Field Sampling Plan
Revision 1

Nevada Environmental Response Trust Site; Henderson, Nevada

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Nevada Environmental Response Trust

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Field Sampling Plan, Revision 1

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

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

Office of the Nevada Environmental Response Trust

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

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Date: 7-17-14

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(Former Tronox LLC Site)
Henderson, Nevada

Responsible Certified Environmental Manager (CEM) for this project

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 provided 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.

7/18/2014

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Contents

Contents (continued)

List of Tables

List of Figures

List of Appendices

Acronyms and Abbreviations

AMPAC	American Pacific Corporation
AP	ammonium perchlorate
ARCH	air rotary casing hammer
ASTM	American Society for Testing and Materials
AWF	Athens Road Well Field
bgs	below ground surface
BHRA	baseline health risk assessment
BMI	Black Mountain Industrial
CEM	Certified Environmental Manager
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COPC	chemical of potential concern
CSM	conceptual site model
DNAPL	dense non-aqueous phase liquid
DPT	direct-push technology
DQO	data quality objective
EB	equipment blank
EC	electrical conductivity
ENSR	ENSR Corporation
ENVIRON	ENVIRON International Corporation
Facility Area	The Site, excluding Parcels C, D, F, G, and H
FB	field blank
FD	field duplicate
FGD	Field Guidance Document
FS	Feasibility Study
FSP	Field Sampling Plan
GPS	global positioning system
GWETS	Groundwater Extraction and Treatment System
HASP	Health and Safety Plan
HCB	hexachlorobenzene
HSA	hollow-stem auger
IDW	investigation-derived waste

IWF	Interceptor Well Field
LOU	Letter of Understanding
mg/L	milligrams per liter (parts per million)
MS/MSD	matrix spike/matrix spike duplicate
NAD83	North American Datum of 1983
NDEP	Nevada Division of Environmental Protection
NERT	Nevada Environmental Response Trust
Northgate	Northgate Environmental Management, Inc.
OCPs	organochlorine pesticides
OPPs	organophosphate pesticides
PAHs	polycyclic aromatic hydrocarbon
PCBs	polychlorinated biphenyl
PE	Professional Engineer
PG	Professional Geologist
PID	photoionization detector
PVC	polyvinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RBC	risk based concentration
RI	remedial investigation
RPD	relative percent difference
SAP	Sampling and Analysis Plan
Site	Nevada Environmental Response Trust (NERT) Site
SWF	Seep Well Field
TB	trip blank
TDS	total dissolved solids
TEQ	toxicity equivalents
TIMET	Titanium Metals Corporation
TOC	Total Organic Carbon
TPH	total petroleum hydrocarbons
Tronox	Tronox LLC

UMCf	Upper Muddy Creek Formation
UMCf-cg1	Upper Muddy Creek Formation, first coarse-grained facies
UMCf-cg2	Upper Muddy Creek Formation, second coarse-grained facies
UMCf-fg1	Upper Muddy Creek Formation, first fine-grained facies
UMCf-fg2	Upper Muddy Creek Formation, second fine-grained facies
USCS	Unified Soil Classification System
USEPA	U.S. Environmental Protection Agency
VOCs	volatile organic compounds
VSP	Visual Sampling Plan Version 6.5
WBZ	water-bearing zone
Work Plan	Remedial Investigation and Feasibility Study Work Plan
xMCf	Transitional Muddy Creek Formation

1.0 Introduction

This Field Sampling Plan (FSP) details the sampling locations, procedures, and methods to be used during the field investigation activities to be conducted as part of the Remedial Investigation/Feasibility Study (RI/FS) at the Nevada Environmental Response Trust (Trust) Site located in Henderson, Nevada (the “Site”). The FSP is intended to be used in connection with the site-specific Health and Safety Plan (HASP) (ENVIRON 2014c) and the Quality Assurance Project Plan (QAPP) (ENVIRON 2014b), each of which have been prepared and submitted to the Nevada Division of Environmental Protection (NDEP) concurrently with this FSP. Together, these three documents comprise the Sampling and Analysis Plan (SAP) for the RI/FS.

1.1 Field Sampling Plan Organization

This document includes the following sections, which are summarized as follows:

- Section 1 provides an introduction.
- Section 2 discusses the data quality objectives (DQOs) for soil, groundwater, and soil gas.
- Section 3 summarizes the sampling and testing objectives for the Remedial Investigation and describes the sampling types, locations, and frequency.
- Section 4 details the sampling procedures and equipment to be used during the investigation.
- Section 5 describes sample designations, sampling handling, and analytical methods to be conducted as part of the investigation.
- Section 6 provides concluding statements about the FSP.
- Section 7 provides references to sources of information.

2.0 Data Quality Objectives

In this section, the United States Environmental Protection Agency (USEPA) DQO process is followed to assist with systematic planning for the proposed environmental sampling program described in this FSP. The DQO process is USEPA's recommended planning process when environmental data are used to select between two alternatives or derive an estimate of contamination. The DQO process is used to develop performance and acceptance criteria that clarify study objectives, define the appropriate type of data, and specific tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions. Performance criteria apply to new data collected for the project, while acceptance criteria apply to existing data proposed for inclusion in the project. As the FSP describes only the collection of new data, acceptance criteria are not applicable to the DQO process used in this FSP.

After performance criteria have been developed, the QAPP describes in comprehensive detail the necessary Quality Assurance (QA), Quality Control (QC), and other technical activities that must be implemented to ensure that the results of the work performed will satisfy the stated performance criteria (USEPA 2001). The QAPP for the proposed sampling at the Site has been developed as a separate document (ENVIRON 2014b), consistent with USEPA guidance (USEPA 2001).

As described in the RI/FS Work Plan (ENVIRON 2014a), numerous investigations of the Site and downgradient plume areas have been performed and these have largely defined the nature and extent of contamination in soil, soil gas, and groundwater. The objectives of the sampling described in this FSP are to better delineate the extent of contamination in areas that have not been completely investigated during previous investigations. Thus, in general the data collected during this sampling program described herein will not be used to support statistical hypothesis testing or estimation, but rather will be used to delineate the extent of contamination in combination with existing data.

The DQO process as described in USEPA guidance involves the following seven steps (USEPA 2006):

1. Define the problem
2. Identify the goal of the study
3. Identify information needed for the study
4. Define the boundaries of the study
5. Develop the analytic approach
6. Specify the performance or acceptance criteria
7. Develop the plan for obtaining data

A summary of steps 1-6 is provided in this section. The sampling plan details in step 7 are described in the remainder of the report.

2.1 Problem Definition, Study Goals, and Data Gaps

A summary of steps 1-3 of the DQO process as applied to the Site is provided in this section. Additional details are provided in the RI/FS Work Plan (ENVIRON 2014a). The Site has been the location of industrial operations since 1942 when it was developed by the US government as a magnesium plant to support World War II operations. Following the war, the Site continued to be used for industrial activities, including production of perchlorates, boron, and manganese compounds. Former industrial and waste management activities conducted at the Site, as well as those conducted at adjacent properties, resulted in contamination of environmental media, including soil, groundwater, and surface water. The Site has been the subject of numerous investigations and removal actions beginning in 1979. Soil removal actions were conducted to remove impacted soil from the Site to minimize potential health risks. The soil removal activities and post-removal conditions at the Site are described in detail in the Revised Interim Soil Removal Action Completion Report (ENVIRON 2012). Groundwater removal actions include the installation of the Groundwater Extraction and Treatment System (GWETS), which is designed to capture and treat perchlorate and hexavalent chromium in shallow groundwater. The components of the GWETS and its performance are described in the RI/FS Work Plan (ENVIRON 2014a) and the latest Annual Remedial Performance Report (Annual Reports) for the Site (ENVIRON 2013a).

Lists of chemicals of potential concern (COPCs) in groundwater and in soil based on leaching were presented in the RI/FS Work Plan (ENVIRON 2014a), based on frequency of detection and comparison to regulatory criteria and risk-based screening levels. The COPCs in groundwater include specific metals, volatile organic compounds (VOCs), pesticides, radionuclides, general chemistry parameters, one semi-volatile organic compound, and one organic acid. Groundwater COPCs are listed in Table 1a. Soil COPCs based on leaching are listed in Table 1b. The approach for identifying COPCs in soil for evaluating risk to human health was identified in the Baseline Health Risk Assessment Work Plan, approved by NDEP on May 20, 2014 (ENVIRON 2014d). Based on our review of the data, soil COPCs will include specific inorganic and organic compounds, asbestos, and radionuclides.

The overall purpose of the RI/FS process is “to gather information sufficient to support an informed risk management decision regarding which remedy appears to be most appropriate for a given site” (USEPA 1988). Based on the extensive investigations conducted to date, a conceptual site model (CSM) for the Site was developed and is described in Section 5.1 of the RI/FS Work Plan (ENVIRON 2014a). After a review of the existing data, areas were identified that require additional investigation to determine the nature and extent of COPCs in soil and groundwater. Many of these areas were previously identified by NDEP as areas requiring further study.

As part of the preparation of the RI/FS Work Plan, two treatability study work plans were developed to initiate the evaluation of in-situ soil flushing at the Site (ENVIRON 2014e) and a permeable reactive barrier situated in the downgradient plume (ENVIRON 2014f). These work plans describe the implementation of pilot-scale testing of these technologies. The sampling and analysis required as part of these treatability studies are specified within the respective work plans and not necessarily herein; however, general procedures and methodologies will apply to all aspects of the RI/FS process.

2.2 Study Area Boundaries

Step 4 of the DQO process is to define the boundaries of the study area. The boundary of the study area for groundwater and soil gas includes both the Site and the Downgradient Plume area, as shown on Figure 1. In association with the installation of groundwater monitoring wells and soil gas sampling, some physical testing of soils will be performed within the groundwater/soil gas study area. The boundary of the study area for investigation of COPCs in soil is called the Facility Area, which is comprised of the 265-acre portion of the Site excluding Parcels C, D, F, G, and H, as shown on Figure 2.

2.3 Analytic Approach and Performance Criteria

A summary of steps 5-6 of the DQO process as applied to the Site is provided in this section. For groundwater and soil gas, a judgmental sampling design is being used, in which sample locations are selected based on professional judgment and the CSM. As a result, no explicit performance criteria were defined for groundwater and soil gas samples.

For soil, preliminary boring locations were generated using the Sego and Wilson (2007) algorithm for locating hot spots. The objective of the hot spot sampling design is to detect the presence of hot spots of a specified size and shape, given a specified number of sampling points. The performance criteria input to the algorithm include a 95% probability of detection, and a 20% false negative error rate[1]. Hot spots were assumed to be circular in shape, and the sample locations were selected using Visual Sample Plan Version 6.5 (VSP) (VSP Development Team 2014). For most soil investigation areas, VSP was used to align the desired number of points to a triangular sampling grid with a random start location and orientation. A separate grid was generated for each sampling area, with each grid having a characteristic hot spot size. The resulting hot spot radii range from 67 to 127 feet. Certain planned soil boring locations were adjusted off the grid to be coincident with nearby prior soil samples or specific investigation locations, as described in Section 3.1.

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[1] The false negative rate is the probability that a sample measurement indicates the contamination is below the acceptable threshold, when in fact it is at or above the threshold.

3.0 Sampling and Testing Objectives and Locations

Sampling objectives for each sample media and each anticipated study area are discussed in the following subsections. In addition, the number and type of investigation locations (e.g., soil borings and groundwater monitoring wells) are described in these subsections.

3.1 Soil Data Gaps

Several data gaps have been identified based on the review completed to date of the post-2010/2011 soil removal soil analytical data set. Additional physical and chemical data are needed in both shallow and deep soils in the areas described in this section. Sixty-four on-Site soil borings (excluding on-Site and off-Site groundwater monitoring well borings, which are discussed in Section 3.2) are planned to be performed in order to address soil data gaps. A complete listing of planned soil borings, sampling intervals, and schedule of laboratory analyses is included in Table 2. Soil investigation areas, numbered 1 through 8, are shown on Figure 2.

In order to appropriately distribute soil borings in soil investigation area 2 and areas 4 through 7, the planned locations for soil borings were selected using the software program VSP Version 6.5 (VSP Development Team 2014). These sampling locations identified using VSP are shown on Figure 3. Sampling locations have not been placed in area 1 because soil boring locations will be designated following pond decommissioning. Sampling locations in soil investigation areas 3 and 8 were placed in specific targeted locations, rather than by using VSP. Sampling locations may be modified based on field observations, access restrictions, and/or subsurface utilities.

3.1.1 Area 1: AP-5 Pond

Relatively high concentrations of perchlorate and chromium have been detected in groundwater in the ammonium perchlorate (AP) process pond 5 (AP-5) area. NDEP previously identified the AP-5 pond as a potential source of metals, hexavalent chromium, perchlorate, chlorate, and ammonium (NDEP 2011). Draining and removal of residual solids from the pond has been proposed to NDEP. Following draining, residual solids removal, and pond decommissioning, eight soil borings are anticipated to be installed in the area of the former AP-5 pond. The AP-5 pond investigation area is shown on Figure 3; however the soil boring locations will be designated following pond decommissioning. The schedule for AP-5 pond decommissioning has not yet been established and is not being facilitated by ENVIRON. ENVIRON will coordinate with NERT and the consultant facilitating the decommissioning and will perform field tasks when appropriate.

Soil samples will be collected at the ground surface (following decommissioning), at intervals of five feet, and at any depth where field screening or observations indicate potential impacts, with the deepest sample collected at the capillary fringe[2] above the groundwater table. A grab groundwater sample will be collected from each boring via a temporary polyvinyl chloride (PVC) well casing. Soil and grab groundwater samples will be analyzed for chlorates, metals, hexavalent chromium, and general chemistry parameters, as shown in Table 2. Selected soil samples may be tested for physical properties as described in Section 3.4.

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[2] Capillary fringe samples will be collected within the deepest encountered unsaturated drilling interval.

3.1.2 Area 2: Soil Between Debris Pile and AP-5 Pond

Relatively high concentrations of perchlorate and chromium have been detected in groundwater in this area. Fifteen soil borings are planned in this area, at the locations shown on Figure 3.

Soil samples will be collected at the surface, at intervals of five feet, and at any depth where field screening or observations indicate potential impacts, with the deepest sample collected at the capillary fringe above the groundwater table. A grab groundwater sample will be collected from each boring via a temporary PVC well casing.

Soil and grab groundwater samples will be analyzed for chlorates and metals, as shown in Table 2. Selected soil samples may be tested for physical properties as described in Section 3.4.

3.1.3 Area 3: Debris Pile

Data are needed to evaluate the nature of the debris in the debris pile and the chemical and physical characteristics of the soil within and below the debris pile, as well as soil in the area south of the debris pile.

Three exploratory trenches/test pits will be excavated within the debris pile to observe the materials in the debris pile and shallow soils underlying the debris pile, if accessible. Visual observations of subsurface soil and debris along with field instrument readings will be used during exploratory trenching to track visual evidence of contamination from the debris in the debris pile. Up to five grab soil samples or debris samples (such as concrete) will be collected for analysis from each of the exploratory trenches/test pits to evaluate if COPCs are present.

Grab soil samples from trenches/test pits will be analyzed for the full suite of soil COPCs identified in the RI/FS Work Plan (ENVIRON 2014a) as well as asbestos, as shown in Table 2.

In addition, six soil borings will be drilled around the perimeter of the debris pile, at the locations shown on Figure 3. Samples will be collected at the ground surface, at intervals of five feet, and at any depth where field screening or observations indicate potential impacts, with the deepest sample collected at the capillary fringe above the groundwater table. A grab groundwater sample will be collected from each boring via a temporary PVC well casing.

While the analytical suite for these samples will be informed by results of samples collected from the exploratory trenches/test pits performed within the debris pile, the soil and grab groundwater samples from the perimeter of the debris pile are currently expected to be analyzed for the full suite of soil COPCs identified in the RI/FS Work Plan (ENVIRON 2014a); with surface and five foot depth samples analyzed for asbestos, as shown in Table 2. Selected soil samples may be tested for physical properties as described in Section 3.4.

3.1.4 Area 4: Area West of Mn-1 Pond

Relatively high concentrations of perchlorate, chromium, and chloroform have been identified in groundwater in the area west of the Mn-1 pond. Eight soil borings will be drilled in this area at the locations shown on Figure 3.

Samples will be collected at the surface, at intervals of five feet, and at any depth where field screening or observations indicate potential impacts, with the deepest sample collected at the capillary fringe above the groundwater table. A grab groundwater sample will be collected from each boring via a temporary PVC well casing.

Soil and grab groundwater samples will be analyzed for chlorates, metals, and VOCs, as shown in Table 2. Selected soil samples may be tested for physical properties as described in Section 3.4.

3.1.5 Areas 5 and 6: Additional Characterization of Category 3 Soils

Additional characterization of Category 3 soils has been identified as a data gap in conjunction with the ongoing review of available soil data for the upcoming Baseline Health Risk Assessment (BHRA), as discussed in Section 5.1.3 and 5.4.1.1 of the RI/FS Work Plan (ENVIRON 2014a). The areas that require additional characterization are summarized below.

<u>Area 5:</u> Relatively high concentrations of dioxins and furans have been identified in surface soil in Area 5 (Figure 2). Additional characterization of this area is needed to confirm dioxin/furan toxicity equivalents (TEQ) concentrations in surface soils. In addition, characterization is needed to further delineate potential dioxin/furan contamination. Twelve soil borings will be drilled in this area, at the locations shown on Figure 3. Soil samples will be collected at the surface and at intervals of five feet down to a depth of 10 feet below ground surface (bgs), and the soil cores will be screened for potential additional sampling. Samples will be analyzed for the full suite of soil COPCs identified in the RI/FS Work Plan (ENVIRON 2014a), with the exception of organophosphorus pesticides (OPPs) as shown in Table 2. The 10-foot samples will be placed on laboratory hold pending the results of the shallower samples. Selected soil samples may be tested for physical properties as described in Section 3.4.

<u>Area 6:</u> Relatively high concentrations of dioxins/furans and hexachlorobenzene (HCB) have been identified in post-excavation near-surface soils in Area 6 (Figure 2). Additional characterization of this area is needed to confirm dioxin/furan TEQ concentrations in surface and near-surface soils. In addition, characterization is needed to further delineate potential dioxin/furan and HCB contamination. Three soil borings will be drilled in this area, at the locations shown on Figure 3. Soil samples will be collected at the surface and at intervals of five feet down to a depth of 10 feet bgs, and the soil cores will be screened for potential additional sampling. Samples will be analyzed for dioxins/furans and organochlorine pesticides (OCPs), as shown in Table 2. Selected soil samples may be tested for physical properties as described in Section 3.4.

3.1.6 Areas 7 and 8: Assessment of Potential Source Areas in Soil for Chloroform Impacts to Soil Gas

Soil gas samples collected in 2008 as part of the Phase B Investigation (ENSR 2008) and reported in the draft Site-Wide Soil Gas Human Health Risk Assessment (Northgate 2010) identified relatively high chloroform concentrations in soil gas in two areas while the concentrations of chloroform in the underlying groundwater are relatively low. The relationship in these areas between the 2008 chloroform concentrations in soil gas and the current chloroform concentrations in groundwater (ENVIRON 2013a) does not appear to be consistent with this relationship in other areas of the Site, as shown on Figure 4.

Both Areas 7 and 8, as shown on Figure 2, have been identified as Letter of Understanding (LOU) Potential Source Areas (NDEP 1994) and the applicable LOUs were designated in the Soil Gas Work Plan as potential sources of VOCs from a review of historical information and Phase A investigation results (ENSR 2008). Additional soil characterization is needed to evaluate the potential source(s) of the chloroform detected in soil gas in these areas.

