TETRA TECH

TECHNICAL MEMORANDUM

To:	**Nevada Environmental Response Trust**
From:	Dan Pastor, Dana Grady, and Ronnie Britto
Date:	December 11, 2018
Subject:	Treatability/Pilot Study Modification No. 6 – Seep Well Field Area Bioremediation Treatability Study Nevada Environmental Response Trust Site, Henderson, Nevada

This technical memorandum has been prepared on behalf of the Nevada Environmental Response Trust (NERT) to present Tetra Tech's recommended modification to the scope of work for the Seep Well Field (SWF) Area Bioremediation Treatability Study that is currently in progress at the NERT site (Figure 1). As presented in the approved *Seep Well Field Area Bioremediation Treatability Study Work Plan* (Work Plan) (Tetra Tech, 2016a), the treatability study is being performed to demonstrate the effectiveness of using in-situ bioremediation (ISB) to reduce the flux of perchlorate mass that is discharging to the Las Vegas Wash. Based on the results to date, the treatability study has demonstrated that ISB is effective at substantially reducing perchlorate and chlorate concentrations in groundwater, as discussed further in Section 1.0.

As part of the forthcoming feasibility study (FS), an evaluation will be conducted to analyze the information collected during both the remedial investigation and treatability/pilot studies to design, evaluate, and recommend the most effective remedial option to meet the established remedial action objectives (RAOs). The data and results gathered from the previous, on-going, and future planned treatability/pilot studies for the NERT site will provide key information to evaluate and recommend remedial alternatives for full-scale remediation. As part of these studies, it is not only important to determine if the remedy can be effective at achieving the RAOs, but equally critical to evaluate key components of the remedy that will make it successful with regards to both implementation and long-term operation and maintenance requirements. Because the SWF Area Bioremediation Treatability Study has demonstrated that ISB can be effective at reducing perchlorate concentrations in groundwater and has already had multiple injection events performed within the area, it is recommended that this treatability study be continued to evaluate key design and optimization improvements as well as long-term operation and maintenance requirements. Additionally, data collected from the extended study should result in reduced pre-design investigation efforts associated with future ISB application at other locations. This could include reductions in the number of borings/monitoring wells, reduced sampling requirements, and/or reduced or eliminated bench-scale efforts.

This memorandum provides a brief description of the treatability study activities and results to date, defines objectives for continuation of the treatability study as part of this modification, and provides a recommendation on the path forward for field activities and evaluation of results.

Tetra Tech, Inc.
150 S. 4th Street, Unit A, Henderson, NV 89015
Tel 702-854-2295 tetratech.com

1.0 TREATABILITY STUDY ACTIVITIES AND RESULTS TO DATE

The treatability study began in December 2016, which included 5 months of initial pre-design activities, comprising geophysics, well installation, baseline soil and groundwater sampling, and aquifer testing. Following completion of pre-design activities, the injection and effectiveness monitoring well network was installed in May/June 2017, followed by a comprehensive baseline groundwater sampling event in July 2017. A total of three injection events have been performed to date (August/September 2017, January/February 2018, and June 2018). Following injections, periodic groundwater monitoring has been performed throughout the study to determine effectiveness of ISB.

Results to date indicate that perchlorate concentrations in groundwater have reduced when compared to baseline concentrations in all 20 downgradient monitoring wells. Of these, groundwater perchlorate concentrations have reduced by greater than 80 percent when compared to baseline concentrations at 15 monitoring wells. Results also indicate that groundwater perchlorate concentrations have reduced to below 18 micrograms per liter (µg/L) at six monitoring wells during the study, several of which sustained these target low concentration levels over multiple subsequent sampling events. Figure 2 provides a two-dimensional visualization of perchlorate concentrations in groundwater during the groundwater sampling events following the most recent third injection event compared to baseline (pre-injection) concentrations.

Chlorate has exhibited a similar pattern with the concentration reductions observed in groundwater at all 20 downgradient wells. Of these reducing trends for chlorate concentrations in groundwater, 18 downgradient wells have achieved greater than 80 percent reduction when compared to baseline concentrations.

