OFFICE OF THE NEVADA ENVIRONMENTAL RESPONSE TRUST TRUSTEE

Le Petomane XXVII, Inc., Not Individually, But Solely as the Nevada Environmental Response Trust Trustee
35 East Wacker Drive - Suite 1550
Chicago, Illinois 60601
Tel: (312)498-2800

May 12, 2016

VIA ELECTRONIC MAIL

Mr. James Dotchin
Bureau of Industrial Site Cleanup
Nevada Division of Environmental Protection
2030 E. Flamingo Rd, Suite 230
Las Vegas NV 89119

RE: Finding and Order Requiring Engineering Evaluation/Cost Analysis
Nevada Environmental Response Trust
Henderson, Nevada
NDEP Facility ID #H-000539

Dear Mr. Dotchin:

As ordered by the Nevada Division of Environmental Protection (NDEP), this letter transmits a work plan and budget for the performance of an EE/CA by the Nevada Environmental Response Trust (Trust).

To satisfy the scheduling requirements established between the Trust and NDEP, the Trust requests NDEP comment and/or approve of the EE/CA work plan and associated budget by May 26, 2016. Furthermore, the Trust understands that NDEP will consult with the United States Environmental Protection Agency, as required by the Trust Agreement, in its approval of the EE/CA work plan and budget attached hereto.

Upon approval of the EE/CA work plan budget, the Trust will immediately begin the execution of the attached work plan, and will formalize this expense in a forthcoming budget amendment.

If you have any questions or concerns regarding this matter, feel to contact me at (312) 498-2800 or at andrew.steinberg@nert-trust.com.

Office of the Nevada Environmental Response Trust

By: _____

Andrew W. Steinberg, not individually but solely as Vice-President
of Le Petomane XXVII, Inc., not individually but solely as
the Nevada Environmental Response Trust Trustee

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ec: Jay Steinberg, as President of the Nevada Environmental Response Trust Trustee and not individually
Steve Clough, Nevada Environmental Response Trust
Dave Emme, NDEP Administrator
Greg Lovato, NDEP Deputy Administrator
Valerie King, Nevada State Environmental Commission, Carson City
Jasmine Mehta, Senior Deputy Attorney General, Attorney General's Office, Carson City
Carlton Parker, NDEP BISC Las Vegas
Weiquan Dong, NDEP BISC Las Vegas
Alison Fong, U.S. Environmental Protection Agency, Region 9
Betty Kuo Brinton, MWDH20
Brenda Pohlmann, City of Henderson
Carol Nagai, MWDH20
Charles K.Hauser, Esq., Southern Nevada Water Authority
Chuck Elmendorf, Stauffer Management Company, LLC
Dave Share, Olin
David Johnson, Central Arizona Water Conservation District
Dave Johnson, LVVWD
Ebrahim Juma, Clean Water Team
George Crouse, Syngenta Crop Protection, Inc.
Jeff Gibson, Endeavour
Jill Teraoka, MWDH20
Joe Kelly, Montrose Chemical Corporation of CA
Joe Leedy, Clean Water Team
Katherine Baylor, U.S. Environmental Protection Agency, Region 9
Kevin Fisher, LV Valley Water District
Lee Farris, BRC
Letitia Moore, U.S. Environmental Protection Agency, Region 9
Marcia Scully, Metropolitan Water District of Southern California
Maria Lopez, Water District of Southern California
Mark Paris, Landwell
Mickey Chaudhuri, Metropolitan Water District of Southern California
Peggy Roefer, CRC
Richard Pfarrer, TIMET
Scott Bryan, Central Arizona Project
Steve Armann, U.S. Environmental Protection Agency, Region 9
Tanya O'Neill, Foley & Lardner

Work Plan
Engineering Evaluation/Cost Analysis – Weir Dewatering Treatment
Nevada Environmental Response Trust Site
Henderson, NV

PREPARED FOR

Nevada Environmental Response Trust
35 E. Wacker Drive, Suite 1550
Chicago, IL 60601

PRESENTED BY

Tetra Tech, Inc.
1489 West Warm Springs Road, Suite 110
Henderson, NV 89014

May 12, 2016

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Figure 1 Proposed Las Vegas Wash Weir Locations

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Attachment 1 Project Cost Summary

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LIST OF ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
ASTM	American Society for Testing and Materials
BWPC	Bureau of Water Pollution Control
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
EE/CA	Engineering Evaluation / Cost Analysis
GAC	Granulated Activated Carbon
NDEP	Nevada Division of Environmental Protection
NERT	Nevada Environmental Response Trust
NPDES	National Pollutant Discharge Elimination System
RAO	Removal Action Objective
SNWA	Southern Nevada Water Authority
T-GAC	Tailored Granulated Activated Carbon

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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.

Description of Services Provided:

Work Plan for Engineering Evaluation/Cost Analysis – Weir Dewatering Treatment

May 12, 2016

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

Date

Nevada CEM Certificate Number: 2167
Nevada CEM Expiration Date: September 18, 2016

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1.0 INTRODUCTION

This Work Plan for the Engineering Evaluation/Cost Analysis for Dewatering Water Treatment (Work Plan) has been prepared on behalf of the Nevada Environmental Response Trust (NERT or Trust) in response to the Finding and Order Requiring Engineering Evaluation/Cost Analysis (EE/CA) (Order) issued by the Nevada Division of Environmental Protection (NDEP), Bureau of Industrial Site Cleanup to the Trust on April 12, 2016.