Area 7: Three soil borings will be drilled in this area, at the locations shown on Figure 3. Soil samples will be collected at the ground surface, at intervals of five feet, and at any depth where field screening or observations indicate potential impacts, with the deepest sample collected at the capillary fringe above the groundwater table. A grab groundwater sample will be collected from each boring via a temporary PVC well casing. Samples will be analyzed for VOCs as shown in Table 2.

Area 8: Two soil borings will be drilled in this area, at the locations shown on Figure 3. Soil samples will be collected at the ground surface, at intervals of five feet, and at any depth where field screening or observations indicate potential impacts, with the deepest sample collected at the capillary fringe above the groundwater table. A grab groundwater sample will be collected from each boring via a temporary PVC well casing. Samples will be analyzed for VOCs as shown in Table 2. Selected soil samples may be tested for physical properties as described in Section 3.4. Additional soil sampling within Area 8 (for purposes other than assessment of potential chloroform sources) is described in the following section.

3.1.7 Investigation of Soil Beneath Unit Buildings and Leach Plant

In addition to assessment of potential source areas in soil for chloroform impacts to soil gas in Area 8 (Section 3.1.6), data are also needed to evaluate the soils beneath Unit buildings and Leach Plant as potential sources of groundwater contamination at the Site. Unit buildings 4 and 5, as well as the Leach Plant, are included within Soil Investigation Area 8 (Figure 2).

The major buildings at the Site include Units 1 through 6, which are aligned in a row extending in a west-east direction across the southern portion of the Site (Figure 5). Historic reported releases at the Site include process chemicals leaking to soil through cracks in the central basements of Units 4 and 5 and the basement of Unit 6. The concrete basements served as sumps to collect process liquor, spillage, and wash water. Removal activities were undertaken in the Unit 6 basement in 1987 to remove the cracked concrete floor, followed by recontouring of the underlying soil and installation of a liner system. Other process leaks and spills (associated with the Units) to soils have been documented. The Unit process effluents contained high levels of total dissolved solids (TDS), perchlorate, and to a lesser degree, hexavalent chromium.

Based on groundwater levels measured in May 2013, the depth to water ranges from approximately 34 to 45 feet bgs in the existing shallow wells near the Unit buildings. Perchlorate concentrations in shallow groundwater near the Unit buildings are available from existing monitoring wells. Three monitoring wells are located downgradient of the three Unit buildings that had reported releases through cracks in central basement concrete floors. Well M-12A is located downgradient of Unit 4 and the Boron Plant, well M-11 is located downgradient of Unit 5, and well M-29 is located downgradient of Unit 6. These three wells were sampled in May and June 2012. The highest perchlorate concentration was detected downgradient of Unit 4 in well M-12A, where the perchlorate concentration was 200 milligrams per liter (mg/L). In contrast, the perchlorate concentration downgradient of Unit 5 in well M-11 was 29 mg/L. Downgradient of Unit 6, the perchlorate concentration at well M-29 was 4.4 mg/L in May 2011 (this well was not sampled in 2012). These downgradient groundwater concentrations suggest that soils underlying Units 4 and 5 could represent an on-going source of perchlorate to underlying groundwater. If present, soils impacted by past releases are most likely to be present beneath Unit 4, followed by Unit 5. As noted above, the basement floor in Unit 6 has been replaced with a new concrete slab and an underlying liner. Given the comparatively low perchlorate concentration in downgradient well M-29, investigation of deep soil sources beneath Unit 6 does not appear warranted at this time.

In groundwater sampling conducted in May and June 2012, relatively high perchlorate concentrations were also detected in wells located within and downgradient of the Leach Plant (M-52, 570 mg/L; M-141, 630 mg/L; M-31A, 1,100 mg/L), suggesting a potential for impacted soil to be present in the Leach Plant area downgradient of the Unit buildings.

Potentially feasible methods for obtaining soil samples directly beneath the Unit 4 and 5 buildings and the Leach Plant include vertical drilling and directional drilling. Drilling at the Unit 4 and 5 buildings will be affected by factors including worker safety issues, severe access constraints for drilling equipment within the operating Unit buildings, low ceiling heights in the basements, and limited access to the basement levels. Based on discussions with Tronox and a site visit with an experienced drilling contractor, vertical drilling is not feasible in either Unit building due to these access and safety factors. However, access for a short mast vertical drilling rig is possible in certain areas of the Leach Plant.

The directional drilling method is subject to several limitations. To achieve the target sampling depth, a 5:1 setback is required. For example, a target sampling depth of 20 feet below grade would require that the rig be positioned 100 feet away from the first soil sampling location. Soil samples are typically collected at 20 to 30 feet intervals along the horizontal drill path. The drill bit is maintained on course by tracking with an above ground instrument that detects signals transmitted from the drill bit. The detection instrument is operated by a worker who walks on the paved or unpaved ground surface directly above the bit. However, the detection instrument is affected by interference from electrical equipment and electric fields.

Based on discussions with Tronox and a drilling contractor Site visit, directional drilling will likely be feasible beneath the central cell basement of Unit 4. However, directional drilling will not be possible in Unit 5 primarily due to the density of operating equipment and interference from electrical equipment in the southern portion of the building.

Therefore, the approach for obtaining soil samples at Unit 4, Unit 5, and the Leach Plant will be to use vertical drilling and soil sampling methods outside the Unit buildings and within the Leach

Plant. Directional drilling and soil sampling methods will potentially be used beneath Unit 4, subject to further evaluation.

Directional Drilling Beneath Unit 4

Subject to further evaluation,[3] one horizontal soil boring will be advanced from west to east beneath the central basement of Unit 4, as shown on Figure 3. The drill rig will be positioned approximately 100 feet west of the building exterior wall foundation. Soil samples will be collected beneath the west wall of the Unit 4 basement and again at horizontal intervals of approximately 30 feet (7 soil samples total). The target sampling depth will be 20 feet below grade (approximately 10 feet beneath the basement floor slab). Based on water level measurements in nearby wells, the depth to groundwater is approximately 35 feet below grade in this area. A review of boring logs for nearby soil borings indicates that the vadose zone soils consist of sand and silty sand alluvium. The presence of loose sandy soils may affect the sample recovery and result in disturbed soil samples for testing. Soil samples collected from the horizontal boring beneath Unit 4 will be analyzed for chlorates, metals, hexavalent chromium, rare metals, VOCs, SVOCs, total petroleum hydrocarbons (TPH), OCPs, OPPs, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), dioxins/furans, organic acid (phthalic acid), radionuclides, and general chemistry parameters.

As described above, the drill bit is maintained on course by tracking with an above ground instrument operated by a worker on the ground surface directly above the drill bit. At Unit 4, the central cell portion of the building has been demolished, and the remaining ground floor slab is unstable and in poor condition. However, inside the Unit 4 basement there are multiple north-south parallel “corridors” where the overlying ground floor slab was removed when the equipment was taken out. The worker will be able to track the bit progress safely by moving progressively from open air corridor to corridor across the building from west to east. When the first target soil sample distance is reached, the drill stem is retracted, a soil sampling device is inserted into the borehole, retracted, and drilling is then resumed to the next target sample distance.

Vertical Drilling

As described in Section 3.2.8, five new shallow groundwater monitoring wells will be installed in the vicinity of Units 4 and 5, at the locations shown on Figure 5. Soil samples for chemical testing will collected at 5 feet intervals from ground surface to first groundwater, expected to be encountered at a depth of 35 feet bgs.

Six vertical soil borings will be drilled in the Leach Plant area, at the locations shown on Figure 3. Two of the six borings will be drilled adjacent to existing monitoring wells M-31A and M-52, where relatively high concentrations of perchlorate have been detected in groundwater. The additional four borings will be located within the Leach Plant. These locations may be adjusted depending on specific access constraints and operations in progress at the time of drilling. Soil samples for chemical testing will be collected at 5 feet intervals from the ground surface to first

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[3] The Trust is contemplating a modified technique for obtaining data beneath the Unit 4 building. ENVIRON will not proceed with this aspect of the plan until the Trust has confirmed the approach.

groundwater (at the capillary fringe), expected to be encountered at a depth of 35-40 feet bgs. A grab groundwater sample will be collected from each boring via a temporary PVC well casing.

Soil samples collected from the vertical borings in the Unit building area and the Leach Plant will be analyzed for chlorates, metals, hexavalent chromium, VOCs, total petroleum hydrocarbons (TPH), and general chemistry parameters. Selected soil samples may be tested for physical properties as described in Section 3.4. In addition, selected soil samples will also be analyzed for redox potential, total organic carbon (TOC), pH, ferrous iron, ferric iron, chloride, nitrate, nitrite, pH, sulfide, sulfate, calcium, potassium, and sodium.

3.2 Groundwater Data Gaps

The ongoing Trust groundwater monitoring program includes monthly and quarterly sampling of on-Site and off-Site monitoring wells. The RI/FS will address several groundwater data gaps and will include installation, gauging, and sampling of new monitoring wells, as well as water level measurement, aquifer testing, and/or sampling of several existing wells. These activities are considered to be separate from the ongoing Trust groundwater monitoring program. Depending on the results of analytical testing during the RI, new wells installed as part of the RI may be added to the ongoing Trust groundwater monitoring program during future monitoring events.

The following data gaps for groundwater have been identified. For groundwater data gaps that are to be addressed with the installation of new groundwater monitoring wells, soil cores and samples will be collected from the groundwater monitoring well pilot borings as the borings are advanced. Eight new on-Site groundwater monitoring wells and approximately 12 new off-Site groundwater monitoring wells (depending on access considerations) will be installed as part of the RI/FS. Vadose zone soil samples from monitoring well pilot borings for chemical analysis are detailed in Table 3. There are 118 existing and planned on-Site groundwater monitoring wells and approximately 63 existing and planned off-Site groundwater monitoring wells (depending on access considerations) that will be sampled as part of the RI/FS. A complete listing of groundwater monitoring wells (both existing and planned) that are to be sampled as part of the RI/FS, as well as the schedule of analyses for each well, is provided in Tables 4, 5, and 6.

3.2.1 Identification of Groundwater COPCs

In Section 5.1.4.2 of the RI/FS Work Plan (ENVIRON 2014a), a preliminary list of groundwater COPCs is presented based on screening of groundwater data collected since 2006 (Table 1a). As part of the RI, ENVIRON will review available groundwater data to determine whether any revisions to this list are necessary. Included in the review will be groundwater analytical data obtained to address data gaps as described in this FSP.

3.2.2 Background Determination

Background concentrations of metals and other naturally occurring COPCs in groundwater have not been determined for the localized area of Site and adjacent facilities. This issue is currently being evaluated by NDEP. For purposes of the RI/FS, naturally occurring COPCs as well as major ions and geochemical parameters will be compared to upgradient concentrations in four wells located on the upgradient (southern) Site boundary. The wells include Shallow Water

Bearing Zone (WBZ) wells M-120 and M-121 (screened in UMCf-cg1) and Middle WBZ wells M-117 and M-118 (screened in UMCf-fg1). The alluvium is unsaturated at the upgradient Site boundary. The well locations are shown on Figure 6. Groundwater samples will be analyzed for naturally occurring and widespread anthropogenic compounds including chlorates, dissolved metals, radionuclides, general chemistry COPCs, major ions, and geochemical parameters, as shown in Table 5.

3.2.3 Further Investigation of the Middle WBZ/Muddy Creek Formation.

Well Installations and Sampling to Define Vertical Extent of Site-related Chemicals in the UMCf Fine-grained Unit – The vertical extent of Site-related COPCs in the UMCf-fg1 unit has been partially defined by recent deeper wells installed in the central portion of the Site and in the vicinity of the Interceptor Well Field (IWF). Installation of deeper wells to further delineate the vertical extent of COPCs will be performed at the following three Site locations:

- M-161D will be installed adjacent to M-161, which is located on the north-central side of the barrier wall and IWF.
- M-162D will be installed adjacent to M-162, which is located on the north side of the barrier wall and IWF at its western end.
- M-186D will be installed adjacent to M-186, which is located on the eastern Site boundary.

The proposed locations for these monitoring wells are shown on Figure 6.

Continuous soil cores will be obtained for soil logging purposes during the drilling of pilot borings to be converted into the monitoring wells. In addition, soil samples for chemical analysis will be collected from the core at the ground surface and at five-foot intervals to a depth of 20 feet bgs, and then at intervals of 10 feet as necessary to reach the groundwater table. Soil samples from the surface and five foot interval depths will be analyzed for the full suite of groundwater COPCs identified in the RI/FS Work Plan (ENVIRON 2014a), with remaining deeper soil samples placed on hold at the laboratory, as shown in Table 3. Selected soil samples will be tested for physical properties as discussed in Section 3.4. Following well installation and development, groundwater elevations will be measured and groundwater samples will be collected and analyzed for groundwater COPCs, as shown in Table 4.

Water Level Measurements for Evaluation of Vertical Head Differences – Previous investigations of the Middle WBZ at the Site and surrounding sites indicate, with a few exceptions, a vertically upward gradient between the Middle and Shallow Zones that generally increases with depth. Following installation of the three new Middle WBZ wells, the previous evaluations of vertical head differences will be updated with current groundwater elevation data.

Slug Testing for Additional Hydraulic Characterization – In order to better characterize hydraulic properties in the Middle WBZ UMCf fine-grained unit, slug tests will be conducted in all the existing and new Trust-owned wells completed in this unit (a total of 24 wells). During these tests, drawdown will be monitored within the test well using a pressure transducer with integral data logging capability. The slug tests will provide data to estimate hydraulic conductivity values in the immediate vicinity of the wells, and also may be used to set pump rates for future step drawdown pump tests, if needed. These data will be incorporated into a numerical model that was developed to assess remedial alternative extraction scenarios for Site groundwater. While the majority of groundwater flow and transport occurs in the shallow alluvial deposits, evaluation of flow rates and mass transport in the deeper Muddy Creek formation will be conducted as part of the FS assessment of the IWF effectiveness.

Wells to be slug tested during the RI/FS include the following:

TR-2	MC-MW-42	M-152*	M-161D (new)
TR-4	M-117	M-153	M-162
TR-7	M-118	M-154	M-162D (new)
TR-9	M-149	M-155	M-181
MC-MW-18*	M-150	M-156*	M-186
MC-MW-39*	M-151	M-161	M-186D (new)

**These wells are not scheduled to be sampled for chemical analysis.*

3.2.4 Further Investigation of Trespassing Chemicals from Neighboring Properties

The Site is situated in between two other operating facilities that are part of the Black Mountain Industrial (BMI) Complex. The Site is bordered by Titanium Metals Corporation (TIMET) on the east and the Olin property on the west. All three facilities released wastewater into the former Beta Ditch for transport to former ponds in the BMI Common Area (see Figure 2 for the location of the former Beta Ditch). During the past decades of operation, chemicals released to groundwater at the individual facilities have become commingled, particularly in the areas near the property boundaries, below the unlined former Beta Ditch, and in downgradient plume areas.

At the Olin property, Montrose is conducting an investigation of dense non-aqueous phase liquid (DNAPL) that has been detected in several wells completed in the Middle WBZ. As shown on Figure 6, DNAPL has also been found in well MC-MW-18 located on the Site. The DNAPL has been tested, and it contains several VOCs (primarily benzene, dichlorobenzenes, and chloroform), pesticides, and herbicides. The most recent phase of Montrose's investigation is an assessment of DNAPL mobility for recovery purposes.

The Trust provides access to Montrose and its consultants for their ongoing monitoring and investigations into DNAPL mobility. To further assess the extent of impact by dissolved VOCs from this adjacent site, groundwater samples will be collected from on-Site wells currently monitored by the Trust groundwater monitoring program and analyzed for VOCs, as shown in

Table 6. The densely-spaced line of wells located immediately upgradient of the barrier wall will not be included in this sampling because other nearby wells provide adequate spatial coverage in the area of the IWF. The selected Trust groundwater monitoring program wells, combined with new monitoring wells discussed in this FSP, total 118 wells, including 94 wells in the shallow water bearing zone and 24 wells in the middle water bearing zone, as shown on Figure 7.

3.2.5 Further Investigation of the Lateral and Vertical Extent of Downgradient Perchlorate Plume in Groundwater

Lateral Plume Extent: Well Installations and Sampling – In order to distinguish between two perchlorate plumes in groundwater (Trust plume and BMI Common Areas plume), three existing off-site wells along Galleria Road east of the Athens Well Field (AWF) (L637, L639, L641) will be evaluated for sampling. Assuming access can be obtained from the well owner, one additional new shallow well (designated as PC-154) will be installed west of L645. If the three existing wells are not suitable for sampling, or if access cannot be obtained, three additional new shallow wells (designated as PC-158, PC-159, PC-160) will be installed nearby. In addition, three new shallow monitoring wells, designated as PC-151, PC-152, PC-153, will be installed along Sunset Road in the area between the Site-related downgradient plume and the American Pacific Corporation (AMPAC) downgradient plume. The locations of these existing and planned wells are shown on Figure 8a.

Continuous soil cores will be obtained for soil logging purposes during the drilling of pilot borings to be converted into the monitoring wells. Selected samples from the soil core will be tested for physical properties as discussed in Section 3.4. Following well installation and development, groundwater samples will be analyzed for the parameters shown in Table 4.

Vertical Plume Extent: Well Installations and Sampling – The vertical extent of perchlorate in the Muddy Creek Formation beneath the AWF extraction wells has not been fully delineated. Deeper monitoring wells, designated as PC-134D, PC-137D, will be installed adjacent to existing wells PC-134A and PC-137 to define the vertical extent of perchlorate-impacted groundwater. The locations of these planned wells are shown on Figure 8a.

Continuous soil cores will be obtained for soil logging purposes during the drilling of pilot borings to be converted into the monitoring wells. Selected samples from the soil core will be tested for physical properties as discussed in Section 3.4. Following well installation and development, groundwater samples will be analyzed for the parameters shown in Table 4.

3.2.6 Further Investigation of Concentrations of Chloroform in the Downgradient Plume

Eight shallow groundwater wells (AA-11, BHE1-10, PC-24, PC-28, PC-64, PC-65, PC-66, and PC-67) located between the Site and the AWF (Figure 9) will be sampled and analyzed for chloroform, as shown in Table 5, to provide data to assess current chloroform concentrations in shallow groundwater. In addition, these wells will be tested for metals, general chemistry, and geochemical parameters to provide data on groundwater conditions in the area between the Site and the AWF. After the planned groundwater sampling is completed, the chloroform data will be reviewed along with previous available sampling results. If the current chloroform concentrations are above the chloroform risk-based concentrations (RBCs) for vapor intrusion established for the Sale Parcels[4], soil gas samples will be collected at two depths adjacent to the three wells with the highest concentrations, as described in Section 3.6. This information will be used to establish the relationship between groundwater and soil gas concentrations in this area of the downgradient plume and to develop a chloroform groundwater RBC for vapor intrusion.

3.2.7 Investigation of Stream-Aquifer Interaction with Las Vegas Wash

Three pairs of groundwater monitoring wells (PC-155A/PC-155B, PC-156A/PC-156B, and PC-157A/PC-157B) will be installed between the Seep Well Field (SWF) and Las Vegas Wash (Figure 8a). At each well pair ("cluster"), the shallow well will be screened from approximately 10 to 30 feet depth and the deeper well will be screened from approximately 40 to 50 feet depth. Comparison of the water levels in Las Vegas Wash at the Pabco Road stream gage with the water levels in the groundwater monitoring wells at the SWF indicate that some amount of surface water from Las Vegas Wash is flowing into the extraction wells at the SWF. The three new well clusters (each with a shallow and a deeper well) will be installed to better quantify the amount of surface water being extracted by the SWF and to better delineate the extent of the area in which the SWF is causing a reversal of groundwater flow.

