UNIT 4 AND 5 BUILDINGS INVESTIGATION WORK PLAN
HENDERSON, NEVADA

Prepared for:

Nevada Environmental Response Trust

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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: Unit 4 and 5 Buildings Investigation Work Plan, Nevada Environmental Trust Site, Henderson, Nevada

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3/30/2015

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Date

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LIST OF ACRONYMS

3DVA	three-dimensional visualization and analysis
ACMs	asbestos containing materials
AWF	Athens Road well field
ASTM	American Society of Testing and Materials
bgs	below ground surface
BMI	Black Mountain Industrial
CEC	cation exchange capacity
CFR	Code of Federal Regulations
COC	chain of custody
COPC	chemicals of potential concern
DI	deionized
DOT	Department of Transportation
ENVIRON	ENVIRON International Corporation
EPA	United States Environmental Protection Agency
FSP	field sampling plan
HASP	health and safety plan
HRSC	high-resolution site characterization
IDW	investigation-derived waste
LBP	lead-based paint
µg/L	micrograms per liter
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MS/MSD	matrix spike/matrix spike duplicates
MVS	Mining Visualization Software
NAD 83	North American Datum of 1983
NAVD 88	North American Vertical Datum of 1988
NDCNR	State of Nevada Department of Conservation and Natural Resources
NDEP	Nevada Division of Environmental Protection
NERT	Nevada Environmental Response Trust
OCPs	organochlorine pesticides
PCBs	poly-chlorinated biphenyls
PVC	polyvinyl chloride
QAPP	quality assurance project plan
RI/FS	remedial investigation/feasibility study

SMP	site management plan
SVOCs	semi-volatile organic compounds
TDS	total dissolved solids
UMCf	Upper Muddy Creek Formation
UMCf-fg1	Upper Muddy Creek Formation, fine-grained unit 1
Tronox	Tronox LLC
USCS	Unified Soil Classification System
VOCs	volatile organic compounds
WBZs	water-bearing zones
xUMCf	transitional Upper Muddy Creek Formation

TABLE OF CONTENTS

FIGURES

TABLE

APPENDICES

1.0 INTRODUCTION

On behalf and at the direction of the Nevada Environmental Response Trust (NERT), Tetra Tech has prepared this Unit 4 and 5 Buildings Investigation Work Plan (Work Plan). The purpose of this Work Plan is to perform an environmental investigation in the area of the Unit 4 and 5 buildings (Investigation Area), located on the NERT property (Site) within the Black Mountain Industrial (BMI) Complex in Henderson, Nevada. The location of the NERT property is shown on Figure 1; the location of the Investigation Area is shown on Figure 2.

This proposed scope of work in the Investigation Area is a component of the NERT Remedial Investigation/Feasibility Study (RI/FS). The approach to investigate the Unit 4 and Unit 5 buildings that was originally recommended in the RI/FS Work Plan (ENVIRON 2014a) included using directional drilling methods to obtain soil and groundwater samples from beneath the basement floor of the central Unit 4 building (Unit 4 cell building). Since the submittal of the RI/FS Work Plan, an active chlorine process pipeline hanging on the exterior of the northern portion of the Unit 4 building (Chlorinator Building) will be decommissioned and a new pipeline constructed at a new location. The prior existence of the chlorine process pipeline in the Investigation Area prevented the safe implementation of a demolition program to remove the ground-level concrete floor of the Unit 4 cell building. Demolition of the ground-level concrete floor of the Unit 4 cell building is necessary to allow an environmental investigation program in the Investigation Area using conventional soil borings and groundwater monitoring wells. The implementation of an investigation program utilizing conventional drilling will allow the collection of a greater density of environmental soil and groundwater data, thereby supporting better remedy selection and reducing the risk that additional investigation would be required to fully characterize the Investigation Area.

As a result of the chlorine line’s planned decommissioning and in consultation with the Nevada Division of Environmental Protection (NDEP), NERT, and ENVIRON International Corporation (ENVIRON), an alternate approach to the originally planned investigation program utilizing directionally drilled borings is presented in this Work Plan. This alternate approach consists of demolishing the ground-level concrete floor of the Unit 4 cell building, constructing an access ramp from the ground level to the basement level to allow demolition and drilling equipment to access the basement level, demolishing the structural supports located on the basement level, and conducting the subsurface soil and groundwater environmental characterization work using conventional drilling and environmental investigation methods.

Areas adjacent to the Unit 4 and 5 buildings that represent data gaps will also be investigated using conventional methods. Accordingly, this Work Plan is provided as a replacement for the entirety of Section 5.4.1.2 (Unit Buildings Investigation Approach) of the RI/FS Work Plan, and will be implemented in conjunction with other RI/FS activities at the Site to avoid duplicative or redundant efforts.

The remainder of this Work Plan is organized as follows:

- Section 2.0 presents project background information, project objectives and goals, a description of the Site, a summary of previous investigations, and data gaps;
- Section 3.0 presents plans for Site preparation activities, including the Unit 4 cell building ground level floor demolition, construction of an access ramp into the basement of the Unit 4 cell building, marking and locating soil borings, and clearance of underground utility lines;

- Section 4.0 presents the Work Plan, which includes:
    - Investigation overview;
    - Collecting soil and groundwater samples for laboratory analysis; and
    - Installing shallow groundwater monitoring wells.
- Section 5.0 presents the project sampling and analysis plan;
- Section 6.0 provides procedures for the management of investigation-derived wastes;
- Section 7.0 presents reporting;
- Section 8.0 presents a preliminary Work Plan implementation schedule; and
- Section 9.0 provides a list of documents referenced in the Work Plan.

It should be noted that the majority of field work presented in this Work Plan will be initiated after the chlorine gas pipeline that crosses through the adjacent Unit 4 chlorinator building, located north of the Unit 4 cell building, has been decommissioned. Components of the Work Plan that do not pose a risk to the chlorine gas pipeline, such as the soil boring and building demolition waste profiling, will begin following regulatory approval of the respective Work Plans. The chlorine gas pipeline is currently scheduled to be decommissioned by the end of April 2015.

2.0 PROJECT BACKGROUND

This section of the Work Plan provides background information including project objectives and goals, a Site description, summary of previous investigations in and around the Investigation Area, and data gaps.

2.1 Project Objectives and Goals

Previous soil and shallow groundwater investigation data (ENVIRON 2014a) indicate that the Investigation Area is a potential perchlorate and hexavalent chromium source to the underlying soil and groundwater. The objective of this environmental investigation is to characterize the vertical and horizontal extent of impacted soil and shallow groundwater underneath the Unit 4 cell building and within the Investigation Area as a part of the Site-wide RI/FS. Specific goals of the proposed investigation include the following:

- Collect sufficient soil and groundwater data to provide scale-appropriate data density for characterization of the nature and extent of perchlorate, hexavalent chromium, and other contaminants in the vadose zone and shallow groundwater within the Investigation Area;

- Estimate the mass of perchlorate and hexavalent chromium in the vadose zone and shallow groundwater in the Investigation Area;

- Evaluate potential migration pathways and the velocity of perchlorate and hexavalent chromium migration in shallow groundwater in the Investigation Area; and

- Evaluate the potential contribution of perchlorate and hexavalent chromium in the Investigation Area to the previously identified Site-wide shallow groundwater plume.

Tetra Tech recognizes that conducting an environmental investigation in an area that has not been characterized and is potentially a significant source of perchlorate and hexavalent chromium to the underlying soil and groundwater, such as the Investigation Area, will require collecting a significant amount of data and more than a single field event to meet the project objectives. A significant data collection effort will be required to identify contaminant source areas, mass, spatial distribution, pathways, and velocity.

Tetra Tech will utilize high-resolution site characterization (HRSC) strategies, technologies and best practices, as defined by the EPA, that use scale-appropriate sampling and measurement densities to obtain detailed geologic, hydrogeologic, and contaminant data to achieve the project objectives and goals. Additionally, data generated from this investigation will be used to support the source term for the groundwater flow and transport model. A detailed description of the investigation strategies and data collection process is provided in Section 4.0.

2.2 Site Location and Description

This section provides a brief description of Site location and history derived from the ENVIRON RI/FS Work Plan (ENVIRON 2014a). The Site comprises approximately 346 acres of the BMI Complex in an unincorporated portion of Clark County that is surrounded by the City of Henderson, Nevada. The Site has been used for industrial operations since 1942, when it was developed by the U.S. government as a magnesium plant in support of World War II operations. Following the war, various industrial activities, including the production of perchlorates, boron, and manganese compounds, continued at the BMI Complex. Former industrial and waste management practices at the Site and adjacent properties have resulted in impacts to soil, groundwater, and surface water.

Tronox LLC (Tronox) formerly owned and operated a portion of the Site, including the Investigation Area. In conjunction with the settlement of Tronox's bankruptcy proceeding, ownership of the Site was transferred to NERT on February 14, 2011. Tronox currently leases a portion of the Site which includes the Investigation Area, and continues to operate its chemical manufacturing business.

There are a total of ten unit buildings (numbered 1 through 10) aligned in a row from west to east along the southern portion of the NERT property. Each unit building consists of three structures: a chlorinator building on the north side, a cell building in the center, and substation building on the south side. Four of the unit buildings (Units 3, 4, 5, 6) are leased from NERT by Tronox (Figure 2). The roof, above grade walls and floors of the Unit 1 and 2 cell buildings have been demolished, with the basement walls and slabs remaining intact. In addition, the eastern half of the Unit 3 cell building has been demolished.

The Unit 4 cell building is no longer used, and its above-ground structures were demolished in the mid-2000s. In 2012, the Unit 4 substation building was retrofitted to house an advanced battery manufacturing process. The Unit 4 chlorinator building is currently used by Tronox, primarily for storage. Tronox currently uses the Unit 5 and 6 buildings for the production of manganese dioxide. A portion of the Unit 5 building is also used for storage.

North of the Unit 4 building, Tronox produces boron products at a Boron Plant. To the north of the Unit 5 and 6 Buildings, Tronox produces manganese sulfate for use in the manganese dioxide production process within a Leach Plant.

The Unit 4 cell building historically contained chlorinators (furnaces) that created molten magnesium chloride by reacting magnesium oxide/carbon pellets with chlorine gas at high temperatures. Magnesium metal was then produced in banks of electrolytic cells in the cell building by electrochemical reduction of the molten magnesium chloride. From 1945 to 1989, sodium chlorate and sodium perchlorate were produced by electrolytic processes, which involved the use of sodium dichromate (hexavalent chromium) on the first floor of the Unit 4 and 5 cell buildings. The concrete basements reportedly served as sumps to collect process liquor, spillage, and wash water, and process chemicals may have leaked to soil through cracks in the basements of the Unit 4 and 5 cell buildings.

The proposed Investigation Area is crossed by soil, asphalt and concrete roads, active utility lines, an above ground chlorine gas pipeline, and railroad spurs. An extensive network of active and inactive underground utility lines is present under the roads and open areas at the Site.

2.3 Geology

The Site is located near the southeast end of the Las Vegas Valley, a northwest-southeast trending structural basin that extends approximately 55 miles and includes metropolitan areas of North Las Vegas, Las Vegas, and Henderson. Locally, the ground surface slopes to the north towards the Las Vegas Wash. Las Vegas Valley is bounded on the west by the Spring Mountains, on the north by the southern ends of the Sheep and Las Vegas Ranges, on the east by Frenchman and Sunrise Mountains, and on the south by the River Mountains and McCullough Range (Plume 1989). The structural basin that underlies Las Vegas Valley is comprised of Precambrian crystalline rocks; Precambrian and Paleozoic carbonate rocks; Permian, Triassic, and Jurassic clastic rocks; and Miocene igneous rocks. Gravity data indicate that the deeper portions of the basin are filled with 3,000 to 5,000 feet of clastic sedimentary deposits that range in age from Miocene through Holocene (Plume 1989).

The clastic sedimentary valley-fill deposits of Las Vegas Valley are more than 4,000 feet thick beneath Henderson (Plume 1989), and consist of Quaternary alluvial deposits, transitional Muddy Creek Formation (xMCf), and Pleistocene Upper Muddy Creek Formation (UMCf). The alluvium is generally described as reddish-brown discontinuous layers of sand and gravel with minor amounts of silt, clay and caliche. The thickness of these alluvial deposits ranges from less than one foot to more than 50 feet beneath the Site (ENVIRON 2014a).

Localized thicker deposits of alluvium that are structurally narrow and linear have been interpreted as stream-deposited sands and gravels that were deposited within paleochannels during flooding events. The paleochannel sand and gravel deposits exhibit significantly greater permeability than the adjacent surrounding formation material. At the base of the alluvium, the transitional Muddy Creek Formation is encountered at some locations, and consists of reworked sediments derived from the Upper Muddy Creek Formation. The Upper Muddy Creek Formation underlies the transitional Muddy Creek Formation (xUMCf) or alluvium, and consists of interbedded coarse-grained and fine-grained sediments that become progressively finer-grained to the north towards the central portion of the valley.

Within the southern 1,000 feet of the Site, the uppermost first fine-grained sediment layer of Upper Muddy Creek Formation (UMCf-fg1) pinches out along a roughly west-northwesterly trend line. South of this transitional trend line, the first coarse-grained sediment layer of Upper Muddy Creek Formation directly underlies the alluvium. The contact between the alluvium and the Upper Muddy Creek Formation is reportedly marked by the appearance of a well-compacted brown silt, sandy silt, stiff clay, or sandy clay (ENVIRON 2014a).

Based on a review of previous monitoring well pilot borings located within or near the Investigation Area, the first native soil unit underlying the area is alluvium, consisting of fine- to medium-grained sand with some silty sand with gravel. Up to 10 feet of fill has been encountered at some locations. The contact between the base of the sandy alluvium and the top of the underlying silty UMCf-fg1 in the vicinity of the Investigation Area is encountered at a depth of approximately 27 to 45 feet below ground surface (bgs) (ENSR 2005).

2.4 Hydrology and Hydrogeological Conditions

Surface water at the Site generally flows from south to north toward the Las Vegas Wash. During the 2011 Interim Soil Removal Action, many portions of the Site were graded such that storm water would be retained on the Site. Existing roads, utility berms, and other site features were created to prevent storm water from flowing off the Site. Two main storm water retention basins, the Central Retention Basin and Northern Retention Basin, were constructed to control storm water flow and maintain storm water on the Site. The Central Retention Basin collects surface runoff from the Tronox-leased area. The Northern Retention Basin collects surface runoff water from north of the former Beta Ditch (located near the center of the Site) and accepts overflow from the Central Retention Basin.

According to previous work performed at the Site, the depth to groundwater ranges from approximately 27 to 80 feet bgs, and is generally deepest in the southern portion of the Site and becomes shallower to the north as it approaches the Las Vegas Wash. The average groundwater gradient ranges from 0.015 to 0.020 feet/foot south of the Athens Road well field (AWF) located approximately 2 miles north of the Investigation Area, decreasing to approximately 0.007 to 0.010 feet/foot to the north of the AWF (ENVIRON 2014a). The direction of groundwater flow on the Site is generally north to north-northeast; to the north of the Site, the direction of groundwater flow is toward the northeast.

The NDEP has defined the following three water-bearing zones (WBZs) that occur within the BMI Complex:

- Shallow WBZ – The first occurrence of groundwater in the area occurs within either the alluvium or the Upper Muddy Creek Formation. Groundwater in the Shallow WBZ occurs under unconfined to partially confined conditions and is considered the "water table aquifer." The base of the Shallow WBZ, as defined by the NDEP, is 90 feet bgs.

- Middle WBZ – Groundwater in the Middle WBZ generally occurs between 90 and 300 feet bgs. Water-bearing units in Middle WBZ are confined (ENVIRON 2014a). Groundwater in the Middle WBZ exhibits an upward vertical gradient.

- Deep WBZ – Groundwater in the Deep WBZ generally occurs between 300 and 400 feet bgs. Water-bearing units in Deep WBZ are confined. Groundwater in the Deep WBZ exhibits an upward vertical gradient.

Environmental investigations at the Site have primarily focused on the Shallow WBZ; however, investigations conducted by Northgate Environmental Management in 2009 included the installation of several monitoring wells in the Middle WBZ to characterize the vertical distribution of chemical constituents (ENVIRON 2014a).

In the vicinity of the Investigation Area, first groundwater in the Shallow WBZ occurs within the alluvium at a depth of approximately 41 to 43 feet bgs in monitoring wells M-11 and M-12A, and locally flows generally north-northwest following the slope of the ground surface (February 2014 data, ENVIRON 2014d).

2.5 Summary of Applicable Previous Investigations

A number of environmental investigations and remedial activities have been performed at the BMI Complex property since the 1970s. A chronological summary of investigations and remedial activities conducted since the 1970s is provided in Section 3.1 of the RI/FS Work Plan (ENVIRON 2014a). A summary of previous environmental investigations conducted in the vicinity of the Investigation Area that are pertinent to this Work Plan is provided below. The soil boring locations and perchlorate and hexavalent chromium results obtained within the Investigation Area are presented on Figure 3. Monitoring well locations and perchlorate and total chromium/hexavalent chromium results are provided on Figures 4 and 5, respectively.

The Phase A Source Area Investigation (Phase A Investigation) was conducted by ENSR in 2006. Two of the soil borings (SA06 and SA07) advanced during this investigation were located in the vicinity of the Investigation Area. Soil boring SA06 was located approximately 280 feet north of Unit 4 cell building and was advanced to a depth of 37 feet bgs. Soil boring SA07 was located approximately 280 feet north (downgradient) of Unit 5 cell building and was advanced to a depth of 34 feet bgs. Soil samples were collected at depths of 0.5 feet to 1.0 foot bgs and at 10-foot intervals thereafter to groundwater at depths of 37 feet (SA06) and 36 feet (SA07).

The compounds that were detected in soil samples collected from SA06 include perchlorate (54.1 milligrams per kilogram [mg/kg] at 35.3-36.8 feet bgs); hexavalent chromium (0.22 mg/kg at 20.3-21.8 feet bgs); and various metals, semi-volatile organic compounds (SVOCs), volatile organic compounds (VOCs), dioxins/furans, and radionuclides (ENSR 2008a). Compounds detected in soil samples collected from SA07 include perchlorate (113 mg/kg at 10.2-11.7 feet bgs); hexavalent chromium (0.56 mg/kg at 0.7-2.2 feet bgs); and various metals, VOCs, dioxins/furans, radionuclides, and asbestos (ENSR 2008b).

In 2009, one soil boring was advanced using hand excavation techniques approximately in the middle of Unit 4 cell building basement floor. Two soil samples collected from this boring at depths of 9.0-10.5 feet bgs and 15.5-17.0 feet bgs contained perchlorate at concentrations of 15.5 mg/kg and 41.5 mg/kg, respectively (ENVIRON 2012).

The Phase B Source Area Investigation (Phase B Investigation) at the Investigation Area was conducted by Northgate Environmental Management in 2009, and included advancing 14 soil borings. The objective of the Phase B Investigation was to further evaluate the extent of contaminants in the area of the Unit 4 and 5 buildings. The list of analytes for soil in the Phase B Investigation was expanded to also include polychlorinated biphenyls (PCBs), organochlorine pesticides (OCPs), total petroleum hydrocarbons, chlorate, cyanide and formaldehyde.

As shown on Figure 3, the greatest perchlorate concentration found during the Phase A and B Investigations was 2,970 mg/kg in soil boring RSAR7 at a depth of 18.9–20.4 feet bgs. Soil boring RSAR7 is located between Unit 4 and 5 buildings. The area between Unit 4 and 5 buildings has undergone remedial soil excavation (Figure 3); however, the excavation was limited to the removal of the upper six to ten feet of soil due to the presence underground utility lines (ENVIRON 2013). The greatest hexavalent chromium concentration detected during the Phase A and B Investigations was 36.4 mg/kg in soil boring RSAR6 at a depth of 25.6–27.1 feet bgs. Soil boring RSAR6 is located west of the Unit 4 cell building. Soil samples collected during the Phase A and B investigations were also analyzed for chloroform. The greatest chloroform concentration detected during the Phase A and B Investigations was 1,300 micrograms per kilogram [µg/kg]) in soil boring SA161, at a depth of 37.9–39.4 feet bgs. Soil boring SA161 is located west of the Unit 4 cell building.

Two Shallow WBZ monitoring wells (M-11 and M-12A) are located downgradient of the Unit 4 and 5 buildings within the Investigation Area. Monitoring wells M-11 and M-12A were installed in 1997 and are routinely sampled for perchlorate and hexavalent chromium as part of the Site groundwater monitoring program. Monitoring well M-11 is located adjacent to soil boring SA07, approximately 280 feet north (downgradient) of Unit 5 cell building. Monitoring well M-12A is located adjacent to soil boring SA06, approximately 280 feet north (downgradient) of Unit 4 cell building, as shown on Figure 4. No other groundwater monitoring wells have been installed within the Investigation Area.

Groundwater samples collected in May 2014 from M-11 and M-12A contained perchlorate at concentrations of 18 milligrams per liter (mg/L) and 160 mg/L, respectively (ENVIRON 2014d). Groundwater samples collected in May 2014 from M-11 and M-12A contained hexavalent chromium at concentrations of 1.2 mg/L and 9.1 mg/L, respectively (ENVIRON 2014d).

Total dissolved solids (TDS) is also analyzed as a part of the ongoing groundwater monitoring program. Groundwater samples collected in May 2014 from M-11 and M-12A contained TDS at concentrations of 2,400 mg/L and 6,600 mg/L, respectively (ENVIRON 2014d). Chloroform, a VOC, was also detected in groundwater samples collected from the Site. Groundwater samples collected in 2009 from M -11 and M-12A contained chloroform at concentrations of 150 micrograms per liter (µg/L) and 980 µg/L, respectively (ENVIRON 2014a).

The presence of significantly greater concentrations of perchlorate and hexavalent chromium concentrations in soil samples collected from locations in close proximity to Unit 4 and 5 buildings (RSAR6 and RSAR7), as compared to soil samples collected north of the buildings (SA06 and SA07), suggests that soil and groundwater beneath the Unit 4 and 5 buildings may potentially have greater perchlorate and hexavalent concentrations than those observed in the area of wells M-11 and M-12A.

2.6 Data Gaps

The Unit 4 and 5 buildings have been identified by NDEP as potentially one of the most significant perchlorate and hexavalent chromium source areas for the entire Site. Potential sources of contaminants in the Investigation Area include cracks in the basement floors of the Unit 4, 5, and 6 cell buildings (ENVIRON 2014a), drainage trenches and a sump located within the Unit 4 cell building basement floor, the chemical storage tank area located on the west side of the Unit 4 cell building, and the railcar loading and unloading areas located south of Unit 4 and 5 buildings.

To date, only a limited amount of soil and groundwater data have been collected in the Investigation Area, and only one soil boring has been advanced beneath the basement of the Unit 4 cell building. These data gaps are addressed by the field investigation described in the remainder of this Work Plan.

3.0 SITE PREPARATION

The majority of the proposed environmental investigation activities cannot be implemented until the chlorine gas pipeline suspended on the south side of the remaining Unit 4 chlorinator building is decommissioned, the Unit 4 cell building is demolished, and an access ramp to accommodate movement of construction and drilling equipment from the ground surface level to the Unit 4 cell building basement level is constructed. A description of these site preparation activities and associated work that will be performed prior to implementing the environmental investigation is summarized in the following sections.

3.1 Health and Safety

A project Health and Safety Plan (HASP) has been developed for the investigation described in this Work Plan. The HASP was developed based on the existing NERT HASP prepared by ENVIRON, and incorporates project-specific work elements described below and Tetra Tech's health and safety requirements. The HASP addresses risks and potential hazards associated with the proposed environmental investigation and demolition activities.

Because the scope of the investigation has been expanded, additional health and safety measures have been incorporated into the final HASP. These measures may include, but are not limited to, the following: saturating the sub-slab soils prior to the investigation, saturating the drill bore with a continuous stream of water, continuous misting of the work area, and/or other measures as necessary to mitigate potential risks due to the presence and explosive characteristics of perchlorate. Water used for drilling will be sampled and analyzed prior to use to document the presence or absence of constituents of concern. Task-specific job safety analyses for drilling and well construction activities are included in the HASP. The HASP will be augmented, amended, or revised as conditions warrant or additional material data becomes available. A copy of the HASP is provided as Appendix A.

Prior to the commencement of each day's activities, a tailgate health and safety meeting will be conducted. Onsite personnel will be required to be familiar with the HASP, attend the daily tailgate meeting, and sign the project HASP acknowledging familiarity with the contents of the document. Additionally, all Site workers will be required to attend the Tronox Health and Safety training. Applicable components of Tronox's health and safety requirements have been incorporated into the Tetra Tech project-specific HASP.

3.2 Unit 4 Cell Building Demolition

The demolition of Unit 4 cell building will include a hazardous materials survey followed by building demolition activities. All work related to building demolition presented in this Work Plan will be performed in accordance with the site management plan (SMP), HASP, and final Demolition Work Plan for Unit 4 cell building. Additionally, the work will be performed in a manner that does not disrupt Tronox's operations and will be in accordance with their requirements.

3.2.1 Demolition Materials Survey

Many of the buildings on the Site are known or suspected to contain hazardous materials, including asbestos-containing materials (ACMs), lead-based paint (LBP), PCBs, and mercury (ENVIRON, 2013). In addition to these materials, there may also be residual perchlorate, chlorate, VOCs, and/or chromium impacts from former Site operations. During Site inspections, Tronox personnel have mentioned the presence of perchlorate residue throughout the Unit 4 cell building basement, and have reported that this residue poses a potential ignitability risk. Due to the potential presence of these materials, a thorough characterization of the building materials, for building waste profiling purposes and worker health and safety, will be performed prior to building demolition.

A pre-demolition materials survey will be performed at the Unit 4 cell building, including the ground level cell floor, basement, and surrounding area that will be demolished, to identify and classify potential hazardous materials that may need to be abated before demolition. Potential hazardous materials may include ACM, LBP, and concrete that may be contaminated with perchlorate, chlorates, metals, and hexavalent chromium. A pre-demolition hazardous materials survey work plan will be prepared and submitted to NDEP under separate cover for concurrence, prior to performing the hazardous materials survey.

Tronox has informed Tetra Tech that they performed an asbestos survey and asbestos abatement throughout most of the basement of the Unit 4 cell building, with the exception of the cells that remain in place along the northeast corner of the basement. Tronox has reported that pipes with ACMs remain in some of the cells in the northeast corner of the basement, and that the cells themselves have not yet been tested for ACMs. The areas that may contain perchlorate residue in the basement will be sampled and analyzed for perchlorate at a laboratory before demolition activities begin.

3.2.2 Unit 4 Cell Building Demolition

A Preliminary Demolition Work Plan for Unit 4 cell building is provided in Appendix C. Data collected during the pre-demolition hazardous materials survey will be used to finalize the Demolition Work Plan for the Unit 4 cell building prior to demolition activities. A summary of some of the key elements of the Unit 4 cell building demolition is provided below:

- **Communication with Facility Personnel:** Prior to developing the final Demolition Work Plan for the Unit 4 cell building, Tetra Tech will interview facility personnel that have historic knowledge of the facility, the methods implemented, and the potential hazards encountered during demolition of Unit 1, 2, and 3 cell buildings. Tetra Tech has approached Tronox, Olin, and TIMET personnel, and they have agreed to share relevant data with the Trust. Best practices and approaches learned from previous unit building demolition activities will be incorporated into the final Demolition Work Plan.

- **Permits and Notification:** Prior to beginning fieldwork, Tetra Tech will provide copies of the approved final Demolition Work Plan for the Unit 4 cell building and the HASP to Tronox for review and concurrence. Tetra Tech will prepare and submit Hot Work and Ground Breaking Permit applications to Tronox in accordance with Tronox requirements. Tetra Tech and its subcontractors will also provide the required documentation for insurance, safety, and contracting requirements to Tronox for approval. Tetra Tech will notify the NDEP and the Clark County Air Pollution Control District, submit a Demolition Notification form, obtain a Dust Control Permit, and file a Dust Control Permit Closure Form. Fire department personnel will also be notified of the planned activities.

- **Work Zone Establishment:** Prior to beginning demolition activities, the limits of the proposed demolition work will be submitted to Tronox to obtain building plan records. Tetra Tech will also establish a work zone area to limit access and maintain safe conditions within the work area. Demarcation of the work zone may consist of using reflective plastic delineators or barricades, temporary fencing, caution tape, or signs.

- **Geophysical Utility Location:** Following Tronox approval of a Ground Breaking Permit for an area, Tetra Tech will retain the services of a geophysical utility location firm to identify buried utilities and other potential subsurface obstructions. Tetra Tech may also utilize alternate methods to identify the presence or absence of subsurface utilities, including but not limited to the use of an air-knife or other utility clearance method.

- **Structure Stabilization:** Prior to initiating demolition activities, Tetra Tech structural engineers will perform a structural survey of the Unit 4 cell building. The northern structure (Unit 4 chlorinator building) and southern structure (Unit 4 substation building) will not be demolished, and will be inspected for structural stability. The condition of the Unit 4 cell building floor, including the framing, floors, suspended pipelines, and walls will be inspected and secured, as needed, to prevent uncontrolled or premature collapse of any portion of the structure. Additionally, the western Unit 4 cell building basement wall will be evaluated to determine the optimal approach for constructing the access ramp from the ground surface to the basement.

- **Cell Floor Demolition:** The cell floor and its concrete support pedestals will be removed to provide sufficient access for the drilling rig. The demolition activities will be conducted in accordance with the methods outlined in the National Association of Demolition Contractors Demolition Safety Manual (2014) and American National Standards Institute ANSI A10.6-1983, Safety Requirements for Demolition Operations.

- **Waste Transportation and Disposal:** The debris generated from the Unit 4 cell building demolition will be temporarily stockpiled on-site and sorted into material-specific waste streams. Iron and other metals will be staged for shipment to appropriate recycling facilities. Concrete and other solid materials will be characterized for bulk waste disposal prior to shipping to the designated facility.

3.3 Construction of Ramp into Basement

A temporary equipment access ramp of sufficient width and grade will be constructed on the west side of Unit 4 cell building to allow construction and drilling equipment to access the basement. Only a portion of the west wall will be removed to construct the ramp. Access ramp preliminary construction details are provided in the Preliminary Demolition Work Plan for Unit 4 cell building (Appendix B). The tentative location for the proposed access ramp is shown on Figure 6.

Tetra Tech will work with Tronox, the demolition contractor, the drilling contractor, and structural engineers to finalize the location and design requirements for the access ramp. Design and construction of the access ramp will take into account the width and weight of the demolition and drilling equipment that will be used, as well as the maximum slope that the equipment will be able to traverse.

Once Tetra Tech, Tronox, and the demolition and drilling contractors agree on the location and design of the access ramp, the basement wall and ground surface footprint of the ramp will be marked with white paint. Prior to the demolition of the west basement wall, the building construction waste materials will be characterized for proper handling, management and disposal.

The demolition contractor will attempt to construct the ramp using existing on-site soil derived from the immediate area, in a manner which results in zero net change in soil volume (i.e. no import or export). However, as a contingency crushed concrete from the demolition and/or additional clean soil fill may be imported to complete the ramp. If any waste soil is generated during ramp construction, the soil will be managed in accordance with the SMP requirements. Waste characterization activities are discussed in more detail in Section 6.0.

3.4 Borehole Locations and Utility Clearance

Prior to performing any subsurface intrusive work, Tetra Tech will work with Tronox to ensure that the investigation area is cleared of subsurface utilities. A description of the utility clearance process is described in this section of the Work Plan.

As an initial step for the subsurface utility clearance, Tetra Tech will provide Tronox with a map depicting the locations of the planned intrusive work and obtain tentative approval for the proposed investigation locations. After obtaining tentative approval from Tronox, Tetra Tech will mark the proposed investigation locations in the field. The locations of the proposed investigation will be identified using a global positioning system unit or by a land surveyor. Following field marking of the proposed investigation locations, Tetra Tech will apply for a Ground Breaking Permit from Tronox. As part of the Ground Breaking Permit process, Tronox will review their utility records and identify any potential conflicts that may exist with the proposed investigation locations. If a conflict is identified, the proposed field investigation location(s) will be adjusted accordingly. Following resolution of any subsurface utility conflicts, Tronox will issue the Ground Breaking Permit.

Once all of the final investigation locations have been cleared and Tronox has issued the Ground Breaking Permit, Tetra Tech will retain the services of a geophysical locator to determine if there are any other underground utility lines that may not have been identified in Tronox's records. These may include abandoned or inactive service utilities. Tetra Tech may also utilize alternate methods to identify the presence or absence of subsurface utilities, including but not limited to the use of an air-knife or other utility clearance method. In the event that a buried utility line is identified at a proposed boring location, Tetra Tech will work with Tronox to determine if an alternative location is needed, or if the identified subsurface utility is abandoned and does not pose a risk.

If during field implementation a subsurface structure or utility is identified, Tetra Tech will cease drilling operations at that location, notify Tronox, and identify an appropriate course of action. The investigation area clearance procedure described in this section of the Work Plan will be followed prior to each field mobilization where intrusive activities are planned.

4.0 INVESTIGATION WORK PLAN

To effectively characterize the Investigation Area, Tetra Tech will perform the investigation using the HRSC strategies as defined by EPA. The HRSC strategies, associated technologies, and best practices will be used to ensure efficient collection of reliable data at an appropriate scale and density to effectively characterize heterogeneous environmental media during the site investigation.

Implementation of this Work Plan will be performed in compliance with the SMP, with the following exceptions:

1. Section 4.3 "Contingency Actions for Encountering Previously Unknown Contaminated Soil" of the SMP will not be followed during implementation of this Work Plan. If previously unknown contaminated soil is encountered, any additional samples needed for in-situ characterization of impacted soil will be addressed in step out borings and analyzed in accordance with methods described Section 4 and 5 of this Work Plan.

2. Section 4.2 of the SMP, "Soil Management for Excavation Control Area Soils" will be followed during implementation of this Work Plan with the exception of Section 4.2.4 "Confirmation Sampling for ECA Excavations". It is currently anticipated that the only area where soil excavation will occur during the implementation of this Work Plan is the construction of the earthen ramp from the ground surface level to the basement level, to allow construction and drilling equipment access to the basement level for Unit 4 building demolition and environmental investigation. Because the excavated soil will be used to construct an earthen access ramp rather than to remove potentially impacted soil, the provisions described in Section 4.2.4 of the SMP are not applicable.

The final remedy of any impacted soil discovered during this investigation will be determined during the Feasibility Study.

4.1 Investigation Overview

The HRSC strategies for the investigation will be supported by three-dimensional visualization and analysis (3DVA), best practices of dynamic work strategies, and expedited laboratory analysis. A preliminary 3DVA framework for the Investigation Area has been developed using Mining Visualization System (MVS) software and relevant existing data. The preliminary 3DVA framework for the Investigation Area is provided on Figure 7. The 3DVA will be used to support efficient analysis of the high-density datasets generated during field work. Using the preliminary framework as a starting point, successive 3D visualizations will be prepared to evaluate data completeness, uncertainties, and potential data gaps. The site-specific sampling plan will then be updated based on these results. Soil and groundwater analytical data will be provided to the 3DVA analyst daily. Visualization updates will be provided to the project team on a weekly basis.

The HRSC-based soil and groundwater characterization for the Investigation Area will consist of collecting geological, soil, and groundwater data from borings located along five transects aligned perpendicular to groundwater flow direction, from borings located in potential contaminant source areas (hot spots), and at step-out boring locations. Preliminary boring locations are shown on Figure 8. The transect boreholes are designed to provide scale-appropriate spatial data for 3DVA, and as such, the location and the number of borings may be adjusted based on field results. Additionally, the transect boreholes will be advanced in a "hop-scotch" pattern to provide a relatively uniform spatial distribution of data, which will minimize data gaps at any one time.

Borings will also be advanced at potential contaminant source areas, including cracks or stained areas on the concrete floor, the sump and drainage trenches in the Unit 4 cell building basement, and the railcar loading and unloading areas. If a source area has been confirmed, step-out borings (if needed) will be advanced at scale-appropriate locations adjacent to the source area for delineation. The strategy for advancing step-out borings will be based on statistical criteria that will be developed from data collected during the investigation. The statistical criteria will provide a means of comparing relative contaminant levels. A general decision flow for step-out soil boring is summarized in Figure 9. A detailed description of the investigation and data collection process is provided in Sections 4.2 and 4.3.

Based on the HRSC approach, three environmental field mobilizations are planned. An overview of the activities conducted during each mobilization is provided below.

- **First Field Mobilization** – The first field mobilization is not contingent on the decommissioning of the chlorine gas pipeline nor the building demolition, and can be implemented following NDEP approval of this Work Plan. Data generated during the first field mobilization will be used to direct and refine implementation of subsequent field mobilizations. Activities to be performed during the first mobilization are described below in Section 4.2.

- **Second Field Mobilization** – The second mobilization will be performed after the chlorine gas pipeline has been decommissioned and the Unit 4 cell building has been demolished. Data and results obtained during the first field mobilization will be used to direct the implementation of the majority of the environmental investigation to be performed during the second mobilization. Activities to be performed during the second mobilization are described below in Section 4.3.

- **Third Field Mobilization** – The third mobilization will be implemented following review of the soil and groundwater results obtained during the second mobilization and concurrence from NDEP on the placement and design of five to seven monitoring wells to be installed in the Investigation Area. Activities to be performed during the third mobilization are described below in Section 4.4.

Field methodologies and procedures to be implemented during the field mobilizations are described in Section 5.0 (Sampling and Analysis Plan) of this Work Plan.

4.2 First Field Mobilization

Implementation of the first field mobilization is not contingent upon the decommissioning of the chlorine gas pipeline positioned on the south side of the Unit 4 chlorinator building and can commence following NDEP approval of this Work Plan. During the first field mobilization, four soil borings will be advanced around the perimeter of the Unit 4 cell building to obtain site-specific data that will be used to direct and refine implementation of subsequent field mobilizations. The data obtained during the first field mobilization that will be used to finalize the approach for the second mobilization include:

- Depth to lithologic unit contacts (alluvium, xUMCf, and UMCf);

- Depth to first groundwater; and

- Depth to the base of the Shallow WBZ.

The four soil borings will be located along the north, south, east, and west sides of the Unit 4 cell building area, as illustrated on Figure 8. The initial four soil borings will be advanced to the depth that corresponds to the base of the Shallow WBZ (90 feet bgs as defined by NDEP). Continuous soil samples will be collected and logged from ground surface to total depth, as described in Section 5.0 of this Work Plan. Soil samples will be collected for laboratory analysis of perchlorate, total chromium, hexavalent chromium, and VOCs at 2.5-foot depth intervals. Perchlorate and hexavalent chromium/chromium are the primary chemicals of concern and the concentrations of these chemicals will be used as a basis for the step-out decisions as described in this section and illustrated on Figure 9. Additionally, VOCs will be analyzed based on historic Site operations and the presence of concentrations of chloroform in soils at the Investigation Area.

Three depth-discrete groundwater samples will be collected from the Shallow WBZ in each borehole and analyzed for perchlorate, total chromium, hexavalent chromium, TDS, and chloroform, as described in Section 5.0. Groundwater samples will be obtained at evenly spaced intervals within the Shallow WBZ. The depth to which these borings will be drilled for the purposes of the first mobilization is estimated to be 90 feet bgs (as defined by NDEP). Advancing the first four soil borings to a depth of 90 feet bgs will provide site-specific lithologic data to update the 3D visualizations and provide the information needed to develop the target total depth of soil borings to be advanced during the second mobilization. After the samples have been collected, each boring will be the destroyed using neat cement grout, cement/sand grout, cement/bentonite grout, or bentonite grout.

Following utility clearance of the initial four soil borings, a land surveyor will survey the location coordinates and elevation of existing monitoring wells located in the area, key features of the Unit 4 and 5 buildings, and surrounding features. Horizontal coordinates will be determined relative to the North American Datum of 1980 (NAD 83), with an accuracy of 0.1 foot. Ground surface elevations will be determined relative to the North American Vertical Datum of 1988 (NAVD 88), with an accuracy of 0.1 foot. The survey data will be used to establish the framework for 3DVA, which will be updated throughout the investigation.

Following the completion of the first field mobilization, Tetra Tech will summarize the results in a Technical Memorandum that will be submitted to the NDEP for review and concurrence. The Technical Memorandum will summarize the activities and results of the first field mobilization, provide a recommended target soil boring completion depth for borings drilled during the second field mobilization, and provide updated 3D visualizations. The completion depth recommendations will be based on the lithology encountered during drilling of the first four borings as well as the analytical results from those borings. The 3D visualizations will include the hydrogeological data gathered from the initial four soil borings advanced during the first field mobilization as well as from all soil borings and groundwater monitoring wells that have been advanced within the Investigation Area.

4.3 Second Field Mobilization

The second field mobilization will occur after submittal of the Technical Memorandum and NDEP concurrence, decommissioning of the chlorine gas pipeline attached to Unit 4 chlorinator building wall, demolition of the Unit 4 cell building floor and structural supports, and construction of the access ramp to the Unit 4 cell building basement. The second field mobilization will include the following activities:

- Advance soil borings along five transects consisting of approximately 9 to 15 borings. The borings will advanced from ground surface to the target completion depth determined from data collected during the first mobilization and NDEP concurrence.

- Advance additional soil borings at potential contaminant source areas. Potential contaminant source areas may include cracks or stained areas on the concrete floor, basement sump and drainage trenches in the Unit 4 cell building basement, and potential product spill areas (railcar loading and unloading areas).

- Collect three depth-discrete groundwater samples from the Shallow WBZ (top, middle, and bottom sections of the saturated water column) during drilling at each location using a depth-discrete sampling tool, as described in Section 5.0.

- Collect soil samples at 2.5-foot depth intervals and at changes in lithology or observed staining, and analyze the samples for perchlorate, hexavalent chromium, total chromium, and VOCs, as described in Section 5.0.

- Provide investigation data to the 3DVA analyst on a daily basis, to allow updated 3D visualizations to be provided to the project team on a weekly basis for updating the investigation plan (e.g., step-out borings).

- Fill each boring upon completion with neat cement grout, cement/sand grout, cement/bentonite grout, or bentonite grout.

- Survey elevations and horizontal coordinates for all soil boring locations, as described in Section 4.2.

Following the completion of the second field mobilization, Tetra Tech will review the data and provide recommendations on the effective placement and design of five to seven groundwater monitoring wells to be installed in the Investigation Area during the third mobilization as described in Section 4.4. The recommendations will be provided to NDEP in the form of a Technical Memorandum.

4.3.1 Field Investigation

Soil and groundwater data are needed in the Investigation Area to characterize the vertical and horizontal extent of impacted soil and groundwater. Soil borings will be advanced in the Investigation Area to address these data gaps. The soil borings will be advanced in five transects across the Investigation Area. As illustrated on Figures 7 and 8, the transects will be oriented in an east-west direction, perpendicular to the prevailing groundwater flow direction. The borings in each transect will be spaced approximately 60 feet apart, where feasible; however, the location of the borings may be adjusted based on the presence of subsurface utilities or other obstructions.

There will be an upgradient transect, located to the south of the Unit 4 and 5 buildings, as well as a downgradient transect, located to the north of the Unit 4 and Unit 5 buildings. In addition to these two transects, there will be three parallel transects, centered inside of the Unit 4 cell building. These transects will include soil borings to the east and west of the Unit 4 and 5 buildings, as well as soil borings within the Unit 4 cell building itself.

Data collected from these areas will be used to characterize the underlying soil and groundwater to determine to what extent the former operations at the Unit 4 and 5 buildings are a source to the site-wide perchlorate and hexavalent chromium plume. Each of the proposed soil borings will be advanced to a target completion depth based on the results of the first field mobilization and NDEP concurrence.

In addition to soil borings located along the five proposed transects, soil borings will be advanced in potential contaminant source areas. These potential contaminant source areas include the former railroad spur loading and unloading stations located south of the Unit 4 cell building, sumps, drains, trenches, visible cracks, or other stained or discolored surfaces. Selectively placed soil borings will be advanced to target these potential contaminant pathways. The location of the proposed soil borings are shown on Figure 8.

In order to maximize field efficiency and to minimize the duration of the second field mobilization, two drill rigs will be used to implement the investigation. Soil samples will be collected at 2.5-foot depth intervals for laboratory analysis of perchlorate, hexavalent chromium, total chromium, and VOCs. In addition to the prescribed soil sampling intervals, additional soil samples will be collected based on field observations, such as soil staining, soil color change, or change in lithology. Analytical laboratory data will be used to make field decisions regarding the need for step-out borings.

4.3.2 Step-Out Soil Borings

The preliminary strategy for evaluating the need for step-out borings is provided on Figure 9. If a contaminant source area is identified, step-out soil borings may be advanced at scale-appropriate distances to delineate the source area. The strategy for advancing step-out borings will be based on statistical criteria developed for perchlorate and hexavalent chromium using data collected during the investigation, as described below. Expedited laboratory analysis will be utilized, where needed, to guide the placement and the need for step-out borings.

To evaluate whether a particular area of impacted soil has been adequately characterized, perchlorate and hexavalent chromium concentrations will be compared with the 90^{th} percentile concentration within that area. If a concentration value is above the 90^{th} percentile, it is higher than 90% of the compared values and would require step-out sampling. A step-out soil boring will then be advanced at a scale-appropriate distance (e.g. approximately 30 to 120 feet), which will depend on factors such as concentration and potential size of the area. Where soil samples have been characterized to concentrations less than this criterion, characterization will be considered complete.

It is currently planned that each soil boring will be advanced to the target completion depth below the alluvium and UMCf-fg1 contacts. Once a soil boring is advanced to groundwater, three depth-discrete groundwater samples will be collected from the soil boring using a depth-discrete water sampler or by constructing a temporary well. The approximate depths of the groundwater samples will be defined following implementation of the first field mobilization.

4.4 Third Field Mobilization

The third field mobilization will consist of installing five to seven groundwater monitoring wells in the Investigation Area, and collecting groundwater samples from the newly installed wells and nearby existing groundwater monitoring wells. The third field mobilization will be implemented following NDEP concurrence with the second field mobilization technical memorandum, which will describe the proposed well locations. The third field mobilization will include the following activities:

- Construct five to seven groundwater monitoring wells in the Investigation Area.

- Collect groundwater level data and groundwater samples from each of the newly installed groundwater monitoring wells and from existing nearby groundwater monitoring wells (M-10, M-11, and M-12A) completed in the Shallow WBZ.

- Survey the monitoring wells and soil boring locations.

A total of five to seven groundwater monitoring wells will be installed at the NDEP-approved locations in the Investigation Area. Soil sample collection and analysis will be performed during drilling, if additional soil data are needed. The drilling and well installation will be completed as described in Section 5.0 (Sampling and Analysis Plan) and Section 5.5 (Groundwater Monitoring Well Installation and Sampling)of this Work Plan.

Following installation of the groundwater monitoring wells during the implementation of the third field mobilization, a land surveyor will survey the horizontal coordinates of each well relative to NAD 83 with an accuracy of 0.1 foot, and the elevation of the ground surface and top of well casing measuring point relative to NAVD 88 with accuracies of 0.1 foot and 0.01 foot, respectively. Groundwater analytical results and survey data will be used to update the 3DVA.

5.0 SAMPLING AND ANALYSIS PLAN

This section of the Work Plan provides a description of the methods that will be utilized during the implementation of the Work Plan. Sample collection and analysis activities will be performed in accordance with the approved Field Sampling Plan (FSP) (ENVIRON 2014b) and Quality Assurance Project Plan (QAPP) (ENVIRON 2014c) developed for the RI/FS. For other procedures that are not described within this Work Plan, the FSP and QAPP will be the guiding documents.

5.1 Drilling

Tetra Tech will advance soil borings using rotosonic, hollow-stem auger, or other appropriate drilling methods. The selected drilling method will allow the soil borings to be advanced safely and allow for the collection of continuous soil cores for accurate lithologic logging and soil sampling. The diameter of each boring will be a nominal eight inches or less. The eight-inch diameter soil boring will be used to allow construction of two-inch diameter groundwater monitoring wells. Smaller diameter borings may be used for the collection of soil and depth-discrete groundwater samples.

During drilling, continuous soil samples will be collected through the entire vertical soil profile. Soil samples will be collected for laboratory analysis at 2.5-foot depth intervals and at lithologic and color changes. If visible staining or discoloration is present, Tetra Tech will collect additional soil samples to target these areas for laboratory analysis.

Upon reaching groundwater, three depth-discrete groundwater samples will be collected from the soil boring, spaced at the top, middle, and bottom of the Shallow WBZ. Groundwater samples will be collected during the first and second mobilizations using a depth-discrete groundwater sampling tool or from temporary wells.

A qualified drilling contractor will be retained by Tetra Tech to advance soil borings, collect soil samples, collect depth-discrete groundwater samples, and construct groundwater monitoring wells. A qualified drilling contractor is one who has appropriate equipment capabilities, a license in the state of Nevada, Hazardous Waste Site Training as specified by CFR 1910.120, and experience on similar projects.

Before the drill rig mobilizes to each selected soil boring location, all down-hole drilling equipment will be cleaned with a high-pressure, high-temperature water spray to avoid potential cross-contamination. Tetra Tech personnel will review applicable reference materials such as well logs completed in the vicinity with the drilling contractor to facilitate drilling and logging operations.

5.2 Lithologic Logging

Soil samples will be stored in core boxes as they are brought to the surface. Continuous soil samples will be collected from ground surface to total depth and logged using the Unified Soil Classification System (USCS) by the onsite geologist.

Equipment used during lithologic logging will vary depending on materials encountered and sample collection methods. Field equipment used during logging may include any or all of the following items: hand lens, dropper bottle containing dilute hydrochloric acid, Munsell™ color chart, USCS classification chart, grain size chart, sample collection bags, sample collection sieve, chip tray, tape measure, and appropriate field forms. Soil sample collection procedures will be reviewed with the field personnel and drilling subcontractor. A logging station will be set up adjacent to the drill rig.

Continuous core soil samples will be collected through the entire soil profile from each soil boring. All geologic/soil cuttings and samples will be logged according to the following procedures, which utilize modified ASTM Method D-2488, as follows:

Textural Classification of Soil: Record the proportion of the following grain size fractions present in the sample: gravel, sand, silt, clay, and organic matter. Estimate and record the predominant grain size(s) present within the gravel and sand fractions in the sample. The on-site geologist will record drilling conditions that may affect the grain size; for example, the crushing of gravel into sand-sized grains.

Color Classification of Soil: Provide a subjective description of soil color in accordance to the Munsell™ color chart, including hue and chroma values. For example, the description light brown, red-brown, or dark brown could be used in describing a soil which has an overall brown appearance.

Coloration: Describe the staining or overall color characteristics including mottling, uniformity, etc.

Grain Type: Describe the type of grains of the dominant grain size. Descriptors include quartz, rock fragment, fossil, and biological (shells, etc.).

Grading: Estimate the degree of grading, overall grain size distribution, of soil samples. Designate by using one of the following descriptors: poorly graded, moderately graded, or well graded. The descriptor “well graded” applies to soil in which there is a poor representation of the continuum of particle sizes. The descriptor “poorly graded” applies to soil in which most particles are approximately the same size.

Roundness: Estimate the predominant roundness categories for the sand and gravel size fractions. The roundness categories are: very angular, angular, sub-angular, sub-rounded, rounded, and for gravel, striated, and faceted.

Matrix: Include a description of the finer material in the sample, if possible. Classification requires a description as either matrix-supported or clast/grain-supported, with a description of the nature of the matrix material.

Plasticity: Determine the degree of plasticity of the lithologic sample. Plasticity is the property in which a soil/sediment can be rapidly deformed or molded without rebounding elastically, changing volume, cracking, or crumbling. Plasticity descriptors are: none, low, medium, and high.

Cementation: Describe the degree to which the formation material is indurated. Descriptors include weak, moderate, and strong.

Strength: Describe the relative strength of the soil. Descriptors include cohesive, non-cohesive, stiff, firm, soft, and loose.

Lithologic Contact from Core or Cuttings: Record the depth of each lithologic contact and thickness of each lithologic unit encountered.

The soil samples will be logged relative to the ground surface, with the surface represented as 0 feet bgs on each log. However, all depth-dependent information (e.g., lithology, sample intervals, depth to water, etc.) will be corrected for elevation (established during the surveys) before it is entered into the 3DVA.

5.3 Analytical Soil Sample Collection

Soil samples selected for laboratory analysis will be submitted to the project analytical laboratory for analysis of perchlorate by USEPA Method 314.0, hexavalent chromium by USEPA Method 7199, total chromium by USEPA 200.7 / 6010B, and VOCs by USEPA Method 8260B.

Soil samples for laboratory analysis will be collected in laboratory-supplied containers, labeled, placed in plastic bags, and stored in a cooler on ice for transport to the project analytical laboratory. Soil samples for perchlorate, hexavalent chromium, and total chromium will be collected in laboratory soil sample jars. Soil samples for VOCs will be collected in En Core or Terra Core samplers by USEPA Method 5035 or 5035A to reduce volatilization and biodegradation of soil samples. The drillers will decontaminate soil collection equipment between samples. Additional details regarding sampling and transportation protocols are discussed below in Section 5.6.

5.4 Depth-Discrete Groundwater Sampling

Once a soil boring is advanced to groundwater, three depth-discrete groundwater samples will be collected. The groundwater samples will be collected at the top, middle, and bottom of the Shallow WBZ. For the purposes of this Work Plan, the top of the Shallow WBZ is defined as the first groundwater encountered, which is expected to occur between 40 and 50 feet bgs and the bottom of the Shallow WBZ is defined by NDEP as 90 feet bgs. The middle groundwater sample will be collected between the top and bottom groundwater samples for each borehole. For example, if the Shallow WBZ is encountered at 50 feet bgs, groundwater samples will be collected at approximately 50, 70, and 90 feet bgs. The base of the shallow WBZ will be defined during the first mobilization and presented for NDEP concurrence in a Technical Memorandum submitted following completion of the first mobilization.

There are several options available for the collection of depth-discrete groundwater samples. Either a depth-discrete sampling tool or a temporary well will be used to collect the groundwater sample. Each of these approaches are discussed below:

- Hydropunch™ and Simulprobe™ are two types of depth-discrete sampling tools that could be utilized and function similarly. Once the driller is at the targeted groundwater sampling interval the Hydropunch™ or Simulprobe™ is advanced ahead of the lowermost drill rod into undisturbed soil to collect a groundwater sample. After groundwater enters the sampler, the groundwater sample is retrieved to the surface using a small diameter bailer and poured into a clean laboratory-supplied container. In the event that a depth-discrete groundwater sample cannot be collected from a specific interval because the formation does not yield sufficient water, the soil boring will be advanced an additional 2 to 5 feet and the process will be repeated to collect a depth discrete sample.

- Constructing a temporary well is another method that may be used to collect a depth-discrete groundwater sample, depending upon the properties of the formation. A temporary well may consist of a manufacturer-supplied small diameter polyvinyl chloride (PVC) pre-packed well or may consist of a standard field-constructed small diameter well. If a standard field constructed approach is utilized, the temporary well will consist of a two-inch diameter or smaller PVC well casing with five feet of 0.010-inch slot screen, and an appropriately sized sand filter pack installed around the well screen up to two feet above the top of the screen interval.

Regardless of whether a manufacturer-supplied small diameter pre-packed well or standard temporary field constructed well is installed, the temporary well will be purged prior to collecting the depth-discrete groundwater sample. A minimum of three casing volumes of water will be purged prior to sampling, if the formation allows. Following purging, a small diameter bailer will be lowered into the temporary well and a groundwater sample will be retrieved to the surface. The collected groundwater sample will then be poured into a clean laboratory-supplied container.

Depth-discrete groundwater samples will be submitted to the laboratory for perchlorate analysis using USEPA Method 314.0, hexavalent chromium analysis by USEPA Method 7199, total chromium by USEPA 200.7 / 6010B, TDS analysis by Method SM2540C, and VOC analysis by USEPA Method 8260B. Details regarding sample handling and transportation protocols are discussed below in Section 5.6.

Following the collection of soil and groundwater samples, the temporary well materials (if installed) will be removed and the boreholes will be plugged in accordance with the State of Nevada Department of Conservation and Natural Resources (NDCNR) regulations. The drillers will place concrete grout, neat cement, or bentonite grout from the bottom of the boring to the surface using a tremie pipe as required in the “Regulations for Water Well and Related Drilling” guidelines provided by NDCNR. The top of the seal material will be finished to match the surrounding grade.

5.5 Groundwater Monitoring Well Installation and Sampling

Tetra Tech will work with NDEP and NERT to review the soil sample and depth-discrete groundwater results obtained during the second field mobilization and finalize the locations of the proposed groundwater monitoring wells. It is currently anticipated that between five and seven groundwater monitoring wells will be installed in the Investigation Area to provide on-going groundwater monitoring data.

Following the completion of the second field mobilization, Tetra Tech will review the data and will provide recommendations for the placement and design of five to seven groundwater monitoring wells to be installed in the Investigation Area. Tetra Tech will work with Tronox to ensure that the proposed well locations do not impact Tronox’s ongoing operations. The recommendations will be provided to NDEP in a Technical Memorandum.

It is anticipated that the new monitoring wells will be screened across the water table with a maximum well screen length of 20 feet, consistent with existing shallow monitoring wells M-10, M-11, M-12, and recently installed shallow monitoring wells M-189 through M-193. This approach will allow direct comparison of the groundwater level and chemical data. At this time, the depth to groundwater is approximately 41 to 43 feet bgs, and the base of the Shallow WBZ as defined by NDEP is 90 feet bgs. If the groundwater depth-discrete sample results indicate that monitoring wells are needed in deeper intervals of the Shallow WBZ, nested-wells may be installed in a single borehole to provide comparison of water quality at various depths. Longer screen monitoring wells (e.g., screened across the entire Shallow WBZ from approximately from 35 to 90 feet bgs) are not planned for groundwater quality monitoring in the Investigation Area.

The proposed monitoring wells will be constructed in accordance with the FSP, and will consist of two-inch diameter, Schedule 40 PVC casing, with 0.010-inch slot size well screen, installed inside an eight-inch diameter borehole. Nested monitoring wells (i.e., multiple well casings installed inside one borehole) maybe installed to monitor groundwater conditions at different depths within the Shallow WBZ. If nested wells are installed, a larger diameter borehole will be necessary. A washed sand filter pack will be installed in the annular space around the well screen up to two feet above the top of the screen interval. The filter pack will be followed by a minimum of two feet of hydrated bentonite, followed by neat cement grout. Figure 10 shows a typical monitoring well design.

The surface completions for the monitoring wells may vary based on whether they are located in vehicle traffic areas. In traffic areas, flush mounted, tamper-resistant, traffic rated well boxes will be installed, at an elevation approximately one-half inch above grade. In areas where there is no vehicle traffic, the completion may consist of a tamper-resistant steel monument casing constructed with a concrete apron. The top of the casing will extend approximately three feet above surrounding grade. If needed, three bollards surrounding the monitoring well monument casing may be installed.

Following the completion of monitoring well construction, but no sooner than 24 hours after well construction is compete, Tetra Tech will develop each of the newly installed monitoring wells. Well development will consist of using a surge block and bailer to swab and surge the filter pack and remove sediment from the well. This process will be followed by pumping with a submersible pump to purge the well of fine-grained sediment. Well development will be considered complete when three to ten casing volumes of water have been removed from the well and index parameters consisting of pH, specific conductivity, turbidity, and temperature are within 10 percent over three consecutive measurements. All index parameter readings will be recorded by Tetra Tech on well development logs.

When development is complete, the water level in the well will be allowed to recover to at least 90 percent of the static water level prior to collecting a groundwater sample. Groundwater samples will be collected using low-flow purging and sampling techniques. During low-flow purging of the wells, a pump will be used capable of purging between approximately 0.1 to 0.13 gallons per minute, to minimize drawdown and induce inflow of fresh groundwater. The pump discharge water will be passed through a flow-through cell field water analyzer for continuous monitoring of field parameters (temperature, pH, turbidity, specific conductance, dissolved oxygen, and oxidation reduction potential [ORP]). Field parameters will be monitored and recorded on the field sampling forms during purging. Purging will be considered complete and the wells will be sampled when the field parameter readings and water levels have stabilized, or after a maximum of one hour of purging.

Groundwater samples collected from the monitoring wells will be analyzed for the chemicals of potential concern (COPCs) identified in Section 5.1.4.2 of the RI/FS Work Plan. These COPCs are provided in Table 1 along with their respective analytical methods.

5.6 Sample Packaging and Transport

Collected soil and groundwater samples will either be analyzed at an on-site mobile laboratory, local fixed-base laboratory, or TestAmerica of Irvine, California. TestAmerica has a sample drop off location in Las Vegas. For much of the field investigation, expedited analytical services will be required to facilitate field decisions with respect to step-out borings and updates to the 3DVA. The viability of a mobile laboratory versus a fixed-based laboratory is being evaluated with regards to sample throughput, reporting limits, and sample turnaround times.

Environmental samples will be placed in appropriate laboratory-supplied containers. Both soil and groundwater sample containers will be labeled, contained in airtight plastic bags and immediately placed in an ice-filled cooler to maintain a sample temperature of 4^{o} C or less. Sample labels will contain at a minimum the following information:

- Site name and project number;
- Sample identification number. The sample identification number for soil samples will incorporate the soil boring identification number and the depth the sample was collected from (e.g., SA-210-35' would represent a sample collected from soil boring SA-210 at a depth of 35 feet bgs);
- Date and time of sample collection. The time will be recorded in 24-hour clock format to avoid ambiguity;
- Preservative, if any;
- Name or initials of sampler; and
- Analyses requested.

If samples are to be delivered to a fixed-base laboratory, glass sample containers will be wrapped with bubble wrap to minimize the potential for breakage during transport. The chain of custody (COC) will be placed in its own airtight plastic bag for transport to the laboratory. The sample coolers will be delivered to the off-site local laboratory or the TestAmerica sample drop off location, or picked up at the Site by a laboratory courier.

In the event that the coolers are shipped, a custody seal will be affixed to the cooler before transport. Coolers that are shipped will adhere to the requirements outlined in the FSP and Department of Transportation (DOT) requirements.

If samples are to be analyzed on-site using a mobile laboratory, the samples will be packed on ice in a cooler by the sample technician and transported with a COC to the mobile laboratory for analysis.

5.7 Quality Assurance/Quality Control Sample Collection

Tetra Tech will collect field quality assurance/quality control samples in accordance with the FSP, which specifies the following:

- Equipment Blanks
    - Obtained by filling decontaminated sampling equipment with reagent-grade deionized (DI) water and sampling the water
    - Collected at a frequency of one in every 20 samples
- Field Blanks
    - Obtained by filling a clean sampling container with reagent-grade DI water, in the field at a sample location
    - Collected at a frequency of one in every 20 samples

- Trip Blanks
  - Prepared by the analytical laboratory by filling volatile organic analysis vial with reagent-grade DI water and adding to the cooler as soon as the first sample is collected
  - Collected at a frequency of one for every cooler containing VOC samples

- Field Duplicates
  - Collected sample will be labeled and packaged in the same manner as primary samples, but with "FD" appended to the sample identification, which is consistent with the FSP approved by NDEP
  - Collected at a frequency of one in every 10 samples

- Matrix Spike/Matrix Spike Duplicates (MS/MSD)
  - A double sample volume of field samples will be collected for samples to be used for MS/MSD
  - Collected at a frequency of one in every 20 samples

5.8 Data Verification and Validation

Samples collected during the field investigation will be reviewed in accordance with the data quality objectives established for the field activity, as described in the QAPP. Data validation will be conducted in accordance with the QAPP, NDEP's Supplemental Guidance on Data Validation (NDEP 2009), and Guidance on Validation for Asbestos Data in Soils for the BMI Plant Sites and Common Areas Projects (NDEP 2012). Electronic data deliverables will be prepared in accordance with the NDEP's Guidance on Unified Chemical Electronic Data Deliverable Format (NDEP 2013) and submitted to NDEP for uploading to the NDEP Site-Wide Database. Data validation will include a review of the following:

- COPCs, media, and associated analytical methods;

- Laboratories procedures and required detection limits; and

- Procedure(s) for establishing data quality criteria.

6.0 MANAGEMENT OF INVESTIGATION-DERIVED WASTES

Investigation-derived waste (IDW) generated during the soil and groundwater investigation will be managed according to applicable state, federal, and local regulations and as described in *Field Guidance Document No.001, Managing Investigation-Derived Waste* (ENVIRON 2014b) and the SMP. A copy of the IDW management plan is provided as Appendix C.

The IDW that will be generated during the environmental investigation includes soil cuttings, personal protective equipment, equipment decontamination water, and groundwater generated during depth-discrete groundwater sampling, well development and groundwater sampling.

Investigation-derived soil waste will be stored in plastic-lined roll-off bins, if feasible. If the volume of soil generated makes storage in roll-off bins infeasible, the soil will be stockpiled on a double-layer 6- to 10-mil plastic liner, with the stockpile covered with plastic sheeting or a tarp at all times, except when the material is being handled. If a stockpile is constructed, berms will be constructed around the stockpile to control precipitation run-on and run-off.

A summary of the IDW management plan is outlined below:

- All IDW will be temporarily contained, labeled and stored on-site in DOT-approved containers (e.g., 55-gallon drums, roll-off bins, or other approved storage container).

- Solid waste materials (i.e. soil cuttings) will be stored on-site separately from liquid waste materials (i.e. purge water, wash and decontamination rinse water).

- Waste storage container information, such as serial numbers of bins and tanks, will be recorded in field logs.

- All containers that are used to hold soil cuttings will be secured by closing and securing the lids.

- Waste water generated during purging or decontamination activities will be temporarily stored in 55-gallon drums and transferred into the GW-11 pond.

- Drums, bins, and tanks will be labeled with "pending analysis" labels, the date accumulation began, contents, source, and contact information, and stored in a designated area.

- Solids and waste water will be characterized by collecting representative samples, as necessary, to determine disposal options. Depending upon the size of the container, one sample may be sufficient for characterization, or several samples may be composited in the field. Generally, a minimum of one sample will be collected for each 10 cubic yards of solid waste, each roll-off bin, or tank for disposal of drilling waste. The receiving waste facility will have specific laboratory analysis requirements. Waste sample analysis will be determined by the receiving waste facility analysis requirements.

- Non-hazardous or unclassified waste may be transported to the waste storage area using appropriate tools such as a dolly, truck, or loader, while the container lids are closed. Hazardous waste may be moved on-site using the same procedures; however, transportation by a vehicle on public right-of-way will require a licensed hauler in accordance with all Resource Conservation and Recovery Act and EPA requirements. All waste manifests will be signed by a NERT representative or designee.

- Copies of the waste manifests, laboratory data sheets, and COC forms will be provided in the final report.

Solids will be characterized by collecting representative samples, as necessary, to determine disposal options. It is anticipated that each sample will be submitted for the following analyses:

- VOCs by USEPA Method 8260B;
- Perchlorate by USEPA Method 314.0;
- OCPs by USEPA Method 8081A;
- pH by USEPA Method 9045D;
- Dioxins/Furans by USEPA Method 8290;
- Asbestos by USEPA Method 600/R-93-116;
- SVOCs by USEPA Method 8270C;
- Metals by USEPA Method 6010B;
- PCBs by USEPA Method 8082; and
- Flashpoint/Ignitability by SW846 7.1.2.

7.0 REPORTING

This section lists documents that Tetra Tech will prepare during and at the completion of the implementation of this Work Plan.

A summary of the project deliverables is presented below.

- Final Demolition Work Plan for Unit 4 cell building. The final Demolition Work Plan will describe the methods and procedures for building demolition and construction of an access ramp into basement.

- First Field Mobilization Technical Memorandum. The Technical Memorandum will summarize the activities and results of the first field mobilization, provide a recommended target soil boring completion depth for borings drilled during the second field mobilization, and provide updated 3D visualizations.

- Second Field Mobilization Technical Memorandum. The Technical Memorandum will summarize the activities and results of the second field mobilization and provide recommendations for the placement and design of five to seven groundwater monitoring wells to be installed in the Investigation Area during the third mobilization.

- Unit 4 and 5 Buildings Investigation Report. Following completion of all work described in this Work Plan, Tetra Tech will prepare a comprehensive Unit 4 and 5 Buildings Investigation Report that is consistent with the RI/FS process. During the report development stage, Tetra Tech will coordinate with ENVIRON regarding report format and the broader RI/FS work being conducted. The investigation report will present a summary of the findings of the investigation and will include, but not be limited to the following information:

    - A description and chronology of field activities;
    - Results of the waste characterization, demolition, and access ramp construction activities;
    - Tabulated soil and groundwater sampling results;
    - Maps and figures including borehole and well location maps, 3DVA, and transect figures;
    - Borehole and well construction logs;
    - Waste manifests, laboratory COC forms, laboratory data reports, laboratory data validation reports;
    - Photographic log of field activities; and
    - Findings, conclusions, and recommendations derived from the environmental investigation.

8.0 PROJECT SCHEDULE

The proposed scope of work described in this Work Plan consists of four main work elements that include three environmental field mobilizations and the demolition of the Unit 4 cell building. The project schedule is built around the decommissioning of the chlorine gas pipeline suspended on the south side of the Unit 4 chlorinator building, which is currently scheduled to be completed by the end of April 2015. A brief description of each of the four main work elements and approximate timetable for completion is presented below.

1. The first field mobilization will be performed following NDEP approval of this Work Plan, and can be performed prior to the decommissioning of the chlorine gas pipeline. It is currently anticipated that this work will commence in the second quarter 2015 and is expected to require less than one month to complete.

2. Following decommissioning of the chlorine gas pipeline, the Unit 4 cell building will be demolished and the access ramp will be constructed. It is currently anticipated that this work will commence during the third quarter and be completed in the fourth quarter 2015. Construction of an access ramp and the demolition of the Unit 4 cell building is expected to require two to three months to complete.

3. Following demolition of the Unit 4 cell building and construction of the access ramp, the second field mobilization, consisting of advancing soil borings and collecting soil and depth-discrete groundwater samples, will be performed. It is currently anticipated that this work will be completed by the end of the fourth quarter 2015. Implementation of the second field mobilization is expected to require two to three months.

4. Following NDEP review and concurrence on the proposed monitoring well locations, the third field mobilization, consisting of the construction of five to seven groundwater monitoring wells and groundwater sampling, will be implemented. It is currently anticipated that this work will be completed during the first quarter 2016. Implementation of the third field mobilization is expected to require one to two months.

A detailed schedule will be prepared following NDEP approval of this Work Plan and the decommissioning of the chlorine gas pipeline.

9.0 REFERENCES

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FIGURES

MAP LOCATION

Nevada Environmental Response Trust Site

Unit 4 and 5 Buildings Investigation Area

Notes:
(1) Basemap and Inset: ESRI Street Map, 2014
(2) Coordinate System: NAD 1983 State Plane Nevada East, U.S. Survey Feet

TITLE: **NERT Location Map**

LOCATION: **Nevada Environmental Response Trust Henderson, Nevada**

TETRA TECH

APPROVED	SB	FIGURE
DRAFTED	SC	1
PROJECT#	114-520225	
DATE	3-18-2015	

Document Path: P:\Databases\Henderson, Nevada\GIS\Figure 1 NERT Location.mxd

Legend

Unit 4 and 5 Buildings Investigation Area

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

N

0 125 250 500 Feet

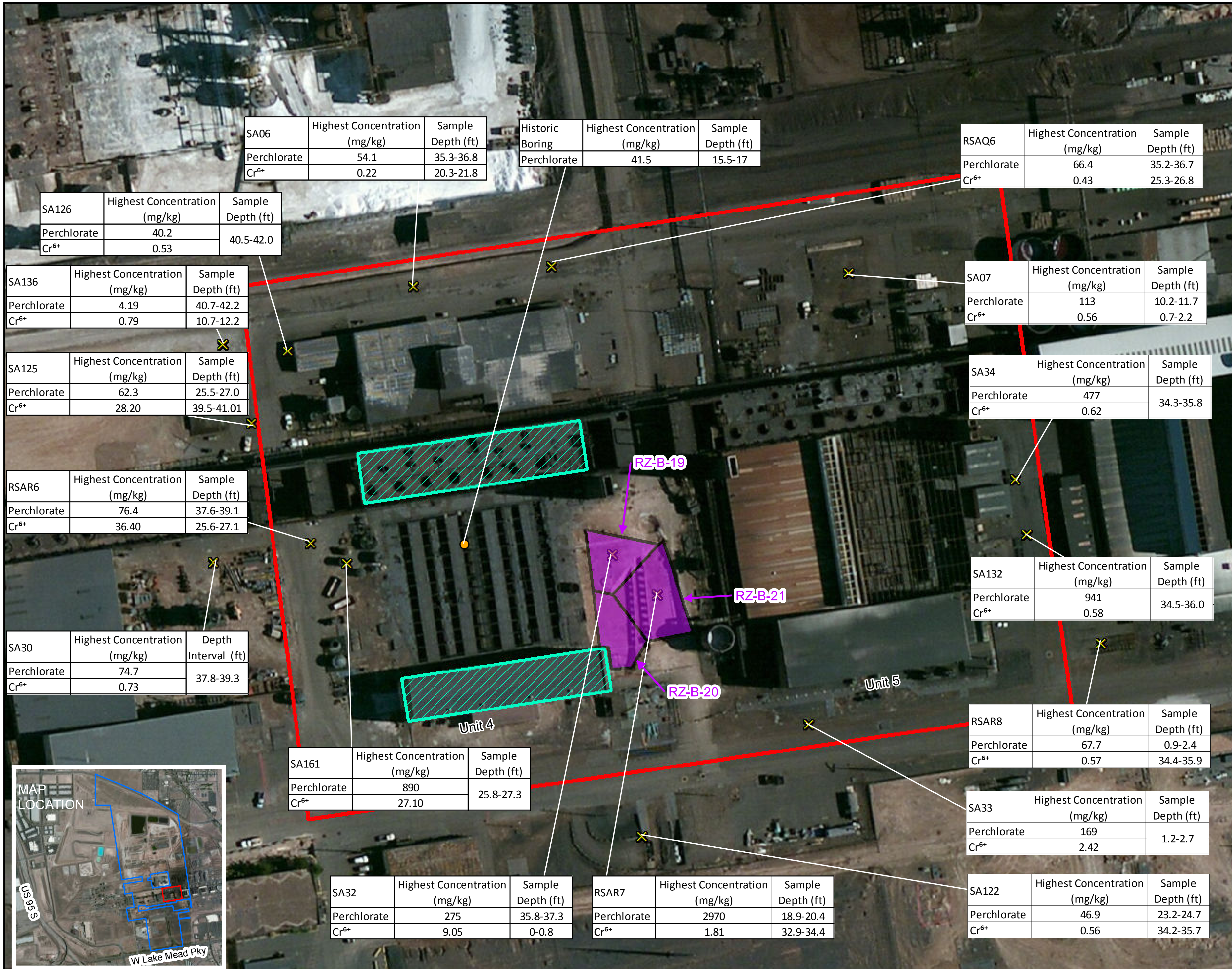
TITLE: **Unit 4 and 5 Buildings Investigation Area**

LOCATION: **Nevada Environmental Response Trust**
Henderson, Nevada

TETRA TECH

APPROVED	JW	FIGURE
DRAFTED	MM	2
PROJECT#	117-0504158	
DATE	3-27-2015	

Document Path: P:\Databases\Henderson, Nevada\GIS\Figure 2 Unit Buildings.mxd



SA06	Highest Concentration (mg/kg)	Sample Depth (ft)
Perchlorate	54.1	35.3-36.8
Cr^{6+}	0.22	20.3-21.8

Historic Boring	Highest Concentration (mg/kg)	Sample Depth (ft)
Perchlorate	41.5	15.5-17

RSAQ6	Highest Concentration (mg/kg)	Sample Depth (ft)
Perchlorate	66.4	35.2-36.7
Cr^{6+}	0.43	25.3-26.8

SA126	Highest Concentration (mg/kg)	Sample Depth (ft)
Perchlorate	40.2	40.5-42.0
Cr^{6+}	0.53	

SA136	Highest Concentration (mg/kg)	Sample Depth (ft)
Perchlorate	4.19	40.7-42.2
Cr^{6+}	0.79	10.7-12.2

SA07	Highest Concentration (mg/kg)	Sample Depth (ft)
Perchlorate	113	10.2-11.7
Cr^{6+}	0.56	0.7-2.2

SA125	Highest Concentration (mg/kg)	Sample Depth (ft)
Perchlorate	62.3	25.5-27.0
Cr^{6+}	28.20	39.5-41.01

SA34	Highest Concentration (mg/kg)	Sample Depth (ft)
Perchlorate	477	34.3-35.8
Cr^{6+}	0.62	

RSAR6	Highest Concentration (mg/kg)	Sample Depth (ft)
Perchlorate	76.4	37.6-39.1
Cr^{6+}	36.40	25.6-27.1

SA132	Highest Concentration (mg/kg)	Sample Depth (ft)
Perchlorate	941	34.5-36.0
Cr^{6+}	0.58	

SA30	Highest Concentration (mg/kg)	Depth Interval (ft)
Perchlorate	74.7	37.8-39.3
Cr^{6+}	0.73	

RSAR8	Highest Concentration (mg/kg)	Sample Depth (ft)
Perchlorate	67.7	0.9-2.4
Cr^{6+}	0.57	34.4-35.9

SA161	Highest Concentration (mg/kg)	Sample Depth (ft)
Perchlorate	890	25.8-27.3
Cr^{6+}	27.10	

SA33	Highest Concentration (mg/kg)	Sample Depth (ft)
Perchlorate	169	1.2-2.7
Cr^{6+}	2.42	

SA32	Highest Concentration (mg/kg)	Sample Depth (ft)
Perchlorate	275	35.8-37.3
Cr^{6+}	9.05	0-0.8

RSAR7	Highest Concentration (mg/kg)	Sample Depth (ft)
Perchlorate	2970	18.9-20.4
Cr^{6+}	1.81	32.9-34.4

SA122	Highest Concentration (mg/kg)	Sample Depth (ft)
Perchlorate	46.9	23.2-24.7
Cr^{6+}	0.56	34.2-35.7

Legend

- Historic Boring
- Remedation Zone (RZ) Polygons
- Previous Soil Boring/Soil Sampling Locations (Approximate)
- Existing Unit 4 Building (Not to be demolished). Active tenant area
- Unit 4 and 5 Buildings Investigation Area

All concentrations listed are highest concentration detected from each soil boring

Polygon RZ-B-19 has been excavated to 1.5' bgs, while RZ-B-20 and RZ- B-21 have been excavated to 6' to 10' bgs.

mg/kg - milligrams per kilogram

Cr^{6+} - Hexavalent Chromium

Data Source: Environ 2014, Summary of Available Data for LOUs 43, 11, 12 and 15

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, USDA, SUGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

N

0 62.5 125 250 Feet

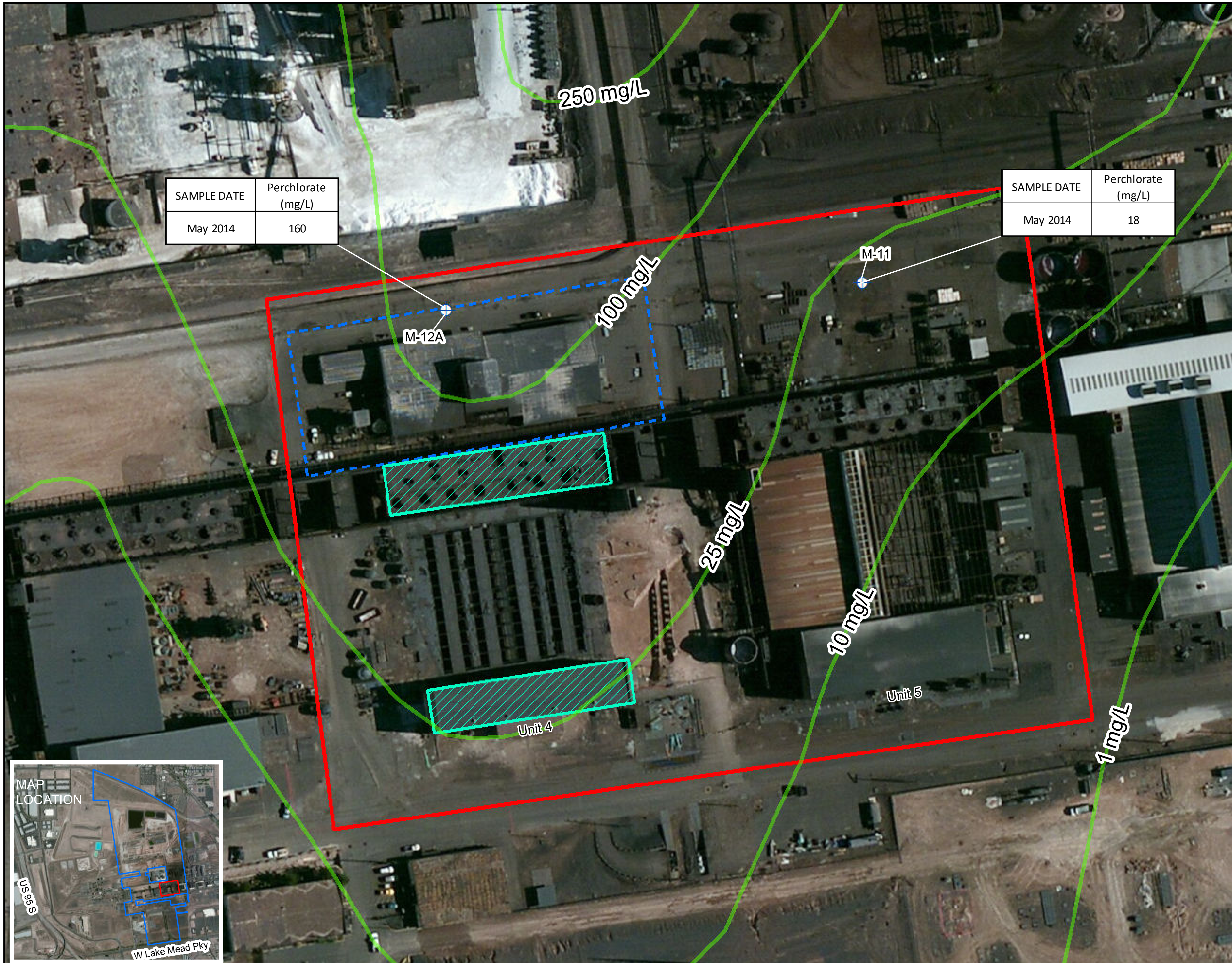
TITLE: **Perchlorate and Hexavalent Chromium Concentrations in Soil**

LOCATION: **Nevada Environmental Response Trust Henderson, Nevada**

TETRA TECH

APPROVED	JW	FIGURE
DRAFTED	MM	3
PROJECT#	117-0504158	
DATE	3-27-2015	

Document Path: P:\Databases\Henderson, Nevada\GIS\Figure 3 Perchlorate and Hexavalent Chromium Concentrations in Soil.mxd



Legend

- Interpreted Perchlorate Concentration Contours (mg/L, Environ 2014)
- Existing Shallow Groundwater Monitoring Well Locations (Approximate)
- Existing Unit 4 Building (Not to be demolished). Active tenant area
- Unit 4 and 5 Buildings Investigation Area
- Department of Homeland Security Restricted Area

mg/L - milligrams per liter

Datasource: Annual Remedial Performance Report for Chromium and Perchlorate July 2013 - June 2014, Environ 2014

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

N

0 62.5 125 250 Feet

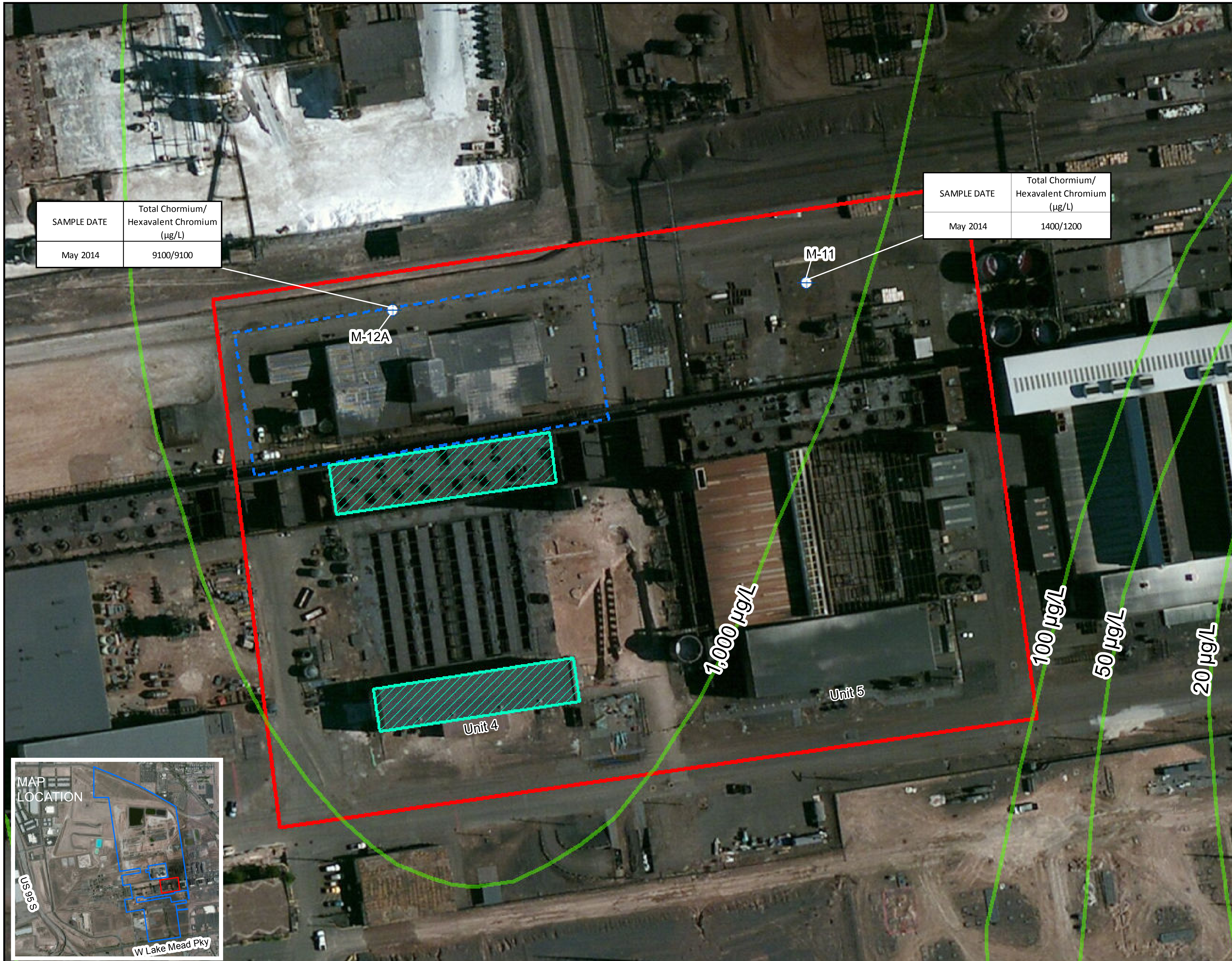
TITLE: **Perchlorate Concentrations in Shallow Groundwater**