As discussed in the Order, the Southern Nevada Water Authority (SNWA) is in the process of constructing weirs along the Las Vegas Wash to mitigate erosion. Weir construction requires surface water diversion of the Las Vegas Wash and groundwater dewatering of the area around the weir location, with discharge of groundwater to the Las Vegas Wash downstream of the construction site. Two weirs, the Sunshine Mountain Weir and the Historic Lateral Weir (see Figure 1), are proposed for construction in the vicinity of where the perchlorate groundwater plume from the NERT site intersects the Las Vegas Wash. Construction of these weirs is scheduled to begin in 2016 and conclude in 2019.

As indicated in the Order, direct discharge of the groundwater extracted during weir construction dewatering without treatment would substantially contribute to continued exceedance of the current Nevada provisional maximum contaminant level for perchlorate of 18 parts per billion within the Las Vegas Wash. The Las Vegas Wash is tributary to Lake Mead, the primary drinking water source for the Las Vegas Valley, and the Colorado River, which is a significant source of drinking water for populations in Arizona and Southern California. Any increase in perchlorate loading to the Las Vegas Wash would threaten these drinking water sources. Pursuant to the Order, the Trust is required to take action necessary to mitigate and abate this substantial threat to public health pursuant to Sections 445A.22691 and 445A.22695 of the Nevada Administrative Code, and consistent with the National Contingency Plan.

The Order requires development of an EE/CA to evaluate the cost, feasibility, schedule and permitting requirements for the transfer and treatment of groundwater extracted during SNWA weir construction dewatering. This Work Plan outlines the data collection necessary for development of the EE/CA (Section 2), a proposed outline of the EE/CA based on currently available information and project understanding (Section 3), a schedule for EE/CA development in compliance with the Order (Section 4), a budget for the development of the EE/CA (Section 5), and references used in the development of this Work Plan (Section 6).

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2.0 DATA COLLECTION FOR EE/CA

Data collection activities to support the EE/CA will include review of recent water quality data from groundwater wells located near to the proposed weir construction areas, and, if necessary collection of additional field data from these wells. Data collection will also include collection of information from SNWA regarding the dewatering operations. The scope of data collection for each of these project elements is included in the subsections below.

2.1 FIELD DATA

Water quality data from select groundwater monitoring wells located near the proposed Sunshine Mountain and Historic Lateral weir construction sites will be reviewed for adequacy for incorporation into the EE/CA evaluation. If necessary, additional groundwater sampling may be conducted from these existing wells.

Wells proposed for data analysis and additional sample collection, if necessary, are shown on Figure 1 and include:

- WMW6.55S (approximately 500 ft southwest of the proposed Sunshine Mountain weir, located on Clark County land)
- WMW6.15S (approximately 1450 ft southeast of the proposed Sunshine Mountain, on Bureau of Reclamation land)
- WMW5.58S (approximately 750 ft southwest of the proposed Historic Lateral weir, on Bureau of Reclamation land)

The following parameters will be analyzed in collected samples to provide information necessary for the comparison of treatment alternatives:

- Perchlorate (method E314.0)
- Chlorate (method E300.1)
- Chloride (method E300.0)
- Ammonia (method SM4500-NH3 D)
- Sodium (method SW6010)
- Calcium (method SW6010)
- Magnesium (method SW6010)
- Nitrate (method E300.0)
- Sulfate (method E300.0)
- Chemical Oxygen Demand (method SM5220C)
- Biochemical Oxygen Demand (method SM5210B)

Field Parameters

- Dissolved Oxygen
- pH

Samples will be analyzed with a rush turn-around-time to facilitate rapid integration of sample results into the EE/CA analysis. Additional sample analyses may be added if necessary for the EE/CA analysis or based upon discussion with the Bureau of Water Pollution Control (BWPC) based upon anticipated National Pollutant Discharge Elimination System (NPDES) permit requirements. Wells will be sampled using low-flow sampling techniques and purged prior to sampling. Purge water will be transported to the site, and following characterization and with Trust approval, added to the GW-11 pond.

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2.2 SNWA DATA

To facilitate evaluation of treatment options, detailed information will be required from SNWA regarding the proposed weir construction. Based on information provided in the Order, Tetra Tech understands that SNWA staff will be readily available to provide all necessary information requested including, but not limited to the following:

- Estimated schedule of bidding and construction of weirs;
- Historical construction data including:
  - Dewatering methods;
  - Typical or as-built design of weirs;
  - Groundwater extraction rates;
  - Duration of groundwater extraction activities; and
  - Perchlorate concentrations in groundwater;
- Conceptual dewatering plan including site-specific dewatering rate and schedule at Sunshine Mountain and Historic Lateral weirs; and
- Property ownership information and access agreements (if any) in vicinity of weir construction and along potential pipeline corridors to treatment system.
- If necessary, access to sample wells indicated in Section 2.1 or as modified during the EE/CA process, coordinated through SNWA's agreements with Bureau of Reclamation and Clark County.
- Any Environmental Assessment or Environmental Impact Statement previously conducted by SNWA related to the weir construction project, in particular any documents specific to endangered species, wetlands, and impacts mitigation measures.

This data request will be submitted to SNWA immediately upon NDEP's approval of this Work Plan. A response will be required from SNWA within 10 business days so that the Trust can to meet the deliverable dates in the Order.