During the installation of these offsite wells, soil samples will not be collected for chemical analysis. However, continuous soil core will be obtained for soil logging purposes during the drilling of soil borings to be converted into the monitoring wells. Selected samples from the soil core will be tested for physical properties as discussed in Section 3.4. Following well installation and development, groundwater samples will be analyzed for the parameters shown in Table 4. In addition, there are 13 existing wells in the vicinity of Las Vegas Wash that will be sampled for the parameters shown in Table 5. The locations of these wells are shown on Figure 8b.

3.2.8 Investigation of Groundwater Impacts at Unit Buildings

Perchlorate concentrations measured in groundwater monitoring wells located downgradient of the Unit buildings suggest that underlying soils impacted by past releases could be acting as an on-going source of groundwater contamination. Such soils are most likely to be present beneath Unit 4, followed by Unit 5. Therefore, five shallow groundwater monitoring wells will be installed, as shown on Figure 5, to better delineate groundwater impacts at the Unit buildings. Two shallow wells (M-189, M-190) will be installed upgradient of Units 4 and 5. Three shallow groundwater monitoring wells (M-191, M-192, M-193) will be installed west of Unit 4, between Units 4 and 5, and between Units 5 and 6, respectively.

Soil sampling to be conducted at the Unit building monitoring wells also addresses Soil Investigation Area 8 as described above in Section 3.1.7. Soil samples will be collected at five foot intervals from the surface to the groundwater table, with the deepest sample to be collected from within the capillary fringe just above the groundwater table. Soil samples will be analyzed for the full suite of groundwater COPCs identified in the RI/FS Work Plan (ENVIRON 2014a). Samples from deeper than 10 feet bgs will be placed on hold at the laboratory for all analytes

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[4] ENVIRON derived RBCs using the inputs to the Johnson and Ettinger model and values for exposure assumptions and toxicity criteria presented in the NDEP-approved *Soil Gas Investigation and Human Health Risk Assessment Work Plan for Parcels C, D, F, G, and H* (ENVIRON 2013b).

except for chlorates, hexavalent chromium, metals, VOCs, general soil chemistry, and pH, which will be analyzed at all depths since these constituents are known to have been present in water generated from manufacturing processes formerly located in these buildings. The analytical suite for soil samples to be collected from these well pilot borings is provided in Table 3.

Continuous soil cores will be obtained for soil logging purposes during the drilling of soil borings to be converted into the monitoring wells. Selected samples from the soil core will be tested for physical properties as discussed in Section 3.4. Following well installation and development, groundwater elevations will be measured and groundwater samples will be analyzed for groundwater COPCs as shown in Table 4.

3.2.9 Additional Groundwater Sampling for COPCs in Groundwater

As part of the ongoing groundwater monitoring program, groundwater samples from designated Site wells are analyzed for chlorate, chromium, hexavalent chromium, perchlorate, and TDS. As discussed in Section 5.4.2.1 of the RI/FS Work Plan (ENVIRON 2014a), to further address data gaps in understanding the nature and extent of COPCs in groundwater, additional groundwater samples will be collected in coordination with an upcoming quarterly groundwater sampling event and analyzed for preliminary groundwater COPCs as listed in Table 1a. The specific proposed analytical testing program for each of the wells, which is summarized in Tables 5 and 6, was determined based on a review of existing analytical data available for COPCs in groundwater, as presented in historical documents (ENSR 2008) and the RI/FS Work Plan (ENVRON 2014a).

Four of the COPCs identified in Table 1a exceeded screening levels only in localized areas, and so a focused analytical testing program has been proposed in Table 5 for these COPCs that includes sampling in wells located near previous exceedances. The four COPCs with localized exceedances are alpha-BHC, bis(2-thylhexyl)phthalate, 4-chlorobenzenesulfonic acid, and total cyanide. For the remaining COPCs listed in Table 1a, the wells identified for sampling are shown in Table 6. As noted in Section 3.2.4 (which describes this set of wells and the analysis of samples from these wells for VOCs), a total of 118 wells will be sampled during this sampling event, including 94 wells in the shallow WBZ and 24 wells in the Middle WBZ, as shown on Figure 7.

In addition, to gain a better understanding of groundwater geochemistry and how geochemical conditions affect the fate and transport of groundwater COPCs, groundwater samples from selected wells will be analyzed for standard geochemical parameters. The wells identified for geochemical testing are shown in Table 4 (for new wells) and Table 5 (for existing wells). Well locations are shown on Figures 8a and 8b. The geochemical parameters, which are summarized in Tables 4 and 5, include important dissolved major and minor ions and redox-sensitive parameters. Following NDEP recommendations, the data quality of the major ion results will be checked by performing an anion-cation balance, comparing measured and calculated TDS, and comparing measured TDS to the electrical conductivity (EC) ratio (NDEP 2007).

3.3 Groundwater Level Measurements

Site-wide groundwater level measurements are collected as part of the ongoing Trust groundwater monitoring program. Data collected during the groundwater monitoring program are used in preparation of the Annual Reports (e.g. ENVIRON 2013a) as required by the Interim Consent agreement (Agreement) for the Site, effective February 2011. In addition, groundwater levels will be measured at all new groundwater monitoring wells installed as part of the RI, and also at existing wells that are sampled as part of the RI. Water level measurements will be taken following well installation and development, and concurrently with an upcoming scheduled groundwater monitoring program quarterly sampling event.

3.4 Soil Physical Properties Testing

Soil retrieved using continuous core sampling equipment from the investigation locations will be logged, and the soil types will be classified in accordance with Unified Soil Classification System (USCS). During logging, selected soil core samples will be identified for physical testing to evaluate physical properties. To help classify the soils, the testing will include grain size analysis (ASTM [American Society for Testing and Materials] D422/4464) and Atterberg limits (ASTM D4318), along with total organic carbon (Walkley-Black). Depending on the integrity of the soil core, additional relatively undisturbed samples may be selected for additional testing including moisture content (API RP 40/ASTM D2216) and bulk density (ASTM D2937), porosity (ASTM D425M), and hydraulic conductivity (API RP40/ASTM D2216/EPA 9100).

The purpose of the physical testing is to obtain information on the characteristics of the major soil types at the Site in both the vadose zone and groundwater units. In general, the samples for physical testing will be selected from the monitoring well pilot borings since those investigation locations will yield a more complete soil profile than shallow soil borings. However, the specific locations and depths of soil samples to be tested depend on factors including core recovery, the degree of disturbance, and the specific types of soil observed during logging of the boring. Approximately 20 soil samples will be selected for testing from alluvial soils, 10 soil samples will be selected from the UMCf-fg1, and 10 soil samples will be selected from the UMCf-cg1, if encountered.

3.5 Possible Additional Characterization of Soil Gas

Additional characterization of soil gas is a possible data gap. However, given that groundwater has been identified as a source of VOCs in soil gas, review and identification of data gaps in the existing soil gas dataset will be completed following investigation of trespassing VOCs in groundwater from neighboring properties, as described above in Section 3.2.4. This review may result in the identification of areas for soil gas sampling and evaluation.

In addition, as described in Section 3.2.6, if concentrations of chloroform in groundwater samples collected from eight shallow wells between the Site and the AWF are above the chloroform RBCs for vapor intrusion established for the Sale Parcels, then soil gas samples will be collected at two depths (5 and 15 feet bgs) adjacent to the three wells with the highest concentrations. This information will be used to establish the relationship between groundwater and soil gas concentrations in this area of the downgradient plume and to develop a chloroform groundwater RBC for vapor intrusion. Planned soil gas sample points, if they are necessary based on the above comparison, and the schedule of analyses for each soil gas sample point are provided in Table 7.

4.0 Sampling Procedures and Equipment

Sampling or other data collection equipment and associated procedures are described in the following sections. Sampling equipment will generally include hand tools for surface or shallow soil sampling, mechanized drilling rigs for subsurface sampling, pumps (with dedicated tubing) or bailers for groundwater sampling, and specialized containers and equipment for soil vapor sampling. In addition to samples that are collected for laboratory analysis, data may also be collected by other means. For example, hydrogeologic data may be obtained by conducting an aquifer test. Similarly, an assessment of subsurface impacts may require exploratory trenching or test pits to access the subsurface and visually assess impacts. Trenching or test pits may be accompanied by grab soil sampling of distinct lithologic layers or chemically-impacted soil zones or debris. Water levels will be measured using hand-held electronic water level sounders during well installation, well development, groundwater sampling, and aquifer testing. During aquifer testing, water levels will also be measured using pressure transducers. Sampling methods and materials are generally based on the USEPA publication SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (USEPA 1997).

Sampling and investigation Field Guidance Documents (FGDs) that include step-by-step instructions for conducting these procedures are provided in Appendix A.

4.1 Documentation Procedures

Records that may be generated during field work include field logs and data sheets, photographic logs, sample chain-of-custody records, equipment inspection/calibration records, and others as necessary. Units of measure for any field measurements and/or analyses will be clearly identified on the field forms and in notes and logs as necessary. The QA/QC Officer, or other appropriate person designated by the ENVIRON Project Manager [as described in the QAPP (ENVIRON 2014b)], will review the field data to evaluate the completeness of the field records.

4.1.1 Field Notes

Field logbooks will provide the means of recording data collection activities at the time they take place. The logbooks will be bound field survey notebooks assigned to field personnel, but they will be stored with the project files in a centralized document repository at an ENVIRON office location when not in use. Activities will be described in as much detail as possible such that the activity being described can be reconstructed without reliance on memory. Entries will be made in language that is objective, factual, and free of personal opinions or terminology that might later prove unclear or ambiguous.

The cover of each logbook will be identified by the project name, project-specific document number, and the time period which the logbook describes (beginning and end dates). The title page of each logbook will have contact information for the ENVIRON Project Manager. Entries into the logbook will contain a variety of project-specific information. At the beginning of each entry, the date, start time, weather, names of all team members present, level of personal protection being used, and the signature of the person making the entry will be entered. Names and affiliations of visitors to the site and the purpose of their visit will be recorded.

All entries will be made in ink signed and dated and no erasures will be made. If an incorrect entry is made, the information will be crossed out with a single strike mark, initialed, and dated by the user. Whenever a sample is collected or a measurement is made it shall be recorded. Any photographs taken will be identified by number and a description of the photograph will be provided. All equipment used to conduct measurements will be identified including serial number and any calibration conducted will be recorded.

4.1.2 Field Data Sheets

Field data sheets will be completed by field personnel during sample collection activities. The types of field data sheets used include groundwater sampling logs, soil boring logs, well construction logs, well development logs, and soil gas sampling logs. If deemed necessary by the ENVIRON Project Manager, electronic copies of the data sheets may be produced after sampling has been completed and these can be provided in the RI report, describing sampling conducted. Example field data sheets are provided in Appendix B.

4.1.3 Photographs

Digital photographs will be taken if necessary to supplement and verify information entered into field logbooks. For each photograph taken, the following will be recorded in the field logbook:

- Date, time, and location,
- Number and brief description of the photograph, and
- Direction in which the photograph was taken, if relevant.

If a number of photographs are taken during a task, general notes will be sufficient on the group of photographs taken, so long as the information outlined above can be inferred from the information provided for each photograph.

4.2 Instrument Calibration Procedures

Instruments requiring calibration include air monitoring equipment (e.g., PIDs, gas multimeters, and dust monitoring meters) and water quality meters (e.g., pH, dissolved oxygen, specific conductivity, and turbidity meters). Equipment that can be field calibrated will be calibrated at least once per day prior to beginning sampling activities, with calibration results documented on an Instrument Calibration Log or in the field logbook. Equipment that must be calibrated in a laboratory setting should be used only if a current calibration certificate is available (for example, a calibration certificate is provided with a piece of rental monitoring equipment). Calibration procedures should be consistent with manufacturer instruction manuals for each instrument. Calibration and maintenance procedures for field equipment are detailed in Table 8 of the QAPP (ENVIRON 2014b). The table is also included in Appendix C of this FSP.

4.3 Decontamination Procedures

Non-dedicated sampling and monitoring equipment that is exposed to environmental contaminants will be thoroughly decontaminated prior to first use and between uses. At a minimum, decontamination procedures will include scrubbing the equipment with a brush or sponge in a solution of Alconox detergent (or equivalent) in potable water, followed by a first rinse in potable water and a second rinse in deionized water. Alternatively, durable equipment (e.g., drill tooling) may be pressure washed using a steam cleaner.

Equipment that is new from the factory must be wrapped in plastic as it is being transported to the Site, otherwise it must be decontaminated prior to use.

Instructions and guidance for decontamination of sampling equipment is included in each FGD that pertains to sampling or testing of environmental media. FGDs are provided in Appendix A.

4.4 Investigation-Derived Waste

Investigation-derived waste (IDW) will be contained in 55-gallon steel drums or other appropriate containers. The drums or containers will be sealed and labeled “Pending Analysis” until analytical data is obtained to represent the IDW. Labels will include the contents of the container (e.g., soil cuttings), the origin of the material (e.g., RI/FS soil sampling), the date(s) the IDW was generated, and a contact phone number for the Generator of the material. IDW containers will be stored in a secure area of the Site that has been designated for the storage of IDW. The FGD for IDW management is included in Appendix A.

4.5 Grab Soil Sampling

Grab soil sampling will be used to obtain a surface or near-surface soil sample using hand tools. Grab soil sampling may also be conducted when obtaining an excavation sidewall or bottom confirmation sample or a trench or test pit bottom or sidewall sample. Grab soil sampling is typically performed using a slide hammer sampler. The slide hammer sampler is a steel cylinder (typically six inches long but longer samplers are also available) that can be equipped with a brass, steel or plastic sample liner. The sampler is attached to a slide hammer (in some cases also using one or more steel rods to elongate the apparatus to reach the desired depth) and the slide hammer is rapidly raised and lowered to drive the sampler into the soil. In some cases, if the soil material is loose and unconsolidated, a plastic or steel hand trowel may be used to scoop soil into a sample container. The FGD for soil sampling is included in Appendix A.

4.6 Soil Borings

Soil borings are expected to be advanced by several different types of equipment, depending on the depth, diameter, direction, and expected lithologies to be encountered. In general, rotary sonic is the drilling method that is preferred to be used at the Site due to relative ease of use, speed, and presence of an outer casing in the drill tooling.

For shallow soil borings to depths less than 50 feet that will not require installation of a groundwater monitoring well, a rotary sonic drill rig, direct-push technology (DPT) drill rig, or hollow stem auger (HSA) drill rig will be used.

For soil borings to depths greater than 50 feet and/or soil borings that will be converted into groundwater monitoring wells, rotary sonic or HSA drilling methods will be used.

For boreholes to be advanced by HSA, if difficult drilling conditions are expected (including gravels, cobbles, caliche, or other hard layers), an HSA drill rig may need to utilize air or mud rotary drilling techniques that allow greater penetration of hard materials in the subsurface while stabilizing a borehole through unconsolidated material. Alternatively, a rotary sonic drill rig is expected to be able to penetrate these relatively hard materials.

For boreholes to be advanced through very hard lithologies including boulders or bedrock, a hammer drilling method such as air rotary casing hammer (ARCH) may be used.

For horizontal soil borings (e.g., borings to be installed beneath Unit Buildings), specialized directional drilling equipment will be used.

The specific type of drilling equipment will be selected for each location based on access considerations, anticipated subsurface conditions, depth of drilling, and sampling goals. The FGD for the drilling and destruction of soil borings is included in Appendix A.

4.6.1 Collection of Soil Samples from Soil Borings

Soil borings advanced by mechanical means will typically produce cores of soil or rock that are available for sampling by the field geologist. Rotary sonic, DPT, HSA, or hammer drilling rigs are capable of producing discrete depth samples and/or continuous cores as needed.

Rotary sonic drill rigs (including compact roto-sonic drill rigs) typically produce soil cores which are extracted from the metal drilling stem into plastic core bags and/or core boxes. Discreet depth samples may be collected from these cores. Based on experience from previous site investigations conducted by others, rotary sonic drilling will be the preferred method for deep monitoring well pilot borings.

DPT drill rigs will typically produce soil cores contained in a plastic core liner, which may be cut open for logging and sampling for discreet-depth samples.

HSA drill rigs typically produce soil cuttings that are brought to the surface along the outer auger surface. The soil cuttings may be periodically examined for lithologic logging purposes. HSA rigs equipped to use air or mud rotary techniques also produce soil cuttings, but the soil cuttings are brought to the surface in suspension, either in air (air rotary) or drilling mud (mud rotary). In order to collect discreet-depth soil samples, these types of drilling rigs can be used in concert with a split-spoon sampler that produces soil cores (usually 18 inches long) that are contained in six-inch-long brass or steel liners which may be sealed and labeled for submittal to an analytical laboratory as discreet-depth samples.

Hammer drill rigs, which employ a drilling fluid (air or mud) and use a hammering action to advance the borehole, are particularly effective at drilling through very hard lithologies including boulders and bedrock. Typical sampling methods include wire-line coring, which uses a gravity-powered sample driver to produce short sections of soil or rock core similar to those produced during HSA drilling.

Specialized directional drilling rigs may be used for horizontal drilling beneath buildings or other obstructions when vertical drilling cannot be performed. However, continuous core collection from horizontal boreholes is not practical because the entire drill stem would need to be removed for each segment of core to be collected.

The FGD for soil sampling is included in Appendix A.

4.6.2 Surveying of Soil Boring Locations

At minimum, soil boring locations will be recorded using a conventional global positioning system (GPS) unit with horizontal accuracy within approximately 10 feet. When precise horizontal and vertical locations of soil borings are required, soil boring locations will be surveyed for horizontal position and elevation by a qualified surveyor to be retained by ENVIRON during the RI. Horizontal position will be surveyed with an accuracy of less than one meter using differential GPS equipment, with locations referenced to the State Plane coordinate system. Elevation will be surveyed with an accuracy of less than one inch using standard survey methods, with elevations referenced to the North American Datum of 1983 (NAD83).

4.7 Groundwater Sampling

Groundwater sampling will be conducted using the “grab” method (in which no purging is performed) when sampling from temporary PVC well casings in soil borings. Groundwater sampling from monitoring wells will be conducted using the “low-flow” method (in which low volumes of water are purged with little or no drawdown while allowing water quality field parameters such as pH, temperature, specific conductivity, dissolved oxygen, and turbidity to stabilize within 10% between three successive measurements).

“Grab” groundwater samples may be collected using a bailer, a peristaltic pump, a submersible pump, tubing equipped with a check valve, or a dipper (e.g., for sampling a pond or storm water catch basin). “Low-flow” groundwater samples will be collected using a pneumatically actuated submersible pump (e.g., a bladder pump). “Traditional” groundwater samples may be collected using a bailer, peristaltic pump, or submersible pump.

During groundwater sampling, a water quality meter (equipped with a flow cell) will be used during purging to track water quality field parameters and assess when stabilization of parameters has occurred. FGDs for “grab” and “low-flow” groundwater sampling are included in Appendix A.

4.8 Groundwater Monitoring Wells

Groundwater monitoring wells will be installed by a licensed driller following specifications provided by ENVIRON. Groundwater monitoring well construction details will depend on the purpose of the well, the types of impacts to the subsurface, and the surrounding lithology of the formation and/or vadose zone. Procedures for the installation, development, and water level measurements of groundwater monitoring wells are provided below.

4.8.1 Groundwater Monitoring Well Installation

Following the completion of a soil boring to be converted into a monitoring well, PVC casing and screen (or another material depending on well design specifications) will be installed such that the screen is at the appropriate depth. The top of the screen should be above the depth of the water table. As drill tooling is withdrawn, sand pack will be placed in the annulus to a point that is about two feet above the top of the screened interval. A nominal two feet thick hydrated bentonite seal will be placed above the sand pack, and the remainder of the annulus will be grouted with a neat cement grout, which will be installed from the bottom up using a tremie pipe.

