

TECHNICAL MEMORANDUM

To: Nevada Environmental Response Trust

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

From: Carl Lenker and Dan Pastor

Date: October 7, 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 August 2019 toward successfully implementing the Unit 4 Source Area In-Situ Bioremediation Treatability Study.

Task Progress Update: August 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 bench-scale study results to date:
 - 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. No additional data are available from the reporting period to report from the test microcosms. UNLV will sample the test microcosms in September to allow additional time for biodegradation to occur. Analyses of the control microcosms indicated that the natural bacteria present in the subsurface at the Unit 4 area can degrade the chemicals of potential concern (COPCs) when a carbon source is provided and that bioaugmentation speeds up the rate of degradation for hexavalent chromium, nitrate, and perchlorate.
 - During this reporting period, UNLV has completed microcosm testing using nano-scale zero-valent iron (nZVI). The microcosm tests were conducted in four phases to evaluate 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. The first phase consisted of testing hexavalent chromium reduction with nZVI and bacteria in the presence and absence of soil collected from the Unit 4 area. The second phase

tested the degradation of chloroform and other COPCs in the absence of soil. The third phase tested the degradation of chloroform and other COPCs in the presence of soil. The fourth phase tested the efficacy of varying nZVI doses on the degradation level of COPCs in the presence of soil. The major findings of the nZVI microcosm testing reported by UNLV are:

- The use of nZVI results in the rapid degradation of hexavalent chromium (occurred within hours).
 - The presence of soil does not have a significant effect on the degradation of hexavalent chromium by nZVI.
 - Bacterial degradation of hexavalent chromium was also successful (occurred within days).
 - The presence of soil does not have a significant effect on the bacterial degradation of hexavalent chromium.
 - Degradation of chloroform, nitrate, and chlorate to non-detectable levels was observed with dosages of nZVI greater than 30 grams per liter (g/L).
 - Bacterial degradation of chloroform, nitrate, and chlorate was observed, with greater degradation observed in the presence of soil.
 - No daughter products of chloroform degradation were detected with nZVI or bacterial degradation.
 - No significant perchlorate degradation was observed with nZVI and soil, regardless of the nZVI dosage.
 - Bacteria present in the Unit 4 soils are successful at reducing the COPCs.
 - High concentrations of nZVI may cause toxicity to bacteria.
- UNLV continued column testing during this reporting period 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. The columns have been running for approximately 178 days with an estimated retention time of approximately 5 to 10 days. Hexavalent chromium and nitrate concentrations completely degraded after 6 days. Chlorate concentrations degraded by over 50 percent after 40 days and remained degraded by over 50 percent after 90 days. Perchlorate concentrations have degraded by approximately 40 percent after 90 days. Chlorate and perchlorate analytical results after 90 days are not yet available. After 150 days, the flow rates through the columns decreased considerably, apparently due to material deposited on the top of the columns. After removing the material from the top of the columns, the flow rates returned to normal. The material appears to be composed of bacteria and some precipitates as observed under a microscope. UNLV will conduct additional testing to understand the nature of this material.
- Schedule and Progress Updates
 - The following activities are scheduled to be conducted in September 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 August 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

**Not Individually, but Solely
as President of the Trustee**

Signature: Jay A. Steinberg, 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: 10/9/19

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.

October 7, 2019

Date

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