LOCATION: **Nevada Environmental Response Trust Henderson, Nevada**

TETRA TECH

APPROVED	JW	FIGURE
DRAFTED	MM	4
PROJECT#	117-0504158	
DATE	3-27-2015	

Document Path: P:\Databases\Henderson, Nevada\GIS\Figure 4 Perchlorate Concentrations in Shallow Groundwater.mxd



Legend

- Interpreted Total Chromium Concentration Contours (µg/L, Environ 2014)
- Existing Shallow Groundwater Monitoring Well Locations (Approximate)
- Existing Unit 4 Building (Not to be demolished). Active tenant area.
- Unit 4 and 5 Buildings Investigation Area
- Department of Homeland Security Restricted Area

µg/L - micrograms per liter

Datasource: Annual Remedial Performance Report for Chromium and Perchlorate July 2013 - June 2014, Environ 2014

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

N

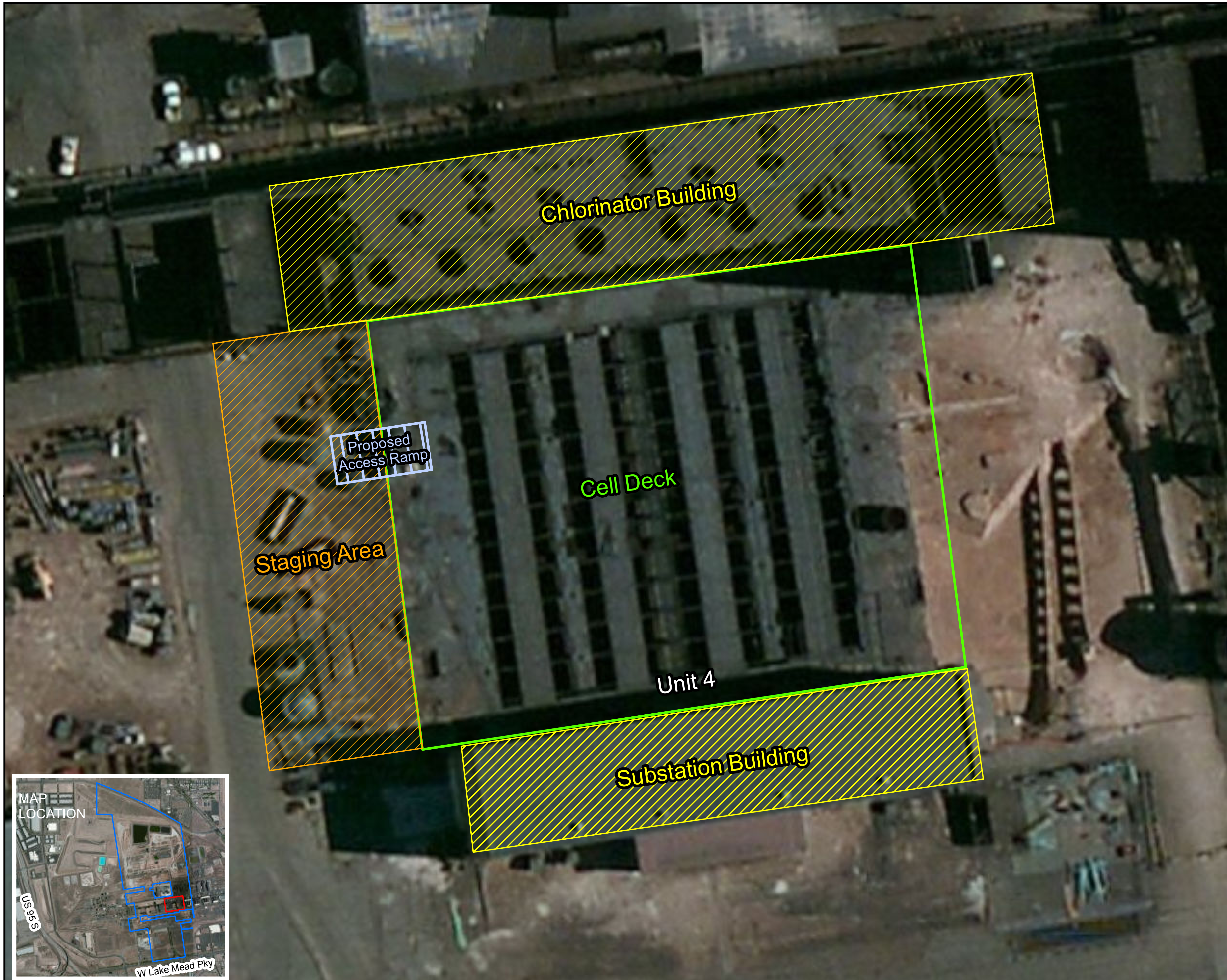
0 62.5 125 250
Feet

TITLE:	**Total Chromium and Hexavalent Chromium Concentrations in Shallow Groundwater**
LOCATION:	**Nevada Environmental Response Trust Henderson, Nevada**

TETRA TECH

APPROVED	JW	FIGURE
DRAFTED	MM	5
PROJECT#	117-0504158	
DATE	3-27-2015	

Document Path: P:\Databases\Henderson, Nevada\GIS\Figure 5 Total Chromium and Hexavalent Chromium.mxd



Legend

- Proposed Access Ramp
- Existing Unit 4 Building (Not to be demolished)
- Staging Area
- Cell Deck

N

0 25 50 100 Feet

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

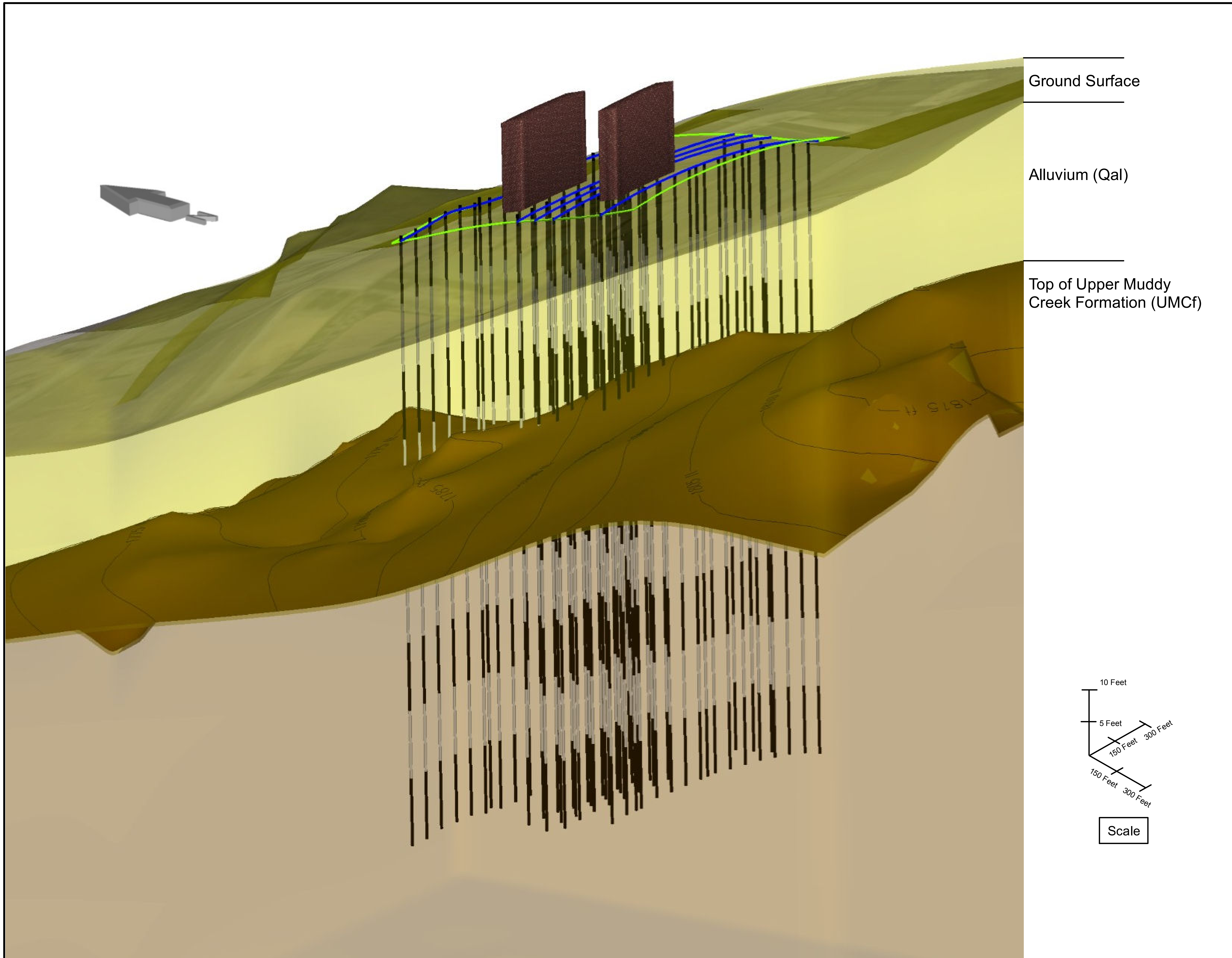
TITLE: Unit 4 Cell Building - Access Ramp

LOCATION: Nevada Environmental Response Trust
Henderson, Nevada

TETRA TECH

APPROVED	JW	FIGURE
DRAFTED	MM	6
PROJECT#	117-0504158	
DATE	3-27-2015	

Document Path: P:\Databases\Henderson, Nevada\GIS\Figure 6 Unit 4 Building - Access Ramp.mxd



Legend

- Ground Surface
- Quaternary Alluvial Deposits
- Top of Upper Muddy Creek Formation
- Upper Muddy Creek Formation
- Existing Unit 4 Building (Not to Scale)
- Sampling Transects
- Unit 4 and 5 Buildings Investigation Area
- Boreholes (Boring Trace Alternates Colors Every 10 Feet in Depth)

References

• Annual Remedial Performance Report for Chromium and Perchlorate, July 2012-June 2013; Nevada Environmnetal Response Trust Site, Henderson, Nevada, August 2013, Environ

• Conceptual Site Model Kerr-McGee Facility, Henderson, Nevada, February 2005, ENSR International

• Northgate Environmnetal Management, Inc.Tronox Plate 10A, January 2010

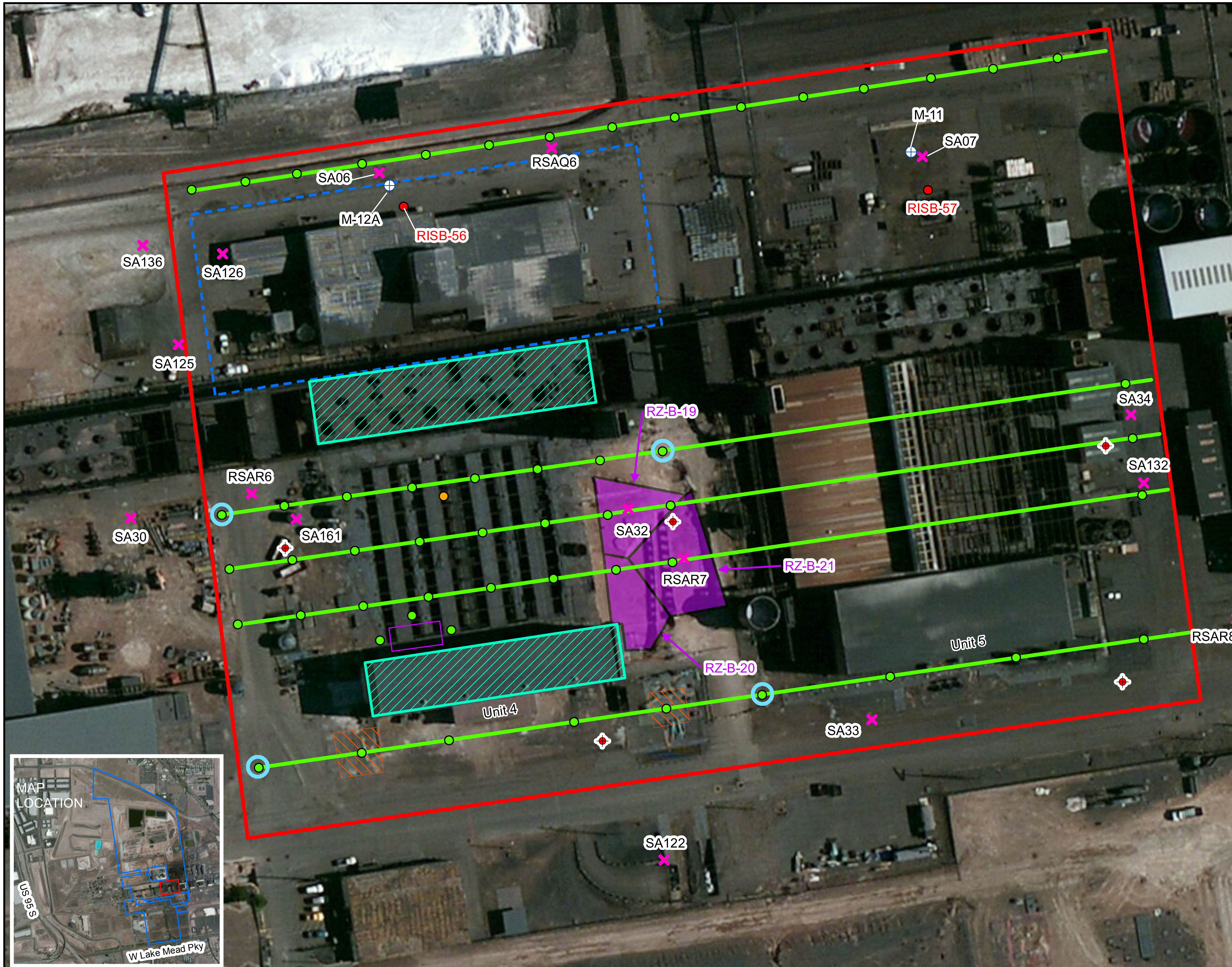
• Northgate Environmnetal Management, Inc.Tronox Figure 3, 2010, Groundwater Model Input Memo

TITLE:
Three-Dimensional Visualization and Analysis Framework

LOCATION:
Nevada Environmental Response Trust
Henderson, Nevada

TETRA TECH

APPROVED	JW	FIGURE
DRAFTED	MM	7
PROJECT#	117-0504158	
DATE	3-27-2015	



Legend

- Soil Boring Locations
- Proposed First Field Mobilization Boreholes - 4 Locations
- Existing Shallow Groundwater Monitoring Well Locations (Approximate)
- Proposed Environ Soil Borings (Approximate)
- Proposed Environ Monitoring Wells (Approximate)
- Historical Boring
- Previous Soil Boring/Soil Sampling Locations (Approximate)
- Sampling Transects
- Southwest Basement Sump (Approximate Location)
- Historic Perchlorate Loading and Unloading Stations
- Existing Unit 4 Building (Not to be demolished). Active tenant area.
- Remedation Zone (RZ) Polygons
- Unit 4 and 5 Buildings Investigation Area
- Department of Homeland Security Restricted Area

Additional boreholes will be sited based on visual observations of potential pathways, i.e. sumps, cracks, drains, or similar features.

Additional step out borings will be advanced as needed based on "real time" analytical results.

Actual borehole locations may vary depending on field conditions

Polygon RZ-B-19 has been excavated to 1.5' bgs, while RZ-B-20 and RZ- B-21 have been excvated to 6' to 10' bgs.

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

N

0 50 100 200 Feet

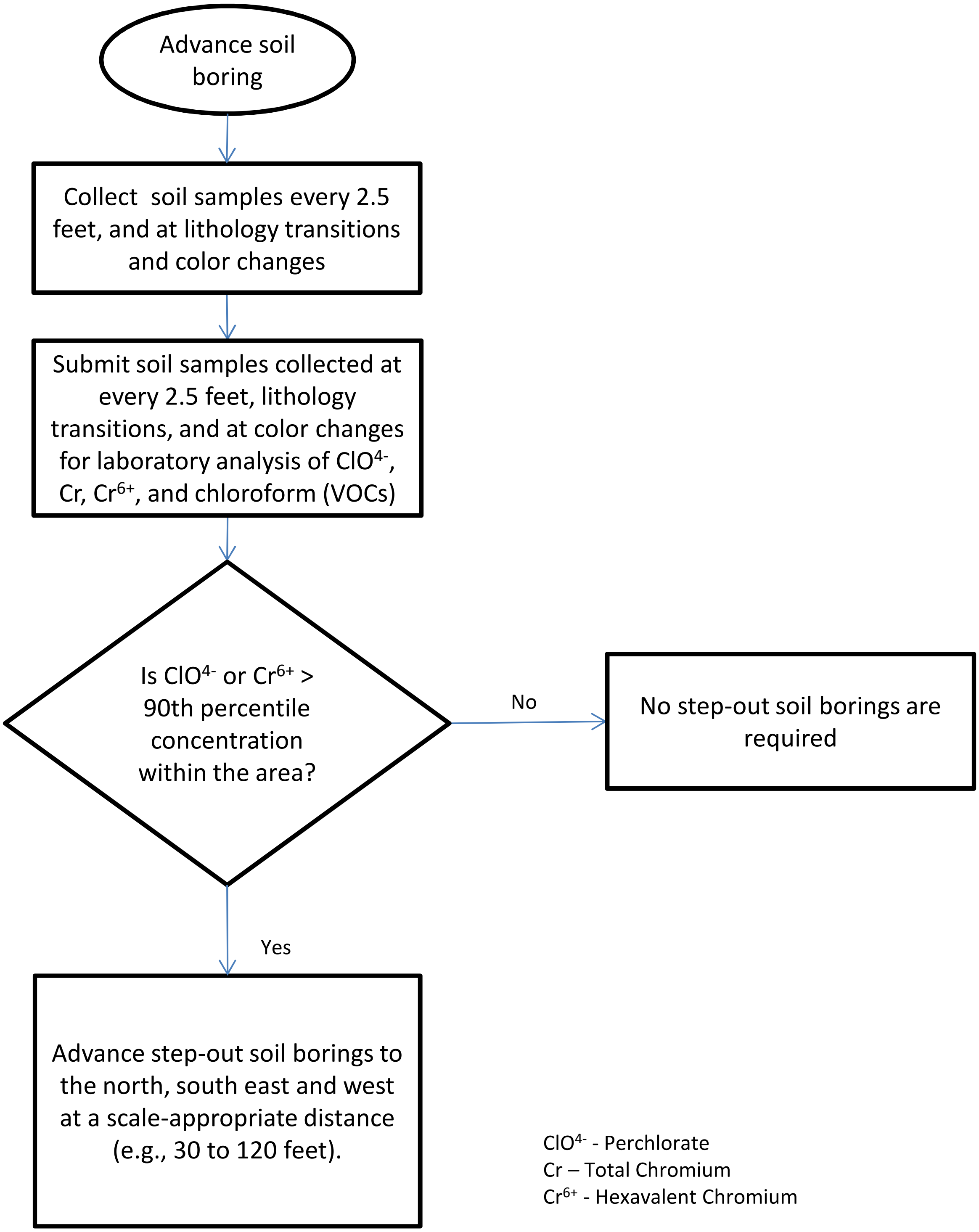
TITLE: **Proposed Investigation Locations**

LOCATION: **Nevada Environmental Response Trust Henderson, Nevada**

TETRA TECH

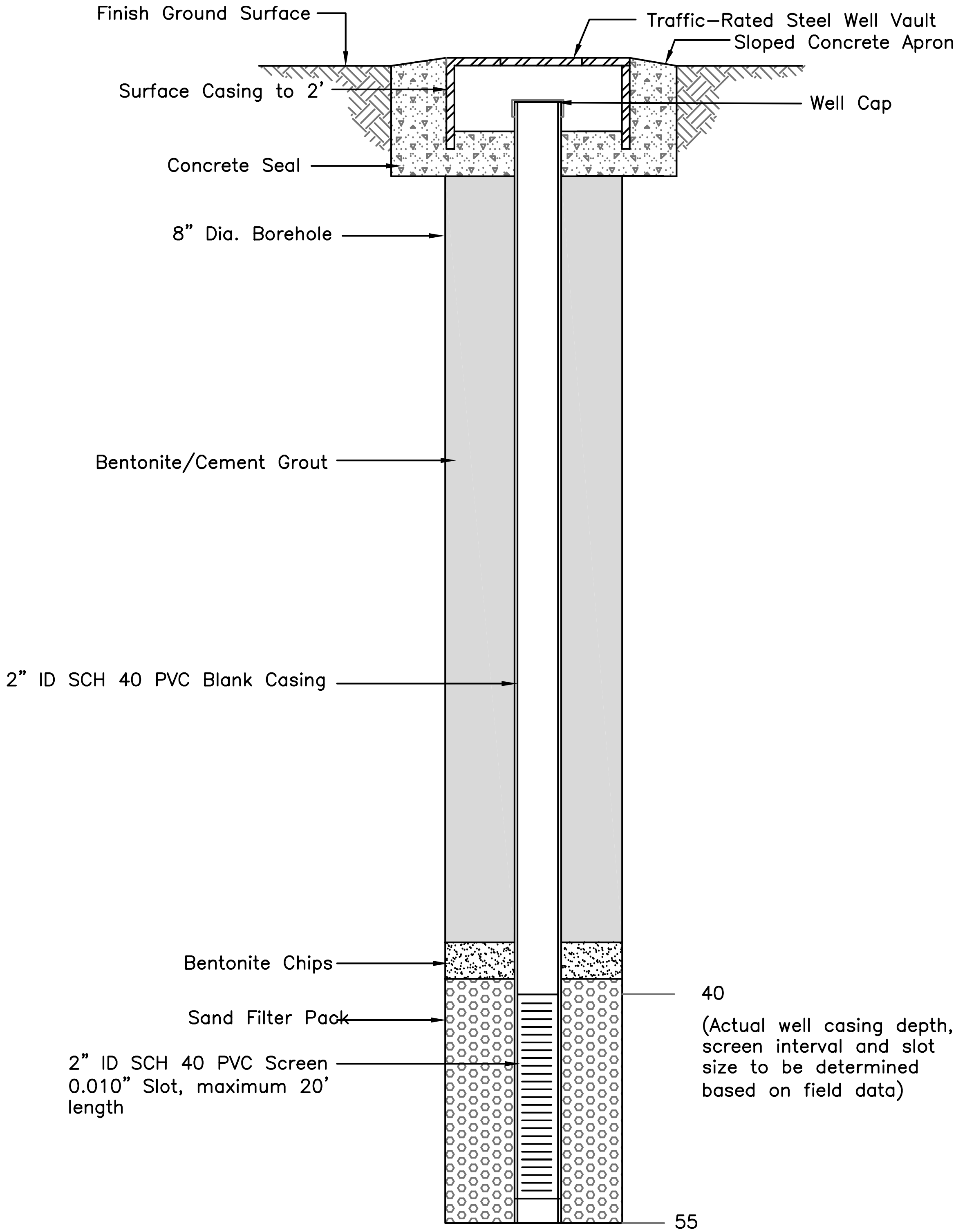
APPROVED	JW	FIGURE
DRAFTED	MM	8
PROJECT#	117-0504158	
DATE	3-27-2015	

Document Path: P:\Databases\Henderson, Nevada\GIS\Figure 8 Proposed Investigation Locations.mxd



ClO^{4-} - Perchlorate
Cr – Total Chromium
Cr^{6+} - Hexavalent Chromium

TITLE:	Soil Boring Advancement Decision Flow		
LOCATION:	Nevada Environmental Response Trust Henderson, Nevada		
TETRA TECH	CHECKED: Roy Marroquin		FIGURE: 9
	DRAFTED: James Walker		
	PROJ.: 117-0504158		
	DATE: 3/25/15		



Note: Drawing Not to Scale

M:\NERT\Figure10.dwg

TITLE: Typical Monitoring Well Diagram

LOCATION: Nevada Environmental Response Trust
Henderson, Nevada

TETRA TECH

APPROVED	RM	FIGURE
DRAFTED	JW	10
PROJECT#	114-520225	
DATE	10-16-2014	

TABLE

Table 1
Chemicals of Potential Concern
Analytical Methods

COPCs:	GW Method
Chlorates:	-
Perchlorate	EPA 314.0
Chlorate	EPA 300.1
Metals:	-
Niobium	EPA 6020A
Palladium	EPA 6020A
Mercury	EPA 7471
Aluminum	EPA 200.7/ 6010B
Barium	EPA 200.7/ 6010B
Boron	EPA 200.7/ 6010B
Cadmium	EPA 200.7/ 6010B
Chromium	EPA 200.7/ 6010B
Cobalt	EPA 200.7/ 6010B
Copper	EPA 200.7/ 6010B
Iron	EPA 200.7/ 6010B
Lead	EPA 200.7/ 6010B
Magnesium	EPA 200.7/ 6010B
Manganese	EPA 200.7/ 6010B
Molybdenum	EPA 200.7/ 6010B
Nickel	EPA 200.7/ 6010B
Silver	EPA 200.7/ 6010B
Strontium	EPA 200.7/ 6010B
Tungsten	EPA 200.7/ 6010B
Zinc	EPA 200.7/ 6010B
Zirconium	EPA 200.7/ 6010B
Antimony	EPA 200.8/ 6020B
Arsenic	EPA 200.8/ 6020B
Selenium	EPA 200.8/ 6020B
Thallium	EPA 200.8/ 6020B
VOCs:	-
Benzene	EPA 8260B
2-Butanone	EPA 8260B
Carbon Tetrachloride	EPA 8260B
Chlorobenzene	EPA 8260B
Chloroform	EPA 8260B
1,2-Dichlorobenzene	EPA 8260B
1,4-Dichlorobenzene	EPA 8260B
1,2-Dichloroethane	EPA 8260B
1,1-Dichloroethene	EPA 8260B
1,1-Dichloropropene	EPA 8260B
1,4-Dioxane	EPA 8260B SIM
Ethyl tert-butyl ether	EPA 8260B
Methylene Chloride	EPA 8260B
Tetrachloroethene	EPA 8260B
1,2,3-Trichlorobenzene	EPA 8260B
Trichloroethene	EPA 8260B

Table 1
Chemicals of Potential Concern
Analytical Methods

COPCs:	**GW Method**
1,2,3-Trichloropropane	EPA 8260B SIM
1,2,4-Trimethylbenzene	EPA 8260B
SVOCs:	-
Dimethylphthalate	EPA 8270B
Formaldehyde	EPA 8315A
1-Methylnaphthalene	EPA 8270B
2-Methylnaphthalene	EPA 8270B
Octachlorostyrene	EPA 8270B
Hexachlorobenzene	EPA 8270B
OPPs:	-
Dimethoate	EPA 8141
Stirophos	EPA 8141
OCPs:	-
alpha-BHC	EPA 8081
beta-BHC	EPA 8081
gamma-BHC	EPA 8081
2,4'-DDE	EPA 8081
4,4'-DDE	EPA 8081
4,4'-DDT	EPA 8081
Dieldrin	EPA 8081
Endosulfan I	EPA 8081
Endosulfan Sulfate	EPA 8081
Endrin Ketone	EPA 8081
PAHs:	-
Acenaphthylene	EPA 8270C SIM
Benzo(a)anthracene	EPA 8270C SIM
Benzo(a)pyrene	EPA 8270C SIM
Benzo(b)fluoranthene	EPA 8270C SIM
Benzo(g,h,i)perylene	EPA 8270C SIM
Indeno(1,2,3-cd)pyrene	EPA 8270C SIM
Phenanthrene	EPA 8270C SIM
PCBs:	-
Aroclor-1260	EPA 8082
PCB-081	EPA 8081 & 8082
PCB-118	EPA 8081 & 8082
PCB-126	EPA 8081 & 8082
PCB-169	EPA 8081 & 8082
PCB-209	EPA 8081 & 8082
Total PCBs	EPA 8081 & 8082
Dioxins/Furans:	-
2,3,7,8-tetrachlorodibenzo-p-dioxin	EPA 8290
other 16 congeners with TEFs	EPA 8290
Organis Acids:	-
Phthalic Acid	Method RRC-83-16
Radionuclides:	-
Radium-226	EPA 903.0

Table 1
Chemicals of Potential Concern
Analytical Methods

COPCs:	**GW Method**
Radium-228	EPA 904.0
Thorium-228	DOE EML HASL 300
Thorium-230	DOE EML HASL 300
Thorium-232	DOE EML HASL 300
Uranium-234	DOE EML HASL 300
Uranium-235	DOE EML HASL 300
Uranium-238	DOE EML HASL 300
Uranium	ASTM D5174 / KPA
TPH:	-
TPH-diesel	EPA 8015B
TPH-gasoline	EPA 8015B
TPH-oil	EPA 8015B
General Chemistry:	-
Ammonia	SM 4500-NH3 D
Bromide	EPA 300.0
Carbonate	SM 2320B
Chloride	EPA 300.0
Nitrate	EPA 300.0
Nitrite	EPA 300.0
Phosphorus (total)	SM 4500PE/EPA 365.1
Ortho-Phosphate	EPA 300.0
Silicon	EPA 200.7 / 6010B
Sulfate	EPA 300.0
Sulfur	EPA 6020
TDS	SM 2540C

APPENDIX A
HEALTH AND SAFETY PLAN

SITE HEALTH AND SAFETY PLAN FOR UNIT 4 AND 5 BUILDINGS INVESTIGATION
HENDERSON, NEVADA

Prepared for:

Nevada Environmental Response Trust

35 East Wacker Drive, Suite 1550
Chicago, IL 60601

Prepared by:

Tetra Tech, Inc.

1489 Warm Springs Road, Suite 110
Henderson, NV, 89014

March 30, 2015

LIST OF ACRONYMS

ACGIH	American Conference of Governmental Industrial Hygienists
ACM	Asbestos-containing material
AHA	Activity Hazard Analysis
ANSI	American National Standards Institute
ASTM	American Society of Testing and Materials
bgs	below ground surface
BMI	Black Mountain Industrial
CFR	Code of Federal Regulations
CIH	Certified Industrial Hygienist
CPR	Cardiopulmonary resuscitation
CRZ	Contamination Reduction Zone
dBA	decibels (on A-weighted scale)
DOT	U.S. Department of Transportation
ENVIRON	Environ International Corporation
EPA	Environmental Protection Agency (U.S.)
eV	Electron volt
EZ	Exclusion Zone
FOL	Field Operations Leader
GES	Geotechnical & Environmental Services
GPS	Global Positioning System
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
HSM	Health and Safety Manual
HSR	Health and Safety Representative
IDLH	Immediately Dangerous to Life or Health
IDW	Investigation Derived Waste
JSA	Job Safety Analysis
LBP	Lead-based paint
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mg/m^3	milligrams per cubic meter of air
N/A	Not Available
NERT	Nevada Environmental Response Trust
NIOSH	National Institute for Occupational Safety and Health
NDEP	Nevada Department of Environmental Protection
OCPs	Organochlorine pesticides
OSHA	Occupational Safety and Health Administration (U.S. Department of Labor)
PAHs	Polynuclear aromatic hydrocarbons
PCBs	Polychlorinated biphenyls
PEL	Permissible Exposure Limit
PHSO	Project Health and Safety Officer
PID	Photoionization Detector
PM	Project Manager
PPE	Personal Protective Equipment
PPM	parts per million
RI/FS	Remedial Investigation/Feasibility Study
SDS	Safety Data Sheet (formerly MSDS)
SSO	Site Safety Officer

SVOCs	Semi-Volatile Organic Compounds
SWP	Safe Work Practices
TBD	To be determined
TDS	Total Dissolved Solids
Tetra Tech	Tetra Tech, Inc.
TIMET	Titanium Metals Corporation
TLV	Threshold Limit Value
TM	Task Manager
TPH	Total Petroleum Hydrocarbons
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
VOCs	Volatile Organic Compounds
WAPA	Western Area Power Administration
WBZ	Water-bearing zone
WECCO	Western Electrochemical Company

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ATTACHMENTS

NEVADA ENVIRONMENTAL RESPONSE TRUST (NERT)
UNIT 4 AND 5 BUILDINGS INVESTIGATION
HENDERSON, NEVADA

We the undersigned have read and approve of the health and safety requirements presented in this health and safety plan for onsite work activities at the NERT site.

Name	Signature	Date
Michelle Gillie, CIH, CPEA, FAIHA Tetra Tech Inc. (Tetra Tech) Health and Safety Director/PHSO		
Roy Marroquin Tetra Tech Task Manager		
Dan Pastor, PE Tetra Tech Project Manager		

This certifies that Tetra Tech has inspected the subject site and has assessed the type, risk level, and severity of hazards for the project and has selected appropriate personal protective equipment for site personnel in accordance with Occupational Safety and Health Administration Title 29 of the *Code of Federal Regulations*, Part 1910.132.

Certified by

Michelle Gillie, CIH, CPEA Tetra Tech Health & Safety Director/PHSO		March 6, 2015

1.0 INTRODUCTION

Tetra Tech Inc. (Tetra Tech) received a work authorization from the Nevada Environmental Response Trust (NERT) in February 2015 to conduct environmental investigation and remedial activities for the NERT Site ("Site") located in Henderson, Nevada. This Health and Safety Plan (HASP) specifies the minimum work practices and procedures for Tetra Tech, Inc. (Tetra Tech) and subcontractor personnel engaged in the Unit 4 and 5 Building Investigation activities at the Site. The current scope of work is detailed in the Tetra Tech *Unit 4 and 5 Buildings Investigation Work Plan* and *Preliminary Demolition Work Plan for the Unit 4 Cell Building* dated March 19, 2015.

This document addresses items specified under Occupational Safety and Health Administration (OSHA) Title 29 of the *Code of Federal Regulations* (CFR), Part 1910.120(b), Hazardous Waste Operations (HAZWOPER) and applicable Nevada Occupational Safety and Health requirements. This HASP is supported by the Tetra Tech Health and Safety Manual (HSM) and safe work practices (SWPs) (**Attachment II**), which were developed to comply with the OSHA HAZWOPER standard and applicable sections of 29 CFR Part 1910 (General Industry Standards) and Part 1926 (Construction Standards). This HASP also incorporates elements of the Tetra Tech Nevada Workplace Safety Program (DCN 2-13) which complies with the Nevada Administrative Code Sections 618.540 and 618.542.

In general, the HASP identifies health and safety hazards and control measures to safely perform designated Site activities in conformance with Federal and state OSHA standards and Tetra Tech policies for health and safety planning. The HASP elements include project roles and responsibilities, job safety analyses, air monitoring, personal protective equipment, decontamination, training and medical surveillance requirements, emergency action plans, and spill prevention and response measures.

This HASP has been developed using the latest available information regarding known or suspected chemical contaminants and physical and biological hazards associated with the proposed work and Site. Tetra Tech has relied upon health and safety information provided by another site consultant as detailed in the ENVIRON International Corporation's (ENVIRON) *Health and Safety Plan for Remedial Investigation and General Site Activities Revision 1 for the Nevada Environmental Response Trust Site*; *Henderson, Nevada* dated July 18, 2014.

Additional documents that were reviewed for the preparation of this HASP include:

- Conceptual Site Model for the Kerr-McGee Facility, Henderson, Nevada (ENSR International, February 2005);
- Site Management Plan, Revision 1 for the Nevada Environmental Response Trust Site; Henderson, Nevada (ENVIRON, October 2013);
- Remedial Investigation and Feasibility Study Work Plan Revision 2 for the Nevada Environmental Response Trust Site; Henderson, Nevada (ENVIRON, June 19, 2014);
- Field Sampling Plan, Revision 1 for the Nevada Environmental Response Trust Site; Henderson, Nevada (ENVIRON, July 18, 2014); and
- Tronox Contractor Safety Handbook (**Attachment VI).**

Tetra Tech will provide a copy of this HASP and other documents relevant to the scope of work to each Tetra Tech employee and subcontractor engaged in work at the Site to fulfill its obligation under 29 CFR 1910.120 (b)(1) to inform subcontractors of site-specific hazards. This HASP must be present at the site during the performance of all Site activities and will be available to all onsite personnel who may be exposed to hazardous onsite conditions, including Tetra Tech and subcontractor personnel participating in site operations, and all authorized site visitors, including regulatory agency representatives. All onsite personnel, including Tetra Tech and subcontractor employees and site visitors, must be informed of site emergency response procedures and any potential health and safety hazards associated with onsite activities. The Tetra Tech Compliance Agreement form in **Attachment I** must be signed by all personnel before they enter the site.

This plan must be reviewed and approved by the Tetra Tech health and safety representative (HSR) and the Tetra Tech program and project managers (see the Reviews and Approvals form after the Contents in this document). Specifications herein are subject to review and revision based on actual conditions encountered in the field during site activities. The HASP will be modified if the scope of work changes or if new information regarding site conditions, hazards, or contaminants of concern becomes available. If deviations are encountered from the field work plan, Tetra Tech and subcontractor personnel will notify the Client and suspend work to assess changes to the work plan and the HASP. Significant revisions to this plan must be approved by the Tetra Tech program and project managers and the Tetra Tech HSR. Authorized modifications to the HASP will be tracked in the Record of Review/Revision [to be inserted into the HASP] and will be communicated to all project personnel.

Each Tetra Tech subcontractor must provide a HASP and/or Job Safety Analysis (JSA) that complies with 29 CFR 1910 and 1926 and addresses the activities of its employees relative to this project. As a minimum, the subcontractor HASP shall provide information on the following if applicable: drilling, demolition, medical and first aid requirements, Site emergency evacuation procedures, sanitation, personal protective equipment (PPE), fire prevention, machinery and mechanized equipment, electrical safety, public safety requirements, chemical, physical and biological hazard evaluation, occupational and community exposure prevention, and detailed information pertaining to temporary facilities such as office trailers and equipment storage areas as needed. The subcontractor's plan must be submitted for review and comment by Tetra Tech prior to start of work on the Site. Tetra Tech reserves the right to review a subcontractor's plan at any time. Subcontractor HASPs and other project submittals will be provided in **Attachment VII.**

By signing the HASP Compliance Agreement (Tetra Tech Form HSP-4), all project personnel indicate that they have reviewed the elements of this HASP, have received site-specific training, understand and will comply with the requirements, and all questions have been answered by Tetra Tech to their satisfaction.

Copies of all pertinent environmental, safety and health records must be maintained <u>at the job site</u>. This includes, but is not limited to, this site-specific HASP, personnel health and safety training documentation, evidence of enrollment in a medical surveillance program, accident/injury reporting, work area and equipment inspections, periodic safety meetings, safety data sheets (SDSs), chemical inventory, air monitoring data, waste container inspections, etc.

1.1 Key Project Personnel and Organization

This section describes health and safety responsibilities of project personnel, summarizes requirements for subcontractors and visitors who wish to enter the Site, and discusses HASP enforcement. Personnel assigned to these positions will exercise the primary responsibility of performing all of their work tasks in a manner that is consistent with the Tetra Tech Health and Safety Policy, the health and safety training they have received, this HASP, and in an overall manner that protects their personal safety and health and that of their coworkers, subcontractor employees, client employees, authorized site visitors, and the general public. The following persons are the primary points of contact and have the primary responsibility for implementing and enforcing this HASP and for overall on-site health and safety.

The Tetra Tech Project Manager (PM) is responsible for the overall direction and implementation of this HASP. The PM is responsible for ensuring that all project tasks receive appropriate health and safety review before commencement of field activities and that the necessary equipment and facilities are available to implement the HASP. The PM will regularly confer with site personnel regarding project activities, site conditions, hazard recognition and control, and HASP compliance.

Tetra Tech Task Managers (TM) have responsibility for technical aspects of their assigned operations as well as coordinating with project management and field staff on health and safety compliance.

The Field Operations Leader (FOL) manages field activities, executes the Work Plan, and enforces safety procedures as applicable to the Work Plan. Responsibilities include providing the necessary equipment and facilities to all field personnel and ensuring health and safety receives appropriate support. The FOL will lead daily tailgate safety meetings, conduct periodic site inspections of all project activities under their purview, including subcontractor operations, and promptly report any incidents, near misses, and subcontractor non-compliance to the PM.

The Project Health and Safety Officer (PHSO) is responsible for developing this HASP in accordance with applicable OSHA regulations and Tetra Tech corporate health and safety program requirements. The PHSO may assign some tasks to the Site Safety Officer (SSO) for field implementation. Specific responsibilities include:

- Providing information regarding site contaminants and physical hazards;
- Establishing air monitoring and decontamination procedures;
- Assigning PPE based on task and potential hazards;
- Determining emergency action procedures;
- Identifying appropriate emergency contacts;
- Participating in the project kickoff meeting;
- Conducting site inspections and field audits during critical phases of the project;
- Stipulating training and medical surveillance requirements;

- Providing standard work practices to minimize potential injuries and exposures; associated with hazardous waste site work; and

- Modifying this HASP, where and when necessary.

The SSO supports site activities by advising the PM on the aspects of health and safety on site. These duties may include the following:

- Being on site during all work activities to oversee health and safety issues for Tetra Tech employees, subcontractors, and visitors at the site.

- Conducting site-specific training which includes review of the HASP at the project initiation and conducting daily tailgate meetings to discuss planned tasks, identified hazards, and required hazard controls.

- Implementing the site-specific HASP including hazard communication, respiratory protection, personal protective equipment, and other associated safety and health programs.

- Verify that the HASP accurately reflects ALL site operations and hazards and is revised or amended as new tasks are assigned or new hazards are recognized.

- Verifying onsite personnel have all necessary training, medical and respirator clearance, and respirator fit-tests as specified by the HASP.

- Advising the PM and/or client of any field practices or conditions that may endanger the health and safety of field personnel, subcontractors, or visitors.

- Recommending corrective actions for any conditions that may endanger the health and safety of field personnel, subcontractors, or visitors.

- Selecting, inspecting, maintaining, and enforcing proper use, cleaning, and maintenance of protective clothing and equipment.

- Monitoring onsite hazards and conditions (frequent site inspections).

- Maintaining visual or verbal communication with all site workers.

- Stopping work if any worksite condition, practice, or operation causes or presents a hazard that can reasonably be expected to result in immediate death, serious physical harm, or severe damage to the environment.

- Working closely with the PM and HSR to determine appropriate corrective action and/or prompt resolution to all hazards.

- Establishing and maintaining work zones and control points by overseeing control of entry and exit at site access points and recording the names and job assignments of all personnel who enter and exit the site.

- Arranging for required work area, personal or ambient hazard monitoring.

- Ensuring that all monitoring equipment used on site has been properly calibrated and is operated in accordance with manufacturer's recommendations and approved sampling methodologies.

- Creating and maintaining records of employee exposure and monitoring results for all onsite personnel.

- Monitoring workers for signs and symptoms of work-related exposures, such as chemical exposure, heat stress and fatigue.

- Conducting daily field inspections for early recognition of potential site and task hazards.

- Coordinating and supervising emergency response and providing emergency first aid and cardiopulmonary resuscitation (CPR) to team members, if required.

- Reporting all occupational illness, injuries, incidents and near-misses to the HSR and PM immediately after stabilization of the incident and notification of emergency medical providers.

- Assisting in conducting incident investigations and preparing reports of serious near-misses, illnesses, injuries, motor vehicle accidents, or property damage

Tetra Tech employees are expected to fully participate in implementing the site HASP by having the necessary training, attending site safety meetings, always wearing designated personal protective equipment (PPE), complying with site safety and health rules, and advising the Tetra Tech SSO of health and safety concerns at the site. Additionally, all Tetra Tech employees have the following rights and responsibilities:

- Tetra Tech employees are expected to report health and safety hazards they face while performing their work. As such, employee reports of health and safety hazards are viewed as positive interactions and no employee of Tetra Tech will retaliate against any other employee who reports a health and safety hazard.

- Tetra Tech employees have the right to refuse to perform work involving significant safety hazards they feel have not been adequately addressed.

- Every Tetra Tech employee has the right to stop work if he/she feels any worksite condition, practice, or operation causes or presents a hazard that can reasonably be expected to result in immediate death, serious physical harm, or severe damage to the environment. Through observations and communication, all parties involved will then develop, communicate, and implement corrective actions necessary and appropriate to modify the task and to resume work. The stop work event will be reported as a near miss incident.

Note: In some cases one person may be designated responsibilities for more than one position. For example, the FOL may also be responsible for the SSO duties. This action will be performed only as credentials, experience, and availability permits.

Subcontractor personnel participating in project operations will be required to read and comply with all sections of this plan. All subcontractor personnel entering the site must sign the Compliance Agreement form (**Attachment I**). Subcontractor personnel must comply with all applicable 29 CFR 1910.120 training, respirator fit testing, and medical surveillance requirements and other applicable OSHA General Industry and Construction Standards (Part 1926). Subcontractors are responsible for providing PPE required by this plan for their personnel and are directly responsible for the health and safety of their employees. Subcontractors will prepare a safety plan and/or Job Safety Analysis for their work assignments which will be submitted to Tetra Tech for review.

All authorized site visitors will be required to read the HASP and sign the Compliance Agreement form (**Attachment I**). Visitors will be expected to comply with relevant OSHA requirements. Visitors will also be expected to provide their own PPE required by the HASP. Visitors who have not met OSHA training, medical surveillance, and PPE requirements are not permitted to enter work areas where exposure to health and safety hazards is possible.

1.2 Stop Work Authorization

All employees are empowered, authorized, and responsible to stop work at any time when an imminent and uncontrolled safety or health hazard is perceived. In a Stop Work event (immediately after the involved task has been shut down and the work area has been secured in a safe manner), the employee shall contact the PM and the PHSO. Through observations and communication, all parties involved shall then develop, communicate, and implement corrective actions necessary and appropriate to modify the task and to resume work. A "stop work" incident will be reported as a near miss incident on the Incident Report form.

1.3 Site Information and Personnel Assignments

Site Name: Nevada Environmental Response Trust Site

Site Address: 560 West Lake Mead Parkway, Henderson, Nevada, 89015

Client Contact: Andrew Steinberg **Phone Number:** (312) 498-2800

Proposed Dates of Work: January 2015 – December 2015

Project Team:

Name	Project Role	Office Phone	Cell Phone
Tetra Tech Management Personnel			
Roy Marroquin	Project Manager (PM)	(949) 809-5234	(714) 856-4686
Don Lee PG, CHG	Drilling Task Manager (TM)	(949) 809-5000	(949) 697-1575
Steven Bradley, CEG, CEM	Demolition Task Manager (TM)	(619) 525-8349	(619) 961-8349
Michelle Gillie, CIH, CPEA	Project Health and Safety Officer (PHSO)	(832) 251-5189	(610) 348-7197
James Walker, PG, CEM	Senior Project Geologist	(949) 809-5216	(323) 717-7554
Tetra Tech Field Personnel			
Becki Dano, CEM	Construction Field Operations Leader (FOL); Geologist	(702) 818-5103	(702) 493-6797

Name	Project Role	Office Phone	Cell Phone
Tetra Tech Management Personnel			
Kyle Hansen, CEM	Field Operations Manager	(801) 949-6663	(801) 949-6663
Tetra Tech Consultant			
Robert C. Morhard	Perchlorate/explosive safety consultant	(610) 306-4637	(610) 306-4637
Subcontractors			
TBD	Driller		
TBD	Utility Locator		
TBD	Demolition Contractor		
TestAmerica	Laboratory	(949) 261-1022	

2.0 EMERGENCY ACTION PLAN

2.1 Introduction

This section describes emergency response planning procedures to be implemented for the site. This Emergency Action Plan conforms to the requirements of 29 CFR 1910.38(a), as allowed in 29 CFR 1910.120(I)(1)(ii). The following sections discuss pre-emergency planning, personnel roles and lines of authority, emergency recognition and prevention, evacuation routes and procedures, emergency contacts and notifications, hospital route directions, emergency medical treatment procedures, fire or explosion, spills or leaks, emergency equipment and facilities, and reporting.

Tetra Tech personnel may participate in minor event response and emergency prevention activities such as:

- Initial fire-fighting support and prevention;
- Initial spill control and containment measures and prevention;
- Removal of personnel from emergency situations;
- Provision of initial medical support for injury/illness requiring only first-aid level support; and
- Provision of site control and security measures as necessary.

The Tetra Tech SSO has primary responsibility for responding to and correcting emergency situations and for taking the appropriate measures to ensure the safety of site personnel and the public. Possible actions may include evacuation of personnel from the site area. The SSO is also responsible for ensuring that corrective measures have been implemented, appropriate authorities have been notified, and follow-up reports have been completed. The SSO will also be responsible for the following:

- Identifying a chain of command for emergency action.
- Coordinate with Tronox if an emergency arises on Tronox-leased property.
- Educating site workers to the hazards and control measures associated with planned activities at the Site, and providing early recognition and prevention where possible.
- Periodically perform practice drills as appropriate to ensure site workers are familiar with incidental response measures.
- Provide the necessary equipment to safely accomplish identified tasks.
- Provide first aid kit, emergency eye wash, fire extinguishers and spill kits and place them in strategic locations for quick access.

Before site work begins, the SSO will provide the local fire or emergency response department the following minimum information:

- Emergency Contact List;

- Site Map and Directions to Site; and
- Safety Data Sheets (SDSs).

Individual subcontractors are required to cooperate with the SSO, within the parameters of their scopes of work.

Project personnel are required to immediately report all serious near misses, injuries, illnesses, spills, releases, fires, explosions, equipment or property damage, and motor vehicle accidents to the SSO. The SSO must be notified of any onsite emergencies and is responsible for ensuring that the appropriate emergency procedures described in this section are followed.

2.2 Emergency Planning

Initial hazard/risk assessment efforts have identified exposure to physical, chemical, and biological hazards and fire as the most probable emergencies that could be encountered during activities at the Site. To minimize or eliminate the potential for these emergency situations and to reduce the severity of any potential incident, pre-emergency planning activities associated with this project include the following:

- Coordinate with the NERT, Tronox, and/or local emergency response personnel to ensure that Tetra Tech emergency actions are compatible with existing emergency response procedures;
- Establish and maintain information at the project staging area (e.g., support zone) for easy access in the event of an emergency:
    - Tetra Tech HASP;
    - Logbook identifying personnel onsite each day;
    - Emergency Contacts List (multiple copies; and posted);
    - Maps to Hospital and Clinic Physician (copies should be placed in each vehicle);
    - Chemical Inventory with Safety Data Sheets (SDSs) (**Attachment V**); and
    - Onsite personnel medical and emergency contact information (Medical Data Sheets, **Attachment I**).

During the project kickoff meeting and daily tailgate safety meetings, all onsite employees will be trained in and reminded of the provisions of this Section, site communication systems, and site evacuation routes. The emergency response provisions will be reviewed on a regular basis by the Tetra Tech SSO and will be revised, if necessary, to ensure that they are adequate and consistent with prevailing site conditions.

2.3 Emergency Recognition and Prevention

Table 5-1 lists potential site chemical hazards, and Table 5-2 provides information on the health and safety hazards associated with the different tasks planned for the site. Onsite personnel will be made familiar with this information and with techniques of hazard recognition through prior health and safety training and site-specific briefings.

2.3.1 Recognition

Many chemical, physical and biological hazards that could lead to emergency scenarios are generally recognizable by visual observation. Thus, hazard identification should include pre-work and periodic 360° walk-around surveys, equipment and tool inspections, and background surveys with direct-reading air monitoring instrumentation.

The FOL, SSO, and subcontractor supervisor will be responsible for performing surveys of work areas prior to initiating site operations and periodically while operations are being conducted. Site surveys will be conducted at all work locations prior to the commitment of resources and personnel. This will be done for the purpose of removing or barricading identified physical hazards. Additionally, site surveys will be conducted at least once a week at all resource/staging areas. All site surveys conducted during this effort will be documented in the Project or Field Operations Logbook and survey findings will be discussed with field personnel as part of the tailgate safety meetings. In addition, site personnel will be responsible for reporting hazardous situations. Where potential hazards exist, Tetra Tech will initiate control measures to prevent adverse effects to human health and the environment.

Emergency situations that may be encountered during site activities will generally be recognized by visual observation. Visual observation will also play a role in detecting potential exposure events to some chemical hazards. To adequately recognize chemical exposures, site personnel must have a clear knowledge of signs and symptoms of exposure associated with the principal site contaminants of concern as presented in this HASP. Tasks to be performed at the site, potential hazards associated with those tasks and the prescribed control methods are discussed in detail in Sections 5.0 and 6.0. Additionally, early recognition of hazards will be supported by daily site surveys to identify and correct any unsafe conditions or work practices that could result in an emergency. The FOL and/or the SSO will be responsible for performing surveys of work areas prior to initiating site operations and periodically while operations are being conducted. Survey findings are documented by the FOL and/or the SSO in the Site Health and Safety logbook; however, site personnel will be responsible for reporting hazardous situations. Where potential hazards exist, Tetra Tech will initiate control measures to prevent adverse effects to human health and the environment.

The above actions will provide early recognition for potential emergency situations, and allow Tetra Tech to instigate necessary control measures. However, if the FOL and the SSO determine that control measures are not sufficient to eliminate the hazard, Tetra Tech will withdraw from the site and notify the appropriate response agencies listed in Table 2-1.

Tronox (NERT tenant) produces boron products within a Boron Plant, and produces manganese sulfate north of the Unit 5 and 6 buildings for use in the manganese dioxide production process within a Leach Plant. ENVIRON (July 2014) noted the following process chemical hazards that could potentially impact onsite workers:

Chemical Hazard	Health Effects	Emergency Response
Boron Trichloride	Reacts violently with water and generates fumes that are highly irritating and corrosive.	If exposed to gaseous form, change into fresh clothing since clothing absorbs fumes rapidly. If skin comes in contact with liquid form, immediately wipe dry before rinsing the skin. If even a small quantity comes in contact with the eyes, promptly initiate irrigation for at least 15 minutes.
Carbon Monoxide	Chemical asphyxiant that is odorless, colorless and tasteless. Also flammable/explosive gas if mixed with air. Symptoms of carbon monoxide include headache, unconsciousness, convulsions, accelerated breathing, and cherry-red skin color.	Use escape respirator with minimum 15-minute breathing air supply while evacuating area. Assess CO concentration with 4-gas meter.
Chlorine	Gas that is irritant to eyes, and upper and lower respiratory tract. Contact with liquid causes skin burns.	Don escape respirator and leave work area. CPR and administration of oxygen may be necessary to treat inhalation.
Hydrogen Sulfide and Sodium Hydrosulfide	Chemical asphyxiant with rotten egg odor.	Don escape respirator and leave work area. CPR and administration of oxygen may be necessary to treat inhalation.
Magnesium and Titanium metals	Magnesium is highly flammable when exposed to a flame and is dangerous when it comes in contact with water/moisture.	Metal fires cannot be extinguished with water and require Class D fire extinguishers.
Manganese Dioxide	Manganese causes central nervous system depression and also targets they blood, kidneys and respiratory tract.	Don escape respirator and leave work area.
Sulfuric acid	Caustic liquid that causes burns to eyes and skin.	In case of contact, wash/flush skin/eyes with copious amounts of water.

Tronox operates an alert system in the event of emergency situations such as fire and chemical releases. The alert system consists of audible alarms that warn employees, contractors, and visitors of emergency conditions that require action based on the alarm sequence as detailed in the table below:

Test 1-1	* *, * *, * *, * *, * *, * *, * *, * *, * *, * *, Test and all clear (may be sounded at any time)
Stage 1 3-3	*** ***, *** ***, *** ***, *** ***, *** ***, *** ALERT! Locate a Tronox employee with a radio for information. No evacuation at this time.
Stage 2 Rapid	*************************************** Conduct emergency shutdown of anything that could produce a spark or flame and evacuate to in-plant meeting points.
Stage 3 Steady	______________________________ Do not delay. Evacuate to out-of-plant meeting points per instructions or wind direction

Tetra Tech will observe all alarms and will respond appropriately. Tetra Tech has observed that wind socks are present at the facility for immediate verification of prevailing wind direction.

2.3.2 Prevention

Tetra Tech and subcontractor personnel will minimize the potential for emergencies by following the HSM and ensuring compliance with the site HASP and applicable OSHA regulations. Daily site surveys of work areas prior to the commencement of that day's activities by the FOL and/or the SSO will also assist in prevention of illness/injuries when hazards are recognized early and control measures are initiated. Site inspection findings will be documented in the field log book or the Tetra Tech Daily Site Log (Form SSC-1). Field audits will be conducted during critical project phases by the PM, TMs or their designees and will be documented on the Tetra Tech Field Audit Checklist (Form AF-1).

2.3.3 Fire Prevention / Flammable Liquids

Tetra Tech and subcontractor personnel are responsible for fire protection in all of their work areas at all times during the duration of this field effort (24 hours per day/seven days per week). Approved fire-fighting equipment and extinguishers in adequate quantities for their work activities must be provided. Fire extinguishers will be kept in close proximity to field activities and their location, along with that of nearby permanent firefighting equipment, will be discussed during the daily tailgate safety meeting.

The Trust Project Lead will be notified as soon as possible of any fire. In case of fire, Tetra Tech and subcontractor personnel will call 9-1-1.

All flammable and combustible liquids must be stored, dispensed and used in accordance with OSHA regulations and the Uniform Fire Code. Bonding and grounding of containers containing flammable liquids will be required. Tetra Tech Safe Work Practices for safe handling of flammable materials is provided in **Attachment I**. Hot work activities such as torch cutting of steel and rebar will require use of the Tetra Tech (or equivalent) hot work permit (Form HW-1) and the Tronox hot work permit, provided in Attachment VI. Subcontractor exposure to lead oxide fume generation during hot work tasks on structures identified with lead-based paint will be controlled through the use of approved respiratory protection or spot paint removal by qualified lead abatement contractors at cutting locations.

Fire and explosion hazards posed by potential subsurface accumulations of perchlorates and required mitigation measures are addressed for all tasks in the Activity Hazard Analysis (AHA) found in **Attachment III.**

2.4 Initial Response and Emergency Notifications

The Tetra Tech SSO must survey the situation and avoid taking any action or delay that could endanger anyone's life. Tetra Tech personnel may perform rescue operations from emergency situations and may provide initial medical support for injury/illness requiring only "basic first-aid" level support, and only within the limits of training obtained by site personnel. Basic first-aid is considered treatment that can be rendered by a trained first-aid provider at the injury location and not requiring follow-up treatment or examination by a physician (for example: minor cuts, bruises, stings, scrapes, and burns). Personnel providing medical assistance are also required to be trained in the requirements of OSHA's Bloodborne Pathogen Standard (29 CFR 1910.1030). Medical attention above first-aid level support will require assistance from the designated emergency response agencies.

Basic first aid measures for chemical exposures and non-medical initial responses are summarized below:

Chemical Exposure	***Skin Contact:*** ▪ Remove contaminated clothing. ▪ Wash immediately with water. ▪ Use soap if available. ▪ If irritation persists, seek medical attention. ***Eye Contact:*** ▪ Flush eyes with water for 15 minutes. ▪ If symptoms persist, seek medical attention. ***Inhalation:*** ▪ Remove person from contaminated atmosphere. ▪ If necessary, provide CPR. Seek medical attention. ▪ DO NOT ENTER A CONFINED SPACE TO RESCUE SOMEONE WHO HAS BEEN OVERCOME UNLESS PROPERLY TRAINED/EQUIPPED AND ALL CSE PROTOCOLS ARE FOLLOWED WITH QUALIFIED ATTENDANT ONSITE. ***Ingestion:*** ▪ NEVER induce vomiting on an unconscious person. ▪ NEVER induce vomiting when ingestion of acids, alkalis, or petroleum products is suspected. ▪ Contact the poison control center (see **Table 2-1** for telephone number). ▪ Administer CPR, if necessary. Seek medical attention. ***Possible Exposure Symptoms:*** • Headache, dizziness, nausea, drowsiness, respiratory tract, skin or eye irritation
Snake Bite	• Follow the standard notification procedures (call 911). Notify emergency response personnel of the nature of the snake bite. • If possible, take photo of snake. • Have victim remain calm until ambulance team arrives.

	• Keep the bite location below the heart at all times. • Apply a pressure wrap (for extremities) just above and over the bite area. With a couple wraps of the pressure wrap in place over the bite area, apply a splint, and continue the application of the pressure wrap. The purpose for the splint is to restrict the movement of the extremity. This, along with the pressure wrap, will aid in restricting the toxins from leaving the site of the bite.
Incipient Stage Fire	• A fire that cannot be readily extinguished with one 10-pound fire extinguisher will be considered major and may require evacuation of project and/or site personnel to safe areas. • Only attempt to put out fire if you are trained in the use of the fire extinguisher, have confidence that you can put the fire out, and you have a route of escape from the fire.
Minor Spill or Leak	• Use onsite spill kit to contain/absorb and remove spilled materials. • See details on spill prevention and containment in SWP 5-47.
Major Spill or Leak	• Evacuate the affected area and relocate personnel to an upwind location. • Inform the Tetra Tech SSO, a Tetra Tech office, and a site representative immediately. • Locate the source of the spill or leak, and stop the flow if it is safe to do so. • Begin containment and recovery of spilled or leaked materials. • Notify the client and appropriate local, state, and federal agencies.

Workers who are ill or who have suffered a non-serious injury may be transported by site personnel to nearby medical facilities, provided that such transport does not aggravate or further endanger the welfare of the injured/ill person.
Personnel requiring treatment greater than first aid will constitute an emergency situation for which the appropriate agency must be notified. Any pertinent information regarding allergies to medications or other special conditions will be provided to medical services personnel. This information is listed on the Medical Data Sheets (**Attachment I)**. If an exposure to hazardous materials has occurred, provide information on the chemical, physical, and toxicological properties of the subject chemical(s) to medical services personnel.

If an emergency cannot be handled using onsite resources, personnel will evacuate to a safe place of refuge and the appropriate emergency response agencies will be notified. It has been determined that the majority of potential emergency situations would be better supported by outside emergency responders. These agencies are located within a reasonable distance from the area of site operations, which ensures adequate emergency response time.

In the event that site personnel cannot control the incident through offensive and defensive measures, the SSO will enact the following emergency notification procedures to secure additional assistance:

- Call 911 or other emergency contacts (Table 2-1) to report the emergency and provide the following information:

    - Location of emergency;
    - Type of emergency;
    - Number of injured personnel; and
    - Brief description of what occurred.

- Stay on the phone and follow the instructions given by the operator. The operator will then notify and dispatch the proper emergency response agencies.

The Emergency contacts list will also be posted in the NERT office building and will be placed in all project vehicles. In case of any emergency (e.g., injury, illness, spill/release, and fire), verbal notification to the Tetra Tech project manager must be provided as soon as possible. If project personnel determine that the situation could either directly or indirectly threaten human health or the environment, the Tetra Tech Project Manager will contact the appropriate emergency response agencies. The nearest medical facilities to the site are the St. Rose Dominican Hospital and Urgent Care Extra clinic. Maps and directions to these facilities are shown below.

For incidents that are not life-threatening, the affected employee may contact WorkCare Incident Intervention **(888-449-7787**) for guidance on first aid and medical treatment. WorkCare may direct the affected employee to a Chartis (workers compensation insurer)-authorized clinic for further evaluation of a work-related injury or illness. The authorized doctor offices or clinics have agreed to accept workers compensation patients without an appointment. The clinic information is provided below:

Urgent Care Extra
2269 N. Green Valley Parkway
Henderson, NV 89014
Tel: 702-855-0500

Any pertinent information regarding allergies to medications or other special conditions will be provided to medical services personnel. This information is listed on Medical Data Sheets filed onsite. If an exposure to hazardous materials has occurred, provide information on the chemical, physical, and toxicological properties of the subject chemical(s) to medical service personnel.

FIGURE 2-1a
ROUTE TO ST. ROSE DOMINICAN HOSPITAL

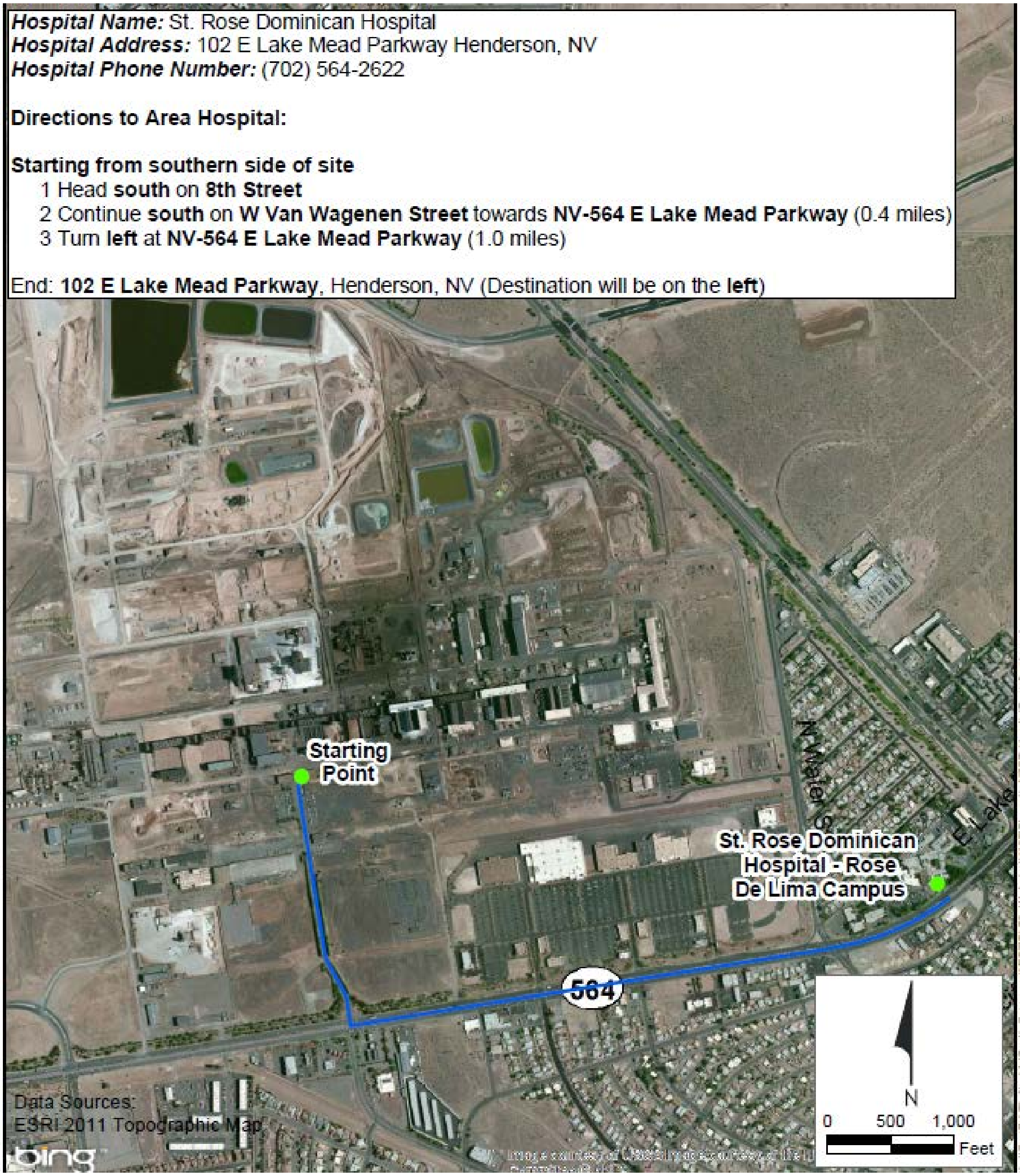
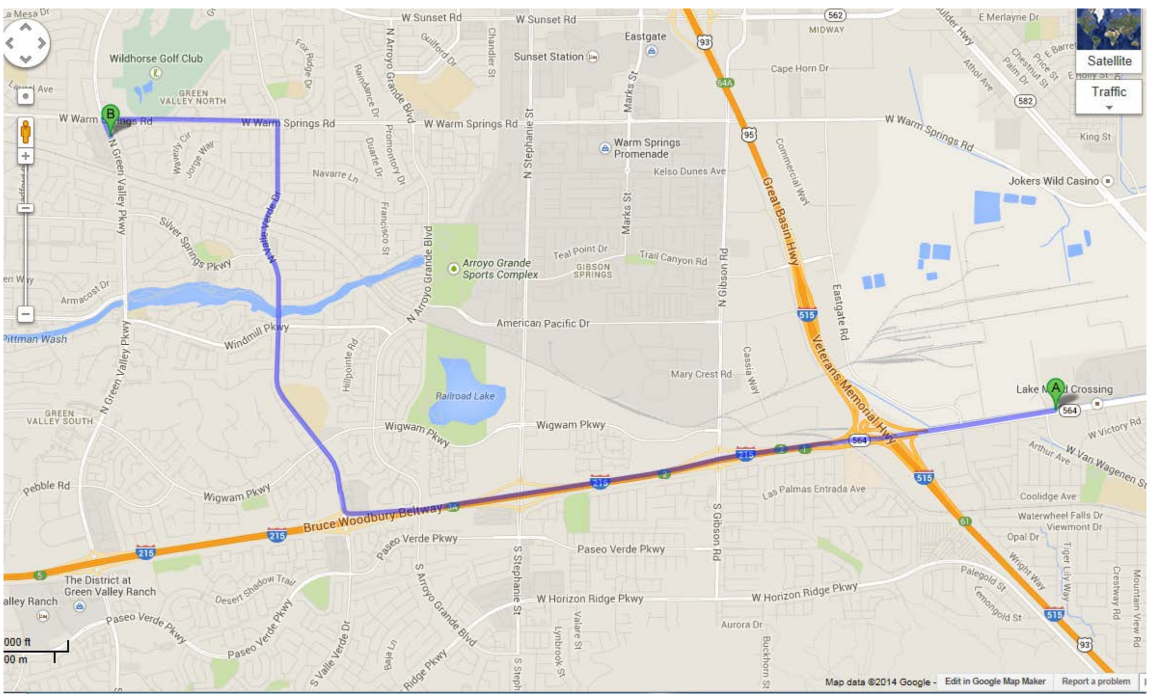


FIGURE 2-1b
Route and Directions to Workers Compensation Clinic (Non-emergencies)
Urgent Care Extra
2269 N. Green Valley Parkway
Henderson, NV 89014
Tel: 702-855-0500

1. From site (A), head West on NV-564 W/West Lake Mead Parkway toward West Van Wagenen Street. (1.1 miles)
2. Continue onto I-215. (2.1 miles)
3. Take exit 3B for Valle Verde Drive. (0.3 mile)
4. Keep right at the fork, follow signs for Valle Verde Drive North and merge onto North Valle Verde Drive. (21. Miles)
5. Turn Left onto West Warm Springs Road. (0.9 miles).

Turn Left onto North Green Valley Parkway. Site is 0.1 miles.



Tetra Tech personnel may be working at multiple locations and may not be in close proximity to each other at the Site. As a result, hand signals, voice commands, and line of site communication may not be sufficient to alert site personnel of an emergency. The use of cell phones, two-way radios, or air horns, etc. will be required when work crews are not in line of sight.

In the event of a utility strike, follow the general and specific utility guidance below:

- Always assume any subsurface pipe or line is live;
- Stop work and remove tools if safe to do so;
- Contact Tronox for guidance if working on leasehold property;
- Contact the emergency number provided if directed to by Tronox;
- Establish a containment perimeter to prevent access by others; and
- Contact the PM and/or TM so they can contact the Client.

Electrical/Telecom Cable Strike	• Stop work. • Evacuate project team to safe location as conditions warrant. • Recognize that some workers may not be able to immediately evacuate (e.g., operator seats in excavators are normally electrically isolated, whereas other parts of the excavator may be energized). • Call the designated Tronox representative. • Call the Emergency Number if Tronox is unavailable. • Provide first aid and summon medical assistance, as needed. • Contact the One Call/utility for guidance if Tronox is unavailable. • Do not allow anyone to enter the area until the electric utility provider has made the cable safe.
Pressurized Gas Pipeline Strike	• Stop work and leave tools in-place but shut off any operating equipment, including engines. • Evacuate the immediate area to a safe distance as Site conditions warrant. • Ensure there are no sources of ignition in the area. • Call the designated Tronox representative. • Call the Emergency Number if Tronox is unavailable. • Provide first aid and summon medical assistance, as needed. • Contact the One Call/utility for guidance if Tronox is unavailable. • Do not re-enter the immediate area until it is safe.
Pressurized Water Main Strike	• Stop work, remove tools and confine jetting water if safe, necessary and appropriate to do so. • Evacuate immediate area. • Ensure that water flowing away is not creating potential hazards (e.g., electrical shorting, flooding, contaminant migration) and where possible, warn those likely to be affected. • Call the designated Tronox representative. • Call the Emergency Number if Tronox is unavailable. • Provide first aid and summon medical assistance, as needed. • Contact the One Call/utility for guidance if Tronox is unavailable. • Do not re-enter the immediate area until it is safe.

2.5 Evacuation Routes, Procedures, and Places of Refuge

An evacuation will be initiated whenever recommended hazard controls are insufficient to protect the health, safety or welfare of site workers. Specific examples of conditions that may initiate an evacuation include, but are not limited to the following: severe weather conditions; fire or explosion; monitoring instrumentation readings which indicate levels of contamination are greater than instituted action levels; Tronox facility emergency alarm; and evidence of personnel overexposure to potential site contaminants.

In the event of an emergency requiring evacuation, personnel will immediately stop activities and report to the designated safe place of refuge unless doing so would pose additional risks. When evacuation to the primary place of refuge is not possible, personnel will proceed to a designated alternate location and remain until further notification from the Tetra Tech FOL. Safe places of refuge will be identified prior to the commencement of site activities by the SSO and will be conveyed to personnel as part of the site-specific training during the project kickoff meeting and daily tailgate safety meetings. Whenever possible, the safe place of refuge will also serve as the telephone communications point for that area. During an evacuation, personnel will remain at the refuge location until directed otherwise by the Tetra Tech FOL or the on-site Incident Commander of the Emergency Response Team. The FOL or the SSO will perform a head count at this location to account for and to confirm the location of site personnel. Emergency response personnel will be immediately notified of any unaccounted personnel. The SSO will document the names of personnel onsite (on a daily basis) in the site Health and Safety Logbook or the daily tailgate safety meeting form. This information will be utilized to perform the head count in the event of an emergency.

Evacuation routes from the site and safe places of refuge are dependent upon the location at which work is being performed and the circumstances under which an evacuation is required. Additionally, site location and meteorological conditions (i.e., wind speed and direction) may dictate evacuation routes. As a result, assembly points will be selected and communicated to the workers relative to the site location where work is being performed. Evacuation should always take place in an upwind direction from the site. Windsocks are located at several locations at the Site. An additional windsock shall be placed near the work area for quick identification of wind direction.

During an evacuation, decontamination procedures will be performed only if doing so does not further jeopardize the welfare of site workers. However, it is unlikely that an evacuation would occur which would require workers to evacuate the site without first performing decontamination procedures.

For work performed by Tetra Tech within the Tronox-leased area, Tetra Tech will coordinate with Tronox on the location of appropriate assembly points.

For work performed by Tetra Tech outside the Tronox-leased area (i.e., you are not signed in at Tronox), project personnel should evacuate and meet at the closest designated assembly point:

- Fiesta (south side of Lake Mead Parkway near Highway 95)

2.6 Emergency Contacts

Prior to initiating field activities, personnel will be thoroughly briefed on the emergency procedures to be followed in the event of an accident. Table 2-1 below provides a list of emergency contacts and their associated telephone numbers. This table must be posted where it is readily available to site personnel (e.g., job site trailer, field office, or other central and visible location). Site maps should also be posted showing potential evacuation routes and designated meeting areas. A copy of the emergency contact list and routes to the nearest hospital and clinic will be kept in all site vehicles.

Any pertinent information regarding allergies to medications or other special conditions will be provided to emergency medical services personnel. This information is listed on Medical Data Sheets filed onsite (**Attachment I**). If an exposure to hazardous materials has occurred, provide hazard information from Table 5-1 to emergency medical service personnel.

The Trust Project Lead shall be contacted immediately in the event of a fatal or serious injury, an unpermitted environmental release, or any environmental, health or safety incident that is likely to generate significant publicity or an adverse situation for the Trust.

2.7 Emergency Equipment

A jump tank (large water-filled container for whole-body immersion), first aid kit with burn kit, a wall-mounted eyewash station or sufficient quantity of eye wash bottles, a spill kit containing absorbent materials and polyethylene sheeting along with an empty drum and shovel to respond to small spills, and a 10-pound ABC-rated fire extinguisher will be maintained onsite at all active work locations and shall be immediately available for use in the event of an emergency. PPE used in daily activities will serve as the primary defense for all chemical and physical/biological hazards encountered. Emergency situations surpassing the level of protection offered by the prescribed PPE will constitute an emergency and require evacuation and notification of the appropriate response agency.

Emergency equipment that will be brought onsite includes the following:

- Industrial type first aid kit with burn kit;
- Tri-class (ABC) fire extinguishers (number and capacity depending on operations);
- Jump tank filled with water for quick rinsing/immersion of irritated or perchlorate-contaminated skin (for demolition and drilling tasks);
- Rinse water in garden pump sprayers or buckets for quick rinsing/immersion of irritated skin (all Tasks);
- Eye wash stations/bottles; and
- Spill kit consisting of plastic shovels, drums and absorbent materials.

TABLE 2-1
EMERGENCY CONTACTS
NEVADA ENVIRONMENTAL RESPONSE TRUST SITE
HENDERSON, NEVADA

AGENCY	TELEPHONE
EMERGENCY (Police, Fire, and Ambulance)	**9-1-1**
City of Henderson Police Department (Non-emergency)	(702) 267-5000
Fire Department (Non-emergency)	Henderson: (702) 267-2222 Clark County: (702) 455-7311
Trust Project Lead (Andrew Steinberg)	(312) 498-2800
Tronox Contact (John Holmstrom)	(702) 465-6703
St. Rose Dominican Hospital, Henderson, NV	(702) 564-2622
NDEP 24-hour Spill Hotline	In-state: (888) 331-6332 Out of state: (775) 687-9485
Chemtrec	(800) 424-9300
National Response Center (oil/chemical spills)	(800) 424-8802
Poison Control Center	(800) 222-1222
PD, Derek Amidon	(303) 513-6643 mobile (801) 364-1064 office
PM, Roy Marroquin	(714) 856-4686 mobile (949) 809-5234 office
Drilling TM, Don Lee	(949) 697-1575 mobile (949) 809-5000 office
PHSO, Michelle Gillie, CIH, CPEA	(610) 348-7197 mobile (832) 251-5189 office
WorkCare Incident Intervention	(888) 449-7787
Public Utility Clearance – Nevada One Call	8-1-1 usanorth811.org
Henderson Public Utilities (emergency numbers)	Call 9-1-1 first NV Energy Electric – (702) 402-2900 Natural Gas – (877) 860-6020 Water – (702) 267-5900

2.8 Injury / Illness Reporting

All emergency situations require follow-up and reporting. After the initial response (e.g., first aid, etc.) to an injury or illness has taken place or emergency responders have been notified, the incidence and details of the incident must be properly reported and documented. Within one (1) hour of occurrence, any occupational injury or illness must be reported to the HSR/Corporate Health & Safety Director at (610) 348-7197. **Attachment I** includes the Tetra Tech Incident Report (Form IR) and the Supplemental Forms A (employee injury or illness), B (property and equipment damage, spills and releases) and C (motor vehicle accidents). All applicable reports must be completed and submitted to the Tetra Tech project manager within 24 hours of an emergency situation. The project manager will review the report and then forward it to the Tetra Tech HSR for review. The report must include proposed actions to prevent similar incidents from occurring. The HSR must be fully informed of the corrective action process to ensure appropriate and sufficient response measures have been implemented.

It should be noted that “near misses” as well as actual injuries and illnesses should be reported. By identifying near miss situations, possible recommendations for preventing a recurrence can be made. Near misses should be reviewed with field personnel during the daily pre-work site briefing.

2.8.1 TOTAL Incident Reporting System

TOTAL is Tetra Tech’s online incident reporting system. Project staff located in the office may use TOTAL to directly report health and safety incidents, notify key personnel, and initiate the process for properly investigating and addressing the causes of incidents, including near-miss events. An incident is considered any unplanned event. It may include several types of near misses, events where no loss was incurred, or incidents that resulted in injuries or illness, property or equipment damage, chemical spills, fires, or damage to motor vehicles.

TOTAL is maintained on the Tetra Tech Intranet site at https://my.tetratech.com/. Once on the “My Tetratech” site, TOTAL can be found under the Health and Safety tab, Incident Reporting section, select “Report an Incident (TOTAL)”.

3.0 SITE BACKGROUND

This section provides site background information.

3.1 Site Description

The Site, which is approximately 346 acres in area, is located 13 miles southeast of the city of Las Vegas in an area of unincorporated Clark County, Nevada surrounded by the City of Henderson (Figure 3-1). The NERT Site resides in Sections 12 and 13 of Township 22 S, Range 62 E (Figure 3-2) at 560 West Lake Mead Parkway, Henderson, Nevada, 89015.

The Site is located in an industrial land use area and within the Black Mountain Industrial (BMI) Complex which includes several facilities owned and operated by a number of chemical companies. The Site is generally rectangular although certain interior portions are owned and operated by other companies, namely Lhoist, Western Area Power Administration (WAPA), BMI, and Titanium Metals Corporation (TIMET). TIMET and Olin Chlor-Alkali have facilities to the east and west of the Site, respectively.

Groundwater treatment facilities, operated by Envirogen Technologies on behalf of the Trust, are located within the northwestern portion of the Site. Three lined ponds on the Site receive process-related wastewater discharges from ongoing Tronox facility operations, and a fourth lined pond receives extracted groundwater from remediation activities. The Site is traversed from west to east by a drainage ditch (Beta Ditch) that historically conveyed liquid wastes from the Site and from neighboring facilities located to the west. The ditch has been re-graded and channelized into a retention pond and no longer discharges offsite to the east, although the west end of the ditch continues to receive storm water drainage from the neighboring western properties.

Another process-related surface impoundment (AP-5 pond) was constructed as a double-lined impoundment basin in 1983 and was used to contain ammonium perchlorate process waters; it was removed from service in 2001. After 2001, Veolia Water North America periodically used Lake Mead water to flush residual solids in the pond to solubilize remaining ammonium perchlorate into the Site wastewater treatment system. As of July 2014, ENVIRON reports that the AP-5 pond still contains residual solids.

A total of ten unit buildings (numbered 1 through 10) are aligned in a row from west to east along the southern portion of the NERT property. Each unit building contains three buildings: chlorinator building on the north side, cell building in the center, and substation building on the south side. Four of the unit buildings (Unit 3, 4, 5, 6) are leased from NERT by Tronox (Figure 3-2). The roof, above grade walls and floors of the Unit 1 and 2 cell buildings have been demolished, with the basement walls and slabs remaining intact. At Unit 3, only the east half of Unit 3 cell building has been demolished.

Unit 4 cell building is no longer used and its above-ground structures were demolished in the mid-2000s. In 2012, the Unit 4 substation building was retrofitted to house an advanced battery manufacturing process. The Unit 4 chlorinator building is currently used by Tronox primarily for storage. Tronox currently uses the Unit 5 and 6 buildings for the production of manganese dioxide. A portion of the Unit 5 cell building is also used for storage.

North of the Unit 4 building Tronox produces boron products within a Boron Plant, and north of the Unit 5 and 6 buildings Tronox produces manganese sulfate (for use in the manganese dioxide production process) within a Leach Plant. A chlorine gas pipeline is suspended along the south side of the Unit 4 chlorinator building. The pipeline is currently active and will be decommissioned prior to Unit 4 cell building demolition.

Additional Site buildings include an administration building, a change house, a laboratory building, a maintenance shop, a steam plant, and various storage buildings. The Site includes dirt, asphalt, and concrete roads, active utility lines, a gaseous chlorine line, and railroad spurs. Extensive active and inactive subsurface utility lines are present under the roads and open Site areas. Residential areas are located north and south of the Site.