For wells to be screened in deeper water-bearing zones, it is important to isolate shallower water-bearing zones. Using rotary sonic drilling, this isolation of shallower zones is accomplished by the outer drill casing. If other methods are to be used for groundwater monitoring well installation in deeper water bearing zones, a conductor casing will first be installed through the shallower water-bearing zone(s) and cemented into place in order to seal off the shallow water-bearing zone and prevent cross-contamination between shallower and deeper water-bearing zones. The installation of conductor casing requires a wider diameter drill tooling to be used for the portion of the borehole that is to be lined with conductor casing. After the installation of the conductor casing, a narrower diameter drill tooling is used to advance the well borehole through the conductor casing to the intended total depth of the well.

In non-vehicle areas, an aboveground completion consisting of a tamper-resistant steel surface casing (extending to an approximate depth of five feet) and concrete apron will be installed with the top elevation of the casing at approximately three to four feet above surrounding grade, and the concrete apron slightly above the surrounding grade.

In vehicle areas such as roadways or parking lots, a flush-mounted completion consisting of a tamper-resistant, traffic-rated vault box will be installed with an elevation about ½ inch above surrounding grade, and vault boxes will be clearly marked as “Monitoring Well”. All wells will be capped with a water-tight locking cap. The FGD for groundwater monitoring well installation is included in Appendix A.

4.8.2 Groundwater Monitoring Well Development

Each newly installed groundwater monitoring well will be developed as soon as possible after the cement has cured, but no sooner than 24 hours after grouting. Well development will be conducted first by using a surge block and bailer to swab/surge the filter pack and remove most of the sediment from the monitoring well, followed by an electric submersible pump to purge the well of additional sediment. Development will be considered complete when a minimum of ten times the casing volume has been removed, purge water is generally clear and free of turbidity, and groundwater field parameters are stable within approximately 10% between three successive measurements. After wells are developed, they will be allowed to recover to 90% of the original static water level prior to sampling or aquifer testing. The FGD for groundwater monitoring well development is included in Appendix A.

4.8.3 Groundwater Monitoring Well Surveying

Groundwater monitoring wells will be surveyed for horizontal position and elevation by a qualified surveyor to be retained by ENVIRON during the RI. Horizontal position will be surveyed with an accuracy of less than one foot using differential GPS equipment, with locations referenced to the State Plane coordinate system. Elevation of the top of the well casing will be surveyed with an accuracy of less than one inch using standard survey methods, with elevations referenced to NAD83.

4.8.4 Water Level Measurements

Groundwater monitoring wells will be sounded for depth to water and total well depth from top of casing. An electronic sounder or interface probe, accurate to the nearest +/- 0.01 feet, will be used to measure depth to water in each well. If free product is expected to be present in the well, an interface probe with equivalent accuracy will be used. When using an electronic sounder or interface probe, the probe is lowered down the casing to the top of the water column, and the graduated markings on the probe wire or tape are used to measure the depth to water from the surveyed point on the rim of the well casing. Typically, the measuring device emits a constant tone when the probe is submerged and most sounders also have a visual indicator light that is activated when the probe contacts water. Total well depth will be sounded from the surveyed top of casing by lowering the probe to the bottom of the well. The thickness and presence of free product (if any) will also be recorded. The FGD for groundwater level and free product measurements is included in Appendix A.

4.9 Soil Gas Sampling

Soil gas sampling will be conducted by installing temporary soil gas probes (referred to herein as “soil gas sample points”). If future sampling events are expected to be necessary, soil gas sample points may be converted to permanent soil gas wells by installing a surface vault box over the top of the sample tubing. Soil gas sample points will be installed by hand methods (e.g., hand auger) or using a drilling rig, depending on access and utility concerns. Soil gas sample points will have a single sampling depth; no “nested” soil gas sample points will be installed due to the potential for cross-contamination between sampling intervals. Soil gas sample points will be purged and sampled in accordance with EPA recommendations including the use of a leak check tracer compound (helium) and associated equipment such as sampling shrouds (to contain the leak check tracer gas around the sample train) and helium detectors (to quantify the leak check atmosphere within the shroud and to detect any leaks in the sample train). Soil gas samples will be collected in laboratory-provided containers (Summa canisters) for shipment to a fixed-based analytical laboratory. The FGD for soil gas sampling is included in Appendix A.

4.9.1 Soil Gas Sample Point Installation

Following the completion of a soil boring to be converted into a soil gas sample point, a Teflon or steel soil gas probe tip will be attached to a length of Teflon tubing and lowered to the desired sampling depth. A sand pack will be emplaced such that the soil gas probe tip is in the middle of a one-foot-long sand pack. Above the sand pack, approximately six inches of unhydrated bentonite chips will be placed, followed by additional bentonite chips in approximately six-inch lifts. For an approximately 2-inch diameter borehole, each lift will be hydrated using two to four ounces of potable water (more water may be used for larger diameter boreholes). In this manner, hydrated bentonite will be placed in the borehole up to the surface. If the soil gas sample point is to be converted into a permanent soil gas monitoring well (i.e., left in place for future sampling events), a tamper-resistant surface completion consisting of a steel surface casing pipe or flush-mounted vault box will be installed to protect the sample tubing, and will be cemented in place.

Procedures for soil gas sample point installation, including a typical soil gas sample point construction diagram, are included in the FGD for soil gas sampling, which is provided in Appendix A.

4.10 Aquifer Testing

Aquifer testing including slug tests or pumping tests will be conducted as part of the RI/FS. Aquifer testing involves pressure transducers equipped with data loggers, submersible pumps or other displacement equipment (e.g., slugs), a tank or other purge water reservoir (for pumping tests), and ancillary equipment. During aquifer testing, a pressure transducer is typically installed near the bottom of the test well (or in another zone depending on the goals of the test), and often also in nearby observation wells. Water is then displaced in the test well, either by the use of a slug (a solid cylinder of known volume) that is inserted and then withdrawn, or by a pump that removes water from the well at a known rate. Changes in water level over time, which provide data about the response of the surrounding aquifer to the water displacement, are recorded by the pressure transducer. Pressure transducer data, as well as pumping rates (if applicable), are used to calculate aquifer parameters. The FGD for aquifer testing is included in Appendix A.

4.11 Exploratory Trenching

Exploratory trenching or test pits will be performed in the debris pile area during the RI. A backhoe or excavator will be used to excavate the trench or test pit. Soil samples will be collected from trench walls for excavations less than four feet in depth. For excavations greater than four feet in depth, soil samples will be collected from the backhoe or excavator bucket or using equipment that allows for sampling without the need for entry into the excavation (i.e., a hand auger or other type of soil sampler at the end of a rod of sufficient length to reach the sample depth). The FGD for exploratory trenching is included in Appendix A.

4.12 Miscellaneous Field Measurements

Miscellaneous field measurements may include measuring dimensions of trenches, excavations, or other physical objects or areas. In general, a tape measure, measuring wheel, or GPS unit will be used to collect these types of field measurements. Other measurements may include groundwater quality monitoring for field parameters, as well as air quality monitoring such as breathing zone or work zone air monitoring for dust, VOCs, explosive atmospheres, or hydrogen sulfide (H_2S). Specialized instruments will be used for air monitoring and groundwater water quality measurements, and instruments will be calibrated as described in Section 4.2.

5.0 Sample Designation, Handling and Analysis

In general, field sampling personnel and subcontracted analytical laboratories will handle samples in a manner to maximize data quality. Samples 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 will 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 in detail. It should be noted that this information is also provided in the QAPP (ENVIRON 2014b) where appropriate, and is included in this FSP for ease of use by field staff during the investigation.

5.1 Sample IDs

To maintain consistency, a sample identification convention has been developed and will be followed throughout the implementation of the RI/FS Work Plan. The sample identification numbers (IDs) will be entered onto the sample labels, field forms, chain-of-custody forms, logbooks, and other records documenting sampling activities.

The identification system for RI primary field samples will include the soil boring (RISB), trench (RIT), groundwater well (M for on-Site, PC for off-Site) or soil gas (RISG) well ID, trench sampling node if applicable (alpha numeric), a sample start depth if applicable (for discrete depth samples only), and the date in YYYYMMDD format. Grab groundwater samples collected from soil borings will be identified similarly to a soil sample but with “GW” in place of the depth. For example,

- A soil sample collected from a depth of 10 to 10.5 feet bgs at borehole RISB-1 on July 1, 2014 will be identified as RISB-1-10.0-20140701.
- A soil sample collected from a depth of 10 to 10.5 feet bgs at monitoring well borehole M-189 on July 1, 2014 will be identified as M-189-10.0-20140701.
- A grab groundwater sample collected from borehole RISB-1 on July 1, 2014 will be identified as RISB-1-GW-20140701.
- A trench soil sample collected from trench RIT-1, node A, at a depth of 2 to 2.5 feet bgs will be identified as RIT-1-A-2.0-20140701.
- A soil gas sample collected from a depth of 5 feet bgs in soil gas sample point RISG-1 on July 1, 2014 will be identified as RISG-1-5.0-20140701.
- A groundwater sample collected from monitoring well M-161D on July 1, 2014 will be identified as M-161D-20140701.

5.1.1 Field QA/QC Sample IDs

Field QA/QC samples and procedures are discussed in Section 5.8. The field QC sample codes that may be applied include:

- EB for Equipment Blanks
- FB for Field Blanks

- TB for Trip Blanks
- FD for Field Duplicates

Field QA/QC sample codes will be appended to the end of the primary sample ID that is represented by the field QA/QC sample.

An Equipment Blank (EB) should be named for the sample collected immediately prior to the collection of the EB.

The Field Blank (FB) and Trip Blank (TB) each represent a group of samples: a batch of twenty for the FB, and all samples within one sample cooler or other shipping container for the TB. Thus the FB and the TB should be named after the first sample of the batch (for FB) or the first sample placed in the cooler or shipping container (for TB).

The Field Duplicate (FD) represents the primary sample that is being duplicated, thus the FD should be named after the corresponding primary sample.

For example, the first soil sample to be placed in a cooler is RISB-1-10.0-20140701. The sample is to be analyzed for VOCs, and a duplicate sample is collected. A TB is placed in the cooler with the sample, and an EB is collected immediately following the collection of the soil sample (after decontamination of sampling equipment). The associated field QA/QC samples will be identified as:

- RISB-1-10.0-20140701-EB *(Equipment Blank)*
- RISB-1-10.0-20140701-FB *(Field Blank)*
- RISB-1-10.0-20140701-TB *(Trip Blank)*
- RISB-1-10.0-20140701-FD *(Field Duplicate)*

Field QA/QC samples and the frequencies of collection are summarized in Section 5.8 of this FSP and detailed in Table 6 of the QAPP (ENVIRON 2014b). The table is also included in Appendix C of this FSP.

5.2 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 or Site name (“NERT”) 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. All corrections will be dated and initialed.

5.3 Containers, Preservation, and Hold Time

The analytical methods, type of sample containers to be used for each sample type and analysis, preservation requirements for all samples, and holding times are provided in Table 7 of the QAPP (ENVIRON 2014b). The table is also included in Appendix C of this FSP.

Each lot of preservative and sampling containers will be certified as contaminant-free by the provider and/or the laboratory. The laboratories will maintain certification documentation in their files. 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.

Soil and groundwater sample containers will be placed in airtight plastic bags, if possible, and refrigerated or placed in a cooler with ice to chill and maintain a sample temperature of 4° (± 2) C.

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.

Certain soil samples will be submitted on hold (“contingent samples”) with instructions for extraction at a later date, or pending analytical results of a corresponding sample submitted for initial analysis.

The laboratory will immediately notify the ENVIRON Project Manager and QA/QC Officer [as described in the QAPP (ENVIRON 2014b)] in the event that the analysis or reporting of results for initial soil samples may be delayed beyond the acceptable hold time of corresponding contingent sample(s). In such a scenario, the affected contingent sample(s) will be extracted in order to extend the acceptable hold time. Once the results of the initial soil samples are available, the ENVIRON Project Manager and/or QA/QC Officer will decide whether the extractions of the corresponding contingent samples should be analyzed.

5.4 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 by the sampling crew and recorded in the field logbook and field data sheets. 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 in accordance with Section 5.2 of this FSP.
- Groundwater and soil 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 and cooled to 4 °C or lower for transport to the laboratory.
- Summa canisters used for soil gas collection do not require cooling or additional bagging.
- All sample lids will stay with the original containers, and will not be mixed.
- Sample bottles or canisters will be wrapped in bubble wrap as necessary to minimize the potential for breakage or damage 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.

The samplers are responsible for proper handling practices until receipt at the laboratory, or by the courier, at which time the Laboratory Project Manager assumes responsibility of the samples through analysis and ultimately to the appropriate disposal of samples. Sample handling procedures specific to the laboratory are described in the individual laboratory QA Manuals provided in the QAPP (ENVIRON 2014b).

5.5 Sample Custody

Standard sample custody procedures will be used to maintain and document sample integrity during collection, transportation, storage, and analysis. Custody documents must be written in waterproof, permanent ink. Documents will be corrected by drawing one line through the incorrect entry, entering the correct information, and initialing and dating the correction. The ENVIRON Project Manager is responsible for proper custody practices so that possession and handling of individual samples can be traced from the time of collection until receipt at the laboratory, or by the courier. The Laboratory Project Manager is responsible for establishing and implementing a control system for the samples in their possession that allows tracing from receipt of samples to disposal.

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 Manager 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

Unused lines on the form will be crossed out and initialed.

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 person who collects the sample is the initial custodian of the sample. Any transfers are documented on the chain-of-custody by the individuals relinquishing and receiving the sample, along with their signature, and the date and time of transfer. This transfer must continue until the custody is released to a commercial carrier (i.e. FedEx), or the laboratory (either at the laboratory or to a laboratory employed courier). If relinquished to a commercial carrier, the carrier assumes custody through their shipping receipt. A copy of the shipping receipt should be attached to the chain-of-custody form as a permanent part of the custody control. If the sample is relinquished to a laboratory courier, the courier will then need to relinquish the sample to the stationary laboratory upon arrival. Once the sample has arrived at the stationary laboratory, it must be entered into the sample custody control system of the laboratory. If the sample is further transported to a subcontracted laboratory, the laboratory will produce an internal chain-of-custody form that will be available upon request. Chain-of-custody forms will be maintained in the project file by ENVIRON and at the analytical laboratory.

To discourage tampering during transport, a custody seal will be placed on each cooler after the samples are packed. These consist of a security tape or label with the date and initial of the sampler or person currently in possession of the sample. Receiving personnel at the laboratory will note on the cooler receipt form whether or not the custody seals are intact.

5.6 Shipping Procedures

If shipping samples using a commercial courier is necessary, each container sent will have a separate chain-of-custody form. Samples collected during the investigation will be identified as environmental samples. Samples will be packed in the same manner as when being transported from the sampler to the laboratory, with the following changes:

- Dry ice is not allowed to be used to chill samples requiring commercial shipment.
- Extra packing material will be used to fill the coolers in order to limit movement within the container.
- Ice should be contained in zip-closure bags and the cooler should be lined with plastic as described below.
- Coolers containing ice and/or liquid samples should be lined with a plastic bag (such as a contractor garbage bag) to limit the potential for leaks in the event of ice bags leaking or sample container breakage. All necessary precautions must be taken to prevent any liquids leaking from sample coolers while in transit.
- Coolers will be closed and taped shut. If the cooler has a drain, it too will be closed and taped shut to prevent leaks.
- A minimum of two custody seals will be affixed to the front and side openings of the cooler so that the cooler cannot be opened without breaking a seal. The seals will be covered with wide clear tape so that the seals do not accidentally break in transit.
- Non-perishable samples collected on the weekend may be held for more than three days if there is no threat of exceeding hold times. If the samples require being chilled and maintained at a cool temperature, they will be stored under refrigeration and shipped the following work day.

5.7 Field Measurement and Laboratory Analytical Methods

Field measurement methods and laboratory analytical methods will be utilized to analyze samples during implementation of the RI/FS Work Plan.

5.7.1 Field Measurement Methods

Samplers will conduct in-field measurements for depth to water; pH, conductivity, turbidity and temperature of groundwater samples; and field screening of organic vapors in soil samples. For groundwater field parameter measurements, an appropriate water quality meter, calibrated as recommended by the manufacturer, will be used. For field screening of organic vapors in soil samples, a photoionization detector (PID) with appropriate lamp ionization potential (9.8 eV, 10.6 eV or 11.7 eV depending on which VOCs are expected to be present), calibrated as recommended by the manufacturer, will be used. All meter calibrations and field measurements will be recorded on the appropriate field forms and/or in the field logbook.

5.7.2 Laboratory Analytical Methods

The project will involve the analysis of soil, groundwater, and soil vapor samples for COPCs and physical parameters. The laboratory analytical methods that will be used to analyze samples are summarized in Table 7 of the QAPP (ENVIRON 2014b). Additional information about each analytical method and sampling requirements such as containers, preservation, and hold times is provided in Table 7 of the QAPP (ENVIRON 2014b). The table is also included in Appendix C of this FSP. Analytical methods and laboratory QA/QC procedures are further detailed in the QAPP (ENVIRON 2014b).

5.8 Field QA/QC Procedures

Field QA/QC samples that will be collected during the proposed investigation include field duplicate samples, field blanks, trip blanks, and equipment blanks. The description and purpose of these samples is discussed in this section. In addition, matrix spike/matrix spike duplicate (MS/MSD) samples and laboratory control sample/laboratory control sample duplicate (LCS/LCSD) procedures are used as laboratory control measures, and while not defined as field QA/QC samples, they may require additional sample volume as described in Section 5.8.5.

Appropriate sample IDs for field QA/QC samples are discussed in Section 5.1.1. The frequency of analysis of field and laboratory QA/QC samples is summarized in Table 6 of the QAPP (ENVRON 2014b). The table is also included in Appendix C of this FSP.

5.8.1 Equipment Blanks (EB)

EB samples are used to assess the effectiveness of decontamination procedures. EB samples are obtained by filling decontaminated sampling equipment with reagent-grade deionized (DI) water, sampling this water, and submitting the sample for analysis. Alternatively, DI water can be poured over or through the decontaminated sampling equipment and then collected and submitted for analysis. EBs will be collected at a frequency of one in every 20 samples and will be analyzed for the same suite of parameters as the primary sample to assess the effectiveness of decontamination procedures.

5.8.2 Field Blanks (FB)

FB samples are used to assess the presence of contaminants arising from field sampling procedures. FB samples are obtained by filling a clean sampling container with reagent-grade DI water, in the field at a sample location. The sample then is analyzed in the same manner as the primary sample. FB samples will be collected at a frequency of one in every 20 samples and will be analyzed for the same suite of parameters as the primary sample to assess potential background contamination or errors in the sampling process.

5.8.3 Trip Blanks (TB)

TB samples are used to assess the potential for cross-contamination of VOCs between samples during storage and shipment. TB samples are only necessary when VOCs are being analyzed in soil, groundwater, and/or soil gas samples. A TB sample consists of one or more sample containers that are prepared at the analytical laboratory by filling with reagent-grade DI water (or, for soil gas sampling, VOC-free air). The TB sample is added to the sample cooler or other shipping container as soon as the first primary sample is collected. The TB sample accompanies the primary samples to the laboratory and is analyzed using the same analytical method as the primary samples.

5.8.4 Field Duplicates (FD)

The FD is a replicate sample collected as close as possible to the same time that the primary sample is collected and from the same location, depth, or source, and is used to document analytical precision. FD samples will be labeled and packaged in the same manner as primary samples but with “FD” appended to the sample ID. FDs will be collected at a frequency of one in every 10 primary samples and will be analyzed for the same suite of parameters as the primary sample. The relative percent difference (RPD) between the field duplicate sample and the primary sample is evaluated to assess the homogeneity of the sample matrix and to assess the reproducibility of laboratory and field sample collection techniques.