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3.0 EE/CA OUTLINE

The EE/CA will evaluate the preliminary cost, technical feasibility, constructability, schedule and permitting requirements for the transfer and treatment of groundwater extracted during SNWA weir construction dewatering operations, as required by the Order. The EE/CA will be prepared in accordance with Chapter 2 of the guidance document "Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA" (EPA 1993). The analysis will include an evaluation of the following design elements:

- Interface of conveyance piping to SNWA dewatering infrastructure
- Conveyance piping from dewatering locations to treatment facility
- Treatment of groundwater extracted during weir construction at no more than 2,000 gallons per minute (including evaluation of design, engineering, construction, start up, operation, maintenance and reporting)
- Conveyance piping from treatment facility to the surface water discharge location

The following is a proposed outline of the EE/CA:

Executive Summary

1. Introduction
2. Site Characterization
    a. Site Description
        i. Physical Setting
        ii. Regulatory History
        iii. Groundwater Characterization
        iv. SNWA Dewatering Plan
    b. Risk Analysis
3. Removal Action Objectives
    a. Scope and Purpose
    b. Justification for Proposed Action
    c. Response Goals
        i. Regulatory Requirements
        ii. Groundwater
        iii. Surface Water
        iv. Treatment System Byproduct
4. Development & Initial Screening of Removal Action Alternatives
    a. Alternative Identification
        i. Treatment System Location & Water Conveyance
            1. Single Treatment Facility & Extended Water Conveyance
            2. Two Treatment Facilities & Limited Water Conveyance
        ii. Treatment Alternatives
            1. Ion Exchange
            2. Low Strength Biological Treatment
            3. Tailored Activated Carbon

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b. Initial Alternative Screening and Selection

5. Analysis of Alternatives
    a. Evaluation Criteria
        i. Effectiveness
        ii. Implementability
        iii. Construction Schedule
        iv. Permitting Requirements
        v. Capital and Operating Cost Estimates
    b. Treatment System Location & Water Conveyance (Detailed Descriptions)
        i. No Action Alternative
        ii. Single Treatment Facility & Extended Water Conveyance
        iii. Two Treatment Facilities & Limited Water Conveyance
    c. Treatment Alternatives (Detailed Descriptions)
        i. No Action Alternative
        ii. Ion Exchange
        iii. Low Strength Biological Treatment
        iv. Tailored Activated Carbon
6. Comparative Analysis of Alternatives
7. Recommended Action Alternative
8. References

Tables

Table 1: Site Characterization – Summary of Groundwater Quality Data
Table 2: Alternative Comparison Summary – Treatment System Location & Water Conveyance
Table 3: Alternative Comparison Summary – Treatment Facility Type

Figures

Figure 1: Site Location Map
Figure 2: Monitoring Well and Plume Location Map
Figure 3: Land Ownership
Figure 4: Conceptual Treatment Facility Location & Conveyance Options
Figure 5: Process Flow Diagram – Ion Exchange – Strong Base
Figure 6: Process Flow Diagram – Ion Exchange – Weak Base
Figure 7: Process Flow Diagram – Low Strength Biological Treatment
Figure 8: Process Flow Diagram – Tailored Activated Carbon

Appendices

Appendix A: Analytical Data
Appendix B: Cost Estimate Worksheets

This outline has been prepared based on the current understanding of removal options and constraints. Throughout the development of the EE/CA if additional options are identified, the EE/CA will be adjusted

accordingly to consider these options. The subsections presented below provide additional details and clarification regarding EE/CA preparation for select sections of the report.

3.1 EE/CA SITE CHARACTERIZATION

The Site Characterization section (EE/CA Section 2) will present a brief description of the physical setting and perchlorate plume as it relates to the scope of this EE/CA assessment in support of the subject weir construction. The site characterization will include a summary of perchlorate impacts to groundwater in the vicinity of the weir construction areas, and a brief regulatory history as it relates to the NERT site and the scope of this EE/CA.

A critical section of the Site Characterization will include the description of the SNWA Dewatering Plan, which will constrain the design criteria for the extracted groundwater treatment and conveyance options based on flowrate and duration of dewatering activities.

As risk analysis has been presented at length in other documents related to the NERT site, this portion of the Site Characterization will draw from and reference existing NERT risk assessment documents to present only a brief summary of risks specifically associated with the extraction of perchlorate impacted groundwater associated with proposed weir construction.

3.2 EE/CA REMOVAL ACTION OBJECTIVES

The removal action objectives (RAOs) to be presented in EE/CA Section 3 will serve to guide the technological requirements of the treatment and conveyance of groundwater extracted during weir construction dewatering operations. Removal action objectives will be consistent with the Remedial Action Objectives set forth in the NERT Remedial Investigation and Feasibility Study Work Plan, Revision 2 (ENVIRON 2014) and include defining regulatory requirements for the system, including but not limited to the following:

- Compliance with Clean Water Act requirements, including NPDES permit limits;
- Compliance with threatened and endangered species protections
- Compliance with state and federal solid and hazardous waste rules and regulations;
- Compliance with worker health and safety requirements; and
- Compliance with private landowner, federal landowner, and city landowner access requirements.