3.2 Site History

Historical operations at the BMI Complex (which includes the NERT Site) included magnesium production by the U.S. government since 1942; production of manganese dioxide, sodium chlorate, sodium perchlorate, ammonium perchlorate (since early 1950s) and other perchlorates by Western Electrochemical Company (WECCO); and boron chemicals production by Kerr-McGee since the early 1970s. The production of boron tribromide, sodium chlorate, and ammonium perchlorate ceased in 1994, 1997 and 1998, respectively. Perchlorate was reclaimed at the Site using existing equipment until early 2002.

The Kerr-McGee facility operated from 1951 until 1998 and produced ammonium perchlorate, sodium perchlorate, magnesium perchlorate, and sodium chlorate. It produced 400 million pounds (200,000 tons) of perchlorates. The groundwater plume at the Site contains approximately 20.4 million pounds of perchlorates in 9 billion gallons of water (Sellers, 2006).

The Unit 4 cell building historically contained chlorinators (furnaces) that created molten magnesium chloride by reacting the magnesium oxide/carbon pellets with chlorine gas at high temperatures in banks of electrolytic cells, producing magnesium metal by electrochemical reduction of the molten magnesium chloride. Historically (1945 – 1989), sodium chlorate and sodium perchlorate were produced by electrolytic processes, which involved the use of sodium dichromate (hexavalent chromium) on the first floor of the Unit 4 and 5 cell buildings. Historic reported releases in the Investigation Area include process chemicals leaking to soil through cracks in the basements of the Unit 4 and 5 cell buildings. Reportedly, the concrete basements served as sumps to collect process liquor, spillage and wash water. The Unit 4 cell building process effluents contained high levels of Total Dissolved Solids (TDS), perchlorate, and to a lesser degree, hexavalent chromium.

Former industrial and waste management practices conduced at the NERT Site, as well as those conduced on adjacent properties, resulted in impacts to soil, groundwater, and surface water at the NERT Site and at off-site locations. Potential sources of contaminants to the groundwater include historical releases of chemicals through cracks in the basement floor of Units 4, 5, and 6 cell buildings, drainage trenches, and a sump located within the Unit 4 cell building basement floor, the chemical storage tank located on the west side of Unit 4 cell building, and the railcar loading and unloading areas south of Unit 4 and 5 cell buildings.

In 2006, Tronox took ownership of the Kerr-McGee facilities and produced electrolytic manganese dioxide for use in the manufacture of alkaline batteries, elemental boron for vehicle airbag igniters, boron trichloride for use in the pharmaceutical and semiconductor industries, and high-strength boron fibers for use in aircraft components and sporting equipment. Tronox filed for Chapter 11 bankruptcy in 2006 and the NERT took title to the Site in February 2011.

Tronox currently has a long-term lease for 114 acres of the Site on which it continues its manufacturing operations.

Depth to groundwater across the Site varies from 27 feet to 80 feet below ground surface (bgs), with the groundwater at the Unit 4 and 5 buildings area reported to be from 41 feet to 43 feet bgs. Groundwater flow is to the north-northeast.

The Nevada Division of Environmental Protection (NDEP) has regulatory authority over environmental activities at the Site. The environmental investigation work proposed in the vicinity of the Unit 4 and 5 buildings is a component of work being performed across the entire NERT Site as part of the Remedial Investigation/Feasibility Study (RI/FS) Work Plan (Revision 1) dated January 10, 2014.

Several environmental investigations and remedial activities have been completed at the BMI Complex property since the 1970s. A chronological summary of investigations and remedial activities conducted since the 1970s is provided in Section 3.1 of the RI/FS Work Plan (ENVIRON, 2014a). A summary of previous environmental investigations conducted in the vicinity of the Unit 4 and 5 buildings is provided below.

A Phase A Source Area Investigation (Phase A Investigation) was conducted by ENSR in 2006. Two of the soil borings (SA06 and SA07) advanced during this investigation were located in the vicinity of the Unit 4 and 5 buildings. Soil boring SA06 was located approximately 280 feet north of Unit 4 cell building and was advanced to a depth of 37 feet bgs. Soil boring SA07 was located approximately 280 feet north (downgradient) of Unit 5 cell building and was advanced to a depth of 34 feet bgs. Soil samples were collected at depths of 0.5 feet to 1.0 foot bgs, and at 10 feet intervals thereafter to depths of 37 feet (SA06) and 36 feet (SA07) until groundwater was encountered.

Compounds detected in soil samples collected from SA06 included: perchlorate (54.1 milligrams per kilogram [mg/kg] at 35.3-36.8 feet bgs), hexavalent chromium (0.22 mg/kg at 20.3-21.8 feet bgs), various metals, semi-volatile organic compounds (SVOCs), volatile organic compounds (VOCs), dioxins/furans, and radionuclides (ENSR 2008a). Compounds detected in soil samples collected from SA07 included: perchlorate (113 mg/kg at 10.2-11.7 feet bgs), hexavalent chromium (0.56 mg/kg at 0.7-2.2 feet bgs), various metals, VOCs, dioxins/furans, radionuclides, and asbestos (ENSR 2008b).

In 2007, one soil boring was advanced through the basement floor of the Unit 4 cell building by hand auger to a depth of 17 feet bgs and a soil sample was collected between 15.5 to 17.5 feet bgs, according to Mr. Kyle Hansen. The soil sample contained a perchlorate concentration of 41.5 milligrams per kilogram (mg/kg, Geotechnical & Environmental Services [GES 2013]. The soil boring locations and results of perchlorate and hexavalent chromium analyses are presented on Figure 3 of the Tetra Tech Work Plan.

The Phase B Source Area Investigation (Phase B Investigation) at the Unit 4 and 5 buildings area was conducted by Northgate Environmental Management in 2009, and included the advancement of 14 soil borings. The objective of the Phase B Investigation was to further evaluate the extent of contaminants in the Unit 4 and 5 building areas. The list of analytes for soil in the Phase B Investigation was expanded to also include polychlorinated biphenyls (PCBs), organochlorine pesticides (OCPs), total petroleum hydrocarbons (TPH), chlorate, cyanide, and formaldehyde.

During the Phase A and B Investigations, the soil sample that contained the greatest perchlorate concentration was encountered at 18.9–20.4 feet bgs interval (2,970 mg/kg) in soil boring RSAR7 located between Unit 4 and 5 buildings. The area between Unit 4 and 5 buildings has undergone remedial soil excavation; however, the excavation was limited to the removal of the upper six feet of soil due to the presence of underground utility lines (ENVIRON 2013b). The soil sample collected during the Phase A and B Investigations that contained the greatest hexavalent chromium concentration was encountered at 25.6–27.1 feet bgs interval (36.4 mg/kg) in soil boring RSAR6 located west of Unit 4 cell building. The soil samples were also analyzed for chloroform. The soil sample collected during the Phase A and B Investigations that contained the greatest chloroform concentration (1,300 micrograms per kilogram or µg/kg) was encountered at 37.9–39.4 feet bgs interval in soil boring SA161 located west of the Unit 4 cell building.

There are two Shallow WBZ monitoring wells (M-11 and M-12A) located downgradient of the Unit 4 and 5 buildings. Monitoring wells M-11 and M-12A were installed in 1997 and are routinely sampled for perchlorate and hexavalent chromium as part of the Site groundwater monitoring program. Monitoring well M-11 is located adjacent to soil boring SA07 and approximately 280 feet north (downgradient) of Unit 5 cell building. Monitoring well M-12A is located adjacent to soil boring SA06 and approximately 280 feet north (downgradient) of Unit 4 cell building. No other groundwater monitoring wells have been installed within the Investigation Area.

Wells M-12A and M-11 showed perchlorate concentrations of 160 milligrams per liter (mg/L) and 18 mg/L, respectively, and hexavalent chromium concentrations of 9.1 mg/L and 1.2 mg/L in May 2014.

Tetra Tech personnel conducted a site visit on October 7, 2014 and on January 27, 2015. Tronox required the following PPE during the site walk: hard hat, safety glasses, steel toe boots, and an escape respirator clipped to the waist.

Legend

Unit 4 and 5 Buildings Investigation Area

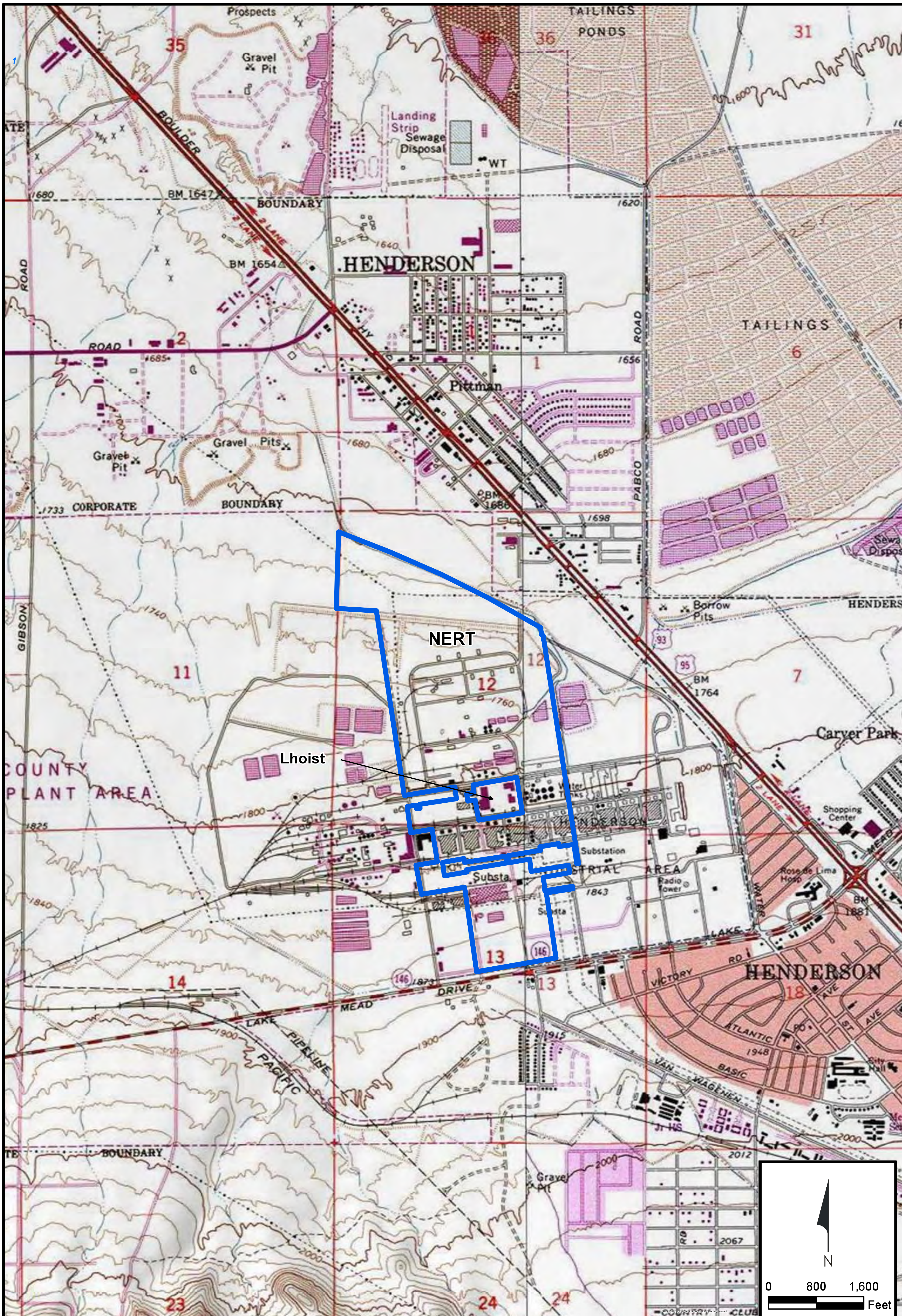
TITLE: **Site Location Map**

LOCATION: **Nevada Environmental Response Trust**
Henderson, Nevada

TETRA TECH

APPROVED	JW	FIGURE	3-1
DRAFTED	DW		
PROJECT#	117-0504144		
DATE	3-18-2015		

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Document Path: P:\Databases\Henderson, Nevada\GIS\Figure 3-1 Site Location Map.mxd Document Path: P:\Databases\Henderson, Nevada\GIS\Figure 3-1 Site Location Map.mxd



TITLE: **Site Map**

LOCATION: **Nevada Environmental Response Trust**
Henderson, Nevada

TETRA TECH

APPROVED	JW	FIGURE	
DRAFTED	DW		3-2
PROJECT#	117-0504144		
DATE	10-2-2014		

4.0 SCOPE OF WORK

An environmental investigation in and around the Unit 4 and 5 buildings is planned to evaluate impacts from former chemical manufacturing operations that may have resulted in a release of perchlorate, total chromium, and hexavalent chromium to the underlying soil and groundwater. In order to conduct the environmental investigation, the central portion (Unit 4 cell buidling) and associated structural supports will be demolished and a ramp will be constructed to allow safe access for equipment to the basement level floor. The northern structure (Unit 4 chlorinator building) and the southern structure (Unit 4 substation building) will not be demolished and will remain intact for Tronox's continued use. Tetra Tech personnel will manage all aspects of the Unit 4 cell building demolition and environmental investigation, including review of a subcontractor demolition safety plan.

Many of the buildings on the Site are known or suspected to contain hazardous materials, including asbestos-containing materials (ACM), lead-based paint (LBP), PCBs, and mercury. In addition to these materials, there may also be residual perchlorate, chlorate, VOCs, and/or chromium impacts from former Site operations. During Site inspections, Tronox personnel have mentioned the presence of anhydrous perchlorate residue throughout the Unit 4 cell building basement and have reported that this residue poses a potential ignitability risk. Due to the potential presence of these materials, a thorough characterization of the building materials for building waste profiling purposes and Site worker health and safety will be performed prior to building demolition.

An ACM survey and abatement was reportedly conducted within the Unit 4 cell building by Tronox in 2008. Abatement included removal of Transite™ (cement asbestos) pipes located within the cell area. According to Tronox representatives, ACM still remains within and adjacent to the structure as non-friable surface coatings, buried Transite™ pipes, and insulation wrap on pipes inside the basement batch tanks, tar-based weather coating on the exterior of the north adjacent Unit 4 chlorinator building and on the corrugated metal sheeting placed along the upper portions of the exterior of the Unit 4 chlorinator building. Lead-based paint is also reported to exist within the structure (e.g., coated structural steel) and may be disturbed during demolition. Chlorates and chromium may be present in concrete materials.

Yellow staining (suspected hexavalent chromium) of the basement's concrete ceiling was observed by Tetra Tech personnel during a site visit in October 2014. Due to the possible presence of these materials, a hazardous materials assessment will be conducted by qualified state-licensed asbestos building inspectors, lead inspectors, and other qualified hazardous materials specialists prior to demolition to identify the material location, condition, classification, and requirements for safe removal, handling, and disposal prior to and during demolition in accordance with applicable Federal and state environmental regulations.

This section summarizes the specific tasks that are to be conducted as part of this scope of work and covered by this HASP. For more detailed description of the planned tasks associated with this project, refer to the *Unit 4 and 5 Buildings Investigation Work Plan* (Tetra Tech) and the *Preliminary Demolition Work Plan for the Unit 4 Cell Building* (Tetra Tech).

Any modifications (additions or substantive changes) to these specified tasks will be a change in scope, which will require a review and appropriate modification of this HASP. In such an event, the PM is responsible for communicating the nature of the change to the PHSO prior to the initiation of any onsite activity associated with the scope of work change. The PHSO is then responsible for assuring that appropriate changes to this HASP are made.

The general scope of work associated with implementing the Unit 4 and 5 Buildings Investigation Work Plan consists of the following:

Activity	Description
1	Advance 4 soil borings to the base of the shallow water-bearing zone (WBZ) around the perimeter of Unit 4 cell building and collect samples for hexavalent chromium and perchlorate leaching tests. Collect land survey data.
1	Comprehensive pre-demolition survey of the Unit 4 cell building ground level, basement, and surrounding area that will be demolished for identification and sampling of hazardous building materials including asbestos, lead-based paint, PCBs, mercury-containing equipment, etc. and surficial contamination with hexavalent chromium (yellow concrete staining) and perchlorate residues.
2	Hazardous building materials pre-demolition abatement after confirmation of decommissioning of the chlorine gas pipeline (as required by findings of Task 1)
3	Structural engineering and condition survey of Unit 4 cell building to evaluate and ensure structure stability during demolition phase. Securing and monitoring of building structures will be performed as needed to prevent uncontrolled or premature collapse of any structure component.
4	Demolition of the Unit 4 cell building (ground level, concrete pedestals, etc., while maintaining the structural integrity of the northern (Unit 4 chlorinator building) and southern (Unit 4 substation building) portions.
5	Construction of an earthen ramp from the ground surface level to the basement level of the Unit 4 cell building to allow safe access for construction, drilling, and other required demolition and environmental equipment. A temporary equipment access ramp of sufficient width and grade will be constructed on the west side of Unit 4 cell to allow construction and drilling equipment access in and out of the basement. Only a portion of the west wall will be removed to construct the ramp.
6	Advance soil borings along 5 transects through the basement floor of the Unit 4 cell building to a depth of approximately 90 feet below surface level grade. Targeted source areas include sumps, trenches, chemical storage tank, and railcar loading/unloading areas.
7	Soil samples will be collected at two-and-one-half foot intervals to total depth and analyzed for perchlorate, hexavalent chromium, and total chromium.
8	Depth-discrete groundwater samples will be collected within three intervals of the shallow WBZ.
9	Well construction, development, and groundwater sampling of the newly installed monitoring wells.

5.0 HAZARD ASSESSMENT

This section provides information regarding the chemical, physical, and biological hazards associated with the Site to be investigated and the planned Site operations. Table 5-1 provides information on potential chemical contaminants, including exposure limits, routes of entry, target organs and adverse health effects.

5.1 Chemical Hazards

The primary contaminants of concern based on prior extensive soil and groundwater investigations at the Site include the following:

- Metals: arsenic, chromium, hexavalent chromium, manganese, magnesium, uranium;
- Perchlorate and chlorate compounds;
- Dioxins/Furans;
- Hexachlorobenzene;
- VOCs/SVOCs/Polynuclear aromatic hydrocarbons (PAHs);
- Asbestos-containing materials and debris;
- Lead-based paint and debris (paint chips);
- PCBs in building materials/equipment; and
- Chlorinated pesticides.

Specific information on potential chemical hazards at the site is provided in **Table 5-1**, including exposure limits, anticipated exposure routes, and toxic effects. Potential routes of exposure include dermal (skin and eye) contact and absorption, inhalation, and ingestion. Dermal contact and accidental ingestion can occur as a result of improper decontamination or PPE usage. Inhalation can occur as a result of airborne contaminants (either vapors or dusts) generated or released during site activities. The chemicals may also contaminate equipment, vehicles, instruments, and personnel.

Tronox has advised Tetra Tech that anhydrous perchlorate residue is present throughout the Unit 4 cell building basement and that Site workers should avoid puddles that form in the building after rain events, because the puddles may contain dissolved perchlorate that could transfer to clothing and could become flammable when dry.

The NDEP has identified the Unit 4 and 5 buildings as potentially one of the most significant perchlorate and hexavalent chromium source areas for the entire NERT Site. The table below summarized the maximum perchlorate and hexavalent chromium concentrations in soil beneath the Unit 4 cell basement and areas around the Units 4 and 5 buildings:

Location	Perchlorate	Hexavalent Chromium
Unit 4 cell building basement boring	41.5 mg/kg (15.5-17 feet bgs)	NA
SA-32 Between Units 4 and 5	275 mg/kg (35.8-37.3 feet bgs)	9.05 (0-0.8 feet bgs)
RSAR7 Between Units 4 and 5	2970 mg/kg (18.9-20.4 feet bgs)	1.81 (32.9-34.4 feet bgs)
SA161 West of Unit 4	890 mg/kg (25.8-27.3 feet bgs)	27.10 mg/kg (25.8-27.3 feet bgs)

Ammonium perchlorate is classified as a UN Class 5.1 oxidizer which may pose a fire hazard in the presence of flammable and combustible materials (e.g., paper, clothing, wood, plastics, fuels, solvents, metals). The material will not burn by itself. When mixed in soil or dissolved in water, it is not reactive or explosive. Tetra Tech has retained a perchlorate and explosives safety expert to perform a formal hazardous operations analysis of the planned work tasks to identify potential risks to Site workers associated with the Unit 4 cell demolition and environmental investigation, specifically concrete coring through the basement floor and drilling through the underlying soil. Appropriate mitigation measures that reduce risks to an acceptable level will be further identified and implemented.

Attachment IV contains hazard communication information on ammonium perchlorate and other perchlorates, including Safety Data Sheet, Environmental Protection Agency (EPA) Fact Sheet and other information. Additionally, an Activity Hazard Analysis (AHA) has been prepared that specifically addresses the potential perchlorate health and safety hazard and planned control measures for all site operations.

Arsenic has been detected in shallow soils throughout the site and in groundwater downgradient of the Unit 4 cell building. The table 4 below (extracted from the 2014 ENVIRON HASP) shows the maximum detected contaminant concentrations in soil and groundwater following soil remediation activities in 2011. [Note: the permissible exposure limit (PEL)/threshold limit value (TLV) for hexavalent chromium was listed as NL which is incorrect; the table has been edited to show the correct PEL]. The shallow groundwater beneath and surrounding the Unit 4 cell building has shown total chromium concentrations varying from 100 mg/L to 10,000 mg/L and chloroform concentrations less than 70 micrograms/Liter (µg/L).

Tetra Tech's Certified Industrial Hygienist performed predictive modeling to evaluate the worst case airborne particulate concentrations using the maximum detected concentrations of the metals in subsurface soil; the model indicates that there is potential for manganese, arsenic and hexavalent chromium particulates (in descending order) to reach the ambient air at levels that could exceed the respective OSHA PELs during earthmoving operations. Drilling operations pose a much lower risk of exposure to airborne dust containing the toxic metals.

Due to the age of the Site buildings and electrical equipment, it is likely that PCBs, LBP, asbestos, mercury and other hazardous materials are present in building materials, components, interior surfaces, equipment, and debris in partially demolished structures. An active suspended chlorine gas line is located near the proposed demolition area, which will be decommissioned prior to Unit 4 cell building demolition.

Hazardous substances used at the Site may include hydrochloric and nitric acids and hexane or acetone for decontaminating groundwater and soil sampling and measurement equipment, water test kits, and other materials. The Safety Data Sheets (SDS) included in **Attachment V** to this HASP summarize health and safety information for hazardous materials that will be brought to the site, such as treatment chemicals, laboratory reagents, decontamination solutions, and sample preservatives.

All containers of hazardous substances must be labeled with the name of the chemical and appropriate hazard warnings. Employees and contractors who use hazardous substances must read the labels and know where SDSs are located in case of an emergency.

Exposure to the Chemicals of Concern will be prevented through the implementation of applicable Tetra Tech safe work practices (**Attachment II**) including avoiding contact with media residues, soils, groundwater, etc., working from an upwind location, screening with real-time direct-reading instruments, use of PPE, minimizing the generation of dust, proper decontamination, and hand washing prior to conducting hand to mouth activities. Table 5-1 below lists the major contaminants of concern, the published occupational exposure limits, routes of entry, target organs, and adverse health effects. There are no occupational exposure limits for perchlorates.

A minimum of two project personnel (the "buddy" system) is required when Level C PPE or higher (including carrying an escape respirator as contingency) is required to protect against chemical exposures via inhalation or dermal contact/absorption.

Table 4: Chemicals of Concern

Chemical	Environmental Media[1]	Highest Measured Concentration (Before 2010-2011 Soil Remediation)	Highest Measured Concentration (After 2010-2011 Soil Remediation)	PEL/TLV[2]
Manganese	SO	560,000 mg/kg	300,000 mg/kg	0.2 mg/m3
Hexachlorobenzene	SO	790 mg/kg	300 mg/kg	0.002 mg/m3
Arsenic	SO	2,000 mg/kg	2,000 mg/kg	0.010 mg/m^3
Perchlorate	SO, GW	56,000 mg/kg (SO) 18,000 mg/l (GW)	56,000 mg/kg (SO) 18,000 mg/l (GW)	NL
Dioxin/Furans	SO	1,900,000 pg/g	73,000 pg/g	NL
Asbestos	SO	94 s/samp	58 s/samp	0.1 f/cc
Hexavalent chromium	SO, GW	140 mg/kg (SO) 47 mg/l (GW)	106 mg/kg 47 mg/l (GW)	0.005 mg/m^3
Total Volatile Organic Compounds	SO, GW	138 mg/kg (SO) 196.1 mg/l (GW)	138 mg/kg (SO) 196.1 mg/l (GW)	Various The most strict for some common compounds are 1 ppm

Notes:

1. Highest concentrations measured as reported above apply to the NERT Site as a whole. Individual work areas may have lower concentrations of the chemicals of concern, or there may not be prior data available.
2. Other Chemicals of Potential Concern (COPCs) that may be present at the site include chlorate, other metals including rare earth metals, SVOCs, PAHs, PCBs, petroleum hydrocarbons, organochlorine pesticides, organophosphorus pesticides, radionuclides, and organic acids. These COPCs are not expected to be a significant factor in potential exposures to field personnel.

[1] Codes for environmental media: **SL**=Sludge; **GW**=Ground Water; **SW**=Surface Water; **LW**=Liquid Waste; **SO**=Soil; **A**=Air; OTH= Other (Specify)

[2] PEL: Permissible Exposure Limit / TLV: Threshold Limit Value, use appropriate PEL which would be country or state specific or if one is not available may be from a recognized source.

mg/m^3: milligrams per cubic meter
mg/l: milligrams per liter
ppm: Parts per million
s/samp: structures per sample
%: Minimum percent allowed for personal entry into a space
NL: No limit found in reference materials

TABLE 5-1
PUBLISHED EXPOSURE LIMITS AND HEALTH EFFECTS
CONTAMINANTS OF CONCERN/BUILDING MATERIALS

Contaminant	Exposure Limits	Exposure Routes	Target Organs	Health Effects
Arsenic (inorganic)	PEL/TLV: 0.01 mg/m^3 Ca IDLH: 5 mg/m^3	Inhalation, skin absorption, skin and/or eye contact, ingestion	Liver, kidneys, skin, lungs, lymphatic system	Ulceration of nasal septum, dermatitis, gastrointestinal disturbances, peripheral neuropathy, respiration, skin hyperpigmentation.
Chromium (Cr +6 compounds)	TLV: 0.01 mg/m^3 insoluble 0.05 mg/m^3 water-soluble PEL: 0.005 mg/m^3 IDLH: NL	Inhalation, ingestion, skin and/or eye contact	Blood, respiratory system, liver, kidneys, eyes, skin	Irritation respiratory system; nasal septum perforation; liver, kidney damage; leukocytosis (increased blood leukocytes), leukopenia (reduced blood leukocytes), eosinophilia; eye injury, conjunctivitis; skin ulcer, sensitization dermatitis
Manganese	TLV: 0.02 mg/m^3 Respirable fraction 0.1 mg/m^3 Inhalable fraction PEL: C 5 mg/m^3 IDLH: 500 mg/m^3	Inhalation, ingestion	Respiratory system, central nervous system, blood, kidneys	Manganism; asthenia, insomnia, mental confusion; metal fume fever: dry throat, cough, chest tightness, dyspnea (breathing difficulty), rales, flu-like fever; low-back pain; vomiting; malaise (vague feeling of discomfort); lassitude (weakness, exhaustion); kidney damage
Asbestos	PEL/TLV: 0.1 fibers/cc Excursion Limit: 1.0 fibers/cc (30 minutes) IDLH: NL Carcinogen	Inhalation, ingestion	Lungs, GI tract, skin	Asbestosis, lung cancer, mesothelioma
Lead (inorganic)	PEL/TLV: 0.050 mg/m^3 IDLH: 100 mg/m^3	Inhalation, ingestion	Eyes, GI tract, CNS, PNS, kidneys, liver, blood, gums	Central nervous system and peripheral nervous system impairment, wrist and ankle drop, colic, hematologic effects (anemia), gum line

Contaminant	Exposure Limits	Exposure Routes	Target Organs	Health Effects
Perchlorates (Ammonium)	NL	Inhalation, ingestion, skin and eye contact	Blood, kidneys, skin, eyes, respiratory tract	Skin, nose and eye irritation; thyroid gland damage; methemoglobin-emia (headache, fatigue, dizziness, blue color to lips and skin), breathing difficulty, kidney damage **Safety hazards**: Flammable in the presence of shocks, heat, and reducing, combustible or organic materials. Extremely explosive in presence of open flames and sparks, and shocks, heat, reducing or organic materials. Slightly explosive in presence of acids. Keep spilled material wet with water spray. Eliminate all ignition sources.
Notes: NL – none listed mg/m^3– milligrams per cubic meter of air ppm – parts per million fibers/cc – number of fibers per cubic centimeter of air Ca – carcinogen C – ceiling limit PEL – Permissible Exposure Limit (OSHA) TLV –TWA – Threshold Limit Value – Time-weighted average (8-hour) 2015 American Conference of Governmental Industrial Hygienists (ACGIH) IDLH- Immediately Dangerous to Life or Health - National Institute for Occupational Safety and Health (NIOSH)				

5.2 Physical Hazards

Injuries resulting from physical hazards can be avoided by using SWPs and employing caution when working in the vicinity of heavy equipment and machinery. Specific SWPs applicable to the Site are provided in **Attachment II** of this HASP. To ensure a safe workplace, the SSO will conduct and document regular safety inspections and will make sure that all Tetra Tech workers, subcontractors and authorized visitors are informed of any potential physical hazards related to the site.

The following is a list of physical hazards that may be encountered at the site or may be present during the performance of site activities.

- Slips, trips, and falls;
- Traffic and heavy equipment hazards (struck by/against/crush hazard;
- Excessive noise (> 85 dBA);

- Cuts (or other injuries associated with hand tool use);
- Manual lifting/material handling (strain/muscle pulls);
- Ambient temperature extremes (heat stress);
- Pinch/compression points;
- Vehicular and foot traffic;
- Electrical hazards;
- Underground utilities;
- Overhead power lines and structures;
- Power and hand tools;
- Suspended loads;
- Rail spurs; and
- Building structure collapse.

Specific hazards are discussed further below, and are presented relative to each task in the task-specific Activity Hazard Analyses and subcontractor Job Safety Analyses (**pending**).

5.2.1 Slips, Trips and Falls

During various site activities there is a potential for slip, trip, and fall hazards associated with wet, steep, or unstable work surfaces. To minimize hazards of this nature, personnel required to work in and along areas prone to these types of hazards will be required to exercise caution, and use appropriate precautions (restrict access, guardrails, life lines and/or safety harnesses) and other means suitable for the task at hand. Site activities will be performed using the buddy system.

5.2.2 Contact with Underground Utilities

Underground utilities such as pressurized lines, water lines, telephone lines, buried utility lines, and high voltage power lines are known to be present throughout the work site. Clearance of underground utilities for each intrusive operation will be coordinated through Tronox.

As an initial step for the subsurface utility clearance, Tetra Tech will provide Tronox with a map depicting the locations of the planned invasive work and obtain tentative approval of the proposed investigation locations. After obtaining tentative approval from Tronox, Tetra Tech will mark the proposed invasive activities in the field. The locations of the proposed invasive activities will be placed using a hand-held global positional system (GPS) unit or use of a land surveyor. Following field marking of the proposed activities, Tetra Tech will apply for a Ground Breaking Permit from Tronox. As part of the Ground Breaking Permit process, Tronox will review their utility records and identify any potential conflicts that may exist with the locations of the proposed work. If a conflict is identified, the proposed field location(s) will be adjusted accordingly. Following resolution of any subsurface utility conflicts, Tronox will issue the Ground Breaking Permit.

Once all of the final locations have been cleared and Tronox has issued the Ground Breaking Permit, Tetra Tech as an additional precaution will retain the services of a geophysical locator to determine if there are any other underground utility lines (e.g., abandoned or inactive service utilities) that may not have been identified in Tronox's records. If geophysical techniques are not selected as the preferred utility locating method, Tetra Tech may utilize alternate methods to identify the presence or absence of subsurface utilities, including but not limited to the use of an air-knife or other utility clearance method. In the event that a buried utility line is identified at a proposed location, Tetra Tech will work with Tronox to determine if an alternative location is needed, or if the identified subsurface utility is abandoned and does not pose a risk.

If during field implementation a subsurface structure or utility is identified, Tetra Tech will cease drilling operations at that location, notify Tronox, and identify an appropriate course of action. The investigation area clearance procedure described in this section of the Work Plan will be followed prior to each field mobilization where invasive activities are planned. Safe Work Practices for Underground Utilities and Tetra Tech's Ground Disturbance Permit are provided in Attachment 1.

5.2.3 High Noise Levels

High noise levels can be generated during the operation of heavy machinery and pressure washers used for decontamination activities. Personnel in the vicinity of operating equipment shall use hearing protection in the form of ear plugs or ear muffs. An exclusion area boundary shall be established to delineate where hearing protection is required.

Qualitative monitoring of work areas may be employed by the FOL and/or SSO or field personnel to determine approximate noise level conditions and the need for hearing protection. This involves observing a common simple rule of thumb: ***If one must raise their voice to be heard by someone who is standing within arm's length, then noise levels are likely to exceed 85 decibels.*** Therefore, hearing protection would be required. The rule of thumb may be used for short duration or intermittent activities or for activities that have been previously quantified.

5.2.4 Strain/Muscle Pulls from Heavy Lifting

During execution of planned activities there is some potential for strains, sprains, and/or muscle pulls due to the physical demands and nature of this site work. To avoid injury during lifting tasks, personnel are to lift with the force of the load carried by their legs and not their backs. When lifting or handling heavy material or equipment, use an appropriate number of personnel. Keep the work area free from ground clutter to avoid unnecessary twisting or sudden movements while handling loads.

5.2.5 Heat/Cold Stress

The southern Nevada summer climate poses risks of extreme heat, and the risk is increased with the use of personal protective clothing. Thus, a major concern is the risk of heat-related illnesses including heat exhaustion and heat stroke (a medical emergency). The SWPs for heat stress and cold stress address thermal stress prevention and monitoring and are provided in **Attachment II**.

5.2.6 Pinch/Compression Points

Handling of tools, machinery, and other equipment on site may expose personnel to pinch/compression point hazards during normal work activities. Where applicable, equipment will have intact and functional guarding to prevent personnel contact with hazards. Personnel will exercise caution when working around pinch/compression points, using additional tools or devices (e.g., pinch bars) to assist in completing activities.

5.2.7 Biological Hazards

Biological hazards such as poisonous plants, bites from poisonous or disease-carrying animals or insects (e.g., snakes, ticks, mosquitoes, spiders, scorpions) are often prevalent at sites that are being investigated as part of hazardous waste site operations. To minimize the potential for site personnel to encounter these hazards, nesting areas in and about work areas will be avoided to the greatest extent possible. Work areas will be inspected to look for any evidence that dangerous animals (e.g. coyotes) may be present. Based on the planned location for the work covered by this HASP, encountering wild animals is not a likely probability.

Mosquitos are associated with the risk of contracting West Nile Virus which can cause a brain inflammation known as encephalitis. The U.S. Centers for Disease Control and Prevention track the incidence of West Nile Virus through the “dead bird” count at the county/state level. Mosquito avoidance measures include:

- Remove stagnant water and other breeding places for mosquitos;
- Use DEET-containing insect repellent; and
- Avoid working during early morning and dusk when mosquitos are active.

Contact with poisonous plants and bites or stings from poisonous insects are other potential natural hazards. Long-sleeved shirts (tucked into pants) and long pants (tucked into boots), and avoiding potential nesting areas, will minimize the potential for exposure. Additionally, insect repellents may be used by site personnel. Personnel who are allergic to stinging insects (such as bees, wasps and hornets) must be particularly careful since severe illness and death may result from allergic reactions. As with any medical condition or allergy, information regarding the condition must be listed on the Medical Data Sheet (**Attachment I**), and the FOL or SSO notified.

5.2.8 Vehicular and Equipment Traffic

If working in or near streets or roadways, hazards associated with vehicular and equipment traffic are likely to exist during various site activities and whenever site personnel performed work on or near roadways. Site personnel will be instructed to maintain awareness of traffic and moving equipment when performing site activities. When working near roadways, site personnel will wear high visibility vests.

Tronox has informed Tetra Tech that the rail spur that reaches the Unit 4 and 5 buildings are no longer active but it is connected to actives lines to the west. No vehicles or equipment should be parked on or near the unused rail spur as there is a risk that some equipment on the active rail spurs could accidently migrate down the unused spur.

5.2.9 Inclement Weather

Project tasks under this Scope of Work will be performed outdoors. As a result, inclement weather may be encountered especially during the summer months when heavy storms with flash flooding may occur. In the event that adverse weather (hurricanes, electrical storms, tornadoes, etc.) conditions arise, the FOL and/or the SSO will be responsible for temporarily suspending or terminating activities until hazardous conditions no longer exist. Additionally, hot dry and windy conditions may increase for the risk of fires on site.

5.2.10 Heavy Equipment Hazards

Ensure that workers are thoroughly trained and competent to perform their assigned task with the equipment used in the investigation. Ensure that back-up alarms are functional on equipment. Heavy equipment will be subjected to an equipment inspection upon arrival on-site, daily, and prior to leaving. This inspection may be recorded on the Equipment Inspection Checklist. The equipment operators and SSO are responsible for the equipment and completion of the Equipment Inspection Checklist, and that all moving parts are guarded if such parts are exposed. Check/test all emergency stop controls. Use escort vehicles with flashing lights to ward and control local traffic when moving large equipment to support area. All manufacturer's specifications and limitations will be adhered to. The equipment operators will establish communication protocol with personnel on the ground, and will maintain awareness of their surroundings at all times. An exclusion zone will also be established to keep ground personnel away from heavy equipment.

Tetra Tech SWPs for protection against these physical hazards are provided in **Attachment II**.

A minimum of two project personnel (the "buddy" system) is required for the following hazardous operations or site conditions:

- Electrical work;
- Working over or near water;
- Heavy lifting (pumps and hoses);
- Excavation work;
- Instances of extreme heat illness risk;
- Instances of extreme hypothermia risk;
- Confined space entry; and
- Working at heights/fall hazard.

6.0 TASK-HAZARD ANALYSIS

This section serves as the primary portion of the Site-specific HASP and Tables 6-1 and 6-2 have been created to summarize the tasks, hazards, and associated control measures currently applied on Site and will be modified and incorporated into this document as new or additional tasks are performed at the Site. The anticipated hazards, recommended control measures, air monitoring recommendations, required PPE, and decontamination measures for each Site task are discussed in detail. This table and the associated control measures shall be revised if the scope of work, contaminants of concern, or other conditions change.

Through using the tables, Site personnel can determine which hazards are associated with each task at the Site, and what associated control measures are necessary to minimize potential exposure or injuries related to those hazards. The table also assists field team members in determining which PPE and decontamination procedures to use based on proper air monitoring techniques and Site-specific conditions.

PPE selection is determined by the chemical hazard, expected concentrations (in air, soil, or other media), route of exposure, and availability of appropriate chemical-resistant materials. Further information is provided in Table 6-2 and Section 5.2.

The applicable Tetra Tech Health and Safety Manual program elements, safe work practices, and forms are attached to this HASP.

The following tasks have been chosen for a detailed Job/Task Hazard Analysis which lists the anticipated hazards, and the required control measures including PPE, air monitoring and decontamination procedures. Some of these tasks are combined in Table 6-2 due to similarity in task steps, hazards and control measures.

- Mobilization/demobilization and non-intrusive surveying/utility clearance;
- Multi-media sampling including soil, groundwater and investigation-derived waste (IDW);
- Soil boring and well installation, development, removal and closure;
- Hazardous building materials inspection and sampling; and
- Partial building demolition and soil ramp construction operations.

Subcontractor work plans, Job Safety Analyses, and other health and safety-related documents will be submitted for review and incorporated into **Attachment VII** when reviewed and approved by Tetra Tech.

6.1 Air Monitoring

Due to the potential for exposure to airborne concrete dust and soil particulates that may contain hexavalent chromium, arsenic, lead, manganese and other toxic metals, Tetra Tech will conduct worker exposure and environmental air (work area perimeter) monitoring during site assessment, building material sampling, demolition, ramp construction, and soil disturbance activities using OSHA and/or NIOSH approved sampling methods. Real-time air monitoring for respirable dust (PM-10) may be required for certain tasks and locations that may generate airborne dust with toxic constituents, depending on the findings of the Building Hazardous Materials Survey. As subsurface soil and groundwater are not known to contain significant concentrations of VOCs, screening with a photoionization detector is not anticipated for site Tasks.

A detailed Sampling and Analysis Plan will be developed by Tetra Tech's Certified Industrial Hygienist pending finalization of the Work Plan and Demolition Plan.

6.2 Personal Protective Equipment

The level of personal protection to be used for work tasks at the NERT Site have been selected based on known or anticipated physical hazards; types and concentrations of contaminants that may be encountered on site; and contaminant properties, toxicity, exposure routes, and matrixes.

All PPE must be labeled or stamped with the applicable American National Standards Institute (ANSI) or American Society of Testing and Materials (ASTM) standard specification to verify compliance with OSHA requirements for PPE design and construction. The types and levels of PPE anticipated to be worn for the performance of various tasks at the Site are as follows:

TABLE 6-1
PPE LEVELS

PPE LEVEL	COMPONENTS
D	Standard work clothes- long sleeves, long pants or coveralls Work gloves (single use) Safety boots (steel toe) with electrical hazard rating (if needed pending utility survey) Boots, outer, chemical-resistant rubber (disposable) Impact-resistant safety glasses with side shields (contact lenses are expressly prohibited onsite; wear prescription safety glasses as required) Hard hat Hearing protection ANSI Class 2 reflective high visibility traffic vest Escape respirators (15 minute air supply) Electrical resistant gloves (rating TBD, based on utility survey)
Modified D	All of the above plus: Tyvek coveralls (if needed) Flame retardant clothing (military equivalent) in active work areas Chemical-resistant gloves (nitrile rubber) Chemical-resistant apron (nitrile rubber)
C	All of the above plus: Full-face, air purifying respirators (National Institute for Occupational Safety and Health [NIOSH]-approved) equipped with P100/organic vapor/acid gas combination cartridges) with prescription eyewear inserts as needed (contact lenses are prohibited) Whole body Tyvek coveralls with head and foot covering

Area evacuation or Level C protection will be required when action levels are exceeded or if airborne concentrations of organic vapors cannot be adequately controlled to background levels in the breathing zone. All project personnel who are required to wear Level C respiratory protection will receive training on the selection, use, limitations, cleaning, and storage of the respirators and also will undergo qualitative respirator fit testing using Bitrex during the site-specific training. This will be conducted by a qualified health and safety professional. Level C respiratory protection is anticipated for friable asbestos and toxic metal (i.e., hexavalent chromium) sampling tasks during pre-demolition building surveys.

Level C protection will be required during potential building material/equipment remedial operations to remove perchlorate and metal contamination, and during soil disturbance, concrete-coring and demolition operations.

Personnel must be trained and maintain proficiency in the selection, limitations, donning/doffing, use, care, cleaning, and storage of PPE that is to be worn. Only PPE that meets the following ANSI standards are to be worn:

- Eye protection – ANSI Z87.1-1989
- Head protection – ANSI Z89.1-1986
- Foot protection – ANSI Z41-1991

6.3 Decontamination Procedures

Decontamination is the process of removing or neutralizing contaminants on personnel or equipment. When properly conducted, decontamination procedures protect workers from contaminants that may have accumulated on PPE, tools, and other equipment. Proper decontamination also prevents transport of potentially harmful materials to uncontaminated areas. Personnel and equipment decontamination procedures are described in the following sections.

The following personnel and equipment decontamination procedures shall be initiated, as necessary, upon completion of each task.

6.3.1 Personal Decontamination

Personnel decontamination will consist of a soap/water wash and rinse for outer protective equipment (e.g., boots, gloves, polyvinyl chloride (PVC) splash suits, etc.). This function will take place at an area adjacent to the sampling operations bordering the support zone.

The decontamination procedure for modified Level D protection will consist of:

- Equipment drop;
- Soap/water wash and rinse of outer gloves and outer boots, as applicable;
- Remove and properly discard glove and clothing items;
- Wash hands and face; and
- Leave contamination reduction zone.

Decontamination of Level C protection, in addition to that described above, shall also include:

- Soap/water wash and rinse of outer gloves and outer boots, as applicable;

- Outer suit, boot covers, outer glove removal;
- Respirator cartridge removal and discard;
- Respiratory (face mask) protection removal and wash/rinse;
- Wash hands and face;
- Leave contamination reduction zone; and
- Replace respirator cartridges (if additional work is to be performed).

Used, disposable PPE will be collected in sealable containers and will be disposed of in accordance with procedures described in the Work Plan (pending characterization, if necessary). Personnel decontamination procedures may be modified as necessary while on site.

6.3.2 Equipment Decontamination

Equipment decontamination will take place at a centralized decontamination pad or other designated area utilizing brushes or steam or pressure washers, as deemed appropriate by the SSO. All Site vehicles will be restricted access to exclusion zones, and also have their wheels/tires sprayed or brushed off so as not to track mud onto the roadways servicing the activities. Roadways shall be cleared of any debris resulting from the on-Site activity.

All downhole drilling equipment will be thoroughly decontaminated prior to the equipment arriving on Site, between borehole locations, and following completion of Site activities. .

Decontamination of all sampling and field monitoring equipment used during site activities will be required. Equipment decontamination procedures are based on guidelines appropriate for low-level contamination. Additional procedures may be found in EPA SOP No. 2006, titled "Sampling Equipment Decontamination" dated August 11, 1994.

Sampling and field equipment will be decontaminated before and after each use as described below.

- Scrub the equipment with a brush in a bucket containing Liquinox® or Alconox® solution and distilled water.
- Triple-rinse the equipment with distilled water, and allow it to air-dry.
- Reassemble the equipment, and place it on plastic or aluminum foil in a clean area. If aluminum foil is used, wrap the equipment with the dull side of the aluminum foil toward the equipment.

Other field equipment can be decontaminated with hot water and/or protected from exposure by covering with disposable covers such as plastic to minimize required decontamination activities. Wastewater from equipment decontamination activities will be transferred to the onsite treatment plant for treatment and disposal.

TABLE 6-2 TASKS/HAZARDS/CONTROL MEASURES

TASK/OPERATION: Mobilization/Demobilization and Site Preparation/Inspection. Includes non-intrusive surface geophysical investigation for buried utilities.

Anticipated Hazards	***Chemical hazards:*** 1) Potential contact with surficial chemical contamination (perchlorate, hexavalent chromium) on structures, concrete and floor surfaces. ***Physical hazards:*** 1) Strain/muscle pulls from heavy lifting. 2) Pinch/compression points. 3) Uneven or unstable terrain, slick surfaces. (slip, trip, and fall hazards). 4) Contact/entanglement with heavy equipment or machinery. 5) Biological hazards (insect/animal bites and stings, poisonous plants). 6) Other physical hazards associated with ongoing operations (foot and vehicular traffic) 7) Inclement weather. Heat stress.
Required Control Measures	***Chemical hazards:*** 1) Avoid contact with suspect contamination (yellow stains, paint chips, concrete tanks that may contain perchlorate). ***Physical hazards:*** 1) Use machinery or multiple personnel for heavy lifts. Use proper lifting techniques (bend with legs and not the waist). 2) Identify pinch points and keep hands away. Use pinch bars or other equipment to keep hands from the point of operation. 3) Preview and prepare work locations where unstable/uneven terrain exists. Mark hazards with cones/pin flags and barricade as needed. 4) Ensure equipment is inspected prior to use and operated by a knowledgeable operator. Maintain line of vision with operator. Use hand signals. Establish safe zones of approach (i.e., Boom + 10 feet). Secure all loose articles to avoid possible entanglement. 5) Avoid insect/animal nesting areas, use repellents (Do NOT use repellents during sampling activities). Report potential hazards to the **SSO.** Frequently inspect clothing and persons during and after activities in wooded or grassy areas for ticks and other vectors. Do daily tick checks after shift. 6) Identify all access/egress routes and locations to assemble within established areas of operation. All equipment capable of self-propelled movement will be equipped with movement alarms as applicable. 7) Suspend site activities in event of inclement weather or heat warnings. See SWPs for heat stress and cold stress.
Air Monitoring	Elevated airborne concentrations impacting the field crews or downwind receptors are not anticipated * See Section 6.1 for further information.
Personal Protective Equipment	Modified Level D protection. See Table 6-1 for further information. Level C protection is a contingency depending on hazmat survey findings.
Decontamination Procedures	See Section 6.3 for personnel and equipment decontamination procedures.

TABLE 6-2 TASKS/HAZARDS/CONTROL MEASURES

TASK/OPERATION: Groundwater and soil (core) sampling. Also includes IDW activities.

Anticipated Hazards	***Chemical hazards*** 1) Potential contact with site COCs (metals, perchlorates). See Table 5-1 for chemical hazard information. See AHA for perchlorate safety. ***Physical hazards*** 1) Slip/trip/fall hazards due to uneven/unstable terrain, slick surfaces, hoses etc. 2) Noise in excess of 85 dBA. 3) Strain/muscle pulls from heavy lifting and tool use. 4) Pinch/compression points. 5) Struck by/against hazards from heavy equipment, vehicles, hoses under pressure, etc. 6) Biological hazards (insect/animal bites or stings, poisonous plants, etc.). 7) Ambient temperature extremes.
Required Control Measures	***Chemical hazards*** 1) Identify and physically barricade operational zones where potential contamination may exist to prevent incidental contact and transfer outside of the operational area. 3) Decontaminate all equipment and supplies between sampling events as well as prior to leaving the Site. ***Physical hazards*** 1) Preview work location for uneven/unstable terrain. Mark hazards with cones/pin flags and barricade as needed. Wear safety boots with non-slip soles. 2) Exposure to excessive noise levels (above 85 dBA) will be mitigated through the use of hearing protection. Use rule-of-thumb –if you have to shout to be heard at 3 foot distance, wear hearing protection. 3) Use machinery or multiple personnel for heavy lifts. Use proper lifting techniques. 4) Identify pinch points and keep hands away. Use pinch bars or other equipment to keep hands from the point of operation. 5) Maintain safe distance from operating equipment/vehicles and line of vision with operator. Secure hoses to minimize movement. 6) Use insect repellants containing at least 10% DEET and tape up where ticks could be encountered. Do daily tick checks. Avoid potential nesting areas and suspicious vegetation (poison ivy, poison oak, etc.) 7) Wear appropriate clothing for the anticipated weather conditions while maintaining the required level of protection. If necessary, perform core body temperature monitoring and pulse measurements to assess thermal stress. See SWPs for heat stress and cold stress.
Air Monitoring	Elevated airborne concentrations impacting the field crews or downwind receptors are not anticipated. * See Section 6.1 for further information.
Personal Protective Equipment	Modified Level D protection. See Table 6-1 for further information.
Decontamination Procedures	*See Section 6.3 for personnel and equipment decontamination procedures.

TABLE 6-2 TASKS/HAZARDS/CONTROL MEASURES SUMMARIZATION

TASK/OPERATION: Oversight of Soil Boring and Monitoring Well Installation and Development.

Anticipated Hazards	***Chemical hazards*** 1) Potential contact with site chemicals of concern (metals, perchlorate). See Table 5-1 for chemical hazard information. See AHA for perchlorate safety. ***Physical hazards*** 1) Contact/entanglement with rotating equipment or machinery. 2) Noise in excess of 85 dBA. 3) Contact with underground or overhead utilities (electric lines, gas lines, water lines, etc.). 4) Strain/muscle pulls from heavy lifting. 5) Uneven or unstable terrain, slick surfaces (slip, trip, and fall hazards). 6) Pinch/compression points. 7) Other physical hazards associated with ongoing operations (foot and vehicular traffic). 8) Biological hazards (insect/animal bites or stings, poisonous plants, etc.). 9) Ambient temperature extremes. Heat stress.
Recommended Control Measures	***Chemical hazards*** 1) Use real-time monitoring instrumentation to screen soil corings, and worker breathing zones, action levels, and identified PPE to control exposures to potentially contaminated media (e.g., air, water, soils, etc.). Exposure to dusty conditions will be controlled through the use of water or personnel avoidance of any visible dust plumes. 2) Identify and physically barricade operational zones where potential contamination may exist to prevent incidental contact and transfer outside of the operational area. 3) Decontaminate all equipment and supplies between drilling events as well as prior to leaving the Site. ***Physical hazards*** Equipment used will be: 1) Inspected in accordance per manufacturer's guidelines. 2) Operated by Certified operators and knowledgeable ground crew. 3) Only manufacturer approved equipment may be used in conjunction with equipment repair procedures (e.g., pins for auger flights). In addition to the equipment considerations, the following standard operating procedures will be used: 1) All personnel not directly supporting the drilling operation will remain at least 25 feet from the point of operation. 2) All loose clothing/protective equipment will be secured to avoid possible entanglement. 3) Hand signals will be established prior to the commencement of drilling activities. 4) The driller and helper can simultaneously handle moving augers or flights only when there is a standby person to activate the emergency stop device. 5) The driller must never leave the controls while tools are rotating unless all personnel are clear of the rotating equipment. 6) A long-handled shovel or equivalent shall be used to clear away drill cuttings from the hole and rotating equipment. Hands or feet shall **not** be used for this purpose. 7) A remote sampling device must be used to sample drill cuttings near rotating tools. 8) Never climb a drill mast while equipment is rotating. 9) Work areas will be kept clear of clutter. 10) All personnel will be instructed in the location and operations of the emergency shut off device(s). This device will be tested initially (and then periodically) to ensure its operational status. 11) Areas will be inspected prior to the movement of drill rigs, backhoes and support vehicles to eliminate any physical hazards. This will be the responsibility of the **SSO**. 12) Exposure to excessive noise levels will be mitigated through the use of hearing protection. 13) Review site drawings for possible utility locations. All utility locater shall be obtained in writing prior to subsurface activities. The locations of all underground utilities will be identified and marked prior to all subsurface investigations. Observe utility clearance process. 14) Drill masts, backhoe booms or other projecting devices shall be at least 20 feet from overhead power lines and a minimum of 4 feet from identified underground locations.

TABLE 6-2 TASKS/HAZARDS/CONTROL MEASURES SUMMARIZATION

TASK/OPERATION: Oversight of Soil Boring and Monitoring Well Installation and Development.

	15) Use machinery or multiple personnel for heavy lifts. Use proper lifting techniques. Bend with legs, not at waist. 16) Preview work location for uneven/unstable terrain. Wear safety boots with non-slip soles. Mark hazards with cones/pin flags and barricade as needed. 17) Identify pinch points and keep hands away. Use pinch bars or other equipment to remove hands from the point of operation, when acquiring samples. 18) Traffic and equipment considerations are to include the following: 19) Establish safe zones of approach (i.e. Boom + 3 feet). 20) All equipment shall be equipped with movement warning systems. 21) All personnel working in high equipment traffic areas are required to wear reflective vests for high visibility. 22) Wear appropriate clothing and PPE. Avoid potential nesting areas and suspicious vegetation (poison ivy, poison oak, etc.). When feasible and necessary, use commercially available insect repellents. Do daily tick checks at end of shift. 23) Wear appropriate clothing for the anticipated weather conditions while maintaining the required level of protection. If necessary, perform core body temperature monitoring and pulse measurements to assess thermal stress. See SWPs for heat stress and cold stress.
Air Monitoring	Elevated airborne concentrations impacting the field crews or downwind receptors are not anticipated. Control of potential exposure will be facilitated through engineering controls by using water to suppress airborne contaminant-laden dust. * See Section 6.1 for further information.
Personal Protective Equipment	Modified Level D protection. See Table 6-1 for further information.
Decontamination Procedures	*See Section 6.3 for personnel and equipment decontamination procedures.

TABLE 6-2 TASKS/HAZARDS/CONTROL MEASURES SUMMARIZATION

TASK/OPERATION: Oversight of Building Demolition, Waste Segregation and Removal, and Soil Ramp Construction.

Anticipated Hazards	***Chemical hazards*** 1) Potential contact with site chemicals of concern (metals, perchlorates) and potential hazardous building materials. See Table 5-1 for chemical hazard information. 2) Verify decommissioning of suspended active chlorine gas line along south-facing Chlorination Room on north side of Unit 4 cell building to prevent disturbance/destruction of active line and possible chlorine gas release. ***Physical hazards*** 1) Contact (struck by/against/rollover/crush) hazards with heavy equipment or machinery. 2) Noise in excess of 85 dBA. 3) Contact with underground or overhead utilities (electric lines, gas lines, water lines, etc.). 4) Strain/muscle pulls from heavy lifting. 5) Uneven or unstable terrain, slick surfaces (slip, trip, and fall hazards). 6) Pinch/compression points. 7) Other physical hazards associated with ongoing operations (foot and vehicular traffic). 8) Biological hazards (insect/animal bites or stings, poisonous plants, etc.). 9) Ambient temperature extremes. Heat stress. 10) Destruction/damage to foundations of northern Chlorination room and southern Rectifier room, corrugated steel sheeting weather (ACM) coating of Chlorination room, and acid-proof brick facing of Rectifier room.
Recommended Control Measures	***Chemical hazards*** 1) Exposure to dusty conditions will be controlled through the use of water or personnel avoidance of any visible dust plumes. All identified regulated asbestos materials and other hazmats will have been removed prior to demolition in accordance with EPA regulations. 2) Identify and physically barricade operational zones where potential contamination may exist to prevent incidental contact and transfer outside of the operational area. 3) Decontaminate all equipment and supplies between drilling events as well as prior to leaving the Site. 2) Structural evaluation/ and protection of active chlorine gas line from falling debris (details in demo work plan); emergency escape respirators (10 minute air supply); coordination with property owner for pipe protection and monitoring, verification of use of stationery monitors/alarms; remain upwind of site operations. ***Physical hazards*** 1) All personnel not directly supporting the demolition/construction operation will remain at least 50 feet from the point of operation. Hand signals will be established prior to the commencement of demolition activities. Areas will be inspected prior to the movement of excavators, backhoes and support vehicles to eliminate any physical hazards. This will be the responsibility of the **SSO**. 2) Exposure to excessive noise levels will be mitigated through the use of hearing protection. 3) Review site drawings for possible utility locations. All utility locater shall be obtained in writing prior to subsurface activities. The locations of all underground utilities will be identified and marked prior to all subsurface investigations. Observe utility clearance process. Drill masts, backhoe booms or other projecting devices shall be at least 20 feet from overhead power lines and a minimum of 4 feet from identified underground locations. 4) Use machinery or multiple personnel for heavy lifts. Use proper lifting techniques. Bend with legs, not at waist. 5) Preview work location for uneven/unstable terrain. Wear safety boots with non-slip soles. Mark hazards with cones/pin flags and barricade as needed. 6) Identify pinch points and keep hands away. Use pinch bars or other equipment to remove hands from the point of operation, when acquiring samples. 7) Traffic and equipment considerations are to include the following: a) Establish safe zones of approach (i.e. Boom + 3 feet). b) All equipment shall be equipped with movement warning systems. c) All personnel working in high equipment traffic areas are required to wear reflective vests for high visibility.

TABLE 6-2 TASKS/HAZARDS/CONTROL MEASURES SUMMARIZATION

TASK/OPERATION: Oversight of Building Demolition, Waste Segregation and Removal, and Soil Ramp Construction.

	8) Wear appropriate clothing and PPE. Avoid potential nesting areas and suspicious vegetation (poison ivy, poison oak, etc.). When feasible and necessary, use commercially available insect repellents. Do daily tick checks at end of shift. 9) Wear appropriate clothing for the anticipated weather conditions while maintaining the required level of protection. If necessary, perform core body temperature monitoring and pulse measurements to assess thermal stress. See SWPs for heat stress and cold stress. 10) Structural evaluation and protection of building foundations, walls, etc. Removal or weathered ACM coating (if safe) or wet demolition with EPA approval. Demolition contractor will submit Demo plan for review by TT engineers.
Air Monitoring	High-risk worker exposure sampling for hexavalent chromium and other toxic metals will be conducted. Work area perimeter air sampling will also be conducted. See Tetra Tech Sampling and Analysis Plan (to be developed). Control of potential exposure will be facilitated through engineering controls by using water to suppress airborne contaminant-laden dust.
Personal Protective Equipment	Level C protection for equipment operator See Table 6-1 for further information.
Decontamination Procedures	See Section 6.3 for personnel and equipment decontamination procedures.

TABLE 6-2 TASKS/HAZARDS/CONTROL MEASURES SUMMARIZATION

TASK/OPERATION: Unit Building Material Surveys, XRF Surveys and Bulk/Wipe Sampling
Inspection of building materials, surfaces, components, equipment and debris in partially demolished areas for possible hazardous materials including asbestos, lead-based paint, PCBs, mercury, radioactive isotopes, etc. Includes bulk or wipe sampling to verify material composition.

Anticipated Hazards	***Chemical hazards*** 1) Potential inhalation of friable asbestos fibers, contact with lead, mercury or PCBs; and potential contact/inhalation with perchlorates, hexavalent chromium and other toxic metals., See AHA for perchlorate safety. ***Physical hazards:*** 1) Noise in excess of 85 dBA. 2) Strain/muscle pulls from heavy lifting and equipment handling 3) Pinch/compression points. 4) Slip, trip, fall hazards. 5) Electrical hazards from mixing equipment, pumps etc. 6) Thermal stress/inclement weather 7) Cuts/laceration hazards from sharp edges. 8) Building/structure collapse. 9) Radiation source in XRF
Recommended Control Measures	***Chemical hazards:*** 1) Use Level C PPE including full-face air purifying respirator equipped with P100 filter cartridges during inspection and sampling tasks. 2) Only EPA qualified and state-licensed asbestos inspector performs asbestos survey. ***Physical hazards:*** 1) Exposure to excessive noise (above 85 dBA) will be controlled through the use of hearing protection. Use rule of thumb – if you must raise your voice to be heard at arm's length, wear hearing protection. 2) Use machinery or multiple personnel for heavy lifts. Use proper lifting techniques. Bend with legs, not at waist. 3) Identify pinch points and keep hands away. Use pinch bars or other equipment to remove hands from the point of operation when acquiring samples. 4) Preview work area for uneven surfaces, berms, puddles, and promptly remove hazards where identified. Use SWP for portable ladder use. Maintain 3-point contact at all times. If not possible, use safety harness and tie off to secure overhead anchor or ladder and when fall hazard exceeds 6 feet. 5) Do not open, inspect, disturb energized equipment for sampling purposes. 6) Wear appropriate clothing for the anticipated weather conditions while maintaining the required level of protection. If necessary, perform core body temperature monitoring and pulse measurements to assess thermal stress. See SWPs for heat stress and cold stress. 7) Wear cut resistant or heavy leather work gloves when handling equipment. Identify potential sharp edges and keep hands away. 8) TT structural engineer will evaluate structural integrity of unit framing, flooring and walls and will design/implement mitigation measures to ensure safe access to these area. 9) Licensed and trained XRF operator.
Air Monitoring	See Tetra Tech Sampling and Analysis Plan for high-risk worker and work area perimeter air sampling for hexavalent chromium and other toxic metals (As, Pb, Mn).
Personal Protective Equipment	Wear Level C full-face protection with P100filter cartridges, nitrile gloves, Tyvek coveralls during sampling tasks.
Decontamination Procedures	See Section 6.3 for personnel and equipment decontamination procedures.

7.0 AIR MONITORING

7.1 Worker and Area Air Sampling

Pending finalization of the Tetra Tech Work Plan and Demolition Plan, Tetra Tech's Certified Industrial Hygienist will prepare a Sampling and Analysis Plan that describes the sampling protocol for heavy metal exposure monitoring specifically for hexavalent chromium and other toxic metals (i.e., arsenic, lead, manganese) using OSHA and NIOSH-approved sampling methods.

8.0 TRAINING/MEDICAL SURVEILLANCE REQUIREMENTS

8.1 Introduction/Refresher/Supervisory HAZWOPER and OSHA Training

This section specifies health and safety training and medical surveillance requirements for Tetra Tech and subcontractor personnel participating in on-site activities. All project personnel must complete 40 hours of introductory hazardous waste operations (HAZWOPER) site training prior to performing work at the Site. Project personnel who have had introductory training more than 12 months prior to site work must have completed 8 hours of refresher training within the past 12 months before being cleared for site work. In addition, 8-hour supervisory training in accordance with 29 CFR 1910.120(e)(4) will be required for site supervisory personnel. Additionally, all personnel with 40 hours of initial HAZWOPER training are also required to have a minimum of 3 days of field experience under the direct supervision of an experienced supervisor. Training on the updated hazard communication/globally harmonized system (29 CFR 1910.1200) will also be required for site personnel handling hazardous chemicals by December 1, 2013.

Documentation of Tetra Tech introductory, supervisory, and refresher training as well as site-specific training will be maintained at the site. Copies of certificates or other official documentation will be used to fulfill this requirement.

Additionally, at least one field person will be current with basic first aid and CPR training and bloodborne pathogens training to be capable of providing aid to an injured co-worker or subcontractor employee in the event of an injury or illness.

Project personnel performing hazardous building material surveys for asbestos must have the Nevada state license/certification for an asbestos building inspector.

Personnel must have received training in all PPE items that are required to be worn for specific tasks with emphasis on Level C and escape respiratory protection and flame-resistant clothing.

Other construction health and safety training may be required for subcontractor personnel including:

- Competent person for excavation, scaffolding, fall protection, asbestos/lead abatement;
- Heavy equipment operator license;
- OSHA 10-hour or 30-hour construction safety training;
- Lead in Construction (hazard communication); and
- Asbestos awareness.

8.2 Site-Specific Training

The Tetra Tech FOL and/or SSO will provide site-specific training to Tetra Tech employees who will perform work on this project. Figure 8-1 will be used to document the provision and content of the project-specific and associated training. Site-specific training includes the following:

- Tronox 2-hour onsite health and safety training (held weekly and renewed every six months);
- Hazard communication training on perchlorates;
- Review of Activity hazard Analysis for perchlorate safety; and
- U.S. Department of Transportation (DOT) Shipping and Receiving Dangerous Goods 49 CFR Part 171-180 (awareness level and function-specific).

Tetra Tech has been provided a copy of the Tronox Contractor Safety Handbook; pertinent information from the Handbook and onsite training have been incorporated into this HASP. Site personnel will be required to sign this form prior to commencement of site activities. This training documentation will be employed to identify personnel who through record review and attendance of the site-specific training are cleared for participation in site activities. This document shall be maintained at the site to identify and maintain an active list of trained and cleared site personnel.

The Tetra Tech SSO will also conduct a daily tailgate safety meeting prior to initiating site work. This will consist of a brief meeting at the beginning of each day to discuss operations planned for that day, and a review of the appropriate Job Safety Analyses with the planned task participants. A short meeting may also be held at the end of the day to discuss the operations completed and any problems encountered, as determined by the FOL and/or SSO.

8.2.1 HASP Review

Tetra Tech will provide site-specific training to all Tetra Tech and subcontractor personnel who will perform work at the Site. Site-specific training will also be provided to all authorized site visitors who wish to enter the exclusion zones to perform functions that may or may not be directly related to NERT or Tetra Tech operations. All personnel and visitors entering the site will be required to review this HASP and sign the Compliance Agreement Form (HSP-4).

Site-specific training will include:

- Contents of this HASP
- Emergency response procedures (evacuation and assembly points)
- Names of designated personnel responsible for site health and safety
- Site and operation hazards and required controls
- PPE requirements
- Spill response procedures
- Review of the contents of relevant SDSs

8.2.2 Daily Safety Tailgate Meetings

The Tetra Tech SSO will conduct a brief meeting daily to discuss operations planned for that day, which must be attended by all onsite Tetra Tech and subcontractor personnel. The daily safety meeting will address:

- Expected conditions at the site;
- Daily activities;

- Job safety analysis (or AHA) review;
- Stop-work authority;
- Safety deficiencies previously observed and status of corrective action;
- Any changes in the emergency procedures; and,
- Personnel bee allergies or medical conditions which are important for coworkers to be aware.

The meeting discussions will be documented on the Daily Tailgate Safety Meeting (Form HST-2) (**Attachment II**), which will be signed daily by all Site workers. All safety-critical questions and the SSC responses/directions will be documented on this Form.

8.3 Medical Surveillance

All Tetra Tech and subcontractor personnel participating in project field activities will have had a physical examination meeting the requirements of OSHA's HAZWOPER medical surveillance program. Tetra Tech has established an employee medical surveillance program with WorkCare, Inc., of Orange, California. Employee HAZWOPER medical clearance and respirator clearance reports are maintained at the Corporate Health and Safety office and by the Tetra Tech Henderson, NV and Irvine, California offices and made available, as necessary, and will be documented using Figure 8-1 for every employee participating in onsite work activities at the Site. Employees who perform work where they may have exposure to potential Site constituents must have a current medical clearance and approval for Site work in accordance with 29 CFR 1910.120 (f).

Each field team member, including visitors, entering the exclusion zone(s) shall be required to complete and submit a copy of the Medical Data Sheet (**Attachment I**). This shall be provided to the SSO, prior to participating in site activities. The purpose of this document is to provide site personnel and emergency responders with additional information that may be necessary in order to administer medical attention.

No additional chemical-specific or regulation-specific medical surveillance is required for activities covered by this HASP. Medical examinations are also available to any employee that has developed, or believes he has developed, signs or symptoms indicating possible overexposure to hazardous substances or health hazards, or if the employee has been injured or exposed above the PEL or published exposure levels in an emergency situation.

8.4 Site Visitors

Site visitors wishing to enter the exclusion zone will be required to produce the necessary information supporting clearance to the site, including information attesting to training and medical surveillance.

FIGURE 8-1

SITE-SPECIFIC TRAINING DOCUMENTATION

My signature below indicates that I am aware of the potential hazardous nature of performing field activities at Nevada Environmental Response Trust Site and that I have received site-specific training which included the elements presented below:

- Names of designated personnel and alternates responsible for site safety and health;
- Safety, health, and other hazards present on site;
- Use of personal protective equipment;
- Safe use of engineering controls and equipment;
- Medical surveillance requirements;
- Signs and symptoms of overexposure;
- Emergency response procedures (evacuation and assembly points);
- Incipient response procedures;
- Review of the contents of relevant Safety Data Sheets;
- Review of the use of Job Safety Analyses; and
- Stop Work Procedures.

I have been given the opportunity to ask questions and all of my questions have been answered to my satisfaction. The dates of my training and medical surveillance requirements indicated below are accurate.

Name (Printed and Signature)	Site-Specific Training Date	40-Hour Training (Date)	8-Hour Refresher Training (Date)	8-Hour Supervisory Training (Date)	Medical Exam

9.0 SITE CONTROL

This section outlines the means by which Tetra Tech will delineate work zones and use these work zones in conjunction with decontamination procedures to prevent the spread of contaminants into previously unaffected areas of the site. It is anticipated that a three-zone approach will be used during work at this site. This approach will be comprised of an exclusion zone, a contamination reduction zone, and a support zone. It is also anticipated that this approach will control access to site work areas, restricting access by the general public, minimizing the potential for the spread of contaminants, and protecting individuals who are not cleared to enter work areas.

9.1 Exclusion Zone

The exclusion zone will be considered the areas of the site of known or suspected contamination and building demolition areas. It is anticipated that the areas around active/intrusive activates will have the potential for contaminants to be brought to the surface. These areas will be marked and personnel will maintain safe distances. Once demolition or active/intrusive activities have been completed and any surface contamination has been removed and excavation completed, the potential for exposure is again diminished and the area can then be reclassified as part of the contamination reduction zone. The exclusion zones for this project are those areas of the site where active work (building demolition excavation areas, well installation, media sampling, etc.) is being performed. Exclusion zones will be delineated as deemed appropriate by the FOL and SSO, through means such as erecting visibility fencing, barrier tape, cones, and/or postings to inform and direct personnel.

A daily roster with the date of each person's entrance into the exclusion zone; the person's name, signature, and organization; and the time of entry and exit will be kept for all personnel working in the zone. Visitors will not be permitted to enter the exclusion zone without proper qualifications, equipment, and Tetra Tech SSO authorization and escort. Exclusion zones will remain marked until the SSO has evaluated the restoration effort and has authorized changing the zone status.

9.2 Containment Reduction Zone

Contamination Reduction Zones (CRZs) will be established to minimize the potential for the spread of contaminated media into previously unaffected areas. The primary function of a CRZ is to provide an adequate area for decontamination activities. For personal and small item (e.g., tools or sampling equipment) decontamination activities, a CRZ will be established at the perimeter of each EZ. For decontamination activities that will require specialized equipment, larger areas, and more significant containment, a heavy equipment decontamination pad CRZ will be established in one or more areas to support the work areas.

In order to move from one EZ to another, the following activities will be performed in the localized CRZs:

- As work progresses move from location to location, tools and equipment and PPE will be washed to remove contamination, if items cannot be decontaminated they will be bagged and removed. Personnel will use hygienic wipes (such as "baby wipes") as necessary for interim personnel decontamination until they can access a facility equipped with hands washing and rinsing capabilities. At the first available opportunity, personnel will wash their face and hands. This is critical prior to breaks and lunch when contamination may be transferred to the mouth through hand to mouth contact.

Disposable PPE, sampling equipment, and other items are to be sequentially removed/deposited and double-bagged. Such waste is to be disposed of in accordance with the direction of the client. Reusable items that are grossly contaminated (such as muddy over-boots, hardhats, etc.) will be required to be removed, bagged, and taken to the established decontamination pad for washing and rinsing prior to being used at another EZ.

9.3 Support Zone

The support zone for this project will include a staging area where site vehicles will be parked, equipment will be unloaded, and where food and drink containers will be maintained. The support zones will be established at areas of the site where away from potential exposure to site contaminants during normal working conditions or foreseeable emergencies, and in an area generally upwind of the exclusion zone. The support zone will consist of any uncontaminated and nonhazardous part of the site, and should be situated in an area generally upwind of any exclusion zone whenever possible. The Support Zone for this project will include a staging area where site vehicles can be parked, equipment will be unloaded, and where food and drink containers will be maintained. The support zones will be established in clean areas of the site. Site visitors not meeting training, medical surveillance, and PPE requirements must stay in the support zone.

9.4 Site Security

The Site has a chain link fence and gate. All equipment will be secured overnight and left on Site. Tetra Tech personnel will retain complete control over active operational zones.

The site contact will serve as the focal point for facility personnel and interested parties and will serve as the primary enforcement contact.

9.5 Site Visitors

Site visitors for the purpose of this document are identified as representing the following groups of individuals:

- Personnel invited to observe or participate in operations by Tetra Tech;
- Regulatory personnel (i.e. EPA, NDEP, OSHA);
- Property Owner (Trust);
- Authorized Personnel; and
- Other authorized visitors.

Non-Tetra Tech personnel working on this project are required to gain initial access to the facility by coordinating with the Tetra Tech FOL or designee and following established facility access procedures.

Once access to the site is obtained, personnel who require site access into areas of ongoing operations will be required to obtain permission from the PM. In addition, site visitors wishing to observe operations in progress will be escorted by a Tetra Tech representative and shall be required to meet the minimum requirements discussed below:

- Site visitors will be directed to the FOL/SSO, who will sign them into the field logbook. Information to be recorded in the logbook will include the individual's name (proper identification required), the entity which they represent, and the purpose of the visit.

- Site visitors must be escorted and restricted from approaching any work areas where they could be exposed to hazards from Tetra Tech operations. If a visitor has authorization from the client and from the Tetra Tech PM to approach active work areas, the FOL must assure that the visitor first provides documentation indicating that he/she/they have successfully completed the necessary OSHA introductory training, receive site-specific training from the SSO, and that they have been medically cleared to work on hazardous waste sites. Site visitors wishing to enter the exclusion zone will be required to produce the necessary information supporting clearance to the site. All jobsite visitors must have a safety orientation prior to commencing work or touring the site. A visitor log will be kept to document the orientation.

Once the site visitors have completed the above items, they will be permitted to enter the operational zone. Visitors are required to observe the protective equipment and site restrictions in effect at the site at the time of their visit. Visitors entering the exclusion zones during ongoing operations will be accompanied by a Tetra Tech representative. Visitors not meeting the requirements, as stipulated in this plan, for site clearance will not be permitted to enter the site operational zones during planned activities. Any incidence of unauthorized site visitation will cause the termination of onsite activities until the unauthorized visitor is removed from the premises. Removal of unauthorized visitors will be accomplished with support from local law enforcement personnel.

9.6 Communication

For operations in which personnel will be working in proximity to one another during field activities, a supported means of communication between field crew members will not be necessary.

The hand signals listed below will be used by site personnel in emergency situations or when verbal communication is difficult.

Signal	Definition
Hands clutching throat	Out of air or cannot breathe
Hands on top of head	Need assistance
Thumbs up	Okay, I am all right, or I understand
Thumbs down	No or negative
Arms waving upright	Send backup support
Gripping partner’s wrist	Exit area immediately

External communication will be accomplished by using the cell phones/telephones at predetermined and approved locations. External communication will primarily be used for the purpose of resource and emergency resource communications. Prior to the commencement of activities at the Site, the FOL will determine and arrange for telephone communications.

10.0 SPILL CONTAINMENT PROGRAM AND WASTE MANAGEMENT PLAN

10.1 Scope and Application

This Spill Prevention and Containment Program applies to the potential release from one or more containers on the work site involving a single or aggregate accumulation of bulk storage materials (over 55-gallons). As the classification of certain materials such as investigation-derived wastes (IDW) is unknown, these materials will be treated as hazardous, pending laboratory certification to the contrary.

In addition, as the job progresses, IDW such as purge water, decontamination fluids, disposable sampling equipment and PPE may be accumulated.

The spill containment and control plan will be engaged any time there is a release of the above-identified materials from a containment system or vessel, piping, valves, etc. in order to minimize associated hazards.

10.2 Potential Spill Areas

Potential spill areas will be periodically monitored in an ongoing attempt to prevent and control further potential contamination of the environment. It is anticipated that the IDW generated as a result of this scope of work will be containerized, labeled, and staged to await further analyses. The results of these analyses will determine the method of disposal.

It is anticipated that bulk hazardous materials (over 55-gallons of IDW) will be generated or handled at any given time as part of this scope of work. It is anticipated that such spillage would constitute a potential danger to human health or the environment.

10.3 Leak and Spill Detection

To establish an early detection of potential spills or leaks, a periodic walk-around by the personnel involved with waste handling will be conducted during working hours to visually determine that storage and mixing vessels are not leaking. Equipment repairs and replacement will be made promptly in the event of a leak detection or spill. If a leak is detected, the contents will be transferred, using a pump, into a new vessel. The leak will be collected and contained using absorbents such as Oil-Dry, vermiculite, or sand, which are stored at the vulnerable areas in a conspicuously marked drum. This used material will also be containerized for disposal pending analysis. Inspections will be documented in the project logbook.

In case of a spill or release of hazardous chemicals, Tetra Tech shall immediately notify the Trust Project Lead, and/or if the severity of the spill warrants, the local fire department by calling 9-1-1. Tetra Tech shall take all necessary steps to control the spread of the release and to provide site control to prevent unauthorized personnel from entering the affected area.

10.4 Personnel Training in Spill Prevention

Personnel will be instructed in the procedures for incipient spill prevention, containment, and collection of hazardous materials in the site-specific training. The FOL and the SSO will serve as the Spill Response Coordinators for this operation, should the need arise. Review SWP 5-47 Spill Prevention and Clean Up which provides additional general and specific guidance on safe chemical transport/storage and spill response protocols. It will be the responsibility of these individuals to ensure they have the supplies and equipment specified in Section 9.5 to support this function. Insufficient supplies or resources should be reported to the Field Supervisor.

10.5 Spill Prevention and Containment Equipment

The following represents the types of equipment that should be maintained at the staging areas for the purpose of supporting this Spill Prevention/Containment Program.

- Sand, clean fill, vermiculite, or other non-combustible absorbent (Oil-dry);
- Drums (55-gallon U.S. DOT 1A1 or 1A2);
- Shovels, rakes, and brooms; and
- Container labels.

Hazardous materials shall be stored in designated areas and all containers effectively closed. Spill equipment/supplied shall be readily available to contain and/or mitigate accidental spills of hazardous materials.

To minimize the hazards associated with moving drums and containers (i.e., lifting, pinch and compression points), material handling will be supported in the following manner:

  - A drum cart with pneumatic tires will be required, if drums are to be moved at the IDW storage area. This cart will be used to relocate drums within the staging and satellite storage location.

Other means of material handling will be evaluated by the SSO based on their ability to minimize or eliminate material handling hazards.

10.6 Spill Control Plan

This section describes the procedures the Tetra Tech field crew members will employ upon the detection of a spill or leak.

- Notify the SSO or FOL immediately upon detection of a leak or spill. Activate emergency alerting procedures for that area to remove non-essential personnel.
- Employ the personal protective equipment stored at the staging area. Take immediate actions to stop the leak or spill by plugging or patching the container or raising the leak to the highest point in the vessel. Spread the absorbent material in the area of the spill, covering it completely.
- Transfer the material to a new vessel; collect and containerize the absorbent material. Label the new container appropriately. Await analyses for treatment and disposal options.
- Re-containerize spills, including 2-inch of top cover impacted by the spill. Await test results for treatment or disposal options.

It is not anticipated that a spill will occur that the field crew cannot handle. Should this occur, notification of the appropriate Emergency Response agencies will be carried out by the FOL or SSO in accordance with the procedures discussed in Section 2.0 of this HASP.

10.7 Waste Management Plan

The IDW that will be generated during the environmental investigation includes soil cuttings, used PPE, equipment decontamination water, and groundwater generated during depth-discrete groundwater sampling, well development and groundwater sampling.

All IDW will be containerized. Investigation-derived soil waste will be stored in plastic-lined roll-off bins, if feasible. If the volume of soil generated makes storage in roll-off bins infeasible, the soil will be stockpiled on a double-layer 6- to 10-mil plastic liner, with the stockpile covered with plastic sheeting or a tarp at all times, except when the material is being handled. If a stockpile is constructed, berms will be constructed around the stockpile to control precipitation run-on and run-off.

- All IDW will be temporarily contained, labeled and stored on-site in DOT-approved containers (e.g., 55-gallon drums, roll-off bins, or other approved storage container).

- Solid waste materials (i.e. soil cuttings) will be stored on-site separately from liquid waste materials (i.e. purge water, wash and decontamination rinse water).

11.0 CONFINED-SPACE ENTRY

Tetra Tech policy prohibits unauthorized entry into confined spaces. It is not anticipated, under the proposed scope of work, that confined space and permit-required confined space activities will be conducted. **Therefore, personnel under the provisions of this HASP are not allowed, under any circumstances, to enter confined spaces**. Identified confined spaces at the NERT site include storage tanks, vessels with manways/hatches, sump vaults, and Unit 4 cell building basement tunnel entrance. Other potential confined spaces may include sewer and storm water manholes, culverts, etc.

A confined space is defined as an area which has the following characteristics:

- Is large enough and so configured that an employee can bodily enter and perform assigned work;
- Has limited or restricted means for entry or exit (for example, tanks, manholes, sewers, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry); and
- Is not designed for continuous employee occupancy.

Additionally, a Permit-Required Confined Space must also have one or more of the following characteristics:

- Contains or has a potential to contain a hazardous atmosphere;
- Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly caving walls or by a floor that slopes downward and tapers to a smaller cross-section; and
- Contains any other recognized, serious, safety or health hazard.

However, should future work require confined space entry, Tetra Tech and subcontractor personnel conducting the entry will first receive confined space entry training for the category of confined space(s) to be entered (permit-required or non-permit-required) and for the designated role each employee will play in the entry operation (i.e., attendant, entrant, supervisor, or rescue). Training will be in accordance with the revised OSHA permit-required confined space entry (CSE) standard (29 CFR 1910.146). The purpose of the CSE procedure is to protect employees from potentially hazardous environments and to facilitate immediate rescue in an emergency situation. For further information on confined space entry operations, consult the HSR. If confined space operations are to be performed as part of the scope of work, detailed procedures and training requirements will have to be addressed and this HASP will be updated/amended as necessary to address the Tetra Tech confined space entry requirements.

12.0 MATERIALS AND DOCUMENTATION

The Tetra Tech Field Operations Leader (FOL) shall ensure the following materials/documents are taken to the project site and used when required:

- A complete copy of this HASP;
- Incident Reports and Supplemental Forms (IR-A, B and C);
- Medical Data Sheets;
- Safety Data Sheets for chemicals brought on site, including injection reagents, decontamination; solutions, fuels, sample preservatives, calibration gases, etc.;
- A full-size OSHA Job Safety and Health Poster (posted in the site trailer, if applicable);
- Training/Medical Surveillance Documentation Form (Blank);
- First-Aid Supply Usage Form;
- Emergency Reference Form (Section 2.0, extra copies for posting); and
- Directions to the Hospital and Workers Compensation Clinic (for non-emergencies).

12.1 Materials to be Posted at the Site

The following documentation is to be posted or maintained at the site for quick reference purposes. In situations where posting these documents is not feasible (such as no office trailer), these documents should be separated and immediately accessible.