2.0 MODIFICATION RECOMMENDATION

Based on the results to date, additional technical evaluation is recommended to develop a more thorough understanding of the key design considerations and operation and maintenance components as they relate to long-term applications of ISB. Specifically, the objectives for continuation of the SWF Area Bioremediation Treatability Study are to evaluate the following:

- ***Injection Frequencies and Substrate Quantities*** – Injection protocol requirements are an important design consideration for the creation and maintenance of adequate anaerobic conditions for sustained perchlorate bioremediation. Generally, injection frequency and carbon substrate requirements for ISB systems can vary over the operational timeframe, particularly with passive systems that involve the periodic injection of slow-release carbon substrates, such as emulsified vegetable oil (EVO), which tend to adsorb and persist in the saturated subsurface over time. Therefore, the injection frequency and required carbon substrate quantities are critical long-term operation and maintenance components that determine both remedy effectiveness and associated cost to maintain the remedial system. As part of this treatability study continuation, the injection frequencies and associated quantities of carbon substrate, nutrients, and distribution water will be evaluated over time to provide optimal dosing that sustains the reducing conditions for ISB of perchlorate and chlorate in groundwater.
- ***Injection Well Network Operation and Maintenance –*** Because injection wells are subject to periodic injection of EVO, nutrients, and distribution water, it is important that the injection wells maintain the long-term ability to accept the carbon substrate so that perchlorate biodegradation is sustained. As injections occur, injection well screens and surrounding filter packs could accumulate biomass, inorganic precipitates, and intermediate by-products of EVO hydrolysis. This phenomenon can result in changes to the injectability (i.e., increases in injection pressures required for subsurface distribution) and may require corrective measures to promote injection well longevity and ensure successful long-term operation of ISB. As a result, it is important to develop a more in-depth understanding of the long-term operation and maintenance requirements of injection well networks associated with ISB systems at the NERT site. This beneficial information can be obtained by performing a variety of well rehabilitation techniques on

injection wells within the SWF treatability study area and then subsequently monitoring the resulting effects on improved injectability.

These objectives are further described in Sections 2.1 through 2.2. Section 2.3 provides additional details on the continuation of the SWF Area Bioremediation Treatability Study and the planned variances from the approved Work Plan.

2.1 Injection Frequencies and Substrate Quantities

For full-scale design, it is important to understand the frequency of injection events and associated injection protocol requirements to achieve the desired long-term response of sustained anaerobic conditions for perchlorate biodegradation. In general, the adsorption, persistence, and capacity of EVO and its associated slow-release hydrolyzed by-products gradually increase with additional injection events. At some point in time, maximization of the adsorption/coating of EVO on subsurface soil grains across a transect occurs with continued injection events. This adsorption phenomenon over time not only leads to the establishment of a more complete biologically active zone and maximized perchlorate biodegradation, but it also could result in either reduced needs for carbon substrate injectate quantities or reduced injection frequencies over time. Bench-scale studies performed at UNLV in connection with the previously completed bioremediation treatability study performed southeast of the Bird Viewing Ponds on City of Henderson property (Tetra Tech, 2016b) and the on-going SWF area bioremediation treatability study indicate that EVO and its hydrolyzed by-products are available for longer periods of time as injections continue because of the adsorption factor. Specifically, bench-scale studies have indicated that EVO adsorption in fine-grained soil was almost twice the amount observed in coarse-grained soil. EVO desorption was also found to be much slower in fine-grained soil, which should make it gradually more available for sustained periods of time for perchlorate bioremediation.

Because of the nuances of oil release phenomena and site-specific adsorption/desorption characteristics that could affect the frequency of injection events and associated EVO quantities, it is recommended that the treatability study be extended through design of the final remedy, or as otherwise directed by the Trust. The extension timeframe of continuing through remedial design was selected based on the expectation that ISB will be a likely component of NERT's final remedy and that the additional data collected during this study can be used to refine the design of an ISB approach. During this extended treatability study, periodic injection events will continue at a likely initial frequency of once every 5 to 6 months. The exact timing of the injection events and quantities of carbon substrate will be determined based on effectiveness monitoring results. As these results indicate signs of carbon substrate depletion (for example, increasing perchlorate, chlorate, and nitrate concentration trends and/or reduction in total organic carbon concentrations), the next injection event will be performed. If reducing conditions are sustained for longer periods of time, the injection frequency and/or carbon substrate quantities may be reduced as the study proceeds. In addition, the quantities of distribution water will also be suitably altered during the continued phase of the treatability study and varied depending on the modified frequency and/or carbon quantities that are adopted during the evaluation process.