3.3 EE/CA INITIAL SCREENING

The initial alternatives screening to be presented in EE/CA Section 4 will serve to present a listing and brief description of alternatives and eliminate options that are readily determined to be infeasible due to a variety of reasons, including but not limited to:

- Effectiveness (i.e., technology does not meet the RAOs);
- Implementability (i.e., alternative is not administratively or technologically feasible for site-specific conditions; treatment technology not yet available commercially);
- Construction Schedule (i.e., technology cannot be constructed by the necessary date for weir construction commencement due to either technological concerns, permitting concerns, or other); and
- Permitting Requirements (i.e., lack of land access; lack of sufficient land availability; permitting requirements are significantly greater than other options without offering commensurate added value); and
- Capital and Operating Cost (i.e., capital or operating cost is significantly higher than other options without offering commensurate added value).

Other reasons to eliminate alternatives at the initial screening phase of the EE/CA may arise during EE/CA development, and will be discussed and referenced as applicable.

3.4 EE/CA ANALYSIS OF ALTERNATIVES

The analysis of alternatives section, EE/CA Section 5, will contain a description of the screening criteria, further defined below, as well as detailed descriptions of the alternatives to be evaluated.

3.4.1 EE/CA Screening Criteria

EE/CA screening criteria are described further in the subsections below.

3.4.1.1 Effectiveness

According to the U.S. Environmental Protection Agency Guidance for Non-Time-Critical Removal Actions (EPA 1993), the effectiveness of an alternative should be evaluated by the following criteria:

- Long-term and short-term effectiveness and permanence;
- Overall protection of human health and the environment;
- Reduction of toxicity, mobility, or volume through treatment; and
- Compliance with applicable or relevant and appropriate requirements.

The ability of each alternative to meet RAOs is considered when evaluating these criteria. For perchlorate treatment, effectiveness will be gauged primarily by the ability of an alternative to remove perchlorate such that groundwater extracted during dewatering meets applicable NPDES permit limits and may be discharged directly into the Las Vegas Wash.

3.4.1.2 Implementability

Implementability addresses the technical and administrative feasibility of implementing an alternative and availability of various services and materials required to accomplish its implementation. Technical feasibility considerations include the applicability of the alternative to the contaminant source, availability of the required equipment and expertise to implement the alternative, and overall reliability of the alternative. In particular, the alternative evaluation with respect to feasibility will include:

- Construction considerations including schedule and availability of manpower, equipment, and materials required for implementation;
- Infrastructure requirements (e.g. power supply, utility connections, if applicable);
- Reliability and simplicity or complexity of the operation and the required maintenance; and
- Accessibility (including access agreements provided by SNWA and land ownership based on information found on the Clark County Tax Assessor's website).

Feasibility also considers the appropriateness of combinations of alternatives based on site-specific conditions. Administrative feasibility evaluates logistical constraints.

3.4.1.3 Construction Schedule

While scheduling constraints can be considered part of administrative feasibility, schedule has been brought forward as an independent evaluation criteria by NDEP. Construction schedule is a critical element for evaluating the alternatives based on the tightly constrained schedule and short lead time for implementation of treatment alternatives required by SNWA's proposed schedule for construction of the Sunshine Mountain and Historic Lateral weirs.

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3.4.1.4 Permitting Requirements

While permitting requirements can be considered part of administrative feasibility, permitting requirements will be included as an independent evaluation criteria to evaluate the relative permitting burden associated with the various alternatives considered. This evaluation will assess permits required, permitting schedule, and relative level of effort to complete permit applications. Locations for siting the treatment facility will be preferentially selected based upon the evaluation of permitting time, such that the preferred locations will not require lengthy permitting processes.

Permit applications will not be completed at this phase of the evaluation. The desktop review for each alternative will include local, state, and federal permits, using publicly-available information. The initial list of anticipated permits or approvals is shown below.

City of Henderson and Clark County

- Grading permit
- Building permit
- Dust control permit
- Air permit (if a combustion source is used for the treatment facility)
- Zoning and land use review

State

- Construction stormwater
- State listed species desktop review
- NPDES discharge permit for water reintroduced to Las Vegas Wash after treatment (primarily based on initial input from NDEP BWPC regarding eventual permit requirements).

Federal

- Permission to access land required to site a treatment facility (if applicable)
- Right-of-way for land crossed (e.g., by water conveyance pipeline)
- Compliance with the National Environmental Policy Act, including potential categorical exclusion from an environmental assessment if available for impacts considered temporary or less than significant in size
- Clean Water Act, Section 404 permitting for waters of the U.S. and wetlands
- Fish and Wildlife Service listed species desktop review

The review of state and federally-listed species will consist of a desktop review of species and presence of potential habitat without a field survey. Likewise, the wetlands review will be conducted using online references and aerial maps. If no federal land is crossed for the proposed siting of the water conveyance pipeline and treatment facility, certain federal permits will not be applicable to that alternative. Other considerations incorporated into the permitting evaluation will include waste management of solid waste and sludges produced from the treatment alternatives. SNWA project documents and prior analyses will be considered in the species and wetland protection evaluations.

3.4.1.5 Capital and Operating Cost Estimates

Evaluating the cost of alternatives involves developing conservative cost estimates based on the materials needed and the construction elements associated with implementing the alternative. These costs do not necessarily represent the cost that may actually be incurred during construction of the alternative because many design details are preliminary at this EE/CA stage of analysis. However, a similar set of assumptions is used for all the alternatives so that the relative differences in cost between alternatives are fairly represented.