- **Chemical Inventory Listing (posted)** - This list represents all chemicals brought on-site, including decontamination solutions, sample preservations, fuel, etc. This list should be posted in a central area.
- **SDSs (maintained)** - The SDSs should also be in a central area accessible to all site personnel. These documents should match all the listings on the chemical inventory list for all substances employed on-site. It is acceptable to have these documents within a central folder and the chemical inventory as the table of contents.
- **The Nevada OSHA Job Safety & Health Protection Poster (posted – Attachment VI)** - This poster should be conspicuously posted in places where notices to employees are normally posted, as directed by 29 CFR 1903.2 (a)(1).
- **Site Clearance (maintained)** - This list is found within the training section of the HASP (Figure 8-1). This list identifies all site personnel, dates of training (including site-specific training), and medical surveillance. The list indicates not only clearance, but also status. If personnel do not meet these requirements, they do not enter the site while site personnel are engaged in activities.

- **Emergency Phone Numbers and Directions to the Hospital(s) and Workers Compensation Clinic (posted)** - This list of numbers and directions will be maintained at all phone communications points and in each site vehicle.

- **Medical Data Sheets/Cards (maintained)** - Medical Data Sheets will be filled out by on-site personnel and filed in a central location. The Medical Data Sheet will accompany any injury or illness requiring medical attention to the medical facility. A copy of this sheet or a wallet card will be given to all personnel to be carried on their person.

- **Personnel Monitoring (maintained)** - All results generated through personnel sampling (levels of airborne toxins, noise levels, etc.) will be posted to inform individuals of the results of that effort.

- **Placards and Labels (maintained)** - Where chemical inventories have been separated because of quantities and incompatibilities, these areas will be conspicuously marked using DOT placards and acceptable [Hazard Communication 29 CFR 1910.1200(f)] labels.

The purpose of maintaining or posting this information, as stated above, is to allow site personnel quick access. Variations concerning location and methods of presentation are acceptable providing the objective is accomplished.

12.2 Hazard Communication – Use of Hazardous Materials

- All hazardous substance (as defined by OSHA) brought onto the Site must be accompanied by a SDS and the containers labeled in accordance with the updated OSHA Hazard Communication/Globally Harmonized Standard for Classification and Labelling of Chemicals, 29 CFR 1910.1200 or applicable state OSHA standard. Tetra Tech and subcontractor personnel will provide SDSs for chemicals brought on site. The contents of these documents will be reviewed by the SSO with the user(s) of the chemical substances prior to any actual use or application of the substances on site. A chemical inventory of the chemicals used on site will be developed using the Health and Safety Manual. The SDSs will then be maintained in a central location (i.e., temporary office) and will be available for anyone to review upon request.

- The Client Project Lead shall be notified prior to bringing any quantity of hazardous materials onto its remediation sites. Hazardous materials shall be stored in designated areas and all containers effectively closed. Spill equipment/supplied shall be readily available to contain and/or mitigate accidental spills of hazardous materials.

13.0 REFERENCES

ENVIRON, 2013b. Site Management Plan, Revision 1, Nevada Environmental Response Trust Site, Henderson, Nevada. October 2013.

ENVIRON, 2014a. Remedial Investigation and Feasibility Study Work Plan, Revision 2, Nevada Environmental Response Trust Site, Henderson, Nevada. June 19, 2014.

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

ENVIRON, 2014. Health and Safety Plan for Remedial Investigation and General Site Activities Revision 1 for the Nevada Environmental Response Trust Site; Henderson, Nevada. July 18, 2014.

ENSR, 2005. Conceptual Site Model, Kerr-McGee Facility, Henderson, Nevada. February 2005.

Occupational Safety and Health Administration General Industry Standards 29 Code of Federal Regulations Part 1910

Occupational Safety and Health Administration Construction Standards 29 Code of Federal Regulations Part 1926

American Conference of Governmental Industrial Hygienists' Threshold Limit Values and Biological Exposure Indices, 2014

Department of Transportation Hazardous Materials Regulations 49 CFR Parts 171-180

Sellers, Kathleen, William Alsop, Stephen Clough, Marilyn Hoyt, Barbara Pugh, Joseph Robb, and Katherine Weeks. *Perchlorate, Environmental Problems and Solutions*. Taylor and Francis Group, 2007

ATTACHMENT I
TETRA TECH FORMS

Form HSP-4 HASP Compliance Agreement
Form HST-2 Daily Tailgate Safety Meeting
Form SSC-1 Daily Site Log
Form AF-1 Field Audit Checklist
Form JSA-1 Job Safety Analysis
Incident Report Forms IR, IR-A, IR-B, IR-C
Medical Data Sheets
Form HW-1 Hot Work Permit

	TETRA TECH, INC. HEALTH AND SAFETY PLAN COMPLIANCE AGREEMENT	**Revision Date: 10/1/2008**
		Document Control Number:
		FORM HSP-4
		Page 1 of 1

Project Name: ______________________________

Project Number: ______________________________

I have read and understand the health and safety plan indicated above and agree to comply with all of its provisions. I understand that I could be prohibited from working on the project for violating any of the safety requirements specified in the plan.

Name	Signature	Employer	Date

TETRA TECH, INC.

DAILY TAILGATE SAFETY MEETING FORM

This form describes the requirements and responsibilities for implementing an incident and injury-free workplace by providing guidance on the daily tailgate safety meeting discussion.

Daily tailgate safety meetings shall be held in a safe location at the start of each work day, shift or task change. The daily tailgate safety meetings shall review the planned work activities for the day, discuss and resolve the risks and mitigations, discuss any health, safety, security and environment (HSSE) concerns and raise the HSSE consciousness of each worker before they start work.

The Field Team Leader (FTL) or Site Safety Officer (SSO) will decide on the location of the daily tailgate safety meetings based on the overall safety of the individuals attending the meeting. Maintaining minimal background noise and establishing more comfortable areas for the meeting location is also preferred. Ultimately, the weather and surrounding environment could be the most limiting factor on the location of the meeting.

For this project, the Project Manager (PM) will:

- Verify that all work activities for this project are consistent with Document Control Number (DCN) 01-05, Health and Safety Management System, as well as any associated practices and permit requirements.
- Carry out all duties specified in the Health and Safety Management System.
- Ensure that all site personnel involved in a work activity are competent and correctly prepared for the work they will perform.
- Verify or delegate the responsibility to verify that the daily toolbox meeting is carried out.

For this project, the FTL will:

- Carry out all duties specified by the PM, as consistent with DCN 01-05.
- Conduct or supervise all work identified and agreed upon in the scope of work.
- Participate in the daily tailgate safety meeting whenever the scope of work requires a permit to work.
- Verify in the daily tailgate safety meeting, the specific roles and responsibilities of the FTL and SSO are clearly understood by all members of the workforce.

For this project, the SSO will:

- Carry out all duties specified by the PM, as consistent with DCN 01-05.
- Be accountable for the safe, responsible and reliable delivery of all work activities.
- Lead or designate an alternative conductor to lead the daily tailgate safety meeting.
- Verify in the daily tailgate safety meeting that workers have a clear understanding of the scope of work, hazards, controls and mitigations of the project.
- Verify in the daily tailgate safety meeting, the specific procedures and policies relevant to the project and are clearly understood by all members of the workforce.

TETRA TECH, INC.

DAILY TAILGATE SAFETY MEETING FORM (Continued)

Either the SSO or FTL will facilitate the daily tailgate safety meeting each day. At least one, if not both individuals shall have a thorough understanding of the following:

- Tetra Tech's hazard/risk assessment process
- The site-specific HASP.
- The contract scope of work.
- The subcontractors on site and their health and safety officer.
- Site requirements of the client.

These meetings prior to starting work shall include, but are not limited to:

- The completion of the daily tailgate safety meeting form.
- A review of relevant Health and Safety Plan (HASP) elements.
    - Reviews of the HASP shall be performed when updated, modified or when deemed necessary by the SSO or FTL.
- A review of all applicable permits.
- Any applicable Hazard Communication (HAZCOM) information review, including MSDSs, and labels.
- A review of 'Stop Work' procedures and responsibilities.
- Address any risks arising from the site walk, including but not limited to, equipment and materials use and location.
- Complete and review a Job Safety Analysis (JSA), appropriate Safe Work Practices (SWP) and applicable Activity Hazard Analysis (AHA) for the tasks to be completed.
- Implement the controls set forth in the JSA, SWP and AHA. Verify that all parties on site have a complete understanding of the work plan and controls that are in place.
- In addition, allocate resources and complete permits.

TETRA TECH, INC.

DAILY TAILGATE SAFETY MEETING FORM (Continued)

Date: ____________ Time: ______________ Project No.: ______________

Client: ______________________________ Site Location: ______________________

Site activities planned for today: ____

Does each job and task have a valid SWP, AHA, or JSA associated with it? Yes ☐ No ☐

Has everyone signed off on the HASP? Yes ☐ No ☐

Have newly identified risks been controlled and documented? Yes ☐ No ☐

Do not proceed unless the answer to all the above questions is Yes.

Current weather conditions: ____

Safety Topics Discussed
Review of Stop Work Authority
Are there multiple operations on site? Yes ☐ No ☐ If yes, describe.
Does the work activity require a MoC? Yes ☐ No ☐ If yes, has the MoC been authorized by the PM? Yes ☐ No ☐
Permits required? Yes ☐ No ☐ If yes, list permits covered in safety meeting.
Protective clothing and equipment for activities planned for today:
Chemical, physical, and biological hazards identified for activities planned for today:
Equipment hazards identified for activities planned for today:

TETRA TECH, INC.

DAILY TAILGATE SAFETY MEETING FORM (Continued)

Review of emergency procedures from HASP (including muster point locations):
Site-safety discussion topics:
Best practices observed: Lessons learned, near misses, other observations: Post-job review: Any "stop work" interventions:

Attendees

By signing in below, I certify that I understand the hazards and risk controls associated with each task I am to perform. I understand the permit requirements applicable to the work being performed and am aware that all tasks must be assessed. I am also aware of my obligation to "stop work." Furthermore, I am physically and mentally fit for duty and am not under the influence of any type of medication, drugs or alcohol that could affect my ability to work safety. I am aware of my responsibility to bring any injury, illness, or other safety issue to the attention of the SSO.

By signing out below, I certify that I am uninjured unless I have already informed the FTL, PM, or SSO.

Sign In Signature and Time	Sign Out Signature and Time

TETRA TECH, INC.

DAILY TAILGATE SAFETY MEETING FORM (Continued)

At the conclusion of this day, I certify that the job site is being left in a safe condition and there were no unissued reports of property damage, spill, fire, explosion, injury, illness, or first aid.

In Meeting Conducted by:

______________________________ ______________________________

Name Title

____

Signature

Out Meeting Conducted by:

______________________________ ______________________________

Name Title

____

Signature

	TETRA TECH, INC. DAILY SITE LOG	**Revision Date: 10/1/2008** **Document Control Number:** FORM SSC-1 **Page 1 of 1**

Site Name: ______________________________ Date: ______________________

Site Safety Coordinator:______________________ Project Number:______________

Name (print)	Company	I have received site-specific training	Time	
			In	Out

Comments:

____

____

Project Name: ______________________________ Project No.: ______________________

Field Location: _____________________________ Completed by: ____________________

Project Manager: _____________________ Site Safety Coordinator: __________________

General Items		In Compliance?		
Health and Safety Plan Requirements		Yes	No	NA
1	Approved health and safety plan (HASP) on site or available			
2	Names of on-site personnel recorded in field logbook or daily log			
3	HASP compliance agreement form signed by all on-site personnel			
4	Material Safety Data Sheets on site or available			
5	Designated site safety coordinator present			
6	Daily tailgate safety meetings conducted and documented			
7	On-site personnel meet HASP requirements for medical examinations, fit testing, and training (including subcontractors)			
8	Compliance with specified safe work practices			
9	Documentation of training, medical examinations, and fit tests available from employer			
10	Exclusion, decontamination, and support zones delineated and enforced			
11	Windsock or ribbons in place to indicate wind direction			
12	Illness and injury prevention program reports completed (California only)			
Emergency Planning				
13	Emergency telephone numbers posted			
14	Emergency route to hospital posted			
15	Local emergency providers notified of site activities			

16	Adequate safety equipment inventory available			
17	First aid provider and supplies available			
18	Eyewash stations in place			
Air Monitoring				
19	Monitoring equipment specified in HASP available and in working order			
20	Monitoring equipment calibrated and calibration records available			
21	Personnel know how to operate monitoring equipment and equipment manuals available on site			
23	Environmental and personnel monitoring performed as specified in HASP			

Safety Items		In Compliance?		
Personal Protection		Yes	No	NA
1	Splash suit			
2	Chemical protective clothing			
3	Safety glasses or goggles			
4	Gloves			
5	Overboots			
6	Hard hat			
7	Dust mask			
8	Hearing protection			
9	Respirator			
Instrumentation				
10	Combustible gas meter			
11	Oxygen meter			

12	Organic vapor analyzer			
Supplies				
13	Decontamination equipment and supplies			
14	Fire extinguishers			
15	Spill cleanup supplies			
Corrective Action Taken During Audit:				
Corrective Action Still Needed:				

Note: NA = Not applicable

Auditor's Signature

Site Safety Coordinator's Signature

Date

TETRA TECH, INC.

ACTIVITY HAZARD ANALYSIS (AHA)

Activity/Work Task:	**Overall Risk Assessment Code (RAC) (Use highest code)**					
Project Location:	**Risk Assessment Code (RAC) Matrix**					
Contract Task Order Number:	**Severity**	**Probability**				
Date Prepared:		Frequent	Likely	Occasional	Seldom	Unlikely
Prepared by:	Catastrophic	**E**	**E**	**H**	**H**	**M**
	Critical	**E**	**H**	**H**	**M**	**L**
Reviewed by:	Marginal	**H**	**M**	**M**	**L**	**L**
	Negligible	**M**	**L**	**L**	**L**	**L**

Notes: (Field Notes, Review Comments, etc.)	Step 1: Review each **"Hazard"** with identified safety "Controls" and determine RAC (See above)	
	"Probability" is the likelihood to cause an incident, near miss, or accident and Identified as: Frequent, Likely, Occasional, Seldom, or Unlikely.	**RAC Chart**
	"Severity" is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible	**E= Extremely High Risk** **H= High Risk**
	Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" on AHA. Annotate the overall highest RAC at the top of AHA.	**M= Moderate Risk** **L = Low Risk**

ACTIVITY / PHASE	POTENTIAL HAZARDS	RECOMMENDED ACTIONS / CONTROLS	RAC

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
Equipment:		
Personal Protective Equipment: **<u>Minimum</u>**: **<u>Optional items</u>**: **Emergency Equipment**		

All persons will sign this AHA indicating that they have reviewed the document and are aware of their responsibilities as stated in the AHA.

Name (Printed)	Signature	Occupation	Date Reviewed/Training

Report Date	Report Prepared By	Incident Report Number

INSTRUCTIONS:

All incidents (including those involving subcontractors under direct supervision of Tetra Tech personnel) must be documented on the IR Form.

Complete any additional parts to this form as indicated below for the type of incident selected.

TYPE OF INCIDENT (Check all that apply)		Additional Form(s) Required for this type of incident
Near Miss (No losses, but could have resulted in injury, illness, or damage)	☐	Complete IR Form Only
Injury or Illness	☐	Complete Form IR-A; Injury or Illness
Property or Equipment Damage, Fire, Spill or Release	☐	Complete Form IR-B; Damage, Fire, Spill or Release
Motor Vehicle	☐	Complete Form IR-C; Motor Vehicle

INFORMATION ABOUT THE INCIDENT

Description of Incident

____

____

____

Date of Incident	**Time of Incident**
	________ AM ☐ PM ☐ *OR* Cannot be determined ☐
Weather conditions at the time of the incident	**Was there adequate lighting?**
	________Yes ☐ No ☐

Location of Incident

________________ Was location of incident within the employer's work environment? Yes ☐ No ☐

Street Address	**City, State, Zip Code and Country**
Project Name / Project #	**Client:**
Tt Supervisor or Project Manager	**Was supervisor on the scene?**
	Yes ☐ No ☐

WITNESS INFORMATION (attach additional sheets if necessary)

Name	**Company**
Street Address	**City, State and Zip Code**
Telephone Number(s)	

CORRECTIVE ACTIONS

Corrective action(s) immediately taken by unit reporting the incident:

____

____

____

Corrective action(s) still to be taken (by whom and when):

____

____

____

ROOT CAUSE ANALYSIS LEVEL REQUIRED

Root Cause Analysis Level Required: Level - 1 ☐ Level - 2 ☐ None ☐

Root Cause Analysis Level Definitions

Level - 1	**Definition:** A Level 1 RCA is conducted by an individual(s) with experience or training in root cause analysis techniques and will conduct or direct documentation reviews, site investigation, witness and affected employee interviews, and identify corrective actions. Activating a Level 1 RCA and identifying RCA team members will be at the discretion of the Corporate Administration office. The following events may trigger a Level 1 RCA: ▪ Work related fatality ▪ Hospitalization of one or more employee where injuries result in total or partial permanent disability ▪ Property damage in excess of $75,000 ▪ When requested by senior management
Level - 2	**Definition:** A Level 2 RCA is self performed within the operating unit by supervisory personnel with assistance of the operating unit HSR. Level 2 RCA will utilize the 5 Why RCA methodology and document the findings on the tools provided. The following events will require a Level 2 RCA: ▪ OSHA recordable lost time incident ▪ Near miss incident that could have triggered a Level 1 RCA ▪ When requested by senior management

Complete the Root Cause Analysis Worksheet and Corrective Action form. Identify a corrective action(s) for each root cause identified within each area of inquiry.

NOTIFICATIONS

Title	Printed Name	Signature	Telephone Number	Date
Project Manager or Supervisor				
Site Safety Coordinator or Office H&S Representative				
Operating Unit H&S Representative				
Other: ____________________				

The signatures provided above indicate that appropriate personnel have been notified of the incident.

INSTRUCTIONS:

Complete all sections below for incidents involving injury or illness.
Do NOT leave any blanks.
Attach this form to the IR FORM completed for this incident.

Incident Report Number: (From the IR Form)

EMPLOYEE INFORMATION

Company Affiliation

Tetra Tech Employee? ☐ TetraTech subcontractor employee (directly supervised by Tt personnel)? ☐

Full Name	**Company (if not Tt employee)**

Street Address, City, State and Zip Code	**Address Type**
______________________________	Home address (for Tt employees) ☐
______________________________	Business address (for subcontractors) ☐

Telephone Numbers

Work: ______________	Home: ______________	Cell: ______________

Occupation (regular job title)	**Department**

Was the individual performing regular job duties?	**Time individual began work**
Yes ☐ No ☐	________ AM ☐ PM ☐ *OR* Cannot be determined ☐

Safety equipment

Provided? Yes ☐ No ☐

Used? Yes ☐ No ☐ If no, explain why

____

____

____

Type(s) provided:

☐ Hard hat	☐ Protective clothing
☐ Gloves	☐ High visibility vest
☐ Eye protection	☐ Fall protection
☐ Safety shoes	☐ Machine guarding
☐ Respirator	☐ Other (list)

____

NOTIFICATIONS

Name of Tt employee to whom the injury or illness was first reported	**Was H&S notified within one hour of injury or illness?**
	Yes ☐ No ☐
Date of report	**H&S Personnel Notified**
Time of report	**Time of Report**

If subcontractor injury, did subcontractor's firm perform their own incident investigation?

Yes ☐ No ☐ If yes, request a copy of their completed investigation form/report and attach it to this report.

INJURY / ILLNESS DETAILS

What was the individual doing just before the incident occurred? Describe the activity as well as the tools, equipment, or material the individual was using. Be specific. Examples: “Climbing a ladder while carrying roofing materials”; “Spraying chlorine from a hand sprayer”; “Daily computer key-entry”

____

____

____

What Happened? Describe how the injury occurred. Examples: “When ladder slipped on wet floor and worker fell 20 feet”; “Worker was sprayed with chlorine when gasket broke during replacement”; Worker developed soreness in wrist over time”

____

____

____

____

Describe the object or substance that directly harmed the individual: Examples: “Concrete floor”; “Chlorine”; “Radial Arm Saw”. If this question does not apply to the incident, write “Not Applicable”.

____

____

MEDICAL CARE PROVIDED

Was first aid provided at the site: Yes ☐ No ☐ If yes, describe the type of first aid administered and by whom?

____

Was treatment provided away from the site: Yes ☐ No ☐ If yes, provide the information below.

Name of physician or health care professional	**Facility Name**
Street Address, City State and Zip Code	**Type of Care?**
______________________________ ______________________________	Was individual treated in emergency room? Yes ☐ No ☐ Was individual hospitalized overnight as an in-patient? Yes ☐ No ☐ Did the individual die? Yes ☐ No ☐ If yes, date: __________ Will a worker’s compensation claim be filed? Yes ☐ No ☐
Telephone Number	

NOTE: Attach any police reports or related diagrams to this report.

SIGNATURES

I have reviewed this report and agree that all the supplied information is accurate

Affected individual (print)	**Affected individual (signature)**	**Telephone Number**	**Date**

This form contains information relating to employee health and must be used in a manner that protects the confidentiality of the employee to the extent possible while the information is being used for occupational safety and health purposes.

INSTRUCTIONS:

Complete all sections below for incidents involving property/equipment damage, fire, spill or release.
Do NOT leave any blanks.
Attach this form to the IR FORM completed for this incident.

Incident Report Number: (From the IR Form)	

TYPE OF INCIDENT (Check all that apply)

Property Damage ☐ Equipment Damage ☐ Fire or Explosion ☐ Spill or Release ☐

INCIDENT DETAILS

Results of Incident: Fully describe damages, losses, etc.

____

____

____

Response Actions Taken:

____

____

____

Responding Agency(s) (i.e. police, fire department, etc.)	**Agency(s) Contact Name(s)**

DAMAGED ITEMS (List all damaged items, extent of damage and estimated repair cost)

Item:	**Extent of damage:**	**Estimated repair cost**

SPILLS / RELEASES (Provide information for spilled/released materials)

Substance	**Estimated quantity and duration**	**Specify Reportable Quantity (RQ)**
		____________ Exceeded? Yes ☐ No ☐ NA ☐

FIRES / EXPLOSIONS (Provide information related to fires/explosions)

Fire fighting equipment used? Yes ☐ No ☐ If yes, type of equipment: ______________________________

NOTIFICATIONS

Required notifications	**Name of person notified**	**By whom**	**Date / Time**
Client: ____________ Yes ☐ No ☐			
Agency: ____________ Yes ☐ No ☐			
Other: ____________ Yes ☐ No ☐			

Who is responsible for reporting incident to outside agency(s)? Tt ☐ Client ☐ Other ☐ Name: ________________

Was an additional written report on this incident generated? Yes ☐ No ☐ If yes, place in project file.

INSTRUCTIONS:

Complete all sections below for incidents involving motor vehicle accidents. Do NOT leave any blanks. Attach this form to the IR FORM completed for this incident.

Incident Report Number: (From the IR Form)	

INCIDENT DETAILS

Name of road, street, highway or location where accident occurred	**Name of intersecting road, street or highway if applicable**

County	**City**	**State**

Did police respond to the accident?	**Did ambulance respond to the accident?**
Yes ☐ No ☐	Yes ☐ No ☐
Name and location of responding police department	**Ambulance company name and location**
Officer's name/badge #	

Did police complete an incident report? Yes ☐ No ☐ If yes, police report number: ____________________
Request a copy of completed investigation report and attach to this form.

VEHICLE INFORMATION

How many vehicles were involved in the accident? _____________ (Attach additional sheets as applicable for accidents involving more than 2 vehicles.)

Vehicle Number 1 – Tetra Tech Vehicle		**Vehicle Number 2 – Other Vehicle**	
Vehicle Owner / Contact Information		**Vehicle Owner / Contact Information**	
Color		**Color**	
Make		**Make**	
Model		**Model**	
Year		**Year**	
License Plate #		**License Plate #**	
Identification #		**Identification #**	
Describe damage to vehicle number 1		**Describe damage to vehicle number 2**	
Insurance Company Name and Address		**Insurance Company Name and Address**	
Agent Name **Agent Phone No.**		**Agent Name** **Agent Phone No.**	
Policy Number		**Policy Number**	

DRIVER INFORMATION

Vehicle Number 1 – Tetra Tech Vehicle		Vehicle Number 2 – Other Vehicle	
Driver's Name		**Driver's Name**	
Driver's Address		**Driver's Address**	
Phone Number		**Phone Number**	
Date of Birth		**Date of Birth**	
Driver's License #		**Driver's License #**	
Licensing State		**Licensing State**	
Gender	Male ☐ Female ☐	**Gender**	Male ☐ Female ☐
Was traffic citation issued to Tetra Tech driver? Yes ☐ No ☐		Was traffic citation issued to driver of other vehicle? Yes ☐ No ☐	
Citation #		**Citation #**	
Citation Description		**Citation Description**	

PASSENGERS IN VEHICLES (NON-INJURED)

List all non-injured passengers (excluding driver) in each vehicle.
Driver information is captured in the preceding section.
Information related to persons injured in the accident (non-Tt employees) is captured in the section below on this form.
Injured Tt employee information is captured on FORM IR-A

Vehicle Number 1 – Tetra Tech Vehicle		Vehicle Number 2 – Other Vehicle	
How many passengers (excluding driver) in the vehicle? ____		How many passengers (excluding driver) in the vehicle? ____	
Non-Injured Passenger Name and Address		**Non-Injured Passenger Name and Address**	
Non-Injured Passenger Name and Address		**Non-Injured Passenger Name and Address**	
Non-Injured Passenger Name and Address		**Non-Injured Passenger Name and Address**	

INJURIES TO NON-TETRATECH EMPLOYEES

Name of injured person 1				Address of injured person 1		
Age	**Gender**	**Car No.**	**Location in Car**	**Seat Belt Used?**	**Ejected from car?**	**Injury or Fatality?**
	Male ☐ Female ☐			Yes ☐ No ☐	Yes ☐ No ☐	Injured ☐ Died ☐
Name of injured person 2				**Address of injured person 2**		
Age	**Gender**	**Car No.**	**Location in Car**	**Seat Belt Used?**	**Ejected from car?**	**Injury or Fatality?**
	Male ☐ Female ☐			Yes ☐ No ☐	Yes ☐ No ☐	Injured ☐ Died ☐

OTHER PROPERTY DAMAGE

Describe damage to property other than motor vehicles	
Property Owner's Name	**Property Owner's Address**

COMPLETE AND SUBMIT DIAGRAM DEPICTING WHAT HAPPENED

MEDICAL DATA SHEET

This Medical Data Sheet must be completed by on-site personnel and kept in the command post during the conduct of site operations. This data sheet will accompany any personnel when medical assistance is needed or if transport to hospital facilities is required.

Project ____

Name ______________________ Home Telephone __________

Address ____

Age __________ Height ______________ Weight ____________

Person to notify in the event of an emergency: Name: ______________________

Phone: ______________________

Drug or other Allergies: ______________________________________

Particular Sensitivities : ______________________________________

Do You Wear Contacts?______________________________________

What medications are you presently using? ______________________________

____

Name, Address, and Phone Number of personal physician: ______________________

____

____

Note: Health Insurance Portability and Accountability Act (HIPAA) Requirements

HIPAA took effect April 14, 2003. Loosely interpreted, HIPAA regulates the disclosure of Protected Health Information (PHI) by the entity collecting that information. PHI is any information about health status (such as that you may report on this Medical Data Sheet), provision of health care, or other information. HIPAA also requires Tetra Tech to ensure the confidentiality of PHI. This Act can affect the ability of the Medical Data Sheet to contain and convey information you would want a Doctor to know if you were incapacitated. So before you complete the Medical Data Sheet understand that this form will not be maintained in a secure location. It will be maintained in a file box or binder accessible to other members of the field crew so that they can accompany an injured party to the hospital.

DO NOT include information that you do not wish others to know, only information that may be pertinent in an emergency situation or treatment.

____________________ ______________________ __________

Name (Print clearly) Signature Date

	TETRA TECH, INC. HOT WORK PERMIT	Document Control Number:
		FORM HW-1
		Page 1 of 4

Project Name: ______________________ Project No.: __________________________

Date: ___________________ Completed by: _________________________________

Work Location: ____

Work to be performed: ____

Hazard Assessment / Preparation for Hot Work

Have combustible materials been relocated more than 35' (10.67m) from hot work or been properly shielded?	☐ Yes	☐ No
Have ducts, drains and sewers been adequately covered to prevent sparks from entering?	☐ Yes	☐ No
Are lower areas protected from overhead work?	☐ Yes	☐ No
Is the hot work equipment in proper working order?	☐ Yes	☐ No
Are the proper material safety data sheets available for review?	☐ Yes	☐ No
Is fire-fighting equipment in proper working order?	☐ Yes	☐ No
If hot work is to be performed indoors, have combustible floors been wetted down or properly shielded?	☐ Yes	☐ No
If arc welding equipment will be used, have measures been taken to protect personnel form shock?	☐ Yes	☐ N/A
If required, is a 20lb (9.07kg) fire extinguisher available and appropriate for the type of fire expected?	☐ Yes	☐ N/A
If hot work is to be performed in or on containers, vessels, tanks or similar equipment, have they been cleaned, purged or ventilated or have other precautions been taken to verify that they are safe for hot work?	☐ Yes	☐ N/A

LIST ANY PERSONAL PROTECTIVE EQUIPMENT THAT IS REQUIRED (OTHER THAN THE MINIMUM REQUIRED)

Note: Confined space work must follow confined space entry procedures established in Document Control No. 2-5 of the Tetra Tech, Inc. Health and Safety Manual

Fire Prevention and Response

Spark Containment Method: ______________________________

Fire Extinguisher Size and Type: ______________________________

Location of Nearest Telephone: ______________________________

Emergency Telephone Numbers: ______________________________

Location of Emergency Alarm: ______________________________

Will PSI Class I work be performed?	☐ Yes	☐ NO
Will PSI Non-Class I work be performed within 35' (10.67m) of combustible materials?	☐ Yes	☐ NO
Will PSI hot work be performed where wall or floor openings within 35' (10.67m) would expose combustibles in adjacent areas?	☐ Yes	☐ NO
Is PSI hot work to be performed where combustibles are adjacent to the opposite Side of partitions, ceilings or roofs being worked on?	☐ Yes	☐ NO
Will fire alarms or suppression systems be disabled for hot work?	☐ Yes	☐ NO

If answers to any of the questions are yes, a dedicated Fire Watch must by assigned:

Name: ______________________________

Sign-Offs

I agree to maintain a line of sight with the hot work operation at all times, to have immediate access to a fire extinguisher and to remain at the hot work area for 30 minutes after the hot work is completed to verify the area is fire-safe

Fire Watch

Fire Watch 1 Name:______________________Fire Watch 1 Signature:______________________

Fire Watch 2 Name:______________________Fire Watch 2 Signature:______________________

Gas Testers

Authorized Gas Tester 1 Name:______________________Signature____________________________________

Authorized Gas Tester 2 Name:______________________Signature____________________________________

Hot Work Operators

I have reviewed and understand the permit conditions specific to the scope of work. I agree to perform hot work operations within these conditions, to stop any work that I deem to be unsafe and to notify the performing authority upon completion or interruption of this permitted work.

PERFORMING AUTHORITY NAME	*PERFORMING AUTHORITY SIGNATURE*
HOT WORK OPERATOR 1 NAME	*HOT WORK OPERATOR 1 SIGNATURE*
HOT WORK OPERATOR 2 NAME	*HOT WORK OPERATOR 2 SIGNATURE*
HOT WORK OPERATOR 3 NAME	*HOT WORK OPERATOR 3 SIGNATURE*
HOT WORK OPERATOR 4 NAME	*HOT WORK OPERATOR 4 SIGNATURE*
HOT WORK OPERATOR 5 NAME	*HOT WORK OPERATOR 5 SIGNATURE*
HOT WORK OPERATOR 6 NAME	*HOT WORK OPERATOR 6 SIGNATURE*

HOT WORK OPERATOR 7 NAME	HOT WORK OPERATOR 7 SIGNATURE
HOT WORK OPERATOR 8 NAME	HOT WORK OPERATOR 8 SIGNATURE

ATTACHMENT II
TETRA TECH SAFE WORK PRACTICES

To prevent injuries and adverse health effects, the following general safe work practices (SWP) are to be followed when conducting work involving known and unknown site hazards. These SWPs establish a pattern of general precautions and measures for reducing risks associated with field operations not conducted on hazardous waste sites. This list is not inclusive and may be amended as necessary.

- Be familiar with and knowledgeable of and adhere to all instructions in the construction health and safety plan (C-HASP), job safety analysis, job hazard analysis, work permit or other health and safety documentation.
- At a minimum, a safety meeting will be held at the start of each project to discuss the hazards of the site and site work. Additional meetings will be held, as necessary, to address new or continuing safety and health concerns.
- Be aware of the location of the nearest telephone and all emergency telephone numbers.
- Attend a briefing on the anticipated hazards, equipment requirements, SWPs, emergency procedures, and communication methods before going on site.
- Plan and delineate entrance, exit, and emergency escape routes.
- Rehearse unfamiliar operations prior to implementation.
- Use the "buddy system" whenever respiratory protection, fall protection, or other protective equipment is in use. Buddies should establish hand signals or other means of emergency communication in case radios break down or are unavailable.
- In order to assist each other in the event of an emergency, buddies should maintain visual contact with each other and with other on-site team members by remaining in close proximity.
- Do not bring nonessential vehicles and equipment onto the site.
- Immediately report all injuries, illnesses, and unsafe conditions, practices, and equipment to the site safety coordinator (SSC).
- Maintain a portion of the site field logbook as a project safety log. The project safety log will be used to record the names, entry and exit dates, and times on site of all Tetra Tech personnel, subcontractor personnel, and project site visitors; and other information related to safety matters.

- A portable eyewash station should be located in the support zone if corrosive materials are used or stored on the site.
- Smoking is not allowed on Tetra Tech projects sites, except in designated smoking areas.
- Do not bring matches and lighters in the exclusion zone or contamination reduction zone.
- Observe coworkers for signs of toxic exposure and heat or cold stress.
- Inform coworkers of nonvisual effects of illness if you experience them, such as headaches, dizziness, nausea, or blurred vision.
- Anyone known to be under the influence of drugs or intoxicating substances that impair the employee's ability to safely perform assigned duties shall not be allowed on the job while in that condition.
- Horseplay, scuffling, and other acts that tend to have an adverse influence on the safety or well-being of the employees is prohibited.
- Work shall be well planned to prevent injuries in the handling of materials and when working with equipment.
- No one shall knowingly be permitted or required to work while the employee's ability or alertness is so impaired by fatigue, illness, or other causes that might unnecessarily expose the employee or others to injury.
- Use proper lifting techniques. Heavy objects will be lifted using the large muscles of the leg instead of the smaller muscles of the back.
- Wear appropriate footwear and all other protective equipment required for work.
- Cleanse thoroughly after handling hazardous substances.
- Maintain all tools and equipment in good condition.
- First aid kits shall be located in a prominent location and stocked with basic first aid supplies.

Revision Date	Document Authorizer	Revision Details
10/1/2008	Chris McClain	NEW

To prevent injuries and adverse health effects, the following general safe work practices (SWP) are to be followed when conducting work involving known and unknown site hazards on hazardous waste sites. These SWPs establish a pattern of general precautions and measures for reducing risks associated with hazardous site operations. This list is not inclusive and may be amended as necessary.

- Do not eat, drink, chew gum or tobacco, take medication, or smoke in contaminated or potentially contaminated areas or where the possibility for contact with site contamination exists.
- Wash hands and face thoroughly upon leaving a contaminated or suspected contaminated area. If a source of potable water is not available at the work site that can be used for hands-washing, the use of waterless hand cleaning products will be used, followed by actual hand-washing as soon as practicable upon exiting the site. A thorough shower and wash must be conducted as soon as possible if excessive skin contamination occurs.
- Avoid contact with potentially contaminated substances. Do not walk through puddles, pools, mud, or other such areas. Avoid, whenever possible, kneeling on the ground or leaning or sitting on drums, equipment, or the ground. Do not place monitoring equipment on potentially contaminated surfaces.
- Remove beards or facial hair that interferes with a satisfactory qualitative respirator fit test or routine pre-entry positive and negative pressure checks.
- Be familiar with and knowledgeable of and adhere to all instructions in the site-specific health and safety plan (HASP). At a minimum, a safety meeting will be held at the start of each project to discuss the HASP. Additional meetings will be held, as necessary, to address new or continuing safety and health concerns.
- Be aware of the location of the nearest telephone and all emergency telephone numbers.
- Attend a briefing on the anticipated hazards, equipment requirements, SWPs, emergency procedures, and communication methods before going on site.
- Plan and delineate entrance, exit, and emergency escape routes.
- Rehearse unfamiliar operations prior to implementation.

- Use the "buddy system" whenever respiratory protection equipment is in use. Buddies should establish hand signals or other means of emergency communication in case radios break down or are unavailable.

- Buddies should maintain visual contact with each other and with other on-site team members by remaining in close proximity in order to assist each other in case of emergency.

- Minimize the number of personnel and equipment in contaminated areas (such as the exclusion zone). Nonessential vehicles and equipment should remain within the support zone.

- Establish appropriate support, contamination reduction, and exclusion zones.

- Establish appropriate decontamination procedures for leaving the site.

- Immediately report all injuries, illnesses, and unsafe conditions, practices, and equipment to the site safety coordinator (SSC).

- Maintain a portion of the site field logbook as a project safety log. The project safety log will be used to record the names, entry and exit dates, and times on site of all Tetra Tech personnel, subcontractor personnel, and project site visitors; air quality and personal exposure monitoring data; and other information related to safety matters. Form SSC-1, Daily Site Log, may be used to record names of on-site personnel.

- A portable eyewash station should be located in the support zone if chemical splashes to eyes are possible.

- Do not bring matches and lighters in the exclusion zone or contamination reduction zone. Flames and open fires are not permitted on site.

- Observe coworkers for signs of toxic exposure and heat or cold stress.

- Inform coworkers of nonvisual effects of illness if you experience them, such as headaches, dizziness, nausea, or blurred vision.

Revision Date	Document Authorizer		Revision Details
	Name	Approval Date	
10/1/2008	Chris McClain		Update from 1998 format
	Rick Lemmon		

This document establishes safe work practices (SWP) to follow during drilling operations. These SWPs are based on suggested safety procedures provided in the National Drilling Association's "Drilling Safety Guide." Procedures to follow before, during, and after drilling are listed below.

Before beginning any drill operation, each employee must conform to the following requirements:

- Wear a hard hat, safety glasses or goggles, steel-toed work boots, a shirt and full-length pants when working with or near the drill rig. Shirts must be tucked in at the belt.
- Do not wear loose or frayed clothing, loose long hair, or loose jewelry while working with rotating equipment.
- Do not eat, drink, or smoke near the drill rig.
- Identify all underground utility and buried structure locations before drilling.
- Ensure that drill masts or other projecting devices will be farther than 25 feet in any direction from overhead power lines.
- Ensure that the drill rig and any other machinery used is inspected daily by competent, qualified individuals. The site safety coordinator (SSC) will ensure compliance with this precaution.
- Drill rig operators will be instructed to report any abnormalities, such as equipment failure, oozing liquids, and unusual odors, to their supervisors or the SSC.
- Establish hand-signal communications for use when verbal communication is difficult. One person per work team will be designated to give hand signals to equipment operators.

While the drill rig is operating, employees must:

- Wear appropriate respiratory and personal protective equipment (PPE) when conditions warrant their use.
- Avoid direct contact with known or suspected contaminated surfaces.
- Move tools, materials, cords, hoses, and debris to prevent tripping hazards and contact with moving drill rig parts.

- Adequately secure tools, materials, and equipment subject to displacement or falling.
- Store flammable materials away from ignition sources and in approved containers.
- Maintain adequate clearance of the drill rig and mast from overhead transmission lines. The minimum clearance is 25 feet unless special permission is granted by the utility company. Call the local utility company for proper clearance.
- Only qualified and licensed personnel should operate drill rigs.
- Workers should not assume that the drill rig operator is keeping track of the rig's exact location. Workers should never walk directly behind or beside heavy equipment without the operator's knowledge.
- Workers should maintain visual contact with drill rig operators at all times.
- When an operator must maneuver equipment in tight quarters, the presence of a second person is required to ensure adequate clearance. If much backing is required, two ground guides will be used: one in the direction the equipment is moving, and the other in the operator's normal field of vision to relay signals.
- Auger sections and other equipment are extremely heavy. All lifting precautions should be taken before moving heavy equipment. Appropriate equipment, such as chains, hoists, straps, and other equipment, should be used to safely transport heavy equipment too heavy to safely lift.
- Proper personal lifting techniques will be used. Workers should lift using their legs, not their backs.
- Workers will not use equipment they are not familiar with. This precaution applies to heavy as well as light equipment.
- All personnel not essential to work activities will be kept out of the work area.
- Workers will be aware of their footing at all times.
- Workers will remain alert at all times.

After drilling operations are completed, employees should do the following:

- Shut down machinery before repairing or lubricating parts (except parts that must be in motion for lubrication).
- Shut down mechanical equipment prior to and during fueling operations. When refueling or transferring fuel, containers and equipment must be bonded to prevent the buildup of static electricity.
- Keep drill rigs in the exclusion zone until work has been completed. Such equipment should then be decontaminated within the designated decontamination area.
- Engage parking brakes when equipment is not in use.
- Implement an ongoing maintenance program for all tools and equipment. All tools and moving equipment should be inspected regularly to ensure that parts are secured, are intact, and have no cracks or areas of weakness. The equipment must turn smoothly without wobbling and must operate in accordance with manufacturer specifications. Defective items should be promptly repaired or replaced. Maintenance and repair logs will be kept.
- Store tools in clean, secure areas to prevent damage, loss, or theft.

Revision Date	Document Authorizer	Revision Details
10/1/2008	Chris McClain	Update from 1998 format

This document establishes safe work practices (SWP) to follow during operating involving boring using direct push technology (DPT). These SWPs are based on suggested safety procedures provided in the National Drilling Association's "Drilling Safety Guide." Procedures to follow before, during, and after drilling are listed below.

Conventional and sonic drilling rigs can penetrate virtually any material to great depth, but they are expensive and cumbersome to operate in environmental investigations. Contaminated material brought to the surface requires special handling and can be a safety concern for workers. An alternative, the direct-push cone penetrometer, was developed in the 1930s in The Netherlands. This device uses up to 40,000 pounds of hydraulic force to push a steel instrumented cone or a sampling device into the ground. No material comes to the surface unless soil or groundwater samples are being collected. Direct-push technology eliminates the need for disposal of cuttings and solidification of drilling fluid. Therefore, DPT is frequently used for environmental investigation applications as an alternative to conventional drilling.

Before beginning any DPT operation, employees must understand and comply with the following requirements:

- Safety glasses or goggles, steel-toed work boots, hard hat, a shirt and full-length pants must be worn when working with or near the direct push rig. Shirts must be tucked in at the belt.
- Do not wear loose or frayed clothing, loose long hair, or loose jewelry while working with rotating equipment.
- Do not eat, drink, or smoke near the direct push rig.
- Identify all underground utility and buried structure locations before drilling.
- Ensure that the direct push rig and any other machinery used is inspected daily by competent, qualified individuals. The site safety coordinator (SSC) will ensure compliance with this precaution.
- Direct push rig operators will be instructed to report any abnormalities, such as equipment failure, oozing liquids, and unusual odors, to their supervisors or the SSC.
- Establish hand-signal communications for use when verbal communication is difficult. One person per work team will be designated to give hand signals to equipment operators.

While the direct push rig is operating, employees should be aware of the following:

- Wear appropriate respiratory and personal protective equipment (PPE) when conditions warrant their use.
- Avoid direct contact with known or suspected contaminated surfaces.
- Move tools, materials, cords, hoses, and debris to prevent tripping hazards and contact with moving direct push rig parts.
- Adequately secure tools, materials, and equipment subject to displacement or falling.
- Store flammable materials away from ignition sources and in approved containers.
- Maintain adequate clearance of the direct push rig and mast from overhead transmission lines. The minimum clearance is 25 feet unless special permission is granted by the utility company. Call the local utility company for proper clearance.
- Only qualified and licensed personnel should operate direct push rigs.
- Workers should not assume that the direct push rig operator is keeping track of their exact location. Workers should never walk directly behind or beside heavy equipment without the operator's knowledge.
- Workers should maintain visual contact with direct push rig operators at all times.
- When an operator must maneuver equipment in tight quarters, the presence of a second person is required to ensure adequate clearance. If much backing is required, two ground guides will be used: one in the direction the equipment is moving, and the other in the operator's normal field of vision to relay signals.
- Proper personal lifting techniques will be used. Workers should lift using their legs, not their backs.
- Workers will not use equipment they are not familiar with. This precaution applies to heavy as well as light equipment.
- All personnel not essential to work activities will be kept out of the work area.
- Workers will be aware of their footing at all times.

- Workers will remain alert at all times.

After drilling operations are completed, employees should do the following:

- Shut down machinery before repairing or lubricating parts (except parts that must be in motion for lubrication).
- Shut down mechanical equipment prior to and during fueling operations. When refueling or transferring fuel, containers and equipment must be bonded and grounded to prevent the buildup of static electricity.
- Keep direct push rigs in the exclusion zone until work has been completed. Such equipment should then be decontaminated within the designated decontamination area.
- Engage parking brakes when equipment is not in use.
- Implement an ongoing maintenance program for all tools and equipment. All tools and moving equipment should be inspected regularly to ensure that parts are secured, are intact, and have no cracks or areas of weakness. The equipment must turn smoothly without wobbling and must operate in accordance with manufacturer specifications. Defective items should be promptly repaired or replaced. Maintenance and repair logs will be kept.
- Store tools in clean, secure areas to prevent damage, loss, or theft.

Revision Date	Document Authorizer	Revision Details
10/1/2008	Chris McClain	NEW

The following sections discuss general procedures for working over or near water, underwater work, and cold water procedures.

1.0 SCOPE

This safe work practice (SWP) provides guidelines for all Tetra Tech employees and subcontractors who work over or near bodies of water three (3) or more feet deep or swiftly moving water. This SWP was developed in accordance with the Occupational Safety and Health Administration (OSHA) standard specified in Title 29 of the *Code of Federal Regulations* (CFR), Part 1926.106, "Working Over or Near Water."

2.0 RESPONSIBILITIES

The project manager (PM) is responsible for identifying all health and safety requirements of each project, including all tasks that may involve worker exposure to hazards or working in or near bodies of water. The PM will appoint a site safety coordinator (SSC) to ensure that this SWP is followed in the field. Workers will follow this SWP whenever working near or in any body of water that is over three (3) feet deep or swiftly moving.

3.0 GENERAL PROCEDURES

When working over or near water, the following precautions will be taken:

- All staff and team members must wear a personal flotation device (PFD) when working within 15 feet of a water body. Personnel will be provided with U.S. Coast Guard (USCG)-approved life jackets or work vests. The PFD should be Class III, which will support the head of an unconscious person above water.

- A Class V PFD, including Class V Hybrid PFD is acceptable only if it is US Coast Guard approved and/or meets International Life-Saving Appliance (LSA) Code and marked for use as a work vest for commercial use or for use on commercial vessels.

- PFDs should be fitted with a Safety of Life at Sea convention compliant whistle or noise making device. When worn at night, PFDs shall have Safety of Life at Sea rated reflective tape or materials affixed to the PFD

- When workers are exposed to conditions where there is a risk of hypothermia, insulated PFDs are to be used.

- PFDs are not appropriate for entrapment hazard such as deep mud

- Prior to each use, the user shall examine PFDs for deterioration or damage that might affect their strength and buoyancy. Defective PFDs shall be removed from service and either repaired or replaced.

- Fall protection systems should be utilized in conjunction with PFD vests and other work near water controls where possible. Examples include guard rails, fall arrest systems, lifelines, harnesses or safety nets.

- In cases where glass enclosed equipment is working around water, a break glass tool and seat belt cutter should be in the vehicle and readily assessable to the operator.

- Life jackets and work vests will be inspected before and after each use.

- Ring buoys with at least 90 feet of line shall be provided and readily available for employee rescue operations.

- The distance between ring buoys shall not exceed 200 feet.

- A USCG-approved life-saving skiff will be available.

- Under no circumstances will team members enter water bodies without protective clothing such as rubber boots or waders.

- At least one person will remain on shore as a look-out.

If a team member falls into the water, a ring buoy, branch, paddle, pole, or other floating object should be extended to the person in the water. Resist the impulse to dive in; employees should not attempt a deep water rescue unless they have been trained in water lifesaving skills.

When the person in the water grabs the extended item, the worker should be pulled toward the shore or boat. If the person is unconscious, the PFD, clothing, or hair should be hooked to pull the person toward the shore or boat. Once the person has been safely retrieved, necessary emergency medical procedures should be performed by qualified personnel. If none are necessary, the retrieved team member should change into dry clothing as soon as possible after any necessary personal decontamination.

4.0 UNDERWATER WORK

Underwater work should be performed in accordance with the procedures and guidelines of the Diving Safety Program (Document Control No. 2-15).

5.0 COLD WATER PROCEDURES

When the water temperature is below 45 °F, hypothermia is a serious risk. A person can loose feeling in the extremities within 5 minutes. Additional protective equipment such as cold water immersion suits may be required. All field staff members should be familiar with cold water survival techniques or should receive training from an American Red Cross-certified swimming instructor in cold water survival techniques when site conditions warrant such knowledge. Cold water safe work practices must be addressed in site specific safety documents.

After a person has been rescued from cold water, he or she should change into dry clothes as soon as possible. If the person who has fallen into the water displays hypothermia symptoms, he or she should be treated immediately and taken to a medical facility. Under no circumstances should the hypothermia victim be given hot liquids because this could accelerate shock. Drinks no warmer than normal body temperature are acceptable. If symptoms are severe and evacuation to a medical facility cannot be quickly conducted, any wet clothing should be removed, the victim should be placed in blankets or sleeping bags in a sheltered location, and the rescuer should climb into the blankets or sleeping bag with victim to provide additional warmth. The victim should also be treated continuously for shock, elevating feet and monitoring the victim's pulse and breathing rate.

If a team member falls into cold water, he or she should not remove any clothing while in the water because clothing provides additional insulation. Although clothing creates an added drag while swimming, the insulation outweighs the disadvantage of the additional drag. Each team member should carry a wool hat to place on his or her head in case he or she falls into the water. A wool hat, even when wet, provides good insulation for the head, where a large amount of body heat is lost.

Revision Date	Document Authorizer	Revision Details
10/1/2011	Chris McClain	Update

1.0 PURPOSE

The purpose of this procedure is to identify minimum requirements, and to provide guidance to Tetra Tech Inc. (Tetra Tech) project personnel concerning the management of construction tools and equipment on construction projects.

2.0 SCOPE

This procedure applies to all Tetra Tech projects that include a construction, O&M, and/or UXO component, including remediation construction.

3.0 MINIMUM REQUIREMENTS

3.1 Definitions

3.1.1 Construction Equipment

For the purposes of this procedure, construction equipment shall mean heavy equipment, such as excavators, scrapers, off-road trucks, dozers, road graders, compactors, dredges, and cranes; light equipment, such as skid-steers, forklifts, generators, and light plants; and operating systems such as screens, crushers, conveyors, pugmills, mobile treatment plants, and pumps. Any discussion of construction equipment shall be understood not to include cars, pickup trucks, flatbed trucks, etc. registered for use on public roadways, which shall be called vehicles hereinafter. Also for the purposes of this procedure, construction equipment shall be synonymous with Contractor's Equipment, a term also commonly used in the construction industry to designate the types of equipment described above.

3.1.2 Terms

The terms "should, may, and might" as used in statements in this procedure are intended to denote a discretionary consideration; the terms "shall & must" are intended to impose a mandatory requirement. The terms "is, are, & will" as used in statements in this procedure are intended to denote discretionary or mandatory requirements that are addressed in other department/disciplines' procedures. However, nothing contained herein should be interpreted as to prohibit development and approval of project-specific procedures or plans that take exception to mandatory direction presented in this procedure provided that the appropriate level of approval, (Executive Vice President of Construction, Business Line Executive Vice President, or the Vice President ESQ Services as appropriate) is obtained for deviations from such requirements.

3.1.3 Tools of the Trade

Specific hand tools and or equipment (e.g., manlifts, trucks, trenchers, and pumps) normally provided by or to workers for the performance of their particular work activity.

3.2 Roles & Responsibilities

3.2.1 Equipment Supervisor

Depending on the project's equipment needs, an individual may be designated as the Equipment Supervisor. Responsibilities of the Equipment Supervisor include:

- Determination of the equipment needs for the project;
- Providing input to the Work Plan concerning equipment;
- Identification of Contract and legal/regulatory requirements for mobilization of equipment on client facilities;
- Submit required certifications, inspection reports, and test reports for equipment;
- Arranging for the mobilization/demobilization of equipment in support of the project's schedule, providing required notices, such as mobilization details and dates, and obtaining Contractual or legally required approvals for mobilization;
- Receipt inspection of equipment arriving at the site, including coordination of any client or third party inspection;
- Coordination with equipment yard personnel or vendors regarding equipment maintenance;
- Ensuring implementation of safe work practices for equipment utilization; and
- Assuring that the return of demobilized equipment is performed in accordance with the terms of the rental/lease/PO agreement and documented correctly, or, for Tetra Tech owned equipment, that the equipment transfer form is completed and coordinated with the Equipment Manager; and
- All other responsibilities as assigned by the Project Manager or Site Supervisor

3.3 Safe Operation Requirements for Tools

3.3.1 Manual T-Post Drivers

There shall be no use of manual fence post drivers, such as those typically used to drive T-posts, without prior approval from the Site Safety Coordinator or the Vice President of Construction. Any approval of the use of such a tool shall require the implementation of an Activity Hazard Analysis (AHA) to identify and control the hazards presented by the tool. The AHA shall address appropriate PPE and position for the task in order to avoid injury to the worker.

3.3.2 Tools

The Site Supervisor shall determine the nature and quantity of tools required for the construction effort and shall ensure that adequate tools are provided in support of the schedule.

Tools may be assigned to workers or crews for the duration of their activities and shall be stored in gang boxes or other secured storage areas when not in use.

The Site Supervisor may designate certain tools to be issued from a tool control area on a daily basis. These tools should be signed out at the beginning of the work, returned to the tool control area at the end of the work, and signed back in.

3.3.3 Worker Provided Personal Tools

Workers may be required to provide personal tools of the trade for their particular work. Master mechanics, for example, may be required to provide tools required for repairs and maintenance of construction equipment and vehicles. Requirements for workers to provide their own tools shall be established based on the project requirements and shall be discussed at the Pre-Job Conference to be held in accordance with the requirements of the Labor Relations Guidelines LR-8, Pre-Job Conferences.

Any worker required or offering to provide personal tools shall be required to present a list of personal tools being provided upon reporting to the project site. The Site Supervisor shall inventory the tools against this list for verification that all listed tools have been provided. The list shall then be maintained for use in performing an inventory of the tools when the worker is to leave the site at the end of the worker's assignment and shall be the basis for any claims for loss or damage.

The Site Supervisor shall ensure that any personal tools brought onto the project site receive a safety inspection. The safety inspection shall include as a minimum, the items addressed in Section 3.3.4 of this procedure.

The Site Supervisor should ensure that secure, lockable facilities are provided for the storage of worker provided personal tools.

The worker shall be responsible for notification of lost or damaged tools immediately on discovery of the loss. The limits of the project's liability (if any) for loss or damage to personal tools provided by the workers should be established at the Pre-Job Conference.

Use of personal tools, other than addressed above, either by manual or by Tetra Tech nonmanual personnel, should not be allowed except as specifically authorized by the Project Manager or Site Supervisor. Project personnel should be notified that Tetra Tech will not be liable for any theft, loss, or damage of unauthorized personal tools on the project site.

3.3.4 Tool Safety Inspection

OSHA 29 CFR Part 1926 Subpart I Tools – Hand and Power provides guidance for tool safety. All tools shall be inspected for the following minimum features by the person using the tool prior to starting the work:

- Proper general condition of tools, electrical cords, and air hoses;
- Presence and serviceability of guards and safety devices;
- Proper electrical grounding or double insulation protection;
- Power tools properly equipped with constant pressure switches;
- Tool retainers installed on pneumatic tools;
- Proper adjustment of the tool; and
- Confirming that the load rating of the tool is sufficient for the work to be performed.

Unsafe tools shall be removed from service and the Site Supervisor advised of the condition for corrective action. An Out of Service tag should be placed on all unsafe or defective tools to prevent their inadvertent use by others. These tools should be physically segregated from the acceptable tools.

3.3.5 Environmental Safety and Quality Policy Implementation

Proper selection of construction equipment can impact employee health, consideration should be given to ergonomic design when selecting construction equipment.

Selection of construction equipment and vehicles may have significant impacts on the environment, either adverse or beneficial. Proper selection of the size and type of equipment and vehicles can reduce the adverse impacts from their operation.

Project procurement practices for construction equipment, parts, supplies, lubricants, and fuel shall be consistent with the principles of pollution prevention. For example, consideration should be given to such factors as rent versus buy options, disposable versus reusable filters, recycled versus virgin oils/fluids, recycling versus disposal of spent fluids and used parts, and fuel efficiency and economy of operation.

Spent fluids, filters, and used parts shall be recycled to the extent practical, or otherwise disposed of in accordance with the environmental compliance elements of the Work Plan or EHS plan.

Proper utilization of construction equipment and vehicles can also reduce adverse impacts on the environment. (For example, it is Tetra Tech's policy to not allow unattended equipment and vehicles to be left with motors running. This is not only a safety consideration; it reduces adverse environmental impacts and is generally cost effective due to reduced fuel consumption.)

3.3.6 Insurance

The Project Manager shall ensure that all construction equipment, including Tetra Tech-owned or rental/lease equipment, is covered by appropriate insurance policies for the intended use of the equipment. Property insurance on construction equipment is normally arranged by Tetra Tech if Tetra Tech bears the risk of loss or if Tetra Tech is required to arrange such insurance. However, all rented/leased construction equipment valued in excess of $100,000, and all cranes regardless of their value shall be reported to the Administration and Compliance Department via the 'Insurance Request for Leased Equipment' (Attachement 5, and available in Tetra Links and from procurement) for specific inclusion under the Tetra Tech property insurance policy. The procurement representative should be contacted to ensure that this occurs in each case. Notification is not required for equipment valued under $100,000 except when the construction equipment provider requests a certificate of insurance be provided, or the equipment is a crane.

The Project Manager, usually through the designated procurement representative, should ensure that duplicate insurance coverage is not provided through the equipment provider since this will increase the rental rates. In those cases where the provider requires insurance certificates to verify coverage by Tetra Tech, the procurement representative should be contacted to obtain the appropriate documentation.

A Vehicle Insurance Form (available from the Vehicle Insurance Coordinator, Tetra Links or procurement) shall be processed and sent to the Vehicle Insurance Coordinator for all vehicles (leased, rented, or owned) which are registered and operated off jobsites on public highways.

3.3.7 Receipt and Inspection

All construction equipment shall be subject to a receipt inspection by a competent person and any Contract or otherwise required additional person(s) prior to acceptance at the project site. The inspections and tests shall be in accordance with the manufacturer's recommendations. Most vendors provide a form for notation of any existing damage to the equipment to be filled out on receipt. The equipment should be inspected carefully to determine its condition, including any damage, missing or non-functional equipment. The agreement should be used as a basis to determine that everything required (e.g., the equipment, its condition, manuals, spares, documentation of inspections, and certifications) has been provided. All discrepancies should be noted on the form. A pre-inspection of the equipment prior to transport to the Project site should be considered. Particular attention shall be given to the following items:

- All safety equipment and its condition;
- Operator (when provided) certification for the equipment;
- Posted operating and safety instructions;
- All pollution control devices and their condition;
- Safe entry and egress, with steps, ladders, handholds, and platforms provided as required, including safe access to perform routine checks, maintenance, and refueling operations;
- Leaking fluids, such as hydraulic oil, engine oil, transmission fluid, and coolant;

- Deteriorated or cracked hydraulic and coolant hoses which could result in leaks or spills;
- Guard belts, gears, shafts, pulleys, fly wheels and other reciprocating, rotating or moving parts shall be guarded to protect workers from becoming caught on, in or between machinery; and
- Presence of the manufacturer operation and maintenance manual.

Equipment or vehicles with deficient conditions relating to safety or protection of the environment shall not be placed into service until the deficiencies have been corrected and documented.

All construction equipment shall be subject to an operational check prior to acceptance at the project site. The operational check should verify that the equipment has the capability to function as intended or as required through the full range of its intended use.

Receipt of construction equipment shall be documented; with a copy of the receipt inspection report provided to the Equipment Supervisor and to the equipment purchase order file. Documentation should include entries for date and time of receipt, condition of equipment, mileage or engine hours at time of receipt, information on next scheduled maintenance, and a record of operating and maintenance manuals received with the equipment. Photographs or a video record of the equipment on receipt should be taken if conditions are noted that would warrant further documentation.

Construction equipment providers will often include terms and conditions on receipt documentation to be signed when construction equipment is delivered to the project site. **Project personnel requested to sign this receipt documentation shall not sign any delivery forms unless authorized to do so by Legal of the Project Manager. Further, if they are required to sign delivery forms, they shall be instructed to cross out all terms and conditions, on both the front and back of the forms, before signing.** Alternately, the person receiving the construction equipment should enter the following statement in the immediate vicinity of their signature: “In lieu of the terms and conditions set forth on this document, the Original Purchase Order (or appropriate form of agreement) terms and conditions apply to the receipt of this item(s).” These actions are necessary to avoid acceptance of additional or different terms and conditions.

Construction equipment delivered to the project site should be accompanied with operating and maintenance manuals. Cranes and lifting equipment shall include certification of satisfactory completion of annual inspection and have load charts posted in the cab. Additionally, some construction equipment may be supplied with common replacement parts, such as filters and belts, and any specialized tools required for routine operation or maintenance. (i.e. forks, buckets, lift arms, and tool carries) These items should be carefully inventoried upon receipt, and documented on the receipt inspection report. Responsibility for protection and maintenance of the construction equipment shall be verified, and all measures necessary to protect the construction equipment from damage or loss will be instituted in accordance with the agreement, operating, and maintenance manuals or other instructions as appropriate.

Disposition requirements for construction equipment found to not be in accordance with the rental/lease/sale agreement when received shall be confirmed with the vendor immediately.

A sample Equipment/Vehicle Inspection Report is included as Attachment 1 to this procedure.

3.3.8 Protection from Environmental Extremes

Consideration shall be given to the environmental conditions to which the construction equipment will be exposed to during its time at the project site or during transportation. The manufacturer's instructions shall be reviewed and followed to ensure adequate protection from damage due to environmental conditions.

Adequate protection to the construction equipment's cooling system shall be verified by ensuring that the appropriate coolant/antifreeze mixture, as recommended by the manufacturer, has been used.

Appropriate procedures for operating or storing construction equipment, such as water treatment systems, shall be developed in accordance with the manufacturer's instructions. Measures such as draining and venting the system, providing auxiliary heat sources (e.g., heat tape), dry storage, shaft rotation, fluid levels, shall be taken to protect construction equipment subject to damage from environmental conditions.

Manufacturer's instructions concerning periodic operation of construction equipment shall be followed.

A means of ensuring that appropriate protective measures are instituted and performed as required should be implemented through the establishment of site procedures, logs, and/or checklists.

3.3.9 Equipment Inspections

All construction equipment shall be inspected daily (when in use) for safety and operability, including manufacturer’s recommended daily inspections. The inspection form/checklist should note any deficiencies for correction and serve as documentation of the inspection performance. The Equipment Supervisor shall be notified of any deficiency immediately. A Daily Equipment Inspection form, a sample of which is included as Attachment 2 to this procedure, should be filled out at the start of the shift and provided to the Equipment Supervisor. Other supplemental forms which may be used in conjunction with Attachment 2 are the equipment specific "Pre-operation Inspection" and/or "Function Tests" forms, which are normally supplied by the equipment manufacturer. This information is usually found in the equipment's Operation Manual.

Government property control procedures usually require the implementation of a vehicle utilization log for vehicles when used on government projects; other projects should also implement a similar system for logging use of these vehicles. The log should be kept in the vehicle and an entry made for each use, including name of the driver, purpose of the trip, starting mileage, ending mileage, fuel purchased, maintenance performed, and any damage incurred. The log sheets should be transmiTetra Teched as required in the contract documents and the project’s documentation plan. Copies of the log sheets will be maintained and filed as discussed in Section 3.3.12 of this procedure.

A separate Daily Equipment Inspection Report should be filled out for each shift if construction equipment is utilized on multiple shifts.

The Equipment Supervisor should use the information on Daily Equipment Inspection forms to schedule any repairs or preventive maintenance required for the equipment. Equipment with missing or defective safety features should not be put in service until repairs have been performed to bring the equipment into compliance with any applicable Tetra Tech H&S Program and/or regulatory requirements.

Implementation of the daily equipment inspections should be the subject of periodic verification inspections performed by the Project Manager, Site Supervisor, and/or the Site Safety Coordinator (SSC). These periodic inspections should include verification that the required maintenance is being performed in a timely manner to ensure that unsafe conditions or impacts to the environment (e.g., spills, releases, and discharges) are not created by delays in correcting deficiencies noted on the Daily Equipment Inspection Forms.

Rigging equipment, wire rope, nylon or KEVLAR slings and chokers shall be inspected by a competent person prior to use each shift; particular attention shall be paid to the rigging condition and presence of load/certification tags.

Cranes (weight handling equipment) shall be subjected to annual and certification inspections per OSHA guidelines. Mobile and crawler cranes shall be inspected on a monthly basis; a sample checklist form is included as Attachment 3 to this procedure.

Construction equipment to be demobilized shall be given a final inspection, similar to the receipt inspection, to identify and document, by means of written description and pictures, the condition of the equipment as it leaves the project site. Where possible, a concurrent inspection by the vendor is preferred. Additionally, some projects, particularly USACE projects, require a certificate of decontamination prior to the equipment leaving the site.

3.3.10 Operator Qualifications

Tetra Tech employees operating vehicles or construction equipment on public rights of way shall be required to have in their possession a valid driver's license appropriate to the location where the item is being operated and containing the appropriate endorsement for the type of vehicle or construction equipment being operated. A Commercial Driver's License (CDL) may be required for operation of some construction equipment on public rights of way, or as a specific requirement of a client's safety program. In addition, individual states may require specific licenses or certifications for operators of certain equipment, such as forklifts, and hoisting equipment. Additionally, the client's safety program may include license or certification requirements for personnel operating equipment on their property. The contract documents should be reviewed carefully to ensure that any such requirements are incorporated into the project's Work Plan or HASP. The Site Supervisor shall verify that the operator possesses the required license(s). Copies of licenses should be maintained in the on-site project employee file.

Any agreements for the rental or lease of vehicles or equipment should be reviewed for any provider's requirements for licensing or certification of operators to ensure that any such requirements are incorporated into the project's Work Plan or HASP.

Operators shall be required to demonstrate their proficiency in operating the construction equipment to be assigned to them prior to being allowed to work. Crane operators shall have qualifications for the type of crane to be operated.

Operator proficiency may be demonstrated through a performance test such as those developed by the International Union of Operating Engineers, or by equipment manufacturers such as Caterpillar. These performance tests include exercises developed to demonstrate operator proficiency in various aspects of equipment operation, including daily operator inspections, ability to follow directions, ability to understand equipment limitations and operating guidelines, safety, and productivity. Also included are checklists that assist an observer in evaluating all of the various aspects of equipment operation. Attachment 4 is an example of Operator/Driver Observation Checklist.

Where it is not possible or practical to demonstrate operator proficiency through a performance test as described above, there should be a period of observation of the operator during the initial period of performance, whether the operator is a new employee or a current employee who is being assigned to a different type of equipment than previously operated on the project site. This observation may be performed by a knowledgeable member of the management team or a designated craft employee such as a foreman or steward. The above referenced checklists could be used for this observation in lieu of the performance test.

Operators shall be physically fit to perform their duties and may be required to participate in the Tetra Tech Medical Surveillance program.

3.3.11 Refresher Training and Evaluation

Refresher training in relevant topics shall be provided to Crane (as defined by OSHA 1910.180(a) operators, and Powered Industrial Truck (PIT) as defined by OSHA 1910.178(a)(1) operators prior to be allowed to continue operating when:

- The operator has been observed to operate the PIT/Crane in an unsafe manner.
- The operator has been involved in an accident or near-miss incident.
- The operator has received an evaluation that reveals that the operator is not operating the PIT/Crane safely.
- The operator is assigned to operate a different type of PIT/Crane; or
- A condition in the workplace changes in a manner that could affect safe operation of the PIT/Crane.

An evaluation of each PIT/Crane operator's performance shall be conducted at least once every three years.

Refresher training in relevant topics shall be provided to all other construction equipment operators when:

- The operator has been observed to operate the equipment in an unsafe manner.
- The operator has been involved in an accident or near-miss incident.
- The operator has received an evaluation that reveals that the operator is not operating the equipment safely.
- The operator is assigned to drive a different type of equipment; or
- A condition in the workplace changes in a manner that could affect safe operation of the equipment.

The employer shall certify that each operator has been trained and evaluated. The certification shall include the name of the operator, the type of equipment, the date of the training, the date of the evaluation, and the identity of the person(s) performing the training or evaluation.

3.3.12 Repairs

All construction equipment shall be repaired as necessary and maintained in good working order. Repairs to rented/leased construction equipment shall be in accordance with the terms of the rental/lease agreement. Repairs to rented/leased and Tetra Tech's construction equipment shall be documented and a record of the repairs maintained in the project files. Copies of the repair records are to be forwarded to the equipment yard for Tetra Tech-owned equipment.

Construction equipment with deficiencies noted on the Daily Inspection Report should be repaired promptly. The Equipment Supervisor, with input from the Environmental and Safety Supervisor as appropriate, should evaluate if a piece of equipment or a vehicle should be removed from service until the deficiency is corrected.

Construction equipment that develops a fluid leak such as engine oil, hydraulic oil, transmission fluid, or coolant shall be removed from service until the deficient condition has been corrected.

Construction equipment with missing or inoperable exhaust systems, including spark or flame arrestors, mufflers, and catalytic converters, shall be removed from service until the deficient condition has been corrected.

Tampering with, removal, modification, or otherwise rendering inoperable any pollution control device on construction equipment shall not be allowed except as specifically authorized by the equipment manufacturer or appropriate authority and the Project Manager or Supervisor's concurrence

Only trained, qualified personnel shall be allowed to repair equipment. The project's Work Plan should address repairs to equipment by designating required actions in the event of an equipment failure.

An Authorization for Capital Expenditure or Lease (AFCEL) is to be completed for all major repair work (i.e., $1500.00 and over) performed on Tetra Tech-owned construction equipment in accordance with Accounting/Finance Procedure AF-8, Fixed Assets. (Note that on some construction equipment, the cost of a specific item, a replacement tire for example, may require the processing of an AFCEL due to the item cost.)

Costs for major repairs, as well as repairs for deficiencies, to Tetra Tech-owned construction equipment shall be charged back to the project releasing the equipment if the need for repairs is identified within 30 days of the equipment's release and removal from a project and there are indications that the repairs are needed as the result of lack of maintenance or failure of the releasing project to otherwise keep the equipment in good working order.

No repair shall be undertaken for damage covered by an insurance claim until the damage is reported to the Administration and Compliance Department and the insurer approves the repairs.

3.3.13 Documentation and Record Keeping

A file shall be established and maintained for each operator which contains documentation that the operator has the proper qualifications, licenses/certificates, and training to perform his/her job function. Records may include training identified in the HASP (e.g., OSHA, DOT, Waste Management training), vehicle operator licenses, results of site-administered proficiency testing, and any other special licenses/certificates required by state/local law or the client.

A file shall be established and maintained for each piece of construction equipment, and all records relating to that equipment shall be placed in the file, including the Receipt Inspection Report, annual inspections (for cranes), record of the date the equipment was first placed in service, Daily Equipment Inspection records, maintenance records, repair records, record of the last date that the equipment was in service, demobilization inspection report, and the decontamination certificate, if applicable. For ease of retrieval, all records pertaining to pieces of equipment should be maintained in separate folders for each piece of equipment.

Additional copies of inspection reports and records may be required to be maintained in other project files, such as the procurement files and/or the Environmental Health and Safety files, based on the project's Documentation Plan.

The Equipment Supervisor should ensure that complete and accurate record of equipment utilization, including a list of idle equipment, is provided to the Quality Control Site Manager on a daily basis..

It may be useful to maintain equipment utilization information on a spreadsheet depending on the size of the project. Information such as equipment mobilization date, date of first use, utilization of equipment by rental period (for example, if rental rate is based on hourly usage and is billed on a monthly cycle, there should be an entry for the number of hours the equipment was used in each billing period), scheduled equipment release date, actual release date, and demobilization date. This information may be useful in verification of vendor invoices, in review of production rates, for preparation of requests for change orders or equitable adjustment, or for backup for use in support of (or defense against) claims.

Copies of all maintenance and repair records for Tetra Tech-owned construction equipment shall be forwarded to the Tetra Tech Equipment Manager at the regional equipment yard on a periodic basis. This period should be monthly, and in no circumstances should it exceed quarterly. An Equipment Service Form is available from the Equipment Manager. This form shall be used to report unscheduled and preventative maintenance on Tetra Tech-owned construction equipment.

The Equipment Manager produces a spreadsheet for Tetra Tech-owned construction equipment that is distributed to the projects on a monthly basis. The Equipment Supervisor shall ensure that reports of mileage or meter readings and routine maintenance for all Tetra Tech-owned construction equipment and vehicles assigned to the project are provided to the Equipment Manager for inclusion on the spreadsheet on a monthly basis. A Meter/Mileage Reading Update Form, available from the Equipment Manager, shall be used to report the required information.

The Equipment Supervisor should review the availability date included on the spreadsheet for Tetra Tech-owned equipment and vehicles assigned to the project and inform the Equipment

Manager of any required revisions to these dates.

The Equipment Supervisor shall complete an Equipment Transfer Report, available from the Equipment Manager, for all Tetra Tech-owned construction equipment and vehicles to be mobilized to, and demobilized from the project. Copies of the Equipment Transfer Reports shall be provided to the Equipment Manager at the regional equipment yard.

There shall be no equipment disposal action (junk or sale) for Tetra Tech-owned construction equipment or vehicles without prior notification and approval from the Tetra Tech President.

4.0 GUIDANCE

4.1 Additional Considerations

4.1.1 Control of Government Property

Activities involving the use of Government property are to be controlled by specific procedures negotiated with the Client in accordance with the contract's terms and conditions; such procedures shall be consulted where appropriate. Such activities may involve the handling or installation of Government property, whether furnished by the Government to Tetra Tech or acquired by Tetra Tech for use in the performance of work and for which the Government has retained title.

Government property may include construction tools and equipment purchased as a project cost, as well as permanent materials or equipment purchased for incorporation into the work. Project-specific procedures for control of Government property are to address issues relevant to the use, storage, inventory control, maintenance, and/or final disposition of the Government property.

4.1.2 Spill Control and Emergency Response Dedicated Tools and Equipment

The project's Emergency Response Plan, or Emergency Action Plan is to identify dedicated personal protective equipment and emergency response tools and equipment to be available for an emergency response to a spill or discharge of hazardous material.

Dedicated emergency response tools and equipment are to be segregated and identified for use in emergency response situations. The use of dedicated emergency response tools or equipment for any other activity is not to be permitted.

4.1.3 Inventory Control

An individual should be designated as the Material Control Supervisor and should be responsible for inventory control of all tools issued from the tool control area. A log should be maintained for all tools issued and should record, as a minimum, the identification by name and employee number of the individual signing out the tool, the date and time the tool was signed out, the intended use of the tool (by area or system), an indication of when the tool is to be returned, and the time and date when the tool is returned.
Inventory control of tools assigned to individuals or crews should be performed on a daily basis as the tools are returned to the gang box or storage area. The crew foreman should be responsible for inventory control of tools assigned to the foreman's crew.

The Site Supervisor should immediately be made aware of any missing tools and should take the appropriate action to investigate and/or replace the missing tools.

4.1.4 Disposition of Tools at Project Completion

The Project Manager should make a determination of the disposition of tools remaining at the end of the project. The project may not be reimbursed by the client for the purchase of tools on certain cost reimbursable and lump sum projects. On other projects, a dollar value for individual tools may establish whether or not the client provides any reimbursement. The terms and conditions of the contract should provide direction as to the required disposition of the tools. Tools for which the project has been reimbursed by the client are to be dispositioned in accordance with the client's preferences and the contract terms and conditions.

Tools purchased for the project as a project cost, and which are not to be turned over to the client, should be dispositioned by the Project Manager. Means of disposition may include, but not be limited to, declaring the tools surplus, sale of the tools, or providing the tools to another project. The Project Manager should consult with the appropriate Business Line Executive Vice Presidents, concerning disposition of project tools.

Tetra Tech owned tools (i.e., not purchased as a project cost) should be dispositioned by the Project Manager based on consultation with the appropriate Business Line Executive Vice Presidents. Means of disposition of Tetra Tech-owned tools may include, but not be limited to, declaring the tools surplus, sale of the tools, return of the tools to an equipment yard, or providing the tools to another project.

4.1.5 Company-Owned Equipment

Tetra Tech utilizes regional equipment yard(s) for the temporary storage and maintenance of Tetra Tech-owned construction equipment and vehicles when not currently assigned to a project. Available Tetra Tech-owned equipment should be considered for support of a project's construction effort based on an analysis of the benefits to the project and/or Tetra Tech. When evaluating Tetra Tech owned equipment the requirements discussed in 4.1.6 below should be considered when making the equipment selection.

4.1.6 Rental/Lease Equipment

Agreements for rental/lease of construction equipment should be coordinated through an authorized procurement representative to ensure that appropriate terms and conditions are included in the agreement. The Scope of Work for the agreement should be developed and reviewed carefully, including review by the Site Supervisor or Equipment Supervisor for inclusion of sufficient detail in order to clearly define the scope of work.

The Equipment Supervisor, or requisitioner if there is no designated Equipment Supervisor, should review the terms and conditions of all rental/lease agreements to determine that the following topics are adequately addressed:

- Receipt and return of the rental or leased equipment and any required accessories;
- Inspection and documentation of receipt and release;
- Provision of documentation required to be submitted, such as Occupational Safety and Health Administration (OSHA) accredited inspection reports, NDE reports, test reports (i.e. load test for cranes), typically annual inspections, and wire rope certification.
- Provision of all safety equipment and accessories, as required, such as fire extinguishers, seat belts, Roll Over Protection Structures (ROPS), Falling Object Protection Structures (FOPS), access steps, handholds, platforms, and anti two-block devices and load moment indicator (cranes);
- Provision of documentation demonstrating operator certification;
- Provision of Certificate of Compliance when required, for instance by NAVFAC P-307 Management of Weight Handling Equipment, Appendix P - Contractor Crane Requirements.

- Provision and requirements of routine and non-routine maintenance and repairs, including payment for labor, parts, filters, lubricants, and fluids;
- Documentation requirements for the above maintenance and repairs;
- Disposal/recycling requirements for used parts, filters, lubricants, and fluids;
- Items such as point of delivery, costs of delivery and return, rental charges during idle time, notification requirements for demobilization, and point of return;
- Appropriate rental rate provisions for straight time and overtime;
- Responsibility for damage to equipment;
- Insurance;
- Indemnification (if included);
- Payment for replacement of parts subject to normal wear and tear, such as tires, tracks, cuTetra Teching edges, and teeth; and
- Documentation requirements required in support of invoices for basic rental rates and overtime rates, as well as labor, parts, filters, lubricants, and fluids.

Rental agreements should be structured to include normal wear and tear on the equipment in the basic rental rate. In all cases, there should be mutual agreement with the equipment vendor as to the condition of the equipment as it is delivered. This should include items such as the life expectancy of the parts subject to wear and tear, their condition on receipt (i.e., percentage of usable life remaining), and the expected condition on return of the equipment. There should be agreement on minor versus major repairs and on what constitutes normal wear and tear. Mutual agreement is essential to mitigate potential claims from vendors for excessive wear and tear.

4.1.7 Mobilization of Equipment

Mobilization of construction equipment may be a long lead time item and may require client or third party involvement or approvals to gain site access, depending on the required equipment. The Site Supervisor or Equipment Supervisor should determine the lead time required, including Contract submitted and advance notice/approval requirements, and plan for the mobilization of equipment to support the project's schedule.

- Planning for mobilization of equipment should include a thorough review of Contract requirements for utilization of each equipment and site access requirements.
- Documentation of certification, and OSHA compliant annual inspection, load testing, safety devices (e.g., anti two-block) installed, wire rope certification, and operator's certification for cranes (weight handling equipment) should be reviewed prior to initiating mobilization of cranes.

4.1.8 Equipment Maintenance

The Equipment Supervisor should be responsible for administration of a construction equipment maintenance program for the project. A spreadsheet of all Tetra Tech-owned equipment, titled the Status of All Project Equipment, is maintained by the Construction Department providing notification of the scheduled maintenance requirements for each piece of equipment. Either this spreadsheet, or a project specific spreadsheet, should be maintained and statused on a periodic basis. Specific maintenance requirements may also be contained in specific contract negotiated property procedures or in other Tetra Tech corporate procedures.

As construction equipment is received on site, it should be added to the spreadsheet for tracking of the required maintenance.

A review of the scheduled maintenance should be performed for all construction equipment to be used in the Exclusion Zone to determine the desirability of performing any upcoming scheduled maintenance prior to placing the equipment in service. It may be difficult and expensive to perform the maintenance under the conditions required in the Exclusion Zone, or to decontaminate the construction equipment in order to perform the maintenance under clean conditions. When the maintenance of equipment in the Exclusion Zone is anticipated, the Site Supervisor should ensure that qualified personnel are available with the appropriate medical clearances and certifications to work in the Exclusion Zone.

4.1.9 Construction Equipment Safe Operation Requirements

Standards for safe operation of equipment are contained in the documents identified herein, inclusive and in particular of the requirements for safe operation of lifting and rigging equipment and weight handling equipment. The Contract typically will specify certain documents/codes to be followed for the project.

- The United States Army Corps of Engineers (USACE) Safety and Health Requirements Manual, EM 385-1-1, Chapters 16, 17, and 18, provide guidance concerning the safe operation of construction equipment.
- Safe operation of earth drilling equipment is addressed in SWP 5-36 Drill Rigs.
- Safe operation of hand and power tools is addressed in OSHA standard 29CFR Part 1926 Subpart I.
- Safe operation of cranes, derricks, hoists, elevators and conveyors is addressed in OSHA standard 29CFR Part 1926 Subpart N.
- Safe operation of motor vehicles, mechanized equipment and marine operations is addressed in 29CFR Part 1926 Subpart O.
- Rollover protective structures and overhead protection is addressed in 29CFR Part 1926 Subpart W.
- The American Society of Mechanical Engineers (ASME) provides guidance in the B30 commiTetra Techee volumes – Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings.
- The United States Department of Energy (DOE) provides guidance for safe lifting operations in Technical Standard DOE-STD-1090 – Hoisting and Rigging.
- The United States Navy publication NAVFAC P-307 – Management of Weight Handling Equipment includes requirements for Contractor Cranes (see appendix P). Navy facilities issue Instructions specific to particular facilities such as ‘NAVSHIPYDPUGET INSTRUCTION 11262.4A’ which provides requirements for weight handling equipment at all Navy facilities within the Puget Sound.

Construction Equipment safety requirements shall be met before any task can be safely and properly performed, including

- Equipment will be used only in the manner in which it was designed.

- Vehicles and equipment shall be kept in the appropriate gear or drive range when in motion, specifically when ascending or descending a grade. Freewheeling or coasting is prohibited.
- Steps, handrails and grab irons shall be used and equipment shall be faced when mounting or dismounting equipment. When climbing onto or from equipment a 3-point contact shall be maintained. Steps, handrails and grab rails shall be kept maintained, clean and free from slip, trip and fall hazards. Allow extra time in winter or rainy conditions to clean ice, snow and mud from equipment.
- Operators shall wear seat belts before starting and while in operation if the equipment is supplied with seat belts.
- Eye protection is mandatory if the equipment does not have an enclosed cab.
- Passengers shall not ride on equipment unless the equipment is designed to accommodate passengers.
- Before dismounting, the operator shall secure the equipment from movement by lowering all ground-engaging attachments, if so equipped (i.e., setting the parking brake, placing the transmission in park, disabling the hydraulics and activating any other elements of the equipment per the operator's manual).
- Wheeled equipment, without ground-engaging attachments, shall be chocked immediately following dismount with chock blocks that are adequate for the wheel size and equipment weight.
- Blades, buckets and other materials shall be in contact with the ground before the operator dismounts the equipment.
- Equipment should not be left unattended while the engine is running. If conditions exist that make it necessary for equipment to be left running in an unattended state (i.e., cold weather and certain start-ups), do not allow the general public entrance to the area unless the area can be clearly delineated. If the area cannot be clearly delineated to preclude casual entrance by the general public, unattended equipment shall not be left running.

- The work site around equipment shall be clear prior to moving equipment. The operator shall be attentive to people and any vehicles that may have entered the area during the walk-around inspection.

- All operations shall be in accordance with manufacturers Standard Operating Procedures (SOPs).

- All ground disturbance operations shall comply with the DCN 4-5 Trenching and Excavation Practices.

- Proper working distances shall be maintained when operating equipment that is near electrical lines, as defined in DCN 5-9 Safe Electrical Work Practices.