In conclusion, performing additional injections beyond the previous 1-year study period will allow a more in-depth understanding of the injection protocol and associated EVO injection requirements over time. As explained herein, modifications to the injection protocol could include (i) reduction in injection frequency, (ii) reduction in quantity of EVO that is injected, or (iii) reduction in both injection frequency and quantity of EVO. The core objective of these modifications would be to arrive at the optimal dosing and variations in EVO requirements for full-scale application of ISB and for cost and technology comparisons for the FS.

2.2 Long-Term Operation and Maintenance of Injection Well Network

For full-scale system design, it is important to understand the long-term effects of periodic carbon substrate injection on the injection well network. The subsurface in the area of the SWF treatability study is comprised largely of silty sands and sandy silts with interbedded sandy gravels. Because the subsurface is relatively

permeable, it has been observed from the three injection events performed to date that the subsurface is quite suited to long-term injection of carbon substrate and nutrients. Distribution water that is added immediately following each injection event assists in diluting and spreading the EVO into the formation. Following multiple injection events, however, there can be occurrences where injection well screens and surrounding filter packs accumulate biomass, inorganic precipitates, and intermediate by-products of EVO hydrolysis. As a result, while the permeability of the surrounding formation itself may remain unaffected, reductions in hydraulic conductivity may occur in the injection wells, which are the prime conduits for introducing periodic quantities of carbon substrate. These reductions can result in loss of injection well efficiency during subsequent injection events, which is inferred from increasing injection pressures and required time for substrate delivery.

A preliminary evaluation of the three injection events to date indicates that the aquifer continues to be amenable to carbon substrate injections. During the third injection event, however, some injection wells exhibited a slight increase in injection pressures (generally increases of 5 to 10 pounds per square inch [psi] compared to previous injection events, with some slightly higher increases of 15 psi). As more injection events are performed, injection pressures could gradually increase in some wells in order for the designed quantity of injectate to be introduced into the subsurface efficiently. Because injection well efficiency is a key component to successful application of ISB, an evaluation of long-term maintenance and/or corrective actions should be performed during this extended treatability study. Specifically, well rehabilitation techniques will be evaluated/implemented to understand long-term corrective actions (if required) and associated costs with respect to injection well operation and maintenance. Because three injection events have already been performed, this study area is the ideal candidate to evaluate different methods and techniques for injection well rehabilitation.

As part of this evaluation, pressures observed at the injection wells will continue to be carefully monitored and recorded during future injection events. This pressure data will be compared to injection pressures observed during previous events on a well-by-well basis to evaluate trends over time. Injection wells that continue to exhibit increases in pressure will be candidates for well rehabilitation, which could include a variety of approaches to arrive at the most effective method. These approaches include an evaluation of conventional well redevelopment (swabbing/scrubbing/surging or jetting with water), shock chlorination via the application of chlorine dioxide or other chemicals to sterilize and destroy the biomass in the vicinity, or the addition of acidic agents to solubilize chemical precipitates. These techniques may be performed separately or in combination to determine the most feasible, economical, and applicable set of rehabilitation mechanisms. Improvement in injection well efficiency will be evaluated based on the injection pressures observed during subsequent injection events. Reduced injection pressures compared to the previous injection events and the associated magnitude of these reductions will determine the effectiveness of the various well rehabilitation techniques. A thorough evaluation of injection well rehabilitation mechanisms will help to optimize a long-term ISB system. It should be noted that a modification to the existing Underground Injection Control (UIC) permit will be required prior to the injection of well rehabilitation chemicals.

Finally, select injection wells which encounter permeability reduction due to build-up of biomass, inorganic precipitates, or lingering carbon substrate from injections will be subject to periodic chemical and microbial analyses of this material. Typical analyses will focus on establishing the type of organic and inorganic composition of the material in the injection wells, the types of inorganic elemental material, biomass type and microbial characteristics, and organic substrate and by-products of EVO that could be persisting within the injection well vicinity. As part of this evaluation, groundwater samples will be collected from select injection wells and transported to UNLV for the following assessment: (i) analysis of suspended solids and volatile solids, (ii) evaluation of organic characteristics, composition, and make-up, and (iii) performing scanning electron microscopy (SEM) and X-ray diffraction of the solid phases encountered to examine and determine the elemental composition of the material from the injection wells.