The cost estimate will be developed from both deterministic and stochastic approaches, consistent with a Class 5 cost estimate as described in American Society of Testing and Materials (ASTM) Standard E2516-11. Select direct costs will be developed based on estimated quantities and unit costs, while other costs will be included as percentages of the direct costs estimated deterministically. Unit costs will be developed by analyzing data available from nationally published cost estimating guides. Cost data principally incorporate past engineering experience, including actual operating costs and unit costs that have been realized during similar projects. Unit costs for construction, often referred to as hard costs, are based on assessments of construction techniques, equipment, site accessibility, material handling distances and methods as well as site conditions. A construction contingency is added to the subtotal of all the construction costs. Soft costs which include construction administration, surveying and engineering costs are valued at a percentage of the total construction costs estimate.

At the direction of NDEP, capital and operating cost estimates will be presented for two scenarios:

- Scenario A will assume simultaneous construction of the Sunshine Mountain and Historic Lateral weirs, requiring concurrent treatment of water produced from construction of both the Sunshine Mountain and Historic Lateral weirs.
- Scenario B will assume weir construction will occur in series, such that the treatment system employed for treatment of groundwater extracted during dewatering of the first weir to be constructed can be transported and employed for treatment of groundwater extracted during dewatering for the construction of the second weir.

The total estimated cost is expected to be within plus 50% and minus 30% of actual costs, commensurate with the conceptual level of design available at this level of evaluation consistent with a Class 5 cost estimate for screening and feasibility purposes as defined in ASTM Standard E2516-11. Total costs for each alternative will be presented in the cost discussion for each alternative with the supporting unit cost spreadsheets presented in Appendix C.

3.4.2 Description of Removal Action Alternatives

EE/CA Sections 5b and 5c will contain detailed descriptions of the removal action alternatives that have progressed through the initial screening phase. For each alternative, a detailed description of technology or alternative will be presented, followed by a detailed evaluation of effectiveness, feasibility, schedule, permitting requirements, and capital and operating cost estimates. For treatment facility location and conveyance options, detailed descriptions of the alternatives including conceptual treatment facility siting and pipeline routing figures will be developed to facilitate discussion of constraints associated with each alternative.

For treatment technologies, process flow diagrams will be developed to further expand upon the narrative description of the technology included in this section. A brief description of treatment alternatives planned for evaluation are provided below.

3.4.2.1 Ion Exchange

Ion exchange is a physical-chemical process in which ions held electrostatically on the surface of a solid are exchanged for ions of similar charge in a solution. Ion exchange materials used for perchlorate treatment typically consist of resins made from materials that contain ionic functional groups to which exchangeable ions are attached.

Ion exchange resins are usually packed into a column, and as contaminated water is passed through the column, contaminant ions are exchanged for other ions such as chlorides or hydroxides in the resin. Ion exchange is often preceded by treatments such as filtration and oil-water separation to remove organics, suspended solids, and other contaminants that can foul the resins and reduce their effectiveness. Ion exchange resins must be

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periodically regenerated to remove the adsorbed contaminants and replenish the exchanged ions. Regeneration of a resin typically occurs in three steps:

1. Backwashing;
2. Regeneration with a solution of ions; and
3. Final rinsing to remove the regenerating fluids

The regeneration process results in a backwash solution, a waste regenerating solution, and a waste rinse water. The volume of spent regeneration solution ranges from 1.5 to 10 percent of the treated water volume depending on the feed water quality and type of ion exchange unit. Sodium chloride (NaCl), ammonium hydroxide (NH4OH), ferric chloride-hydrochloric acid (FeCl3 -HCl), and sodium hydroxide (NaOH) are some commonly used regenerants for regenerating perchlorate-laden resins. The regeneration process may require 3 to 5 bed volumes of regenerant solution and 2 to 3 bed volumes of water for rinsing. Furthermore, the regeneration water and spent resin containing high levels of perchlorate would require additional treatment (e.g., biological reduction) prior to disposal or reuse.

It should be noted that not all ion exchange resins that are used commercially to treat perchlorate are regenerable. Strong base resins have high selectivity for perchlorate but cannot be regenerated. Therefore, once the resin is deactivated, it has to be disposed of either in a hazardous waste landfill or by incineration. Weak base resins have lower selectivity for perchlorate but can be regenerated by sodium hydroxide and sulfuric acid. The regenerant generated from these operations can then be treated using a small biological process.

3.4.2.2 Biological Treatment

Biological treatment of perchlorate occurs under anoxic conditions which is the absence of molecular oxygen. With the addition of an electron donor such as methanol or ethanol, these microbial cultures are capable of reducing perchlorate to water, chloride, and carbon dioxide. Many of the bacterial cultures identified for perchlorate removal are denitrifying facultative anaerobes and typically have been adapted from a strain of marine organism. These organisms have been acclimated to perchlorate rich environments. Many reactors use a growth support medium for biomass accumulation such as Granular Activated Carbon (GAC), sand, or plastic media.

