NEVADA DIVISION OF
ENVIRONMENTAL
PROTECTION

STATE OF NEVADA
Department of Conservation & Natural Resources
Steve Sisolak, Governor
Bradley Crowell, Director
Greg Lovato, Administrator

June 6, 2019

Jay A. Steinberg
Nevada Environmental Response Trust
35 East Wacker Drive, Suite 690
Chicago, IL 60601

Re: **Tronox LLC (TRX) Facility**
Nevada Environmental Response Trust (Trust) Property
NDEP Facility ID #H-000539
Nevada Division of Environmental Protection (NDEP) Response to: *Seep Well Field Area Bioremediation Treatability Study Results Report*

Dated: May 6, 2019

Dear Mr. Steinberg,

The NDEP has received and reviewed the Trust's above-identified Deliverable and provides comments in Attachment A. A revised Deliverable should be submitted **by 08/06/2019** based on the comments found in Attachment A. The Trust should additionally provide an annotated response-to-comments letter as part of the revised Deliverable.

Please contact the undersigned with any questions at wdong@ndep.nv.gov or 702-486-2850 x252.

Sincerely,

Dong Weiqo

Weiquan Dong, P.E.
Bureau of Industrial Site Cleanup
NDEP-Las Vegas City Office

WD:cp

EC:
Jeffrey Kinder, Deputy Administrator NDEP
Frederick Perdomo, Deputy Administrator NDEP
James Dotchin, NDEP BISC Las Vegas
Carlton Parker, NDEP BISC Las Vegas
Allan Delorme, Ramboll Environ
Alison Fong, U.S. Environmental Protection Agency, Region 9
Andrew Barnes, Geosyntec
Andrew Steinberg, Nevada Environmental Response Trust
Anna Springsteen, Neptune & Company Inc.
Betty Kuo Brinton, MWDH2O

Brenda Pohlmann, City of Henderson
Brian Loffman, lepetomane
Brian Waggle, Hargis + Associates
Carol Nagai, MWDH2O
Carrie Hunt, Olin Corporation
Chris Ritchie, Ramboll Environ
Chuck Elmendorf, Stauffer Management Company, LLC
Dan Pastor, P.E. TetraTech
Dave Share, Olin
Dave Johnson, LVVWD
David Parker, Central Arizona Water Conservation District
Derek Amidon, Tetratech
Ebrahim Juma, Clean Water Team
Ed Modiano, de maximis, inc.
Eric Fordham, Geopentech
Gary Carter, Endeavour
George Crouse, Syngenta Crop Protection, Inc.
Greg Kodweis, SNWA
Harry Van Den Berg, AECOM
Jay Steinberg, Nevada Environmental Response Trust
Jeff Gibson, Endeavour
Jill Teraoka, MWDH2O
Joanne Otani
Joe Kelly, Montrose Chemical Corporation of CA
Joe Leedy, Clean Water Team
John Edgcomb, Edgcomb Law Group
John Pekala, Ramboll Environ
Kelly McIntosh,GEI Consultants
Kirk Stowers, Broadbent & Associates
Kirsten Lockhart, Neptune & Company Inc.
Kim Kuwabara, Ramboll Environ
Kurt Fehling, The Fehling Group
Kyle Gadley, Geosyntec
Kyle.Hansen, Tetratech
Lee Farris, BRC
Marcia Scully, Metropolitan Water District of Southern California
Maria Lopez, Water District of Southern California
Mark Duffy, U.S. Environmental Protection Agency, Region 9
Mark Paris, Landwell
Michael J. Bogle, Womble Carlyle Sandridge & Rice, LLP
Michael Long, Hargis +
Mickey Chaudhuri, Metropolitan Water District of Southern California
Nicholas Pogoncheff, PES Environmental, Inc.
Orestes Morfin, CAP
Paul Black, Neptune and Company, Inc.
Paul Hackenberry, Hackenberry Associates, LLC
Patti Meeks, Neptune & Company Inc.
Peggy Roefer, CRC
Ranajit Sahu, BRC
Richard Pfarrer, TIMET
Rick Kellogg, BRC
R9LandSubmit@EPA.gov
Steve Clough, Nevada Environmental Response Trust
Steven Anderson, LVVWD
Tanya O'Neill, Foley & Lardner L
Todd Tietjen, SNWA

Attachment A

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);
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.
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.
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.
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
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.
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%.
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.
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.
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, CH_4 and Se substantially increased from the baseline condition. Please explain if the best perchlorate reduction is likely associated with the secondary mobilization of some unwanted chemicals.

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.
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.
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).
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 $V=\pi*r^2*h*\theta_e$ (Payne 2008*, where: r is the injection radius of influence, h is the height of the well screen, and θ_e is the effective porosity) and comparing the calculated radial distance to the concentrations of TOC and perchlorate.
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 were injected during the 2nd injection event. Please define the numeric value of TOC at which the injection is not needed.
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 Tech Inc., March 29, 2019). It is also helpful to compare the budget cost and 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.
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.

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 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.
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 (10^5 to 10^6 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 injection in SWTS-MW16. Therefore, interpreting the results obtained from PLFA analysis is difficult. NDEP suggests a comprehensive and systematical analysis for the

PLFA results collected from all completed in-situ bio treatability studies and ranking the usefulness of the PLFA parameters on the perchlorate reduction.

21. Appendix O Long-Term Water Level Monitoring Memorandum, there is significant vertical upper gradient from SWTS-MW10C 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?

*Payne, F. C., J. A. Quinnan, and S. T. Potter. . 2008. "Remediation Hydraulics. ." *CRC Press, Boca Raton, Fla.: .*
PERF. 2013. "Performance evaluation of in situ chemical oxidation of petroleum impacts in soil and groundwater." *Petroleum Environmental Research Forum (PERF)* Project 2009-01