2.3 Treatability Study Continuation and Work Plan Variances

As explained in this memorandum, it is recommended that injections and effectiveness monitoring continue as part of the SWF Area Bioremediation Treatability Study. As part of this treatability study, an effectiveness monitoring program has been implemented that includes periodic groundwater sampling performed in accordance with the approved Work Plan (Tetra Tech, 2016a) and approved Remedial Investigation *Field Sampling Plan, Revision 1* (ENVIRON, 2014). Because the primary objectives of this treatability study have been completed and objectives for continuation of this study are limited in nature, the effectiveness monitoring program that has been previously implemented per the approved Work Plan can be reduced with respect to both parameters and frequency. If future data collected as part of this study indicates that the frequency of effectiveness monitoring sampling events can be further decreased, additional adjustments will be made following consultation with NDEP. Table 1 presents the recommended reduced sampling protocol for effectiveness monitoring performed during continuation of this treatability study. Explanation of the reduction in frequency or elimination of analytes was determined based on the data obtained to date, which will be formally presented in the forthcoming SWF Area Bioremediation Treatability Study Results Report. An overview of these results and their significance with respect to the adjusted sampling frequency is provided below:

- Reduction in frequency of the key parameters of perchlorate, chlorate, nitrate, total organic carbon, sulfate, and field parameters is recommended due to the large dataset obtained during the first year of the treatability study. However, because these are key parameters in evaluating continued remediation success of the ISB and determining the timing of the subsequent injection events, these analytes still should be evaluated periodically throughout the study, or as otherwise directed by the Trust. As a result, the groundwater sampling frequency and analysis for these parameters is recommended to occur once every 6 weeks. (Table 1 describes previous and proposed sampling frequencies.)
- Results to date indicate minimal concentration increases in ferrous iron and sulfide concentrations in groundwater. During the first year of the treatability study, only transient detections of ferrous iron and sulfide were observed at select downgradient monitoring wells (less than 2.5 milligrams per liter [mg/L] and 1.6 mg/L, respectively). Based on these results, the frequency of ferrous iron and sulfide field screening is recommended to be reduced to quarterly, or as otherwise directed by the Trust.
- Metals mobilization has either been absent or limited in downgradient monitoring wells since injections began. Specifically, post-injection groundwater concentrations of arsenic, iron, and manganese are similar to concentrations observed during baseline. For example, baseline arsenic concentrations ranged from non-detect to 110 μg/L. The highest groundwater concentration for arsenic observed during post-injection groundwater sampling was 180 μg/L, which was from a single sampling event and has since reduced to below baseline concentrations. Manganese is another metal that has been measured immediately downgradient of the injection wells at elevated concentrations when compared to baseline because of the created reducing conditions. However, groundwater concentrations observed in samples collected from farther downgradient monitoring wells have not reflected much change. Although metals mobilization has been very limited and temporary, it remains important to evaluate and, therefore, will continue to be evaluated in periodic groundwater sampling. However, it is recommended that the frequency of dissolved metals and manganese analysis be reduced from monthly to semi-annually.
- Following carbon substrate injections, methane has been detected above baseline concentrations within the treatability study area, with observed increases from 0.00025 mg/L to a high of 12 mg/L in one solitary monitoring well located between the injection well transects. Because of the limited production of methane and geochemical characterization of the reducing conditions, it is likely that the reducing conditions created were not sufficient for significant methanogenesis to occur resulting in the generation of methane. Significant increases in methane concentrations compared to baseline concentrations were not observed in other downgradient monitoring wells. 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 that is present in the vadose zone. As a result, methane analysis has been reduced from monthly to annually.

- Perchlorate reductase and phospholipid fatty acids have been monitored throughout the treatability study and the data to date provide a basic understanding of the microbial community. As a result, these analyses will be evaluated on an annual basis.
- Alkalinity, chloride, hexavalent chromium, total dissolved solids, total nitrogen, total phosphorus, and volatile fatty acids have been eliminated from the effectiveness monitoring program. Results to date have provided sufficient understanding of the ISB effects with respect to these parameters, and therefore further evaluation of these parameters is not needed.