- Employees shall not get on or off a vehicle or piece of equipment while it is moving.

4.1.10. General Traffic Requirements

The traffic rules in this section shall be followed, at a minimum, when heavy equipment and haul trucks are operated on project sites. The PM or SSC shall implement new traffic rules as conditions or project changes dictate.

- All applicable local governing authority driving rules shall be followed when driving heavy equipment and haul trucks on public or project sites.

- Operators shall understand and adhere to the site traffic right-of-way rules and work zone configurations.

- Speed limits, dependent on the risk associated with the site, shall be posted for the location and shall always be observed. Violation of speed limits shall result in disciplinary actions, which shall be posted and discussed with the workforce. Appropriate signage shall adequately communicate haul roads and traffic hazards.

- Vehicles and equipment shall follow at a safe distance as determined by road conditions, the specific vehicle and loading. The site shall define a minimum following distance.

- Passing shall be limited to areas of adequate clearance, visibility and where marked accordingly. Passing may be prohibited completely on some sites or areas.

- Lights should be used to direct equipment at night; work zone lighting shall be sufficient for the work being performed.

- Adequate equipment spotters and ground employees should be deployed in conjunction with the job zone and traffic control plan. Spotters shall be not in the path of equipment travel while equipment is backing into a dump or loading area. Spotters shall wear bright, reflective clothing and be competent in directing and signaling equipment. Spotters and operators shall have a clear understanding of signal protocol for the site. When applicable, equipment will be equipped with a working signal alarm while backing up.

- A communications plan shall be developed by the site to allow the workforce to have communications with operators and spotters. A direct communication technique such as radio communication is preferred. If noise may impede operators to hear radios, then visual alerts (e.g., warning lights) inside the cab that are visible to the operator shall be considered.

4.1.11 Road Construction and Maintenance

For the safest and most efficient worksite, these construction and maintenance rules shall be followed when applicable:

- Elevated haul roads and roads, where risk is high from activities such as building dikes, shall have side berms or barriers that are axle height or greater to accommodate for the largest type of equipment that normally occupies the road. Drainage shall be allowed.

- All curves shall have open sight lines and have as large a radius as practical.

- Haul road/traffic changes shall be communicated to all affected personnel.

- Roadways shall be constructed with a slight crown to facilitate drainage.

- All roadways, including haul roads, shall be routinely maintained in a safe condition, including the elimination or control of dust, ice or similar hazards. Adequate dust control equipment shall be provided on the job site and shall be utilized to control the hazards.

4.1.12 Demobilization of Equipment

Construction equipment should be demobilized when no longer required for the work. The Executive Vice President of Construction should be provided with a status of Tetra Tech-owned construction equipment and scheduled release dates in order to coordinate availability of equipment with other projects.

The Project Manager or designee should request demobilization instructions from the Executive Vice President of Construction or designee to determine the location to receive Tetra Tech-owned equipment.

Construction equipment leaving the Exclusion Zone of a remediation construction project will be decontaminated in accordance with the requirements of DCN 3-9 Decontamination and the site specific HASP.

Individual state regulations may require cleaning of construction equipment leaving a site, not limited to remediation construction, in order to control the spread of microorganisms contained in the soil. Such requirements are to be identified in the project HASP plans.

Revision Date	Document Authorizer	Revision Details
2/16/2012	Chris McClain	Content & Format Revision

Tetra Tech, Inc. (Tetra Tech), conducts field work at a variety of national and international locations. Each location or work task may have unique hazards associated with it. This document identifies some unusual special hazards associated with field work and provides guidance on minimizing or preventing exposure to these hazards and should be included as an attachment to the site-specific health and safety plan, as appropriate. The following topics are discussed:

- Bear protection guidance;
- Guidance on the use of firearms;
- Remote location guidance;
- Mine hazards;
- Abandoned building guidance; and
- Aircraft hazards.

1.0 BEAR PROTECTION GUIDANCE

Tetra Tech employees may encounter "nuisance" bears typically associated with human trash dumps; however, this guidance does not address this situation because these areas will most likely have bear protection policies already in place. This policy will therefore concentrate on chance bear encounters in remote locations. Avoidance of bear encounters, reducing the possibility of injury, and prevention of the killing of bears are stressed.

For work in Alaska, the Tetra Tech field team should consult and follow the recommendations of *A Field Guide to Yukon Bears for the Exploration and Placer Industries* (field guide) published by the Yukon Wildlife Branch of the Canadian Department of Renewable Resources. This field guide provides information on bear taxonomy, habitat, and behavioral patterns, as well as recommendations on avoiding and surviving encounters. All Tetra Tech team members working at locations in Alaska where bears may be encountered must be familiar with the recommendations and information in the field guide. For work conducted in other geographical regions, similar field guides should be consulted.

Tetra Tech will also consider contracting a field guide for teams working in areas with a known risk of bear encounters. The guide will carry firearms as a last-resort defense against bears. The firearms used will be those recommended in the field guide. All persons bearing firearms must comply with the firearms policy (see Section 2.0 below). Destroying a bear will be a last-resort measure when imminent danger to field team members occurs.

Before field work begins, the Tetra Tech project manager should contact wildlife agencies that regulate the location in which Tetra Tech employees may encounter bears. Each state may have information on bear activity in their location, as well as on specific requirements that describe how wounded or destroyed bears will be managed. In Alaska, for example, the following requirements apply to destroyed bears:

- The bear must be skinned and the head removed.
- The shooting will be reported as soon as possible to the Tetra Tech project manager and to the Alaska Department of Fish and Game.
- The skin and head of any destroyed bears will be given to the Alaska Department of Fish and Game or the Division of Fish and Wildlife Protection as soon as possible.
- A written report of the circumstances leading to the shooting of the bear will be prepared and submitted to the project manager within 2 weeks of the shooting. A copy of this report will be provided to the U.S. Department of Agriculture (USDA) Forest Service.
- The Alaska Division of Fish and Wildlife Protection requires that specific forms be filled out and submitted when a bear is destroyed to protect life and property. These forms will be filled out as soon as possible after the shooting.
- If a bear is wounded but not killed, the field team should leave the area as soon as possible because wounded bears are extremely unpredictable and dangerous. The shooting and its results should be reported to the Alaska Department of Fish and Game and the Division of Fish and Wildlife Protection as soon as possible.

2.0 GUIDANCE ON THE USE OF FIREARMS

While working on Tetra Tech projects, Tetra Tech employees will not carry firearms. However, members of Tetra Tech field teams, such as guides or escorts, may carry firearms as additional protection in cases such as encounters with a bear or other dangerous wildlife. Even if they are

not carrying the firearm, all field team members will be expected to have an understanding of firearm safety. The following basic firearm safety rules will be followed at all times:

- All firearms should be treated as though they are loaded weapons until confirmation that they are not. Field team members should not accept the assurance of another person that the weapon is not loaded.
- A weapon should **never** be pointed at another person, whether the weapon is unloaded or not. Almost all accidental shootings and self-inflicted wounds result from pointing a weapon believed to be unloaded at a person.
- If the barrel of the firearm has been plugged, the firearm should not be operated before the barrel has been thoroughly cleaned. The cleaner should confirm that the weapon is UNLOADED BEFORE CLEANING.
- A target should always be identified before discharging the weapon. Employees should never shoot at rustling bushes or glimpses of color.
- Even if a team member is not the designated operator of the weapon, all team members should familiarize themselves with the inspection, loading, and unloading of the weapon, as well as the operation of safety catches.

Any team member violating this policy will not continue to work on the project. Any Tetra Tech employee violating this policy will also be subject to disciplinary action.

If a firearm is discharged, the circumstances of the discharge must be reported, in writing, to the project manager and operating unit health and safety manager (HSM) as soon as possible. All weapon discharge reports will be forwarded to the corporate health and safety director (CHSD) for review.

Any injury to wildlife or a field member as a result of the discharge will be reported as soon as possible to the site safety coordinator (SSC), the project manager, and the HSM. If the weapon was discharged to destroy a bear, the report of the bear destruction can be used for the firearm discharge report.

3.0 REMOTE LOCATION GUIDANCE

Job sites in remote locations are typically accessed by air or boat. As a result, quick egress is not possible. For this reason, all Tetra Tech field teams working in remote locations must prepare for several contingency situations. The two main situations of concern are medical emergencies and personnel stranded at the remote site.

All field teams will be equipped with a first aid kit that includes splints and back and neck supports, and all field staff will be trained in the use of first aid equipment. Because of the extended egress time, all personnel will be equipped with first aid supplies to treat anticipated injuries, including sprained and broken extremities; hypothermia; cuts and abrasions; and back, head, and neck injuries. Wearing proper clothing and proper footwear for the terrain is stressed to prevent injury.

Because field teams may rely on air or boat transport from the job site, bad weather or mechanical problems could result in the team having to spend one or more nights at the remote job site. In this case, all field teams should be equipped with an emergency pack that includes the following items:

- Water filtration or purification supplies;
- Freeze-dried food supplies for 3 days;
- Emergency shelter, such as a tent;
- Sleeping bags;
- Space blankets;
- Cooking utensils;
- Waterproof matches;
- Cooking stove;
- Marine radio and spare batteries;
- Flashlight or lantern; and

- Emergency flares.

With this emergency pack, the field team will be able to identify its position to rescuers and call for rescue in the case of a medical emergency. If the field team has to set up camp for the night in Alaska, the recommendations made in *A Field Guide to Yukon Bears for the Exploration and Placer Industries* will be followed. As an additional location aid, each team member should be issued a fluorescent orange vest to wear while in the woods. This fluorescent vest will aid in the location of lost or injured members of the field team.

4.0 MINE HAZARDS

Field work in locations where mining has occurred presents unique hazards. These hazards include open shafts, open drifts, abandoned structures, and abandoned explosives. Under no circumstances are Tetra Tech employees allowed to enter open shafts or drifts or abandoned structures.

If Tetra Tech personnel must inspect an area suspected to have been undermined, Tetra Tech team members must determine whether the area is safe by probing the area with a walking stick before inspecting the area. Tetra Tech team members will not walk into an area where visibility is poor without checking ground stability first.

If a team member falls into an open shaft, the remaining team members will first summon emergency aid. Because the shaft and materials surrounding the shaft may be unstable, no attempt to rescue the fallen team member should be made until emergency rescue personnel arrive on site.

If boxes of unidentified materials are present on site, all boxes will be treated as though they contain explosives. Some explosives become shock sensitive with age. Tetra Tech team members will therefore stay a minimum of 10 feet from boxes of known explosives or unknown content. The presence of any explosives observed on site will be noted and reported to the project manager, SSC, and the USDA Forest Service or other appropriate agency as soon as possible.

5.0 ABANDONED BUILDING GUIDANCE

Tetra Tech team members may investigate sites where abandoned buildings are present. Tetra Tech and team member staff should not enter abandoned buildings unless a structural engineering expert has determined that the building is structurally sound. Once inside the building, staff should watch for evidence of rodents, wild animals, poisonous insects, transients, safety hazards, and health hazards such as damaged and friable asbestos-containing materials.

6.0 AIRCRAFT HAZARDS

Tetra Tech and team member staff may be required to enter and exit either float planes or helicopters to access remote sites. Entering and exiting helicopters and float planes can be dangerous. In order to facilitate safe entry and exit from these aircraft, all Tetra Tech and team member staff will enter, exit, and load the aircraft as prescribed in the guidelines provided by the aircraft vendor. Each field team staff member will participate in a safety meeting with the pilot of each new aircraft prior to beginning work. Field team members will not exit or enter float planes until authorized by the pilot or the pilot's representative.

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10/1/2011	Chris McClain	Update

This safe work practice (SWP) establishes standards to prevent injuries to Tetra Tech, Inc. (Tetra Tech), employees resulting from electrical work.

1.0 RESPONSIBILITIES

The project manager (PM) is responsible for ensuring that work areas and tasks are evaluated for the presence of high-voltage or other hazardous electricity sources and that all electrical equipment and circuits are de-energized prior to any normal electrical maintenance work. Any site-specific safe electrical work practices should be identified and detailed in the site-specific health and safety plan (HASP), construction health and safety plan (C-HASP), job hazard analysis (JHA), job safety analysis (JSA), work permit or other site-specific health and safety documentation. The PM will notify the local utility company when elevated work occurs (including equipment with masts and booms) near their overhead power lines and guy wires. The voltage of the lines should be verified when the communication with the utility occurs, and the PM should ask about any permits that may be necessary.

The PM should also evaluate the risk associated with the work as it pertains to overhead power lines or other electrical sources. If the risk is deemed high, and the work cannot be avoided or changed to reduce or avoid the risk, Corporate Tetra Tech Health & Safety personnel will be consulted and a permit system shall be implemented. The permit would include information specific to the equipment being used, the operators, roles of field personnel, and limitations to reduce risk. In many cases, Tetra Tech will elect to not perform high risk work.

The site safety coordinator (SSC) is responsible for ensuring that on-site work is performed in accordance with this SWP. This will include conducting daily safety meetings that will include a discussion of this SWP. In some cases, work will be performed at a facility where client procedures require coordination with on-site client representatives. These representatives could include trained Permit Issuing Authorities. The SSC will be the Tetra Tech point of contact for the on-site client representatives.

2.0 POWER LINES

Site activities will proceed with caution in any area where historical data or instrument surveys indicate the presence of utility lines (such as gas, telephone, and other lines). All site activities at these locations will be coordinated and documented by the site safety coordinator.

The minimum clearances summarized below will be maintained between equipment and energized overhead power lines. Additional distances may be required depending on equipment in use, wind conditions, sway distance of lines and the equipment, and other factors causing changes in the spatial relationship of the equipment and power line. Local regulations, including those of the utility company, may require greater clearances. The more stringent guidelines will be followed.

Voltage	Working Clearance	Equipment Clearance (feet)
Less than 50 kilovolts (kV)	10 feet	4
50 to less than 345 kV	10 feet, plus 4 inches per extra kV (50 kV or more)	10
345 to 750 kV	10 feet, plus 4 inches per extra kV (50 kV or more)	16

If site activities nearer power lines are required, necessary arrangements to turn off the power will be coordinated by the project manager. If that is not possible, insulating blankets may be used to shield the lines. These must be installed by the utility company. Care must still be taken to avoid damaging the lines, even if they are de-energized or shielded.

Guy wires present additional hazards and will be flagged when they are within the work area. The working distances in the table above will also be used for safe working distances when working near guy wires. Additional precautions are needed when heavy equipment is being moved near guy wires. This will include either barriers to prevent equipment from contacting the wires, or dedicated spotters who will monitor the distances and provide warning to equipment operators.

Electrical service shall be provided by certified electricians in accordance with all applicable local and National Electric Codes (NEC) when high-voltage electrical service is required for site or project activities. Before work begins, Tetra Tech shall ascertain by inquiry, direct observation, or instruments, whether any part of an energized electric power circuit, exposed or concealed, is located so that the performance of work may bring any person, tool, or machine into physical or electrical contact with the electrical power circuit. The location shall be posted wherever such a circuit exists. All employees shall be advised of the location of such lines, the hazards involved, and the protective measures to be taken.

3.0 GENERAL SAFE WORK PRACTICES

The general procedures below shall be implemented, depending on site location, equipment, and work to be performed.

- Site team members should locate and ensure that there will be no adverse contact with overhead utilities prior to positioning or moving any elevated work platform. Drill rigs or other boomed equipment shall not be moved with the mast or boom in the raised position. Except for unloading, dump trucks shall be moved with the beds in the lowered position. Dump trucks, when unloading their contents, should be facing away from overhead utilities or parallel to them so that the truck is not moving toward the overhead lines.

- Boomed equipment shall not be left overnight underneath overhead power lines.

- Equipment shall not be serviced underneath overhead utilities.

- Ground fault circuit interrupters should be used in the absence of properly grounded circuitry or when portable tools must be used around wet areas.

- Electric lines, cables, and extension cords shall be guarded and maintained in good condition.

- All underground power lines should be identified and maintained before any ground-breaking work is performed.

- All power equipment should be locked out before the commencement of work by following Tetra Tech SWP No. 6-2, “Control of Hazardous Energy Sources (Lockout/Tagout).” These procedures shall apply to all electrical circuits, electrical power equipment, steam systems, hydraulic systems, compressed air and gas systems, and any other systems that have the potential for causing injury or damage if they are improperly or accidentally energized.

- All temporary electrical equipment used on a project should conform to the NEC, the National Electrical Safety Code, and other site requirements for that specific application. No damaged or defective tools shall be used.

- Extension cords should be used with portable electric tools of the three-wire type, protected from damage, and not fastened with staples, hung from nails, or suspended from wires. Splices should be soldered wire connections with insulation equal to the cable. Worn or frayed cables shall not be used.

- Extension cords shall not be used in lieu of permanent wiring applications.

- Portable task lights should be equipped with guards. Temporary lights should not be suspended by electric cords unless designed for suspension. Broken or burned out lamps must be replaced immediately.

- Receptacles for attachment plugs of the approved, concealed-contact type should be used. Where different voltages, frequencies, or type of current are supplied, receptacles should be of such design that attachment plugs are not interchangeable.

- Each disconnecting means for motors and appliances and each service feeder or branch circuit should be marked legibly at the point where it originates to indicate its purpose unless such devices are located and arranged so that the purpose is evident.

- Cables passing through work areas should be covered or elevated to protect them from damage. Cables and cords should be kept clear of walkways and other locations where they may be damaged or create tripping hazards.

- Boxes for disconnecting electricity should be secured, rigidly fastened, and fitted with covers.

- Appropriate warning signs should be posted in high-voltage areas, which should also be barricaded.

- Energized wiring in boxes, circuit breaker panels, and similar places should be covered at all times.

- Tetra Tech shall not permit any employee to work near any part of an electric power circuit that the employee could contact in the course of work unless the employee is protected against electric shock by de-energizing the circuit and grounding it, or by guarding it effectively by insulation, barricades, or other means.

4.0 GROUNDING

The grounding procedures below shall apply as appropriate to all project sites. Additional site-specific procedures shall be detailed in the site-specific HASP.

- All electrical tools and equipment must be approved, double-insulated, and properly grounded or used with ground-fault circuit interrupters.
- For 15- and 20-ampere receptacle outlets on single-phase, 120-volt circuits that are not part of the permanent wiring of the building or structure, either ground-fault circuit interrupters or an approved equipment grounding conductor program will be used.
- Moving equipment that is used near overhead power lines shall be equipped with grounding chains.

An equipment grounding conductor program will include the following:

- Each cord set, attachment cap, plug, and receptacle of cord sets, and any equipment connected by a cord and plug, except cord sets and receptacles that are fixed and not exposed to damage, will be inspected before each day's use for external defects and possible internal damage.
- Tests will be performed on all cord sets, receptacles that are not part of the permanent wiring of the building or structure, and cord- and plug-connected equipment required to be grounded. Grounding conductors will be tested for continuity. Each receptacle and attachment cap or plug will be tested for correct attachment of the equipment grounding conductor.

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	Name	Approval Date	
10/1/2008	Chris McClain		Update from 1998 format
	Rick Lemmon		

This safe work practice (SWP) presents general guidelines for basic fall protection when working in elevated areas. Elevated work or elevated construction work will require detailed procedures included in a site-specific health and safety plan (HASP), or construction health and safety plan (C-HASP). SWP 5-11, "Portable Ladder Safety," should also be consulted. Form 5-10 Working at Heights or equivalent must be completed when work is conducted in elevated areas.

1.0 RESPONSIBILITIES

The project manager (PM) is responsible for ensuring that work areas are evaluated for the presence of slip, trip, stumble and fall hazards prior to the start of work. Any site-specific fall protection practices should be identified and detailed in the site-specific health and safety plan (HASP), construction health and safety plan (C-HASP), job hazard analysis (JHA), job safety analysis (JSA), work permit or other site-specific health and safety documentation. The site safety coordinator is responsible for ensuring that on-site work is performed in accordance with this SWP.

Site specific fall protection procedures must be developed by an employee trained and qualified as a "competent person" in accordance with OSHA standard 29 CFR 1926 Subpart M. Anchor points and lifelines must be designed and approved by a trained "Qualified Person." The operating unit health and safety manager (HSM) shall assist with the implementation of the SWP.

2.0 PRACTICES

During elevated work, the precautions below must be taken.

- All fall hazards should be identified at work sites with the potential for elevated work. Once an elevated fall hazard has been recognized, an appropriate control measure must be selected. Priority should be given to elimination of the fall hazard over the use of fall protection equipment.
- Approved safety harnesses and shock-absorbing lanyards or self-retracting lifelines (SRLs) shall be worn by employees whose work exposes them to falls of greater than six (6) feet.

- Workers must be protected from falls of less than 4 feet when working over machinery or equipment that would pose an additional hazard if the employee were to fall.

- Anchorage points for lanyards or SRLs should be located at a level no lower than the employee's waist to limit the free fall distance to a maximum of 4 feet and to not allow the employee to contact the next lower work level, where practical.

- All fall protection devices should be used only in accordance with manufacturer's recommendations.

- All fall protection devices shall be inspected daily before use.

- Any lifeline, harness, or lanyard actually subjected to in-service loading (a fall) should be immediately removed from service and not used again for employee fall protection.

- Anchor points and lanyards capable of supporting a minimum force of 5,400 pounds should be used.

- Employees who are required to wear fall protection must be trained in the use of the equipment, as well as in fall protection work practices.

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This safe work practice (SWP) applies to portable ladders only. Fixed ladder systems shall be used when regular access is required such as for entering storage tanks and raised work platforms. These SWPs follow the regulatory requirements for ladders as found in Title 29 of the *Code of Federal Regulations* (CFR) Part 1926.1053. Procedures to ensure portable ladder safety are listed below.

- Ladders should be maintained in good condition at all times. Damaged ladders shall be withdrawn from service immediately.
- Ladders should be inspected regularly and removed from service and repaired or discarded if defective.
- Rungs should have slip-resistant surfaces and be kept free of grease and oil.
- Tops and pail shelves of portable stepladders should not be used as steps.
- Rung and cleat ladders should be placed so that the horizontal distance from the top support to the foot of the ladder is one-quarter of the working length of the ladder.
- Ladders should not be placed in front of doorways, drives, or passageways.
- Ladders should not be placed on boxes, barrels, or other unstable bases to add height.
- Employees should always face the ladder during ascent or descent.
- Metal ladders should not be used in areas with the potential for contact with electric circuits.
- Ladder side rails shall extend at least 3 feet above the upper landing surface to which the ladder is used to access.
- Ladder shall be used only on stable and level surfaces and secured. Do not use ladders on slippery surfaces.

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This safe work practice (SWP) establishes procedures to protect field personnel and the public from exposure to hazardous materials resulting from the handling, opening, sampling, transferring, overpacking, and shipping of drums.

All drum and container handling operations must adhere to all applicable federal, state, local, contractual, and company requirements. Preparation and shipping of containers of hazardous materials must comply with applicable U.S. Environmental Protection Agency (EPA) and U.S. Department of Transportation (DOT) regulations. All drums and containers used during hazardous waste operations must meet appropriate DOT regulations for the materials they contain.

Drum and container handling should be approached in a systematic, stepwise manner, especially when the contents are unknown or containers are in poor condition. Inspection, opening, sampling, overpacking, and staging requirements for drums and containers are described below

1.0 RESPONSIBILITIES

Operating unit health and safety managers (HSMs) are responsible for providing technical guidance to project managers and site safety coordinators (SSC) on drum and container handling procedures. Project managers are responsible for ensuring implementation of this SWP, when warranted, on their projects. SSCs are responsible for enforcement of this SWP at the work site. Field personnel are required to adhere to drum and container handling guidelines and procedures.

2.0 DRUM AND CONTAINER INSPECTION

Drums or containers must be visually inspected before any work is conducted in order to gain as much information as possible about their contents. Field personnel should document in the field logbook the following information:

- Any labels or other markings indicating possible contents;
- Drum or container condition (such as rusted, leaking, or dented);
- Signs of pressure (such as bulging or swelling);

- Drum or container size, construction, and type; and
- Configuration of drum or container head (open or closed top).

After observations are documented in the field logbook, each drum or container should be labeled with an identification code for future tracking.

3.0 DRUM AND CONTAINER OPENING

For efficient and safe drum or container opening, personnel must adhere to the guidelines below.

- If available, remote-controlled drum or container opening equipment should be used.
- In order to protect the employee, a suitable shield shall be placed between the employee and the drum being opened.
- Only spark-proof tools should be used to open drums and containers.
- Drums or containers containing unknown materials should be opened using Level B personal protection, including splash protection.
- Drums or containers containing radioactive material should not be opened or handled until the appropriate personnel with expertise in this area have been consulted.
- Air monitoring equipment should be available near the drum or container being opened, such as combination oxygen and combustible gas meters, colorimetric tubes, and photoionization detectors.
- Tools used for drum or container opening should be decontaminated after each use to avoid mixing incompatible wastes.
- Drums or containers should be resealed as soon as possible to minimize vapor generation.
- If possible, drums or containers exhibiting signs of pressure should not be opened.

4.0 DRUM AND CONTAINER SAMPLING

Drum and container sampling poses a variety of potential hazards to worker health and safety, including direct contact with hazardous materials, inhalation of hazardous vapors, and the possibility of drum or container explosion or rupture. The guidelines below should be used to properly sample drums and containers.

- Prior to sampling, a sampling plan must be developed that includes the following information:
  - Background information on the waste;
  - Which drums or containers will be sampled;
  - Appropriate sampling devices; and
  - Sample containers to be used,
- Sampling personnel should not stand on drums or containers or lean over other drums or containers to obtain samples.
- All phases in the vertical cross section of each drum or container should be sampled.
- Disposable glass tubing or other disposable sampling devices should be used to sample liquid.
- When sampling liquids, absorbent pads should be placed on drum tops to collect spillage that may occur while transferring samples into containers.
- Sampling personnel should document container number, any container labeling, sampling date and time, and number and color of different phases.

5.0 DRUM AND CONTAINER OVERPACKING

During an emergency, drums and containers should be handled as detailed below.

- Leaks should be plugged or patched immediately if this can be done without risk.

- Damaged drums and containers should be placed in an overpack container with absorbent pads to collect any spilled material or the contents transferred into a clean, compatible drum or container.

- Absorbent material should be used to collect any leakage that may occur during shipment.

During remedial actions, the procedures below apply to drum and container handling.

- Drums or containers should be placed in overpack containers, and any identification number assigned to the drum or container should be placed on the outside of the overpack container.

- If drum or container contents are to be bulked with other drum or container contents, the compatibility of the contents should be verified by a field characterization study prior to bulking.

6.0 DRUM AND CONTAINER STAGING

Staging refers to moving drums or containers in an organized manner to predesignated areas. Drums or containers may be staged to facilitate characterization and remedial action and also to protect drums or containers from potentially hazardous site conditions (such as high temperatures and proximity to ignition sources or heavy equipment). To ensure that staging is conducted in a safe and efficient manner, the guidelines below should be followed.

- Staging activities should be kept to a minimum to prevent hazards associated with increased handling of drums or containers.

- The staging area should be as close as possible to the site exit.

- The staging area should be level and covered with plastic sheeting or absorbent material.

- The staging area should be diked to contain possible spills.

- Drums or containers should be secured on pallets whenever possible to aid in the safe movement of drums or containers and to isolate the drums or containers from the soil surface.

- Drums or containers should not be stacked on top of each other.

- Drums or containers should be staged according to chemical composition of the contents. Drums or containers containing incompatible materials should be kept segregated.

- Drums and containers should be staged far enough apart to allow for the movement of equipment and personnel.

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This safe work practice (SWP) provides guidelines for handling flammable materials and controlling ignition sources in a manner that will prevent explosions and fires that may result in injuries. The guidelines also present procedures for proper flammable liquids transfer.

1.0 RESPONSIBILITIES

The project manager (PM) is responsible for ensuring that the work area is evaluated for the presence of flammable hazards and ignition sources and that all precautions provided in this SWP are implemented. The PM is also responsible for ensuring that appropriate air monitoring procedures are defined in the site-specific health and safety plan (HASP), construction health and safety plan (C-HASP), job hazard analysis (JHA), job safety analysis (JSA), work permit, or other site-specific health and safety documentation. The site safety coordinator (SSC) is responsible for recognizing potential flammable hazards and ignition sources, conducting air monitoring, posting warning signs, and notifying on-site workers of the hazards.

All field personnel must know that explosion and fires at a work site may result from any of the following:

- Chemical reaction;
- Ignition of explosive or flammable materials;
- Agitation of shock-sensitive compounds;
- Sudden release of materials under pressure;

Field personnel must also understand that each flammable gas and vapor has a minimum concentration in air below which propagation of flame does not occur on contact with an ignition source. This concentration is known as the lower explosive limit (LEL) and is expressed as a percent in air. Likewise, for every flammable gas and vapor, there is also a maximum concentration of gas or vapor in air above which propagation of flame does not occur. This value is known as the upper explosive limit (UEL) and is also expressed as a percent in air. The flammable range of a particular gas or vapor is the range between the LEL and UEL where the gas-air mixture will support combustion.

Proper precautions must be taken to protect against fire and ignition hazards, including air monitoring, elimination of ignition sources, and proper chemical handling and transfer. These precautions are discussed below.

2.0 AIR MONITORING

If condition or activities on a site may result in a potentially flammable or explosive atmosphere, then air monitoring must be performed. Air monitoring procedures must be detailed in a site specific health and safety plan (HASP), construction health and safety plan (C-HASP), job hazard analysis (JHA), job safety analysis (JSA), work permit, or other site-specific health and safety documentation. Monitoring for flammable or explosive atmospheres is typically performed using a combustible gas indicator (CGI). This instrument is designed to provide data in terms of the percent LEL. If the specific flammable gas or vapor is known (such as methane), a specific gas meter may be used.

Because flammable gases and vapors can be heavier or lighter than air, it is important to remember that the instrument probe should be moved slowly up and down at multiple levels when monitoring for gases. Response time varies between different meters, sensor types, sample hose lengths, and accessories used.

3.0 ELIMINATION OF IGNITION SOURCES

The risk of fires and explosions will be reduced when ignition sources are eliminated by using the following procedures:

- Ignition sources that are not required for the completion of the project are not be allowed in the exclusion zone or contamination reduction zone at hazardous waste sites or in the vicinity of work associated with flammable materials at any site.
- Warning signs should be posted and the work zone barricaded or blocked off before any work is conducted that might release flammable gases or vapors.
- All ignition sources should be eliminated from areas where flammable gases or vapors may be present or migrate to.

- If the wind direction may carry flammable gases or vapors into areas outside the work zone where ignition sources may be present, work should not be performed without careful monitoring of concentrations at the work zone boundary.

- Sparks caused by friction or electrostatic effects should be controlled using with proper grounding and bonding procedures for transfer of flammable liquids. This requires maintaining constant contact using metal between the containers and providing a metallic route to the ground to discharge electrostatic buildup.

- Sparkless tools should be used.

4.0 PROPER CHEMICAL HANDLING AND TRANSFER

Precautions to reduce the risk of fire and explosion during chemical handling and transfer include the following:

- Liquids and residues should be removed from containers or tanks using explosion-proof or air-driven pumps.

- Pump motors and suction hoses should be bonded to the container or tank or otherwise grounded to prevent electrostatic ignition hazards.

- If a vacuum truck is used to remove liquids or residues, the area of operation for the vacuum truck should be vapor or gas free. The truck should be located upwind and outside of the path of probable gas or vapor travel. Vacuum pump exhaust gases should be discharged downwind of the truck through a hose of adequate size and length.

- Vacuum trucks should be properly bonded or grounded while in use.

- After chemicals have been transferred, lines leading to the truck should be disconnected using nonsparking procedures and then the lines should be drained of their contents. Precautions should be taken to ensure that the contents of the lines do not spill into the environment during line disconnection.

- Only nonsparking or nonheat-producing tools should be used for opening containers and tanks. Electrical equipment shall also be explosion-proof.

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This safe work practice (SWP) provides contingency measures for spills and unintentional discharges from handling and transporting hazardous materials. Spill and discharge control practices should follow specific procedures to ensure the safety of responders and bystanders and to limit environmental impacts.

1.0 GENERAL PROCEDURES

Immediate action should be taken to control and contain any spill following the general guidelines below:

- Unnecessary personnel should be kept away from the spill or discharge.
- The hazardous area should be isolated.
- If the spill or discharge creates a hazardous situation or results in injury or an environmental release, the emergency procedures of the HASP should be implemented. Emergency response telephone numbers, designated contacts, and special reporting procedures are presented in the HASP.
- Personnel should stay on the upwind side of the spill or discharge.
- Entry into a confined space or low area where liquids or vapors may accumulate should be avoided.
- Sources of ignition should be eliminated if the spill or discharge involves combustible materials.
- Drains, manholes, waterways, sewers, and the like should be identified and covered or protected.
- The spill should be controlled or absorbed using appropriate media or devices.
- When the spill or discharge is fully contained and under control, spill or discharge material should be collected.
- Following cleanup, the spill area should be evaluated by collecting soil samples and screening the area with air monitoring instruments.

2.0 SOLIDS

If the spill or discharge material is solid and nonreactive, the material should be scooped up and placed in a suitable and compatible container until the disposal method has been determined.

3.0 LIQUIDS

If liquid is discharged, the following general procedures apply:

- The point of discharge should be immediately identified and measures taken to eliminate further discharges by uprighting or patching containers, transferring contents, or other appropriate methods.
- Any discharged liquids or sludge should be removed or retrieved.
- Discharged materials should be cleaned up with absorbent materials or devices.
- Spent absorbent material should be placed into storage or disposal containers.

4.0 REPORTING

In some instances, a release may require reporting to government agencies. If a reportable quantity is released (this quantity is stated on the Material Safety Data Sheet) or human health or the environment is threatened, appropriate national, state, and local administering agency personnel should be notified. The timeframe for notification may vary from agency to agency. Notification may be required immediately or within 24 hours, depending on the type, location, and amount of released material. The appropriate agency to report spills to should be determined during HASP development.

All spills and chemical releases must be reported and investigated in accordance with DCN 2-2 Incident Reporting and Investigation Program. Details must be documented on the IR Form and IR – B.

damages that result from unauthorized reuse of this SWP. Authorized users are responsible for obtaining proper training and qualification from their employer before performing operations described in this SWP.

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1.0 INTRODUCTION

This safe work practice (SWP) addresses situations during which heat illness is likely to occur and provides procedures for preventing and treating heat-related injuries and illnesses. This SWP is applicable to all Tetra Tech employees performing outdoor activities at both domestic and international project locations. This SWP incorporates safety regulations of the States of California and Washington to protect outdoor workers from heat-related illness. An "outdoor place" is an open area such as an agricultural field, forest, park, equipment and storage yard, outdoor utility installation, tarmac, and road. An outdoor workplace also can include a construction site at which no building shell has been completed, and areas of a construction site outside of any building shells that may be present.

Many factors contribute to heat illness and UV exposure, including personal protective equipment (PPE), ambient temperature and humidity, workload, sun exposure, and the physical condition of the employee, as well as predisposing medical conditions. However, the primary factors of heat illness are elevated ambient temperatures in combination with fluid loss. Because heat illness is one of the more common health concerns during field activities, employees must be familiar with the signs, symptoms, and various treatment methods of each form of heat illness. Health effects from heat illness may range from transient heat fatigue or rashes to serious illness or death. Tracking the weather is imperative during outdoor field projects because heat-related illness and fatalities occur primarily during heat waves.

2.0 Definitions

The following are typical terms and definitions associated with heat illness prevention and monitoring activities:

Acclimatization – Gradual adaptation of the body to work under temperature conditions to which it is exposed. Acclimatization peaks in most people within 4 to 14 days of regular work taking up at least 2 hours per day in the heat.

Ambient Temperature – Temperature of the surroundings.

Electrolytic Sports Drink – A beverage containing sodium and potassium salts that replenish the body's water and electrolyte levels after dehydration caused by physical activity.

Environmental Risk Factors for Heat Illness – Working conditions under which heat illness could occur. Environmental risk factors include air temperature, relative humidity, radiant heat from the sun and other sources, conductive heat sources such as the ground, air movement (or lack of), workload severity and duration, and protective clothing and PPE worn by employees.

Heat Illness – A serious medical condition resulting from the body's inability to cope with a particular heat load. Symptoms include heat cramps, heat exhaustion, and heat stroke (see Table 1).

Heat Index – An index that combines air temperature and relative humidity to indicate the human-perceived equivalent temperature (i.e., how hot it feels outdoors).

Heavy Work – Digging/hand-auguring, heavy lifting, cutting trees, using heavy hand tools, and similar tasks.

Light Work – Walking, writing notes, handling samples, and similar tasks.

Medium Work – Bailing wells, moving light equipment, driving nails, and similar tasks.

Personal Risk Factors for Heat Illness – Factors such as an individual's age, degree of acclimatization, health, water consumption, alcohol consumption, caffeine consumption, and use of prescription medications that affect the body's water retention or other physiological responses to heat.

Preventive Recovery Period – Period of time needed to recover from the heat in order to prevent heat illness.

Relative Humidity – The amount of water vapor that exists in a gaseous mixture of air and water vapor.

Shade – Blockage of direct sunlight. Canopies, umbrellas, and other temporary structures or devices may be used to provide shade. One indicator that blockage is sufficient is absence of a shadow of an object within the area of blocked sunlight. Shade is not adequate when heat in the area of shade defeats the purpose of shade, which is to allow the body to cool. For example, a car sitting in the sun does not provide acceptable shade to a person inside it unless the car is running with air conditioning.

Wet Bulb Globe Temperature (WBGT) - a measurement used to indicate heat stress. WBGT takes into account the effects of humidity

3.0 Employee Duties and Responsibilities

Written procedures help Project Managers (PM), Site Safety Coordinators (SSC), and field team members reduce the risk of heat-related illnesses, and ensure that emergency assistance is provided without delay to all Tetra Tech employees. The following are the duties and responsibilities of the Project Team for implementing and managing the Heat Illness Prevention and Monitoring SWP.

3.1 Project Management

The PM must understand and agree to the responsibility for implementing this SWP for worker safety. The PM will assure that all employees at the work site comply with this SWP.

- The PM must designate an appropriate field team member to serve as the SSC who will implement this SWP and who will perform and document necessary monitoring requirements for worker safety.
- The PM will ensure necessary resources required to implement this SWP and necessary monitoring resources for worker safety are acquired and present at the work site prior to initiation of project activities in hot environments.
- The PM will work with the Director of Health and Safety and identify at risk employees.
- The PM will ensure all field team members are trained in heat illness management prior to working outdoors.
- The PM and SSC will modify working hours to schedule work during the cooler hours of the day, when possible. When a modified or shorter work-shift is not possible, more water and rest breaks shall be provided.
- The PM and SSC will verify that the elements of this SWP are documented in the Health and Safety Plan, as necessary.

3.2 Site Safety Coordinator

- The SSC must understand and agree to the responsibility for implementing this SWP in the field, and implement the necessary monitoring requirements for worker safety during outdoor activities.
- The SSC must have appropriate Occupational Safety and Health Administration (OSHA)-related training and experience to understand and implement this SWP, and to ensure required monitoring for worker safety during outdoor activities.
- The SSC must ensure that resources needed to implement this SWP and required monitoring for worker safety are acquired and present at the work site prior to initiation of project activities in hot environments.
- The SSC must maintain all necessary resources required under the SWP during project activities in hot environments.
- The SSC must ensure implementation and appropriate documentation of required monitoring for worker safety during site activities.
- The SSC must be familiar with and continuously monitor all employees, and must remain alert for onset of heat-related symptoms.
- The SSC and co-workers are encouraged never to discount any signs or symptoms of heat-related illness shown by one or more project team members, and to immediately report these signs or symptoms.
- The SSC will carry a cell phone or other means of communication to ensure that emergency services can be contacted, and will verify that these resources are functional at the worksite prior to each shift.

3.3 Field Team

- The field team will be able to recognize the hazards of working in warm environments.

- Co-workers will use a "buddy system" to monitor each other closely for discomfort or symptoms of heat illness.

- Every morning, workers must attend a daily tailgate safety meeting to be reminded of site-specific emergency procedures.

- A copy of site specific heat illness procedures shall be available for employee review.

4.0 Description and Requirements

4.1 Effects of Hot Weather

As the environment heats up, the body tends to warm up as well. The body's internal thermostat maintains a constant temperature by pumping more blood to the skin, which is cooled by evaporation from increasing perspiration production. In this way, the body increases the rate of heat loss to balance the heat burden created by a hot environment. Such situations generally do not cause harm, as long as the body is allowed to adjust to cope with the increasing heat.

In a very hot environment, however, the rate of heat gain exceeds the rate of heat loss. In this situation, the body's coping mechanisms can be overwhelmed, resulting in heat illness and leading to a range of serious and possibly fatal conditions.

4.2 Preparation for Hot Weather Work

The following list describes the process for preparing to work in hot weather conditions:

- Identify work that can pose a risk of heat stress and Ultraviolet (UV) exposure.
- Identify at-risk employees.
- Identify possible controls:
  - Establish controls for hot weather situations
  - Determine mandatory work and rest regimens based on current conditions, workload, clothing requirements, temperature and humidity for Threshold Limit Value (TLV).
  - Identify required fluid and food replacement schedules.

- Provide a location to cool down during breaks.
- Establish requirements to address UV exposure.
- Monitor workers in extreme heat conditions.

• Establish emergency response procedures to be followed for heat-related emergency situations.

• Provide for first aid and establish the requirement that first aid be administered immediately to employees displaying symptoms of heat-related illness.

• Provide training to employees and verify training records about site legal and regulatory requirements and about the characteristics and effects of heat stress and the recognition and prevention of heat-related injuries (See Table 1).

5.0 Employee Training

Training is an important component of heat illness prevention. Employees are instructed to recognize and treat heat-related illnesses during 8-hour health and safety refresher and first aid training courses. The conditions, symptoms, and treatment for heat-related illnesses are listed below in Table 1.

TABLE 1
HEAT ILLNESS CONDITIONS

Condition	Causes	Signs and Symptoms	Treatment
Heat cramps	Fluid loss and electrolyte imbalance from dehydration	• Painful muscle cramps, especially in legs and abdomen • Faintness • Profuse perspiration	• Move affected worker to cool location • Provide sips of liquid such as Gatorade® • Stretch cramped muscles • Transport affected worker to hospital if condition worsens
Heat Exhaustion	Blood transport to skin to dissipate excessive body heat, resulting in blood pooling in the skin with inadequate return to the heart	• Weak pulse • Rapid and shallow breathing • General weakness • Pale, clammy skin • Profuse perspiration • Dizziness • Unconsciousness	• Move affected worker to cool area • Remove as much clothing as possible • Provide sips of cool liquid or Gatorade® (only if conscious) • Fan the person but do not overcool or chill • Treat for shock • Transport to hospital if condition worsens
Heat Stroke**	Life threatening condition from profound disturbance of body's heat-regulating mechanism	• Dry, hot, and flushed skin • Constricted pupils • Early loss of consciousness • Rapid pulse • Deep breathing at first, and then shallow breathing • Muscle twitching leading to convulsions • Body temperature reaching 105 or 106 degrees Fahrenheit (°F) or higher	• Immediately transport victim to medical facility • Move victim to cool area • Remove as much clothing as possible • Reduce body heat promptly by dousing with water or wrapping in wet cloth • Place ice packs under arms, around neck, at ankles, and wherever blood vessels are close to skin surface • Protect patient during convulsions
**** Any of these symptoms require immediate attention. If heat stroke is suspected, emergency medical personnel should be immediately contacted and on-site first aid provided.**			

Employee training procedures include, but are not limited to, the following:

- All employees (including and especially newly hired employees) will receive heat illness prevention training prior to working outdoors.
- SSCs will hold short tailgate meetings daily to review important heat illness and prevention information with all field team members.
- All workers will be assigned a "buddy" or experienced coworker to ensure that they understood the training and follow the company procedures.
- PMs and SSCs will be trained before assignment to supervise outdoor workers.

6.0 Heat Illness Prevention and Monitoring Requirements

6.1 Identification of Work Conditions

Hot weather is a condition that will be encountered during Tetra Tech operations. When work takes place outdoors during warm weather, working conditions shall be identified for both heat stress conditions and UV exposure.

6.2 Heat Index

The Heat Index (HI) can be used as a first indicator of thermal comfort. The HI can be obtained by directly measuring the dry bulb temperature and relative humidity. The dry bulb temperature and relative humidity forecast can be obtained by checking the local weather station information or measured by using a wet bulb thermometer. A direct reading of HI can be obtained by placing a heat stress monitor in full shade at the workplace.

The HI does not take into account acclimation, clothing or nature of work; therefore, if the HI is at 80°F (26.7°C) or above, further evaluation is required to adjust workload and clothing.

6.3 Heat Exposure Limits and Measurement

The TLV is a means of providing heat exposure limits and gauging potential heat impacts. To determine the TLV, the Wet Bulb Globe Temperature (WBGT) index is measured. The WBGT is calculated using a formula that takes into account air temperature, speed of air movement, radiant heat from hot objects, sunshine and body cooling due to sweat evaporation. WBGT direct reading meters, often called 'heat stress analyzers,' are also available. These meters give direct WBGT readings; no calculations are necessary.

A trained person shall take WBGT measurements. If a WBGT direct reading meter is not available, two different methods are used to calculate WBGT in the workplace: one for workplaces with direct sunlight, and the other for workplaces without direct sunlight. In addition, when conditions of the workplace fluctuate widely, time-weighted WBGT is often used. The WBGT calculation is used in determining heat stress exposure guidelines and heat stress and clothing guidelines. Table 2 presents approximate WBGT values.

APPROXIMATE WBGT VALUE (°F) TABLE

Dry Bulb Temperature		Relative Humidity																			
°C	°F	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
18.33	65	59	59	60	61	62	62	63	64	64	65	66	67	67	68	69	70	70	71	72	73
18.89	66	59	60	61	61	62	63	64	65	65	66	67	68	68	69	70	71	71	72	73	74
19.44	67	60	61	61	62	63	64	65	65	66	67	68	69	69	70	71	72	72	73	74	75
20.00	68	60	61	62	63	64	64	65	66	67	68	69	69	70	71	72	73	74	74	75	76
20.56	69	61	62	63	63	64	65	66	67	68	69	69	70	71	72	73	74	75	75	76	77
21.11	70	62	62	63	64	65	66	67	68	69	69	70	71	72	73	74	75	76	77	77	78
21.67	71	62	63	64	65	66	67	68	69	69	70	71	72	73	74	75	76	77	78	79	79
22.22	72	63	64	65	66	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81
22.78	73	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82
23.33	74	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
23.89	75	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84
24.44	76	65	66	67	68	69	71	72	73	74	75	76	77	78	79	80	81	82	83	85	86
25.00	77	66	67	68	69	70	71	72	74	75	76	77	78	79	80	81	82	84	85	86	87
25.56	78	66	67	69	70	71	72	73	74	76	77	78	79	80	81	82	84	85	86	87	88
26.11	79	67	68	69	71	72	73	74	75	76	78	79	80	81	82	84	85	86	87	88	90
26.67	80	68	69	70	71	72	74	75	76	77	79	80	81	82	84	85	86	87	88	90	91
27.22	81	68	69	71	72	73	75	76	77	78	80	81	82	83	85	86	87	89	90	91	92
27.78	82	69	70	71	73	74	75	77	78	79	81	82	83	85	86	87	88	90	91	92	94
28.33	83	69	71	72	73	75	76	78	79	80	82	83	84	86	87	88	90	91	92	94	95
28.89	84	70	71	73	74	76	77	78	80	81	83	84	85	87	88	90	91	92	94	95	97
29.44	85	71	72	73	75	76	78	79	81	82	84	85	87	88	89	91	92	94	95	97	98
30.00	86	71	73	74	76	77	79	80	82	83	85	86	88	89	91	92	94	95	97	98	100
30.56	87	72	73	75	76	78	80	81	83	84	86	87	89	90	92	93	95	97	98	100	101
31.11	88	72	74	76	77	79	80	82	84	85	87	88	90	92	93	95	96	98	100	101	103
31.67	89	73	75	76	78	80	81	83	85	86	88	90	91	93	94	96	98	99	101	103	104
32.22	90	74	75	77	79	80	82	84	86	87	89	91	92	94	96	97	99	101	103	104	106
32.78	91	74	76	78	80	81	83	85	87	88	90	92	94	95	97	99	101	102	104	106	108
33.33	92	75	77	79	80	82	84	86	88	89	91	93	95	97	98	100	102	104	106	107	109
33.89	93	76	77	79	81	83	85	87	89	90	92	94	96	98	100	102	103	105	107	109	111
34.44	94	76	78	80	82	84	86	88	90	92	93	95	97	99	101	103	105	107	109	111	113
35.00	95	77	79	81	83	85	87	89	91	93	95	97	99	101	103	105	107	108	110	112	114
35.56	96	77	79	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110	112	114	116
36.11	97	78	80	82	84	86	89	91	93	95	97	99	101	103	105	108	110	112	114	116	118
36.67	98	79	81	83	85	87	90	92	94	96	98	100	103	105	107	109	111	113	116	118	120
37.22	99	79	82	84	86	88	91	93	95	97	99	102	104	106	108	111	113	115	117	120	122
37.78	100	80	82	85	87	89	91	94	96	98	101	103	105	108	110	112	115	117	119	121	124
38.33	101	81	83	85	88	90	92	95	97	100	102	104	107	109	111	114	116	119	121	123	126
38.89	102	81	84	86	89	91	93	96	98	101	103	106	108	111	113	116	118	120	123	125	128
39.44	103	82	84	87	89	92	94	97	100	102	105	107	110	112	115	117	120	122	125	127	130
40.00	104	83	85	88	90	93	96	98	101	103	106	108	111	114	116	119	121	124	127	129	132
40.56	105	83	86	89	91	94	97	99	102	105	107	110	113	115	118	121	123	126	129	131	134
41.11	106	84	87	89	92	95	98	100	103	106	109	111	114	117	120	122	125	128	131	133	136
41.67	107	84	87	90	93	96	99	101	104	107	110	113	116	119	121	124	127	130	133	136	138
42.22	108	85	88	91	94	97	100	103	106	108	111	114	117	120	123	126	129	132	135	138	141
42.78	109	86	89	92	95	98	101	104	107	110	113	116	119	122	125	128	131	134	137	140	143
43.33	110	86	90	93	96	99	102	105	108	111	114	117	120	124	127	130	133	136	139	142	145
43.89	111	87	90	93	97	100	103	106	109	113	116	119	122	125	128	132	135	138	141	144	148
44.44	112	88	91	94	98	101	104	107	111	114	117	121	124	127	130	134	137	140	143	147	150
45.00	113	88	92	95	99	102	105	109	112	115	119	122	126	129	132	136	139	142	146	149	153
45.56	114	89	93	96	99	103	106	110	113	117	120	124	127	131	134	138	141	145	148	152	155
46.11	115	90	93	97	100	104	108	111	115	118	122	125	129	133	136	140	143	147	150	154	158
46.67	116	90	94	98	101	105	109	112	116	120	123	127	131	134	138	142	146	149	153	157	160
47.22	117	91	95	99	102	106	110	114	118	121	125	129	133	136	140	144	148	152	155	159	163
47.78	118	92	96	100	103	107	111	115	119	123	127	131	134	138	142	146	150	154	158	162	166
48.33	119	92	96	100	104	108	112	116	120	124	128	132	136	140	144	148	152	156	160	164	168
48.89	120	93	97	101	105	110	114	118	122	126	130	134	138	142	147	151	155	159	163	167	171

Notes: Calculated values assume outdoor work in full sun, with a light (<5 mph) wind.
WBGT of green-shaded cells is less than dry-bulb temperature.

6.4 Heat Stress Exposure Guidelines

Heat stress exposure guidelines recommended by the American Conference of Governmental Industrial Hygienists (ACGIH) are shown in Table 3: ACGIH Screening Criteria for Heat Stress Exposure. This table is used to determine the allocation of work in a work/rest cycle, which is dependent on the type of work and WBGT values.

Table 3: ACGIH Screening Criteria for Heat Stress Exposure

PERMISSIBLE HEAT EXPOSURE THRESHOLD LIMIT VALUE															
Clothing Type	Summer Lightweight			Cotton Coveralls			Winter Work			Permeable Water Barrier (Tyvek)			Fully-Encapsulating Suit (Level 4)		
Work Load	Light	Moderate	Heavy	Light	Moderate	Heavy	Light	Moderate	Heavy	Light	Moderate	Heavy	Light	Moderate	Heavy
Work/Rest Schedule / WBGT	(°F)	(°F)	(°F)	(°F)	(°F)	(°F)	(°F)	(°F)	(°F)	(°F)	(°F)	(°F)	(°F)	(°F)	(°F)
Continuous Work	86	80	77	82	76	73	79	73	70	75	69	66	68	62	59
75% Work, 25% Rest / Hr	87	82	79	83	79	75	80	75	71	76	72	68	69	64	61
50% Work, 50% Rest / Hr	89	85	82	85	81	79	81	78	75	78	74	71	71	67	64
25% Work, 75% Rest / Hr	90	88	86	86	84	82	83	81	79	79	77	75	72	70	68

Notes: Temperature is approximate WBGT from accompanying tables, based on outdoor work, temperature, and relative humidity measurement during work activities. Light Work includes walking, writing notes, handling samples, and similar activities (metabolic rate up to 200 kilocalories [kcal]/hour). Medium Work includes bailing wells, moving light equipment, driving nails, and similar tasks (metabolic rate of 200-350 kcal/hour). Heavy Work is digging, heavy lifting, cutting trees, using heavy hand tools, and similar tasks (metabolic rate above 350 kcal/hour).

Table 3 is based on five-day work weeks and eight-hour work days with conventional breaks. Conventional breaks include a 15-minute break in a four-hour period and a half-hour lunch in an eight-hour period. The ACGIH exposure limits are intended to protect most workers from heat-related illnesses. The limits are higher than that if they had been developed to prevent discomfort. A safety factor should be used to protect sensitive individuals or increase comfort. Examples to clarify work load intensity:

- Rest: sitting (quietly or with moderate arm movements).
- Light work: sitting or standing to control machines, performing light hand or arm work (e.g., using a table saw), occasional walking, driving.
- Moderate work: walking about with moderate lifting and pushing or pulling, walking at a moderate pace, scrubbing in a standing position.
- Heavy work: digging, carrying, pushing/pulling heavy loads, walking at a fast pace, pick and shovel work, carpenter sawing by hand.
- Very heavy: very intense activity at a fast to maximum pace (e.g., shoveling wet sand).

For example, in order to minimize heat stress exposure, an employee who is acclimated and is performing heavy work such as shoveling dirt in a temperature of 78°F (25.6°C), would fall into a work/rest regimen of 100% work.

TLVs assume that workers who are exposed to these conditions are adequately hydrated, are not taking medication, are wearing lightweight clothing and are in generally good health.
When the WBGT is at a temperature that exceeds the TLV, 'Stop Work' should be enforced.

6.5 Heat Stress and Clothing Guidelines

The exposure limit should be adjusted for workers wearing heavy clothing. ACGIH recommendations for these conditions are listed in Table 4: Correction of TLV for Clothing.

Table 4: Correction of TLV for Clothing

Clothing Type	WBGT Correction (in °F [°C])
Work Clothes (long-sleeved shirts and pants)	0 (0)
Cloth coveralls (woven material)	+3 (0)
Spunbonded Meltdown Spunbonded polypropylene coveralls	+6 (+0.5)
Polyolefin coveralls	+8 (+1)
Double-layer woven clothing	+9 (+3)
Limited-use vapor-barrier coveralls	+18 (+11)

For example, an acclimated worker wearing double-layer woven clothing doing moderate work in 30°C would have a corrected exposure level of 30 + 3 = 33°C (91.4°F). This would lower the allowable exposure to 0-25% work from 25-50% work.

For Fire Retardant Clothing (FRC), there is no WBGT correction. FRC can be obtained in various weight materials. The lightest weight FRC should be worn during work in warm environments. No second layer of clothing should be worn except for cotton undergarments.

These values are not to be used for completely encapsulating suits. The assumption is that coveralls are worn with only modest clothing underneath, not a second layer of clothing.

6.6 Identifying At-risk Employees

A screening program for identifying at risk employees shall include identification of health conditions that are aggravated by extreme environmental temperatures. How a person functions under conditions of heat stress will be unique that person and will depend on:

- Age.
- Weight.
- Metabolism.
- Alcohol or drug use.
- Pre-existing medical conditions.

- Level of physical fitness.
- Use of medications.
- Individual sensitivity to heat.
- Possibility of hypertension.

Note: Employees with any 'at-risk' conditions shall have more stringent work/rest regimens or controls

6.7 Health and Safety Controls

Controls shall be based on a risk assessment approach. Conditions and available controls will vary from site to site. Therefore, the HASP shall define and document the site specific control plan. Controls shall be appropriate for the risks that are associated with heat hazards.

6.7.1 Acclimation

The human body can adapt to heat exposure to some extent. This physiological adaptation is called acclimation. Acclimation is a response by the body that results in increased heat tolerance.

People differ in their ability to acclimate to heat. Usually, acclimation is obtained in four to five days. However, it is lost in approximately the same amount of time. After a period of acclimation, the same activity will produce fewer cardiovascular demands. The worker will perspire more efficiently, leading to better evaporative cooling, and thus will more easily be able to maintain normal body temperatures.

All site workers who could be exposed to hot weather conditions shall be acclimated or go through an acclimation process, as necessary. Where workers are already acclimated, no acclimation process is necessary. A previously acclimated person is someone who has already been in similar working and heat conditions.

6.7.2 Fluid and Nutrient Replacement

Cool (50°-60°F [10°-15°C]) water or other cool liquid, except alcoholic beverages, should be made available to workers.

<u>Provision of Water (Not Temperature Dependent)</u>

Water is the principal preventive measure to minimize the risk of heat-related illnesses. Tetra Tech employees shall have access to potable drinking water (or electrolytic sports drink). Where the supply of water is not plumbed or otherwise continuously supplied, water shall be provided in sufficient quantity at the beginning of the work shift to provide **1 quart per employee per hour for drinking for the entire shift**. Frequent drinking of water shall be encouraged by the SSC. Water provision requirements include the following:

- At least 2 quarts of water per employee will be available at the start of the shift.
- The SSC will monitor water containers every 30 minutes, and employees are encouraged to report low levels or dirty water to the SSC when observed.
- The SSC will provide reminders to the field team members to drink frequently, and more water breaks will be provided as needed.
- During the daily tailgate safety meeting each morning, the SSC will remind the field team about the importance of frequent water consumption throughout the shift.
- Water containers will be placed as close to the workers as safety conditions allow.
- When drinking water levels within a container drop below 50%, the water shall be replenished immediately.
- If a common water source is used, disposable/single-use drinking cups will be provided to employees each day.
- Communication devices such as radios, cell phones, or air horns may be used to remind field team members to take water breaks.

Although some commercial replacement drinks contain salt, this is not necessary for acclimated people, because most people have enough salt in their normal diets. Commercial replacement drinks contain high amounts of sugar and may contribute to an individual's inability to cope with the warm environment. If used, commercial replacement drinks should not be used at full strength and should be diluted with water on at least a one-to-one ratio.

Energy drinks shall not be used while working in warm environments.

Poor nutrition, over eating and under eating are factors contributing to heat stress. During hot conditions, employees should eat small, regular meals.

6.7.3 Additional Control Measures

Outdoor workers are exposed to not only potential heat illness, but also UV radiation. Long-term exposure to UV radiation poses additional risks and can lead to a variety of skin disorders, including skin cancer and cataracts of the eyes.

Protection from UV exposure, sunscreen and appropriate eye protection should be considered in addition to the additional controls listed below:

<u>Access to Shade (Not Temperature-Dependent)</u>

Access to rest and shade or other cooling measures are important preventative steps to minimize the risk of heat-related illnesses and exposure to UV radiation. Tetra Tech employees suffering working in extreme temperatures for any period of time shall be provided access to an area with shade that is either open to the air or provided with ventilation or cooling. Such access to shade shall be permitted at all times. Procedures for the provision of shade include the following:

- SSC will set up an adequate number of shaded areas as needed. Examples of shaded areas include vehicles with air conditioning, umbrellas, canopies, or other portable devices. Shading should be placed in close proximity to the work activity (no more than 50-100 yards away, or at the closest location safety conditions allow).

- Employees should have access to an office, construction trailer, or other places with air conditioning.

- Every morning a short tailgate meeting will occur to remind workers about the importance of rest breaks and the location of shade.

- Other cooling measures may be used **if (and only if)** these can be deemed effective as shade.

- As safety conditions allow, SSCs shall provide areas for employee breaks that are:
  - Readily accessible
  - In the shade, open to air, and ventilated
  - Near sufficient supplies of drinking water

7.0 Heat Illness Monitoring

A medical monitoring program shall be planned with the assistance of a medical or industrial hygiene professional. The monitoring program shall be specify the leading indicators to be used (e.g. heat rate, body temperature, blood pressure, respiration rate, and other) and frequency of measurement.

Heat illness monitoring will be conducted by the SSC or his/her designee when work conditions warrant implementation of a work/rest schedule based on temperature conditions and PPE requirements associated with project activities. Monitoring will be conducted as follows:

- Heart Rate: Count the radial (wrist) pulse during a 30-second period as early as possible in the rest period; if heart rate exceeds 110 beats per minute at the beginning of the rest period, shorten the next work cycle by one-third without changing the rest period.
  - If the heart rate still exceeds 110 beats per minute at the next period, shorten the following work cycle by one-third.

- Body Temperature: If body temperature exceeds 99.6 degrees Fahrenheit (°F) (37.6 degrees Celsius [°C]), shorten the next work cycle by one-third without changing the rest period. If body temperature still exceeds 99.6 °F at the beginning of the next rest period, shorten the following work cycle by one-third. Do not permit a worker to wear impermeable PPE when his or her body temperature exceeds 100.6 °F (38.1 °C). Use any of the following thermometers:

- Oral Thermometer – Use a clinical thermometer (3 minutes under the tongue) to measure the oral temperature at the end of the work period.
- Tympanic (ear) Thermometer
- Temporal (swipe) Thermometer

The SSC will document throughout the entire work shift results of heat illness monitoring for each team member participating in work activities.

8.0 EXTREME CONDITIONS

Extra Measures During Heat Waves

Extreme environmental conditions during a heat wave can cause an employee's physical and mental conditions to change rapidly into a serious medical condition. Workers previously fully acclimatized are at risk for heat illness during a heat wave because during a heat wave, the body does not have enough time to adjust to a sudden, abnormally high temperature or other extreme conditions. The onset of heat illness may be confused with other problems and may not always be obvious before it becomes life-threatening. Therefore, the following extra measures may be required to prevent and/or respond to heat illness.

- **Alertness to the Weather** – Make sure to monitor the weather and the specific locations where work activities are occurring. Continue to stay updated throughout the work shift on the changing air temperatures and other environmental factors. **Use current weather information to make the appropriate adjustments in work activities throughout the workday.**
- **Extra Vigilance** – Apply real-time communication and the "Buddy System" to account for the whereabouts of employees at more frequent intervals throughout the work shift and at the end of the work shift.
- **Additional Water Consumption** – Encourage employees to drink small quantities of water more frequently, and have effective replenishment measures in place for provision of extra drinking water to ensure available supplies.

- **Additional Cooling Measures** – Other alternative cooling measures may be necessary in addition to shade (e.g., allowing employees to spend time in air conditioned places or having them spray themselves with water).

- **Additional and/or Longer Rest Breaks** – Allowing employees to take more frequent and longer breaks may be necessary.

- **Change of Work Scheduling and Assignments** – One or more of the following additional measures may be necessary:

  - Start the work shift earlier in the day or later in the evening.
  - Cut work shifts short or stop work altogether.
  - Bring in more personnel to accommodate longer, more frequent breaks as necessary to meet production requirements.
  - Reduce the severity of work by scheduling slower paced, less physically demanding work during the hot parts of the day, and the heaviest work activities during the cooler parts of the day (early morning or evening).

9.0 Establish Emergency Response

Specific procedures to be followed for heat related emergency response shall be established and documented in the HASP.

10.0 Variation to the Heat Illness Prevention and Monitoring Program

Before deviation from the requirements of this document, a designated manager shall authorize the variation. The exception process does not need to be followed for variations that impose more stringent requirements that those outlined in this document.

11.0 Disclaimer

This safe work practice (SWP) is the property of Tetra Tech, Inc. (Tetra Tech). Any reuse of the SWP without Tetra Tech's permission is at the sole risk of the user. The user will hold harmless Tetra Tech for any damages that result from unauthorized reuse of this SWP. Authorized users are responsible for obtaining proper training and qualification from their employer before performing operations described in this SWP.

Revision Date	Document Authorizer		Revision Details
	Name	Approval Date	
4/27/2011	Chris McClain	4/27/2011	Update from 1998 format

This safe work practices (SWP) describes situations where cold stress is likely to occur and discusses procedures for the prevention and treatment of cold-related injuries and illnesses. Cold conditions may present health risks to employees during field activities. The two primary factors that influence the risk potential for cold stress are temperature and wind velocity. Wetness can also contribute to cold stress. Other factors that increase susceptibility to cold stress include age (very young or old), smoking, alcohol consumption, fatigue, and wet clothing. Hypothermia can occur at temperatures above freezing if the individual has on wet or damp clothing or is immersed in cold water. The combined effect of temperature and wind can be evaluated using a wind chill index as shown in Table 1.

Bare flesh and body extremities that have high surface area-to-volume ratios such as fingers, toes, and ears are most susceptible to wind chill or extremely low ambient temperatures. Because cold stress can create the potential for serious injury or death, employees must be familiar with the signs and symptoms and various treatments for each form of cold stress. Table 2 provides information on frostbite and hypothermia, the two most common forms of cold-related injuries.

1.0 Training

Training is an essential component of cold stress prevention. Employees are taught to identify and treat cold-related injuries during various mandatory training events such as, but not limited to, the 8-hour HAZWOPER refresher, site-specific training, tailgate meetings, and first aid training courses.

2.0 Cold stress assessment

If a worker is or may be exposed to cold stress conditions, employees should conduct a cold stress assessment to determine the potential for hazardous exposure of workers. The first step in a cold stress assessment is to determine the areas, occupations, or tasks that place workers at risk of hypothermia or cold-related injuries. Consider factors such as the following:

- Areas with an equivalent chill temperature (ECT) below 19.4°F (see below)
- Fine dexterity tasks that require work with bare hands
- Contact with metal surfaces or use of evaporative liquids (gasoline, alcohol, or cleaning liquids)
- Working on or near bodies of water

- Areas about which employees have expressed concern

Once the areas or tasks that should be monitored are determined, the risk of developing hypothermia or a cold-related injury should then be evaluated. A cold stress assessment shall include determining the air temperature (below 45ºF) and wind speed (to determine the "equivalent wind chill temperature"). This information is available by obtaining weather, temperature, and wind information from a local weather source, or if there is a monitoring station close to the area in which the work is to be conducted. The site safety officer (SSO) shall check temperature, wind speed, and the conditions of the worker every hour to determine appropriate controls.

Wind chill is a concern when the equivalent chill temperature is less than 19.4°F (See Table 1). The conditions when this occurs are:

- The air is calm and the temperature falls below 19.4°F
- The wind speed is 5 mph or greater and the air temperature is 23°F
- The wind speed is 10 mph or greater and the air temperature is 32°F
- The wind speed is 20 mph or greater and the air temperature is 41°F

As part of the risk assessment, the potential for worker exposure to artificially generated air velocities should also be considered, for example when working in walk-in refrigerators and freezers, when riding all-terrain vehicles or snowmobiles, or when exposed to helicopter rotor downwash.

A general assessment of contact cooling for exposed skin, particularly the hands, should consider the following when workers are in contact with metal:

- Below 59°F - Prolonged contact may impair dexterity.
- Below 44°F - Prolonged contact may induce numbness.
- Below 32°F - Prolonged contact may induce frostnip or frostbite.
- Below 19.4°F - Brief contact with may induce frostnip or frostbite.

For materials other than metal, such as plastics and wood, the temperatures will be lower than those noted above since they are less conductive than metal. Contact with metal or other like-conductive materials should be avoided if possible. Any contact with liquids at subzero temperature is also of concern and should be avoided if possible.

Workers should be provided with gloves or other method of warming the hands when the air temperature is below:

- 61°F for sedentary work
- 39°F for light work
- 19.4°F for moderate work

3.0 Cold Exposure Control Plan

If a worker is or may be exposed to cold stress conditions, the employer shall assign a buddy system and develop and implement a cold exposure control plan on site. Some specific components of the cold exposure control plan, as they relate to education and training of workers are described below.

3.1 Control Plan Education and training

This element should contain initial and ongoing training and education that will be provided to all workers who work in areas where there is a reasonable likelihood of exposure to conditions that could cause cold stress.

The training and education material provided to workers who have not previously worked in a cold stress environment should include the following information:

- Recognition of the signs and symptoms of impending hypothermia or excessive cooling of the body even when shivering does not occur
- Recognition of impending frostbite
- Proper re-warming procedures and appropriate first aid treatment
- Proper use of clothing
- Proper eating and drinking practices
- Safe work practices appropriate to the work that is to be performed

As previously noted, those workers exposed to cold-stress environments, Tetra Tech provides refresher training and education to ensure that workers remain knowledgeable about the above-mentioned items.

3.2 Engineering controls

Tetra Tech reduces the exposure hazard of workers to thermal conditions that could cause cold stress or injury using a hierarchy of control methods: engineering controls, followed by administrative controls and, as a last resort, personal protective equipment.

Here are some examples of engineering controls Tetra Tech uses to reduce cold exposure:

- Isolate the worker from the environment, where possible.
- Use local heating for the body and especially bare hands. This may include the use of warm air jets, radiant heaters, or contact warming plates.
- Provide barricades or other structures to block air or reduce air velocities at the work location.
- Provide a designated shelter to warm up during breaks.
  - At extreme temperatures employees will be directed to the warm shelters at regular intervals, or anytime cold stress signs or symptoms develop.
  - The shelter will be the designated area to change into dry clothing
- Provide heated metal tools and equipment handles or cover them with thermal insulating materials.
- Use machine controls and tools designed so that workers do not have to remove mittens or gloves to use them.

3.3 Administrative controls

If the above action is not practicable, Tetra Tech will reduce the exposure hazard by providing effective administrative controls to reduce the exposure hazard of workers to thermal conditions that could cause cold stress or injury.

Several administrative controls Tetra Tech commonly uses to reduce worker exposure to cold stress are described below:

- Work/warm-up schedules
  - A work/warm-up schedule (see Table 3) refers to the period a worker spends working in a cold environment and the time spent in a warm area.
  - Worker acclimatization should be a major factor in determining work/rest schedules for extreme cold (ECT of 10°F or less)

- Scheduling and organization of work – Tetra Tech will schedule tasks so as to minimize the length of time of exposure and to maximize the temperatures to which workers may be exposed. For example:
  - Schedule tasks for the warmest part of the day or when the wind is the most calm.
  - Minimize standing or sitting still for long periods in cold conditions (ECT of 10°F or less).
  - Identify employees with conditions and risk factors which could contribute to cold stress
    - Require more frequent work/warm up schedule, mandatory insulated clothing, and establish a “buddy system”.
    - These individuals shall be excluded from work in temperatures of 30°F or below.
  - Schedule routine maintenance and repair work for warmer seasons of the year.
  - Postpone non-urgent tasks when equivalent chill temperatures are in the "great danger" portion of the "Cooling Power of Wind" ACGIH table (Table 1).
  - Take the equivalent chill temperature (Table 1) into account when planning or scheduling work activities.
  - Warm shelters are made available when work is performed continuously in cold weather with an ECT at or below 20°F
- Fluid replacement and diet
  - An ample supply of warm drinks and/or soup should be available, and workers encouraged to drink them in order to replace fluids lost through breathing and perspiration.
  - Workers should restrict their intake of coffee because of diuretic and circulatory effects.
  - A diet high in fats and carbohydrates will help to maintain body temperature.
- Appropriate measures such as warm vehicles/shelters, clothing and blankets will be available for cold related injuries.
- Heavy work shall not be assigned as to cause heavy sweating that will result in wet clothing.
-

Employees should be thoroughly cognizant of the signs and symptoms of frostbite and hypothermia (see Table 3) in themselves as well as in coworkers. All instances of cold stress should be reported to the site safety coordinator. If a worker exposed to cold shows signs or reports symptoms of cold stress or injury, the worker must be removed from further exposure and treated by an appropriate first aid attendant, if available, or a physician. Work schedules may be adjusted and warm-up regimes imposed as needed to deal with temperature and wind conditions. Continuous skin exposure is not permitted when air speed and temperature results in an Equivalent Chill Temperature (ECT) of 25°F (32°C)

3.4 Personal Protective Equipment

If the above actions are not practicable, Tetra Tech will reduce the exposure hazard by providing effective PPE to reduce the exposure hazard of workers to thermal conditions that could cause cold stress or injury.

Several examples of PPE Tetra Tech commonly uses to reduce worker exposure to cold stress are described below:

- Protecting of exposed skin surfaces with appropriate clothing (such as face masks, handwear, and footwear) that insulates, stays dry, and blocks wind;
- Using adequate insulating clothing to maintain a body core temperature of above 98.6° F (36 °C);
- Providing extra insulating clothing on site in case of extreme temperature drops within a single shift;
- If an employee's clothing becomes wet while working below 40°F, he or she will automatically be given a change of clothing and checked for cold stress symptoms.
- Additional cold weather clothing will be identified for individuals with predisposed conditions that contribute to cold stress situations;

TABLE 1
COOLING POWER OF WIND ON EXPOSED FLESH EXPRESSED AS EQUIVALENT TEMPERATURE

The ACGIH criteria, in the Fahrenheit scale, are listed in the following table as it appears in "Cold Stress" portion of the 2011 Threshold Limit Values and Biological Exposure Indices (or most current). The table shows the cooling power of wind on exposed flesh. If there is a wind, use the wind speed in the first column and the actual temperature across the top to find what the equivalent temperature would be under calm conditions.

Estimated wind speed (in mph)	**Actual temperature reading** (degrees Fahrenheit)											
	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
	Equivalent chill temperature (degrees Fahrenheit)											
Calm	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68
10	40	28	16	4	-9	-24	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-32	-45	-58	-72	-85	-99	-112
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-121
25	30	16	0	-15	-29	-44	-59	-74	-88	-104	-118	-133
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-125	-140
35	27	11	-4	-20	-35	-51	-67	-82	-98	-113	-129	-145
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116	-132	-148
Wind speeds greater than 40 mph have little additional effect	**LITTLE DANGER** In < 1 hour with dry skin. Maximum danger of false sense of security.				**INCREASING DANGER** Danger from freezing of exposed flesh within one minute.				**GREAT DANGER** Flesh may freeze within 30 seconds.			
	Trench foot and Immersion foot may occur at any point on this chart.											

Note: Equivalent chill temperature requiring dry clothing to maintain core body temperature above 36 C (96.8 F) per cold stress TLV.

TABLE 2
TWO OF THE MOST COMMON COLD STRESS CONDITIONS

Condition	Causes	Signs and Symptoms	Treatment
Frostbite	Freezing of body tissue, usually the nose, ears, chin, cheeks, fingers, or toes	• Pain in affected area that later goes away • Area feels cold and numb • Incipient frostbite (frostnip) - skin is blanched or whitened and feels hard on the surface • Moderate frostbite - large blisters • Deep frostbite - tissues are cold, pale, and hard	• Move affected worker to a warm area • Immerse affected body part in warm (100 to 105 °F) water—not hot! • Handle affected area gently; do not rub • After warming, bandage loosely and seek immediate medical treatment
Hypothermia	Exposure to freezing or rapidly dropping temperatures	• Shivering, dizziness, numbness, weakness, impaired judgment, and impaired vision • Apathy, listlessness, or sleepiness • Loss of consciousness • Decreased pulse and breathing rates • Death	• Immediately move affected person to warm area • Remove all wet clothing and redress with loose, dry clothes • Provide warm, sweet drinks or soup (only if conscious) • Seek immediate medical treatment

TABLE 3
WORK/WARM-UP SCHEDULE FOR A 4-HOUR SHIFT

A WORK/WARM-UP SCHEDULE IS AN EXAMPLE OF AN ADMINISTRATIVE CONTROL. THE ACGIH STANDARD CONTAINS A WORK/WARM-UP SCHEDULE FOR A 4-HOUR SHIFT FOR WORKERS WHO ARE PROPERLY CLOTHED.

Table 3 TLVs Work/Warm-up Schedule for Outside Workers based on a Four-Hour Shift*

Air Temperature - Sunny Sky		**No Noticeable Wind**		**5 mph Wind**		**10 mph Wind**		**15 mph Wind**		**20 mph Wind**	
°F (approx)	°C (approx)	Max. work Period	No. of Breaks**	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks
-15° to -19°	-26° to -28°	(Norm breaks) 1		(Norm breaks) 1		75 min.	2	55 min.	3	40 min.	4
-20° to -24°	-29° to -31°	(Norm breaks) 1		75 min.	2	55 min.	3	40 min.	4	30 min.	5
-25° to -29°	-32° to -34°	75 min.	2	55 min.	3	40 min.	4	30 min.	5	Non-emergency work should cease	
-30° to -34°	-35° to -37°	55 min.	3	40 min.	4	30 min.	5	Non-emergency work should cease			
-35° to -39°	-38° to -39°	40 min.	4	30 min.	5	Non-emergency work should cease					
-40° to -44°	-40° to -42°	30 min.	5	Non-emergency work should cease							
-45° & below	-43° & below	Non-emergency work should cease									

Notes:
1. Schedule applies to moderate to heavy work activity with warm-up breaks of ten (10) minutes in a warm location. For light-to-moderate work (limited physical movement): apply the schedule one step lower. For example, at -35°C (-30°F) with no noticeable wind (step 4), a worker at a job with little physical movement should have a maximum work period of 40 minutes with four breaks in a 4-hour period (step 5).

2. The following is suggested as a guide for estimating wind velocity if accurate information is not available: 5 mph: light flag moves; 10 mph: light flag fully extended; 15 mph: raises newspaper sheet; 20 mph: blowing and drifting snow.

3. If only the wind chill cooling rate is available, a rough rule of thumb for applying it rather than the temperature and wind velocity factors given above would be: (1) special warm-up breaks should be initiated at a wind chill cooling rate of about 1,750 W/m2; (2) all non-emergency work should have ceased at or below a wind chill of 2,250 W/m2. In general, the warm-up schedule provided above slightly under-compensates for the wind at the warmer temperatures, assuming acclimatization and clothing appropriate for winter work. On the other hand, the chart slightly over-compensates for the actual temperatures in the colder ranges, since windy conditions rarely prevail at extremely low temperatures.

4. TLVs apply only for workers in dry clothing.

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Biological hazards, or "biohazards," include plants, animals or their products, and parasitic or infectious agents that may present potential risks to worker health. This safe work practice (SWP) discusses procedures for working with biohazards, preventive guidelines, and first-aid procedures for the most common hazards field staff are likely to encounter. This SWP does not address biohazards such as those associated with medical waste. Procedures for working with this type of biohazard should be addressed in the site-specific health and safety plan (HASP), construction health and safety plan (C-HASP), job safety analyses (JSAs), activity hazard analyses (AHAs), or other health and safety project planning documents on a case-by-case basis.

During preparation for site work, the document preparer should consider which plants, animals, and other biological agents may be encountered; assess their potential risk to project personnel; and attach this SWP to the document if necessary. Office health and safety representatives should become familiar with biological hazards indigenous to the geographical area in which most of their office personnel work and assist in evaluating the risks to personnel on projects staffed from their offices. SWPs for insects, snakes, animals, plants, waterborne pathogens (giardia), and hantavirus are provided below.

1.0 INSECTS

SWPs for reducing the chance of insect bites or stings and for treating bites or stings are listed below.

- Workers should keep as much skin area covered as possible by wearing long-sleeved shirts, long pants, and a hat. Pant legs should be tucked into socks or boots and shirts into pants. In addition, workers should wear light colored clothing.
- A proven insect repellent should be used on bare skin and clothing.
- When possible, tall grasses and brush that could harbor ticks should be avoided.
- Several times during the day and at the end of the work day, each worker should perform a check for evidence of imbedded ticks or previous bites. Particular attention should be paid to the scalp, neck, ankles, back of the legs, and waist.

- When opening well covers, vaults, or other closed items, workers should watch for hornet or wasp nests and black widow or brown recluse spiders. Workers should never reach into spaces with unprotected arms.

- Workers should watch carefully for bees around open soft drinks or food.

- If a worker is stung by a bee, the stinger should be carefully removed, if present. The wound should be washed and a cold pack applied. Allergic reaction should be watched for and is evidenced by extreme swelling, redness, pain, or difficulty breathing.

- If a worker is stung or bit by a spider or scorpion, medical attention should be obtained immediately.

2.0 SNAKES

SWPs for encounters with snakes and for treating snakebites are listed below.

- Workers should avoid walking in areas known to harbor snakes. Workers should be cautious when picking up or moving items that have been on the ground.

- Workers should wear boots made of heavy material that protect the ankles and pants. Heavy work gloves should be worn for picking up items.

- If one snake is encountered, others may be present. Workers should leave the area by retracing their steps.

- If a worker is bitten, the wound should be washed and the injured area immobilized and kept lower than the heart, if possible. Ice or a tourniquet should not be applied to a snake bite. The wound should not be cut. If medical care is more than 30 minutes away from a work site, a snakebite kit should be available on site and workers should know how to use it.

3.0 ANIMALS

SWPs for encounters with animals and for treating associated wounds are listed below.

- If workers encounter a wild animal, the animal should be observed for unusual behavior such as a nocturnal animal out during the day, drooling, an appearance of partial paralysis, irritability, meanness, or a strangely quiet demeanor.

- Workers should never touch the body of a dead animal because certain diseases could be carried by fleas still on the body.

- Workers should avoid animal droppings (including bird droppings). Pathogens, some of which can become airborne, may still be present in the droppings.

- If a worker is bitten, he or she should get away from the animal to avoid further bites. Workers should not try to stop, hold, or catch the animal.

- If the wound is minor, it should be washed with soap and water. Any bleeding should then be controlled, and an antibiotic ointment and dressing should be applied. All animal bite wounds should be watched for signs of infection.

- If the wound is bleeding seriously, the bleeding should be controlled but the wound should not be cleaned. Medical assistance should be summoned immediately.

- If a rabid animal is suspected, immediate medical attention should be summoned. If possible, workers should try to remember what the rabid animal looked like and the area in which it was last seen. The animal should be reported by calling the local emergency number.

4.0 PLANTS

SWPs for plants are as follows:

- Workers should be aware of the types and appearances of poisonous plants in the work site area. Poison ivy, oak, and sumac are the most frequently encountered plants that can cause reaction from casual contact. If a worker is extremely sensitive to these plants, he or she should avoid the area entirely because airborne drift could be sufficient to cause a reaction. Other plants, such as fireweed, can cause painful, short-term irritation and should be avoided as well. Workers should avoid touching face and eye areas after contact with any suspicious plant.

- Workers should wear proper clothing if working in or near overgrown areas. Disposable outerwear should be used, if necessary, and workers should not touch the material with bare hands during removal if the outerwear may have contacted poisonous plants.

- If contact with a poisonous plant has occurred, the affected area should be immediately washed thoroughly with soap and water. If a rash or weeping sore has already begun to develop, a paste of baking soda and water should be applied to the area several times a day to reduce discomfort. Lotions such as Calamine or Caladryl should be applied to help soothe the area. If the condition gets worse and affects large areas of the body or the face, a doctor should be consulted.

- Bushy and wooded areas should be thoroughly checked for thorn-bearing trees, brush, and bramble. In some cases, impalement can cause severe pain or infection.

5.0 WATERBORNE PATHOGENS-GIARDIA

Giardia is a waterborne pathogen consisting of a protoplasmic parasite of the mammalian digestive tract. Giardia is present worldwide, with the highest occurrence in areas with poor sanitation. In the United States, most reported cases are in mountainous regions where drinking water is obtained from streams and is unfiltered or untreated.

Giardia is contracted by ingesting water contaminated with giardia cysts in the dormant state. Giardia parasites can only thrive in the digestive tracts of mammals. Dormant giardia organisms enter water through the feces of infected animals or humans. Giardia symptoms include severe diarrhea and upset stomach. Some people are asymptomatic but can transmit the disease to others. Medical treatment of giardia can be difficult and unpleasant; therefore, prevention is critical. Precautions for preventing exposure to giardia are listed below.

- Workers should assume that all fresh water streams are infected with the giardia organism and not drink any <u>untreated</u> water.

- Team members collecting sediment and water samples from streams should wash their hands thoroughly with soap and water after collecting the samples.

- Giardia parasites are relatively easy to destroy or filter. Water should be treated for drinking or cooking with iodine or another recommended giardia treatment before use.

6.0 HANTAVIRUS

Hantavirus pulmonary syndrome (HPS) is a potentially fatal infection caused by a rodent-borne hantavirus. HPS begins with a brief illness most commonly characterized by fever, muscle pain, headache, coughing, and nausea or vomiting. Other early symptoms include chills, diarrhea, shortness of breath, abdominal pain, and dizziness. In the first identified cases of HPS, this stage of the infection lasted 2 to 5 days before victims were hospitalized. Typically, by the time of hospitalization, victims were found to have tachycardia (a heart rate of greater than 100 beats per minute) and tachypnea (a breathing rate of greater than 20 breaths per minute). Fever was also common. In most cases, death occurred within 2 to 16 days of the onset of symptoms, and victims exhibited pulmonary edema and severe hypotension.