Addition of nutrients such as ammonia and phosphorus may be required to enhance microbial growth. Microbial degradation of perchlorate proceeds according to the following anoxic reduction process:

$$\underset{\text{(perchlorate)}}{ClO_4^-} \rightarrow \underset{\text{(chlorate)}}{ClO_3^-} \rightarrow \underset{\text{(chlorite)}}{ClO_2^-} \rightarrow \underset{\text{(chloride)}}{Cl^-} + \underset{\text{(oxygen)}}{O_2}$$

The rate limiting step in this process is degradation of perchlorate to chlorate. More than 30 different strains of perchlorate-degrading microbes have been identified, with many classified in the Proteobacteria class of the bacteria kingdom. Soil and groundwater samplings throughout the United States have confirmed the pervasiveness of perchlorate-reducing bacteria.

Fluidized bed reactors, packed bed reactors, and suspended bed reactors are different types of commercially available bioreactors that have been successfully demonstrated to reduce perchlorate in water. Packed or fixed bed bioreactors are made up of static sand or plastic media to support the growth of microbes. Fluidized bed bioreactors are made up of suspended sand or granular-activated carbon media to support microbial activity and growth of biomass. The activated carbon media are selected to produce a low-concentration effluent (i.e., at part-per-billion levels). Fluidized systems provide larger surface area for growth of microorganisms. The fluidized bed expands with the increased growth of biofilms on the media particles. The result of this biological growth is a system capable of additional degradative performance for target contaminants in a smaller reactor volume than with a fixed bed. However, the fluidized bed reactors generally require greater pumping rates than fixed beds reactors.

3.4.2.3 Tailored Activated Carbon

Activated carbon is commonly used to remove numerous contaminants from water. As water passes through the carbon, contaminants adsorb to the surface of the carbon particles. GAC is manufactured from high-carbon-content materials such as coal, wood, or coconut shells. To create more surface area onto which contaminants can adsorb, the carbon material is activated by heating. Part of the surface area of each standard (virgin) GAC particle is positively charged. This surface area attracts negatively charged contaminants, such as perchlorate.

However, because the positively charged surface area of standard carbon is limited, using standard GAC is not effective in removing high concentrations of perchlorate from groundwater. Although standard GAC has generally not been found to efficiently remove perchlorate, the adsorptive capacity may be increased through coating the surface with a thin layer of a tailored surface-active substance. This coating produces tailored GAC (T-GAC). The tailoring agent, or surfactant, creates a positively charged matrix on the GAC's carbon surface that attracts the negatively charged perchlorate ion.

Over the course of operation, the T-GAC's adsorptive sites will be taken up by perchlorate and competing ions, exhausting the carbon and rendering it spent. Similar to ion exchange, breakthrough of the contaminant occurs when the effluent contaminant concentration exceeds the treatment objective. The effluent must be monitored for contaminant breakthrough so that GAC can be managed (replaced or regenerated) as the carbon becomes exhausted and can no longer adsorb contaminants.

3.5 EE/CA COMPARATIVE ANALYSIS OF ALTERNATIVES

EE/CA Section 6 will contain the comparative analysis of alternatives. Summary tables comparing each alternative will be developed and presented as part of this section to facilitate direct comparison of the alternatives across the various screening criteria. This comparative analysis will address the relative performance of each alternative for each screening criteria and present advantages and disadvantages of each alternative relative to one another. This comparative analysis will highlight tradeoffs between the alternatives that will impact the selection of the preferred alternative for each element of the recommended action (treatment facility location and conveyance options, and treatment alternative).

3.6 RECOMMENDED ACTION ALTERNATIVE

EE/CA Section 7 will contain the recommended action alternatives for treatment facility location, conveyance approach, and treatment alternative. The recommended action will consist of the alternative that best meets screening criteria. This section will present brief descriptions of the evaluation process followed to select a preferred alternative, including weighting of importance of various screening criteria, if appropriate, and advantages and disadvantages of each alternative.

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4.0 SCHEDULE

In accordance with the Order, the EE/CA schedule will adhere to the following deadlines:

1. Within 10 days of the Order (by April 22, 2016), submit to NDEP a written reply indicating NERT's intention to comply with the Order. This task has been satisfied.
2. Within 30 days of the Order (by May 12, 2016), submit to NDEP a Work Plan and budget (Deliverables) to complete the EE/CA. This task is satisfied by the submittal of this document.
3. NERT requests NDEP comment and/or issue approval of the Deliverables within two weeks of the submittal of this document (by May 26, 2016),
4. Within ten business days of NDEP approval of Deliverables, obtain all information from SNWA, including facilitating access to complete additional groundwater sampling, if necessary with Clark County and Bureau of Reclamation based on existing SNWA access agreements (estimated at June 2, 2016 based on NDEP approval of Deliverable date of May 26, 2016)
5. Within 90 days of NDEP's approval of Deliverables submit to NDEP a completed EE/CA (estimated at August 24, 2016 based on NDEP approval of Deliverable date of May 26, 2016)
6. Within 30 days following NDEP's approval and requested implementation of the EE/CA, a new NPDES permit application(s) will be completed and submitted to the BWPC to facilitate the treatment of the Sunrise Mountain weir and Historic Lateral weir groundwater sources (not included in this scope of work).

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5.0 BUDGET

The cost to prepare the EE/CA as described within this Work Plan has been estimated at $187,000 consistent with the detailed budget analysis (project cost summary) attached to this Work Plan as Attachment 1. This estimate includes a general project contingency of 15% or approximately $24,000, to address matters including, but not limited to:

- Extensive negotiation for access for groundwater sampling;
- Extensive interaction with SNWA to obtain access to documents;
- Extensive discussion with BWPC regarding potentially applicable NPDES requirements;
- Additional permits requiring evaluation; and
- Additional treatment technologies requiring detailed evaluation.