5.8.5 Matrix Spike/Matrix Spike Duplicates and Laboratory Control Samples/Laboratory Control Sample Duplicates

The matrix spike/matrix spike duplicate (MS/MSD) is a laboratory control sample on which additional QA/QC analyses are performed in order to assess the effect of matrix interference on the analytical results. MS/MSD procedures are performed on field samples at a frequency of one per 20 samples. Field samples to be used for MS/MSD analyses must be collected with a double sample volume. Similarly, laboratory control samples/laboratory control sample duplicates (LCS/LCSDs) provide controls during laboratory analysis, and may also require additional sample volume to be collected in the field.

6.0 Summary

This FSP details the sampling locations, procedures, and methods to be used during the field investigation activities to be conducted as part of the RI/FS at the Site. The FSP is intended to be used in connection with the QAPP (ENVIRON 2014b) and the site-specific HASP (ENVIRON 2014c), each of which have been prepared and submitted to the NDEP concurrently with this FSP. Together, these three documents comprise the SAP for the RI/FS. Execution of the items contained within the three documents that comprise the SAP is contingent upon receipt of NDEP and Trust approval of the documents and the associated budgets.

The FSP is intended to provide a reference guide for all sampling and other data collection activities at the Site. Some sections of the document contain information that is also contained within the QAPP (ENVIRON 2014b) (e.g., field QA/QC sampling guidance, instrument calibration guidance, etc.). The repetition of this information is intentional and its purpose is to ensure that field personnel can easily locate relevant information while in the field.

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Tables

TABLE 1a. PRELIMINARY CHEMICALS OF POTENTIAL CONCERN IN GROUNDWATER
FIELD SAMPLING PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

Chlorates	Perchlorate	Chlorate
Metals	Aluminum	Iron
	Arsenic	Lead
	Boron	Magnesium
	Chromium VI	Manganese
	Chromium (total)	Strontium
	Cobalt	Tungsten
Volatile Organic Compounds (VOCs)	Benzene	Carbon Tetrachloride
	Bromodichloromethane	Chlorobenzene
	Bromoform	Chloroform
	1,2-Dichlorobenzene	Chloromethane
	1,4-Dichlorobenzene	Dibromochloromethane
	1,1-Dichloroethane	Methylene Chloride
	1,2-Dichloroethane	Tetrachloroethene
	1,1-Dichloroethene	Trichloroethene
	1,4-Dioxane	1,2,3-Trichloropropane
Organochlorine Pesticides (OCPs)	alpha-BHC	Heptachlor epoxide
Radionuclides	Radium-226 and -228	Thorium-232
	Thorium-228	Uranium-238
	Thorium-230	Uranium
Semi-Volatile Organic Compounds (SVOCs)	bis(2-Ethylhexyl)phthalate	
General Chemistry	Ammonia	Nitrite
	Bromide*	Phosphorus (total)
	Chloride	Sulfate
	Cyanide (total)	Total Dissolved Solids
	Nitrate	
Organic Acids	4-Chlorobenzenesulfonic acid	

Notes:

* = The asterisk indicates that no comparison screening criterion is available.

TABLE 1b. PRELIMINARY CHEMICALS OF POTENTIAL CONCERN IN SOIL BASED ON LEACHING TO GROUNDWATER
FIELD SAMPLING PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

Chlorates	Perchlorate	Chlorate
Metals	Aluminum	Mercury
	Antimony	Molybdenum
	Arsenic	Nickel
	Barium	Niobium
	Boron	Palladium*
	Cadmium	Selenium
	Chromium	Silver
	Cobalt	Strontium
	Copper	Thallium
	Iron	Tungsten
	Lead	Zinc
	Magnesium	Zirconium
	Manganese	
Volatile Organic Compounds (VOCs)	Benzene	1,1-Dichloropropene*
	2-Butanone	1,4-Dioxane
	Carbon Tetrachloride	Ethyl tert-butyl ether*
	Chlorobenzene	Methylene Chloride
	Chloroform	Tetrachloroethene
	1,2-Dichlorobenzene	1,2,3-Trichlorobenzene
	1,4-Dichlorobenzene	Trichloroethene
	1,2-Dichloroethane	1,2,3-Trichloropropane
	1,1-Dichloroethene	1,2,4-Trimethylbenzene
Semi-Volatile Organic Compounds (SVOCs)	Dimethylphthalate*	2-Methylnaphthalene
	Formaldehyde	Octachlorostyrene*
	1-Methylnaphthalene	Hexachlorobenzene^{+}
Organophosphorus Pesticides (OPPs)	Dimethoate	Stirophos*
Organochlorine Pesticides (OCPs)	alpha-BHC	Dieldrin
	beta-BHC	Endosulfan I*
	gamma-BHC	Endosulfan Sulfate*
	2,4’-DDE*	Endrin Ketone*
	4,4'-DDE	
	4,4'-DDT	
Polycyclic Aromatic Hydrocarbons (PAHs)	Acenaphthylene	Benzo(g,h,i)perylene*
	Benzo(a)anthracene	Indeno(1,2,3-cd)pyrene
	Benzo(a)pyrene	Phenanthrene
	Benzo(b)fluoranthene	
Polychlorinated Biphenyls (PCBs)	Aroclor-1260	PCB-169
	PCB-081	PCB-209
	PCB-118	Total PCBs
	PCB-126	

TABLE 1b. PRELIMINARY CHEMICALS OF POTENTIAL CONCERN IN SOIL BASED ON LEACHING TO GROUNDWATER
FIELD SAMPLING PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

Dioxins/Furans	2,3,7,8-tetrachlorodibenzo-p-dioxin	
	Other 16 congeners with TEFs*	
Organic Acids	Phthalic Acid*	
Radionuclides	Radium-226	Uranium-234
	Radium-228	Uranium-235
	Thorium-228	Uranium-238
	Thorium-230	Uranium
	Thorium-232	
Total Petroleum Hydrocarbons (TPH)	TPH-diesel*	TPH-oil*
	TPH-gasoline*	
General Chemistry	Ammonia*	Phosphorus (total)
	Bromide*	Ortho-Phosphate*
	Carbonate*	Silicon*
	Chloride*	Sulfate*
	Nitrate	Sulfur*
	Nitrite*	Sulfur*

Notes:

* = The asterisk indicates that no comparison screening criterion is available.

\+ = Although Hexachlorobenzene (HCB) is an organochlorine pesticide, HCB will be analyzed as an SVOC and not by the same method as the other organochlorine pesticides. For consistency with the QAPP, it is listed here as an SVOC.

TABLE 2. SOIL AND GRAB GROUNDWATER SAMPLING IN BORINGS AND EXPLORATORY TEST PITS
FIELD SAMPLING PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

Boring or Test Pit IDs	Area Number and Location Description	Rationale	Anticipated Approximate Depth to Groundwater (ft bgs)	Sampling Intervals (ft bgs)	Soil and Grab Groundwater Analytical Testing Program															
					Asbestos	Chlorates[1]	Common Metals[2]	Hexavalent Chromium	Rare Metals[3]	VOCs[4]	SVOCs[5]	Organophosphorus Pesticides[6]	Organochlorine Pesticides[7]	PAHs[8]	PCBs[9]	Dioxins/ Furans[10]	Organic Acids[11]	Radio-nuclides[12]	Total Petroleum Hydrocarbons[13]	General Chemistry[14]
TEST PITS																				
RIT-1 through RIT-3	AREA 3 Debris Pile	Assessment of subsurface impacts and materials within Debris Pile area	NR	Five locations per trench, representing various materials encountered (debris, discoloration, etc)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SOIL BORINGS																				
RISB-1 through RISB-8*	AREA 1 Pond AP-5	Assessment of impacts to subsurface beneath pond (to be completed after pond decommissioning)	30	0-0.5		X	X	X												X
				5-5.5		X	X	X												X
				10-10.5		X	X	X												X
				Additional 5' intervals as necessary to capillary fringe		X	X	X												X
				Capillary fringe		X	X	X												X
				Grab GW		X	X	X												X
RISB-15 through RISB-29	AREA 2 Area Between Debris Pile and AP-5	Assessment of subsurface impacts between Debris Pile and AP-5 area	30	0-0.5		X	X													
				5-5.5		X	X													
				10-10.5		X	X													
				Additional 5' intervals as necessary to capillary fringe		X	X													
				Capillary fringe		X	X													
				Grab GW		X	X													
RISB-9 through RISB-14**	AREA 3 Debris Pile	Assessment of subsurface impacts around perimeter of Debris Pile area	30	0-0.5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
				5-5.5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
				10-10.5		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
				Additional 5' intervals as necessary to capillary fringe		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
				Capillary fringe		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
				Grab GW		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
RISB-30 through RISB-37	AREA 4 Area West of Pond Mn-1	Assessment of subsurface impacts in area west of Pond Mn-1	35	0-0.5		X	X			X										
				5-5.5		X	X			X										
				10-10.5		X	X			X										
				Additional 5' intervals as necessary to capillary fringe		X	X			X										
				Capillary fringe		X	X			X										
				Grab GW		X	X			X										
RISB-38 through RISB-49	AREA 5 North of WC-East Pond	Additional characterization of Category 3 soils: assessment of surface and near surface dioxin TEQ impacts	NR	0-0.5		X	X	X	X	X	X		X	X	X	X	X	X	X	X
				5-5.5		X	X	X	X	X	X		X	X	X	X	X	X	X	X
				10-10.5		Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold
RISB-50 through RISB-52	AREA 6 Southwest of GW-11 Pond	Additional characterization of Category 3 soils: assessment of surface and near-surface dioxin TEQ and HCB impacts	NR	0-0.5									X			X				
				5-5.5									X			X				
				10-10.5									X			X				
RISB-53 through RISB-55	AREA 7 Northwest of L'Hoist	Assessment of potential source areas in soil for chloroform impacts to soil gas	40	0-0.5						X										
				5-5.5						X										
				10-10.5						X										
				Additional 5' intervals as necessary to capillary fringe						X										
				Capillary fringe						X										
				Grab GW						X										

TABLE 2. SOIL AND GRAB GROUNDWATER SAMPLING IN BORINGS AND EXPLORATORY TEST PITS
FIELD SAMPLING PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

Boring or Test Pit IDs	Area Number and Location Description	Rationale	Anticipated Approximate Depth to Groundwater (ft bgs)	Sampling Intervals (ft bgs)	Soil and Grab Groundwater Analytical Testing Program															
					Asbestos	Chlorates[1]	Common Metals[2]	Hexavalent Chromium	Rare Metals[3]	VOCs[4]	SVOCs[5]	Organophosphorus Pesticides[6]	Organochlorine Pesticides[7]	PAHs[8]	PCBs[9]	Dioxins/ Furans[10]	Organic Acids[11]	Radio-nuclides[12]	Total Petroleum Hydrocarbons[13]	General Chemistry[14]
RISB-56 through RISB-57	AREA 8 Unit Buildings	Assessment of potential source areas in soil for chloroform impacts to soil gas	45	0-0.5						X										
				5-5.5						X										
				10-10.5						X										
				Additional 5' intervals as necessary to capillary fringe						X										
				Capillary fringe						X										
				Grab GW						X										
RIDSB-1	AREA 8 (cont'd) Soil Investigation Beneath Unit Buildings	Assessment of subsurface impacts beneath Unit Building 4 using directional soil boring (DSB) Soil sampling will also be conducted in monitoring well borings to be advanced at the Unit Buildings (see Table 3).	NR	Beginning at the west wall of the Unit 4 basement, soil samples to be collected at 30 ft intervals at an approximate depth of 20 ft below grade (7 samples)		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
RISB-58 through RISB-63	AREA 8 (cont'd) Soil Investigation Beneath Leach Plant	Assessment of subsurface impacts beneath the Leach Plant	40	0-0.5		X	X	X		X									X	X
				5-5.5		X	X	X		X									X	X
				10-10.5		X	X	X		X									X	X
				Additional 5' intervals as necessary to capillary fringe		X	X	X		X									X	X
				Capillary fringe		X	X	X		X									X	X
				Grab GW		X	X	X		X									X	X

Notes:

* Soil borings in the AP-5 Pond area are to be advanced following removal of pond solids and decommissioning of pond.

** Analytical suite for soil borings to be advanced around perimeter of debris pile may be modified based on the results of trench samples collected from within the debris pile.

ft bgs: feet below ground surface

GW: Groundwater

1. Includes perchlorate and chlorate.
2. Includes aluminum, antimony, arsenic, barium, boron, cadmium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, selenium, silver, thallium, and zinc.
3. Includes niobium, palladium, strontium, tungsten, and zirconium.
4. Includes benzene, 2-butanone, carbon tetrachloride, chlorobenzene, chloroform, 1,2-dichlorobenzene, 1,4-dichlorobenzene, 1,2-DCA, 1,1-DCE, 1,1-dichloropropene, 1,4-dioxane, ETBE, methylene chloride, PCE, 1,2,3-trichlorobenzene, TCE, 1,2,3-trichloropropane, and 1,2,4-trimethylbenzene.
5. Includes dimethylphthalate, formaldehyde, 1-methylnaphthalene, 2-methylnaphthalene, octachlorostyrene, and HCB.
6. Includes dimethoate and stirophos.
7. Includes alpha-BHC, beta-BHC, gamma-BHC, 2,4'-DDE, 4,4'-DDE, 4,4'-DDT, dieldrin, endosulfan I, endosulfan sulfate, and endrin ketone.
8. Includes acenaphthylene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, indeno(1,2,3-cd)pyrene, and phenanthrene.
9. Includes Aroclor-1260, PCB-081, PCB-118, PCB-126, PCB-169, PCB-209, and total PCBs. Congeners will be placed on hold pending review of total PCB results.
10. Includes 2,3,7,8-tetrachlorodibenzo-p-dioxin and 16 congeners with TEFs
11. Includes phthalic acid.
12. Includes radium-226, radium-228, thorium-228, thorium-230, thorium-232, uranium-234, uranium-235, uranium-238, and uranium.
13. Includes TPH-diesel, TPH-gasoline, and TPH-oil.
14. Includes ammonia, bromide, carbonate, chloride, nitrate, nitrite, phosphorus (total), ortho-phosphate, silicon, sulfate, and sulfur.

TABLE 3. SOIL SAMPLING IN GROUNDWATER MONITORING WELL PILOT BORINGS
FIELD SAMPLING PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

Well/ Pilot Boring ID	On-Site or Off-Site?	Location Description	Groundwater Investigation Rationale	Expected Depth to Groundwater (ft bgs)	Soil Sampling Intervals (ft bgs)	Soil Analytical Testing Program															
						Chlorates[1]	Cr VI	Metals[2]	Rare Metals[3]	VOCs[4]	SVOCs[5]	Organo-phosphorus Pesticides[6]	Organo-chlorine Pesticides[7]	PAHs[8]	PCBs[9]	Dioxins/ Furans[10]	Organic Acids[11]	Radio-nuclides[12]	Total Petroleum Hydrocarbons[13]	General Soil Chemistry[14]	pH
M-161D	On-Site	Adjacent to M-161	Investigation of Middle WBZ/Upper Muddy Creek Formation	30	0-0.5	X		X	X	X	X	X	X	X	X	X	X	X	X	X	
					5-5.5	X		X	X	X	X	X	X	X	X	X	X	X	X	X	
					10-10.5	Hold		Hold	Hold	X	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	
					10.5-15.5	Hold		Hold	Hold	X	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	
					20-20.5	Hold		Hold	Hold	X	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	
					Additional 10' intervals as necessary to GW table	Hold		Hold	Hold	X	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	
M-162D	On-Site	Adjacent to M-162		25	0-0.5	X		X	X	X	X	X	X	X	X	X	X	X	X	X	
					5-5.5	X		X	X	X	X	X	X	X	X	X	X	X	X	X	
					10-10.5	Hold		Hold	Hold	X	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	
					10.5-15.5	Hold		Hold	Hold	X	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	
					20-20.5	Hold		Hold	Hold	X	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	
					Additional 10' intervals as necessary to GW table	Hold		Hold	Hold	X	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	
M-186D	On-Site	Adjacent to M-186		45	0-0.5	X		X	X	X	X	X	X	X	X	X	X	X	X	X	
					5-5.5	X		X	X	X	X	X	X	X	X	X	X	X	X	X	
					10-10.5	Hold		Hold	Hold	X	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	
					10.5-15.5	Hold		Hold	Hold	X	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	
					20-20.5	Hold		Hold	Hold	X	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	
					Additional 10' intervals as necessary to GW table	Hold		Hold	Hold	X	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	
M-189	On-Site	Upgradient (South) of Unit 4 (Soil Investigation Area 8)	Investigation of Groundwater Impacts at Unit Buildings	40	0-0.5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
					5-5.5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
					10-10.5	X	X	X	Hold	X	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	X	X
					Additional 5' intervals as necessary to GW table	X	X	X	Hold	X	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	X	X
M-190	On-Site	Upgradient (South) of Unit 5 (Soil Investigation Area 8)		40	0-0.5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
					5-5.5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
					10-10.5	X	X	X	Hold	X	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	X	X
					Additional 5' intervals as necessary to GW table	X	X	X	Hold	X	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	X	X

TABLE 3. SOIL SAMPLING IN GROUNDWATER MONITORING WELL PILOT BORINGS
FIELD SAMPLING PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

Well/ Pilot Boring ID	On-Site or Off-Site?	Location Description	Groundwater Investigation Rationale	Expected Depth to Groundwater (ft bgs)	Soil Sampling Intervals (ft bgs)	Soil Analytical Testing Program															
						Chlorates[1]	Cr VI	Metals[2]	Rare Metals[3]	VOCs[4]	SVOCs[5]	Organo-phosphorus Pesticides[6]	Organo-chlorine Pesticides[7]	PAHs[8]	PCBs[9]	Dioxins/ Furans[10]	Organic Acids[11]	Radio-nuclides[12]	Total Petroleum Hydrocarbons[13]	General Soil Chemistry[14]	pH
M-191	On-Site	Between Units 3 and 4 (Soil Investigation Area 8)	Investigation of Groundwater Impacts at Unit Buildings	40	0-0.5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
					5-5.5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
					10-10.5	X	X	X	Hold	X	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	X	X
					Additional 5' intervals as necessary to GW table	X	X	X	Hold	X	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	X	X
M-192	On-Site	Between Units 4 and 5 (Soil Investigation Area 8)		40	0-0.5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
					5-5.5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
					10-10.5	X	X	X	Hold	X	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	X	X
					Additional 5' intervals as necessary to GW table	X	X	X	Hold	X	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	X	X
M-193	On-Site	Between Units 5 and 6 (Soil Investigation Area 8)		40	0-0.5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
					5-5.5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
					10-10.5	X	X	X	Hold	X	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	X	X
					Additional 5' intervals as necessary to GW table	X	X	X	Hold	X	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	X	X

Notes:

ft bgs: feet below ground surface
GW: Groundwater
WBZ: Water Bearing Zone
Cr VI: Hexavalent Chromium

1. Includes perchlorate and chlorate.
2. Includes aluminum, antimony, arsenic, barium, boron, cadmium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, selenium, silver, thallium, and zinc.
3. Includes niobium, palladium, strontium, tungsten, and zirconium.
4. Includes benzene, 2-butanone, carbon tetrachloride, chlorobenzene, chloroform, 1,2-dichlorobenzene, 1,4-dichlorobenzene, 1,2-DCA, 1,1-DCE, 1,1-dichloropropene, 1,4-dioxane, ETBE, methylene chloride, PCE, 1,2,3-trichlorobenzene, TCE, 1,2,3-trichloropropane, and 1,2,4-trimethylbenzene.
5. Includes dimethylphthalate, formaldehyde, 1-methylnaphthalene, 2-methylnaphthalene, octachlorostyrene, and HCB.
6. Includes dimethoate and stirophos.
7. Includes alpha-BHC, beta-BHC, gamma-BHC, 2,4'-DDE, 4,4'-DDE, 4,4'-DDT, dieldrin, endosulfan I, endosulfan sulfate, and endrin ketone.
8. Includes acenaphthalene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, indeno(1,2,3-cd)pyrene, and phenanthrene.
9. Includes Aroclor-1260, PCB-081, PCB-118, PCB-126, PCB-169, PCB-209, and total PCBs. Congeners will be placed on hold pending review of total PCB results.
10. Includes 2,3,7,8-tetrachlorodibenzo-p-dioxin and 16 congeners with TEFs
11. Includes phthalic acid.
12. Includes radium-226, radium-228, thorium-228, thorium-230, thorium-232, uranium-234, uranium-235, uranium-238, and uranium.
13. Includes TPH-diesel, TPH-gasoline, and TPH-oil.
14. Includes ammonia, bromide, carbonate, chloride, nitrate, nitrite, phosphorus (total), ortho-phosphate, silicon, sulfate, and sulfur.