3.0 SCHEDULE

It is recommended that this study be continued through design of final remedy, which is anticipated in Q1 2023, or as otherwise directed by the Trust, with the anticipated schedule of activities as follows:

- Injection events are anticipated to initially occur once every 5 to 6 months, but the exact timing and frequency will be determined based on effectiveness monitoring results. The first injection event under this modification (fourth injection event to date) is planned for January 2019. Injections will continue to be performed through remedial design.
- Effectiveness monitoring will generally consist of groundwater sampling once every 6 weeks for a reduced set of analytes. The first groundwater sampling event under this modification will be performed in December 2018 to evaluate groundwater concentrations prior to the fourth injection event. Effectiveness monitoring will continue for the duration of the treatability study through remedial design.
- Well rehabilitation activities will be performed, if required, on an as-needed basis.
- Quarterly progress updates will be submitted to NDEP throughout the treatability study.
- Upon termination of the extended treatability study activities, an Addendum to the SWF Area Bioremediation Treatability Study Results Report will be submitted. The addendum will include:
    - Summary of field activities;
    - Analytical results summary of groundwater samples collected during the treatability study;
    - Evaluation of the continued effectiveness of ISB;
    - Assessment of the injection protocol using the information obtained during this extended study and its applicability to long-term remediation; and
    - Evaluation of the well rehabilitation activities, their effectiveness, and recommendations for corrective actions and maintenance (if required) for long-term remedial ISB operations.

The work recommended in this modification will begin upon NDEP approval and first availability of the injection subcontractor.

4.0 REFERENCES

ENVIRON. (2014). *Field Sampling Plan, Revision 1, Nevada Environmental Response Trust Site, Henderson, Nevada.* July 18.

Tetra Tech, Inc. (2016a). *Seep Well Field Area Bioremediation Treatability Study Work Plan, Nevada Environmental Response Trust Site, Henderson, Nevada*. September 6.

Tetra Tech, Inc. (2016b). *Groundwater Bioremediation Treatability Study Results Report, Nevada Environmental Response Trust Site, Henderson, Nevada.* November 23.

CERTIFICATION

Treatability/Pilot Study Modification No. 6 – Seep Well Field Area Bioremediation Treatability Study

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, not individually, but solely as President, 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: 12/11/18

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 Treatability/Pilot Study Modification No. 6 – Seep Well Field Area Bioremediation Treatability Study.