Currently, experts believe that HPS is spread by the deer mouse (*Peromyscus maniculatus*). Though the deer mouse has been found to be the primary host of hantavirus, several other rodent species have also tested positive for the virus. Pinon mice (*Peromyscus truei*), brush mice (*Peromyscus boylii*), and western chipmunks (*Tamia spp.*) are also likely to carry the virus. Also, cases of HPS have been reported in areas of the United States where these particular rodents are not indigenous.

Infected rodents shed the virus in their urine, feces, and saliva. Humans can be exposed to the virus through (1) inhalation of suspended rodent excreta or dust particles containing rodent excreta, (2) introduction of rodent excreta into the eyes or broken skin, and (3) ingestion of food or water contaminated by rodent excreta. HPS has a reported mortality rate of 55 percent. Transmission of hantavirus from infected individuals to healthy persons has not been documented.

Prevention of HPS infection is essential because no known antidote and no specific treatment exists for treating HPS. Therefore, employees should practice risk reduction and control measures. Guidelines for workers in locations that may have rodent infestations or habitats are listed below.

- The best approach for HPS control and prevention is through environmental hygiene practices that deter rodents from colonizing the work environment.

- Information about the symptoms of HPS and detailed guidance on preventive measures should be provided to all employees assigned to field activities.

- Medical attention should be sought immediately for workers who develop a febrile or respiratory illness within 45 days of the last potential exposure to rodents. Attending physicians should be advised of each worker's potential for occupational exposure to hantavirus. Physicians should contact local health authorities promptly if hantavirus-associated illness is suspected. A blood sample should be obtained from the affected worker and forwarded with the baseline serum sample through the state health department to the Centers for Disease Control and Prevention for hantavirus antibody testing.

- Respiratory protective equipment should be worn when handling rodents, when removing rodents from traps, and when working in areas with evidence of rodent droppings or hair. Respiratory protective equipment should include, at a minimum, a half-face air-purifying respirator (APR) or powered APR equipped with a high-efficiency particulate air (HEPA) filter (P100). Full-face regulators may be needed under some circumstances. Respiratory protective equipment should be used in accordance with Occupational Safety and Health Administration regulations.

- Dermal protection should be worn when handling rodents or traps containing rodents, or if contact with contaminated surfaces could occur. Dermal protection should include rubber or plastic gloves that should be washed and disinfected before removal.

- A trap contaminated with rodent urine or feces or in which a rodent was captured should be disinfected with a commercial disinfectant or a 0.4 percent bleach solution. A dead rodent should be disposed of by placing the carcass in a plastic bag containing enough general-purpose household disinfectant to thoroughly wet the carcass. The bag should be sealed and disposed of by burning or by burying it in a 2- to 3-foot-deep hole. Local and state health departments can also provide appropriate disposal methods.

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1.0 PURPOSE

Numerous types of injuries can result from unsafe or improper handling and storing of materials. Workers should be able to recognize the methods for eliminating—or at least minimizing—the occurrence of such incidents. Employers and employees should examine their workplaces to detect any unsafe or unhealthful conditions, practices, or equipment and take corrective action.

This Health and Safety Safe Work Practice (SWP) describes the potential hazards of handling materials and provides information on training, education, and applying general safety principles that will help reduce workplace accidents involving moving, handling, and storing of materials.

2.0 POTENTIAL HAZARDS FOR WORKERS

Workers frequently cite the weight and bulkiness of objects that they lift as major contributing factors to their injuries. Bending, twisting, and turning were the more commonly cited movements that caused back injuries. Other hazards include falling objects, improperly stacked materials, and the potential for injury from the use of various types of equipment.

Potential injuries that can occur when manually moving materials include:

- Strains and sprains from lifting loads improperly or from carrying loads that are too large or too heavy.
- Fractures and bruises caused by being struck by materials or by being caught in pinch points.
- Cuts and bruises caused by falling materials that have been improperly stored or by incorrectly cutting ties or other securing devices.

In addition, mechanical handling equipment operation can present hazards. Refer to the Tetra Tech Health and Safety Safe Work Practices (SWP) 05-45; Forklift Safety and SWP 05-37 Critical Lift Safe Practices for information on the training components and safe work practices for operating forklifts and working around cranes.

3.0 PRECAUTIONS WHEN MOVING, STACKING AND WORKING WITH STORED MATERIALS

This section describes the precautions workers should take when manually or mechanically moving materials, when stacking materials, and when working with stored materials. In addition, a number of material handling tools are posted online in the toolkit section including 1) Body Strain Risk Worksheet, 2) Back Checklist – Lifting and Material Handling Guide, and 3) Strain Prevention Behavior Checklist. For critical lifts requiring rigging refer to the Tt SWP 05-37; Critical Lifts.

3.1 Moving Materials Manually

Proper lifting technique is critical to back safety, but proper planning may be even more important. Before you lift that box, tool, or piece of equipment, take a moment to consider your action:

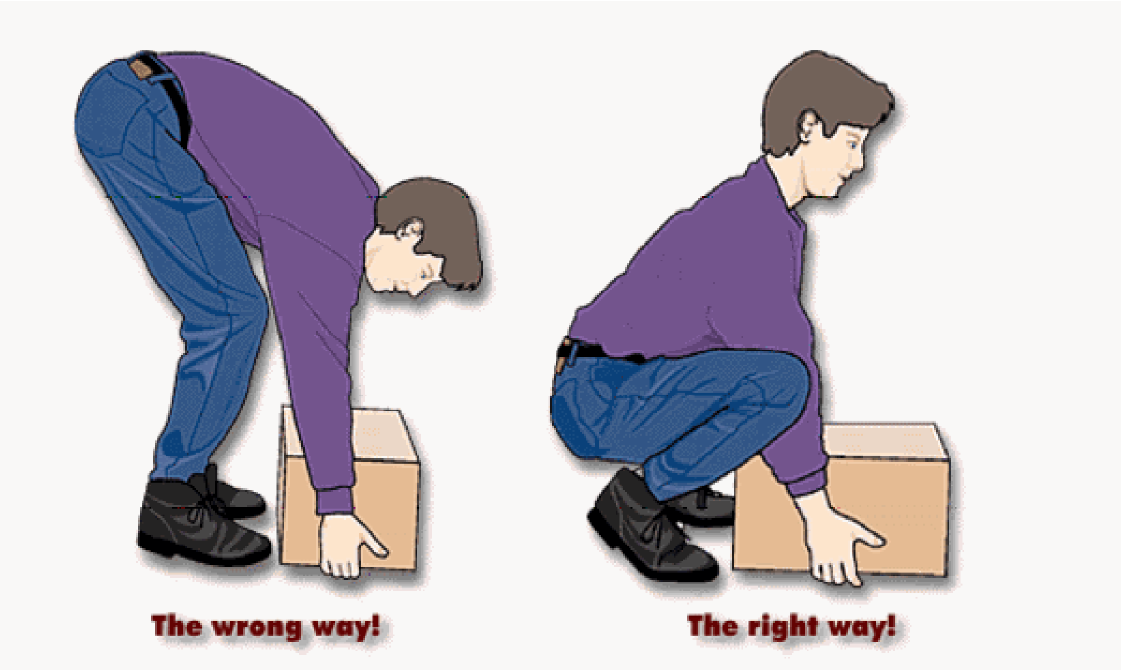
- Do you need to lift the item manually?
- How heavy is it?
- Where are you moving the item?
- Where does it have to go?
- What route do you have to follow?

Workers should always wear appropriate personal protective equipment (e.g., gloves, eye protection, steel-toed safety shoes or boots) and use proper lifting techniques when manually moving materials.

3.1.1 Proper Lifting Technique

- Wear shoes with non-slip soles.
- Clear a space around the object.
- Check your route. Make sure that the floors are not slippery and that there are no obstacles to maneuver around.
- Stand close to the object. Keep your feet apart, staggered if possible.
- Keeping your back upright, lower your body by bending your knees.
- Grip the object firmly.
- Tighten your abdominal muscles.
- Lift with a straight back, pushing with your legs for strength. Keep your head up and look straight ahead.
- Do not hold your breath.
- If you must turn - turn with your feet and your ENTIRE body. Never jerk or twist!
- Hold the object close to your body.
- Make sure you can see over the object.
- Lift and lower the load slowly and smoothly.
- Do not rely on a belt.

- If unsure about technique or weight of the object, ask for help
- If at anytime during lifting there are signs of discomfort or a problem, set down the load and get help.



3.1.2 Workers should seek help to lift items in the following circumstances:

- When a load is too heavy.
- When a load is so bulky that they cannot properly grasp or lift it.
- When they cannot see around or over a load.
- When they cannot safely handle a load.

3.1.3 Follow these procedures to prevent injury from oversize loads:

- Always practice safe lifting techniques
- Position yourself as close to the load as possible when moving an item from a hard-to-reach place. Slide it out to get it closer, and be sure that you have adequate room for your hands and arms.
- Provide sufficient headroom under overhead installations, lights, pipes, and sprinkler systems.

- Be aware of adjacent obstructions, on either side or above the load. Think about where the item will be placed once you've lifted it. Will it be overhead? Under an overhang? In a narrow spot?
- Allow as much room as possible to set the load down. You can always shift it slightly later.
- Check your path from place to place. Remove tripping hazards.
- Make sure that the lighting is sufficient to see where you are going. Stabilize uneven or loose ground, or choose an alternate route. The shortest way isn't always the fastest, or the safest.
- When loading or unloading equipment or materials from a pickup truck, always do so from the back end with the tailgate down. Do not lift anything over the sides of the bed and never stand on the tires to gain access.
- When possible, attach handles or holders to loads and use blocking materials to manage loads safely. When placing blocks under a raised load, be sure that the load is not released before you can remove your hands from under the load. Blocking materials and timbers should be large and strong enough to support the load safely. Do not use materials with rounded corners, cracks, splintered pieces, or dry rot.
    - Handle only stable or safely arranged loads.
    - When using mechanical help, remember to push, not pull – you'll have more control and greater leverage.
    - Fasten the load to the equipment so sudden stops or vibrations don't jar it off.

3.2 Moving Materials Mechanically

Use mechanical help – a dolly, hand truck, or forklift – wherever possible. However, keep in mind that using mechanical equipment to move and store materials may increase the potential for employee injuries due to hazards associated with the equipment being used. Follow these general safety rules.

- Let the weight, size, and shape of the material being moved dictate the type of equipment used. All materials-handling equipment has rated capacities indicating the maximum weight the equipment can safely carry and the conditions under which it can handle the weight. The department or project manager must ensure that the capacity is displayed on each piece of equipment and that it is not exceeded.
- Do not place extra weight on the rear of a counterbalanced forklift to allow an overload.

- Center the load on the platform as close to the support as possible to minimize the potential for tipping over or the load to fall.
- Adjust the load to the lowest position when traveling.
- Follow the equipment manufacturer's operational requirements.

3.3 Stacking Materials

Stacking materials can be dangerous if workers do not follow safety guidelines. Falling materials and collapsing loads can crush or pin workers, causing injury or death. To help prevent injuries, follow these general safety rules:

- Consider the need for availability of the material.
- Paint walls or posts with stripes for quick reference of the maximum stacking heights.
- Ensure that stacks are stable and self-supporting.
- Stack bags and bundles in interlocking rows to keep them secure.
- Step back the layers and cross-key bags at least every 10 layers. To remove bags from the stack, start from the top row first.
- Band or secure boxed materials with crossties or shrink plastic fiber.
- Do not store pipes and bars in racks that face main aisles, where it may create a hazard to passersby when supplies are removed.

3.4 Avoiding Storage Hazards

Workers must be aware of the height and weight of stored materials, their accessibility, and the condition of the containers where the materials are being stored. To prevent creating hazards when storing materials, the following guidelines should be used:

- Keep storage areas free from materials that could cause tripping, fires, explosions, or that may harbor rats or other pests.
- Place stored materials inside buildings that are under construction and at least 6 feet from hoist ways, or inside floor openings and at least 10 feet away from exterior walls.
- Separate materials that are not compatible (refer to SWP 05-13; Flammable Hazards and Ignition Sources).

4.0 OTHER IMPORTANT SAFETY MEASURES

Injuries from handling and storing materials may be reduced by adopting sound ergonomics practices, taking general fire safety precautions, keeping aisles and passageways clear and using ladders safely. Managers are expected to periodically evaluate current work station configurations and employees' work techniques to assess the potential for and prevention of injuries. Injuries caused by improper lifting will be inviestigated in accordance with Tetra Tech DCN 02-02 Incident Reporting and Investigation Program. Investigatvive findings will be incorporated into work procedures to avoid future injuries. The following general guidelines are provided to aid managers and workers in these areas.

4.1 Ergonomics

Ergonomics (the study of work) is based on the principle that the job should be adapted to fit the person rather than forcing the person to fit the job. Workplace conditions should be restructured or changed to make the job easier and reduce stressors that cause musculoskeletal disorders. Ergonomic principles may require reducing the size or weight of the objects lifted, installing a mechanical lifting aid, or changing the height of a pallet or shelf. Although no lifting approach completely eliminates back injuries, a substantial number of injuries can be prevented by implementing sound ergonomic practices and by training employees in appropriate lifting techniques.

Not all back injuries are a result of sudden trauma; most are of a cumulative type, where a repeated minor injury has flared up, continued use of a heavy tool in the same position has caused pain, or a great deal of time is spent in the same position.

4.2 Fire Safety

Flammable and combustible materials must be stored according to their fire characteristics. Flammable liquids, for example, must be separated from other material by a firewall. Other combustibles must be stored in an area where smoking and using an open flame or spark-producing device is prohibited. Dissimilar materials that are dangerous when they come into contact with each other must be stored apart.

4.3 Aisles and Passageways

Allow sufficient clearance of aisles at loading docks, through doorways, at turning points, and in other parts of the workplace when mechanically moving materials. Providing sufficient clearance will prevent workers from being pinned between the equipment and fixtures, such as walls, racks, posts, or other machines. Sufficient clearance will also prevent the load from striking an obstruction and falling on an employee.

Ensure that passageways remain clear of obstructions and tripping hazards. Do not store materials in excess of supplies needed for immediate operations in aisles or passageways.

5.0 TRAINING AND EDUCATION

OSHA recommends that employers establish a formal training program to teach workers to recognize and avoid materials handling hazards. Training of Tt personnel on this topic will be implemented through the issuance of this SWP and periodic discussion of the topic during monthly health and safety meetings, as well as during pre-project and tailgate safety meetings. The training should reduce workplace hazards by emphasizing the following factors:

- Avoidance of unnecessary physical stress and strain.
- Awareness of what a worker can comfortably handle without undue strain.
- Proper use of equipment.
- Recognition of potential hazards and how to prevent or correct them.
- Prevention of back injuries

Prevention of back injuries should receive special emphasis because of the high incidence of back injuries. Training on proper lifting techniques should cover the following topics:

- Health risks of improper lifting vs. the benefits of proper lifting.
- Body strengths and weaknesses and determining one's own lifting capacity.
- Physical factors that might contribute to an accident.
- Safe postures and timing for smooth, easy lifting.
- Warning signals from your body to watch for when lifting.

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By far, the most common cause of skin cancer is overexposure to the sun. Ninety percent of all skin cancers occur on parts of the body that not usually covered by clothing. People who sunburn easily, and those with fair skin and red or blond hair are more prone to develop skin cancer. The amount of time spent in the sun also affects a person's risk of skin cancer. Premature aging of the skin also occurs with prolonged sun exposure. Tetra Tech encourages personnel to avoid prolonged exposure to the sun, and recommends the following:

- Sunburn can occur during any time of the year. To avoid sunburn, wear hats with wide brims.
- Use sunscreen with a Sun Protective Factor (SPF) rating of 15 or higher.
- To prevent skin cancer:
    - Cover up with a wide brimmed hat and a bandanna for your neck. Wear long-sleeved shirts and pants which the sun cannot penetrate.
    - Use sunscreens to help prevent skin cancer as well as premature aging of your skin. Use a Sun Protective Factor (SPF) rating of 15 or higher.
    - Apply sunscreen at least an hour before going into the sun and again after swimming or perspiring a lot.
    - Do not use indoor sun lamps, tanning salons/parlors, or tanning pills.
- You can still get burned on a cloudy day. Try to stay out of the direct sun at midday, because sun rays are their strongest between 10 a.m. and 3 p.m. Beware of high altitudes - where there is less atmosphere to filter out the ultraviolet rays. Skiers should remember that snow reflects the sun's rays, too.
- Know your skin. Whatever your skin type, do a monthly self-examination of your skin to note any moles, blemishes or birthmarks. Check them once a month and if you notice any changes in size, shape or color, or if a sore does not heal, see your physician without delay.

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This safe work practice (SWP) provides guidelines for proper and thorough cleaning of respiratory protection equipment. The Occupational Safety and Health Administration (OSHA) regulates the use of respiratory protection for general industry in Title 29 of the *Code of Federal Regulations* (CFR) Part 1910.134, "Respiratory Protection." Appendix B-2 of the standard outlines mandatory requirements for respirator cleaning and is used as the basis for this SWP. This SWP supplements Document Control Number (DCN) 2-6, "Respiratory Protection Program." It provides specific respirator cleaning and disinfection procedures and shall be included as an attachment to the site-specific health and safety plan for projects for which respirator use is planned or is a contingency.

1.0 APPLICABILITY

This SWP shall apply to any project that involves use of respirators with reusable facepieces.

Respirators shall be cleaned and disinfected as discussed below.

- Respirators issued for the exclusive use of an employee shall be cleaned and disinfected as often as necessary to be maintained in a sanitary condition.
- Respirators issued to more than one employee shall be cleaned and disinfected before being worn by different individuals.
- Respirators maintained for emergency use shall be cleaned and disinfected after each use.
- Respirators used in fit testing and training shall be cleaned and disinfected after each use.

2.0 CLEANING AND DISINFECTION PROCEDURES

Mandatory respirator cleaning procedures as defined in 29 CFR Part 1910.134, Appendix B-2, are listed below. All wash and rinse water should be warm, with a maximum temperature of 110 °F (43 °C).

1. Remove filters, cartridges, or canisters. Disassemble facepieces by removing speaking diaphragms, demand and pressure-demand valve assemblies, hoses, and any other components as recommended by the manufacturer. Discard or repair any defective parts.

2. Wash components in warm water with a mild detergent or with a cleaner recommended by the manufacturer. A stiff bristle (not wire) brush may be used to facilitate the removal of dirt.

3. Rinse components thoroughly in clean, warm, preferably running water. Drain all components.

4. When the cleaner does not contain a disinfecting agent, respirator components should be immersed for 2 minutes in one of the following:

   - Hypochlorite solution [50 parts per million (ppm) of chlorine] made by adding approximately one milliliter of laundry bleach to 1 liter of warm water

   - Aqueous solution of iodine [50 ppm iodine made by adding approximately 0.8 milliliter of tincture of iodine (6 to 8 grams ammonium and/or potassium iodide per 100 cubic centimeters of 45 percent alcohol) to 1 liter of warm water]

   - Other commercially available cleansers of equivalent disinfectant quality when used as directed if their use is recommended or approved by the respirator manufacturer

5. Rinse components thoroughly in clean, warm, preferably running water. Drain all components. The importance of thorough rinsing cannot be over emphasized. Detergents or disinfectants that dry on facepieces may cause dermatitis. In addition, some disinfectants may cause deterioration of rubber or corrosion of metal parts if not completely removed.

6. Components should be air-dried or hand-dried with a clean, lint-free cloth.

7. Reassemble the facepiece. Replace filters, cartridges, and canisters prior to next use.

8. Test the respirator to ensure that all components work properly.

9. Place the respirator in a clean bag and seal for storage.

Depending on work conditions, respirator facial sealing surfaces may need periodic cleaning during the course of daily use. Cleaning of the facial sealing surface during work breaks can reduce the chance of facial irritation caused by sweat, natural skin oil, or irritating materials that may have deposited on the facepiece. Facial sealing surfaces can be cleaned using disinfectant wipes soaked in isopropyl alcohol or benzalkonium chloride. After use of the disinfectant wipe, the sealing surface should air dry or be dried thoroughly using paper towels or tissues.

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This safe work practice (SWP) was developed to ensure the proper use of respirators in routine and foreseeable emergency situations. The SWP supplements Document Control No. 2-6, "Respiratory Protection Program." This SWP shall be included as an attachment to the site-specific health and safety plan (HASP) for projects for which respirator use is planned or is a contingency.

1.0 APPLICABILITY

This SWP shall apply to any project that involves use of air purifying respirators and shall not be used for situations involving the use of supplied air systems such as self-contained breathing apparatuses and air-line apparatuses.

2.0 ROUTINE RESPIRATOR USE PROCEDURES

The procedures below apply to the routine use of air purifying respirators:

- Respirators shall not be issued to or worn by individuals when conditions prevent valve function or a good facial seal. These conditions may include but are not limited to facial hair, such as the growth of beard, sideburns, or excessive mustaches, and possibly the wearing of corrective eyeglasses.

- If spectacles, goggles, face shields, or welding helmets must be worn with a facepiece, they will be worn so as not to adversely affect the seal of the facepiece to the face.

- For all tight-fitting respirators, a positive and negative pressure seal check shall be performed each time the respirator is donned. Seal checks shall be performed as follow:

  – *Negative pressure check:* Close off the inlet opening of the canister or cartridge(s) by covering it with the palm of the hand(s), inhale gently so that the facepiece collapses slightly, and hold the breath for 10 seconds. If the facepiece remains in its slightly collapsed condition and no inward leakage of air is detected, the tightness of the respirator is satisfactory.

  – *Positive pressure check*: Close off the exhalation valve and exhale gently into the facepiece. The face fit is considered satisfactory if a slight positive pressure can be built up inside the facepiece without any evidence of outward leakage of air at the seal. The exhalation valve cover may have to be removed to perform this procedure.

  - *Manufacturer's recommended seal check*: If the respirator manufacturer recommends specific procedures for performing a user seal check, these procedures may be used instead of the negative and positive pressure checks.

- Work areas must be monitored for conditions that may adversely affect the effectiveness of respiratory protection. Employees may leave the work area where respirators are required under the following conditions:

  - To wash the face and respirator facepieces as necessary to prevent eye or skin irritation;
  - If vapor or gas breakthrough, changes in breathing resistance, or leakage of the facepiece is detected;
  - To replace the respirator or the filter, cartridge, or canister elements;
  - If established monitoring instrument action levels are exceeded; or
  - For any other criteria as established in a site-specific health and safety plan (HASP), construction health and safety plan (C-HASP), job hazard analysis (JHA), job safety analysis (JSA), work permit or other site-specific health and safety document.

3.0 RESPIRATOR USE DURING EMERGENCY SITUATIONS

Emergency situations may arise during the wearing of respiratory protection. These situations could include medical emergency, respirator failure, fire, chemical spills or leaks, and other events that pose an immediate risk. Procedures for respirator use during emergency situations are summarized below.

- When an emergency situation arises that creates or has the potential to create immediately dangerous to life and health (IDLH) conditions, the work environment shall be evacuated immediately and shall not be reentered by employees without suitable protective gear.

- Work environments with the potential for the development of atmospheres that may present IDLH conditions shall only be entered by employees using the buddy system.

- When an emergency situation arises that includes physical hazards that may interfere with the proper use of respiratory protection, the work environment shall be evacuated.

- Under no circumstances shall respirator users remove facepieces in hazardous atmospheres. In the event of respirator malfunction, users should leave the hazardous environment immediately and proceed to a known safe location before removal of the facepiece.

- Episodes of respirator failure shall be thoroughly investigated before work activities begin again. The investigation shall include re-evaluation of work area atmospheric conditions, review of the respirator selection criteria and service life calculations, and an evaluation of the working conditions under which respirator failure occurred.

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The safe work practice (SWP) addresses the need for proper and thorough procedures for qualitative fit testing of respirators. The Occupational Safety and Health Administration (OSHA) regulates general industrial use of respiratory protection under Title 29 of the *Code of Federal Regulations* (CFR), Part 1910.134. Appendix A of the standard outlines mandatory procedures to use for both qualitative fit tests (QLFT) and quantitative fit tests (QNFT). This SWP was written in accordance with the requirements of Appendix A for QLFTs. This SWP must be used in conjunction with the Tetra Tech, Inc. (Tetra Tech), "Respiratory Protection Program," Document Control Number (DCN) 2-6.

The following sections describe the SWP's applicability, qualifications of fit testers, and fit testing procedures for use during QLFTs.

1.0 APPLICABILITY

This SWP applies to all Tetra Tech employees who use respirators on the job and to employees who conduct any fit testing. In addition, when a Tetra Tech company or office uses an outside service to perform fit testing, the organization conducting the fit testing shall meet the minimum requirements for QLFT and QNFT procedures specified in Appendix A of the standard.

Respirator fit testing shall be conducted at the following intervals:

- Prior to initial use of a respirator;
- Whenever a different respirator facepiece (size, style, model, or make) is used;
- At least annually thereafter; or
- After any reported or observed changes in an employee's physical condition that could affect respirator fit. This includes but is not limited to, facial scarring, dental changes, cosmetic surgery, or an obvious change in body weight.

If an employee notices that the fit of a respirator has become unacceptable, he or she will be given an opportunity to select another respirator facepiece.

2.0 QUALIFICATION OF FIT TESTERS

Tetra Tech employees who conduct QLFTs must demonstrate sufficient understanding and expertise in the required testing procedures. Fit testers shall qualify through appropriate education, experience, or both. Qualifications of fit testers shall be determined on a case-by-case basis by operating unit health and safety managers (HSMs) based on the fit tester's demonstrated knowledge of OSHA-mandated fit test procedures and performance of a simulated fit test. The HSM must ensure that persons administering fit tests are able to prepare test solutions, calibrate and operate equipment, perform tests properly, recognize invalid tests, and ensure that test equipment is in proper working order. The fit tester must also demonstrate how to clean and maintain equipment to operate within the parameters for which it was designed.

3.0 FIT TESTING PROCEDURES

Appendix A of 29 CFR 1910.134 provides instruction for five OSHA-accepted QLFT procedures. Tetra Tech has selected two of these procedures for its fit-test program. The sections below describe general requirements that must be followed during all fit tests and for any fit test method used. The Both Bitrex™ QLFT protocol is discussed below.

3.1 General Requirements

QLFTs must be conducted in accordance with the general requirements discussed below.

- The test subject shall be shown how to put on a respirator, position it on the face, set strap tension, and determine an acceptable fit. A mirror shall be available to assist the subject in evaluating the fit and positioning the facepiece.
- The test subject must be allowed to choose from a sufficient selection of models and sizes to identify a respirator that fits correctly and is comfortable. The subject shall be informed that he or she is being asked to select the respirator that provides the most acceptable fit. The subject shall be asked to hold each chosen facepiece up to the face and eliminate those that obviously do not provide an acceptable fit.
- The subject shall don the most comfortable respirator and wear it for at least 5 minutes to assess comfort. If the subject is not familiar with a particular respirator, the subject shall be directed to don the mask several times and to adjust the straps each time to become adept at setting proper strap tension.
- The tester shall review the following points with the subject and allow the subject adequate time to determine the comfort of the respirator:
  - Position of the mask on the nose

- Room for eye protection
- Ability to talk
- Position of the mask on the face and cheeks

- The following criteria shall be used to help determine the adequacy of the respirator fit:
  - Chin properly placed
  - Adequate strap tension (not overly tight)
  - Fit across nose bridge
  - Proper size to span distance from nose to chin
  - Tendency of respirator to slip
  - Self-observation in a mirror to evaluate fit and respirator position

- The subject shall conduct a user seal check using the negative- and positive-pressure seal check procedures described in Appendix A of this SWP. Before conducting the check, the subject shall be instructed to seat the mask on the face by moving the head from side to side and up and down slowly while taking a few slow, deep breaths. If the seal checks fail, the subject shall choose another facepiece.

- Seal checks and fit testing shall not be conducted if there is any facial hair growth such as stubble beard growth, beard, mustache, or sideburns that interferes with the facepiece sealing surface. Any interfering apparel shall be altered or removed.

- If the subject experiences difficulty in breathing during testing, the testing shall stop immediately and he or she shall be referred to a company physician for assessment.

- If the subject finds the fit of the respirator unacceptable, the subject shall be given the opportunity to select a different respirator and to be retested.

- Prior to commencement of the fit test, the subject shall be given a written description of the respirator user seal check procedures (see Appendix A) and exercises to perform during the testing. Exercises and a prepared text to be read during the test are included in Appendix B of this SWP.

- All exercises in Appendix B must be performed for all QLFT methods.

3.2 BITREX™ Solution Qualitative Fit Test Protocol

Bitrex™ solution (denatonium benzoate) is a taste aversion agent. To conduct a QLFT using Bitrex™, the test subject must first pass a taste threshold screening. The entire procedure must be explained to the test subject before the screening is conducted. The sections below describe taste threshold screening and fit test procedures. Particulate filters (cartridges) are used during this test.

3.2.1 Taste Threshold Screening

The taste threshold screening is intended to determine whether the individual tested can detect the taste of Bitrex™. The procedures below shall be used for the taste screening.

- Prior to testing, the tester shall prepare a quantity of threshold check solution by adding 13.5 milligrams (mg) of Bitrex™ to 100 milliliters (mL) of 5 percent salt solution in distilled water. A nebulizer for taste screening shall be clearly marked to distinguish it from the fit test solution nebulizer. The taste screening nebulizer shall be thoroughly rinsed in water, shaken to dry, and refilled at least each morning and afternoon or at least every 4 hours.

- During the taste screening as well as during the fit testing, subjects shall wear an enclosure around the head and shoulders that is approximately 12 inches in diameter by 14 inches tall. The front portion of the enclosure shall be clear from the respirator and allow free movement of the head when a respirator is worn. An enclosure substantially similar to the 3M hood assembly, parts #14 and #15 combined, is adequate.

- The test enclosure shall have a 0.75-inch hole in front of the test subject's nose and month area to accommodate the nebulizer nozzle.

- The test subject shall don the test enclosure. Throughout the threshold screening test, the test subject shall breathe through his or her slightly open mouth with tongue extended. The subject is instructed to report when he or she detects a bitter taste.

- Using a DeVilbiss Model 40 Inhalation Medication Nebulizer or equivalent, the test conductor shall spray the threshold check solution into the enclosure. To produce the aerosol, the nebulizer bulb is firmly squeezed so that the bulb collapses completely. The bulb is then released and allowed to fully expand. Correct use of the nebulizer means that approximately 1 mL of liquid is used at a time in the nebulizer body.

- The nebulizer should be rapidly squeezed 10 times and then the test subject is asked whether the Bitrex™ solution can be tasted. If the subject reports tasting the bitter taste during the 10 squeezes, the screening test is complete. The taste threshold is noted as 10 regardless of the number of squeezes actually completed.
- If the first response is negative, the nebulizer is rapidly squeezed 10 more times and the test subject is again asked whether the Bitrex™ solution is tasted. If the test subject reports tasting the bitter taste during the second 10 squeezes, the screening test is completed. The taste threshold is noted as 20 regardless of the number of squeezes actually completed.
- If the second response is negative, the nebulizer is rapidly squeezed 10 more times and the test subject is again asked whether the Bitrex™ solution is tasted. If the test subject reports tasting the bitter taste during the third 10 squeezes, the screening test is completed. The taste threshold is noted as 30 regardless of the number of squeezes actually completed.
- If the Bitrex™ solution is not tasted after 30 squeezes, the test subject is unable to taste the Bitrex™ solution and cannot be fit tested using the Bitrex™ solution test.
- The tester will note the number of squeezes required to solicit a taste response. When a taste response has been elicited, the test subject shall be asked to note the taste for reference in the fit test.

3.2.2 Bitrex™ Solution Fit Test Procedures

The procedures below must be followed to conduct the actual Bitrex™ solution fit test:

- A fit test solution is prepared by adding 337.5 mg of Bitrex™ to 200 mL of a 5 percent salt solution in warm water. A second nebulizer dedicated to fit testing shall be clearly marked to distinguish it from the taste screening solution nebulizer. The nebulizer shall be thoroughly rinsed in water, shaken to dry, and refilled at least each morning and afternoon or at least every 4 hours.
- The test subject shall be instructed not to each, drink, smoke, or chew gum for 15 minutes before the test.

- The person being fit tested shall don the respirator without assistance and perform the required user seal check (see Appendix A).

- The fit test uses the same enclosure described for taste threshold screening in Section 3.2.1. The test subject shall don the enclosure while wearing the respirator selected as described in the general requirements in Section 3.1. The respirator shall be properly adjusted and equipped with particulate filter(s).

- As before, the test subject shall breathe through his or her slightly opened mouth with tongue extended, and shall be instructed to report is he or she tastes the bitter taste of Bitrex™

- The nebulizer is inserted into the hole in front of the enclosure, and an initial concentration of the fit test solution is sprayed into the enclosure using the same number of squeezes (either 10, 20, or 30) based on the number of squeezes required to elicit taste response noted during the screening test.

- After generating the aerosol, the test subject shall be instructed to perform the test exercises provided in Appendix B.

- Every 30 seconds, the aerosol concentration shall be replenished using one half the number of squeezes used initially (such as 5, 10, or 15).

- The test subject shall indicate to the tester if at any time during the fit test the taste of Bitrex™ solution is detected. If the test subject does not report tasting the Bitrex™ solution, the test is passed.

- If the taste of Bitrex™ solution is detected, the fit is deemed unsatisfactory and the test is failed. A different respirator shall be tried, and the entire test procedure (screening and test) is repeated.

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APPENDIX A

RESPIRATOR USER SEAL CHECK PROCEDURES

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RESPIRATOR USER SEAL CHECK PROCEDURE

Individuals using tight-fitting respirators must perform a user seal check each time a respirator is put on to ensure that an adequate seal is achieved. Two methods are available for use; one is the positive- and negative-pressure check and the other is the respirator manufacturer's method. Either the positive- and negative-pressure checks described below may be used or, if a manufacturer of a particular respirator brand has developed its own recommended seal check method, that method may be used in place of the negative- and positive-pressure seal checks. User seal checks are not a substitute for qualitative or quantitative fit tests. The user check procedures described below are as described in the mandatory Appendix B-1 of Title 29 of the *Code of Federal Regulations*, Part 1910.134.

- Positive-Pressure Check

  Close off the exhalation valve and exhale gently into the facepiece. The face fit is considered satisfactory if a slight positive pressure can be built up inside the facepiece without any evidence of outward leakage of air at the seal. For most respirators, this method of leak testing requires the wearer to first remove the exhalation valve cover before closing off the exhalation valve and then carefully replace it after the test.

- Negative-Pressure Check

  Close off the inlet opening(s) of the canister or cartridge(s) by covering the opening with the palm of the hand(s) or by replacing the filter seal(s). Inhale gently so that the facepiece collapses slightly, and hold the breath for 10 seconds. The inlet opening of some cartridges cannot be effectively covered with the palm of the hand. In this case, the test can be performed by covering the inlet opening of the cartridge with a thin latex or nitrile glove. If the facepiece remains in its slightly collapsed condition and no inward leakage of air is detected, the tightness of the respirator is considered satisfactory.

APPENDIX B

RESPIRATOR FIT TEST EXERCISES

RESPIRATOR FIT TEST EXERCISES

Test subjects shall perform the exercises below during fit test process. Prior to the actual fit test, the test subject shall (1) select a suitable and comfortable respirator; (2) don, adjust, and then wear the respirator for 5 minutes to assess comfort; (3) conduct a user seal check in accordance with the procedures outlined in Appendix A, (4) report any difficulties breathing while wearing the respirator, (5) select a different respirator if the fit and level of comfort is unacceptable, and (6) perform the fit test exercises described below in the order listed. The qualitative fit test (QLFT) shall be performed in a test environment.

Test Exercises

Each exercise below shall be conducted for 1 minute. During testing, the subject will be questioned and observed to determine if the respirator is comfortable. The respirator shall not be adjusted during the fit testing procedure. Any adjustment voids the test, and the test must be repeated from the beginning.

1. Normal breathing. In a normal standing position without talking, breathe normally.
2. Deep breathing. In a normal standing position, breathe slowly and deeply. Be careful not to hyperventilate.
3. Turning head from side to side. Standing in place, slowly turn the head from side to side between the extreme positions on each side. Hold the head at each extreme momentarily and inhale at each side.
4. Moving head up and down. Standing in place, slowly move the head up and down. Inhale in the up position (such as when looking toward the ceiling).
5. Talking. Talk out loud slowly and loud enough to be heard clearly by the fit tester. Read the entire "Rainbow Passage" on the next page.
6. Bending over. Bend at the waist as if to touch the toes.
7. Normal breathing. Complete the same exercise as item 1 above.

After these test exercises are completed, the tester shall ask the test subject about the comfort of the respirator. If the respirator is uncomfortable, another respirator shall be tried and the fit test, as well as user check and screening procedures, will be repeated.

RAINBOW PASSAGE

"When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. There is, according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. When a man looks for something beyond reach, his friends say he is looking for the pot of gold at the end of the rainbow."

Source: Appendix A of Title 29 of the *Code of Federal Regulations,* Part 1910.134

Work planning, hazard assessment, engineering and administrative controls are Tetra Tech's primary lines of defense to ensure our employees are not injured on the job. The use of Personal Protective Equipment (PPE) is the last line of defense that protects our employees and contractors from hazards, especially from the hazards associated with unplanned events.

Certain work environments pose an increased risk of flash fires. Wearing Flame Resistant Clothing (FRC) greatly reduces the extent and severity of injuries from these events. The following safe work practice (SWP) addresses FRC requirements when working on oil and gas sites. Flash fire hazards and controls associated with electrical work are discussed in electrical and personal protective equipment safe work practices (SWP 5-9 Safe Electrical Work Practices and DCN 2-7 Personal Protective Equipment).

A flash fire is one that spreads rapidly through a diffuse fuel, such as dust, gas, or vapors of an ignitable liquid, without the production of damaging pressure. The intensity of a flash fire depends on the size of the gas or vapor cloud. Hydrocarbon flash fires can generate temperatures greater than 1,000 degrees Fahrenheit, can last up to five seconds and result in severe burns and even death.

Flash fires require fuel, an ignition source and oxygen. Fuels include crude oil, distillates, gasoline, LPGs and condensates. Ignition sources may be electrical motors, tools, generators, hot work activities, and static electricity. These environmental conditions are present in oil and gas drilling, well servicing and production related operations, petrochemical plants and refineries and electric and gas utilities. FRC will be required for employees working in these areas.

Responsibilities

Responsibilities for this effective implementation of this SWP include:

Project Managers

Project managers are responsible to ensure that hazard assessment and controls have been identified, addressed and safe work process established. They are also responsible for conducting site-specific PPE hazards assessments, selecting the appropriate PPE and requiring its use. PMs must ensure that employees are properly trained on the selection, care and use of PPE and that sufficient resources are allocated to support compliance with site safety procedures.

Health and Safety

Health and safety personnel are responsible to provide technical guidance to project management on PPE procedures, and approving the site-specific PPE selection criteria developed in site-specific health and safety plans (HASPs), Construction Health and Safety Plans (C-HASPs), Job Hazard Analyses (JHAs), Job Safety Analysis (JSAs), work permits and other site specific health and safety documents. The site safety coordinator (SSC) will be appointed by the project manager to administer procedures for use of PPE at the project work site and ensure PPE is used as required on the site.

Employees

Employees are responsible for utilizing safe work practices and integrating health and safety elements into all aspects of their work including the proper use of assigned personal protective equipment at all times.

Oil and Gas Operations

FRC will be provided and required to be worn by employees supporting oil and gas projects involving drilling, well-serving and production-related operations. Note there may be additional tasks or operations on oil and gas projects that may present a flash burn hazard and require the use of FRC that are not discussed below. Any additional tasks must be evaluated to determine if flammable materials are present in quantities necessary to generate a flash fire.

Drilling Operations

Active drilling operations that have reached gas and hydrocarbon zones present the greatest potential for flash fires. Pressure from underground gas or hydrocarbons can kick well fluids up the hole and into work areas. FRC is not usually needed during initial rig up and normal drilling operations, however, prior to reaching active gas or hydrocarbon zones, appropriate FRC shall be worm by potentially exposed personnel working on the well site. The SSHO shall ensure that personnel are wearing FRC prior to reaching impacted drilling zones.

Appropriate FRC shall also be worn when there is a history of fluid or gas kicks from underground producing zones.

FRC shall be worn in conditions listed above until the final casing is cemented and the well is effectively closed.

Well Servicing Operations

Well servicing tasks also present flash fire risks. FRC shall also be worn during any of the following well servicing tasks:

- Fracturing or perforating a well;
- Open hole work;
- Pulling wet string tubing;
- Snubbing tubing;
- Swabbing operations;
- Using bridge plugs or packers;
- Flow testing, bowing down or venting a well;
- Plugging an abandoned well;
- Flowback operations;
- Cementing;
- Stimulation;
- Wireline operations; and,
- Any operation working with wellhead or wellbore under pressure

Production-Related Operations

The potential for flash fires also exists in oil and gas production-related activities, FRC will be provided and worn during production-related operations such as:

- Equipment Openings (e.g. line breaking or valve openings);
- Gauging;
- Transfer of hydrocarbons;
- Maintenance operations on production equipment;
- Hot work operations;
- Tank heating;
- Using open flame; and
- Start up operations.

FRC Selection

All purchased FRC will comply with the National Fire Protection Association (NFPA) 2112, Standard on Flame Resistant Garments for Protection of Industrial Personnel against Fire. FRC shall be provided at no cost to employees. In addition, the following factors shall be considered when selecting FRC:

- Thermal protective characteristics of the fabric;
- Physical characteristics of the fabric;
- Garment construction and components (for example pockets or types of closures);
- Avoidance of static discharge;
- Design of the garment ;
- Type of conditions under which the garment will be worn;

- Comfort properties of the fabric; and

- Cleaning and maintenance considerations.

FRC shall be selected so that it covers both the upper and lower body and flammable under layers as completely as possible.

FRC shall contain primary closure systems that function after exposure to flash fire hazard and that avoid meltable closure systems.

FRC shall have optional reflective stripes conform to the International Safety Equipment Association (ISEA) 107, Level 2

For optimum protection, FRC shall not be tight fitting and minimally interfere with the performance of the work tasks.

Certain synthetic fabrics can induce static electricity and pose a source of ignition in a flammable atmosphere. Clothing made from static-inducing fabrics, such as acetate, nylon, polyester and rayon should not be worn. Please note that nylon used in the blend of some FRC but it has been tested and approved by the manufacturer.

Use of FRC

Assigned FRC shall be used in accordance with the manufacturer's instructions and in the following manner:

- Collars shall be closed;

- Sleeves and cuffs are down;

- If warranted, head, hand and foot coverings shall be worn;

- Flame resistant or non-melting undergarments (closest to the skin) will be worn. Incidental amounts of elastic used in non-melting fabric underwear or socks are permitted; and,

- Employees shall not wear non-flame resistant clothing over flame resistant clothing. Note: FRC rain gear must be worn over FRC coveralls.

Maintenance of FRC

FRC should be kept clean and laundered in accordance with manufacturer's recommendations.

FRC contaminated by flammable substances, hazardous material or biological agents shall be cleaned and decontaminated in accordance with manufacturer's instructions. If decontamination instructions are not provided or if decontamination is not recommended for the specific contaminant and the contamination is judged to present a hazard, then contaminated FRC will be disposed of in accordance with applicable federal, state or other applicable regulations. Contaminated FRC shall not be laundered in public facilities.

Soiled FRC shall not be stored with personal belongings.

Employees shall inspect FRC following each use, cleaning and following any use where there was potential for damage or contamination.

Inspection shall include an examination of all components including if present, the outer shell lining, interlining, wind/moisture barrier, hardware, wristlets, seams zippers, buttons, and reinforcements.

Damaged or deteriorated FRC will be immediately removed from service. FRC will be retired when they exceed the manufacturer's stated service life.

Storage of FRC shall be in accordance with manufacturer's recommendations. FRC should not be stored in direct or indirect sunlight.

Training

All employees required to wear FRC shall receive training on the limitations, use, care and maintenance of flame resistant clothing including instructions and warnings provided by the manufacturer of the garment.

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1.0 PURPOSE

This program provides requirements for identification, location, and avoidance of underground utilities, appurtenances, and structures during intrusive activities. The program also addresses actions to be taken in response to encountering or contacting underground utilities.

2.0 SCOPE

These requirements are applicable to all Tetra Tech operations. The procedures address the requirements and recommendations for identifying and locating, working around, and encountering or contacting underground utilities.

3.0 MAINTENANCE

The Vice President, Corporate Health and Safety or designee is responsible for updating this procedure. Approval authority rests with Tetra Tech's Senior Vice President, Corporate Administration. Suggestions for revision shall be submitted to Corporate Administration department.

4.0 DEFINITIONS

4.1 Aggressive Methods

The use of mechanized equipment such as excavators, backhoes, drill rigs, directional drilling, road saws, etc. Non-Aggressive methods involve the use of manual or non-mechanized methods such as hand-digging with shovels and air/hydro/vacuum methods.

4.2 Buffer Zone

As defined in this procedure, the area around a utility where only non-aggressive excavation methods may be utilized, unless specific conditions are met.

The definition cited above, and the excavation requirements and restrictions associated with it, will vary depending on the particular state regulations. Tetra Tech requires the imposition of a four-foot

Buffer Zone on all sides of the utility as measured from the outside edges of the utility, both horizontally and vertically. Since most jurisdictions recognize Buffer Zones which vary somewhere in the range of 18 to 36 inches, this distance must be verified by consulting the applicable state regulations before excavating so that adjustments to surface markings can be made to achieve the required four-foot buffer zone.

Referred to as the "Tolerance Zone", "Safety Zone", or "Approximate Location of Underground Utilities" in some jurisdictions.

Information relative to excavation within the buffer zone is contained in Section 5.2.2.4.

4.3 Competent Person

A Competent Person has the ability to recognize hazards associated with underground utilities and the authority to stop or direct operations to ensure the safety of personnel and conformance with this procedure. The Competent Person has an understanding of this procedure, and the "One-Call" system requirements for the jurisdiction where excavation is occurring. The Competent Person must be capable of notifying One-Call agencies and maintaining and tracking One-Call Locate Numbers. Additionally, they must have knowledge of methods and work practices for utility identification, avoidance, and protection.

4.4 De-Energize

As applicable to a utility, to physically eliminate and/or prevent the presence, transmission, flow, or release of energy or materials which may cause harm to personnel or property.

4.5 Excavation

An operation for the purpose of movement or removal of earth, rock, or the materials in the ground, including but not limited to; digging, blasting, auguring, backfilling, test boring, drilling, pile driving, directional drilling, grading, plowing-in, hammering, pulling-in, jacking-in, trenching, tunneling, structural demolition, milling, scraping, tree and root removal (grubbing), fence or sign post installation. Tetra Tech requires that the designated One-Call agency for the applicable jurisdiction be contacted any time an intrusive activity is planned.

4.6 Jurisdiction

The authority having legal jurisdiction relative to regulations and requirements for notification of excavation activities and associated identification and marking. In the United States, the states have jurisdiction, and most consider the regulations applicable when excavation is to be performed in any location, including any public or private way, any company right-of-way or easement, or any public or privately owned land or way.

4.7 Locate

To indicate the existence of a utility by establishing a mark through the use of flags, pins, stakes, paint, or some other customary manner, that approximately determines the location of a line or facility.

4.8 Locate Request

A communication between an entity performing intrusive activities and a utility marking agency (One-Call, etc.).

4.9 Observer

The person assigned to visually monitor and, as needed, signal the operator during mechanized intrusive activity when the activity is occurring within four feet of the outside edge of the buffer zone. This person remains in close communication with the equipment operator(s) and will stop the activity if needed.

4.10 One-Call Agency

An entity that administers a system through which a person can notify owners/operators of underground lines or utilities of the intent to perform intrusive activities in proposed public areas.

4.11 Positive Response

Communication with the entity performing intrusive activities, prior to the activity, to ensure that all contacted (typically via the One-Call agency) owner/operators have located and marked the underground utilities.

4.12 Potholing

The practice of exposing an underground facility by safe, non-aggressive excavation methods in order to ascertain the precise horizontal and vertical position and orientation of underground lines or utilities.

4.13 Underground Utility

An underground or submerged conductor, pipe, or structure used in providing electric or communications service (including but not limited to, traffic control loops and similar underground or submerged devices), or an underground or submerged pipe used in carrying, providing, or gathering gas, oil or oil product, sewage, storm drainage, water or other liquid service (including, but not limited to, irrigation systems), and appurtenances thereto. As used in this procedure, utility includes all underground appurtenances and structures.

The following are examples of the types of underground utilities that may be present in a given location:

- Natural gas pipelines
- High voltage electric cables
- Water pipelines
- Fiber optic telecommunications lines
- Steam pipelines
- Gasoline, oil, or other fuels
- Sewer pipelines
- Hazardous Materials
- Underground Storage Tanks (USTs)
- Abandoned underground structures containing hazardous materials, hazardous wastes, and radioactive materials

Note: Electrical and pressurized mechanical underground utilities that are not energized shall be considered as applicable to the requirements of this procedure until they are disconnected and removed or protected by a lockout/tagout system approved by Tetra Tech (see Section 5.2.2.6)

4.14 Underground Utility Owner

Any person, utility, municipality, authority, political subdivision or other person or entity who owns, operates, or controls the operation of an underground line/facility.

4.15 White Lining

The practice whereby the entity which intends to perform intrusive activities pre-marks the site with an outline of the area where intrusive activities will occur. This involves the use of white paint, flags, stakes, or a combination thereof to mark the extent of where work is to be performed. The marking may vary depending on what intrusive activities are to be conducted. For example, for general excavation, an area outline of the excavation shall be marked, while for drilling, the individual boreholes shall be marked. Studies have shown that pre-marking is a practice that does prevent utility contact incidents.

5.0 DISCUSSION

5.1 Responsibilities

5.1.1 Competent Person

The Competent Person shall be responsible for:

- Obtaining a copy of, and understanding the applicable regulations for the state of jurisdiction where the excavation activities are to be performed.
- Contacting the appropriate One-Call agency or private locating service, as applicable.
- Recording One-Call locate numbers.
- If necessary, renewing One-Call locate numbers before expiration.
- Ensuring that white-lining of the area to be excavated is performed.

- Ensuring that a "positive response" has been received from every utility owner/operator identified by the One-Call agency and that they have located their underground utilities and have appropriately marked any potential conflicts with the areas of planned intrusive activities.
- Completion of the Ground Disturbance Permit (Excavation/Utility Locates) or equivalent.
- Reviewing applicable AHAs or other client specific requirements with all project members before work begins.
- Conducting training on communication protocols to be used by the excavation observer and equipment operator.
- Ensuring Implementation of appropriate work practices during intrusive activities (including maintaining the prescribed buffer zone for use of aggressive methods).
- Conducting daily inspections of the excavation area to make sure that all markings are intact.
- Maintaining required records.
- Providing the Project Manager or Site Supervisor with all required documentation on a daily basis.

5.1.2 Observer

Whenever intrusive operations with mechanized equipment are being conducted within four feet of the outside edge of the buffer zone, horizontally and vertically, an observer must be assigned to monitor the activities. The observer is responsible for:

- Observing the operation to ensure that the operator stops operations if utilities are observed.
- Reviewing hand signals and other forms of communication with the operator.
- Properly signaling the operator.

- Stopping the operation immediately if the observer's attention must be diverted even momentarily.
- Stopping the operation immediately if a hand signal or other directive is not followed. Operations will not resume until the observer and operator mutually agree that the reason(s) for not complying with the directive(s) are/is identified and fully corrected.
- Maintaining required records, such as logbook entries, or other, as requested by line management.

5.1.3 Line Management

The Project Manager (PM) shall be responsible for:

- Ensuring compliance with this procedure.
- Providing the necessary resources for compliance with this procedure.
- Designating Competent Personnel in consultation with the Site Safety Coordinator prior to the start of work.

5.1.4 Site Safety Coordinator

The Site Safety Coordinator (SSC) shall be responsible for:

- Providing oversight on the implementation of the requirements contained in this procedure.
- Consulting with the PM and Competent Person on underground utility issues.

5.2 Procedure

The following sections provide the requirements and recommendations of this procedure, which are intended to prevent injury to personnel, damage to infrastructure, and associated indirect effects associated with encountering or contacting underground utilities during the execution of intrusive work. Underground utilities present multiple potential hazards that must be recognized before and during work which occurs near them, therefore, this procedure is divided into sections addressing underground utility identification and location, working around or near underground utilities, and actions to be taken in the event that underground utilities are encountered or contacted. Hazards that may be presented by underground utilities include explosion and fire, electrocution, toxic exposures, pathogens, and drowning.

5.2.1 Identifying and Locating Underground Utilities

The possibility of the existence of underground utilities must be evaluated as early as possible in the planning phase for any project which involves intrusive activities. The Project Safety Checklist or equivalent should be used for documentation of the identification of this potential hazard and the procedures to be followed to address them. The following sections describe various methods for identifying and locating utilities on a site. Plans should be verified during the readiness review. The Ground Disturbance Permit (Excavations/Utility Locate) or equivalent must be completed before any activities meeting the definition of excavation are conducted. This document is intended to be used as a guide during the process of locating and marking utilities in the area and in the overall process of underground utilities management during the course of the project.

All underground utilities on a site involving excavation, must be located and identified before intrusive activities commence, by one or more of the following entities:

- The Utility Owner
- A Private or Public Utility Locating Service
- An Approved Tetra Tech Competent Person

These options are described in greater detail in the following Sub-Sections:

5.2.1.1 Pre-Planning and the Site Specific Health and Safety Plan

The Site-Specific Health and Safety Plan developed for the project must:

- Identify the location and types of underground utilities that are believed to be present on the site.
- Reference this procedure and describe how it will be implemented on the project.
- Contain an Activity Hazard Analysis in which the hazards associated with underground utilities are identified, as well as the measures used to control them.

- Contain, as an appendix, a copy of the applicable regulations from the state of jurisdiction where excavation activities are to be performed. These can usually be obtained via the Internet.
- Contain clear and concise procedures to be followed in the event that contact with underground utilities occurs.
- Address underground utilities and potential associated scenarios in the emergency response section.

5.2.1.2 "One-Call" Locating and Marking Services

Every state has utility marking service programs having various names such as "One-Call", "Dig-Safe", "Call-Before-You-Dig", "Dig-Safely", and many others. These services will identify the types and locations of any utility that may exist in an area to be excavated, as long as the property is in the public domain.

The appropriate One-Call service for the jurisdiction where the project is located must be contacted prior to beginning excavation work. The One-Call agency should be given as detailed a description of the property as possible; address, cross street, utility pole numbers, physical description, etc.

Notification to the One-Call service shall allow sufficient lead time for the agency to mark the utilities before excavation begins. The lead times vary, but range from two to ten days, depending on the state of jurisdiction.

A complete listing of One-Call agencies and telephone numbers for all states is available in the "Call-Before-You-Dig Call Center Directory", which can be accessed online.

Once notified, the One-Call agency will provide the contractor with a unique "locate number" or "reference number". This reference number must be kept in the project files by the Competent Person or designee. Additionally, the reference numbers have expiration dates, which may vary depending on the particular One-Call agency. The valid period of the locate number and required renew notification date shall be requested from the One-Call agency.

On a project with multiple contractors, each contractor must request a separate locate number. Under no circumstances will any other contractor or entity be allowed to work under our locate number. Subcontractors to Tetra Tech may excavate under the locate number secured by Tetra

Tech, provided that they are excavating within the area which was previously white-lined by Tetra Tech and subsequently marked. However, the One-Call agency must be contacted and notified of this arrangement so that the subcontractor can be recorded as working under the existing locate number. If a Tetra Tech subcontractor will be excavating in an area not white-lined by Tetra Tech, then the Tetra Tech subcontractor must request a new locate.

The area where work is to be performed shall be white-lined by Tetra Tech personnel before the locating service goes to the site.

It is good practice to arrange a pre-excavation meeting at the project site with the personnel performing the utility location and marking. This meeting will facilitate communications, coordinate the marking with actual excavation, and assure identification of high-priority utilities.

The One-Call agency should provide the identities of the utility owners that will be notified of the locate request. This information shall be recorded on the Ground Disturbance Permit maintained in the project files. The contact person and phone number for each utility owner shall also be recorded.

The utility owners should provide a “positive response” relative to the locate request, which can consist of two types of action by the utility owner. The facility owner or operator is required to 1) mark it’s underground utilities with stakes, paint, or flags, or 2) notify the excavator that the utility owner/operator has no underground utilities in the area of the excavation.

The positive responses shall be recorded on the Ground Disturbance Permit and cross-checked with the list of utility owners that the One-Call agency stated that they would notify. If it is discovered that a utility owner has not provided a positive response, then the One-Call agency must be notified.

Excavation shall not be conducted until positive responses have been received from all utility owners identified by the One-Call agency as having underground utilities on the property.

Before beginning excavation, the excavator must verify that the location marked was correct, and the distinct, color-coded markings of all utility owners are present.

Examine the site to check for any visible signs of underground utilities that have not been located and marked such as pedestals, risers, meters, warning signs, manholes, pull boxes, valve boxes, patched asphalt or concrete pavement, areas of subsidence, fresh sod or grass, lack of grass or vegetation, and new trench lines.

The markings placed by the utility owners must be documented by Tetra Tech using a still, digital, or video camera. The photo-documentation shall be maintained with the project files indefinitely.

The markings placed by the utility owners or marking services shall follow the American Public Works Association Uniform Color Code as described in ANSI Standard Z 535.1. This code appears below.

American Public Works Association Uniform Color Code

Red - Electric Power Lines, Cables, Conduit

Orange - Communications, Telephone, Cable TV

Yellow - Gas, Oil, Steam, Petroleum or Gaseous Materials

Green - Sewers and Drains

Blue - Potable Water Systems

Purple - Reclaimed Water, Irrigation, Slurry Lines

Pink - Temporary Survey Markings

White - Proposed Excavation

5.2.1.3 Private Utility Locating and Marking Services

As discussed, One-Call agencies arrange for the identification and marking of underground utilities only on public property, up to the point of contact with private property. In the event that excavation activities are to be conducted on non-public properties, the presence, location, depth, and orientation of all underground utilities within the white-lined area shall be ascertained through records review, including any site plot plans, utility layout plans, and as-built drawings available from the property owner, as well as through interviews with knowledgeable personnel associated with the property. Additionally, the information gathered from these sources shall be verified by physical detection methods (non-aggressive), performance of a geophysical survey, or by procuring the services of a private utility locating and marking service. If any detection methods are to be self-performed, the requirements of 5.2.1.4 must be followed.

The above requirements are also intended to address the potential presence of unknown or undocumented underground utilities, therefore, the area to be excavated must also be evaluated by the PM to determine if the potential for unknown or undocumented underground utilities exist. If the determination is made that the presence of these unknown or undocumented underground utilities is unlikely, then a variance should be requested to eliminate the requirement to identify them.

Variance to this requirement above must be approved by the PM and SSC.

5.2.1.4 Self-Performance of Utility Locating and Marking

The techniques and instruments used to locate and characterize underground utilities can be extremely complicated and difficult to use effectively. Additionally, interpretation of the data generated by this instrumentation can be difficult. The utility marking services described in 5.2.1.1 and 5.2.1.2 are staffed by well-trained, experienced professionals who perform locating activities on a regular basis. For these reasons, it is most desirable that these professional services are used for utility location and marking on projects.

In some instances, such as long-term projects where excavation is a primary task, and the presence of underground utilities is extensive, it may be prudent to self-perform locating and marking activities.

If locating and marking is to be self-performed, all personnel using instrumentation will be trained on the use of the equipment that will be used, and the interpretation of the data.

There are a variety of locating methods which may be utilized for self-performance of utility locating as categorized below:

- Magnetic field-based locators or path tracers
- Buried electronic marker systems (EMS)
- Ground penetration radar-based buried –structure detectors
- Acoustics-based plastic pipe locators

- Active probes or beacons for non-metallic pipes
- Magnetic polyethylene pipe

Before self-performing any underground utility locating on a project, approval must be obtained from the Operating Unit Health and Safety Manager.

5.2.2 Working Near or Around Underground Utilities

After the site has been properly evaluated for the presence of underground utilities, intrusive activities may begin. Since there is no perfect way of eliminating the hazards presented by underground utilities, an effort must be made to perform the tasks following the direction and guidance as described by the following best practices that should be implemented during the execution of the project.

5.2.2.1 Work Site Review

Before beginning intrusive activities, a meeting shall be held between all members of the project team. This shall consist of a review of the marked utility locations with the equipment operators, observers, laborers, etc.

5.2.2.2 Preservation of Marks

During excavation, efforts must be made to preserve the markings placed by the utility owners until they are no longer required. If any markings are obliterated, the One-Call agency must be contacted for re-marking. No intrusive activities are to take place if markings are not visible.

5.2.2.3 Excavation Observer

Whenever intrusive operations are being conducted within four feet of the edge of the buffer zone, an observer must be assigned to monitor the activities. The observer will be designated each day, and a review of hand signals and other forms of communication between the observer and operator will be conducted. The directives of the observer will be followed precisely and immediately by those operating equipment.

5.2.2.4 Excavation Within The Buffer Zone

Performing intrusive activities within the buffer zone requires careful adherence to proper guidelines and procedures to minimize the risk of contact with underground utilities.

The purpose of the buffer zone is to designate and define an area where careful, prudent, and reasonable excavation practices are to be used to prevent contact with underground utilities. However, there may be occasions where it is necessary to perform aggressive excavation methods in this designated area.

The boundaries of the buffer zone as defined in Section 4.2 will be observed at all times during intrusive activities. Aggressive excavation methods (excavators, backhoes, drill rigs) must be restricted to areas outside of the 4-foot buffer zone unless a special exemption to this requirement is obtained.

Consider whether the objective of the project can be completed without performing intrusive activities in the buffer zone at all. This will greatly reduce the risks presented by performing work in close proximity to underground utilities. If after consideration, the determination is made that intrusive activities in the buffer zone are necessary, then a formal exemption request shall be made to the PESM according to the guidelines below.

A request to utilize aggressive excavation methods in the buffer zone may be made if:

There is no other appropriate and reasonable alternative to using aggressive methods in the buffer zone; and

- The utility has been de-energized (and purged if necessary), verified as de-energized, and locked-out (per Section 5.2.2.6); or
- the depth and orientation of the utility has been adequately and visually determined through the use of non-aggressive methods such as air/hydro/vacuum excavation, potholing, probing, hand-digging, or a combination thereof; and
- for utilities containing electrical energy, the depth of the existing water table is below the location of the utility; and
- application for the exemption has been submitted to the SSC; and
- the exemption has been granted and approved in writing by the SSC.

The following conditions will apply to this request:

- Aggressive methods may be used in the buffer zone only to the extent allowed by the applicable state or other jurisdictional regulations.
- Appropriate physical protection measures for exposed utilities as described in Section 5.2.2.5 shall be implemented to eliminate the potential for equipment contact with utilities.
- The extent of the project excavation area to be covered by the exemption request must be specified.
- When evaluating the use of aggressive excavation methods in the buffer zone, the SSC will consider the type of utility involved and the associated risk potential.

Based on this evaluation, the SSC may impose further conditions and requirements, which will be detailed in the HASP.

Even if the above exemption conditions are met, the SSC has authority to deny the request, the reasons for which will be provided.

Unless exempted according to the above provisions of this procedure, only non-aggressive methods may be used within the buffer zone. Non-aggressive, or non-mechanized equipment is used in order to prevent mechanical contact with underground utilities which could result in damage to the utility and create the potential for personal injury and property damage. Following are examples of non-aggressive excavation methods:

- Hand-digging
- Non-conductive hand tools must be used when digging within the buffer zone surrounding underground electrical utilities.
- If conductive hand tools must be used near electrical lines, then the SSC shall be consulted to determine additional requirements relative to safe electrical practices, procedures, and equipment.
- Hydro-excavation (water pressure).
- Air excavation (air pressure).

- Vacuum extraction (soil excavation/removal).
- Air excavation/vacuum extraction combination.
- Aggressive methods may be used for the removal of pavement over a utility, if allowed by the state regulations.

5.2.2.5 Protection of Underground Utilities

It is very important that consideration be given to the protection of underground utilities when performing adjacent intrusive activities. This is necessary not only to prevent physical damage and associated indirect effects, but also to prevent the potential for injury to employees and the public.

When using aggressive excavation methods within the buffer zone around exposed underground utilities, physical protection may be appropriate. Basically, this involves creation of a physical barrier between the mechanized operation and the utility. The following are some possible types of physical protective measures:

- Heavy timbers, similar to swamp mats.
- Sheets of plywood.
- Blasting mats.
- Once exposed, underground utilities no longer have the support provided by surrounding soil and may need to be physically supported to prevent shifting, bending, separation, or collapse, which could result in damage to the utility, and possibly personnel. Following are suggested support methods:
- Timber shoring underneath the utility.
- Timbers or girders over the top of the excavation fitted with hangers that support the utility.
- Design by a PE for complicated or large applications.
- Utilities must also be protected from objects that may fall into the excavation such as rocks and equipment. This can be accomplished by following these guidelines:

- Cast spoils as far away from the excavation as possible. Excavated and loose materials shall be kept two feet from the edge of excavations, as required by OSHA.
- Relocate large rocks, cobbles, and boulders away from the excavation and sloped spoils piles.
- When vehicles and machinery are operating adjacent to excavations, warning systems such as soil berms, stop logs or barricades shall be utilized to prevent vehicles from entering the excavation or trench.
- Scaling or barricades shall be used to prevent rock and soils from falling into the excavation.
- Barriers shall be provided to prevent personnel from inadvertently falling into an excavation.

5.2.2.6 De-Energizing Utilities

Utilities can carry many types of potential energy, including electricity, flowing liquids, liquids under pressure, gasses under pressure, etc. A release, such as may happen if a utility conveyance is compromised, could result in personal injury, property damage, and other indirect effects. If the white lines of the proposed excavation area overlaps or extends into the buffer zone of a known underground utility, then if at all possible, that utility shall be de-energized to physically prevent the transmission, flow, or release of energy. Conversely, if the buffer zone of the known utility lies outside of the white-lined, proposed excavation area, then de-energization is not required.

The owner of the utility shall be contacted to determine the feasibility and methodology of de-energizing the utility. Plenty of lead-time should be provided for this since it may take utility companies weeks to de-energize some utilities.

Depending on the utility and the material being conveyed, isolation points which may be suitable for de-energizing include but are not limited to the following:

- Electrical circuit breakers
- Slide gate

- Disconnect switches
- Piping flanges
- Other similar devices

When utilities are de-energized, it must be verified by demonstration. This can be accomplished by testing equipment, switching on a machine or lighting, opening a valve, etc. For any current-carrying electrical equipment, such as cables, electrical panels, etc., successful de-energization must be certified through the use of appropriate electrical testing equipment.

Whenever a utility is de-energized, a means of ensuring that the energy isolation device and equipment cannot be operated until the device is removed must be provided. Typically, this is achieved by utilizing a lockout device, accompanied by a written tag that physically controls the configuration of the energy isolation point. Lockout devices include but are not limited to the following:

- Locks
- Chains
- Valve covers
- Circuit breaker hasps
- Blind flanges
- Slip blinds, and
- Multiple lock hasps

When de-energizing and locking out of utilities is practiced, the provisions of DCN 2-16 Control of Hazardous Energy Lockout/Tagout, shall be followed, as applicable.

In the event that a utility is de-energized, but there is no means of adequately providing a physical locking-out of the utility, then a spotter must be posted at the point of isolation to ensure that the utility is not re-energized. The spotter must be supplied with a communication device such as a site radio.

5.2.2.7 Damage Discovery

During excavation, utility damage may be discovered which is pre-existing or otherwise not related to a known contact. Disclosure to the utility owner is very important because the possibility of utility failure or endangerment of the surrounding population increases when damage has occurred. The utility may not immediately fail as a result of damage, but the utility owner or operator must be afforded the opportunity to inspect the utility and make a damage assessment and effect repairs if necessary. The following guidance applies:

- Observe and photograph the utility from a safe distance and determine in there is damage. Damage would be all breaks, leaks, nicks, dents, gouges, grooves, or other damages to utility lines, conduits, coatings, or cathodic protection systems.
- The One-Call agency or private location service must be contacted immediately.

5.2.3 Encountering or Contacting Underground Utilities

In the event that encountering or contacting an underground utility occurs, it is imperative that the appropriate actions are taken to minimize damage to the utility, prevent personal injury, and minimize indirect effects.

5.2.3.1 Encountering Underground Utilities

It is possible that underground utilities will be encountered in locations that have previously been “cleared” of having underground utilities by the locating service, or are found outside of the area which has been marked as having underground utilities. In either case, if this occurs, the following applies:

- Intrusive activities must be curtailed
- The One-Call agency or private location service must be contacted immediately
- The PM and PESM must be notified
- No further intrusive activities may be conducted until:
- The One-Call agency/private location service and/or the subject utility owner visit the site;

- Identification of the utility owner and the type of material/energy being conveyed by the utility has been made; and
- The orientation and depth of the subject utility has been determined and suitably marked.
- A Tetra Tech Incident Report and Investigation form must be completed per DCN 2-2 Incident Reporting and Investigation Program. The report should be accompanied by photographs clearly showing the marking(s), and the actual location, with a distance gauge to document how far off the mark the utility was encountered.

5.2.3.2 Contacting Underground Utilities

If excavation or other equipment being used for intrusive activities makes contact with an underground utility, the following guidelines apply:

- Intrusive activities must be stopped immediately.
- Observe the utility from a safe distance and determine if there is damage. Damage would be all breaks, leaks, nicks, dents, gouges, grooves, scratched coatings, cathodic protection compromise, material leakage, obvious electrical energy.
- Move all personnel to the evacuation meeting point as described in the SSHP.

EXCEPTION: If an electrical line has been contacted and it is your belief that equipment (such as an excavator) is electrically energized, do not approach the equipment. Order the operator to remain in the equipment until emergency personnel can de-energize the source (unless the equipment is on fire, at which time the operator should jump off of the vehicle and shuffle along the ground to a safe area). Shuffling is required because current flows outward through the soil in a ripple pattern called a power gradient, creating a pattern of high and low potential, Shuffling decreases the chance that these gradients could be bridged, causing current to flow through the body, resulting in electrocution.

- Secure the area to prevent the public from entering.
- Contact emergency responders as specified in the SSHP.
- The One-Call agency or if known, the utility owner must be contacted immediately.

- The PM and SSC must be notified.
- No further intrusive activities may be conducted until:
- The utility owner inspects the scene and after repairs, verifies that all danger has passed.
- The orientation and depth of the subject utility has been determined and suitably marked.
- Permission from the emergency responders to resume work has been given.

A Tetra Tech Incident Report and Investigation form must be completed per DCN 2-2. The report should be accompanied by photographs clearly showing the marking(s), and the actual location, with a distance gauge to document how far off the mark the utility was encountered.

State and Local regulations must be reviewed to determine if reporting to any additional agencies is required.

5.3 Training

Competent Persons shall have adequate experience and/or training to carry out the requirements of this procedure.

6.0 SOURCES OF INFORMATION

6.1 Organizations

- Common Ground Alliance
- Center for Subsurface Strategic Action (CSSA)
- DigSafely
- National Utility Contractors Association (NUCA)
- National Utility Locating Contractors Association (NULCA)
- Underground Focus Magazine

- NUCA State Listing of One-Call centers
- Utility Safety Magazine

6.2 Vendors and Commercial Sites

- RadioDetection, Inc. (Detection Instruments)
- Heath Consultants (Detection Instruments)
- Ben Meadows Company (Detection Instruments)
- So-Deep, Inc. (Complete Utilities Services)
- Concept Engineering Group, Inc. (Air Excavation Equipment)
- Rycom Instruments, Inc. (Detection Instruments)
- Schonstedt Instrument Company (Detection Instruments)
- Forestry Suppliers, Inc. (Fiberglass Probe – "Fiberglass Tile Probe", Part #77543, Approx. $20.00, Telephone 800-647-5368)

7.0 REFERENCES

Common Ground Study of One-Call Systems and Damage Prevention Best Practices, August, 1999, Sponsored by US DOT.

Revision Date	Document Authorizer Name	Revision Details
10/01/2011	Chris McClain	Update

1.0 PURPOSE

The purpose of this procedure is to provide information for projects that will ensure all drilling operations are conducted using established industry standards, requirements, and safe work practices.

2.0 SCOPE

The requirements of this procedure apply to drillers and drilling subcontractors working on Tetra Tech, Inc. (hereinafter referred to as "the Company") projects. This procedure involves all operations for drill rigs including set-up, disassembly, rotary and auger drilling, CPT, DPT, air rotary, core drilling, grouting, service and maintenance, and related operations performed in support of monitoring and recovery well installation, abandonment, soil borings, and geological sampling and exploration.

3.0 MINIMUM REQUIRMENTS

3.1 Responsibilities

3.1.1 Tetra Tech Employees and Subcontractor Personnel

All project site personnel involved with drill rig activities shall have site training/orientation and are responsible for understanding and complying with the requirements of this procedure. All employees shall bring all potential, perceived, or actual unsafe conditions or concerns to the attention of the Site Safety Coordinator (SSC) and/or supervision immediately, or as described in the site-specific Health and Safety Plan (HASP). If they feel their concern is not addressed, then Project Management should be contacted.

3.1.2 Subcontractor Drill Rig Crew

Employees who operate, maintain and work on drill rigs shall have the applicable certifications, qualifications, and training in the operation, maintenance, and safe work practices for drill rigs as required and addressed in the site-specific HASP. The drilling crew will review and follow requirements in equipment operator's manual, drilling safety plan, and site-specific HASP. The drilling safety plan and HASP shall be specific to the type of drilling equipment and operations to be performed, include all local, state, federal, and client requirements and regulations, and address applicable Environmental Health and Safety topics covered in Tetra Tech H&S Programs. The safety plans shall also address information and safe work practices contained in the National Drilling Association (NDA), Drilling Safety Guide.

It is also the responsibility of all employees involved in drilling operations to:

- Report immediately any equipment that needs repair/replacement.
- Use personal protective equipment (PPE) as addressed in the site-specific HASP.
- Replace any guard or cover removed for inspection, maintenance, or setup before operating equipment.

3.1.3 Line Management

The Project Manager (PM) is responsible for selecting a qualified drilling subcontractor for the project, ensuring all project employees and subcontractors follow the requirements in this procedure and for the health and safety of all Tetra Tech and subcontractor employees on the job site. The PM shall ensure this procedure is included and other appropriate health and safety requirements in the subcontractor's scope of work and specifications.

3.1.4 Project Site Safety Coordinator (SSC) Personnel

SSC Personnel shall:

- Ensure workers, including subcontractor personnel, follow the requirements in this procedure, and are qualified/trained to operate equipment and perform project work activities.
- Ensure all equipment has been inspected in accordance with the manufacturer's requirements and recommendations prior to use.
- Review and approve drilling safety plan for specific activities prior to project start-up.
- Assist Line Management in project oversight and implementing safe work practices based on Tetra Tec environmental health and safety, quality programs, equipment manufacturer's recommendations, the NDA Drilling Safety Guide, and the U.S. Army Corps of Engineers, EM 385-1-1, Safety and Health Requirements Manual, and any

client specific requirements as applicable.

3.2 Equipment Inspections

Initial acceptance inspection for drill rigs and equipment shall be performed when equipment first arrives on site and prior to using. Daily drill rig and equipment inspections shall be performed in accordance with manufacturer's recommendations and documented on Attachment 1, or similar form. Responsibility for equipment inspections shall be addressed in the site-specific HASP and include, but are not limited to the following:

- Structural damage
- Loose nuts and bolts
- Proper tension in chain drives
- Inspection of cables and lines
- Loose or missing guards or protective covers
- Fluid leaks on the drilling equipment and/or truck the rig is mounted on, and all support vehicles
- Damaged hoses and/or damaged pressure gauges and pressure relief valves
- Check and test all safety devices and warning systems daily, such as emergency shut down/deadman switch operation.
- Check that all gauges, warning lights, and control levers are functioning properly and listen for unusual sounds each time engine is started
- If a boom is used on a support truck, it may be deemed a crane and require a crane checklist prior to use. This should be verified with the client and subcontractor prior to the equipment arriving on site and inspections and use shall be addressed in the safety plan
- Presence of functional safety equipment and tagged fire extinguisher
- Presence of the operator's manual and recent mechanic's checklist as required

Potential, or out-of-the-ordinary, problems shall be documented and reported to supervision and SHSO/ESS prior to using equipment. Documentation shall also include contacts and determinations with the Project Manager, Project Environmental Safety Manager (PESM), and client if necessary, to determine if the equipment is safe to use, or repairs are required prior to use.

3.3 Maintenance and Housekeeping

Proper maintenance and housekeeping is essential to providing safe drilling operations. All maintenance shall be performed safely in accordance with equipment manufacturer's recommendations. These requirements may include, but are not limited to:

- Keep drill rigs and associated equipment in safe working condition.
- Shut down the drill rig engine to make repairs or adjustments or to lubricate fittings (except repairs or adjustments that can only be made with the engine running). Take precautions to prevent accidental starting of an engine during maintenance by locking, removing or tagging the ignition key
- Always block the wheels or lower the leveling jacks or both and set hand brakes before working under a drill rig.
- When appropriate and possible, release all pressure on the hydraulic systems, drilling fluid system, and the air pressure systems of the drill rig prior to performing maintenance. In other words, reduce the drill rig and operating system to a "zero energy state" before performing maintenance. Use extreme caution when opening drain plugs, radiator caps, and other pressurized plugs and caps.
- Do not touch engine or exhaust system of an engine following its operation until they had adequate time to cool.
- Follow the manufacturer's recommendations for using the proper quantity and quality of lubricants, hydraulic oils and/or coolants.
- Replace all caps, filler plugs, protective guards, panels, high-pressure hose clamps, and chains or cables that have been removed for maintenance before returning the drill rig to service.

The following housekeeping practices shall be used:

- Work areas shall be kept reasonably clean and free of debris in order to minimize slip and trip hazards.
- Any leaks or spills shall be promptly cleaned up to minimize slipping, fire hazards, and environmental releases.
- Means shall be provided to convey any hazardous substances away from the rig floor while pulling wet strings of pipe.
- Pipes, drill rods, casings, augers and other drilling tools must be properly placed in racks or sills to prevent rolling and/or sliding.
- Penetration or other driving hammers must be placed at a safe location on the ground and secure from moving.

3.4 Fire Prevention and Protection

The following fire prevention and protection practices shall be used:

- Smoking, open fires, or other potential sources of ignition shall be permitted only in designated areas located at a safe distance from the wellhead of flammable liquid storage areas. Operations, or areas which constitute a fire hazard, shall be conspicuously posted with a sign, "NO SMOKING OR OPEN FLAME."
- Hazardous substances shall be stored in approved containers and properly labeled.
- Never cut/weld on or near fuel tanks.
- Do not use gasoline or other flammable liquids as a cleaning agent on equipment or tools.
- Refuel equipment in a well-ventilated area.
- Do not fill tanks while the engine is running; allow engine and exhaust to cool down. Turn off all electrical switches.
- Equipment, cellars, rig floors, and ground areas adjacent to the well shall be kept free from oil or gas accumulations which might create or aggravate fire hazards.
- Oxygen, natural gas, or liquefied petroleum gas shall not be used to operate spray guns or pneumatic tools.
- Combustible materials, such as oily rags and waste, shall be stored in covered metal

containers. The contents shall be disposed of daily.

- Fire extinguishers shall be located, tagged, inspected, and maintained at the work site. More or larger extinguishers shall be provided where the type of operation produces more hazardous conditions.
- Firefighting equipment shall not be tampered with and shall not be removed for other than fire protection and firefighting purposes.

3.5 Personal Protective Equipment (PPE)

The drilling safety plan and site-specific HASP shall address the required PPE to be used when working around drill rig and on the work site.

Typical PPE required includes, but not limited to:

- Hard hats
- Safety glasses with side shields
- Steel toed boots
- Hearing protection

In addition, the following safe practices shall be used:

- Loose or poorly fitted clothing shall not be worn during drilling operations.
- While on the worksite, an employee shall refrain from, or minimize, wearing jewelry or other adornments which are prone to snagging or hanging and causing injury.
- An employee whose length of hair poses a hazard on the worksite shall keep his or her hair contained in a suitable manner while working. Hair and beard styles shall not interfere with the wearing of respiratory protective equipment.
- An employee, when engaged in work 6 feet or more above the rig floor or other working surfaces must follow Fall Protection requirements in SWP 5-10 Fall Protection Practices.

- A safety harness and any lifeline and lanyard must be used only for safeguarding the employee from falls.
- The safety harness, lifeline, and lanyard must be provided, constructed, inspected, and maintained.
- When working in the mast or derrick, an employee must be provided with a safety harness and a lanyard or lifeline which is adjusted to allow the minimum of drop in case of a fall.

3.6 Drill Rig Utilization and Alterations

Do not attempt to exceed manufacturer's ratings of speed, force, torque, pressure, flow, etc. Only use the drill rig and tools for the purposes which they are intended and designed for (i.e., auger strings cannot be connected with anything but bolts designed to connect auger strings).

Alterations to a drill rig or drilling tools shall only be made by qualified personnel and only after consultation and approval from the manufacturer, site supervision, PM and SSC.

3.7 Work Site Set-up and Demobilize

Prior to drilling, follow SWP Underground Utilities, requirements and perform adequate site clearing and leveling to accommodate the drill rig equipment and supplies, and provide a safe working area. Drilling shall not be commenced when tree limbs, unstable ground or site obstructions cause unsafe conditions.

The following precautions shall be used when setting up and demobilizing equipment:

- Know the traveling height (overhead clearance), width, length and weight of the drill rig with carrier and know any road or bridge load limits, width and overhead limits, making sure these limits are not exceeded and allowing an adequate margin of safety.
- Always use the assistance of someone on the ground as a guide/spotter when lateral or overhead clearance is close, or uneven terrain, or other conditions warrant.
- Never move a drill rig unless the vehicle brakes are in sound working order.
- Allow for mast overhang when cornering or approaching other vehicles or structures.

- Watch for low hanging electrical lines, particularly at the entrances to drilling sites.
- Never travel on a street, road, highway with the mast (derrick) of the drill in the raised or partially raised position.
- After the drill rig has been moved to drilling site, set all brakes and/or locks, block wheels, and remove all ignition keys when drill is left unattended.

The following safety precautions relating to off-road movement shall be used:

- Before moving a drill rig, first walk the route of travel, inspecting for depressions, stumps, gullies, ruts and similar obstacles.
- Always check the brakes of a drill rig carrier before traveling, particularly on rough, uneven or hilly ground.
- Discharge all passengers before moving a drill rig on rough or hilly terrain.
- Engage the front axle (for 4 x 4, 6 x 6, etc. vehicles or carriers) when traveling off highway on hilly terrain.
- Use caution when traveling a side-hill. Conservatively evaluate side-hill capability of drill rigs, because the arbitrary addition of drilling tools may raise the center of gravity. When possible, travel directly uphill or downhill. Increase tire pressures before traveling in hilly terrain (do not exceed rated tire pressure).
- Attempt to cross obstacles such as small logs and small erosion channels or ditches squarely, not at an angle.
- Never travel off-road with the mast (derrick) of the drill rig in the raised or partially raised position.

3.8 Safety During Drilling Operations

Safety requires the attention and cooperation of every worker and site visitor. Instruct all personnel to "stand clear" of the drill rig immediately prior to and during starting of drill rig engine. Start all engines according to the manufacturer's recommendations.

Make sure all gear boxes are in neutral, all hoist levers are disengaged, all hydraulic levers are in the correct non-actuating positions and the cathead rope is not on the cathead before starting a drill rig engine.

The following safe drilling practices shall be used:

- Do not drive the drill rig from hole with the mast (derrick) in the raised position.
- Check for overhead obstructions before raising the mast (derrick).
- Maintain minimum clearance from all overhead electric lines as addressed in SWP 5-9 Safe Electrical Work Practices.
- Before raising the mast (derrick), all drill rig personnel (with the exception of the operator) and visitors shall be cleared from the areas immediately to the rear and the sides of the mast. All drill rig personnel and visitors shall be informed that the mast is being raised prior to raising it.
- Before the mast (derrick) of a drill rig is raised and drilling is commenced, the drill rig must first be leveled and stabilized with leveling jacks and/or solid cribbing. The drill rig shall be re-leveled if it settles after initial set up. Lower the mast (derrick) only when the leveling jacks are down and do not raise the leveling jack pads until the mast (derrick) is lowered completely.
- Before starting drilling operations, secure and/or lock the mast (derrick) if required according to the drill manufacturer's recommendations.
- The operator of a drill rig shall only operate a drill rig from the position of the controls. If the operator of the drill rig must leave the area of the controls, the operator shall shift the transmission controlling the rotary drive into neutral and place the feed control lever in neutral. The operator shall shut down the drill engine before leaving the vicinity of the drill rig.
- Tools shall not be discarded carelessly around the drill rig, and shall be carefully passed by hand between personnel or by use of a hoist line if possible.
- When encountering a "hot spot" during drilling operations involving volatiles, vacate the immediate area and allow the borehole to vent. Resume work after monitoring instruments indicate an atmosphere in compliance with the site-specific HASP.
- If it is necessary to drill within an enclosed area, make certain that exhaust gases are vented out of the area. Exhaust gases can be toxic and some cannot be detected by smell.