TABLE 4. INITIAL GROUNDWATER SAMPLING AT NEW GROUNDWATER MONITORING WELLS
FIELD SAMPLING PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

Monitoring Well ID	Location Description	Rationale for Sampling	Well Construction Details for New Wells*								Groundwater Analytical Testing Program - Initial Round of Sampling									
			Pilot Boring Depth (ft bgs)	Casing Diameter and Type	Screen Size (inches)	Screened Interval (ft bgs)	Sand Pack Interval (ft bgs)	Sand Pack Size	Expected Depth to First GW (ft bgs)	Notes	Chlorates[1]	Dissolved Metals[2]	VOCs[3]	OCPs[4]	Radio-nuclides[5]	SVOCs[6]	Organic Acids[7]	General Chemistry COPCs[8]	Major Ions [9,10]	Geochemical Parameters [11,12]
New On-Site Wells																				
M-161D	Adjacent to M-161	Investigation of Middle WBZ/ Upper Muddy Creek Formation	150	4" PVC	0.01	130-140	128-140	No. 2/12	30		X	X	X	X	X	X	X	X	X-mod	X-mod
M-162D	Adjacent to M-162		150	4" PVC	0.01	130-140	128-140	No. 2/12	25		X	X	X	X	X	X	X	X	X-mod	X-mod
M-186D	Adjacent to M-186		180	4" PVC	0.01	150-170	148-170	No. 2/12	45		X	X	X	X	X	X	X	X	X-mod	X-mod
M-189	South of Unit 4	Investigation of Groundwater Impacts at Unit Buildings	60	2" PVC	0.02	35-50	33-50	No. 3	40		X	X	X	X	X	X	X	X	X-mod	X-mod
M-190	South of Unit 5		60	2" PVC	0.02	35-50	33-50	No. 3	40		X	X	X	X	X	X	X	X	X-mod	X-mod
M-191	Between Units 3 and 4		60	2" PVC	0.02	35-50	33-50	No. 3	40		X	X	X	X	X	X	X	X	X-mod	X-mod
M-192	Between Units 4 and 5		60	2" PVC	0.02	35-50	33-50	No. 3	40		X	X	X	X	X	X	X	X	X-mod	X-mod
M-193	Between Units 5 and 6		60	2" PVC	0.02	35-50	33-50	No. 3	40		X	X	X	X	X	X	X	X	X-mod	X-mod
New Off-Site Wells																				
PC-134D	AWF, adjacent to PC-134	Investigation of Vertical Extent of Downgradient Plume	100	4" PVC	0.01	80-90	78-90	No. 2/12	30		X	Cr only	X						X	X
PC-137D	AWF, adjacent to PC-137		100	4" PVC	0.01	80-90	78-90	No. 2/12	30		X	Cr only	X						X	X
PC-151	Along Sunset Road between Site-related plume and AMPAC downgradient plume	Investigation of Lateral Extent of Downgradient Plume	40	2" PVC	0.02	20-35	18-35	No. 3	25		X	Cr only	X						X	X
PC-152			40	2" PVC	0.02	20-35	18-35	No. 3	25		X	Cr only	X						X	X
PC-153			40	2" PVC	0.02	20-35	18-35	No. 3	25		X	Cr only	X						X	X
PC-154	West of L645		35	2" PVC	0.02	15-30	13-30	No. 3	20	To be installed pending street or offsite property access. If no access, this well will not be installed.	X	Cr only	X						X	X
PC-158	To be determined if needed, locations along Galleria Road east of AWF		35	2" PVC	0.02	15-30	13-30	No. 3	20	To be installed if no access for sampling existing wells L637, L639, and/or L641	X	Cr only	X						X	X
PC-159			35	2" PVC	0.02	15-30	13-30	No. 3	20		X	Cr only	X						X	X
PC-160			35	2" PVC	0.02	15-30	13-30	No. 3	20		X	Cr only	X						X	X
PC-155A	Between Las Vegas Wash and SWF, east of WMW-6.55S	Investigation of Stream-Aquifer Interactions with Las Vegas Wash	35	2" PVC	0.02	10-30	8-30	No. 3	15	Shallow and deep Alluvium well cluster	X	Cr only							X	X
PC-155B			55	2" PVC	0.02	40-50	38-50	No.3	15		X	Cr only							X	X
PC-156A			35	2" PVC	0.02	10-30	8-30	No. 3	15	Shallow and deep Alluvium well cluster	X	Cr only							X	X
PC-156B			55	2" PVC	0.02	40-50	38-50	No.3	15		X	Cr only							X	X
PC-157A			35	2" PVC	0.02	10-30	8-30	No. 3	15	Shallow and deep Alluvium well cluster	X	Cr only							X	X
PC-157B			55	2" PVC	0.02	40-50	38-50	No. 3	15		X	Cr only							X	X

TABLE 4. INITIAL GROUNDWATER SAMPLING AT NEW GROUNDWATER MONITORING WELLS
FIELD SAMPLING PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

Notes:

***** Well construction details may be modified based on subsurface lithologies encountered during drilling.

ft bgs: feet below ground surface

GW: groundwater

Cr: Chromium

OCPs: Organochlorine pesticides

SVOCs: Semivolatile organic compounds

VOCs: Volatile organic compounds

1. CHLORATES: Includes perchlorate and chlorate.
2. DISSOVED METALS: Includes aluminum, arsenic, boron, chromium (total), chromium VI, cobalt, iron, lead, magnesium, manganese, strontium, and tungsten (except where noted otherwise).
3. VOCs: Includes benzene, bromodichloromethane, bromoform, 1,2-dichlorobenzene, 1,4-dichlorobenzene, 1,1-DCA, 1,2-DCA, 1,1-DCE, 1,4-dioxane, carbon tetrachloride, chlorobenzene, chloroform, chloromethane, dibromochloromethane, methylene chloride, PCE, TCE, and 1,2,3-trichloropropane.
4. OCPs: Includes alpha-BHC and heptachlor epoxide.
5. RADIONUCLIDES: Includes radium-226, radium-228, thorium-228, thorium-230, thorium-232, uranium-238, and uranium.
6. SVOCs: Includes bis(2-ethylhexyl)phthalate.
7. ORGANIC ACIDS: Includes 4-chlorobenzenesulfonic acid.
8. GENERAL CHEMISTRY COPCs: Includes ammonia, bromide, chloride, nitrate, nitrite, phosphorus (total), sulfate, and total dissolved solids (TDS).
9. MAJOR IONS: Includes total dissolved solids (TDS) and major dissolved ions (calcium, magnesium, sodium, potassium, sulfate, nitrate, chloride, and bicarbonate/ carbonate/ hydroxide alkalinity).
10. MAJOR IONS (X-mod) - Analyte list modified for on-site wells also tested for Dissolved Metals to remove duplicate parameters: Calcium, sodium, potassium, and bicarbonate/ carbonate/ hydroxide alkalinity
11. GEOCHEMICAL PARAMETERS: Includes field parameters (pH, electrical conductivity (EC), dissolved oxygen, redox potential, temperature, turbidity, ferrous iron, sulfide), dissolved organic carbon, phosphate, nitrite, sulfide (lab), and dissolved cations (aluminum, antimony, arsenic, barium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, vanadium, and zinc).
12. GEOCHEMICAL PARAMETERS (X-mod) - Analyte list modified for on-site wells also tested for General Chemistry COPCs to remove duplicate parameters: Includes field parameters (pH, electrical conductivity (EC), dissolved oxygen, redox potential, temperature, turbidity, ferrous iron, sulfide), dissolved organic carbon, phosphate, sulfide (lab), and dissolved cations (antimony, barium, cadmium, copper, mercury, nickel, vanadium and zinc).

TABLE 5. SUPPLEMENTAL SAMPLING AT EXISTING GROUNDWATER MONITORING WELLS
FIELD SAMPLING PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

			Focused Groundwater Analytical Testing Program									First Groundwater	
Existing Monitoring Well ID	**Location Description**	**Rationale for Sampling**	**Chlorates[1]**	**Dissolved Metals[2]**	**Chloroform**	**Alpha-BHC/ Heptachlor Epoxide**	**BEHP[3]**	**4-CBSA[4]**	**Cyanide (Total)**	**Major Ions[5]**	**Geochemical Parameters[7]**	**Depth May 2014 (feet bgs)**	**Elevation May 2014 (feet msl)**
On-Site Wells [9]													
M-5A	Various On-Site Locations	Resampling of Wells With Localized Exceedences of Screening Levels						X				37.76	1714.04
M-125								X				37.44	1733.89
M-126						X		X				34.31	1724.70
M-128						X						36.48	1747.32
MC-3						X						34.47	1691.26
M-14A						X						31.79	1729.14
M-55									X			26.17	1724.71
M-38							X					31.05	1728.68
M-66							X					30.89	1723.35
M-22A							X					30.08	1729.38
M-65							X					30.81	1723.10
M-117	Southern (Upgradient) Site Boundary Wells	Assessment of Geochemistry at Site Upgradient Boundary								X - mod	X - mod	71.80	1808.51
M-118										X -mod	X - mod	66.08	1810.83
M-120										X -mod	X - mod	81.15	1797.43
M-121										X -mod	X - mod	77.72	1797.91
MC-45	Transect at Northern (Downgradient) Site Boundary	Assessment of Geochemistry at Site Downgradient Boundary								X -mod	X - mod	29.11	1681.85
MC-50										X -mod	X - mod	30.37	1682.95
MC-53										X -mod	X - mod	32.17	1683.09
M-6A										X -mod	X - mod	38.82	1694.37
M-98										X -mod	X - mod	Dry	Dry
M-99										X -mod	X - mod	33.24	1697.50
M-100										X -mod	X - mod	Dry	Dry
M-155										X -mod	X - mod	0 (Artesian)	1730.69
M-101										X -mod	X - mod	Dry	Dry
Off-Site Wells													
L637	Along Galleria Road east of the AWF	Investigation of Lateral Extent of Downgradient Plume	X	Cr only						X	X	NA	NA
L639			X	Cr only						X	X	NA	NA
L641			X	Cr only						X	X	NA	NA
AA-11	Between Site and AWF	Further Investigation of Chloroform Concentrations in Downgradient Off-Site Wells	X	Cr only	X					X	X	30.77	1629.28
BHE1-10			X	Cr only	X					X	X	NA	1670.83*
PC-24			X	Cr only	X					X	X	20.22	1613.26
PC-28			X	Cr only	X					X	X	11.68	1639.17
PC-64			X	Cr only	X					X	X	10.49	1664.80
PC-65			X	Cr only	X					X	X	10.29	1664.92
PC-66			X	Cr only	X					X	X	13.48	1660.05
PC-67			X	Cr only	X					X	X	13.97	1659.85

TABLE 5. SUPPLEMENTAL SAMPLING AT EXISTING GROUNDWATER MONITORING WELLS
FIELD SAMPLING PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

Existing Monitoring Well ID	Location Description	Rationale for Sampling	Focused Groundwater Analytical Testing Program									First Groundwater	
			Chlorates[1]	Dissolved Metals[2]	Chloroform	Alpha-BHC/ Heptachlor Epoxide	BEHP[3]	4-CBSA[4]	Cyanide (Total)	Major Ions[5]	Geochemical Parameters[7]	Depth May 2014 (feet bgs)	Elevation May 2014 (feet msl)
PC-132	Transect Upgradient of AWF	Assessment of Groundwater Geochemistry								X	X	9.78	1624.92
PC-50										X	X	12.48	1620.98
PC-129										X	X	18.62	1615.37
PC-128										X	X	18.36	1615.00
PC-127										X	X	18.14	1614.28
PC-126										X	X	21.76	1612.62
PC-124										X	X	24.87	1610.86
PC-107	Transect Downgradient from AWF	Assessment of Groundwater Geochemistry								X	X	9.76	1607.18
HMW-15										X	X	11.29	1600.68
PC-103										X	X	24.03	1575.46
PC-98R										X	X	23.97	1569.38
PC-53										X	X	28.29	1566.88
PC-2										X	X	28.99	1568.08
PC-4										X	X	35.64	1564.78
HM-2										X	X	27.83	1560.17
PC-110	Transect Upgradient of SWF	Assessment of Groundwater Geochemistry								X	X	15.76	1578.80
HMW-13										X	X	17.01	1578.50
PC-108										X	X	15.37	1572.56
PC-68										X	X	19.33	1557.06
PC-59										X	X	20.14	1555.91
PC-60										X	X	20.98	1555.49
PC-56										X	X	21.73	1555.10
PC-58										X	X	22.49	1554.30
PC-94										X	X	12.76	1536.19
COH-2	Wells Downgradient from SWF near Las Vegas Wash	Assessment of Groundwater Geochemistry and Stream-Aquifer Interaction	X	Cr only						X	X	NA	NA
COH-2A			X	Cr only						X	X	NA	NA
HMW-8			X	Cr only						X	X	NA	NA
HMW-9			X	Cr only						X	X	NA	NA
HMW-23			X	Cr only						X	X	NA	NA
MCF-29A			X	Cr only						X	X	NA	NA
MCF-29B			X	Cr only						X	X	NA	NA
MCF-30A			X	Cr only						X	X	NA	NA
MCF-30B			X	Cr only						X	X	NA	NA
MW-K8			X	Cr only						X	X	NA	NA
WMW5.58S			X	Cr only						X	X	NA	NA
WMW6.15S			X	Cr only						X	X	NA	NA
WMW6.55S			X	Cr only						X	X	NA	NA

TABLE 5. SUPPLEMENTAL SAMPLING AT EXISTING GROUNDWATER MONITORING WELLS
FIELD SAMPLING PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

Existing Monitoring Well ID	Location Description	Rationale for Sampling	Focused Groundwater Analytical Testing Program									First Groundwater	
			Chlorates[1]	Dissolved Metals[2]	Chloroform	Alpha-BHC/ Heptachlor Epoxide	BEHP[3]	4-CBSA[4]	Cyanide (Total)	Major Ions[5]	Geochemical Parameters[7]	Depth May 2014 (feet bgs)	Elevation May 2014 (feet msl)

Notes:

* Groundwater level recorded in May 2013

feet msl = elevation in feet, mean sea level datum	AWF: Athens Road Well Field
feet bgs = feet below ground surface	SWF: Seep Well Field

OCPs: Organochlorine pesticides

SVOCs: Semivolatile organic compounds

VOCs: Volatile organic compounds

1. CHLORATES: Includes perchlorate and chlorate.
2. DISSOLVED METALS: Includes chromium (total).
3. BEHP = bis(2-ethylhexyl)phthalate
4. 4-CBSA = 4-chlorobenzenesulfonic acid.
5. MAJOR IONS: Includes total dissolved solids (TDS) and major dissolved ions (calcium, magnesium, sodium, potassium, sulfate, nitrate, chloride, bicarbonate/ carbonate/ hydroxide alkalinity).
6. GEOCHEMICAL PARAMETERS: Includes field parameters (pH, electrical conductivity (EC), dissolved oxygen, redox potential, temperature, turbidity, ferrous iron, sulfide), dissolved organic carbon, phosphate, nitrate, sulfide (lab), and dissolved cations (aluminum, antimony, arsenic, barium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, vanadium, and zinc).
7. See Table 6 for the Trust monitoring program on-site wells to be tested for chemicals of potential concern (COPCs) in groundwater. The Major Ions and Geochemical Parameters analyte lists shown in this Table 5 have been modified for the on-site wells to remove duplicate parameters as follows:

   MAJOR IONS (X-mod) - MODIFIED FOR ON-SITE WELLS: Includes calcium, sodium, potassium, and bicarbonate/ carbonate/ hydroxide alkalinity.

   GEOCHEMICAL PARAMETERS (X-mod) - MODIFIED FOR ON-SITE WELLS: Includes field parameters (pH, electrical conductivity (EC), dissolved oxygen, redox potential, temperature, turbidity, ferrous iron, sulfide), dissolved organic carbon, phosphate, sulfide (lab), and dissolved cations (antimony, barium, cadmium, copper, mercury, nickel, vanadium and zinc).

TABLE 6. TRUST MONITORING PROGRAM WELLS TO BE SAMPLED FOR VOCs AND OTHER COPCs
FIELD SAMPLING PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

On-Site Monitoring Well ID	Existing or Planned?	Groundwater Analytical Testing Program					Groundwater Level	
		Chlorates[1]	Dissolved Metals[2]	Radio-nuclides[3]	VOCs[4]	General Chemistry COPCs[5]	Depth May 2014 (feet bgs)	Elevation May 2014 (feet msl)
ON-SITE MIDDLE WBZ WELLS								
M-117	Existing - Upgradient site boundary well	X	X	X	X	X	71.80	1808.51
M-118	Existing - Upgradient site boundary well	X	X	X	X	X	66.08	1810.83
M-149	Existing	X	X	X	X	X	44.51	1752.30
M-150	Existing	X	X	X	X	X	22.41	1736.45
M-151	Existing	X	X	X	X	X	18.02	1712.61
M-153	Existing	X	X	X	X	X	29.99	1766.70
M-154	Existing	X	X	X	X	X	11.05	1747.73
M-155	Existing	X	X	X	X	X	+3 (Artesian)	1733.69
M-161	Existing	X	X	X	X	X	22.9	1729.50
M-161D	New (planned)	X	X	X	X	X	NA	NA
M-162	Existing	X	X	X	X	X	21.61	1726.21
M-162D	New (planned)	X	X	X	X	X	NA	NA
M-165	Existing	X	X	X	X	X	22.15	1721.69
M-181	Existing	X	X	X	X	X	28.03	1733.73
M-186	Existing	X	X	X	X	X	45.25	1755.35
M-186D	New (planned)	X	X	X	X	X	NA	NA
TR-1	Existing	X	X	X	X	X	+9.5 (Artesian)	1761.64
TR-2	Existing	X	X	X	X	X	24.99	1726.80
TR-3	Existing	X	X	X	X	X	+3 (Artesian)	1775.84
TR-4	Existing	X	X	X	X	X	35.81	1736.74
TR-5	Existing	X	X	X	X	X	0 (Artesian)	1800.27
TR-7	Existing	X	X	X	X	X	10.4	1818.63
TR-9	Existing	X	X	X	X	X	35.81	1818.48
TR-11	Existing	X	X	X	X	X	+16 Artesian	1732.64
ON-SITE SHALLOW WBZ WELLS								
M-2A	Existing	X	X	X	X	X	41.47	1739.69
M-5A	Existing	X	X	X	X	X	37.76	1714.04
M-6A	Existing	X	X	X	X	X	38.82	1694.37
M-7B	Existing	X	X	X	X	X	36.19	1696.64
M-10	Existing	X	X	X	X	X	49.71	1786.50
M-11	Existing	X	X	X	X	X	43.39	1772.14
M-12A	Existing	X	X	X	X	X	41.87	1770.60
M-13	Existing	X	X	X	X	X	45.44	1769.45
M-14A	Existing	X	X	X	X	X	31.79	1729.14
M-19	Existing	X	X	X	X	X	34.73	1732.04
M-21	Existing	X	X	X	X	X	40.77	1751.30
M-22A	Existing	X	X	X	X	X	30.08	1729.38
M-23	Existing	X	X	X	X	X	33.71	1686.83
M-25	Existing	X	X	X	X	X	32.07	1727.86
M-29	Existing	X	X	X	X	X	NA	NA
M-31A	Existing	X	X	X	X	X	45.84	1751.03
M-32	Existing	X	X	X	X	X	NA	NA
M-33	Existing	X	X	X	X	X	NA	NA