The contingency will only be used with the prior approval of the Trust.

ED_002461_00004143-00019

6.0 REFERENCES

ASTM. (2011). *Standard Classification for Cost Estimate Classification System.* American Society for Testing and Materials. E2516-11.

ENVIRON. (2014). *Remedial Investigation and Feasibility Study Work Plan, Revision 2, Nevada Environmental Response Trust Site, Henderson, Nevada.*

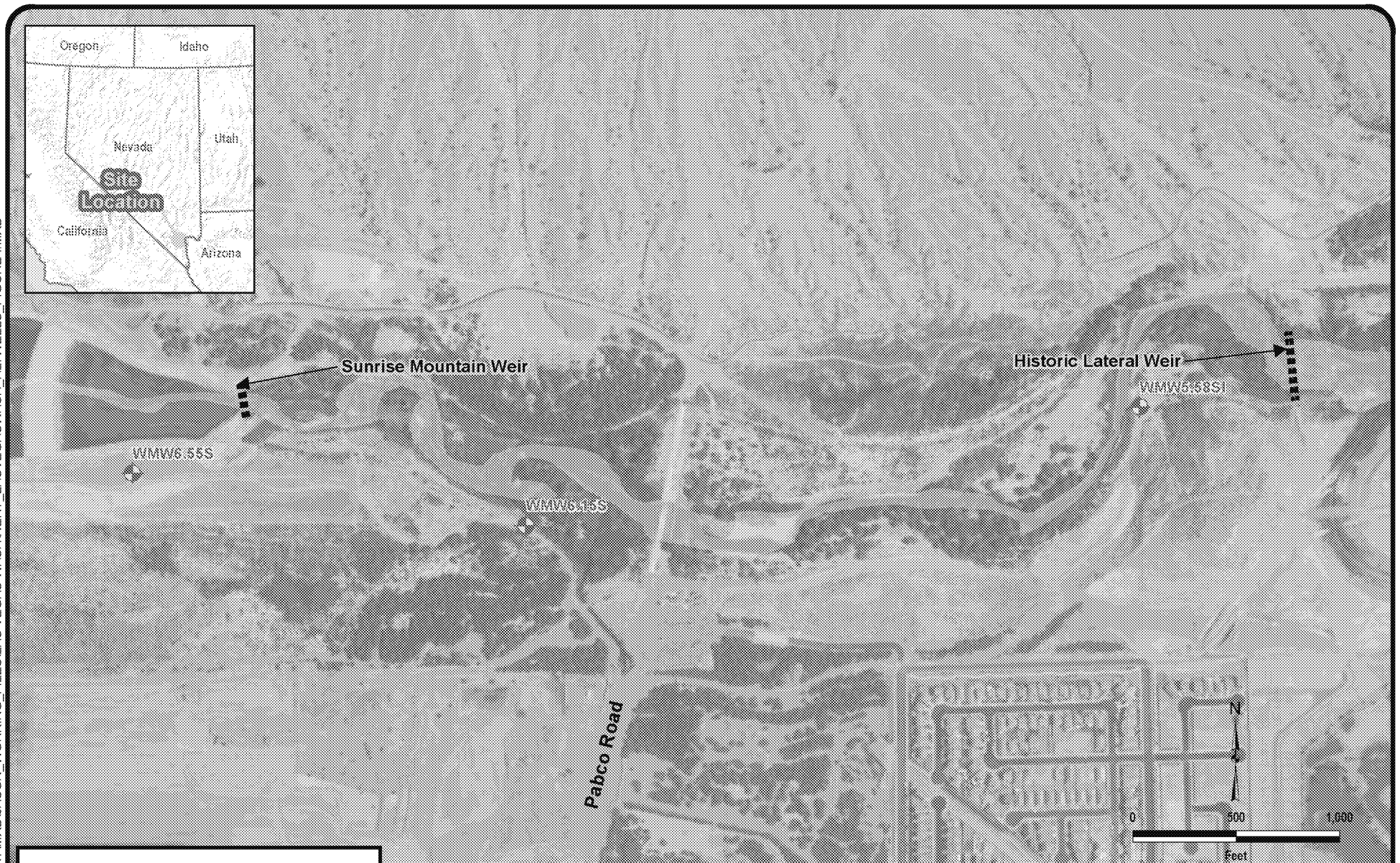
EPA. (1993). *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA*. Office of Solid Waste and Emergency Response, United States Environmental Protection Agency. PB93-963402 Publication 9360.0-32 EPA/540-R-93-057.

NDEP (2016). *Tronox LLC (TRX) Facility Nevada Environmental Response Trust (Trust) Property: Finding and Order Requiring Engineering Evaluation / Cost Analyiss (EE/CA)*. April 12, 2016.