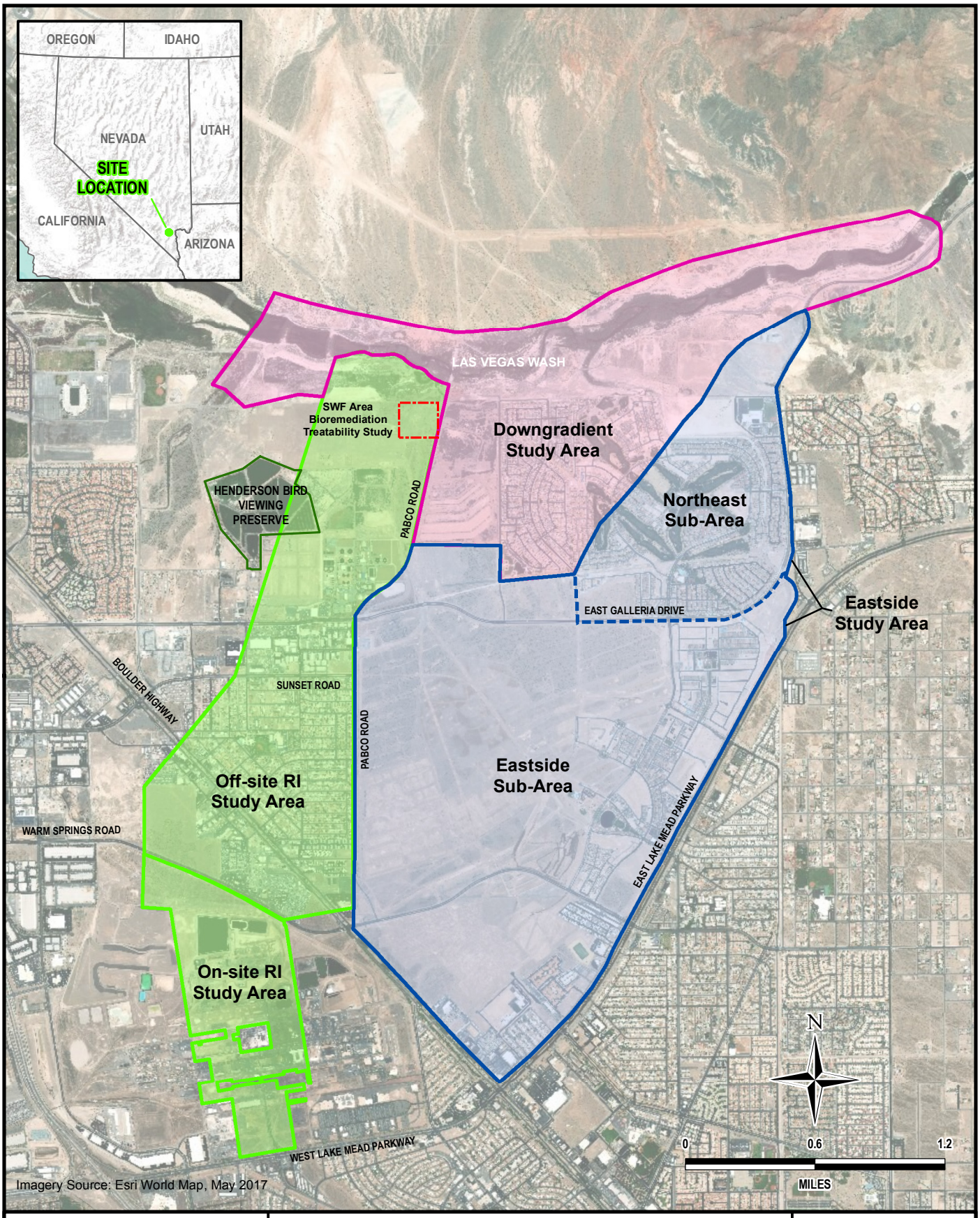
December 11, 2018

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

Date

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

Figures



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TETRA TECH
www.tetratech.com
150 S. 4th Street, Unit A
Henderson, Nevada 89015
Phone: (702) 854-2293

NEVADA ENVIRONMENTAL RESPONSE TRUST

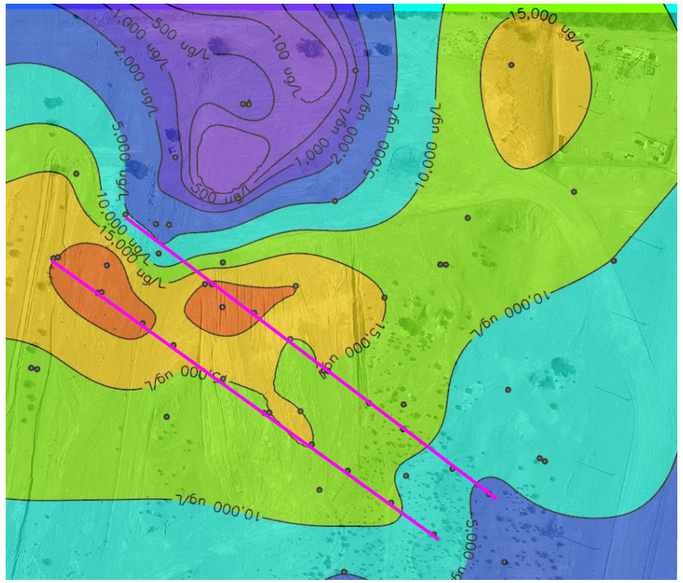
TREATABILITY/PILOT STUDY MODIFICATION NO. 6 -
SEEP WELL FIELD AREA BIOREMEDIATION TREATABILITY STUDY
HENDERSON, NEVADA

