."* As part of the extended study (i.e. NERT's Treatability Study Modification No. 6), Tetra Tech and UNLV are planning on evaluating this material further to understand if it is possible to distinguish the composition of organic material in the wells.
16. Table 4 SWF Area Bioremediation Treatability Study Cost Summary- first, "ODC" needs to be defined; Second, NERT should report actual costs following the items and the format of Table 1 - Detailed Budget of Galleria Drive Bioremediation Treatability Study Phase 2 Cost Estimate and Basis (Tetra TechInc., March 29, 2019). It is also helpful to compare the budget cost and	A note has been added to Table 4 to define the ODCs (Other Direct Costs) and labor and ODCs have been separated. Subsequent to receipt of NDEP Comments Dated June 6, 2019, the Trust was advised by NDEP that additional cost details are not required at this time and that NDEP and

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the actual cost if the detailed budget of this project along with the actual treatability study cost in the same format and layout. Please submit to NDEP spreadsheet files of all tables presented in this report and associated addendum. This request is also applied to all future deliverables.	EPA are comfortable with the level of financial information currently provided by the Trust through its established expense reporting process.
17. Section 3.0 Results of Appendix F "Hydraulic conductivity values reported for consecutive slug tests done in injection wells showed decreases of up to three orders of magnitude throughout the treatability study. However, the injection rates during the second and third injection events did not show comparable decreases over time. Evaluation of the water and biological material in the injection wells indicated that the apparent decrease in K values at injection wells was likely due to a thin biofilm present on the injection well screens rather than to an actual decrease in hydraulic conductivity of the formation." The injection pressure of Appendix K Injection Summary Tables increased in the second and third injection events. This observation is consistent with the decreases of hydraulic conductivity from the slug tests done in the injection wells. Although the injection rates during the second and third injection events did not show comparable decreases over time under increasing injection pressure, it is likely that significant biomass have been accumulated in the injection well screen. The effectiveness on the perchlorate reduction presented in Appendix M Concentration Trends for Effectiveness Monitoring Wells decreased after the second and third injection events. Therefore, the question on the long-term effectiveness of the in-situ bioremediation in the published case studies may happen at this study too. NDEP asks that NERT makes the best effort to demonstrate the cost-effectiveness, the long-term effectiveness of the perchlorate mass reduction effectiveness, the flexibilities of the long-term operation and maintenance of the in-situ bioremediation technology during the extended injection and operation.	Comment noted. The extension of the SWF Treatability Study (i.e. NERT's Treatability Study Modification No. 6) will continue to evaluate long-term effectiveness, long-term operation and maintenance, and overall cost effectiveness of the technology. Development of biomass in the treatment zone is expected as part of the ISB process and therefore, a key component of the treatability study extension is evaluation of techniques to periodically redevelop and rehabilitate wells as biomass accumulation as well as inorganic precipitation (particularly calcium compounds in gypsum rich and alkaline conditions) and combinations of inorganic and organic components including biomass and EVO products. The statement cited by the comment was not intended to imply that hydraulic conductivity had not decreased at all, but to explain that the slug tests produced inaccurate estimates of how much decrease in hydraulic conductivity had occurred. The slug tests implied that the hydraulic conductivity had decreased to the point that injection would be very difficult, but in reality, the decrease was much less than the slug tests results would suggest as indicated by continued injections into the subsurface. The text in Appendix F, Section 3.0 of the revised report has been updated for clarity.
18. Section 4.4.2 Column Adsorption and Desorption Test. "The oil adsorption in the top 4-inches of the UMCf soil column in the low, medium and high	Comment noted. This data will be used as appropriate in future treatability studies targeting the UMCf. Additionally, oil sorption tests have also been performed for the Galleria Drive Bioremediation Treatability Study and the Las Vegas Wash Bioremediation Pilot Study to determine location-specific information.