TABLE 6. TRUST MONITORING PROGRAM WELLS TO BE SAMPLED FOR VOCs AND OTHER COPCs
FIELD SAMPLING PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

On-Site Monitoring Well ID	Existing or Planned?	Groundwater Analytical Testing Program					Groundwater Level	
		Chlorates[1]	Dissolved Metals[2]	Radio-nuclides[3]	VOCs[4]	General Chemistry COPCs[5]	Depth May 2014 (feet bgs)	Elevation May 2014 (feet msl)
M-35	Existing	X	X	X	X	X	32.21	1740.57
M-36	Existing	X	X	X	X	X	NA	NA
M-37	Existing	X	X	X	X	X	30.93	1730.13
M-38	Existing	X	X	X	X	X	30.84	1728.89
M-52	Existing	X	X	X	X	X	41.14	1761.25
M-57A	Existing	X	X	X	X	X	29.11	1724.33
M-58	Existing	X	X	X	X	X	29.59	1721.66
M-64	Existing	X	X	X	X	X	26.26	1723.50
M-65	Existing	X	X	X	X	X	29.30	1724.61
M-66	Existing	X	X	X	X	X	30.76	1723.48
M-67	Existing	X	X	X	X	X	21.91	1724.00
M-68	Existing	X	X	X	X	X	26.15	1724.08
M-69	Existing	X	X	X	X	X	33.57	1716.18
M-70	Existing	X	X	X	X	X	34.37	1713.88
M-71	Existing	X	X	X	X	X	35.02	1712.02
M-72	Existing	X	X	X	X	X	31.87	1714.62
M-73	Existing	X	X	X	X	X	28.68	1712.46
M-74	Existing	X	X	X	X	X	28.32	1716.76
M-75	Existing	X	X	X	X	X	42.38	1741.83
M-76	Existing	X	X	X	X	X	39.19	1746.03
M-77	Existing	X	X	X	X	X	39.27	1762.46
M-79	Existing	X	X	X	X	X	30.59	1711.94
M-80	Existing	X	X	X	X	X	35.69	1710.35
M-81A	Existing	X	X	X	X	X	35.56	1708.60
M-83	Existing	X	X	X	X	X	30.88	1711.14
M-92	Existing	X	X	X	X	X	36.48	1764.28
M-93	Existing	X	X	X	X	X	35.58	1761.96
M-97	Existing	X	X	X	X	X	39.92	1760.93
M-98	Existing	X	X	X	X	X	Dry	Dry
M-99	Existing	X	X	X	X	X	33.24	1697.50
M-100	Existing	X	X	X	X	X	Dry	Dry
M-101	Existing	X	X	X	X	X	Dry	Dry
M-103	Existing	X	X	X	X	X	Dry	Dry
M-115	Existing	X	X	X	X	X	37.51	1750.13
M-120	Existing - Upgradient site boundary well	X	X	X	X	X	81.15	1797.43
M-121	Existing - Upgradient site boundary well	X	X	X	X	X	77.72	1797.91
M-123	Existing	X	X	X	X	X	40.87	1744.26
M-124	Existing	X	X	X	X	X	36.57	1751.09
M-125	Existing	X	X	X	X	X	37.44	1733.89
M-126	Existing	X	X	X	X	X	34.31	1724.70
M-128	Existing	X	X	X	X	X	36.48	1747.32
M-132	Existing	X	X	X	X	X	26.19	1718.30
M-133	Existing	X	X	X	X	X	26.72	1716.90
M-134	Existing	X	X	X	X	X	32.46	1719.68
M-135	Existing	X	X	X	X	X	32.89	1718.96
M-136	Existing	X	X	X	X	X	28.33	1723.54

TABLE 6. TRUST MONITORING PROGRAM WELLS TO BE SAMPLED FOR VOCs AND OTHER COPCs
FIELD SAMPLING PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

On-Site Monitoring Well ID	Existing or Planned?	Groundwater Analytical Testing Program					Groundwater Level	
		Chlorates[1]	Dissolved Metals[2]	Radio-nuclides[3]	VOCs[4]	General Chemistry COPCs[5]	Depth May 2014 (feet bgs)	Elevation May 2014 (feet msl)
M-137	Existing	X	X	X	X	X	57.21	1790.33
M-138	Existing	X	X	X	X	X	56.16	1790.19
M-139	Existing	X	X	X	X	X	35.43	1777.76
M-140	Existing	X	X	X	X	X	NA	NA
M-141	Existing	X	X	X	X	X	42.24	1754.92
M-142	Existing	X	X	X	X	X	30.16	1743.39
M-144	Existing	X	X	X	X	X	37.69	1775.62
M-146	Existing	X	X	X	X	X	34.77	1777.71
M-147	Existing	X	X	X	X	X	35.19	1743.20
M-148A	Existing	X	X	X	X	X	46.14	1753.90
M-163	Existing	X	X	X	X	X	26.48	1721.47
M-164	Existing	X	X	X	X	X	33.72	1713.89
M-182	Existing	X	X	X	X	X	33.40	1728.43
M-189	New (planned)	X	X	X	X	X	NA	NA
M-190	New (planned)	X	X	X	X	X	NA	NA
M-191	New (planned)	X	X	X	X	X	NA	NA
M-192	New (planned)	X	X	X	X	X	NA	NA
M-193	New (planned)	X	X	X	X	X	NA	NA
H-28A	Existing	X	X	X	X	X	38.47	1693.28
MC-29	Existing	X	X	X	X	X	37.51	1685.94
MC-45	Existing	X	X	X	X	X	29.11	1681.85
MC-50	Existing	X	X	X	X	X	30.37	1682.95
MC-51	Existing	X	X	X	X	X	31.73	1684.15
MC-53	Existing	X	X	X	X	X	32.17	1683.09
MC-93	Existing	X	X	X	X	X	33.71	1685.55
MC-97	Existing	X	X	X	X	X	36.93	1682.37
MW-16	Existing	X	X	X	X	X	36.13	1718.68
TR-10	Existing	X	X	X	X	X	61.63	1792.43
TR-6	Existing	X	X	X	X	X	37.24	1763.12
TR-8	Existing	X	X	X	X	X	49.78	1779.30

Notes:

COPCs: Chemicals of potential concern

VOCs: Volatile organic compounds

1. CHLORATES: Includes perchlorate and chlorate.
2. DISSOLVED METALS: Includes aluminum, arsenic, boron, chromium (total), chromium VI, cobalt, iron, lead, magnesium, manganese, strontium, and tungsten.
3. RADIONUCLIDES: Includes radium-226, radium-228, thorium-228, thorium-230, thorium-232, uranium-238, and uranium.
4. VOCs: Includes benzene, bromodichloromethane, bromoform, 1,2-dichlorobenzene, 1,4-dichlorobenzene, 1,1-DCA, 1,2-DCA, 1,1-DCE, 1,4-dioxane, carbon tetrachloride, chlorobenzene, chloroform, chloromethane, dibromochloromethane, methylene chloride, PCE, TCE, and 1,2,3-trichloropropane.
5. GENERAL CHEMISTRY COPCs: Includes ammonia, bromide, chloride, nitrate, nitrite, phosphorus (total), sulfate, and total dissolved solids (TDS).
6. See Figure 7 for monitoring well locations.

TABLE 7. SOIL GAS SAMPLING POINTS
FIELD SAMPLING PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

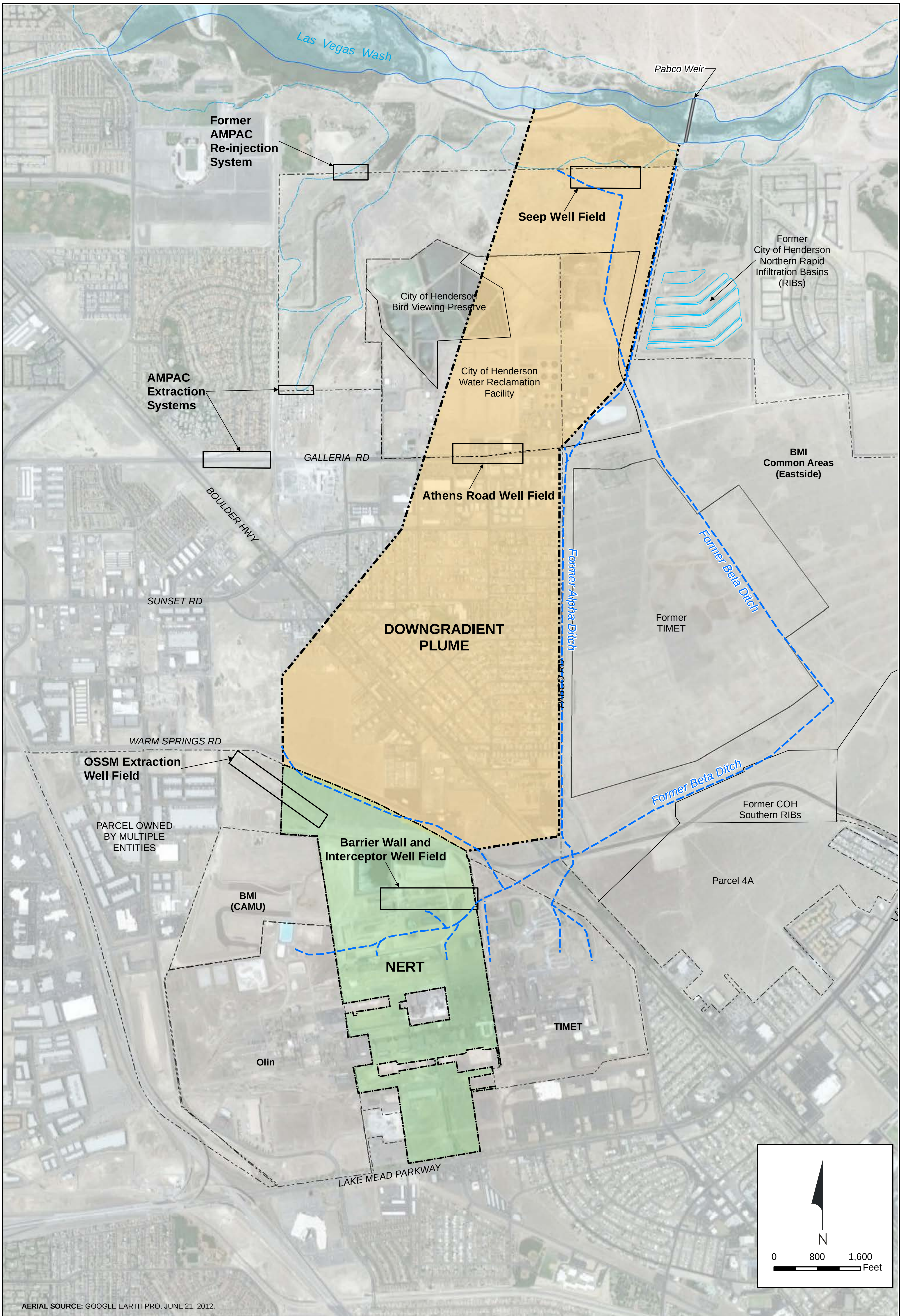
Soil Gas Sampling Point ID	Location Description	Rationale	Sampling Interval (ft bgs)	Analytical Testing	
				VOCs EPA Method TO-15	Leak Check Compound (Helium)
RISG-1-5	Of 8 wells between Site and AWF, if chloroform above RBC, soil gas will be collected adjacent to the 3 wells with highest chloroform concentrations (see Section 3.3).	Establish relationship between groundwater and soil gas concentrations in downgradient plume. Develop chloroform groundwater RBC for vapor intrusion.	5	X	X
RISG-1-15			15	X	X
RISG-2-5			5	X	X
RISG-2-15			15	X	X
RISG-3-5			5	X	X
RISG-3-15			15	X	X

Notes:

ft bgs: feet below ground surface

RBC: Risk Based Concentration

Figures



AERIAL SOURCE: GOOGLE EARTH PRO. JUNE 21, 2012.

ENVIRON

Groundwater Study Area
Nevada Environmental Response Trust Site, Henderson, Nevada

Figure
1

DRAWN BY: RS
DATE: 11/30/12
CONTRACT NUMBER: 21-34800I
APPROVED BY:
REVISED: 12/11/13

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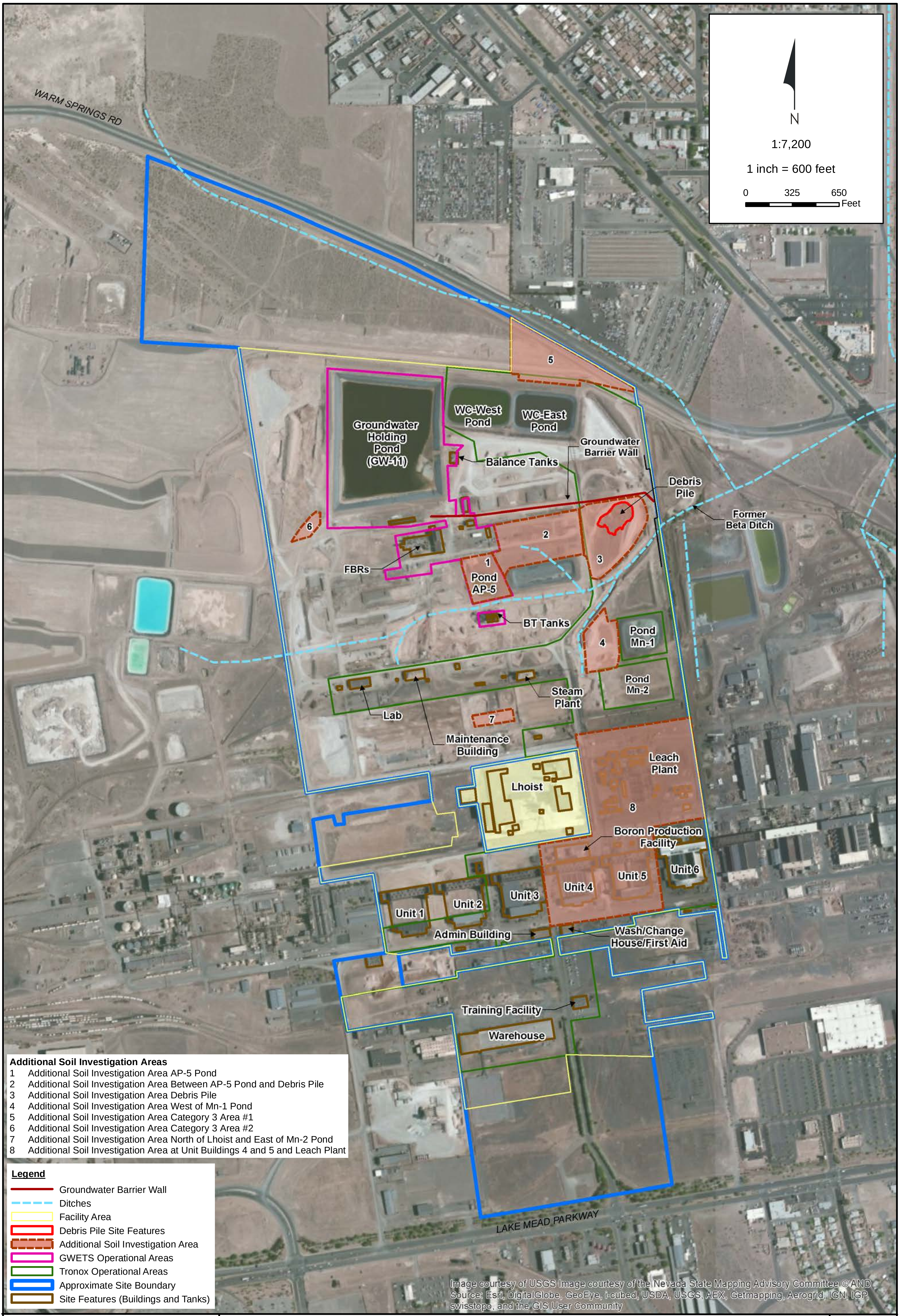

Additional Soil Investigation Areas

1	Additional Soil Investigation Area AP-5 Pond
2	Additional Soil Investigation Area Between AP-5 Pond and Debris Pile
3	Additional Soil Investigation Area Debris Pile
4	Additional Soil Investigation Area West of Mn-1 Pond
5	Additional Soil Investigation Area Category 3 Area #1
6	Additional Soil Investigation Area Category 3 Area #2
7	Additional Soil Investigation Area North of Lhoist and East of Mn-2 Pond
8	Additional Soil Investigation Area at Unit Buildings 4 and 5 and Leach Plant

Legend

—	Groundwater Barrier Wall
- -	Ditches
☐	Facility Area
☐	Debris Pile Site Features
▨	Additional Soil Investigation Area
☐	GWETS Operational Areas
☐	Tronox Operational Areas
☐	Approximate Site Boundary
☐	Site Features (Buildings and Tanks)

Image courtesy of USGS Image courtesy of the Nevada State Mapping Advisory Committee © AND , Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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ENVIRON

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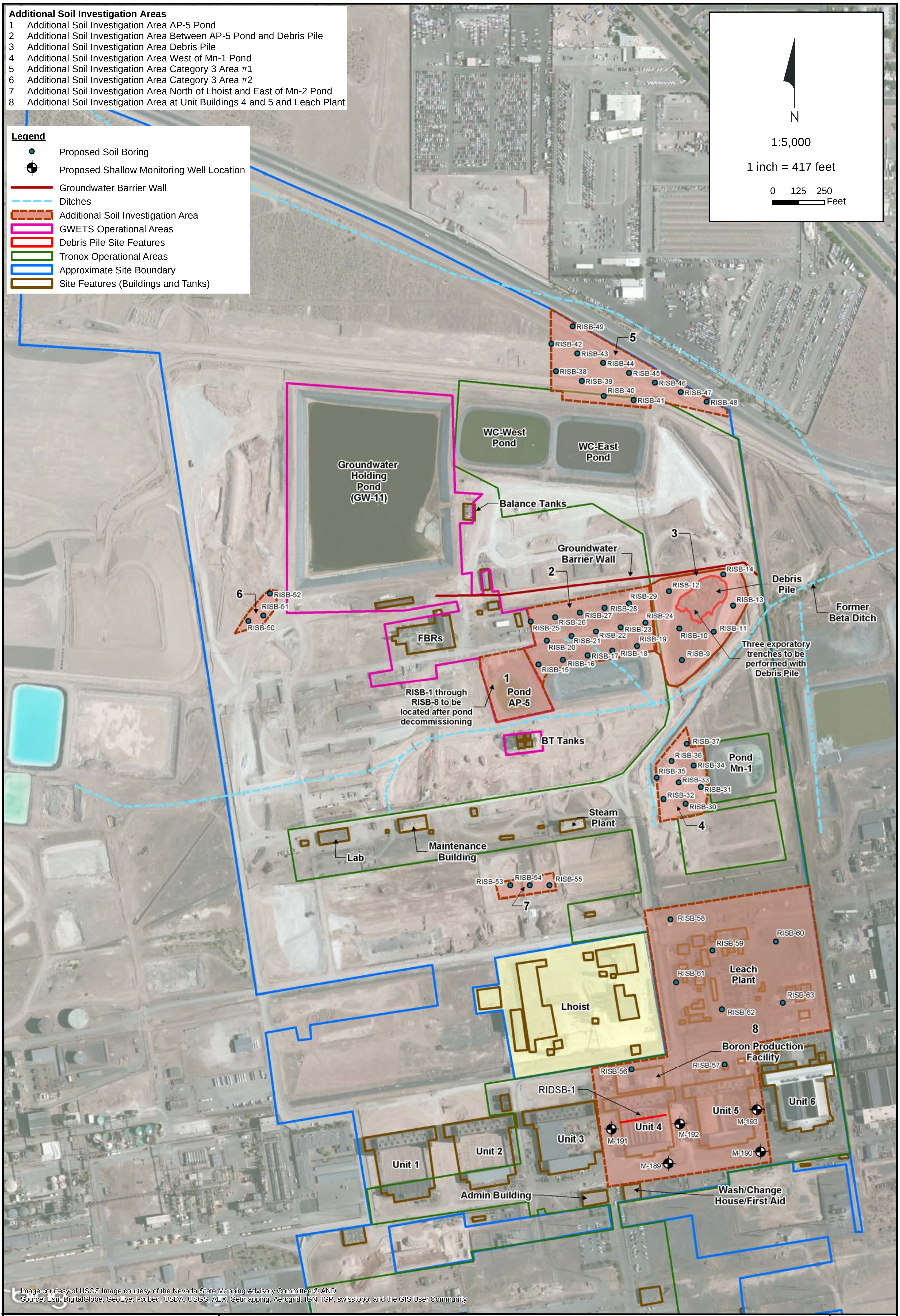
Additional Soil Investigation Areas
Nevada Environmental Response Trust Site, Henderson, Nevada