TREATABILITY STUDY LOCATION

Project No.:	117-7502018
Date:	NOVEMBER 05, 2018
Designed By:	SRA

Figure No.
1

Baseline conditions - July 2017



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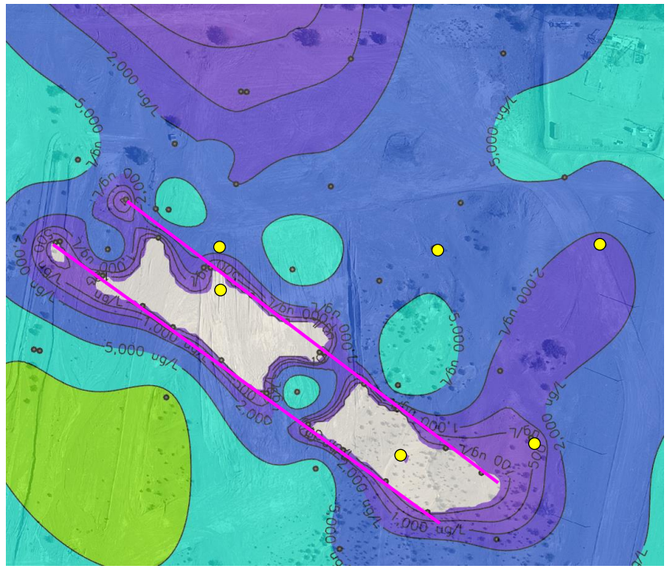

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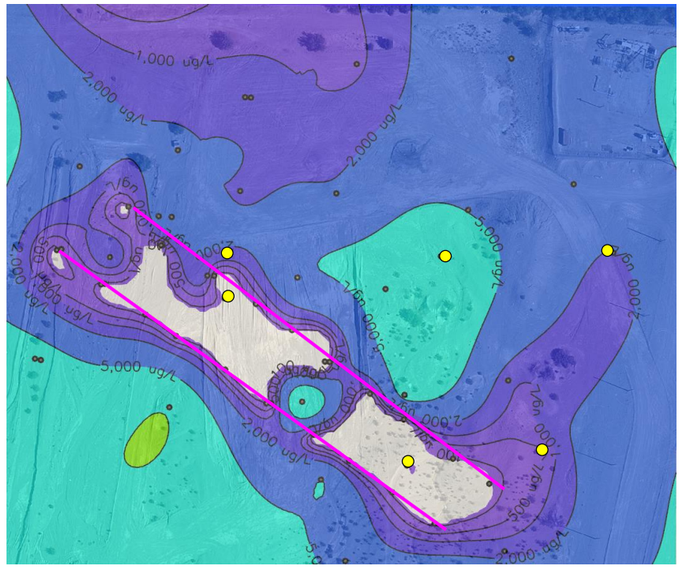
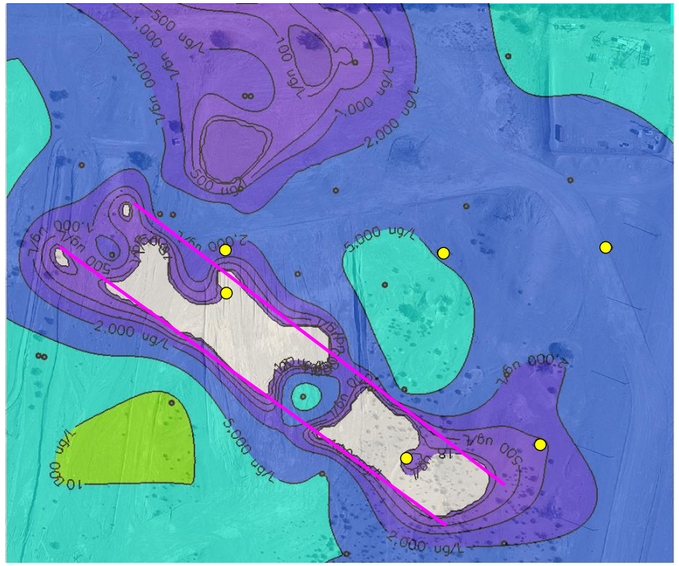


September 2018



Perchlorate in groundwater (µg/L)

- 27,000
- 25,000
- 20,000
- 15,000
- 10,000
- 5,000
- 2,000
- 1,000
- 500
- 100
- 18

- Sample locations
- Monitoring wells that have achieved <18 ug/L during the treatability study.
- Injection Well Transect Lines

N

0 200 400

Feet

Notes:

1. Each image represents a horizontal slice through the interpolated perchlorate concentration plume at 1522 feet amsl (above mean sea level).
2. Baseline concentrations presented from July 2017 are representative of pre-injection conditions.
3. Injection events have occurred in August/September 2017, January/February 2018, and June 2018. Images presented in this figure represent groundwater sampling events that have occurred following the third injection event in June 2018.