Ramboll Environ. (2015). *Site Management Plan, Revision 2, Nevada Environmental Response Trust Site, Henderson.*

ED_002461_00004143-00020

Figures



Legend

- Monitoring Wells
- Proposed Weirs
- Approximate Las Vegas Wash Location

TETRA TECH

www.tetratech.com

1489 West Warm Springs Road, Suite 110
Henderson, Nevada 89014
PHONE: (702) 966-8340

NEVADA ENVIRONMENTAL RESPONSE TRUST

HENDERSON, NEVADA

PROPOSED LAS VEGAS WASH WEIR LOCATIONS

Project No.	117-7502016
Date	MAY 2016
Designed By	JWR
Figure No.	1

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Attachment 1

Project Cost Summary

12-May-16

EE/CA - Weir Dewatering Treatment

Phases / Tasks		Project Total		Data Collection		EECA - Site Characterization, Removal Action		EECA Location & Conveyance Analysis		EECA Permitting Review		EECA Treatment Technology Alternative Analysis		Response to NDEP Comments	
		984 hrs	$ 187,483.75												
Tetra Tech Labor	Hrly Rate	Tot Est. Hrs	Total Est. Cost	Hours	Cost	Hours	Cost	Hours	Cost	Hours	Cost	Hours	Cost	Hours	Cost
Principal IV	$255.00	95.0	$ 24,225.00	7.0	$ 1,785.00	3.5	$ 892.50	3.5	$ 892.50	6.0	$ 1,530.00	63.0	$ 16,065.00	12.0	$ 3,060.00
Principal I	$211.00	26.0	$ 5,486.00	-	$ -	-	$ -	-	$ -	24.0	$ 5,064.00	-	$ -	2.0	$ 422.00
Sr Consultant I	$194.00	222.0	$ 43,068.00	11.0	$ 2,134.00	0.5	$ 97.00	0.5	$ 97.00	1.0	$ 194.00	188.0	$ 36,472.00	21.0	$ 4,074.00
Sr Project Manager II	$184.00	4.0	$ 736.00	4.0	$ 736.00	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -
Sr Project Manager I	$174.00	38.0	$ 6,612.00	18.0	$ 3,132.00	3.0	$ 522.00	1.0	$ 174.00	2.0	$ 348.00	11.0	$ 1,914.00	3.0	$ 522.00
Project Engineer/Scientist/Manager IV	$166.00	134.0	$ 22,244.00	18.0	$ 2,988.00	24.0	$ 3,984.00	24.0	$ 3,984.00	20.0	$ 3,320.00	36.0	$ 5,976.00	12.0	$ 1,992.00
Project Engineer/Scientist/Manager I	$131.00	242.0	$ 31,702.00	10.0	$ 1,310.00	-	$ -	16.0	$ 2,096.00	16.0	$ 2,096.00	200.0	$ 26,200.00	-	$ -
Document Management II	$115.00	8.0	$ 920.00	-	$ -	1.0	$ 115.00	1.0	$ 115.00	1.0	$ 115.00	4.0	$ 460.00	1.0	$ 115.00
Staff I	$110.00	212.0	$ 23,320.00	-	$ -	-	$ -	-	$ -	-	$ -	212.0	$ 23,320.00	-	$ -
Document Management I	$90.00	1.0	$ 90.00	1.0	$ 90.00	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -
Technician IV	$89.00	2.0	$ 178.00	-	$ -	-	$ -	-	$ -	2.0	$ 178.00	-	$ -	-	$ -
Subtotal Tetra Tech Labor		984.0 hrs	$ 158,581.00	69.0	$ 12,175.00	32.0	$ 5,610.50	46.0	$ 7,358.50	72.0	$ 12,845.00	714.0	$ 110,407.00	51.0	$ 10,185.00
--Total Tetra Tech Labor			$ 158,581.00		$ 12,175.00		$ 5,610.50		$ 7,358.50		$ 12,845.00		$ 110,407.00		$ 10,185.00
Subcontractors			Total Est. Cost		Cost		Cost		Cost		Cost		Cost		Cost
Test America			$ 4,000.00		$ 4,000.00		$ -		$ -		$ -		$ -		$ -
Subtotal Subcontractors			$ 4,000.00		$ 4,000.00		$ -		$ -		$ -		$ -		$ -
		Markup	$ 340.00	8.50%	$ 340.00										
--Total Subcontractors			$ 4,340.00		$ 4,340.00		$ -		$ -		$ -		$ -		$ -
Other Direct Costs			Total Est. Cost		Cost		Cost		Cost		Cost		Cost		Cost
Samling Equipment & Shipping			$ 150.00		$ 150.00		$ -		$ -		$ -		$ -		$ -
Subtotal Other Direct Costs			$ 150.00		$ 150.00		$ -		$ -		$ -		$ -		$ -
		Markup	$12.75	8.50%	$12.75										
--Total Other Direct Costs			$ 162.75		$ 162.75		$ -		$ -		$ -		$ -		$ -
Contingencies			Total Est. Cost		Cost		Cost		Cost		Cost		Cost		Cost
Labor Contingency			$ 24,400.00		$ 2,500.00		$ 800.00		$ 1,100.00		$ 1,900.00		$ 16,600.00		$ 1,500.00
Subtotal Contingencies			$ 24,400.00		$ 2,500.00		$ 800.00		$ 1,100.00		$ 1,900.00		$ 16,600.00		$ 1,500.00
--Total Contingencies			$ 24,400.00		$ 2,500.00		$ 800.00		$ 1,100.00		$ 1,900.00		$ 16,600.00		$ 1,500.00
Project/Task --Total			$ 187,483.75		$ 19,177.75		$ 6,410.50		$ 8,458.50		$ 14,745.00		$ 127,007.00		$ 11,685.00
PROJECT Total			$ 187,483.75												

NOTES: 1. Amounts allocated above by subtask and category are approximate. Project will be managed to the overall budget.