- Clean mud and grease from your boots before mounting a drill platform and use hand holds and railings. Maintain three points of contact at all times when climbing or dismounting. Watch for slippery ground when dismounting from the platform.
- During freezing weather, do not touch metal parts of the drill rig with exposed flesh. Freezing of moist skin to metal can occur almost instantaneously.
- All air and water lines and pumps should be drained when not in use if freezing weather is expected.
- All unattended boreholes must be adequately covered or otherwise protected to prevent drill rig personnel, site visitors or animals from stepping or falling into the hole. All open boreholes shall be covered, protected or backfilled adequately and according to local or state regulations on completion of the drilling project.
- When using a ladder on a drill rig, face the ladder and grasp either the side rails or the rungs with both hands while ascending or descending. Maintain three points of contact at all times when climbing or dismounting. Do not attempt to use one or both hands to carry a tool while on a ladder. Use a hoist line and a tool "bucket" or a safety hook to raise or lower hand tools.

3.9 Safe Use of Wire Line Hoists, Wire Rope and Hoisting Hardware

The use of wire line hoists, wire rope and hoisting hardware shall be as stipulated by 29 CFR 1910, 29 CFR 1926, and the American Iron Steel Institute Wire Rope Users Manual. The following safe practices shall be used:

- Visually inspect all wire ropes and fittings during use and thoroughly inspect them at least once a week for: abrasion, broken wires, wear, reduction in rope diameter, reduction in wire diameter, fatigue, corrosion, damage from heat, improper reeving, jamming, crushing, bird caging, kinking, core protrusion and damage to lifting hardware. Replace wire ropes when inspection indicates excessive damage according to the Wire Rope Users Manual. Thoroughly inspect all wire ropes which have not been used for a period of a month or more before returning them to service.
- During rig operations, monitor the condition of the wire rope and the reel for uneven or improper spooling.
- End fittings and connections consist of spliced eyes and various manufactured devices. Install all manufactured end fittings and connections according to the

manufacturer's instructions and follow the manufacturer's load specifications.

- If a ball-bearing type hoisting swivel is used to hoist drill rods, inspect and lubricate the swivel daily to assure that the swivel freely rotates under load.
- If a rod slipping device is used to hoist drill rods, do not drill through or rotate drill rods through the slipping device, do not hoist more than 1 foot (0.3 cm) of the drill rod column above the top of the mast (derrick), do not hoist a rod column with loose tool joints and do not make up, tighten, or loosen tool joints while the rod column is being supported by a rod slipping device. If drill rods should slip back into the borehole, do not attempt to break the fall of the rods with your hands or by tensioning the slipping device.
- Most sheaves on exploration drill rigs are stationary with a single part line. Never increase the number of parts of line without first consulting with the manufacturer of the drill rig.
- Wire ropes must be properly matched with each sheave - if the rope is too large, the sheave will pinch the wire rope - if the rope is too small, it will groove the sheave. Once the sheave is grooved, it will severely pinch and damage larger sized wire ropes

The following procedures and precautions must be understood and implemented for safe use of wire ropes and rigging hardware:

- Use tool handling hoists only for vertical lifting of tools (except when angle hole drilling). Do not use tool handling hoists to pull objects away from the drill rig; however, drills may be moved using the main hoist if the wire rope is spooled through proper sheaves according to the manufacturer's recommendations.
- When stuck tools or similar loads cannot be raised with a hoist, disconnect the hoist line and connect the stuck tools directly to the feed mechanism of the drill. Do not use hydraulic leveling jacks for added pull to the hoist line or the feed mechanism of the drill.
- When attempting to pull out a mired down vehicle or drill rig carrier, only use a winch on the front or rear of the vehicle and stay as far away as possible from the wire rope. Do not attempt to use tool hoists to pull out a mired down vehicle or drill rig carrier.
- Minimize shock loading of a wire rope - apply loads smoothly and steadily.
- Avoid sudden loading in cold weather.

- Never use frozen ropes.
- Protect wire rope from sharp corners or edges.
- Replace faulty guides and rollers.
- All lifting hooks shall be equipped with safety latches.
- Replace damaged safety latches on safety hooks before using.
- Know the safe working load of the equipment and tackle being used. Never exceed this limit.
- Inspect and test clutches and brakes of hoists periodically.
- Know and do not exceed the rated capacity of hooks, rings, links, swivels, shackles and other lifting aids.
- Always wear gloves when handling wire ropes.
- Do not guide wire rope on hoist drums with your hands.
- Following the installation of a new wire rope, first lift a light load to allow the wire rope to adjust.
- Never carry out any hoisting operations when the weather conditions are such that hazards to personnel, the public, or property are created.
- Never leave a load suspended in the air when the hoist is unattended.
- Keep your hands away from hoists, wire rope, hoisting hooks, sheaves and pinch points as slack is being taken up and when the load is being hoisted.
- Never hoist the load over the head, body or feet of any personnel.
- Never use a hoist line to "ride up" the mast (derrick) of a drill rig.
- Replacement wire ropes should conform to the drill rig manufacturer's specifications.

3.10 Safe Use of Cathead and Rope Hoists

The following safety procedures shall be employed when using a cathead hoist:
Keep the cathead clean and free of rust and oil and/or grease. Clean the cathead with a wire brush if it becomes rusty. Check the cathead periodically, when the engine is not running, for rope wear grooves. Replace the cathead if a rope groove forms to a depth greater than 1/8 inch (3 mm).

- Always use a clean, dry, sound rope. A wet or oily rope may "grab" the cathead and cause drill tools or other items to be rapidly hoisted to the top of the mast.
- Should the rope "grab" the cathead or otherwise become tangled in the drum, release the rope and sound an appropriate alarm for all personnel to rapidly back away and stay clear. The operator shall also back away and stay clear. If the rope "grabs" the cathead, and tools are hoisted to the sheaves at the top of the mast, the rope will often break, releasing the tools. If the rope does not break, stay clear of the drill rig until the operator cautiously returns to turn off the drill rig engine and appropriate action is taken to release the tools. The operator shall keep careful watch on the suspended tools and shall quickly back away after turning off the engine.
- The rope shall always be protected from contact with all chemicals. Chemicals can cause deterioration of the rope that may not be visibly detectable.
- Never wrap the rope from the cathead (or any other rope, wire rope or cable on the drill rig) around a hand, wrist, arm, foot, ankle, leg or any other part of your body.
- Always maintain a minimum of 18 inches of clearance between the operating hand and the cathead drum when driving samples, casing or other tools with the cathead and rope methods. Be aware that the rope advances toward the cathead with each hammer blow as the sampler or other drilling tool advances into the ground.
- Never operate a cathead (or perform any other task around a drill rig) with loose unbuttoned or otherwise unfastened clothing or when wearing gloves with large cuffs or loose straps or lacings.
- Do not use a rope that is any longer than necessary. A rope that is too long can form a ground loop or otherwise become entangled with the operator's legs.
- Do not use more rope wraps than are required to hoist a load.

- Do not leave a cathead unattended with the rope wrapped on the drum.
- Position all other hoist lines to prevent contact with the operating cathead rope.
- When using the cathead and rope for driving or back-driving, make sure that all threaded connections are tight and stay as far away as possible from the hammer impact point.
- The cathead operator must be able to operate the cathead standing on a level surface with good, firm footing conditions without distraction or disturbance.

3.11 Safe Use of Augers

The following precautions shall be observed when using augers:

- The operator and tool handler shall establish a system of responsibility for the various activities required for auger drilling, such as connecting and disconnecting auger sections, and inserting and removing the auger fork. The operator must assure that the tool handler is well away from the auger column and that the auger fork is removed before starting rotation.
- Only use the manufacturer's recommended method of securing the auger to the power coupling. Do not touch the coupling or the auger with your hands, a wrench or any other tools during rotation.
- Whenever possible, use tool hoists to handle auger sections.
- Never place hands or figures under the bottom of an auger section when hoisting the auger over other auger sections or other hard surfaces such as the drill rig platform.
- Never allow feet to get under the auger section that is being hoisted.
- When rotating augers, stay clear of the rotating auger and other rotating components of the drill rig. Never reach behind or around a rotating auger for any reason whatsoever.
- Avoid using hands or feet to scrape mud or cuttings as auger comes out of the hole. The preferred method would be to use tools such as a long-handled shovel to move auger cuttings away from the auger.
- Do not attempt to remove earth from rotating augers. Augers should be cleaned only

when the drill rig is in neutral and the augers are stopped from rotating.

3.12 Safe Practices During Rotary and Core Drilling

Rotary and core drilling tools shall be inspected prior to use. Special precautions for safe rotary or core drilling involve chucking, joint break, hoisting and lowering of drill rods and the following:

- Lubricate and check water swivels and hoisting plugs for "frozen" bearings before use. Use only approved lubrication fluids.
- Check drill rod chuck jaws periodically and replace when necessary.
- Check the capacities of hoists and sheaves against the anticipated weight to the drill rod string plus other expected hoisting loads.
- Only the operator of the drill rig shall brake or set a manual chuck so that rotation of the chuck will not occur prior to removing the wrench from the chuck.
- Do not break drill rods during lowering into the hole with drill rod chuck jaws.
- Do not hold or lower drill rods into the hold with pipe wrenches.
- If a string of drill rods are accidentally or inadvertently release into the hole, do not attempt to grab the falling rods with your hands or a wrench.
- In the event of a plugged bit or other circulation blockage, relieve or bleed down the high pressure in the piping and hose between the pump and the obstruction before breaking the first tool joint.
- When drill rods are hoisted from the hole, they shall be cleaned for safe handling with a rubber or other suitable rod wiper. Do not use your hands to clean drilling fluids from drill rods.
- If work must progress over a portable drilling fluid (mud) pit, do not attempt to stand on narrow sides or cross members. The mud pit shall be equipped with rough surfaced, fitted cover panels of adequate strength to hold drill rig personnel.
- Do not lean unsecured drill rods against the mast. Either provide some method of securing the upper ends of the drill rod sections for safe vertical storage or lay the rods down

- For air rigs, be aware of the air discharge line and the cyclone. The discharge line from the casing to the cyclone should have a safety chain on either end in the event that the coupler comes loose. Do not stand in the area where the discharge line could hit you if it broke. Do not stand directly downwind where you could get hit by drill cuttings should the discharge line break free of the cyclone.

4.0 DEFINITIONS

4.1 Air Rotary Drilling

This method utilizes air as a circulating medium to; cool the drill bit, bring drill cuttings to the surface and maintain borehole integrity. When drilling with a conventional air rotary system, the cuttings are removed from the borehole using high annular pressure created by an air compressor at the surface. The air that is circulated also acts to cool the drill bit as it circulates from inside the drill rod and out and around the bit.

4.2 Annular Space

The space surrounding the pipe suspended in the wellbore. The outer wall of the annular space may be an open hole or it may be larger pipe.

4.3 Auger Rig

Drilling method in which a hole is drilled by rotating a corkscrew type hollow stem steel drill.

4.4 Cable Tool Drilling

Drilling method in which hole is drilled by advancing a drive barrel and/or hand tool. As the hole is advanced a steel casing is driven by a cable to prevent collapse.

4.5 Cathead

A spool-shaped extension of the draw works shaft used to lift heavy equipment and to make up or break out drill pipe.

4.6 Cone Penetration Testing (CPT)

Cone specialty probes and samplers that when deployed remove soil data for testing pertinent to geotechnical and environmental site investigations.

4.7 Core Drilling

Specifically used to remove a cylinder of material. The material left inside the drill bit is referred to as the *core* and the drilling apparatus used in obtaining a core sample is often referred to as a corer. Core drilling is used for many applications, either where the core needs to be preserved, or where drilling can be done more rapidly since much less material needs to be removed than with a standard bit.

4.8 Cribbing

Logs, 2 X 4s or other non-compressible material used to support an object above the ground/floor.

4.9 Cuttings

Soil or other particles obtained during drilling operations. Cuttings are brought to the surface by circulating mud-laden fluid in rotary drilling or by hollow stem auger drilling. They are bailed out in cable tool drilling.

4.10 Derrick

Any one of a large number of types of load-bearing structures. In drilling work, the standard derrick has four legs standing at the corners of the substructure and reaching to the crown block. The substructure is an assembly of heavy beams used to elevate the derrick above the ground and provide space to install blowout preventers, casing heads, etc. The standard derrick has largely been replaced by the mast for drilling. The mast is lowered and raised without disassembly.

4.11 Direct Penetration Testing (DPT)

Soil probing techniques, also referred to as “Direct Push” techniques, where tools and sensors are inserted into the ground without the use of drilling to remove soil and make a path for the tool. This allows for nominal disturbance to the ground surface and assures sample integrity and data quality.

4.12 Mud

The liquid that is circulated through the wellbore during rotary drilling and workover operations. In addition to its function of bringing cuttings to the surface, mud also cools and lubricates the bit and drill string, protects against blowouts by containing subsurface pressures, and deposits a mud cake on the wall of the borehole to prevent loss of fluids to the formations. Although it originally was a suspension of earth solids, especially clays, in water, the mud used in modern drilling operations is a somewhat more complex three-phase mixture of liquids, reactive solids, and inert solids. The liquid phase may be fresh water, diesel oil, or crude oil and may contain one or more conditioners.

4.13 Rotary Drilling

The drilling method by which a hole is drilled by a rotating bit to which a downward force (drill collars) is applied. The bit is fastened to and rotated by the drill stem, which also provides a passage for the circulating fluid.

4.14 Sheave

A wheel or disc with a grooved rim, especially one used as a pulley.

4.15 Sonic Drilling

This method provides continuous samples in a wide range of soil types, including soils with large particles that preclude sampling by many other techniques. The drill stem and sampler barrel are vibrated vertically at frequencies between about 50 and 180 Hz (hence the name sonic) such that the sampler barrel normally advances by slicing through the soil undisturbed.

DRILL RIGS ATTACHMENT 1
EQUIPMENT SAFETY INSPECTION CHECKLIST FOR SMALL AUGER, ROTARY, AND CORE RIGS

I. Rig Carrier
( ) Overall Appearance
( ) Overall Operation: head/brake lights, turn signals, horn, wipers, tires, steering
( ) Oil Leaks
( ) Fuel Leaks
( ) Fire Extinguisher
( ) Back-up Alarm
( ) Exhaust System
( ) Wheel Chocks
( ) Outrigger Jacks
( ) Fuel Tank Placard(s)
( ) Portable fuel containers
( ) Other: ______________
( ) Other: ______________

II. Mast
( ) Crown Block ( ) Hinge Pins ( ) Lock Pins/Devices ( ) Lights/Wiring ( ) Safety Climbing Device ( ) Safety Belts/Harness ( ) Racking Board ( ) Ladders ( ) Deadman Anchors ( ) Standpipe ( ) Swivel Hose ( ) Safety Chains/Clamps ( ) Mast Rams/Cylinders ( ) Welds ( ) Lubrication ( ) Other:____________ ( ) Other:____________

III. Rig Engine(s)
( ) Fuel Tank(s) ( ) Exhaust System ( ) Electrical System ( ) Belt/Drive Line Guards ( ) Emergency Shut-down System(s) ( ) Heat Shields ( ) Fluid Leaks ( ) Gauges ( ) Clutches ( ) Other:____________ ( ) Other:____________

IV. Power Train/Drill Unit
( ) Chain/Belt Guards ( ) Fluid Leaks ( ) Driveline Guards ( ) Hydraulic Hoses ( ) Safety Chains/Lanyards

IV. Power Train/Drill Unit (continued)
( ) Gauges ( ) Loose Bolts ( ) Rotary Table ( ) Drive Head ( ) Auger Drive ( ) Other:____________ ( ) Other:____________

V. Pump(s) / Compressor(s)
( ) Sheaf Relief Valve Cover(s) ( ) Pressure Relief Valve(s) ( ) Flowline Safety Clamps/chains ( ) Belt/Chain Guards ( ) Vibrator Line Anchor ( ) Other:____________ ( ) Other:____________

VI. Hoists/Catheads
( ) Chain Guard(s)
( ) Spool/Drum wear (>1/8 inch depth), cracks
( ) Sheaves
( ) Safety Devices/Spool Divider
( ) Clutch(s)
( ) Brake(s)
( ) Hydraulics
( ) Wireline Drum-coring
( ) Drive Hammer(s)
( ) Other:____________
( ) Other:____________

VII. Wireline/Catline
( ) Wear/broken strands/kinks ( ) Spooling ( ) Cable Clamps and Thimbles ( ) Cable Ends ( ) Catline Rope Condition ( ) Catline Rope knot taped ( ) Other:____________ ( ) Other:____________

VIII. Hoisting Equipment
( ) Hoisting Plug(s) ( ) Lifting Iron(s) ( ) Elevators ( ) Weight Indicator ( ) Safety Hook(s)-latch in working order ( ) Splice(s) ( ) Slips ( ) Foot Clamps ( ) Chain Wrenches ( ) Rod Pins ( ) Other:____________ ( ) Other:____________

IX. Downhole Equipment
( ) Drillpipe ( ) Drill collars ( ) Core Rod ( ) Core Barrel(s) ( ) Augers ( ) Samplers ( ) Bailers ( ) Center Bit ( ) Other:____________ ( ) Other:____________

X. Miscellaneous Safety Items
( ) Kill Switch - functional ( ) Placards/Warning Signs ( ) Applicable OSHA Postings ( ) First Aid Kit ( ) Applicable Regulation Posting ( ) Emergency Medical Posting(s) ( ) Emergency Procedures ( ) Spill Kit ( ) Hydraulic Lines cabled ( ) Other:____________ ( ) Other:____________

XI. Personal Protective Equipment
( ) Hard Hats ( ) Safety Glasses ( ) Safety boots/shoes ( ) Hearing Protection ( ) Other:____________ ( ) Other:____________

XII. Licenses
( ) Drillers licensed ( ) Hydraulic license ( ) 40-hour HAZWOPER & annual update ( ) Medical clearance ( ) Site-specific training

XIII. Other Items
( ) ____________ ( ) ____________

COMMENTS:____

Revision Date	Document Authorizer Name	Revision Details
10/1/2011	Chris McClain	Update

1.0 Loads

Loads are secure and do not exceed manufacturer's specifications and legal limits for the vehicle.

Vehicles will be equipped with only necessary equipment, laid out or positioned in the safest configuration. Loads, equipment and other items shall be tied down or secured before commencing motion, and total weight shall never exceed the weight limitations of the vehicle.

2.0 Guidance

Loads, equipment and other items transported external to the driving compartment or on a trailer shall be:

- Secured in such a manner to prevent against the loss of the load via leaking, spilling, blowing off or falling from the motor vehicle.
- Contained, immobilized or secured in such a manner to prevent shifting.
- If likely to roll, restrained by chocks, wedges, a cradle or other equivalent means to prevent rolling.
- If considered top heavy and capable of tipping, secured in such a manner to prevent tipping.
- If placed beside each other and secured by transverse tie-downs, either placed in direct contact with each other or prevented from shifting towards each other while in transit.

Securing devices and systems shall be capable of withstanding the following three forces, applied separately:

- Deceleration in the forward direction.
- Acceleration in the reverse direction.
- Acceleration in a lateral direction.

The manufacturer shall apply any tie-down points added to a vehicle, or the tie-down points shall meet manufacturer's specifications.

Loads, equipment and other items transported under a pickup truck bed-covering device shall be considered secured.

The driver shall verify that loads, equipment and other items transported inside a vehicle's driving compartment are secure and/or positioned to eliminate or minimize safety risks to the occupants. When loading these items, the driver shall consider:

- Transporting them in the trunk of a car (e.g., a suitcase or computer bag).
- Stowing them under or behind a seat, glove box or armrest console.
- Covering them with netting or holding them in the seats with seatbelts or similar devices.

Revision Date	Document Authorizer		Revision Details
	Name	Approval Date	
4/21/2012	Chris McClain		

1.0 PURPOSE

Tt employees involved in remediation of spills or hazardous waste releases may be required to handle containers of hazardous waste. Services performed at hazardous and non-hazardous waste sites may also necessitate handling materials such as gasoline and oil for equipment operation, and chemicals for preservation of samples brought onto a site. Tt facilities may also maintain chemicals on-site in the construction materials engineering (CME) and analytical laboratories. These scenarios present the primary potential for spills or container leaks.

This safe work practice (SWP) addresses general guidance for spill prevention and cleanup. Specific guidance for spill response can also be found in site-specific health and safety plans developed for hazardous waste sites, work plans for non-hazardous waste sites, the chemical hygiene plan, and the facility emergency response plan. Spill and discharge control practices should follow specific procedures to ensure the safety of responders and bystanders and to limit environmental impacts.

2.0 SPILL PREVENTION

The best spill response approach is to prevent spills from occurring. In order to achieve this, the following practices should be employed at Tt facilities and client job sites.

- Make sure that all containers are appropriately labeled and that material safety data sheets (MSDS) are available. Before handling operating and analysis materials or hazardous waste, appropriate precautions should be in place to prevent spills and exposure to individuals.

- Store chemicals in appropriate locations. Make sure that incompatible chemicals are not stored in the same area. Refer to Appendix A for a general listing of incompatible chemicals.

- When transporting chemicals, ensure that the containers are properly closed, secured, and labeled. Do not carry more than one container at one time. If this is required, place containers within totes.

- Only keep the necessary quantity of each chemical on hand. For ease of use, keep chemicals in working containers that are appropriately sized for handling.

- Ensure that chemicals that are no longer needed and expended chemical containers are disposed of according to regulations pertaining to the specific material.

3.0 GENERAL SPILL RESPONSE PROTOCOLS

In the event that a spill does occur, the following general steps should be followed:

- The first concern should be for human health and safety. Tend to injuries immediately, evacuate the area if necessary, and alert appropriate response personnel.

- If the material is flammable or combustible, an attempt should be made to remove all sources of heat or ignition. However, this does NOT mean unplugging machinery; doing so may cause sparks.

- Consult the MSDS before spill cleanup activities to determine the proper PPE and cleanup equipment to be utilized.

- If the material is still spilling or leaking, attempt to stop additional spillage and contain the area to prevent spread of the contamination.

- Cleanup should be conducted according to the proper techniques described in the MSDS, site-specific health and safety plan, and/or emergency response plan.

- Cleanup should only be attempted by properly trained personnel wearing appropriate PPE.

- All waste should be disposed of according to applicable regulations.

- IF THE SPILL IS TOO LARGE – CALL IN APPROPRIATE RESPONSE PERSONNEL. DO NOT ATTEMPT TO MANAGE THE SPILL YOURSELF.

4.0 DETAILED SPILL RESPONSE PROTOCOLS

This section provides more detailed steps to follow in the event of a spill or leak.

4.1 Immediate Actions

In the event of a spill, employees should immediately:

- Check for injured personnel.
- Clear the affected area.
- Contain the spill and isolate it, if it is safe to do so.
- Contact the facility manager, project manager (PM) or site safety coordinator (SSC).

Immediate action should be taken to control and contain any spill following the general guidelines below:

- Unnecessary personnel should be kept away from the spill or discharge.
- The hazardous area should be isolated.
- If the spill or discharge creates a hazardous situation or results in injury or an environmental release, the emergency procedures of the HASP should be implemented. Emergency response telephone numbers, designated contacts, and special reporting procedures are presented in the HASP.
- Personnel should stay on the upwind side of the spill or discharge.
- Entry into a confined space or low area where liquids or vapors may accumulate should be avoided.

- Sources of ignition should be eliminated if the spill or discharge involves combustible materials.
- Drains, manholes, waterways, sewers, and the like should be identified and covered or protected.
- The spill should be controlled or absorbed using appropriate media or devices.
- When the spill or discharge is fully contained and under control, spill or discharge material should be collected.
- Following cleanup, the spill area should be evaluated by collecting soil samples and screening the area with air monitoring instruments.

4.2 Decontamination of Personnel

If an individual is contaminated while handling or transporting hazardous materials, emergency response personnel must be notified and a spill team activated. The individual must also be decontaminated and receive medical attention. If decontamination procedures would cause further injury, decontamination should not be performed. Instead, use a blanket or other material to contain the contamination during transport, and inform emergency response personnel that the victim has not been decontaminated.

4.3 Risk Assessment

The risk assessment is based upon the hazards posed by the chemicals, the quantity of materials involved, and the location of the spill. A spill response leader should be designated if the spill warrants activation of a spill team (i.e., when a person is injured or contaminated, or a spill is beyond the control of the individual or site personnel). He/she is responsible for all aspects of the response until relieved by a qualified replacement. The spill response leader should determine the level of risk by answering the following questions:

4.3.1 What chemical is involved?

This may be determined by interviewing the person(s) who reported the spill and reviewing associated MSDS. Use knowledge of the work area and visual inspection to make a preliminary identification. This will be verified by direct inspection by the entry team.

4.3.2 How much has spilled?

Information gained when answering the question above should determine the quantity involved. For a continuing leak, attempt to estimate the leak rate. If the quantity cannot be determined, you must assume release of the complete contents of the container.

4.3.3 Where is the incident located?

Take into account the relative area as well as the physical location. For example, determine where the spill is located relative to drains, water bodies, and other potential receptors.

4.4 Development of Spill Cleanup Plan

The spill response leader should develop a spill cleanup plan that includes the following elements:

- Ensure that safety is the number one priority and that all safety issues are addressed prior to beginning spill cleanup.
- Ensure that communication links between the spill response leader, members of the spill response team and emergency response personnel are in place.
- Determine if the risk level associated with the spill allows for internal personnel to conduct the cleanup or if emergency response personnel should be summoned.
- Determine the number of workers needed to safely and effectively perform the cleanup.

- Identify spill response materials and ensure that materials are adequate for the anticipated spills.

- Assign cleanup duties and responsibilities to the spill response team members.

- Inform the appropriate facility manager, project manager, and client contacts.

- Determine the required PPE to be worn by entry and backup spill team members and ensure that it is worn during the activities. Use the site health and safety plan contingency section or the facility emergency response plan to assist in this activity. Typical protective equipment may be Level C or D. In the event that the spill warrants a higher level of protection, Tt personnel should summon emergency response personnel.

- If the spill or discharge material is solid and nonreactive, the material should be scooped up and placed in a suitable and compatible container until the disposal method has been determined.

- If liquid is discharged, the following general procedures apply:

  - The point of discharge should be immediately identified and measures taken to eliminate further discharges by uprighting or patching containers, transferring contents, or other appropriate methods.

  - Any discharged liquids or sludge should be removed or retrieved.

  - Discharged materials should be cleaned up with absorbent materials or devices.

  - Spent absorbent material should be placed into storage or disposal containers.

- Determine proper equipment and spill control media to be used based on the chemical of concern. Typical equipment needed to accomplish spill cleanup may include:

- Seal/plug material
- Absorption socks and booms
- Broom
- Shovel
- Open head 55-gallon drum with liner
- 85-gallon salvage drum

- Control the area so that unnecessary personnel do not enter and situations that may escalate the hazards in the area are eliminated. Ideally, the exclusion zone should be physically barricaded off. At a minimum, barricade tape can be placed.

- An exclusion zone, contamination reduction zone, and a support zone may be needed. Only authorized personnel will be allowed in these areas. Wind direction, plant and surrounding populations, and the properties of the spilled material must be considered in establishing the initial controlled zone. Exclusion zones should be barricaded (or at least taped off with barricade tape) to prevent general public access. The zone can be expanded or contracted as more information is gathered about the spill.

- Determine if the situation requires monitoring of explosive atmosphere, oxygen deficiency, or toxic levels of chemicals. This will also help determine the level of PPE required and conditions that would require the area to be evacuated and emergency response personnel summoned.

4.5 Implementation Spill Cleanup Plan

After the spill response leader has developed a plan to containerize and remove all material contaminated by the spill, the assigned members of the spill team will complete the following steps.

4.5.1 Cleanup, containerize, and decontaminate the area

- Attempt to control the source of the leak if the full contents of a drum or container have not spilled. Perhaps the simplest procedure is to position the drum or container so that the leak is above the liquid level. Alternatively, a drum patch or plug can be applied to the leak. The leaking chemical may also be controlled using absorbent spill berms positioned around the drum or container.

- Contain free-flowing liquids by diking or absorbing.

- Place all spill residues and cleanup equipment in an appropriate container.

- If solvent is used to decontaminate equipment, floors, or walkways, appropriate fire protection should be used.

- Decontaminate and salvage as much equipment as possible.

- Use only a final water wash where it is safe and appropriate to do so.

4.5.2 Analyze the affected area for proper decontamination safety

- Use monitoring and detection equipment, if needed.

- Check equipment for problems.

- Examine walkways, floors, and stairs for obstructions or hazards (i.e. slip/fall exposure from liquid residue).

- Use any resources needed (safety, industrial hygiene, environmental, etc.) to ensure that the area has been decontaminated and is safe to re-enter.

4.5.3 Secure all response equipment

- Restock spill supplies.

- Repair damaged equipment.

4.5.4 Release site resumption of operations

- Notify operating personnel.
- Document spill or release in on-site or facility log.

As soon as the area is safe for reoccupancy, the spill response leader, in conjunction with the site or facility manager, must initiate actions to allow the facility to resume normal operations.

- Use established procedures to announce an “All Clear.”
- Properly mark spill residue containers for hazardous waste management.
- Clean and prepare all emergency response materials for immediate use storage.
- Complete all spill response reports as required.

5.0 FINAL TERMINATION OF THE INCIDENT

The project manager (PM) and site safety coordinator (SSC) should conduct a formal review and debriefing of the responders at the conclusion of the project. Corrective actions may need to be implemented if a cause for the spill was determined and can be prevented from happening again.

Final termination of the incident will be complete when the appropriate personnel review all reports and any corrective actions are completed.

6.0 REPORTING

In some instances, a release may require reporting to government agencies. If a reportable quantity is released (this quantity is stated on the Material Safety Data Sheet) or human health or the environment is threatened, appropriate national, state, and local administering agency personnel should be notified. The timeframe for notification may vary from agency to agency.

Notification may be required immediately or within 24 hours, depending on the type, location, and amount of released material. The appropriate agency to report spills to should be determined during HASP development.

All spills and chemical releases must be reported and investigated in accordance with Tt Program 2.1 Incident Reporting and Investigation. Details must be documented on the Forms IR and IR–B and entered into the Tetra Tech TOTAL system for appropriate incident review and tracking.

INCOMPATIBLE CHEMICALS

When certain hazardous chemicals are stored or mixed together, violent reactions may occur because the chemicals are incompatible (i.e., unsuitable for mixing). Classes of incompatible chemicals should be segregated according to hazard class during storage. Use the following general guidelines for hazard class storage.

- Flammable/combustible liquids and organic acids
- Flammable solids
- Mineral acids
- Caustics
- Oxidizers
- Perchloric acid
- Compressed gases

Separate hazardous chemicals in storage as follows:

- Oxidizing acids are segregated from organic acids, and flammable and combustible materials.

- Acids are separated from inorganic bases.
- Acids are separated from active metals such as sodium, potassium, and magnesium.
- Acids are separated from chemicals that could generate toxic gases upon contact, such as iron sulfide and sodium cyanide.
- Water-reactive chemicals such as calcium oxide are stored in a cool, dry place away from any potential water source.
- Oxidizers are physically segregated from flammable and combustible chemicals or materials.
- Oxidizers are physically segregated from reducing agents such as zinc, alkaline metals, and formic acid.
- Large bottles of corrosives are stored on a low shelf or in specially designed (i.e., UL listed) cabinets. Single-glass bottles of acids and corrosives can also be placed within buckets or other means for both safe handling and as a means of secondary containment in the event of breakage.

Carefully read the label before storing any chemical substance. Use the materials safety data sheets (MSDS) to find special storage information and information on incompatibilities. If you have questions regarding proper storage of chemicals or if a container is not clearly labeled, contact a qualified individual for additional information.

Before mixing, storing, or transporting any chemicals, refer to the following partial list of incompatible chemicals, the chemicals' MSDS, or other reliable reference for further information or to verify compatibility.

List of Incompatible Chemicals

Chemical	Incompatible Chemical(s)
Acetic Acid	Aldehyde, bases, carbonates, hydroxides, metals, oxidizers, peroxides,

Chemical	Incompatible Chemical(s)
	phosphates, xylene
Acetylene	Halogens (chlorine, fluorine, etc.), mercury, potassium, oxidizers, silver
Acetone	Acids, amines, oxidizers, plastics
Alkali and alkaline earth metals	Acids, chromium, ethylene, halogens, hydrogen, mercury, nitrogen, oxidizers, plastics, sodium chloride, sulfur
Ammonia	Acids, aldehydes, amides, halogens, heavy metals, oxidizers, plastics, sulfur
Ammonium nitrate	Acids, alkalis, chloride salts, combustible materials, metals, organic materials, phosphorous, reducing agents, urea
Aniline	Acids, aluminum, dibenzoyl peroxide, oxidizers, plastics
Azides	Acids, heavy metals, oxidizers
Bromine	Acetaldehyde, alcohols, alkalis, amines, combustible materials, ethylene, fluorine, hydrogen, ketones (acetone, carbonyls, etc.), metals, sulfur
Calcium oxide	Acids, ethanol, fluorine, organic materials
Carbon (activated)	Alkali metals, calcium hypochlorite, halogens, oxidizers
Carbon tetrachloride	Benzoyl peroxide, ethylene, fluorine, metals, oxygen, plastics, silanes
Chlorates	Powdered metals, sulfur, finely divided organic or combustible materials
Chromic acid	Acetone, alcohols, alkalis, ammonia, bases
Chromium trioxide	Benzene, combustible materials, hydrocarbons, metals, organic materials, phosphorous, plastics
Chlorine	Alcohols, ammonia, benzene, combustible materials, flammable compounds (hydrazine), hydrocarbons (acetylene, ethylene, etc.), hydrogen peroxide, iodine, metals, nitrogen, oxygen, sodium hydroxide
Chlorine dioxide	Hydrogen, mercury, organic materials, phosphorous, potassium hydroxide, sulfur
Copper	Calcium, hydrocarbons, oxidizers
Hydroperoxide	Reducing agents
Cyanides	Acids, alkaloids, aluminum, iodine, oxidizers, strong bases
Flammable liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
Fluorine	Alcohols, aldehydes, ammonia, combustible materials, halocarbons, halogens, hydrocarbons, ketones, metals, organic acids
Hydrocarbons (e.g. butane, propane benzene, turpentine, etc.)	Acids, bases, oxidizers, plastics
Hydrofluoric acid	Metals, organic materials, plastics, silica (glass), (anhydrous) sodium
Hydrogen peroxide	Acetylaldehyde, acetic acid, acetone, alcohol's carboxylic acid,

Chemical	Incompatible Chemical(s)
	combustible materials, metals, nitric acid, organic compounds, phosphorous, sulfuric acid, sodium, aniline
Hydrogen sulfide	Acetylaldehyde, metals, oxidizers, sodium
Hypochlorites	Acids, activated carbon
Iodine	Acetylaldehyde, acetylene, ammonia, metals, sodium
Mercury	Acetylene, aluminum, amines, ammonia, calcium, fulminic acid, lithium, oxidizers, sodium
Nitrates	Acids, nitrites, metals, sulfur, sulfuric acid
Nitric acid	Acetic acid, acetonitrile, alcohol's, amines, (concentrated) ammonia, aniline, bases, benzene, cumene, formic acid, ketones, metals, organic materials, plastics, sodium, toluene
Oxalic acid	Oxidizers, silver, sodium chlorite
Oxygen	Acetaldehyde, secondary alcohol's, alkalis and alkalines, ammonia, carbon monoxide, combustible materials, ethers, flammable materials, hydrocarbons, metals, phosphorous, polymers
Perchloric acid	Acetic acid, alcohols, aniline, combustible materials, dehydrating agents, ethylbenzene, hydriotic acid, hydrochloric acid, iodides, ketones, organic material, oxidizers, pyridine
Peroxides, organic	Acids (organic or mineral)
Phosphorous (white)	Oxygen (pure and in air), alkalis
Potassium	Acetylene, acids, alcohols, halogens, hydrazine, mercury, oxidizers, selenium, sulfur
Potassium chlorate	Acids, ammonia, combustible materials, fluorine, hydrocarbons, metals, organic materials, sugars
Potassium perchlorate (also see chlorates)	Alcohols, combustible materials, fluorine, hydrazine, metals, organic matter, reducing agents, sulfuric acid
Potassium permanganate	Benzaldehyde, ethylene glycol, glycerol, sulfuric acid
Silver	acetylene, ammonia, oxidizers, ozonides, peroxyformic acid
Sodium	Acids, hydrazine, metals, oxidizers, water
Sodium nitrate	Acetic anhydride, acids, metals, organic matter, peroxyformic acid, reducing agents
Sodium peroxide	Acetic acid, benzene, hydrogen sulfide metals, oxidizers, peroxyformic acid, phosphorous, reducers, sugars, water
Sulfides	Acids
Sulfuric acid	Potassium chlorates, potassium perchlorate, potassium permanganate

Revision Date	Document Authorizer Name	Revision Details
01/31/2013	Chris McClain	New

ATTACHMENT III
TETRA TECH COMPLETED ACTIVITY HAZARD ANALYSES

Units 4 and 5 Buildings Perchlorate (Task M02)

Tetra Tech, Inc.	**TETRA TECH, INC.** **ACTIVITY HAZARD ANALYSIS (AHA)**

Activity/Work Task: NERT Unit 4 Investigation - Perchlorate Hazard	**Overall Risk Assessment Code (RAC) (Use highest code)**	**M**

Project Location: NERT Site, Henderson, NV	**Risk Assessment Code (RAC) Matrix**					
Contract Task Order Number: 117-0504155	**Severity**	**Probability**				
Date Prepared: 02/23/2015		Frequent	Likely	Occasional	Seldom	Unlikely
Prepared by: Michelle Gillie, CIH/Corporate Health & Safety	Catastrophic	**E**	**E**	**H**	**H**	**M**
	Critical	**E**	**H**	**H**	**M**	**L**
Reviewed by: Robert C. Morhard/ExploConsult LLC; Roy Marroquin	Marginal	**H**	**M**	**M**	**L**	**L**
	Negligible	**M**	**L**	**L**	**L**	**L**
Notes: This AHA addresses the perchlorate health and safety hazard only for all site operations. All other identified project chemical, physical and biological hazards are addressed in the HASP sections 4-6.	Step 1: Review each **"Hazard"** with identified safety "Controls" implemented and determine RAC (See above)					
	"Probability" is the likelihood to cause an incident, near miss, or accident and Identified as: Frequent, Likely, Occasional, Seldom, or Unlikely.					**RAC Chart**
	"Severity" is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible					**E= Extremely High Risk** **H= High Risk**
	Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" on AHA. Annotate the overall highest RAC at the top of AHA.					**M= Moderate Risk** **L = Low Risk**

ACTIVITY / PHASE	POTENTIAL HAZARDS	RECOMMENDED ACTIONS / CONTROLS	RAC
All Tasks	Fire/explosion Worker injury/death Property/equipment damage	**A formal Process Hazard Analysis will be performed by a qualified perchlorates and explosives safety expert in advance of any actual site work.**	
Unit 4 first floor and basement inspection for hazardous materials in areas that will be demolished	Dermal contact with perchlorate residues on basement concrete floor and structures (open tanks, trenches, etc.) Potential fire hazard if perchlorate residues dry on flammable/combustible clothing or leather	Modified Level D PPE including single-use rubber overboots to cover leather safety boots. Tyvek coveralls if significant residue observed. Follow decon and safe disposal procedures for IDW as described in HASP. Avoid walking in areas that show staining, residue accumulation, puddling, etc. Do not walk into trenches, depressions, or low-lying areas. Do not disturb any dust, debris, suspect materials on floors and horizontal surfaces. Do not eat, smoke, or drink where Ammonium Perchlorate is suspected to avoid ingestion or inhalation. Use good personal hygiene practices to prevent inadvertent ingestion, inhalation and contact.	**L**

ACTIVITY / PHASE	POTENTIAL HAZARDS	RECOMMENDED ACTIONS / CONTROLS	RAC
		In the event of exposure to eyes immediately utilize eye wash station for at least 15 minutes. In the event of skin contact with Ammonium Perchlorate, wash skin with soap and water immediately. At the end of the work shift, wash with soap and water as soon as possible. Wash hands with soap and water carefully before eating, drinking, smoking, or using the toilet.	
Unit 4 concrete chip sampling with hand tools (hammer and chisel), and surface wipe sampling for waste material characterization	Dermal contact with perchlorate residues on basement concrete floor and structures (open tanks, trenches, etc.); inhalation and/or ingestion with suspect debris. Fire and explosion hazard	**Above controls plus:** Wear impact resistant face shield or eye protection with side shields or goggles. Wet/dampen area to be sampled with continuous water spray mist. Wear neoprene/nitrile rubber gloves. Collect and manage excess concrete chips as IDW pending characterization.	**L**
Concrete cutting (8-inch thickness with rebar) at 12-30 locations in Unit 4 basement floor. Removal of cut concrete section to access sub-slab soil.	Fire and explosion hazard due to extreme reactivity of ammonium perchlorate Worker injury/death Property damage	Verify that Unit 4 south rectifier room/battery operations do not increase site safety risks (e.g., metals, acidic wastes handling). Ammonium Perchlorate is a strong oxidizer; and mixtures with SULFUR, ORGANIC MATERIALS, and FINELY DIVIDED METALS are explosive and friction and shock sensitive. Ammonium Perchlorate is not compatible with STRONG ACIDS (such as HYDROCHLORIC, SULFURIC and NITRIC); METALS (such as ALUMINUM, COPPER, and POTASSIUM); METAL OXIDES; PHOSPHORUS; and COMBUSTIBLES. Coordinate with local emergency responders in advance of operations to confirm local emergency planning requirements. Coordinate with Tronox and Trust to schedule work when operations are inactive and adjacent buildings are empty. Verify there are no flammable, combustible, finely divided metals, static electricity, friction or mechanical impacts in work area. Set up sand bags around concrete cutting area. Workers will wear high-performance (military equivalent) flame retardant clothing when accessing the work area. Use high-pressure water jet to cut concrete in rectangular/square sections and operate remotely.	**M**

ACTIVITY / PHASE	POTENTIAL HAZARDS	RECOMMENDED ACTIONS / CONTROLS	RAC
		Following the use of the water jet to cut away the concrete access panel, an area in the rebar lattice may be cut to allow the drill steel to be used to allow further drilling below the concrete foundation. A rotary saw will be used to cut the rebar lattice, and the saw will be quenched with a significant stream of water aimed directly onto the blade to mitigate sparks and heat. Use non-sparking tool to lift concrete section. Examine exposed soil for evidence of deposited perchlorate salts (white granular material). Assess soil moisture content and ensure minimum of **25% moisture content by ASTM method or equivalent.** Apply copious and continuous water to exposed soil via hose holder at boring location to flood subslab soil and allow to percolate. Reassess moisture content and ensure minimum of 25% prior to boring or next lift.	
Drilling with hollow stem auger	Fire and explosion hazard due to extreme reactivity of ammonium perchlorate Worker injury/death Property damage	Conduct test at known safe location to evaluate temperatures of all tooling and drilling equipment using ASTM method or equivalent to ensure safe operating temperatures. Set up sand bags around soil boring area. Minimize number of workers in active work zone. Establish safety zone **of 350 feet minimum in all directions**. Apply copious and continuous water to exposed soil via hose at boring location. Keep water flow in auger during drilling. Monitor all tooling and drilling temperatures **with a handheld heat sensing device** to be sure that **temperatures do not exceed 150° C (302° F)** Workers will wear high-performance (military equivalent) flame retardant clothing when accessing the work area. Place water-filled jump tank close to work area for quick immersion in case of dermal contact, irritation or fire.	**M**
Soil sampling and logging	Dermal contact with perchlorate residues Fire and explosion hazard due to extreme reactivity of ammonium perchlorate Worker injury/death Property damage	Workers will wear high-performance (military equivalent) flame retardant clothing when accessing the work area. Wet/dampen area to be sampled with continuous water spray mist. Wear neoprene/nitrile rubber gloves. Collect and manage excess soil cuttings as IDW pending characterization.	**M**

ACTIVITY / PHASE	POTENTIAL HAZARDS	RECOMMENDED ACTIONS / CONTROLS	RAC
		Do not place on plastic sheeting or in plastic-lined roll-off if dry salts are observed. Place in unlined steel drum.	
Groundwater sampling	Contact with dissolved perchlorates in GW Fire and explosion hazard due to extreme reactivity of ammonium perchlorate Worker injury/death Property damage	Workers will wear high-performance (military equivalent) flame retardant clothing when accessing the work area. Wear rubber overboots. Wear neoprene/nitrile rubber gloves. Use good personal hygiene practices to prevent inadvertent ingestion, inhalation and contact.	L

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
Equipment:		
Personal Protective Equipment: **<u>Minimum</u>**: **<u>Optional items</u>**: **Emergency Equipment**		Hazard communication training on perchlorates in addition to HASP/AHA review.

All persons will sign this AHA indicating that they have reviewed the document and are aware of their responsibilities as stated in the AHA.

Name (Printed)	Signature	Occupation	Date Reviewed/Training

ATTACHMENT IV
PERCHLORATE HAZARD COMMUNICATION INFORMATION

SAFETY DATA SHEET

1. IDENTIFICATION

Product Identifier:	Ammonium Perchlorate
Synonyms:	AP, ammonium salt of perchloric acid
Product Code:	Reach Registration 01-2119490079-30-0001
SDS compliant with regulations:	(EC) No 1907/2006 (REACH), (EC) No 1272/2008 (CLP)
Manufacturer / Supplier:	American Pacific (AMPAC), Western Electrochemical Co.
Address:	10622 West 6400 North, Cedar City, UT 84721
Telephone:	+1 (435) 865-5000 **Fax:** +1 (435)-865-5005
Emergency Contact:	CHEMTREC Customer Number: CCN721187 US Tel: 1 (800) 424-9300 Int'l Tel: +1 (703) 741-5970
Email:	sds@apfc.com
Use of the substance/preparation:	Analytical chemistry, oxidizer in various propellant or explosive mixtures, various industrial uses involving need for oxidizing or ionization in aqueous solution properties.

2. HAZARDS IDENTIFICATION

Signal Word: Danger

GHS03: flame over circle

GHS07: exclamation mark

GHS08: health hazard

Preparation classification:
Physical Hazard:

H271: May cause fire or explosion; strong oxidizer.
EUH044: Risk of explosion if heated under confinement.

Health Hazard:

H373: May cause damage to thyroid through prolonged or repeated exposure via oral and inhalation route.
Xi; R36 Irritant; Irritating to eyes.
EUH401: To avoid risks to human health and the environment, comply with instructions for use.

Precautionary Statements:

P221: Take any precaution to avoid mixing with combustible materials.
P272: Contaminated work clothing should not be allowed out of the workplace.
P363: Wash contaminated clothing before reuse.

Potential acute health effects:

Eye: irritation, redness, tearing
Skin: Irritating to mucous membranes and skin
Inhalation: may cause respiratory tract irritation; coughing, and shortness of breath; high concentrations may cause more significant respiratory effects
Ingestion: may cause gastrointestinal irritation; larger doses my cause nausea and vomiting.

Potential chronic effects:

Perchlorates act to reversibly and competitively inhibit iodine uptake by the thyroid gland. Perchlorate is soluble in water, so exposure to ammonium perchlorate can be via water contaminated with ammonium perchlorate or inhalation in the workplace.
With chronic exposure given sufficient dose (see (United States National Research Council) NRC, 2005) and duration, ammonium perchlorate can cause thyroidal stores of iodine to be reduced, which may lead to hypothyroidism. For workers that live in areas of the world with endemic iodine deficiency, it is important that these people receive adequate iodine in the diet or are supplemented with iodine.

Information pertaining to particular dangers for man and environment: May be explosive when mixed with combustible material. Risk of explosion if heated under confinement

For the full text of the H - Statements see Section 16

3. COMPOSITION / INFORMATION ON INGREDIENTS

Chemical Name: Ammonium Perchlorate

Ingredient Name	Chemical Makeup	CAS#	EC#	%
Ammonium Perchlorate	NH_4ClO_4	7790-98-9	232-235-1	~100

4. FIRST AID MEASURES

As a general rule, in case of doubt or if symptoms persist, always call a physician.

Routes of exposure	Signs and symptoms of exposure:	Emergency and first aid procedures:
Skin:	May cause local irritation or stinging effect.	Wash exposed area immediately with plenty of water. Remove contaminated clothing and footwear.
Inhalation:	Airborne concentrations of ammonium perchlorate can aggravate pre-existing respiratory problems. Chronic exposure may interfere with the uptake of iodine by the thyroid which may cause hypothyroidism.	If experiencing increased respiration or shortness of breath, move to fresh air. Administer oxygen if exposed person is unconscious. Never give anything by mouth to an unconscious person.
Ingestion:	Ingestion of large quantities has been reported to cause staggering in small mammals. Chronic ingestion of sufficient quantities may interfere with uptake of iodine by the thyroid which may cause hypothyroidism.	Give water. Induce vomiting, keep airway clear. Seek medical attention.
Eyes:	Irritation of the eyes will cause stinging effect.	Flush eyes with fresh water for at least 15 minutes and move exposed person to a non-contaminated area.

5. FIRE FIGHTING MEASURES

Flammable properties:
Flash point: not flammable.
Flash point method: not applicable.
Auto-ignition temperature: not applicable. Ammonium perchlorate decomposes spontaneously at 300° C in its pure state. Contaminants may cause decomposition at lower temperatures typically down to 270^{O} C but decomposition temperature has been listed as low as 240^{O} C in one case
Upper flammability limit (volume % in air): not applicable.
Lower flammability limit (volume % in air): not applicable.

Extinguishing media: water - other extinguishing materials are ineffective

Unusual fire and explosion hazards: ammonium perchlorate is an oxidizing agent and may cause rapid combustion or explosions if mixed with fuels, including organic materials or powdered metals. This does not include dot shipping containers if intimate mixtures are not present and the shipping container is not inordinately contaminated.

Special firefighting precautions/instructions: 1) Do not fight fires involving mixtures of ammonium perchlorate and fuels. Ammonium perchlorate is an oxidizing agent and may cause rapid combustion or explosions if mixed with fuels. 2) Burning ammonium perchlorate may produce chlorine, chlorine dioxide, hydrogen chloride, and oxides of nitrogen as well as mixtures with any other compounds involved in the combustion. These are common by-products of combustion and are likely to be serious health concern; thus, keep upwind or wear self-contained breathing apparatus when attempting to rescue.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions: Handle the dispersed product wearing protective gloves and glasses as described in section 8.

Environmental precautions: Dispose of waste recovered in accordance with applicable local, state, and federal regulations. Avoid contaminating the environment via the sewers or water sources. Dispose of in accordance with local, state, and federal regulations

Methods for cleaning up: Sweep up material and containerize. Clean contaminated floor surface with water. Move away incompatible products (organic materials, reducing agents).

7. HANDLING AND STORAGE

The regulation relating to storage premises apply to workshops where the product is handled.

Handling:
Handle away from heat and humidity sources (if possible in covered and well ventilated premises).
Avoid contact with incompatible substances (organic materials and reducing agents, especially fuels, oils, greases, etc.).
Avoid contact with eyes and skin (wear appropriate personal protective equipment: glasses, gloves and mask in case of dust).
Prevent any contamination of the environment via the sewers or water sources.

Fire prevention:
Avoid any contamination. Contaminated materials may be sensitive to shocks and friction.

Recommended equipment and procedures:
Store in original closed containers in areas that are specially designated for storage of compatible oxidizers

Prohibited equipment and procedures:
Do not use containers that have not been approved for shipping this particular oxidizer. Refer to relevant transportation codes for the area of use, but is suggested that the UN requirements be met if they are more stringent.

Specific uses:
Analytical chemistry, oxidizer in various propellant or explosive mixtures, various industrial uses involving need for oxidizing or ionization in aqueous solution properties

Storage:
Do not store with reducing agents, organic materials, especially fuels, oils, greases, etc.
Do not store with explosive substances that may detonate.
Do not store close to a heat source that could cause temperatures to approach the decomposition temperature.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

It is always advisable to minimize dusting and use respiratory protection for environments where substantial dust is generated or where there may be exposure to water with high concentrations of perchlorate.

Technical measures:
Ventilate as necessary to minimize dust exposures. Inspect and clean ventilation systems regularly.

Control Parameters:

INGREDIENT NAME	ACGIH	OSHA
Ammonium Perchlorate	TLV/TWA: 10 mg/m3 (Nuisance Dust)	PEL/TWA 15 mg/m3 (Nuisance Dust)

EC Exposure limit values (human):

Exposure Route	DNEL (worker)	DNEL (population)
Ingestion	2.2 mg/kg bw/d	20 µg/kg bw/d
Inhalation	0.28 mg/m3	70 µg/m3

Exposure controls:
Appropriate engineering controls. Ventilate as necessary to minimize dust exposures. Inspect and clean ventilation systems regularly.

Personal protective equipment:

Skin Protection: Wear impervious aprons or rain gear to reduce contamination of cotton or other fiber clothing. Plastic, rubber or latex gloves are recommended. Leather or cotton gloves should not be used unless a management program is implemented to ensure detection of contamination and immediate cleaning and change in case of contamination. Cotton clothing may be used if chance of contact is minimal or if clothing is monitored for contamination and changed if contamination occurs. In any case where combustible protection is used, a strong management system must be in place to monitor contamination and ensure appropriate removal and cleaning or severe risk of fire and personal injury or death exists. There are no known cloth materials that will not combust vigorously with perchlorates including nomex, Kevlar based materials, or clothing that is normally considered fire retardant or resistive. Observation and management of contamination is the only practicable safety measure.

Hand Protection: Type of glove recommended-Plastic, rubber or latex gloves are recommended. Leather or cotton gloves should not be used unless a management program is implemented to ensure detection of contamination and immediate cleaning and change in case of contamination.

Eye Protection: Under normal conditions, wear safety glasses. Under dusty conditions, wear chemical safety goggles.

Respiratory Protections: Under normal conditions, respiratory protection is not required. Where dusty conditions develop, use a mask or respirator approved by the EC state where this product is used for dusts.

Additional Recommendations: Avoid contamination of cotton or other absorbent material. As in any industrial working environment, workers should routinely wear clean clothes to work. Do not wear any work clothing that has become contaminated with ammonium perchlorate. Remove contaminated clothing immediately and keep wet until thoroughly washed. Keeping contaminated clothing wet minimizes hazards until the laundering is completed. Showering is recommended after handling any industrial chemical. Smoking of tobacco should not be permitted while wearing contaminated clothing. Leather boots may become contaminated and could be a source of combustion damaging feet. Rubber boots are recommended unless a very strict management program to detect contaminated leather boots is in place much as listed on the glove section above.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance: White crystal	**Physical state:** Solid	**Molecular weight:** 117.50 g/mol	**Chemical formula:** NH_4ClO_4	**Odor:** No odor
Specific gravity (water = 1.0): 1.95	**Solubility in water (weight %):** 20.8 g/ 100 mL at 20° C	**pH:** material is a solid however, dissolved in water the pH is slightly acidic	**Boiling point:** Not applicable, decomposes	**Melting point:** Decomposes at 300° C in its pure state, impurities may lower the decomposition temperature significantly.
Density: 1.950 g/cm3	**Partition coefficient: noctanol/ Water:** No data available	**Auto Ignition Temperature:** No data available	**Upper flammability or explosive limits:** Not applicable	**Lower flammability or explosive limits:** Not applicable
Vapor pressure: solid, not applicable	**Vapor density (air = 1.0):** not applicable	**Evaporation rate:** Not applicable	**Flash point:** Not flammable (Flash point method and additional flammability data are found in Section 5.)	

10. STABILITY AND REACTIVITY

The preparation is stable at the handling and storage conditions recommended per section 7 of this Safety Data Sheet.

Reactivity: Do not mix with organic materials, reducing agents, metal powders or powdered carbon.

Chemical stability: Stable under normal conditions.

Conditions to avoid: Avoid elevated temperatures over 270°C, which can cause spontaneous exothermic decomposition. Cloth fabric of any type including dust collector bags intimately contaminated with ammonium perchlorate is subject to ignition through friction or impact. Water scrubber type dust collection systems are recommended. High-energy static electricity may also serve as an ignition source when contamination or combustibles are intermixed.

Materials to avoid: Sulfuric acid, powdered metals, and intimate mixtures with organics.

Hazardous decomposition products: Chlorine, chlorine dioxide, oxygen, nitrogen oxides, hydrogen chloride.

11. TOXICOLOGICAL INFORMATION

As with any toxicant, assessing dose and exposure are required to understand potential toxicity.

Ammonium perchlorate acts to reversibly and competitively inhibit iodine uptake by the thyroid gland. The half-life of ammonium perchlorate ranges from 8 to 12 hours.

Ammonium perchlorate does not bioaccumulate. Perchlorate is not metabolized and is excreted from the kidneys.

Harmful if swallowed or inhaled in large doses. In the early 1960s another salt of perchlorate, potassium perchlorate, given at 600 to 1000 mg/day for weeks of exposure as an oral therapeutic agent to treat hyperthyroidism was reported to be associated with a few cases of aplastic anemia and agranulocytosis (NRC, 2005). Since that time, there have been no known reports of aplastic anemia. There have been no reports of ammonium perchlorate associated with aplastic anemia or agranulocytosis.

Immediate (acute) effects:
Oral LD50: rat; 4200 mg/kg Rat-par-LDLo = 3500 mg/kg
Oral LD50: rabbit; 1900 mg/kg Rabbit-par-LDLo = 750 mg/kg
Inhalation LC50: No references found.
Skin sensitization: not reported to be a skin sensitizer

Delayed (subchronic and chronic) effects:
Thyroid: No long-term health effects have been reported with worker exposure to ammonium perchlorate. Perchlorate is water soluble, so exposure to ammonium perchlorate can be via water contaminated with ammonium perchlorate or inhalation in the workplace. With chronic exposure, sufficient dose, and duration, ammonium perchlorate may cause thyroidal stores of iodine to be reduced, which may lead to goiter (enlarged thyroid gland) and hypothyroidism. Occupational studies indicated no adverse health effects on workers exposed for 3 years or more to perchlorate. These studies also demonstrate that blood chemistry and hormone values are not altered with occupational exposures as high as 0.48 mg per kilogram body weight (Braverman et al., 2005; Lamm et al., 1999). In 2005, a United States National Academies of Science (NAS) Committee comprehensively reviewed the literature related to oral exposures of perchlorate and reported that "to cause declines in thyroid hormone production that would have adverse health effects, iodide uptake would most likely have to be reduced by at least 75% for months or longer" and "...the perchlorate dose required to cause hypothyroidism in adults would probably be more than 0.40 mg/kg per day, assuming a 70-kg body weight" (NAS, 2005). The NAS also identified a no-observed-effect-level of 0.007 mg/kg/day in humans, based on Greer et al. 2002, which is a dose that does not cause inhibition of iodide uptake. This is further supported by a small study in no effect on thyroid function was reported with six months of exposure up to 0.3 mg/d (Braverman et al., 2006). For workers that live in areas of the world with endemic iodine

deficiency, it is important that these people receive adequate iodine in the diet or are supplemented with iodine.

Carcinogen:
IARC: NO
NTP: NO
OSHA: NO

Reproductive:
In 2005, the California Environmental Protection Agency's Office of Environmental Health Hazard Assessment (OEHHA) Developmental and Reproductive Toxicology Identification (DART) Committee concluded that available scientific information on perchlorate was not sufficient for placing the substance on a list (Prop 65) list of chemicals known to the State of California to cause birth defects or other reproductive harm.

Immunology:
Immunotoxicity studies in mice revealed no changes in immunologic function in response to perchlorate exposure (Keil et al. 1998, 1999).

Other Medical conditions aggravate by exposure:
Excessive dust inhalation can aggravate respiratory conditions.

12. ECOLOGICAL INFORMATION

Toxicity Data:
Daphnia Magna Acute 48-hour LC_{50} 490 mg/l water with sodium perchlorate
Pimephales Promelas Acute 96 hour LC_{50} 1655 mg/l water with sodium perchlorate
Ceriodaphnia dubia Chronic 6 day LC_{50} 77.8 mg/l water with ammonium perchlorate
Pimephales promelas Subchronic 7 day LC_{50} 270 mg/l water with ammonium perchlorate
Latuca Sativa Subchronic 7 day LC_{50} 614 mg/kg soil
Eisenia Foetida Acute 7 day LC50 4450 mg/kg soil

Persistence and degradability:
Perchlorate ion is persistent but can be decomposed by naturally occurring bacteria in anoxic conditions in the presence of a suitable electron donor.

Bio-accumulative potential:
Perchlorate has a half-life of approximately 8 hours and is excreted unchanged, mostly in urine. Perchlorate does not bio-accumulate (NAS, 2005).

13. DISPOSAL CONSIDERATIONS

The generation of waste should be avoided or minimized wherever possible. Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements.

Disposal should be in accordance with applicable regional, national and local laws and regulations. Local regulations may be more stringent than regional or national requirements.

The information presented below only applies to the material as supplied. The identification based on characteristic(s) or listing may not apply if the material has been used or otherwise contaminated. It is the responsibility of the waste generator to determine the toxicity and physical properties of the material generated to determine the proper waste identification and disposal methods in compliance with applicable regulations.

Refer to Section 7: HANDLING AND STORAGE and Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION for additional handling information and protection of employees.

Is the unused product a RCRA hazardous waste if discarded? Yes –if discarded as a solid and not in solution. If discarded as a solution carefully evaluate before any determination of waste status to avoid misinterpretation. Caution: Intentionally placing solid material into solution to dispose of it may violate several regulations if not managed carefully thereafter. Various states have local regulations that are applicable and are changing. Evaluate carefully all applicable regulations for your location before determining status and method of disposal!

If yes, the RCRA ID number is: D001

The information offered in section 13 is for the product as shipped. Use and/or alterations to the product such as mixing with other materials may significantly change the characteristics of the material and alter the RCRA classification and the proper disposal method.

Follow all rules and recommendations of the EC member state in which product is used.

Ammonium perchlorate should be disposed as a solid to either a hazardous waste landfill, in the US. Similar regulations apply to the EU and other parts of the world. Do not dispose of ammonium perchlorate where it is likely to contact water and dissolve and then enter the environment. Verify the local state (country) requirements where the material is sited before disposing. If transported to another country (state), additional regulations may apply. In any case, manage disposal to protect persons and the environment.

The information offered in section 13 is for the product as shipped. Use and/or alterations to the product such as mixing with other materials may significantly change the characteristics of the material and alter the RCRA classification and the proper disposal method.

14. TRANSPORT INFORMATION

Proper Shipping Name:

Ammonium perchlorate
Ammonium perchlorate manufactured by AMPAC meets the 5.1 Oxidizer classification UN Number 1442, Packing Group 2. The product is shipped with a 5.1 oxidizer label. AMPAC does not manufacture material with nominal granulometry less than 70 µm.

UN NUMBER: UN1442	**PROPER SHIPPING NAME:** Ammonium Perchlorate	**US DOT HAZARD CLASS:** Oxidizer 5.1	**PACK GROUP:** II	UN1442, Ammonium Perchlorate, 5.1, II

Additional transport information:
For additional information on shipping regulations affecting this material, contact the information number found in Section 1. Note: AMPAC, the parent of Western Electrochemical Co. Division has performed tests as required and applied to DOT and received approvals listed at the right for various grades of AP as 5.1 oxidizer as shown to the right. Other AP does not automatically meet this classification and would require testing and DOT approval to achieve a 5.1 oxidizer class. These exemptions are specific to the facility located at 10622 West 6400 North, Cedar City, Utah 84720 Ammonium perchlorate Propellant grade 170 micron and greater has received classification as a 5.1 oxidizer under EX 2003110036.

Ammonium perchlorate propellant grade with average particle size of 70 microns and larger; Ammonium perchlorate wetted with not less than 5% water, and Ammonium perchlorate, non-propellant grade, with average particle size 70 microns and larger has received classification as a 5.1 oxidizer under EX2004020234. Both exemptions have container and weight restrictions and are not directly transferable to any other parties without application to and approval of DOT through the RSPA office or its successor office.

Environmental Hazards: Please see section 12. Prevent any contamination of the environment via the sewers or water sources.

Special precautions for user: Please see section 7.

15. REGULATORY INFORMATION

U.S. Federal regulations:

TSCA: CAS# 7790-98-9 is listed on the TSCA inventory.
SARA 302/304/311/312 extremely hazardous substances: None of the chemicals in this product have a TPQ.
SARA 302/304 emergency planning and notification: No products were found.
SARA 302/304/311/312 hazardous chemicals: No products were found.
Clean Water Act (CWA) 307: No products were found.
Clean Water Act (CWA) 311: No products were found.
Clean Air Act (CAA) 112 accidental release prevention: No products were found.
Clean Air Act (CAA) 112 regulated flammable substances: No products were found.
Clean Air Act (CAA) 112 regulated toxic substances: No products were found.

This preparation was classified in compliance with the following directives and regulations:

(EC) No 1907/2006 (REACH)
(EC) No 1272/2008 (CLP)
(EC) No 453/2010

Hazard symbols:
O Oxidizing

Risk phrases:
R9 Explosive when mixed with combustible material.
R44 Risk of explosion if heated under confinement.

Safety Statements:

S17:	Keep away from combustible material
S36/37:	Wear suitable protective clothing and gloves
S16:	Keep away from sources of ignition - No smoking
S14:	Keep away from ... (incompatible materials to be indicated by the manufacturer).

A Chemical Safety Assessment has been conducted for ammonium perchlorate.

STATE RIGHT-TO-KNOW In addition to the ingredients found in Section 2, the following are listed for state right-to-know purposes.

INGREDIENT NAME	SARA/CERCLA RQ (lb)	SARA EHS TPQ (lb)
Ammonium Perchlorate	Examine local regulations to determine	Examine local regulations to determine

Due to the rapidly changing regulatory environment in individual states, it is very difficult to maintain up to date information for each state in a material safety data sheet. The user must examine the local regulations in force and comply with all requirements.

Information about limitation of use: For use only by technically qualified individuals.

United States OSHA: Ammonium perchlorate is on the list of process safety management chemicals with a threshold quantity of 7500 pounds 29 CFR 1910.119.

16. OTHER INFORMATION

Not for Food or Drug Use. The user is responsible to evaluate the safety and environmental consequences of any intended uses. The manufacturer assumes no liability for any usages that result in adverse consequences.

Additional H-Statements –

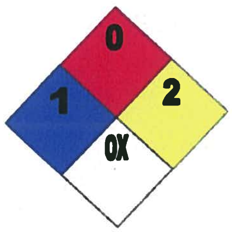
H201 Explosive; mass explosion hazard
H271 May cause fire or explosion; strong oxidizer
H319 Causes serious eye irritation.
H373 May cause damage to organs through prolonged or repeated exposure.

Additional Classification Systems:

Hazardous Materials Identification System (HMIS) ratings (scale 0 – 4)

Health Hazard	1
Fire Hazard	0
Reactivity	2

National Fire Protection Association (NFPA) ratings (scale 0 – 4)



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4. CHEMICAL AND PHYSICAL INFORMATION

4.1 CHEMICAL IDENTITY

Information regarding the chemical identity of the most widely used perchlorates is located in Table 4-1.

4.2 PHYSICAL AND CHEMICAL PROPERTIES

Perchlorates are high melting point inorganic salts that are soluble in water at environmentally significant concentrations. There are five perchlorate salts that are manufactured in substantial amounts: magnesium, potassium, ammonium, sodium, and lithium perchlorate. Perchlorates are powerful oxidizing agents and at elevated temperatures can react explosively (Schilt 1979). The activation energy of ammonium perchlorate is 123.8 kJ/mol below 240 °C, 79.1 kJ/mol above 240 °C, and 307.1 kJ/mol between 400 and 440 °C (Mendiratta et al. 1996). The production volume of ammonium perchlorate far outpaces the other salts (Mendiratta et al. 1996).

Information regarding the physical and chemical properties of these five perchlorate salts is located in Table 4-2.

Table 4-1. Chemical Identity of Perchlorates[a]

Characteristic	Magnesium perchlorate	Potassium perchlorate	Ammonium perchlorate	Sodium perchlorate	Lithium perchlorate
Synonym(s)	Anhydrous magnesium perchlorate; perchloric acid, magnesium salt (1:1)	Potassium hyperchloride; perchloric acid, potassium salt (1:1)	Perchloric acid, ammonium salt (1:1) PKHA, APC[b]	Perchloric acid, sodium salt (1:1)	No data
Registered trade name(s)	Anhydrone, Dehydrite	Peroidin, Astrumal, Irenal, Irenat	No data	Irenat	No data
Chemical formula	$Mg(ClO_4)_2$	$KClO_4$	NH_4ClO_4	$NaClO_4$	$LiClO_4$[c]
Chemical structure	$[Mg^{2+}][ClO_4^-]_2$	$[K^+][ClO_4^-]$	$[NH_4^+][ClO_4^-]$	$[Na^+][ClO_4^-]$	$[Li^+][ClO_4^-]$
Identification numbers:					
CAS Registry	10034-81-8	7778-74-7	7790-98-9	7601-89-0	7791-03-9[c]
NIOSH RTECS	SC8925000	SC9700000	SC7520000	SC9800000	No data
EPA Hazardous Waste[d]	D003	D003	D003	D003	D003
OHM/TADS	No data	No data	7216589	No data	No data
DOT/UN/NA/IMDG	UN1475, IMO 5.1	UN 1489, IMO 5.1	UN1442, IMO 5.1	UN1502, IMO 5.1	UN1481[e]
HSDB	661	1222	474	5038	No data
NCI	No data	No data	No data	No data	0106672[f]

[a]All information was obtained from HSDB 2006 unless otherwise noted. Perchlorate ion was not included in this table since it is never found independent of a corresponding cation.
[b]Ashford 1994
[c]O'Neil 2001
[d]EPA 1992a
[e]ERG 2004
[f]ChemIDplus 2007

CAS = Chemical Abstracts Services; DOT/UN/NA/IMDG = Department of Transportation/United Nations/North America/International Maritime Dangerous Goods Code; EPA = Environmental Protection Agency; HSDB = Hazardous Substance Data Bank; NCI = National Cancer Institute; NIOSH = National Institute for Occupational Safety and Health; OHM/TADS = Oil and Hazardous Materials/Technical Assistance Data System; RTECS = Registry of Toxic Effects of Chemical Substances

Table 4-2. Physical and Chemical Properties of Perchlorates[a]

Property	Magnesium perchlorate	Potassium perchlorate	Ammonium perchlorate	Sodium perchlorate	Lithium perchlorate
Molecular weight	223.21	138.55	117.49	122.44	106.39
Color	White	Colorless or white	White crystals[b]	White	Colorless crystals[c]
Physical state	Solid granular or flaky powder	Solid crystals	Solid orthombic crystals	Solid deliquesce crystals	Solid crystals
Melting point	~250 °C dec.	400 °C dec.	130 °C dec.[d]	471 °C dec.[d]	236 °C[e]
Boiling point	N/A	N/A	N/A	N/A	~400 °C dec.[c]
Density at -20 °C	2.21 g/mL[f]	2.52 g/mL	1.95 g/mL	2.02 g/mL[g]	2.43 g/mL
Odor[b]	No odor	No odor	No odor	No odor	No odor
Odor threshold:					
Water	N/A	N/A	N/A	N/A	N/A
Air	N/A	N/A	N/A	N/A	N/A
Taste	No data	No data	Imparts a bitter and salty taste to water[c]	No data	No data
Solubility:					
Freshwater at 25 °C[f]	9.96×10^5 mg/L	2.06×10^4 mg/L	2.49×10^5 mg/L	2.10×10^6 mg/L	5.97×10^5 mg/L
Organic solvent(s)[d]					
Methanol	5.18×10^5 mg/L	1.05×10^3 mg/L	6.86×10^4 mg/L	5.14×10^5 mg/L	1.82×10^6 mg/L
Ethanol	2.40×10^5 mg/L	1.20×10^2 mg/L	1.91×10^4 mg/L	1.47×10^5 mg/L	1.52×10^6 mg/L
n-Propanol	7.34×10^5 mg/L	1.00×10^2 mg/L	3.87×10^3 mg/L	4.89×10^4 mg/L	1.05×10^6 mg/L
Acetone	4.29×10^5 mg/L	1.55×10^3 mg/L	2.26×10^4 mg/L	5.17×10^5 mg/L	1.37×10^6 mg/L
Ethyl acetate	7.09×10^5 mg/L	1.00×10^1 mg/L	3.20×10^2 mg/L	9.65×10^4 mg/L	9.51×10^5 mg/L
Ethyl ether	2.91×10^3 mg/L	No data	No data	No data	1.14×10^6 mg/L
Vapor pressure at 25 °C[a]	Very low	Very low	Very low	Very low	Very low
Polymerization	N/A	N/A	N/A	N/A	N/A

Table 4-2. Physical and Chemical Properties of Perchlorates[a]

Property	Magnesium perchlorate	Potassium perchlorate	Ammonium perchlorate	Sodium perchlorate	Lithium perchlorate
Incompatibilities	Oil, grease, benzene, calcium hydride, charcoal, olefins, ethanol, strontium hydride, sulfur, sulfuric acid, and carbonaceous material[b,f]	Charcoal, magnesium, reducing agents, sulfur, oil, grease, benzene, calcium hydride, olefins, ethanol, strontium hydride, sulfuric acid, carbonaceous material[b,f]	Nitryl perchlorate, potassium iodate, potassium permanganate, metals, powdered carbon, ferrocene, sulfur, organic matter, charcoal, copper[b,f]	Organic material, oil, grease, benzene, calcium hydride, charcoal, olefins, ethanol, strontium hydride, sulfur, sulfuric acid, carbonaceous material[b,f,g]	Sulfur, sulfuric acid, powdered magnesium, aluminum, benzene, calcium hydride, charcoal, olefins, ethanol, strontium hydride, carbonaceous material[b,f]
Other	Sensitive to rubbing, shock, percussion, sparks, and heating.[c] Dissolves in water with evolution of a considerable amount of heat.	Sensitive to rubbing, shock, percussion, sparks, and heating.[c]	Sensitive to rubbing, shock, percussion, sparks, and heating.[c]	Sensitive to rubbing, shock, percussion, sparks, and heating.[c] Hygroscopic.[d]	Sensitive to rubbing, shock, percussion, sparks, and heating.[c]

[a]Perchlorate ion was not included in this table since it is never found independent of a corresponding cation. All information was taken from O'Neil 2001 unless otherwise noted. Measured data were not available for the following end points: log K_{ow}, K_{oc}, Henry's law constant. Conversion factors were also not available. Autoignition temperature, flashpoint, flammability limits, and explosive limits are not applicable.
[b]Lewis 2000
[c]Von Burg 1995
[d]Schilt 1979
[e]Bauer 1990
[f]Vogt et al. 1986
[g]Lewis 2001

dec. = decomposes; N/A = not applicable

United States
Environmental Protection
Agency

Technical Fact Sheet – Perchlorate

January 2014

TECHNICAL FACT SHEET – PERCHLORATE

At a Glance

- White crystalline solid or colorless liquid.
- Both naturally occurring and man-made anion.
- Sampling at current federal sites as well as at Formerly Used Defense Sites detected perchlorate primarily in association with sites historically involved in the manufacture, maintenance, use and disposal of ammunition and rocket fuel.
- Highly soluble in water; migrates quickly from soil to groundwater.
- Primary pathways for human exposure include ingestion of contaminated food and drinking water.
- Short-term exposure to high doses may cause eye and skin irritation, coughing, nausea, vomiting and diarrhea.
- Health-based goals or drinking water standards developed by various states.
- Various detection methods available include ion chromatography, liquid chromatography, mass spectroscopy and electrospray ionization.
- Common treatment technologies include ion exchange, bioreactors and in situ bioremediation.

Introduction

This fact sheet, developed by the U.S. Environmental Protection Agency (EPA) Federal Facilities Restoration and Reuse Office (FFRRO), provides a summary of the contaminant perchlorate, including physical and chemical properties; environmental and health impacts; existing federal and state guidelines; detection and treatment methods; and additional sources of information. This fact sheet provides basic information on perchlorate to site managers and other field personnel who are addressing perchlorate contamination at cleanup sites or in drinking water supplies.

Perchlorate is a persistent contaminant of concern that has presented a number of issues to the government, the private sector and other organizations and interested parties. These issues include health effects and risks, regulatory standards and cleanup levels, degradation processes and treatment technologies (EPA FFRRO 2005).

What is perchlorate?

- Perchlorate is a naturally occurring and man-made anion that consists of one chlorine atom bonded to four oxygen atoms (ClO_4^-) (EPA FFRRO 2005; ITRC 2005).
- Perchlorate may occur naturally, particularly in arid regions such as the southwestern United States (Rao and others 2007).
- Manufactured forms of perchlorate include perchloric acid and salts such as ammonium perchlorate, sodium perchlorate and potassium perchlorate (EPA FFRRO 2005; ITRC 2005).
- Perchlorate is found as a natural impurity in nitrate salts from Chile, which are imported and used to produce nitrate fertilizers and other products (EPA FFRRO 2005; ITRC 2005).
- Perchlorate is commonly used as an oxidizer in solid propellants, munitions, fireworks, airbag initiators for vehicles, matches and signal flares (EPA FFRRO 2005; ITRC 2005). It is also used in some electroplating operations and found in some disinfectants and herbicides (ATSDR 2008; ITRC 2005).

What is perchlorate? (continued)

- Of the domestically produced (high grade) perchlorate, 90 percent is manufactured for use in the defense and aerospace industries, primarily in the form of ammonium perchlorate (GAO 2005; ITRC 2005).
- Perchlorate has been used by the U.S. Department of Defense (DoD) as an oxidizer in munitions and missiles since the 1940s (EPA FFRRO 2005; ITRC 2005).

Exhibit 1: Physical and Chemical Properties of Perchlorate Compounds
(ATSDR 2008; EPA FFRRO 2005; ITRC 2005; NIH 2013; NIOSH 2013)

Property	Ammonium Perchlorate	Sodium Perchlorate	Potassium Perchlorate	Perchloric Acid
Chemical Abstracts Service (CAS) Numbers	7790-98-9	7601-89-0	7778-74-7	7601-90-3
Physical Description (physical state at room temperature)	White orthorhombic crystal	White orthorhombic deliquescent crystal	Colorless orthorhombic crystal or white crystalline powder	Colorless, oily liquid
Molecular weight (g/mol)	117.49	122.44	138.55	100.47
Water solubility (g/L at 25^{o}C)	200	2,096	15	Miscible in cold water
Melting / Boiling point* (^{o}C)	Melting Point: > 200 (Decomposes)	Melting Point: 471 to 482	Melting Point: 400 to 525	Melting Point: -112 Boiling Point: 19
Vapor pressure at 25^{o}C (mm Hg)	Very low	Very low	Very low	6.8
Specific gravity (g/cm^3)	1.95	2.52	2.53	1.77
Octanol-water partition coefficient (log K_{ow})	-5.84	-7.18	-7.18	-4.63

*Different melting point temperatures are identified in literature.
Abbreviations: g/mol – grams per mole; g/L – grams per liter; ^{o}C – degrees Celsius; mm Hg – millimeters of mercury; g/cm^3 – grams per cubic centimeter.

What are the environmental impacts of perchlorate?

- Perchlorate is highly soluble in water, and relatively stable and mobile in surface and subsurface aqueous systems. As a result, perchlorate plumes in groundwater can be extensive. For example, the perchlorate plume at a former safety flare site (the Olin Flare Facility) in Morgan Hill, California, extends more than 9 miles (EPA 2011; ITRC 2005).
- Because of their low vapor pressure, perchlorate compounds and the perchlorate anion do not volatilize from water or soil surfaces to air (ATSDR 2008; ITRC 2005).
- Perchlorate released directly to the atmosphere is expected to readily settle through wet or dry deposition (ATSDR 2008).
- High concentrations of perchlorate have been detected primarily at current and Formerly Used Defense Sites historically involved in the manufacture, testing and disposal of ammunition and rocket fuel or at industrial sites where perchlorate is manufactured or used as a reagent during operations (ATSDR 2008; ITRC 2005).
- Types of military and defense-related facilities with known releases include missile ranges and missile and rocket manufacturing facilities. However, since site-specific documentation may not be available and based on historical uncertainties, it is generally difficult to identify specific military sites with known perchlorate releases. From 1997 to 2009, the Department of Defense reported perchlorate detections at 284 (almost 70 percent) of its installations sampled (GAO 2010; ITRC 2005).
- In addition, the past disposal of munitions in either burial pits or by open burning and open detonation may have resulted in releases to the environment. The amount of perchlorate released can vary depending on the length of time the disposal area was used and the types of munitions disposed of in the area (ITRC 2005).

What are the environmental impacts of perchlorate? (continued)

- Studies have shown perchlorate accumulates in some food crop leaves, tobacco plants and in broad-leaf plants (ATSDR 2008).
- Surveys conducted by the U.S. Food and Drug Administration have detected perchlorate in food crops and milk (FDA 2008).
- As of October 2009, perchlorate had been detected at varying levels in drinking water, groundwater, surface water, soil or sediment at private and federal facilities in 45 states, three U.S. territories and Washington D.C. The maximum concentrations reported in any media ranged from less than 4 parts per billion (ppb) to more than 500,000 ppb (ASTSWMO 2011; GAO 2010).
- EPA reported perchlorate detections at more than 40 hazardous waste sites on the EPA National Priorities List as of June 2010 (GAO 2010).

What are the routes of exposure and the health effects of perchlorate?

- Primary pathways for human exposure to perchlorate are ingestion of contaminated food and drinking water (ATSDR 2008; EPA FFRRO 2005).
- Perchlorate is readily adsorbed after oral exposure and can migrate from the stomach and intestines to the bloodstream (ATSDR 2008).
- The thyroid gland is the primary target of perchlorate toxicity in humans. Thyroid hormones play an important role in regulating metabolism and are critical for normal growth and development in fetuses, infants and young children. Perchlorate can interfere with iodide uptake into the thyroid gland at high enough exposures, disrupting the functions of the thyroid and potentially leading to a reduction in the production of thyroid hormones (ATSDR 2008; Cal/EPA 2012; NAS 2005).
- Study results indicate that exposure to high doses of perchlorate can result in the decrease of body weight, cause hypertrophy of the thyroid gland and decrease gene expression of thyroglobulin (Tg) and thyroperoxidase (TPO), which are involved in the biosynthesis of thyroid hormones (Wu and others 2012).
- Potassium perchlorate was historically used to treat hyperthyroidism and Graves' Disease (an autoimmune disorder) because of its ability to inhibit thyroid iodide uptake (ATSDR 2008; NAS 2005).
- Studies conducted on rodents showed that perchlorate concentrations below that required to alter thyroid hormone equilibrium are unlikely to cause thyroid cancer in human beings (ATSDR 2008; EPA IRIS 2005).
- Short-term exposure to high doses of ammonium, sodium or potassium perchlorate may cause eye, skin and respiratory tract irritation, coughing, nausea, vomiting and diarrhea. Perchloric acid is corrosive to the eyes, skin and respiratory tract, and short-term exposure to high doses may cause sore throat, coughing, labored breathing, deep burns, loss of vision, abdominal pain, vomiting or diarrhea (NIOSH 2013).

Are there any federal and state guidelines and health standards for perchlorate?

- The EPA assigned perchlorate a chronic oral reference dose (RfD) of 0.0007 milligrams per kilogram per day (mg/kg/day) (EPA IRIS 2005).
- The Agency for Toxic Substances and Disease Registry (ATSDR) has established a minimal risk level (MRL) of 0.0007 mg/kg/day for chronic-duration oral exposure (365 days or more) to perchlorate (ATSDR 2008, 2013).
- EPA has decided to regulate perchlorate under the Safe Drinking Water Act. EPA has initiated the process of proposing a national primary drinking water regulation (EPA 2012b).
- The EPA established an Interim Lifetime Drinking Water Health Advisory of 15 micrograms per liter (µg/L), which is a concentration of a perchlorate in drinking water that is not expected to cause any adverse noncarcinogenic effects for a lifetime of exposure (EPA 2009, 2012a).
- EPA has calculated a residential soil screening level (SSL) of 55 milligrams per kilogram (mg/kg) and an industrial SSL of 720 mg/kg for perchlorate and perchlorate salts (ammonium, potassium, sodium and lithium) (EPA 2013). [1]

[1] Screening Levels are developed using risk assessment guidance from the EPA Superfund program. These risk-based concentrations are derived from standardized equations combining exposure information assumptions with EPA toxicity data. These calculated screening levels are generic and not enforceable cleanup standards but provide a useful gauge of relative toxicity.

Are there any federal and state guidelines and health standards for perchlorate? (continued)

- EPA calculated a tap water screening level of 11 µg/L for perchlorate and perchlorate salts (EPA 2013).
- The EPA Office of Solid Waste and Emergency Response (OSWER) recommended a preliminary remediation goal (PRG) of 15 µg/L at Superfund sites (where there is an actual or potential drinking water exposure pathway), where no federal or state applicable or relevant and appropriate requirements exist under federal or state laws. PRGs are developed based on readily available information and are modified, as necessary, before final cleanup goals are established, based on information that becomes available during the remedial investigation/feasibility study (EPA 2009).
- Numerous states have promulgated enforceable standards for perchlorate in drinking water. For example, Massachusetts (2 µg/L) and California (6 µg/L) have established enforceable standards for perchlorate in drinking water (CDPH 2012; Massachusetts DEP 2006).
- California EPA released Draft California Human Health Screening Levels (CHHSLs) for perchlorate. The draft CHHSLs for perchlorate in soil are 28 mg/kg for residential property and 350 mg/kg for commercial/industrial property (Cal/EPA 2010).
- In 2012, California EPA's Office of Environmental Health Hazard Assessment (OEHHA) proposed to revise the existing Public Health Goal for perchlorate in drinking water from 6 µg/L to 1 µg/L (Cal/EPA 2012).
- At least 10 other states have also developed advisory levels or health-based goals for perchlorate, ranging from 1 to 18 µg/L for drinking water and 1 to 72 µg/L for groundwater (GAO 2010).

