

TECHNICAL MEMORANDUM

To: Nevada Environmental Response Trust

Cc: Nevada Division of Environmental Protection
United States Environmental Protection Agency

From: Carl Lenker and Eric Klink

Date: September 10, 2019

Subject: Unit 4 Source Area In-Situ Bioremediation Treatability Study Monthly Progress Report

At the direction of the Nevada Environmental Response Trust (NERT or Trust), Tetra Tech, Inc. (Tetra Tech) has prepared this memorandum that summarizes Tetra Tech's progress made during July 2019 toward successfully implementing the Unit 4 Source Area In-Situ Bioremediation Treatability Study.

Task Progress Update: July 2019

Task M21 – Unit 4 Source Area In-Situ Bioremediation (ISB) Treatability Study

- Task Leader – Arul Ayyaswami
- Current Status
 - The University of Nevada – Las Vegas (UNLV) continued microcosm and column testing in accordance with the Unit 4 Source Area In-Situ Bioremediation Treatability Study Bench-Scale Work Plan and Treatability Study Modification No. 1. The following is a brief summary of the microcosm study results for the July 26, 2019 sampling event:
 - UNLV performed microcosm tests with a combination of molasses, molasses with acetate, mixed microbial cultures, and soil and groundwater collected from boring and well locations near the Unit 4 Building. After 337 days, perchlorate concentrations continued to reduce from a starting concentration of approximately 1,800 mg/L to 820 mg/L in microcosms utilizing molasses as the carbon substrate and an initial total dissolved solids (TDS) concentration of approximately 21,000 mg/L. In microcosms utilizing molasses as the carbon substrate and an initial TDS concentration of approximately 18,000 mg/L, perchlorate concentrations remained reduced with a concentration less than 0.2 mg/L, compared to the starting concentration of approximately 1,500 mg/L. In microcosms utilizing molasses as the carbon substrate and an initial TDS concentration of approximately 15,000 mg/L, perchlorate concentrations continued to reduce from a starting concentration of approximately 1,400 mg/L to 930 mg/L. In general, the degradation of the chemicals of potential concern (COPCs) is slower in the microcosms containing molasses and acetate than molasses alone.