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saturation levels were 0.030 g/g dry soil, 0.435 g/g dry soil, and 0.260 g/g dry soil, respectively, which was higher than that in the alluvium." All results should be utilized in all future work on the Galleria Rd. and Las Vegas Wash in-situ bioremediation treatability studies because the saturated UMCf is being significantly targeted at these two sites.	
19. Appendix M Concentration Trends for Effectiveness, NDEP suggests replacing the map of baseline conditions with a similar chart of dissolved oxygen, ORP, As, phosphate as the chart of concentrations vs time. The metadata (e.g., the screen interval depths, the distance and the direction from the closest injection wells, the effective porosity and the hydraulic conductivity) of monitoring well is suggested with the Notes.	Appendix M of the revised report has been updated as requested.
20. Appendix N Microbial Analytical Reports and Table D.6 Groundwater Biotrap Microbial Results Summary, the concentration of biomass before and after the injection stayed moderate (105 to 106 cells) and the biomass of SWFTS-MW-20 decreased after the injection. "As a general rule, biomass levels which increase or decrease by at least an order of magnitude are considered to be significant. However, changes in biomass levels of less than an order of magnitude may still show a trend. It is important to remember that many factors can affect microbial growth, so factors other than the treatment could be influencing the changes observed between sampling events. Some of the factors to consider are: temperature, moisture, pH, etc." The biomass of the proteobacteria, majority of Hydrocarbon utilizing bacteria decreased in SWTS-IW08 and SWTS-IW16 after the injection, but proportions of proteobacteria are of interest because it is one of the largest groups of bacteria and represents a wide variety of both aerobe and anaerobes. Anaerobic metal reducers (BrMonos) was steadily and consistently increased after the injection, which is likely a better parameter for indicating the perchlorate reduction. However, Section 6.2.7.2 Analysis of Microbial Results state that the increased presence of firmicutes generally indicates the growth of bacteria that can ferment the injected EVO and its daughter products to hydrogen for utilization by the microbes belonging to the proteobacteria group for the reduction of perchlorate, but the firmicutes decreased after the	Tetra Tech agrees that the distribution of various bacterial communities following the addition of a carbon substrate has a scientific background from a theoretical basis. However, in the actual subsurface that is being addressed, there are numerous factors that control the changes that are witnessed from advanced microbial techniques such as PLFA analyses. Often, there is a lag between the injections and the onset of firmicutes, which are indicative of the ability to ferment emulsified vegetable oil to daughter products such as acetate and hydrogen that are directly useable by groups such as proteobacteria. Therefore, periodic measurements using Biotraps could miss out on biochemical activities that have occurred in the interim. The same is true with the measurement of perchlorate reductase, which at many perchlorate sites has been shown to recede into the background when perchlorate concentrations reduce and resurfaces only when sufficient perchlorate is present in the groundwater that is subject to microbial testing. Even though BrMonos in this study may indicate a perceived mathematical correlation with perchlorate decreases, there is no scientific microbial-based connection that is known between these two parameters. Therefore, it may not be prudent to set a mathematical basis for this conclusion. For chlorinated solvents, Microbial Insights has established a database that conglomerates both qualitative and quantitative data related to contaminant reduction. Unfortunately, the same is not the case with perchlorate. Tetra Tech will

NDEP Comment	Response to Comment
injection in SWTS-MW16. Therefore, interpreting the results obtained from PLF A analysis is difficult. NDEP suggests a comprehensive and systematical analysis for the PLF A results collected from all completed in-situ bio treatability studies and ranking the usefulness of the PLF A parameters on the perchlorate reduction.	engage with Microbial Insights to explore ways this can be achieved for the NERT site, primarily to provide value for long-term treatment by attempting a more comprehensive evaluation of the data than has been thus far collected and the data that will be obtained from future studies.
21. Appendix O Long-Term Water Level Monitoring Memorandum, there is significant vertical upper gradient from SWTS-MW1OC to SWTS-MW10A. NDEP asks a confirmation that this vertical upper gradient is real because the groundwater elevation reported for these two wells when they were installed was almost same. If the vertical upper gradient is real, what is the vertical perchlorate mass flux?	The vertical upward gradient has been measured on multiple occasions in the field in several wells, both in the Seep Well Field Area Bioremediation Treatability Study and in the nearby Las Vegas Wash Bioremediation Pilot Study, Transect 1a. However, an estimate of perchlorate flux cannot be made at this time because it would require (1) data to characterize the vertical hydraulic conductivity of the UMCf, (2) identification of the primary discharge areas, and (3) an understanding of whether discharge is primarily occurring horizontally (i.e., into paleochannels incised into the UMCf) or vertically (upward through the UMCf itself). Such analysis reflects a localized artifact that was not included in the scope of this study. Furthermore, it should be noted that the upflux of perchlorate from the UMCf will be evaluated from a remedial perspective in the forthcoming Las Vegas Wash Bioremediation Pilot Study and discussed in much greater detail in the forthcoming RI Report for OU-3.