What detection and site characterization methods are available for perchlorate?

- The following methods can be used to analyze perchlorate in drinking water, groundwater, surface water and irrigation water:
  - EPA Method 314.0 - Ion Chromatography (EPA OGWDW 2012).
  - EPA Method 314.1 Rev 1.0 - Inline Column Concentration/Matrix Elimination Ion Chromatography with Suppressed Conductivity Detection (EPA OGWDW 2012).
  - EPA Method 314.2 - Two-Dimensional Ion Chromatography with Suppressed Conductivity Detection (EPA OGWDW 2012).
  - EPA Method 331.0 Rev. 1.0 - Liquid Chromatography/Electrospray Ionization/ Mass Spectrometry (EPA OGWDW 2012).
  - EPA Method 332.0 - Ion Chromatography with Suppressed Conductivity and Electrospray Ionization/Mass Spectrometry (EPA FFRRO 2005).
- The following methods can be used to analyze perchlorate in surface water, groundwater, wastewater, salt water and soil:
  - EPA SW-846 Method 6850 - High Performance Liquid Chromatography/Electrospray Ionization/Mass Spectrometry (EPA 2007a).
  - EPA SW-846 Method 6860 - Ion Chromatography/Electrospray Ionization/Mass Spectrometry (EPA 2007b).
- The presence of high amounts of other anions, such as chloride, sulfate or carbonate, may interfere with the analysis of perchlorate (EPA 1999).
- Researchers have demonstrated the ability to distinguish man-made and natural sources of perchlorate in water samples using chlorine and oxygen stable isotope ratio analysis (Bŏhlke and others 2005; ITRC 2005).

What technologies are being used to treat perchlorate?

- **Ex Situ Treatment**
  - Ion exchange using perchlorate-selective or nitrite-specific resins is a proven method for removal of perchlorate from drinking water, groundwater, surface water and other media. Laboratory-study results indicate that an electrically switched ion exchange system using a conductive carbon nanotube nanocomposite material could be used for the large-scale treatment of wastewater (ITRC 2008; DoD SERDP 2011).

ATTACHMENT V
SAFETY DATA SHEETS AND CHEMICAL INVENTORY

INTENDED TO BE BLANK

CONTENTS TO BE ADDED LATER

ATTACHMENT VI
TRONOX CONTRACTOR SAFETY HANDBOOK AND PERMIT FORMS

Hot Work Permit
Ground Breaking Permit

BEFORE THIS PERMIT CAN BE SIGNED, THE FOLLOWING RULES MUST BE COMPLIED WITH AND THE APPROPRIATE BOX CHECKED.

1. No burning or welding is permitted where sprinklers are out of service

   Sprinklers in area? ☐ Yes ☐ No   If yes, in service? ☐ Yes ☐ No

2. No burning or welding is permitted in the presence of flammable dust, gas or liquid, or on tanks, lines or equipment previously containing such material which have not been purged.

A)	Tanks, lines, other equipment cleaned, purged, and tested?	☐YES ☐NO
B)	Atmosphere tested for flammable vapors and oxygen?	☐YES ☐NO

O2: _____%   LEL: _____%

ATMOSPHERE TESTERS SIGNATURE

3. Before burning or welding operations are started, the following applicable precaution ***must be taken*** and the appropriate box checked.

A)	Area swept clean and wet down. If needed, floor and surroundings?	☐YES ☐ NO
B)	Combustibles moved at least 35 feet from operation or protected with metal guards or flame proofed tarpaulins?	☐YES ☐ NO
C)	Floor/wall openings, cracks or holes within 35 feet of operation covered?	☐YES ☐ NO
D)	Fire watch(es) assigned to watch for dangerous sparks in area as well as floors above and below?	☐YES ☐ NO
E)	Proper fire protection provided (hoses & extinguishers)? NOTE: Wall mounted extinguishers are not to be used for fire watch(es).	☐YES ☐ NO

TYPE OF EXTINGUISHING AGENT

☐ Water Hose   Fire Extinguisher: ☐ Water   ☐ A   ☐ B   ☐ C   ☐ D

F)	Conveyors or ducts that could transport sparks shut down or isolated?	☐YES ☐ NO
G)	Are sandwich-type constructed materials involved and has the prevention been addressed in these areas?	☐YES ☐ NO
H)	In discontinued chlorate/perchlorate areas, can this job be done without cutting torches or welding equipment?	☐YES ☐ NO
I)	Area operator notified? **Name:**	☐YES ☐ NO
J)	Precautions taken to prevent heat transmission, by radiation or conduction, to unobserved combustibles?	☐YES ☐ NO
K)	Welder certification verified?	☐YES ☐ NO

4.	Burning/welding equipment inspected and found in safe condition?	☐YES ☐ NO
5.	Anti-flashback/backflow devices on torch and regulator?	☐YES ☐ NO

6. The area, including floors above and below should be monitored for at least one hour after work stops and permit is turned into the Tronox Authorizing Supervisor.

   Area Monitored By (print & signature):

7. Three (3) hour follow-up inspection required? ☐YES ☐ NO

   Inspection By (print & signature):

8. NAME OF AUDITOR (TITLE, DEPT.)   DATE

   CONCERNS/FOLLOW-UP REPORT WRITTEN? (If yes, attach)

HOT WORK PERMIT (HENDERSON) (TR-10057 04/14) X-A.14. Att. 1

BOTH SIDES OF THIS PERMIT MUST BE COMPLETED

This permit is required in all plant areas *except* designated shop areas and other areas as approved by the Executive Safety committee.

MAXIMUM PERMIT DURATION IS 12 HOUR SHIFT.

GOOD THIS DATE ONLY	FROM TO
BUILDING OR LOCATION (be specific)	FLOOR

CONTRACTOR ☐ Yes ☐ No

If yes, Contractor Name

EQUIPMENT TO BE WORKED ON (be specific)

TYPE OF HOT WORK

☐ Open Flame(propane/acetylene) ☐ Electric Welding ☐ Grinding/Cutting

☐ Electrical Equipment ☐ Other:

PURPOSE

INFORMATION FOR HAZARD COMMUNICATION

HAZARDS

☐ Perchlorate ☐ Flammable ☐ Pressured

☐ Chlorine ☐ H2S ☐ Other ______________________________

I certify that I have personally examined the location where the above work is to be done. The required precautions for safe hot work appearing on the reverse side of this card have been checked as indicated.

TRONOX AUTHORIZING SUPERVISOR

TRONOX OR CONTRACTOR AUTHORIZING SUPERVISOR SIGNATURE

I have been properly instructed for safe BURNING & WELDING and understand my duties.

WELDER	CERT
WELDER	CERT

I have been properly instructed for FIRE WATCH and understand my duties.

FIRE WATCH

FIRE WATCH

CONTRACTOR SIGNATURE ABOVE INDICATED AGREEMENT WITH AND ACCEPTANCE OF THE CONDITIONS OF THIS PERMIT.

GROUND BREAKING PERMIT (HENDERSON) (TRX-5223-A) (08/14)

Reference Procedures X-A.30. Att. 1 and X-E.4. Att. 1

Both sides are to be completed before any excavation or concrete cutting is started, regardless of depth.

GOOD THESE DATES ONLY	FROM	TO

LOCATION

WORK TO BE DONE

MATERIALS / UTILITIES INVOLVED

This job site at applicable drawings have been reviewed. The precautions listed on this permit are necessary for the duration of the job.

SIGNATURE - PRODUCTION SUPERVISOR

SIGNATURE - MAINTENANCE SUPERVISOR

SIGNATURE - ENGINEER

SIGNATURE - UTILITY DEPARTMENT SUPERVISOR

SIGNATURE - PERMIT APPROVER

The following items must be completed before starting the excavation or concrete cutting and must be followed for the duration of the work.

	REQUIRED	NOT NECESSARY
Obstructions / Obstacles Removed From Site		
Barricades for Isolating Area.		
Flashers for Night.		
Line Breaking Permit.		
Additional PPE or Safety Equipment.		
Production Manager Notified of Utilities to be Shut Off		
Shoring.		
Atmospheric Tests for Flammable Vapors.		
Hot Work Permit.		
Rescue Harness / Tag Lines.		
Electrical Lines & Other Utilities Isolated		
Drawings Checked for Utility Locations at Work Area.		
Personnel to be Briefed on Safety Precautions.		
Utility Companies to be Notified (Gas, Power, Phone, etc.)		
Are Special Precautions Needed on This Job? Is so, Please List Below.		

SPECIAL PRECAUTIONS:

ATTACHMENT VII
SUBCONTRACTOR HEALTH AND SAFETY SUBMITTALS

INTENDED TO BE BLANK

CONTENTS TO BE ADDED LATER

ATTACHMENT VIII
NEVADA OSHA POSTER AND WORKPLACE SAFETY BROCHURE

NEVADA SAFETY AND HEALTH PROTECTION ON THE JOB

The Nevada Occupational Safety and Health Act, NRS Chapter 618, provides job safety and health protection for workers through the promotion of safe and healthful working conditions throughout the State of Nevada. Requirements of the Act include the following:

EMPLOYERS:

Each employer shall furnish to each of his employees employment and a place of employment free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees; and shall comply with occupational safety and health standards adopted under the Act.

EMPLOYEES:

Each employee shall comply with all occupational safety and health standards, rules, regulations and orders issued under the Act that apply to his own actions and conduct on the job.

The Nevada Occupational Safety and Health Administration (Nevada OSHA) of the Division of Industrial Relations, Department of Business and Industry, has the primary responsibility for administering the Act. Nevada OSHA enforces occupational safety and health standards, and its Safety and Health Representatives/ Industrial Hygienists conduct jobsite inspections to ensure compliance with the Act.

INSPECTION:

The Act requires that a representative of the employer and a representative authorized by the employees be given an opportunity to accompany the Nevada OSHA inspector for the purpose of aiding the inspection.

Where there is no authorized employee representative, the Nevada OSHA Safety and Health Representative/ Industrial Hygienist must consult with a reasonable number of employees concerning safety and health conditions in the workplace.

COMPLAINT:

Employees, public or private, or their representatives have the right to file a complaint with the nearest Nevada OSHA office requesting an inspection if they believe unsafe or unhealthful conditions exist in their workplace. Nevada OSHA will hold confidential names of employees complaining.

The Act provides that employees may not be discharged or discriminated against in any way for filing safety and health complaints or otherwise exercising their rights under the Act.

An employee, public or private, who believes he has been discriminated against may file a complaint within thirty (30) days of the alleged discrimination with the nearest Nevada OSHA office or with Occupational Safety and Health Administration, U.S. Department of Labor, 71 Stevenson Street, P.O. Box 3766, San Francisco, CA 94119-3766.

CITATIONS:

If upon inspection Nevada OSHA believes an employer has violated the Act, a citation alleging such violations will be issued to the employer. Each citation will specify a time period within which the alleged violation must be corrected.

The Nevada OSHA citation must be prominently displayed at or near the place of alleged violation for three days, or until it is corrected, whichever is later, to warn employees of dangers that may exist there.

PROPOSED PENALTY:

The Act provides for mandatory penalties against employers of up to $7,000 for each serious violation and for optional penalties of up to $7,000 for each nonserious violation. Penalties of up to $7,000 per day may be proposed for failure to correct violations within the proposed time period. Also, any employer who willfully or repeatedly violates the Act may be assessed penalties of up to $70,000 for each such violation.

Criminal penalties are also provided for in the Act. Any willful violation resulting in death of an employee, upon conviction, is punishable by a fine of not more than $20,000 or by imprisonment for not more than six months, or by both. Conviction of any employer after a first conviction doubles these maximum penalties. Penalties may be proposed for public employers.

VOLUNTARY ACTIVITY:

While providing penalties for violations, the Act also encourages efforts by labor and management, before a Nevada OSHA inspection, to reduce injuries and illnesses arising out of employment.

The Nevada Occupational Safety and Health Administration of the Division of Industrial Relations, Department of Business and Industry, encourages employers and employees to reduce workplace hazards voluntarily and to develop and improve safety and health programs in all workplaces and industries.

Such cooperative action would initially focus on the identification and elimination of hazards that could cause death, injury, or illness to employees and supervisors.

Further information and assistance will be provided by Nevada OSHA to employees and employers upon request.

MORE INFORMATION:

Additional information and copies of the Act, specific Nevada OSHA safety and health standards, and other applicable regulations may be obtained by calling or writing the nearest Nevada OSHA district office in the following locations:

Southern Nevada
1301 N. Green Valley Pkwy., Suite 200
Henderson, Nevada 89074
Telephone: (702) 486-9020
Fax: (702) 990-0358

Northern Nevada
4600 Kietzke Lane, Suite F-153
Reno, Nevada, 89502
Telephone: (775) 688-3700
Fax: (775) 688-1378

NOTE:

Persons wishing to register a complaint alleging inadequacy in the administration of the Nevada Occupational Safety and Health Plan may do so at the following address:

OSHA, U.S. Department of Labor
71 Stevenson Street
P. O. Box 3766
San Francisco, CA 94119-3766
Telephone: (415) 975-4310

EMPLOYERS: This poster must be displayed prominently in the workplace.

(Rev. 12-14)

WORKPLACE SAFETY IS EVERYONE'S RESPONSIBILITY.

I have (check one)___ read this document or ___ viewed the video, entitled "Nevada Workplace Safety: Your Rights and Responsibilities" and I understand my rights and responsibilities for safety in the workplace.

Employee Name (please print)______________________ Date________

Employee's Signature______________________

Place of Viewing Video______________________

Employer's Name (please print)______________________

Employer's Signature (or representative)______________________

Any employee who does not understand this document should contact his or her supervisor, employee representative or the Division of Industrial Relations of the Nevada Department of Business & Industry.

Las Vegas: (702) 486-9140
Reno: (775) 688-3730
Elko: (775) 778-3312
Toll-Free: (877) 472-3368

Note: This portion must be maintained in the employee's personnel file

NEVADA WORKPLACE SAFETY

Stop and Learn Your Rights and Responsibilities

The Division of Industrial Relations of the Nevada Department of Business & Industry helps employers provide a safe and healthful workplace. This document explains the rights and responsibilities of both employers and employees in creating a safe working environment.

EMPLOYEE RIGHTS AND RESPONSIBILITIES

The Nevada Occupational Safety and Health Act was created to allow you to do your job in a safe and healthy workplace. **But it is up to you to make sure that job safety works.** Here are some tips to help you stay safe on the job.

Know and follow all safety rules set by:

+ Your employer
+ The Nevada Occupational Safety and Health Act
+ State of Nevada Occupational and Health Administration (NVOSHA)

You can get copies of all Nevada safety and health standards from the Safety Consultation and Training Section of the Division of Industrial Relations or on the web at www.4safenv.state.nv.us. **Also, your employer may be required to have a written workplace safety program.**

If your employer requires personal protective equipment, such as hard hats, safety shoes, safety glasses, respirators, or hearing protection, **you are responsible to wear and/or use the equipment.**

If you do not know how to safely use tools, equipment or machinery, be sure to ask your supervisor.

If you see something that's unsafe,report it to your supervisor. That's part of your job. Give your employer a chance to fix the problem. **If you think the unsafe condition still exists, it is your right to file a complaint with NVOSHA.** The Division will not give your name to your employer.

There are laws that **protect you** if you are punished for filing a safety and health complaint. If you feel you have been treated unfairly for making a safety and health complaint, you have 30 days from the date of the punishment to file a discrimination complaint with NVOSHA.

Most on-the-job injuries are covered by Workers' Compensation Insurance. From cuts and bruises to serious accidents, coverage begins the first minute you're on the job.

It is your responsibility to report any on-the-job injury immediately to your supervisor or foreman using "The Notice of Injury or Occupational Disease" (C-1 Form). Your employer must file an "Employer's Report of Injury" (C-3 Form) within six working days after the receipt of a "Claim for Compensation" (C-4 Form) from a physician or chiropractor.

But remember, filing a false claim will result not only in a loss of benefits, but could mean costly fines and/or jail time.

If there is a dangerous situation at work and an employee, with no reasonable alternative, refuses in good faith to expose themselves to a dangerous condition, they would be protected from subsequent retaliation. The condition must be of such a nature that a reasonable person would conclude that there is a real danger of death or serious harm and that there is not enough time to contact NVOSHA and for NVOSHA to inspect. Where possible, the employee must have also sought from the employer, and been unable to obtain, a correction of the condition.

During a NVOSHA inspection, you have the right to talk privately with the inspector and take part in meetings with the inspector before and after the inspection. You are encouraged to point out hazards, describe injuries and illnesses from these hazards, discuss past worker complaints and inform the inspector of working conditions that are not normal during the inspection. If after the inspection citations are proposed to the employer, the employer is required to post the citations where employees can see them.

EMPLOYER RIGHTS AND RESPONSIBILITIES

Safety Consultation and Training Section (SCATS) was created to assist employers in complying with Nevada laws which govern occupational safety and health. They are available to provide a workplace hazard assessment. This service can assist employers in minimizing on-the-job hazards, and is provided at **no charge**. The Division also offers no cost safety training and informational programs for Nevada employers.

A Nevada employer with 11 or more employees must establish a written workplace safety program. A safety committee is required if you have more than 25 employees or if an employer's employees are engaged in the manufacturing of explosives.

You must maintain a workplace that is free from unsafe conditions.

As an employer **you are responsible for complying with all Nevada safety and health standards and regulations** found in the:

+ Nevada Occupational Safety and Health Act
+ Occupational Safety and Health Standards and Regulations

Copies of all occupational safety and health standards and regulations are available from the Division of Industrial Relations (SCATS and NVOSHA) or on the web at www.4safenv.state.nv.us.

You are also responsible for ensuring that your employees comply with these same rules, standards and regulations. **You must select someone to administer and enforce** occupational safety and health programs in your workplace.

Before assigning an employee to a job, **you must provide proper training in a language and format that is understandable to each employee:**

+ Safe use of equipment and machinery
+ Personal protective gear
+ Hazard recognition
+ Emergency procedures
+ Hazardous chemicals and substances found at the jobsite or in the workplace

You must also inform all employees of the safety rules, regulations and standards which apply to their respective duties.

It is your responsibility to maintain accurate accident, injury and safety records and reports. These files must be made available, upon request, to the affected employee and representatives of NVOSHA.

The Nevada Safety and Health Poster, provided by the Division of Industrial Relations, **must be posted** in a prominent place on the job site.

Any accident occurring in the course of employment which is fatal to one or more employees or which results in hospitalization of three or more employees must be reported by the employer orally to the nearest NVOSHA office within 8 hours after the time that the accident is reported to any agent or employee of the employer.

Employers must acquire and maintain Workers' Compensation Insurance at all times. You are responsible for filing any workers' compensation claims with your employer.

Additional employer responsibilities:

+ Perform tests such as air sampling and noise monitoring.
+ Prevent employee exposure to harmful substances to include chemicals, lead, asbestos, and sharps.
+ Provide hearing exams, medical testing, fall protection, machine guarding, cave-in and confined space safety equipment and protection, respirators, personal protective equipment, etc., as required by NVOSHA and OSHA standards.

The law requires that employers shall provide newly-hired employees with a copy of this document or with a video setting forth the rights and responsibilities of employers and employees to promote safety in the workplace.

Employers shall keep a signed copy of the attached receipt in the employee's personnel file to show he or she has been made aware of these rights and responsibilities.

ADDITIONAL INFORMATION

If you require further information or would like to obtain copies of safety and health standards, videos of this pamphlet in English and Spanish or more copies of the pamphlet, contact the following:

State of Nevada Department of Business & Industry Division of Industrial Relations Safety Consultation and Training Section

In Southern Nevada	In Northern/Central Nevada
1301 N. Green Valley Parkway	4600 Kietzke Lane
Suite 200	Suite E-144
Henderson, NV 89074	Reno, NV 89502
(702) 486-9140	(775) 688-3730
Fax: (702) 990-0362	Fax: (775) 688-1478

In Northeastern Nevada	Or Call, Toll-Free
350 West Silver Street	1 (877) 4SAFENV (472-3368)
Suite 210	www.4safenv.state.nv.us
Elko, NV 89801	
(775) 778-3312	
Fax: (775) 778-3412	

State of Nevada Department of Business & Industry Division of Industrial Relations NVOSHA

In Southern Nevada	In Northern Nevada
1301 N. Green Valley Parkway	4600 Kietzke Lane
Suite 200	Suite F-153
Henderson, NV 89074	Reno, NV 89502
(702) 486-9020	(775) 688-3700
Fax: (702) 990-0358	Fax: (775) 688-1378

A video of this information is available in English and Spanish through the Division of Industrial Relations, Safety Consultation and Training Section.

This document may be copied. For additional copies, contact the Division of Industrial Relations or visit www.4safenv.state.nv.us.

ATTACHMENT IX
LABORATORY SAMPLE PACKAGING, LABELING, AND SHIPPING REQUIREMENTS (DOT)

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CONTENTS TO BE ADDED LATER

APPENDIX B
PRELIMINARY DEMOLITION WORK PLAN

PRELIMINARY
DEMOLITION WORK PLAN
UNIT 4 CELL BUILDING
HENDERSON, NEVADA

Prepared for:

Nevada Environmental Response Trust

35 East Wacker Drive
Suite 1550
Chicago, Illinois 60601

Prepared by:

Tetra Tech, Inc.

1489 Warm Springs Road, Suite 110
Henderson, NV 89014

March 30, 2015

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: Preliminary Demolition Work Plan Unit 4 Cell Building, Nevada Environmental Trust Site, Henderson, Nevada

Kyle S. Hansen

03/30/2015

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

Date

CEM Certificate Number: 2176
CEM Expiration Date: September 18, 2016

LIST OF ACRONYMS

ACM	Asbestos Containing Materials
AHERA	Asbestos Hazard Emergency Response Act
ANSI	American National Standards Institute
COPC	Chemicals of potential concern
DAQ	Department of Air Quality
EM	Electromagnetic
ft^2	square feet
GPR	Ground Penetrating Radar
HUD	Department of Housing and Urban Development
LCM	Lead Containing Materials
LBP	Lead-Based Paints
LBP/LCM	Lead Based Paint/Lead Containing Materials
NAVLAP	National Voluntary Laboratory Accreditation Program
NERT	Nevada Environmental Response Trust
NESHAP	National Emission Standards for Hazardous Air Pollutants
OSHA	Occupational Safety and Health Agency
PCBs	poly-chlorinated biphenyls
PLM/DS	Polarized Light Microscopy with Dispersion Staining
PM	Project Manager
PUL	Precision Utility Locating
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
SMP	Site Management Plan
Tronox	Tronox LLC
XRF	X-ray Fluorescence

TABLE OF CONTENTS

LIST OF FIGURES

APPENDICES

1.0 INTRODUCTION

This Preliminary Demolition Work Plan describes the activities that will be undertaken at the Unit 4 cell building located at Tronox LLC (Tronox) within the Nevada Environmental Response Trust (NERT) property in Henderson Nevada. The NERT site location is shown on Figure 1. An environmental investigation consisting of soil and groundwater characterization is proposed to be conducted in and around the Unit 4 and 5 buildings. In order to access the basement level of the Unit 4 cell building for the demolition activities and implementation of the environmental investigation, the central portion (Unit 4 cell building) of Unit 4 buildings will be demolished and an earthen ramp will be constructed from the ground surface level to the basement level. The environmental investigation work proposed in the vicinity of the Unit 4 and 5 buildings is a component of work being performed across the entire NERT site, as part of the Remedial Investigation/Feasibility Study (RI/FS) Work Plan (Revision 2) dated June 19, 2014 (ENVIRON, 2014). All proposed work presented in this Demolition Work Plan will be performed in accordance with the Site Management Plan (SMP) (ENVIRON 2013).

There are a total of ten unit buildings (numbered 1 through 10) aligned in a row from west to east along the southern portion of the NERT property. Each unit building consists of three structures: a chlorinator building on the north side, a cell building in the center, and substation building on the south side. Four of the unit buildings (Units 3, 4, 5, 6) are leased from NERT by Tronox (Figure 2). The roof, above grade walls and floors of the Unit 1 and 2 cell buildings have been demolished, with the basement walls and slabs remaining intact. In addition, the eastern half of the Unit 3 cell building has been demolished.

Unit Buildings 5 and 6 are still in use and operated by Tronox. Past operations at Unit 4 cell building may have resulted in a release of perchlorate and chromium to the underlying soil and groundwater (ENVIRON 2011). In order to complete an environmental assessment of Unit 4 area, the Unit 4 cell building floor and associated structural supports of the building will be demolished to allow safe access to the basement floor to conduct the environmental investigation. The proposed area for demolition is shown on Figure 3. The northern structure (Unit 4 chlorinator building) and the southern structure (Unit 4 substation building) will not be demolished and will remain intact for continued use by Tronox.

Prior to developing the Final Demolition Plan, Tetra Tech will interview facility personnel that have historic knowledge of the facility, the methods implemented, and potential hazards encountered when demolishing the Unit 1, 2, and 3 buildings. Tetra Tech has approached Tronox, Olin and TIMET personnel and they have agreed to share relevant data with the Trust. Best practices and approaches learned from previous Unit building demolitions will be incorporated into the Final Demolition Plan. Demolition of the Unit 4 cell building floor slab will not be initiated until the decommissioning of the active chlorine gas pipeline suspended on the northern Unit 4 chlorinator building has been completed (Figure 3).

Tetra Tech personnel will manage and supervise the cell floor demolition and environmental investigation. A project specific Health and Safety Plan has been prepared and is included in the Unit 4 and 5 Buildings Investigation Work Plan. This Preliminary Demolition Plan is included as an Appendix to the Unit 4 and 5 Buildings Investigation Work Plan.

1.1 Site Description

The Unit Building structures were constructed during World War II for magnesium production. The Unit 4 cell building historically contained chlorinators (furnaces) that created molten magnesium chloride by reacting the magnesium oxide/carbon pellets with chlorine gas at high temperature and banks of electrolytic cells that produced magnesium metal by electrochemical reduction of the molten magnesium chloride. The southern portion of the Unit 4 buildings currently houses a battery manufacturing process and is referred to as the Unit 4 substation building or rectifier building. The northern portion of the Unit 4 buildings, referred to as the Unit 4 chlorinator building, is currently in use at the ground level for storage and houses an air compressor. The upper floors of the structure are not currently in use and are in poor condition. A chlorine gas line is suspended along the south side of the Unit 4 chlorinator building, adjacent to the proposed work area. The existing chlorine line will be decommissioned and will be relocated prior to demolition activities.

The chemicals of potential concern (COPC) associated with the Unit 4 cell building include chlorates, chromium, hexavalent chromium, perchlorate, asbestos containing materials (ACM), and lead-based paints (LBP). An ACM survey and abatement was conducted within the Unit 4 cell building by Tronox in 2008. Abatement included removal of transite pipes located within the cell area. According to Tronox representatives ACM still remains within and adjacent to the structure as non-friable surface coatings, buried transite pipes, and wrap on pipes inside the basement batch tanks, tar-based weather coating on the exterior of the north adjacent Unit 4 chlorinator building. Lead based paint coating is also reported to exist within the structure and may be disturbed during demolition. Chlorates and chromium may be present in concrete materials. Due to the possible presence of these materials, a hazardous materials assessment survey will be conducted prior to preparing the Final Demolition Plan to identify the location of these materials and determine requirements for safe management, handling and disposal during demolition.

The above-grade cell floor of the Unit 4 cell building consists of steel beams supported by reinforced concrete decks with an overall footprint of approximately 44,400 square feet (ft^2). Figures 4 and 5 provide historical plans and cross sections of the Unit 4 cell building. Recent (2014) photographs of the Unit 4 cell building are provided below.

Unit 4 cell building floor, Unit 4 chlorinator building in background
(View looking northeast)

Unit 4 cell building floor with Unit 4 substation building in background
(View looking southwest)

Unit 4 cell building floor (View looking north)

Unit 4 cell building basement floor

1.2 Demolition Plan Organization

The remainder of this Preliminary Demolition Work Plan includes a description of the tasks associated with preparing for and executing the proposed demolition work including: site location, project limits and site access figures and a list of references. A copy of the site specific permits that will be required for demolition activities is provided in Appendix A.

2.0 DEMOLITION ACTIVITIES

The primary activities associated with the Unit 4 cell building demolition include the following:

- Notifications and permits;
- Hazardous materials survey;
- Geophysical utility location;
- Work zone establishment;
- Structure stabilization;
- Cell floor demolition; and
- Waste transportation and disposal.

Each of these activities are further discussed in the following subsections.

2.1 Notifications and Permits

Prior to performing the proposed work, Tetra Tech will provide Tronox with a copy of the Final Work Plan, Demolition Plan and Health and Safety Plan for review and concurrence. The Final Demolition Plan will address planned demolition activities, including areas of bulk demolition and areas of detailed disassembly and demolition. The Final Demolition Plan and the Health and Safety Plan will identify any hazardous areas that are identified before the initiation of demolition activities.

In accordance with Tronox requirements, Hot Work and Ground Breaking Permits will be required prior to performing these activities (Tronox 2014a and b, Appendix A). Additionally, notification to the Clark County Department of Air Quality (DAQ) will be required. The DAQ will at a minimum require submitting a Demolition Notification Form, obtaining a Dust Control Permit, filing a Dust Control Permit Closure Form, and filing of a National Emission Standards for Hazardous Air Pollutants (NESHAP) Notification of Asbestos Abatement (DAQ 2014a, b, c). The selected demolition contractor will be responsible to adhere to all of the DAQ Rules and Regulations during demolition activities. The Tetra Tech Project Manager (PM) will notify fire department personnel of the planned activities and implementation schedule. Advance notification of demolition plans, the demolition schedule, and the names and phone numbers of responsible project staff will be provided to NERT, Tronox, NDEP, and the local police and fire department.

2.2 Hazardous Material Survey

Prior to initiating demolition field activities, a pre-demolition hazardous materials survey will be performed at the Unit 4 cell building including; the surface level, cell floor basement, and surrounding area that will be demolished to identify potential hazardous materials that may need to be properly abated before demolition. Potential hazardous materials may include ACM, LBP, and contaminated concrete that may contain chlorates, metals, hexavalent chromium, and perchlorate residue.

The survey will include screening for metals using a portable X-ray fluorescence (XRF) analyzer and collecting samples of suspect ACM. Unbiased core samples for general waste characterization and disposal will be collected from concrete decks, column support pads and wall sections to be demolished. Biased core samples will be collected in cell floor areas where visible staining suggests release of metals or other hazardous materials such as perchlorate and hexavalent chromium may have occurred. A pre-demolition materials work plan titled, Unit 4 and 5 Demolition Survey Work Plan has been prepared and is included in the Unit 4 and 5 Buildings Investigation Work Plan.

If hazardous materials such as ACM, LBP, perchlorate or hexavalent-chromium are identified at concentrations that pose a potential health risk to workers, a Nevada licensed abatement or hazardous waste contractor will be mobilized to the site to selectively abate the materials prior to demolition. If it is determined that pre-removal is not feasible, selective demolition, removal and disposal will occur during the demolition when the area is accessible.

2.2.1 ACM Survey

Included in this task is the performance of a pre-demolition sampling survey of suspect ACM at the Unit 4 cell building, including sampling and analysis of suspect ACM in accordance with Asbestos Hazard Emergency Response Act (AHERA) protocols. The pre-demolition ACM survey is expected to include the following activities:

- A visual inspection of the building to provide a general understanding of the various types and conditions of accessible suspect ACM that may be present at the building.
- Sampling of suspect ACM observed in representative areas surveyed.
- Analysis of asbestos bulk samples by Polarized Light Microscopy with Dispersion Staining (PLM/DS) by a National Voluntary Laboratory Accreditation Program (NAVLAP) asbestos accredited laboratory.
- Reporting of the sampling results to NERT and NDEP, type(s) of ACM identified, location of identified ACM, and an estimate of the quantities of ACM.
- The results will be included in a hazardous material survey report and used to determine the demolition and abatement procedures, as well as potential health and safety procedures. The hazardous material survey report will be included as an Appendix to the Final Investigation Report.

2.2.2 LBP Survey

Tetra Tech will perform a pre-demolition lead-based paint/lead containing materials (LBP/LCM) survey using x-ray fluorescence (XRF) of the building to provide information on whether LBP/LCM is present in the building in accordance with department of Housing and Urban Development (HUD) guidelines. The LBP/LCM survey is expected to include the following:

- Sampling of suspect LBP/LCM using XRF to document the presence/absence of LBP, as well as other types of suspect LCM, such as ceramic tile. Tetra Tech expects to use the XRF method to test suspect LBP/LCM surfaces in the building. Typically, the LBP/LCM XRF direct reading survey result data is provided the same day. Confirmation paint chip samples will be collected at selected locations in the building.

2.2.3 Hazardous Materials Survey

Tetra Tech will perform a pre-demolition visual hazardous materials survey in the building to document the following potential sources of hazardous materials:

- **Polychlorinated biphenyls (PCBs):** estimate the number of fluorescent light fixture ballasts (all ballasts will be presumed to be PCB-containing). Other potential sources of PCBs include electrical transformers or other electrical switchgear and components, and hydraulic oil in elevators, lifts and trash compactors.

- **Mercury:** estimate the number of fluorescent lamps, thermostats, and exit lighting units (all are presumed to contain mercury).

- **Perchlorate:** estimate the residual anhydrous perchlorate present on the building surfaces throughout the Unit 4 cell building basement.

- **Other hazardous materials:** document types and estimate quantities of other potential sources of hazardous materials, including radioactive, acidic, and toxic substances. Sources may include exit signs, smoke detectors, and batteries contained in emergency devices, refrigeration equipment that may contain ammonia or freon, paints, solvents, petroleum products, and cleaning chemicals.

The results of the hazardous materials survey will be compiled in a report and used to determine the demolition, abatement procedures, and health and safety protocol. The hazardous material survey report will be included as an Appendix to the Final Investigation Report.

2.3 Utility Location and Ground Breaking Permit

Prior to beginning demolition activities, the limits of the proposed demolition work will be submitted to Tronox to obtain building plan records to identify if there are any subsurface utilities located in the area of the proposed work. Following tentative approval from Tronox of the proposed field locations, Tetra Tech will apply for a ground breaking permit from Tronox. As part of the Ground Breaking Permit process, Tronox will review their utility records and identify any potential conflicts that may exist with the locations of the proposed invasive work. If a conflict is identified, the proposed work area(s) will be adjusted accordingly. Following resolution of any subsurface utility conflicts, Tronox will issue the Ground Breaking Permit.

As an additional precaution, a geophysical utility clearance survey consisting of ground penetrating radar (GPR), electromagnetic (EM) 61, precision utility locating (PUL), or other appropriate geophysical methods may be performed to identify utilities and any other potential subsurface obstructions. If geophysical techniques are not effective, Tetra Tech may utilize alternate methods to identify the presence or absence of subsurface utilities, including but not limited to the use of an air-knife or other utility clearance methods.

The Tronox Ground Breaking Permit process and utility clearance will also identify nearby active utilities that could be at risk of damage, as a result of the subsurface environmental investigation activities, and measures will be implemented to ensure the protection of these utilities. Underground Service Alert of Nevada will also be notified of the pending subsurface activities during the utility clearance program.

2.4 Work Zone Establishment

Before demolition activities begin, a work zone area will be established to prohibit personnel, who are not working on the demolition of the Unit 4 cell building from entering the demolition area. Access to the work zone will be restricted to personnel and companies authorized by the Tetra

Tech Project Manager, project Health and Safety Manager, and must be approved for access by both NERT and Tronox.

Demarcation of the work zone may consist of using delineators, temporary fencing, caution tape, and signs. Work zone controls will remain in place for the duration of the demolition and environmental investigation activities. Work zone boundaries may be modified based on the progress of the building demolition and debris/waste management requirements. At the conclusion of each work day, the work zone will be secured to restrict access to the area.

2.5 Structural Evaluation and Stabilization

Prior to initiating field demolition activities, a structural survey of the Unit 4 cell building on the north and south sides of the cell floor area will be conducted by a Tetra Tech structural engineer to evaluate the condition of the steel framing, steel reinforcement within the floors, walls, structural loads and earth loads on the walls and foundations so that mitigation measures can be taken, if necessary, to prevent uncontrolled collapse of any portion of the structure (Occupational Safety and Health Administration [OSHA] Standard 1926.850(a)). In addition, dimensions and depth of burial of any adjacent footings to the Unit 4 cell building will be determined in order to estimate lateral loads applied to the basement walls. Findings of this survey will be incorporated into the Final Demolition Plan prior to contractor mobilization.

Specific features within and adjacent to the Unit 4 cell building will require additional protective measures during demolition include; a water line and a compressed air line located along the south-facing Unit 4 chlorinator building on the north side of the Unit 4 cell building, foundations systems for the northern (Unit 4 chlorinator building) and southern (Unit 4 substation building), other adjacent buildings, weather coating (corrugated steel sheeting) on the Unit 4 chlorinator building, and the acid-proof brick facade on the Unit 4 substation building. These measures will be included in the scope of work issued to the demolition contractor, subject to review and approval by the Tetra Tech Structural Engineer.

The active water line and compressed air line are located on the south side exterior of the Unit 4 chlorinator building. These pipelines are suspended above the planned work area and will be evaluated for structural stability and protected from falling debris during all demolition activities. The Unit 4 substation building and the Unit 4 cell building basement share a common wall on the south side of the building. The basement wall and adjacent footings will remain intact. The Unit 4 chlorinator building is supported by steel columns founded on reinforced concrete footings. A structural evaluation of the existing Unit 4 chlorinator building and Unit 4 substation building foundations will be performed. Additionally, an evaluation of the structural condition of the basement walls, where the access ramp is to be constructed along the west side of the Unit 4 cell building, will be performed. Recommendations for protection of the potentially-affected structures, work areas and workers will be provided in the Final Demolition Plan for approval by NERT and NDEP prior to implementation of the Demolition Plan.

Weather coating corrugated steel reportedly containing asbestos is present on the exterior of the Unit 4 chlorinator building. This material is highly weathered and may dislodge from the structure during demolition activities. If dislodged, the demolition contractor will handle and dispose of the material appropriately as potentially hazardous waste generated during the demolition. The Unit 4 substation building has a brick façade that may also require protective measures during demolition.

2.6 Cell Floor Demolition

Demolition activities of the Unit 4 cell building cell floor and structural supports will be conducted in accordance with the methods outlined in the National Association of Demolition Contractors *Demolition Safety Manual* (2014) and American National Standards Institute (ANSI) A10.6-1983, Safety Requirements for Demolition Operations.

The Tetra Tech Project Engineer and selected demolition contractor's Site Superintendent will examine the structure to determine the safest, most effective demolition approach and sequence. Demolition activities are to be performed in a safe and controlled manner. The above grade Unit 4 cell building floor, to be demolished, consists of suspended concrete walkways separated by open beam areas that previously supported the cells, as shown on Figure 4 (BMIa 1941). The walkways are supported by steel beams founded on concrete column pads. The steel columns, beams, concrete decks and concrete piers supporting the columns will be demolished, as illustrated on Figure 5 (BMIb 1941). The basement level support columns will be removed during demolition to allow unobstructed movement of demolition and drilling equipment. The basement level concrete slab will not be demolished and will remain. Upon completion of the demolition activities, all exposed steel or rebar in the basement walls will be epoxy coated to minimize weathering.

To facilitate demolition and waste removal operations, an earthen access ramp, from the ground level to the basement level, will be constructed on the west side of the Unit 4 cell building. Construction of a ramp will be used to allow access of demolition, drilling, and other ancillary equipment required to complete the demolition and conduct the planned environmental investigation.

The demolition contractor will attempt to construct the ramp using existing on-site soil derived from the immediate area, in a manner which results in zero net change in soil volume (i.e. no import or export). However, as a contingency additional clean soil fill may be imported to complete the ramp. If any waste soil is generated during ramp construction, the soil will be managed in accordance with the SMP requirements. The ramp is to be constructed at a maximum 5:1 (horizontal:vertical) ratio resulting in an approximate length of 40 feet, and a width of approximately 20 feet. The demolition contractor's scope of work will include preparation of a demolition plan and approach to accomplish this work that will be reviewed for acceptance by Tetra Tech Health and Safety Officer and Tetra Tech structural and geotechnical engineers.

2.6.1 Stockpile Management and Profiling

Tetra Tech will direct the contractor to segregate demolition construction debris by material type. Specific stockpiles categories will be developed in conjunction with the selected demolition subcontractor.

NERT will assume responsibility for: 1) Waste materials determined to be a Resource Conservation and Recovery Act (RCRA) or non-RCRA hazardous waste; 2) Soil, if any, excavated during the demolition work; and/or 3) Other debris generated during the demolition program that may be sent to a recycling facility. Representative samples for waste profiling purposes will be collected from debris stockpiles intended to be disposed of off-site and/or transported to a recycling facility.

2.6.2 Dust Control

Because the Unit 4 cell building grade level floor is a concrete and steel structure, a moderate amount of dust generation is anticipated. A Dust Control Permit will be obtained from the Clark County DAQ. Dust control measures consisting of application of a water mist or other suitable dust suppressant will be implemented as necessary during demolition activities. All work will be performed in compliance with Clark County Air Quality dust control measures. Demolition activities will be temporarily halted and re-evaluated should visible dust be released outside of the work zone.

2.6.3 Field Documentation

Tetra Tech field staff will maintain a daily log to document field activities, air monitoring logs, digital photographs to document field activities, and completed chain-of-custody records for samples submitted for analytical testing. These field records will be used to document the work performed by the Contractor that is associated with contaminated materials or general building materials and wastes, including excavation, segregation, stockpiling, stockpile sampling, and off-site transportation and disposal. The records will include field logs for recording observations or any measurements obtained during the demolition program.

2.7 Waste Management and Disposal

The debris from the demolition of the Unit 4 cell building will be temporarily stockpiled on-site and sorted into material specific waste streams as indicated in Section 2.6.1. Steel and other metals will be staged for shipment to an appropriate recycling facility. Concrete and other solid materials will be characterized for bulk waste disposal. Acceptance of the waste stream will be required prior to shipping to the designated facility. All stockpiled materials will be protected from wind or rain to prevent inadvertent transport through dust or water run-off from the work area. Any hazardous materials selectively removed from the Unit 4 cell building will be disposed of at an appropriately permitted disposal facility. (Southern Nevada Health District, 2014). Planned access and haul routes from the Unit 4 area are shown on Figure 2.

3.0 DEMOLITION WORK PLAN UPDATE

Upon completion of the hazardous materials surveys, geophysical survey and engineering evaluations, the Preliminary Demolition Work Plan will be updated. The Final Demolition Work Plan will provide specific procedures, protocols and activity specific health and safety measures to be implemented during the planned building demolition. The Final Demolition Plan will be submitted to the NDEP for concurrence prior to implementing the work.

4.0 REFERENCES

Basic Magnesium Inc., (BMIa) 1941. Electrolysis Plant, Supports and Framing Around Cells Drawing D-14

BMIb, 1941. Typical Cell Block with Rectifier, Drawing CB-1

Clark County Department of Air Quality (DAQ), 2014a, Demolition Notification Form http://www.clarkcountynv.gov/Depts/AirQuality/Documents/DustControl/AsbestosForms/ASB02_DemolitionNotificationForm.pdf

DAQ, 2014b, Dust Control Application, http://www.clarkcountynv.gov/Depts/AirQuality/Documents/DustControl/DustForms/Application.pdf

DAQ, 2014c, Asbestos Abatement, http://www.clarkcountynv.gov/Depts/AirQuality/Documents/DustControl/AsbestosForms/ASB01_Abatement_Form.pdf

ENVIRON International Corporation (ENVIRON), 2011. Phase I Environmental Site Assessment of Tronox LLC, Clark County, Nevada. January.

ENVIRON, 2013. Site Management Plan, Revision 1, Nevada Environmental Response Trust Site, Henderson, Nevada. October 31. NDEP approved November 7.

ENVIRON, 2014. Remedial Investigation and Feasibility Study Work Plan, Revision 2, Nevada Environmental Response Trust Site, Henderson, Nevada. June 19.

Southern Nevada Health District, 2014, http://www.southernnevadahealthdistrict.org/solid-waste/permit-disposal-fac.php

Tronox, 2014a, Hot Works Permit Application (Appendix A)

Tronox, 2014b, Ground Breaking Permit Application (Appendix A)

FIGURES

MAP LOCATION

Nevada Environmental Response Trust Site

Unit 4 and 5 Buildings Investigation Area

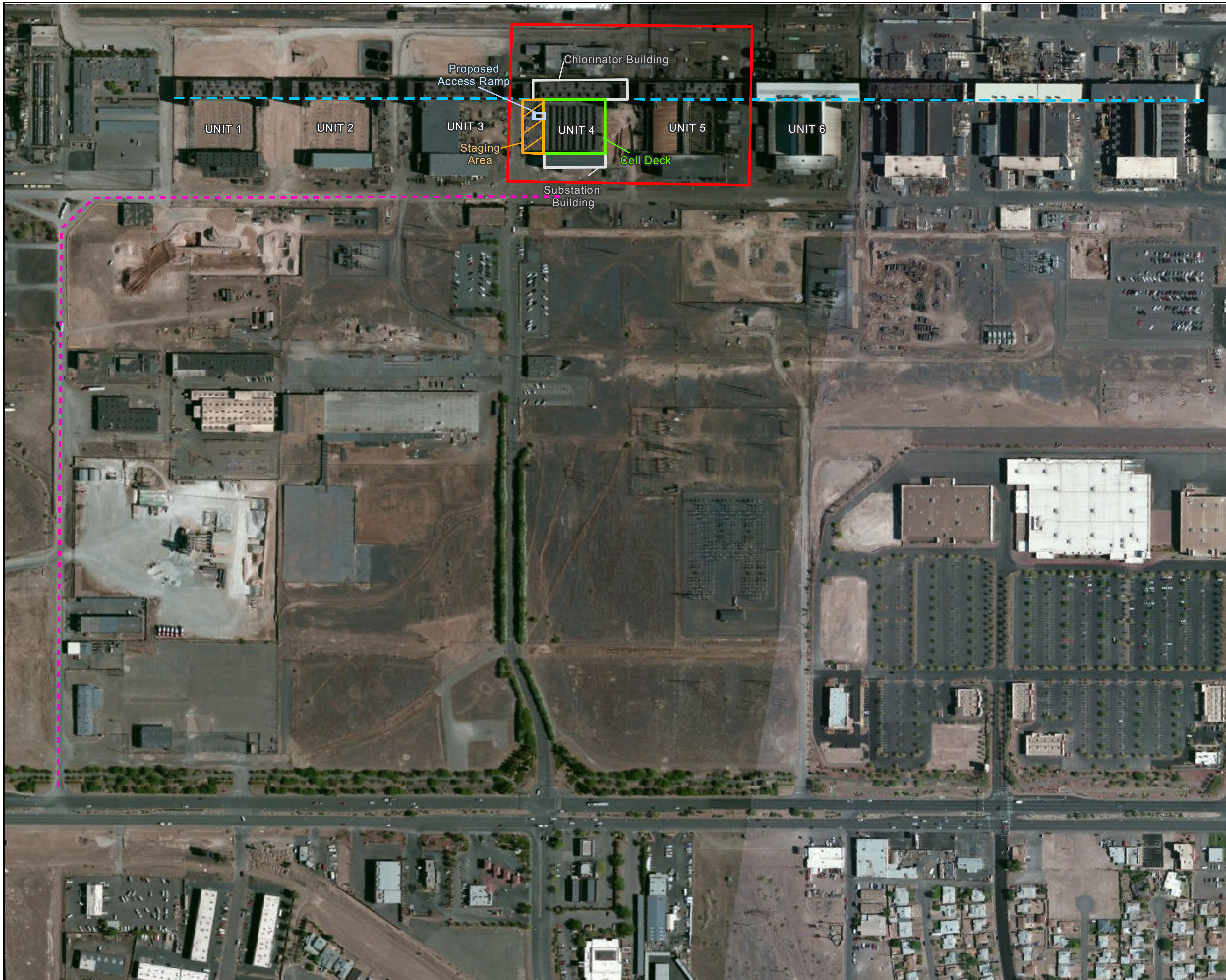
Notes:
(1) Basemap and Inset: ESRI Street Map, 2014
(2) Coordinate System: NAD 1983 State Plane Nevada East, U.S. Survey Feet

TITLE:	NERT Location Map
LOCATION:	Nevada Environmental Response Trust Henderson, Nevada

TETRA TECH

APPROVED	SB	FIGURE
DRAFTED	SC	1
PROJECT#	114-520225	
DATE	3-18-2015	

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
Document Path: P:\Databases\Henderson, Nevada\GIS\Figure 1 NERT Location.mxd



Unit 4 Cell Building Deck

Staging Area

Proposed Access Ramp

Building

Access and Haul Route

Above Ground Chlorine Gas Line

Notes:
(1) Aerial Source: ESRI Aerial Imagery 2014
(2) Inset Source: ESRI Street Map 2014
(3) Coordinate System: NAD 1983 State Plane Nevada East, U.S. Survey Feet

N

0 125 250 500 Feet

TITLE:	Unit 4 Cell Building Demolition Access and Haul Routes
LOCATION:	Nevada Environmental Response Trust Henderson, Nevada

TETRA TECH

APPROVED	SB	FIGURE
DRAFTED	SC	2
PROJECT#	114-520225	
DATE	3-18-2015	

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
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Unit 4 Cell Building Deck

Staging Area

Proposed Access Ramp

Building

Chlorine Gas Line

Notes:
(1) Aerial Source: Google Earth 2013
(2) Inset Source: ESRI Street Map 2014
(3) Coordinate System: NAD 1983 State Plane
Nevada East, U.S. Survey Feet

N

0 25 50 100
Feet

TITLE: **Unit 4 Proposed Demolition Area**

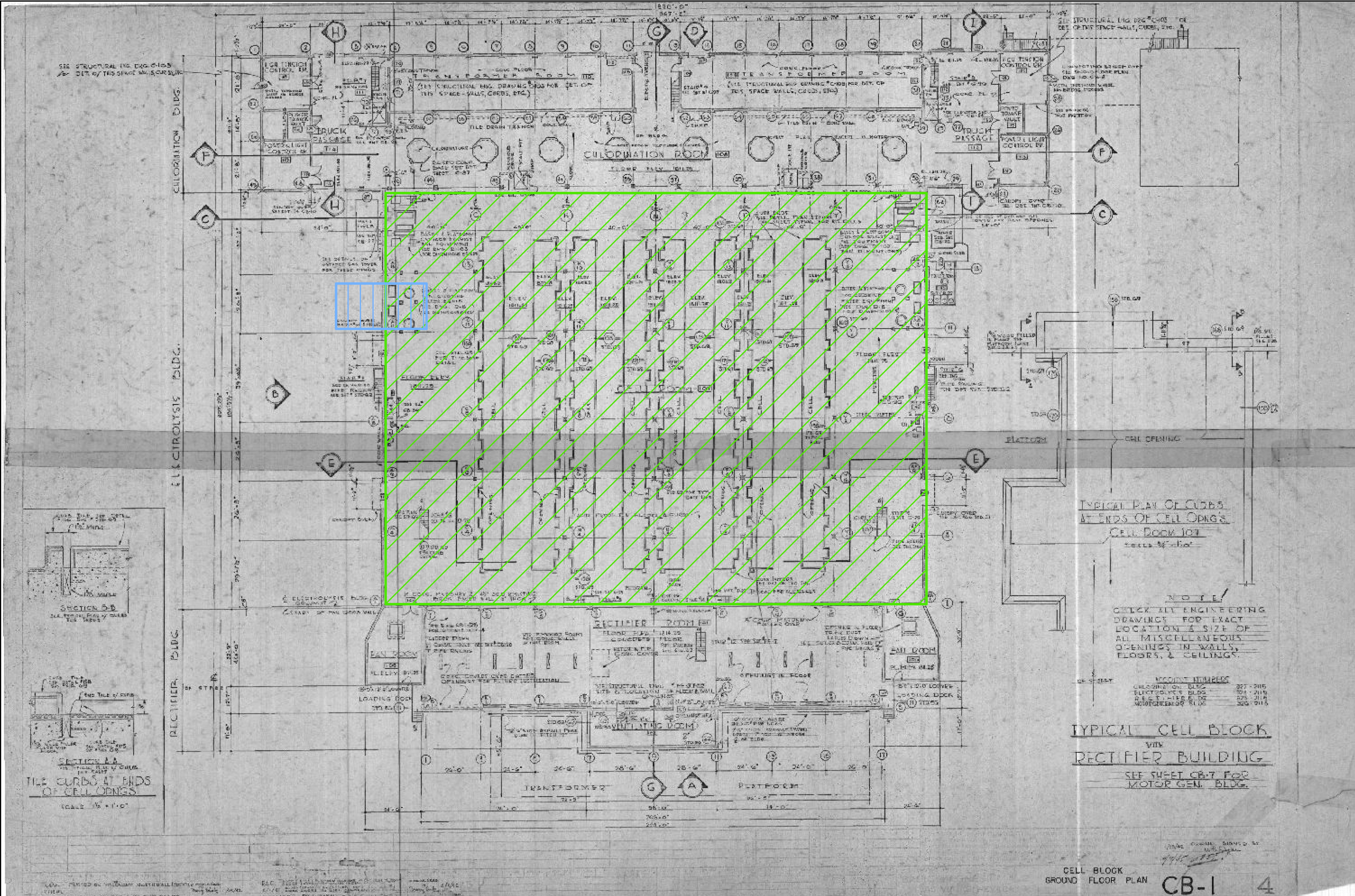
LOCATION: **Nevada Environmental Response Trust**
Henderson, Nevada

TETRA TECH

APPROVED	SB	FIGURE
DRAFTED	SC	3
PROJECT#	114-520225	
DATE	2-25-2014	

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors
Esri, HERE, DeLorme, TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

Document Path: P:\Databases\Henderson, Nevada\GIS\Other Tetratech Office\Figure 3; Proposed Demolition.mxd



Unit 4 Cell Deck Area

Proposed Access Ramp

DATE 2-25-2015

PROJECT# 114-520225

LOCATION: Nevada Environmental Response Trust Henderson, Nevada

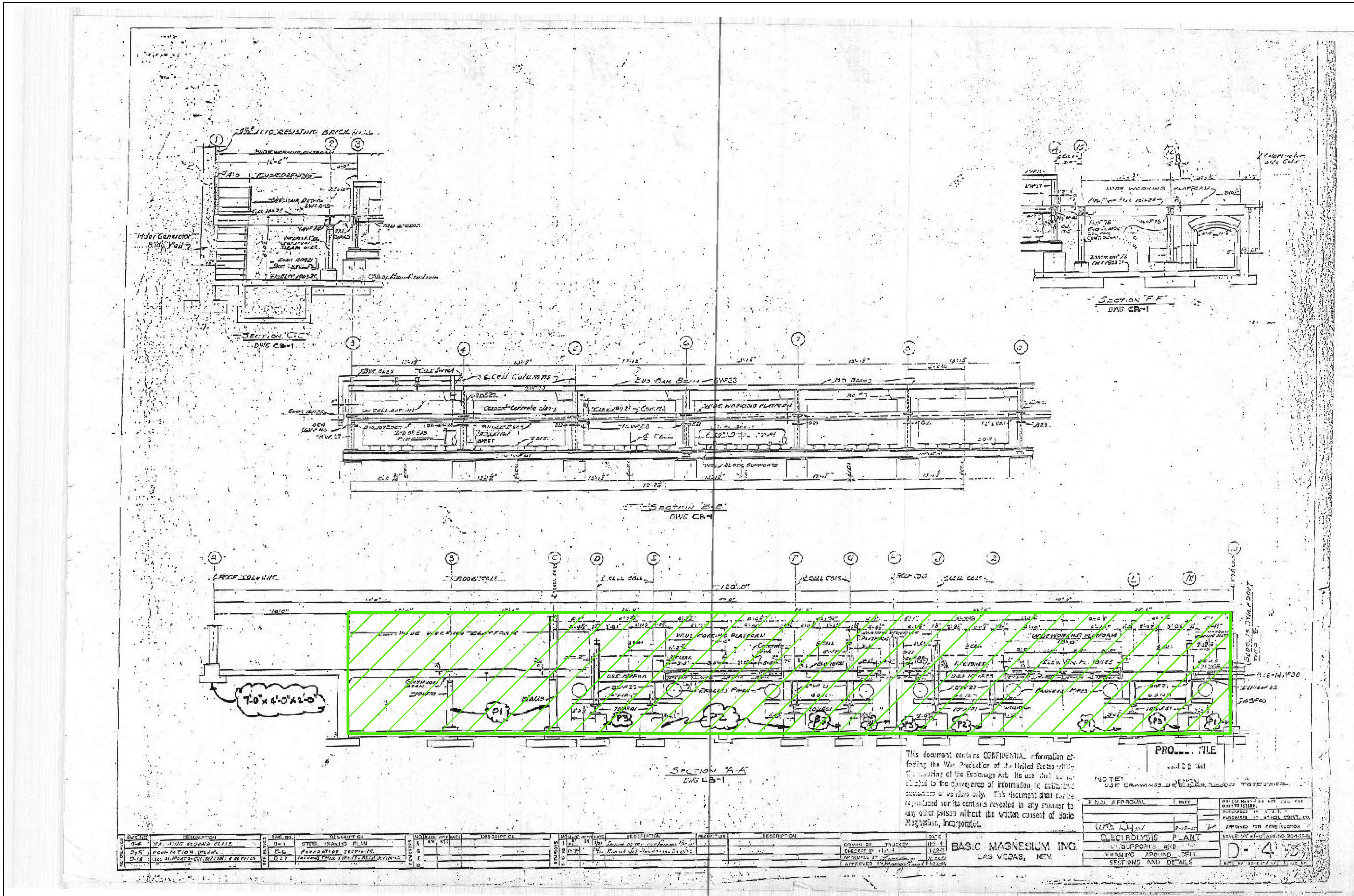
FIGURE 4

DRAFTED SC

APPROVED SB

TITLE: Cell Building Floor Plan Limit of Demolition

TETRA TECH



Unit 4 Cell Deck Area

Proposed Acess Ramp

TITLE:
Cell Building Profile Limit of Demolition

LOCATION:
Nevada Environmental Response Trust
Henderson, Nevada

DATE	2-25-2015
PROJECT#	114-520225
FIGURE	5
DRAFTED	SC
APPROVED	SB

TETRA TECH

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APPENDIX A
TRONOX PERMITS

BEFORE THIS PERMIT CAN BE SIGNED, THE FOLLOWING RULES MUST BE COMPLIED WITH AND THE APPROPRIATE BOX CHECKED.

1. No burning or welding is permitted where sprinklers are out of service

   Sprinklers in area? ☐ Yes ☐ No   If yes, in service? ☐ Yes ☐ No

2. No burning or welding is permitted in the presence of flammable dust, gas or liquid, or on tanks, lines or equipment previously containing such material which have not been purged.

A)	Tanks, lines, other equipment cleaned, purged, and tested?	☐YES ☐NO
B)	Atmosphere tested for flammable vapors and oxygen?	☐YES ☐NO
	O2: _____% LEL: _____%	

ATMOSPHERE TESTERS SIGNATURE

3. Before burning or welding operations are started, the following applicable precaution ***must be taken*** and the appropriate box checked.

A)	Area swept clean and wet down. If needed, floor and surroundings?	☐YES ☐ NO
B)	Combustibles moved at least 35 feet from operation or protected with metal guards or flame proofed tarpaulins?	☐YES ☐ NO
C)	Floor/wall openings, cracks or holes within 35 feet of operation covered?	☐YES ☐ NO
D)	Fire watch(es) assigned to watch for dangerous sparks in area as well as floors above and below?	☐YES ☐ NO
E)	Proper fire protection provided (hoses & extinguishers)? NOTE: Wall mounted extinguishers are not to be used for fire watch(es).	☐YES ☐ NO

TYPE OF EXTINGUISHING AGENT

☐ Water Hose   Fire Extinguisher: ☐ Water   ☐ A   ☐ B   ☐ C   ☐ D

F)	Conveyors or ducts that could transport sparks shut down or isolated?	☐YES ☐ NO
G)	Are sandwich-type constructed materials involved and has the prevention been addressed in these areas?	☐YES ☐ NO
H)	In discontinued chlorate/perchlorate areas, can this job be done without cutting torches or welding equipment?	☐YES ☐ NO
I)	Area operator notified?	☐YES ☐ NO
	Name:	
J)	Precautions taken to prevent heat transmission, by radiation or conduction, to unobserved combustibles?	☐YES ☐ NO
K)	Welder certification verified?	☐YES ☐ NO

4. Burning/welding equipment inspected and found in safe condition? ☐YES ☐ NO

5. Anti-flashback/backflow devices on torch and regulator? ☐YES ☐ NO

6. The area, including floors above and below should be monitored for at least one hour after work stops and permit is turned into the Tronox Authorizing Supervisor.

   Area Monitored By (print & signature):

7. Three (3) hour follow-up inspection required? ☐YES ☐ NO

   Inspection By (print & signature):

8. NAME OF AUDITOR (TITLE, DEPT.)   DATE

   CONCERNS/FOLLOW-UP REPORT WRITTEN? (If yes, attach)

HOT WORK PERMIT (HENDERSON) (TR-10057 04/14) X-A.14. Att. 1

BOTH SIDES OF THIS PERMIT MUST BE COMPLETED

This permit is required in all plant areas *except* designated shop areas and other areas as approved by the Executive Safety committee.

MAXIMUM PERMIT DURATION IS 12 HOUR SHIFT.

GOOD THIS DATE ONLY	FROM TO
BUILDING OR LOCATION (be specific)	FLOOR

CONTRACTOR ☐ Yes ☐ No

If yes, Contractor Name

EQUIPMENT TO BE WORKED ON (be specific)

TYPE OF HOT WORK

☐ Open Flame(propane/acetylene) ☐ Electric Welding ☐ Grinding/Cutting

☐ Electrical Equipment ☐ Other:

PURPOSE

INFORMATION FOR HAZARD COMMUNICATION

HAZARDS

☐ Perchlorate ☐ Flammable ☐ Pressured

☐ Chlorine ☐ H2S ☐ Other ____________________

I certify that I have personally examined the location where the above work is to be done. The required precautions for safe hot work appearing on the reverse side of this card have been checked as indicated.

TRONOX AUTHORIZING SUPERVISOR

TRONOX OR CONTRACTOR AUTHORIZING SUPERVISOR SIGNATURE

I have been properly instructed for safe BURNING & WELDING and understand my duties.

WELDER	CERT
WELDER	CERT

I have been properly instructed for FIRE WATCH and understand my duties.

FIRE WATCH

FIRE WATCH

CONTRACTOR SIGNATURE ABOVE INDICATED AGREEMENT WITH AND ACCEPTANCE OF THE CONDITIONS OF THIS PERMIT.

GROUND BREAKING PERMIT (HENDERSON) (TRX-5223-A) (08/14)

Reference Procedures X-A.30. Att. 1 and X-E.4. Att. 1

Both sides are to be completed before any excavation or concrete cutting is started, regardless of depth.

GOOD THESE DATES ONLY	FROM	TO

LOCATION

WORK TO BE DONE

MATERIALS / UTILITIES INVOLVED

This job site at applicable drawings have been reviewed. The precautions listed on this permit are necessary for the duration of the job.

SIGNATURE - PRODUCTION SUPERVISOR

SIGNATURE - MAINTENANCE SUPERVISOR

SIGNATURE - ENGINEER

SIGNATURE - UTILITY DEPARTMENT SUPERVISOR

SIGNATURE - PERMIT APPROVER

The following items must be completed before starting the excavation or concrete cutting and must be followed for the duration of the work.

	REQUIRED	NOT NECESSARY
Obstructions / Obstacles Removed From Site		
Barricades for Isolating Area.		
Flashers for Night.		
Line Breaking Permit.		
Additional PPE or Safety Equipment.		
Production Manager Notified of Utilities to be Shut Off		
Shoring.		
Atmospheric Tests for Flammable Vapors.		
Hot Work Permit.		
Rescue Harness / Tag Lines.		
Electrical Lines & Other Utilities Isolated		
Drawings Checked for Utility Locations at Work Area.		
Personnel to be Briefed on Safety Precautions.		
Utility Companies to be Notified (Gas, Power, Phone, etc.)		
Are Special Precautions Needed on This Job? Is so, Please List Below.		

SPECIAL PRECAUTIONS:

APPENDIX C
INVESTIGATION-DERIVED WASTE MANAGEMENT PLAN

FIELD GUIDANCE DOCUMENT NO. 001
MANAGING INVESTIGATION-DERIVED WASTE

Prepared by …………………………	Elysha Anderson, PE
Peer Reviewed by ………………	Dan Clark
Approved by ……………………..	John M. Pekala, PG, CEM
Applicable to ……………………	Nevada Environmental Response Trust Site Henderson, Nevada
Effective date ……………………	January 24, 2014
Revision Notes …………………	0 First Issuance
Documents used as reference during preparation …………….	Code of Federal Regulations (CFR), Title 40, Part 261 CFR, Title 49, Parts 172, 173, 178, and 179 Nevada Revised Statutes (NRS) Chapter 459.400 US Environmental Protection Agency (USEPA), *Guide to Management of Investigation-Derived Waste*, Publication 9345.3-03FS, dated April 1992

Table of Contents

1.0 INTRODUCTION

This Field Guidance Document (FGD) describes procedures for managing investigation-derived waste (IDW) at the Nevada Environmental Response Trust Site that will be conducted by or under the oversight of ENVIRON personnel. Although this FGD describes procedures for managing IDW for this project, it should be understood that there may be details of this type of work not specifically discussed in this FGD that would be followed by personnel trained in these techniques. To ensure that management of IDW is performed safely and completely, ENVIRON personnel involved in field activities should be sure that they understand the scope of work and the level of detail necessary for each field activity prior to mobilizing to perform the work.

This FGD is intended as a guidance document and does not supersede ENVIRON Health and Safety procedures or Site-Specific Health and Safety Plan (HASP) requirements. All ENVIRON employees shall follow the guidelines, rules, and procedures contained in site-specific HASPs prior to adhering to any procedures recommended in this FGD. The ENVIRON Project Manager and Task Leader must ensure that all project personnel review and sign the applicable HASP, and that the completed HASP and relevant project information is maintained in the project file. The signatures of the Project Manager and Task Leader indicate approval of the methods and precautions outlined in the HASP. The ENVIRON Project Manager and Task Leader will also be responsible for seeing that project personnel involved in field activities follow the procedures outlined in this and other applicable FGDs.

All personnel performing on-site operations with the potential for exposure to hazardous substances or health hazards are required to be 40-hour trained in accordance with Code of Federal Regulations (CFR) 1910.120 and will meet the personnel training requirements in accordance with 29 CFR 1910.120(e).

Environmental investigation activities such as drilling and sampling may generate solid, liquid, and other wastes that must be properly managed. This FGD describes the procedures to be followed for handling and managing routine IDW, including:

- Solid waste, both hazardous and non-hazardous (e.g., soil cuttings, contaminated debris or equipment)
- Liquid waste, both hazardous and non-hazardous (e.g., purge water, rinse water from decontamination)
- Personal Protective Equipment (PPE) (e.g., gloves, spent respirator cartridges, chemical-resistant coveralls)

This FGD is not applicable to the handling of flammable liquid wastes such as non-aqueous phase liquids (NAPL), which require additional protective measures. Nor is this FGD designed to address management of industrial wastes unrelated to an environmental investigation. This FGD describes the procedures for assisting clients with on-site handling and managing of IDW; however, disposal of IDW is the responsibility of the client.

The procedures presented herein are intended to be of general use and may be supplemented by a Work Plan, Sampling and Analysis Plan, Quality Assurance Project Plan, and/or a Health and Safety Plan. Some of these procedures may not be required depending on the specific scope of work being conducted. As the work progresses, and if warranted, appropriate revisions may be made by the Task Manager. Procedures in this protocol may be superseded by applicable regulatory requirements.

2.0 EQUIPMENT/MATERIALS

Equipment and materials needed to conform to this FGD include:

- Health and Safety Plan (HASP)
- Site information (maps, contact numbers, previous field logs, etc.)
- Containers for waste (e.g., 55-gallon open and closed top drums, or covered roll-off bins) and material to cover waste to protect from weather
- Fire extinguisher and spill containment equipment
- Equipment for transferring solid wastes (e.g., shovels, buckets, front-end loaders, etc.)
- Equipment for transferring liquid wastes (e.g., pumps, portable tanks, etc.)
- Secondary containment pallet for drums containing liquids
- Equipment for moving containers (e.g., drum dolly, truck with lift gate, etc.)
- Air monitoring equipment (i.e., air monitoring pumps, Photoionization Detector (PID), Flame Ionization Detector (FID), other as required by the HASP)
- Water quality meters for measuring temperature, pH, and specific electrical conductance
- Sampling equipment (trowels, telescoping sampling arm, dipper or coliwasa, sample pump and tubing, etc.)
- Certified-clean sample containers and preservation supplies, sample labels, ZiplocTM bags
- Cooler with ice
- Decontamination supplies (e.g., phosphate-free detergent, alconox, distilled water)
- Tool kit with appropriate tools (socket wrench set, pry bar, drum wrench)
- Hazardous/non-hazardous waste drum labels
- Permanent marking pens
- Plastic garbage bags, ZiplockTM storage bags, roll of plastic sheeting
- PPE (Long-sleeved shirt and pants, steel-toed boots, hardhat, nitrile gloves, safety glasses with side sheets, etc.)

- Field Forms (If the project requires it, a project-specific Field Logbook may substitute for the following)
  - *Field Investigation Daily Log*

3.0 PROCEDURES

Several types of waste are generated during site investigations that may require special handling methods. These include solid, liquid, and used PPE. The storage and handling of these materials is discussed below.

3.1 Solid Waste

Soil cuttings and drilling mud generated during investigation activities shall be kept on-site in containers. Covers should be included on the containers and must be secured at all times and only open during filling activities. The containers shall be labeled in accordance with this FGD. An inventory containing the source, volume, and description of material put in the containers shall be logged on prescribed forms and kept in the project file.

3.2 Liquid Waste

Groundwater generated during monitoring well development, purging, and sampling can be collected in truck-mounted containers and/or other transportable containers (i.e., 55-gallon drums). Only closed-top drums will be used for storing liquid wastes; open-top drums are generally not appropriate containers for liquids. Bungs on drums must be secured at all times and only open during filling or pumping activities. The containers shall be labeled in accordance with this FGD. Waste that is generated during equipment decontamination shall be collected in a separate container. All waste containers shall be properly accounted for through an inventory process.

3.3 Personal Protective Equipment (PPE)

PPE that is generated throughout investigation activities shall be placed in plastic garbage bags and stored in secure containers. The containers shall be properly sealed and labeled according to this FGD. If the solid or liquid waste is characterized as hazardous waste, then the corresponding PPE should also be disposed as hazardous waste. If not, all PPE should be disposed as non-hazardous waste at an appropriate facility. Trash that is generated as part of field activities may be disposed of in regular collection facilities as long as the trash was not exposed to hazardous media.

3.4 Waste Container Labeling

For situations where the waste characteristics are known, the waste containers should be packaged and labeled in accordance with state and federal regulations that govern the labeling of waste. General labeling requirements are discussed below.

The following information shall be placed on all non-hazardous waste labels:

- Description of waste (i.e., purge water, soil cutting);
- Contact information (i.e., contact name and telephone number); and
- Date when the waste was first accumulated.

The following information shall be placed on all hazardous waste labels:

- Description of waste (i.e., purge water, soil cutting);
- Generator information (i.e., name, address, contact telephone number);
- EPA identification number (supplied by on-site client representative); and
- Date when the waste was first accumulated.

When the final characterization of a waste is unknown, a notification label should be placed on the drum with the words "waste characterization pending analysis" (or similar) and the following information included on the label:

- Description of waste (i.e., purge water, soil cutting);
- Generator information (i.e., contact name and telephone number);
- Date when the waste was first accumulated.

Once the waste has been characterized, the label should be changed as appropriate for a non-hazardous or hazardous waste.

Waste labels should be constructed of a weatherproof material and filled out with a permanent marker to prevent being washed off or becoming faded by sunlight. It is recommended that waste labels be placed on the side of the container, since the top is more subject to weathering.

However, when multiple containers are accumulated together, it also may be helpful to include duplicate labels on the top of the containers to facilitate organization and disposal. Each container of waste generated shall be recorded in the field notebook used by the person responsible for labeling the waste. After the waste is disposed of, either by transportation off-site or disposal on-site in an approved disposal area, an appropriate record shall be made in the same field notebook to document proper disposal of the IDW.

3.5 Waste Characterization

Waste characterization will be performed to determine if the IDW generated is a hazardous waste as defined by federal and state regulations. Waste characterization will be performed through the use of existing information and without additional testing if the existing information is sufficient to make a professional judgment (e.g., manifests, Material Safety Data Sheets, preliminary assessments, previous test results, knowledge of the waste generation process, direct observation of the IDW for discoloration, odor or other indicators of contamination). If existing information is not available to properly characterize the IDW, testing will be performed using USEPA-recommended methods described in SW 846: Test Methods for Evaluating Solid Waste Physical/Chemical Methods, or other methods as applicable.

Discrete samples collected during the environmental investigation may be used for waste characterization by comparing sample results to federal hazardous waste characteristic thresholds. The Toxicity Characteristic Leaching Procedure (TCLP) is the threshold based on Federal guidelines. This applies to organic as well as inorganic compounds.

Solid IDW concentrations can be compared to twenty times the established federal TCLP (20xTCLP) values. The 20xTCLP values is generally regarded as a threshold level for requiring additional leach testing to characterize the toxicity characteristics of a waste.

Acid leach testing may be performed following the federal TCLP for comparison with the TCLP value. The TCLP method uses an acetic acid buffer solution as the extraction fluid. The mixing is done for 18 hours during the TCLP test. The dilution factor is 20x for the TCLP test. If a sample has a total metal concentration less than 20x its TCLP value, it cannot fail with respect to the TCLP index even if the compound is totally soluble; hence, the comparisons to 20x TCLP values.

3.6 Waste Accumulation On-site

The accumulation of IDW on-site is the responsibility of the client and/or the site owner. The following procedures should be followed for accumulation of IDW.

Solid, liquid, or PPE waste generated during investigation activities that are classified as nonhazardous or “characterization pending analysis” should be disposed of as soon as possible by the client. Until disposal, such containers should be inventoried, stored as securely as possible, and inspected regularly, as a general good practice.

Solid, liquid, or PPE waste generated during investigation activities that are classified as hazardous shall not be accumulated on-site longer than 90 days. All hazardous waste containers shall be stored in a secured storage area. The following requirements for the hazardous waste storage area must be implemented:

- Proper hazardous waste signs shall be posted as required by any state or federal statutes that may govern the labeling of waste;
- Secondary containment to contain spills;
- Spill containment equipment must be available;
- Fire extinguisher; and
- Adequate aisle space for unobstructed movement of personnel.

Weekly storage area inspections shall be performed and documented to ensure compliance with these requirements. Throughout the project, an inventory shall be maintained to itemize the type and quantity of the waste generated.

3.7 Waste Sampling and Profiling

The waste material will be profiled and approval will be received before transportation and disposal is arranged. Final determination of the disposal site will be based on approval from the disposal facility. The facility may require profiling of the containerized IDW including collection of additional samples from the containers themselves. The following procedures will be followed for sampling IDW containers.

In general, one composite sample will be collected using a trowel or coring device from each large container or from a group of drums containing equivalent solid wastes. Small samples of soil cuttings or drill mud will be taken from several locations and depths of the handling containers and placed in sampling jars. Composite samples should not be collected in a manner to dilute high concentration wastes with low concentration wastes. Grab water samples will be collected using a dipper or composite liquid waste sampler or “coliwasa.” Sampling handling and custody procedures will be followed as described in Section 7 of this SOP. Documentation of the sampling will be performed in accordance with the procedures outlined in Section 8 herein.

If a container is known or suspected to contain a hazardous waste based on the initial characterization, the applicable procedures outlined in USEPA document, Samplers and Sampling Procedures for Hazardous Waste Streams (EPA-600/2-80-018) will be followed.

3.8 Waste Transport

Non-hazardous or unclassified waste that is presumed to be non-hazardous or non-designated waste may be transported on-site to a waste accumulation area using appropriate tools such as a drum dolly or a truck with a lift-gate. Containers must be properly closed during transport and care must be taken to secure the containers so they do not move in an uncontrolled manner.

Hazardous waste may be moved on-site using the same precautions as described above. However, it may not be transported using a vehicle in the public right-of-way. A state-certified hazardous waste hauler shall transport all wastes classified as hazardous. Typically, the facility receiving any waste can coordinate a hauler to transport the waste. Shipped hazardous waste shall be disposed of in accordance with all RCRA/USEPA requirements. All waste manifests or bills of lading will be signed either by the client or the client’s designee. In general, ENVIRON personnel should not sign client manifests.

3.9 Waste Disposal

The disposal of IDW is the responsibility of the client. This section is for assisting the client in IDW disposal. All waste generated during field activities will be stored, transported, and disposed of according to applicable state, federal, and local regulations. All wastes classified as hazardous will be disposed of by the client at a licensed treatment storage and disposal facility or managed in other approved manners.

Solid, liquid, and PPE waste will be characterized for disposal through the use of client knowledge, laboratory analytical data created from soil or groundwater samples gathered during the field activities, and/or composite samples from individual containers.

In general, waste disposal should be carefully coordinated with the facility receiving the waste. Facilities receiving waste have specific requirements that vary even for non-hazardous waste, so characterization should be conducted to support both applicable regulations and facility requirements.

3.10 Equipment Decontamination

The equipment used to transfer wastes, all sampling equipment, and water quality meters will be decontaminated by the following procedures:

- The sampling and waste transferring equipment (shovels, buckets, pumps) will be hand washed with phosphate-free detergent and a scrubber, then thoroughly rinsed with distilled water, or steam-cleaned.
- Water quality meter sensors will be rinsed with distilled water between sampling locations. No other decontamination procedures are necessary or recommended for these meters since they are sensitive instruments. After sampling, the meters must be cleaned and maintained per the manufacturer's requirements.
- Decontamination water will be collected and stored on-site for future disposal by the client unless other arrangements have been made.

3.11 Sample Handling and Custody

Samples (if required for waste characterization) will be collected, handled, and stored in such a manner that they are representative of their original condition and chemical composition. Identification of samples and maintenance of custody are important elements that must also be utilized to ensure samples characterize site conditions. All samples will be properly identified and maintained under chain-of-custody protocol to protect sample integrity. The following sections discuss the sample handling and custody requirements.

3.11.1 Sample Identification

To maintain consistency, a sample identification convention including unique identifiers for all groundwater and QC samples must be developed and followed throughout the project. The sample identifiers will be entered onto the sample labels, field forms, chain-of-custody forms, and other records documenting sampling activities.

3.11.2 Sample Labels

A sample label will be affixed to all sample containers sent to the analytical laboratory. Field personnel will complete an identification label for each sample with the following information written in waterproof, permanent ink:

- Client and project number
- Sample location and depth, if relevant
- Unique sample identifier
- Date and time sample collected
- Filtering performed, if any
- Preservative used, if any
- Name or initials of sampler
- Analyses or analysis code requested

The use of pre-printed sample labels is preferred in order to reduce sample misidentification problems due to transcription errors. Sample labels must be completed and affixed to the sample container in the field at the time of sample collection.

If errors are made on a sample label, corrections will be made by drawing a single line through the error and recording the correct information. Corrections will be dated and initialed.

3.11.3 Containers, Preservation, and Hold Time

Each lot of preservative and sampling containers will be certified as contaminant-free by the supplier. All preserved samples will be clearly identified on the sample label and Chain-of-Custody form. If samples requiring preservation are not preserved, field records will clearly specify the reason for the discrepancy.

Chemical activity continues in the sample until it is either analyzed or preserved. Once the sample has been preserved, the sample may be held for a period of time before analysis. The time from the collection of the sample to the analysis is defined as the holding time. The holding time varies depending on the media being sampled and the analyses being performed. The collection, preservation, and analysis of samples must be conducted to avoid exceeding relevant holding times.

3.11.4 Sample Handling and Transport

Proper sample handling techniques are used to ensure the integrity and security of the samples. Samples for field measured parameters will be analyzed immediately in the field and recorded in the appropriate field forms. Samples for laboratory analysis will be transferred immediately to appropriate laboratory supplied containers in accordance with the following sample handling protocols:

- Don clean gloves before touching any sample containers, and take care to avoid direct contact with the sample;
- Samples will be quickly observed for color, appearance, and composition and recorded as necessary;
- The sample container will be labeled before or immediately after sampling;
- Sample containers and liners will be capped with Teflon®-lined caps before being placed in Ziploc™-type plastic bags. The samples will be placed in an ice chest kept at 4 °C for transport to the laboratory.
- All sample lids will stay with the original containers, and will not be mixed.
- Sample bottles will be wrapped in bubble wrap as necessary to minimize the potential for breakage during shipment.
- The *Chain-of-Custody* form will be placed in a separate plastic bag and taped to the cooler lid or placed inside the cooler. A custody seal will be affixed to the cooler if the samples are to be shipped by commercial carrier. For shipped samples, U.S. Department of Transportation shipping requirements will be followed and the sample shipping receipt will be retained in the project files as part of the permanent Chain-of-Custody document.

3.11.5 Sample Chain of Custody

Sample chain-of-custody procedures will be used to maintain and document sample integrity during collection, transportation, storage, and analysis. A sample is considered to be under the control of, and in the custody of, the responsible person if the samples are in their physical possession, locked or sealed in a tamper-proof container, or stored in a secure area.

The *Chain-of-Custody* form provides an accurate written record that traces the possession of individual samples from the time of collection in the field until they are accepted at the analytical laboratory. The Chain-of-Custody form also documents the samples collected and the analyses requested. The sampler will record the following information on the Chain-of-Custody forms:

- Client and project number
- Name or initials and signature of sampler
- Name of destination analytical laboratory
- Name and phone number of Project Leader in case of questions
- Unique sample identifier for each sample
- Data and time of collection for each sample
- Number and type of containers included for each sample
- Analysis or analyses requested for each sample

- Preservatives used, if any, for each sample
- Sample matrix for each sample
- Any filtering performed, if applicable, for each sample
- Signatures of all persons having custody of the samples
- Dates and times of transfers of custody
- Shipping company identification number, if applicable
- Any other pertinent notes, comments, or remarks

Blank spaces on the Chain-of-Custody will be crossed out and initialed by the field sampler between the last sample listed and the signatures at the bottom of the sheet.

The field sampler will sign the Chain-of-Custody and will record the time and date at the time of transfer to the laboratory or an intermediate person. A set of signatures is required for each relinquished/received transfer, including internal transfer. The original imprint of the Chain-of-Custody will accompany the sample containers and a duplicate copy will be kept in the project file.

If the samples are to be shipped to the laboratory, the original *Chain-of-Custody* relinquishing the samples will be sealed inside a plastic bag within the ice chest, and the chest will be sealed with custody tape that has been signed and dated by the last person listed on the *Chain-of-Custody*. U.S. Department of Transportation shipping requirements will be followed and the sample shipping receipt will be retained in the project files as part of the permanent *Chain-of-Custody* document. The shipping company (e.g., Federal Express, UPS) will not sign the *Chain-of-Custody* forms as a receiver; instead the laboratory will sign as a receiver when the samples are received.

4.0 PRECAUTIONS

Certain precautions should be taken to ensure safety during the implementation of this FGD. It is important to always remain alert and aware of your surroundings.

The activities described in this FGD require the implementation of a site-specific Health and Safety Plan to inform personnel of the hazards associated with this work and to describe the methods that will be employed to mitigate those hazards. The HASP must be prepared and approved by the Project Manager, Task Leader and the Project Health and Safety Coordinator prior to initiating field work.

5.0 RECORDKEEPING

Information collected during the performance of these procedures may be recorded on individual field forms. If the project requires it, a project-specific Field Logbook may replace any of the individual field forms with the exception of the Chain-of-Custody form. Following review by the Task Manager, the original field records will be kept in the project file. The following forms may be used to document the field activities:

- *Field Investigation Daily Log*
- *Equipment Calibration Log*
- *Chain-of-Custody*

The *Field Investigation Daily Log* will be completed for each day of fieldwork containing (at a minimum) the times and descriptions of the work performed, the activities of any contractors and/or visitors on-site, arrival and departure times for all involved, and any other pertinent information. For larger projects, or when otherwise deemed appropriate by the Task Manager, this information may alternatively be recorded in a field logbook. In these cases, a separate Field Logbook must be used for each project or site.

The *Equipment Calibration Log* will be used to document the calibration and status of any measuring instruments used in the field, e.g., PID/FID, water level measuring device, water quality meters, etc. The frequency and method of calibration will depend on the instrument. Any instruments used will be used in accordance with the factory-provided operating and/or service manuals.

Locations and unique identification of samples collected will be recorded on the *Field Investigation Daily Log*, a site map, and/or other appropriate forms.

Sample names, date/times, analyses to be performed and other pertinent information will be recorded on the *Chain-of-Custody* form as a means of identifying and tracking the samples.