- UNLV continued microcosm testing using nano-scale zero-valent iron (nZVI). The microcosm tests evaluated the effectiveness of nZVI to treat groundwater collected from the Unit 4 area and in various combinations with mixed microbial cultures, molasses, nutrients, groundwater, and soil. As previously reported, hexavalent chromium concentrations reduced within these microcosms from approximately 22 mg/L to less than 1 mg/L within 4 hours using the stoichiometric requirement of nZVI. Nearly complete degradation of nitrate (initial concentration of approximately 80 mg/L) and chlorate (initial concentration of approximately 6,600 mg/l) was achieved within 28 days and 13 days, respectively, in microcosms containing nZVI, mixed microbial cultures, molasses, nutrients, groundwater, and soil. Chloroform concentrations reduced by approximately 50% within 1 day in all microcosms and up to 71% within 28 days in microcosms containing nZVI, mixed microbial cultures, molasses, nutrients, groundwater, and soil. No significant perchlorate degradation occurred in microcosms containing nZVI. UNLV conducted additional nZVI microcosm testing to evaluate the effect of nZVI dosing on the rates of degradation. The initial results from these tests indicate that using doses of nZVI from 30 g/L (approximately twice the stoichiometric demand) to 100 g/L resulted in faster degradation of the COPCs, except perchlorate. The final analytical results of the nZVI microcosm testing are not yet available and will be summarized in future progress reports.
- UNLV continued column testing with two intermediate columns (columns packed with a mixture of sand and soil collected from 75 to 85 feet bgs) and two deep columns (columns packed with a mixture of sand and soil collected from 95 to 105 feet bgs). The columns use a continuous feed solution of molasses, diluted groundwater from wells U4-E-01I, U4-E-02I, and U4-E-05D, sodium bicarbonate, mixed microbial cultures, and nutrients. Hexavalent chromium concentrations at the effluent of the columns remain less than 0.05 mg/L in both the intermediate and deep columns. In the intermediate columns, the concentrations of nitrate, chlorate, and perchlorate have all decreased. Additional groundwater was collected from U4-E-01I on July 11, 2019 for analysis and future use in the intermediate columns. In the deep columns, nitrate concentrations reduced from approximately 25 mg/L to less than 1 mg/L and chlorate concentrations decreased from approximately 3,750 mg/L to less than 400 mg/L. Perchlorate concentrations decreased from approximately 450 mg/L to 110 mg/L in one deep column but did not decrease in the second column. Bioaccumulation is observed within the columns, but flow rates of approximately 0.05 to 0.1 ml/min, which corresponds to a horizontal groundwater flow velocity of approximately 0.2 to 0.5 ft/day, have been maintained after 124 days of operation. UNLV is continuing to evaluate the data associated with the column testing. Additional results will be summarized in future progress reports.
- Schedule and Progress Updates
 - The following activities are scheduled to be conducted in August 2019:
 - Continued UNLV microcosm and column testing in accordance with the Unit 4 Source Area In-Situ Bioremediation Treatability Study Bench-Scale Work Plan and Treatability Study Modification No. 1.
 - Development of the Unit 4 Source Area In-Situ Bioremediation Treatability Study Work Plan Addendum for Phase 2 at the completion of laboratory testing, provided the data support moving forward with a field test. The submittal timeline of the Addendum will be dependant on the duration of the microcosm and column studies.
- Health and Safety
 - There were no health and safety incidents related to Task M21 during July 2019.

CERTIFICATION

Unit 4 Source Area Bioremediation Treatability Study Monthly Progress Report


**Nevada Environmental Response Trust Site
(Former Tronox LLC Site)
Henderson, Nevada**

Nevada Environmental Response Trust (NERT) Representative Certification

I certify that this document and all attachments submitted to the Division were prepared at the request of, or under the direction or supervision of NERT. Based on my own involvement and/or my inquiry of the person or persons who manage the systems(s) or those directly responsible for gathering the information or preparing the document, or the immediate supervisor of such person(s), the information submitted and provided herein is, to the best of my knowledge and belief, true, accurate, and complete in all material respects.

Office of the Nevada Environmental Response Trust

Le Petomane XXVII, not individually, but solely in its representative capacity as the Nevada Environmental Response Trust Trustee

Signature:  JAY A. STEINBERG, PRESIDENT NERT, ON BEHALF OF, not individually, but solely in his representative capacity as President of the Nevada Environmental Response Trust Trustee

Name: Jay A. Steinberg, not individually, but solely in his representative capacity as President of the Nevada Environmental Response Trust Trustee

Title: Solely as President and not individually

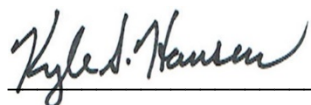
Company: Le Petomane XXVII, Inc., not individually, but solely in its representative capacity as the Nevada Environmental Response Trust Trustee

Date: 9/10/19

CERTIFICATION

I hereby certify that I am responsible for the services described in this document and for the preparation of this document. The services described in this document have been prepared in a manner consistent with the current standards of the profession, and to the best of my knowledge, comply with all applicable federal, state, and local statutes, regulations, and ordinances. I hereby certify that all laboratory analytical data was generated by a laboratory certified by the NDEP for each constituent and media presented herein.

Description of Services Provided: Prepared Unit 4 Source Area Bioremediation Treatability Study Monthly Progress Report.



Kyle Hansen, CEM
Field Operations Manager/Geologist
Tetra Tech, Inc.

September 10, 2019

Date

Nevada CEM Certificate Number: 2167
Nevada CEM Expiration Date: September 18, 2020