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TETRA TECH
www.tetratech.com
150 S. 4th Street, Unit A
Henderson, Nevada 89015
PHONE: (702) 854-2293

NEVADA ENVIRONMENTAL RESPONSE TRUST SITE
TREATABILITY/PILOT STUDY MODIFICATION NO. 6 –
SEEP WELL FIELD AREA BIOREMEDIATION TREATABILITY STUDY
HENDERSON, NEVADA

2D VISUALIZATION PLAN VIEW OF PERCHLORATE DISTRIBUTION IN GROUNDWATER: BASELINE VS. POST-THIRD INJECTION EVENT

Project No.:	117-7502018
Date:	December 3, 2018
Designed By:	CKG

Figure No. **2**

Tables

Table 1
Modification to Sampling Protocol
Seep Well Field Area Bioremediation Treatability Study

Parameter	Analytical Method	Purpose	Previous Frequency	Recommended Frequency
Field Parameters				
EC	Field Meter	Assess geochemical conditions	Baseline, Weekly, Biweekly, Monthly	Once every 6 weeks
pH	Field Meter			
DO	Field Meter			
ORP	Field Meter			
Temperature	Field Meter			
Turbidity	Field Meter			
Laboratory Parameters				
Perchlorate	E314	Assess treatment effectiveness	Baseline, Weekly, Biweekly, Monthly	Once every 6 weeks
Chlorate	E300.1	Assess treatment effectiveness and examination as intermediate by-product of perchlorate biodegradation	Baseline, Monthly	Once every 6 weeks
Nitrate	E300.0	Assessment of nitrate as the most likely competing electron acceptor and carbon substrate consumer	Baseline, Weekly, Biweekly, Monthly	Once every 6 weeks
TOC	SM5310B	Assess carbon substrate distribution in the aquifer	Baseline, Weekly, Biweekly, Monthly	Once every 6 weeks
Sulfate	E300.0	Assessment of sulfate as an electron acceptor and potential carbon substrate consumer	Baseline, Weekly, Biweekly, Monthly	Once every 6 weeks
Ferrous Iron	HACH Field Kit	Assess effect of reducing conditions on iron	Baseline, Monthly	Quarterly
Sulfide	HACH Method 8131	Examine secondary geochemical impacts	Baseline, Monthly	Quarterly
Manganese	SW846 6010B	Assess potential for biologically-driven dissolution of manganese	Baseline, Monthly	Semi-Annually
Dissolved Metals(1)	SW6010/6020	Assess secondary impacts of treatment (includes arsenic)	Baseline, Monthly	Semi-Annually
Methane	EPA Method RSK175	Examine secondary geochemical impacts	Baseline, Monthly	Annually
PLFA	Microbial Insights Method	Examine microbial response to carbon substrate addition	Baseline, Month 2	Annually
Perchlorate Reductase Gene	Microbial Insights Method	Examine microbial response to carbon substrate addition	Baseline, Month 2	Annually
Alkalinity	SM2320B	Assess geochemical conditions	Baseline, Monthly	Eliminate

Table 1
Modification to Sampling Protocol
Seep Well Field Area Bioremediation Treatability Study

Parameter	Analytical Method	Purpose	Previous Frequency	Recommended Frequency
Laboratory Parameters				
Chloride	E300.0	Potential estimation of conservative end-product of biodegradation	Baseline, Monthly	Eliminate
Hexavalent Chromium	SW846 7199	Assess secondary impacts of treatment	Baseline, Monthly	Eliminate
TDS	SM2540C	Assess any impact of salts on delayed or slower perchlorate biodegradation in the flow through mode	Baseline, Monthly	Eliminate
Total Nitrogen	E351.2	Examine the need for micronutrients	Baseline, Monthly	Eliminate
Total Phosphorus	E365.3	Examine the need for micronutrients	Baseline, Monthly	Eliminate
VFAs	BF-MB-009, Rev 3	Surrogate carbon substrate assessment	Baseline, Monthly	Eliminate

Acronyms and Abbreviations:

EC: Electrical conductivity

DO: Dissolved Oxygen

ORP: Oxidation-reduction potential

PLFA: Phospholipid Fatty Acids

TOC: Total organic carbon

TDS: Total dissolved solids

VFAs: Volatile Fatty Acids

(1) Metals include arsenic, chromium, iron, and manganese.