Figure
2

Drafter: RS
Date: 1/24/2014
Contract Number: 21-34800I
Approved by:
Revised:



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ENVIRON
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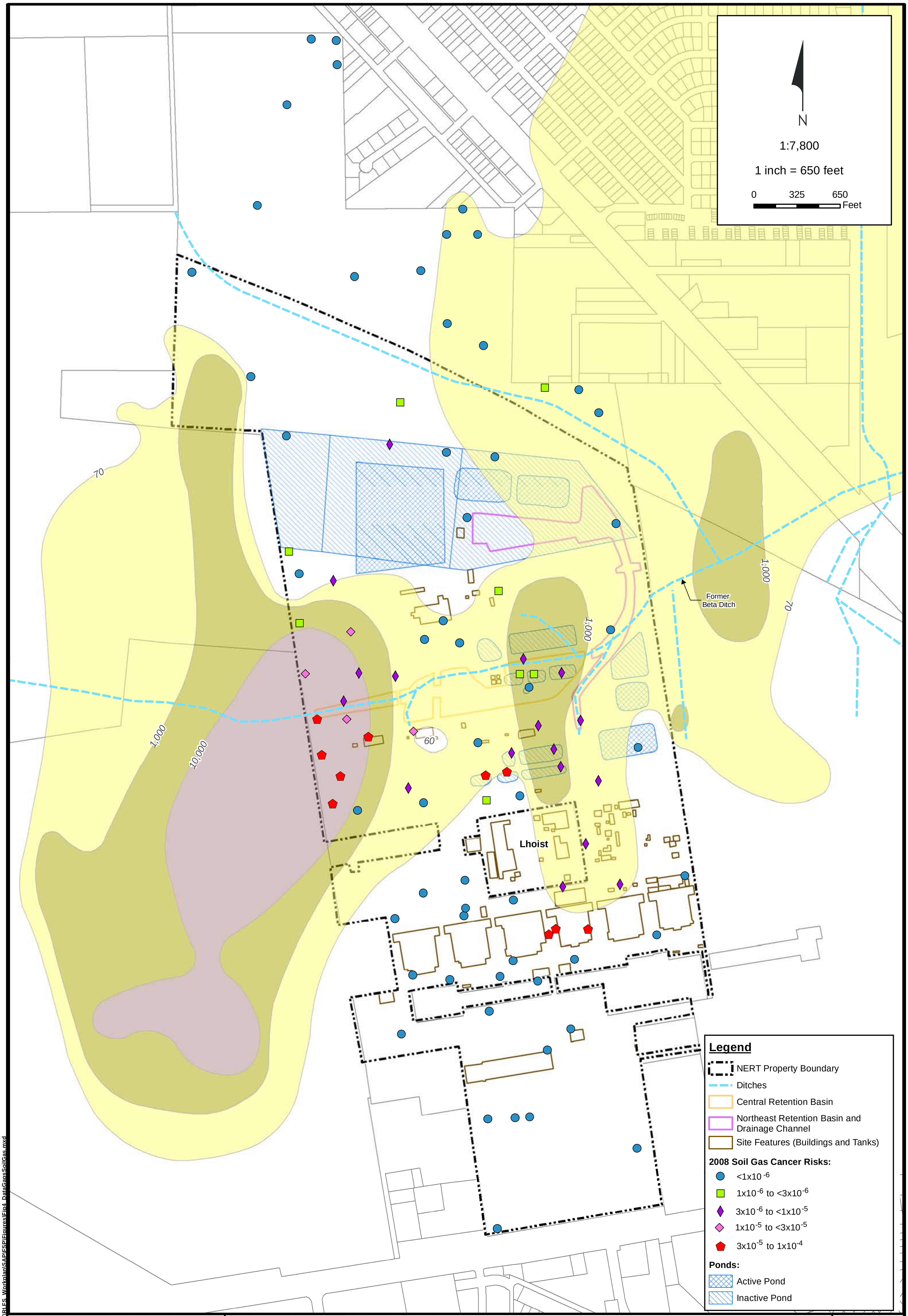
Proposed Soil Sampling Locations
Nevada Environmental Response Trust Site, Henderson, Nevada

Figure
3

Drafter: LAT Date: 2/6/2014 Contract Number: 21-34800I Approved by: Revised:



ENVIRON

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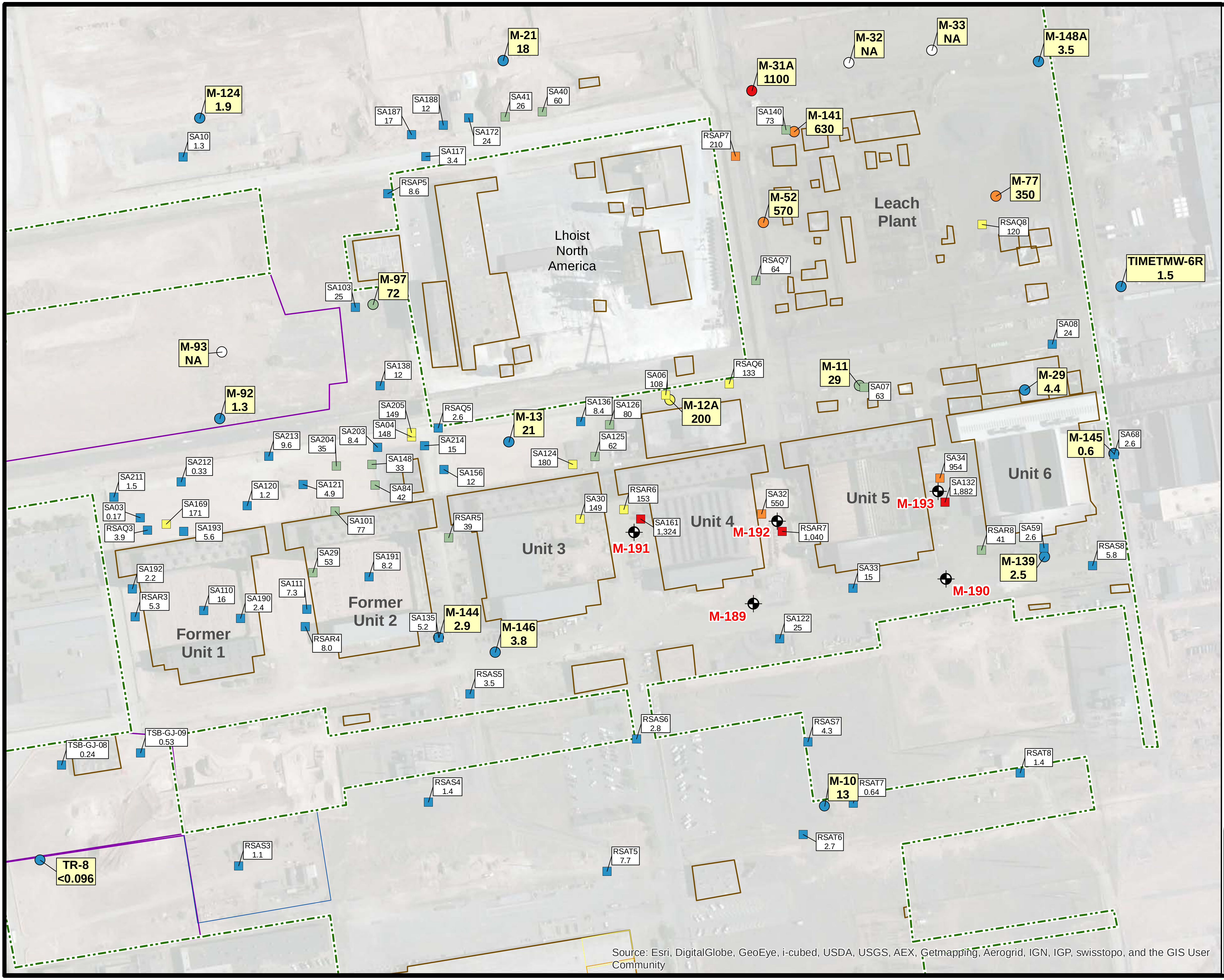
Chloroform in Groundwater and in 2008 Soil Gas Samples
Nevada Environmental Response Trust Site, Henderson, Nevada

Figure
4

Drafter: RS Date: 1/24/2014 Contract Number: 21-34800I Approved by: Revised:

Path: H:\LePetomane\NERT\RI_FS_Workplan\SAP\FSP\Figures\Fig4_DataGapsSoilGas.mxd



Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Path: H:\LePetomane\NERT\Soil Excavation\GIS\Maps\Unit Building Figures\UnitBuildingData_Bsize-2.mxd

Legend:

⊕ Proposed Shallow Monitoring Well Location

▭ NERT Property Boundary

Perchlorate, mg/L

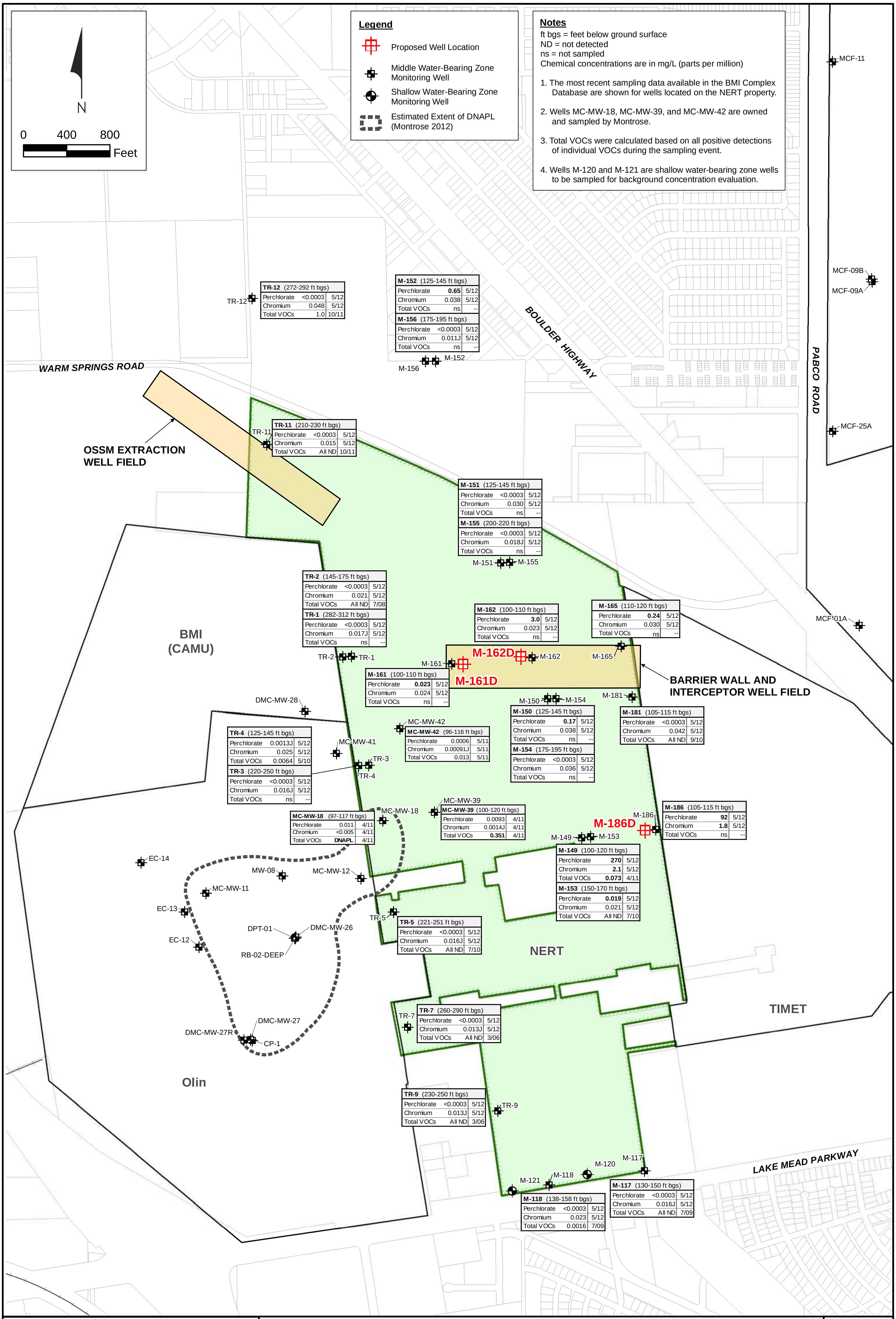
🟦	0 - 25
🟩	26 - 100
🟨	101 - 200
🟧	201 - 1,000
🟥	1,001 - 2,000
○	Shallow Monitoring Well
☐	Soil Sample

Notes:
1. Groundwater Samples taken May and June 2012.
2. Well M-29 was sampled in May 2011.
3. 2009 soil perchlorate results converted to equivalent mg/L.
4. Depth to groundwater ranges between 34 and 45 feet bgs in this area.

ENVIRON

Proposed Monitoring Wells at Unit Buildings and Leach Plant
Nevada Environmental Response Trust Site
Henderson, Nevada

Date: 1/24/2014	Contract Number: 21-34800I		Figure 5
Drafter: RS	Approved:	Revised:	



TR-12 (272-292 ft bgs)		
Perchlorate	<0.0003	5/12
Chromium	0.048	5/12
Total VOCs	1.0	10/11

M-152 (125-145 ft bgs)		
Perchlorate	**0.65**	5/12
Chromium	0.038	5/12
Total VOCs	ns	--
M-156 (175-195 ft bgs)		
Perchlorate	<0.0003	5/12
Chromium	0.011J	5/12
Total VOCs	ns	--

TR-11 (210-230 ft bgs)		
Perchlorate	<0.0003	5/12
Chromium	0.015	5/12
Total VOCs	All ND	10/11

M-151 (125-145 ft bgs)		
Perchlorate	<0.0003	5/12
Chromium	0.030	5/12
Total VOCs	ns	--
M-155 (200-220 ft bgs)		
Perchlorate	<0.0003	5/12
Chromium	0.018J	5/12
Total VOCs	ns	--

TR-2 (145-175 ft bgs)		
Perchlorate	<0.0003	5/12
Chromium	0.021	5/12
Total VOCs	All ND	7/08
TR-1 (282-312 ft bgs)		
Perchlorate	<0.0003	5/12
Chromium	0.017J	5/12
Total VOCs	ns	--

M-162 (100-110 ft bgs)		
Perchlorate	**3.0**	5/12
Chromium	0.023	5/12
Total VOCs	ns	--

M-165 (110-120 ft bgs)		
Perchlorate	**0.24**	5/12
Chromium	0.030	5/12
Total VOCs	ns	--

M-161 (100-110 ft bgs)		
Perchlorate	**0.023**	5/12
Chromium	0.024	5/12
Total VOCs	ns	--

M-150 (125-145 ft bgs)		
Perchlorate	**0.17**	5/12
Chromium	0.038	5/12
Total VOCs	ns	--
M-154 (175-195 ft bgs)		
Perchlorate	<0.0003	5/12
Chromium	0.036	5/12
Total VOCs	ns	--

M-181 (105-115 ft bgs)		
Perchlorate	<0.0003	5/12
Chromium	0.042	5/12
Total VOCs	All ND	9/10

TR-4 (125-145 ft bgs)		
Perchlorate	0.0013J	5/12
Chromium	0.025	5/12
Total VOCs	0.0064	5/10
TR-3 (220-250 ft bgs)		
Perchlorate	<0.0003	5/12
Chromium	0.016J	5/12
Total VOCs	ns	--

MC-MW-42 (96-116 ft bgs)		
Perchlorate	0.0006	5/11
Chromium	0.00091J	5/11
Total VOCs	0.013	5/11

MC-MW-18 (97-117 ft bgs)		
Perchlorate	0.011	4/11
Chromium	<0.005	4/11
Total VOCs	**DNAPL**	4/11

MC-MW-39 (100-120 ft bgs)		
Perchlorate	0.0093	4/11
Chromium	0.0014J	4/11
Total VOCs	**0.351**	4/11

M-186 (105-115 ft bgs)		
Perchlorate	**92**	5/12
Chromium	**1.8**	5/12
Total VOCs	ns	--

M-149 (100-120 ft bgs)		
Perchlorate	**270**	5/12
Chromium	**2.1**	5/12
Total VOCs	**0.073**	4/11
M-153 (150-170 ft bgs)		
Perchlorate	**0.019**	5/12
Chromium	0.021	5/12
Total VOCs	All ND	7/10

TR-5 (221-251 ft bgs)		
Perchlorate	<0.0003	5/12
Chromium	0.016J	5/12
Total VOCs	All ND	7/10

TR-7 (260-290 ft bgs)		
Perchlorate	<0.0003	5/12
Chromium	0.013J	5/12
Total VOCs	All ND	3/06

TR-9 (230-250 ft bgs)		
Perchlorate	<0.0003	5/12
Chromium	0.013J	5/12
Total VOCs	All ND	3/06

M-118 (138-158 ft bgs)		
Perchlorate	<0.0003	5/12
Chromium	0.023	5/12
Total VOCs	0.0016	7/09

M-117 (130-150 ft bgs)		
Perchlorate	<0.0003	5/12
Chromium	0.016J	5/12
Total VOCs	All ND	7/09

Legend

⌖ Proposed Well Location
⊞ Middle Water-Bearing Zone Monitoring Well
⊕ Shallow Water-Bearing Zone Monitoring Well
⬚ Estimated Extent of DNAPL (Montrose 2012)

Notes

ft bgs = feet below ground surface
ND = not detected
ns = not sampled
Chemical concentrations are in mg/L (parts per million)

1. The most recent sampling data available in the BMI Complex Database are shown for wells located on the NERT property.
2. Wells MC-MW-18, MC-MW-39, and MC-MW-42 are owned and sampled by Montrose.
3. Total VOCs were calculated based on all positive detections of individual VOCs during the sampling event.
4. Wells M-120 and M-121 are shallow water-bearing zone wells to be sampled for background concentration evaluation.

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2200 Powell St., Suite 700, Emeryville, CA 94608

Proposed On-site Wells, Middle Water-Bearing Zone
Nevada Environmental Response Trust Site, Henderson, Nevada

Figure
6

Drafter: RS
Date: 1/24/2014
Contract Number: 21-34800I
Approved by:
Revised: 12/11/13

Path: H:\LePetomane\NERT\RI.FS_Workplan\SAP\FSP\Figures\Fig7_TrustMonitoringSampMap.mxd

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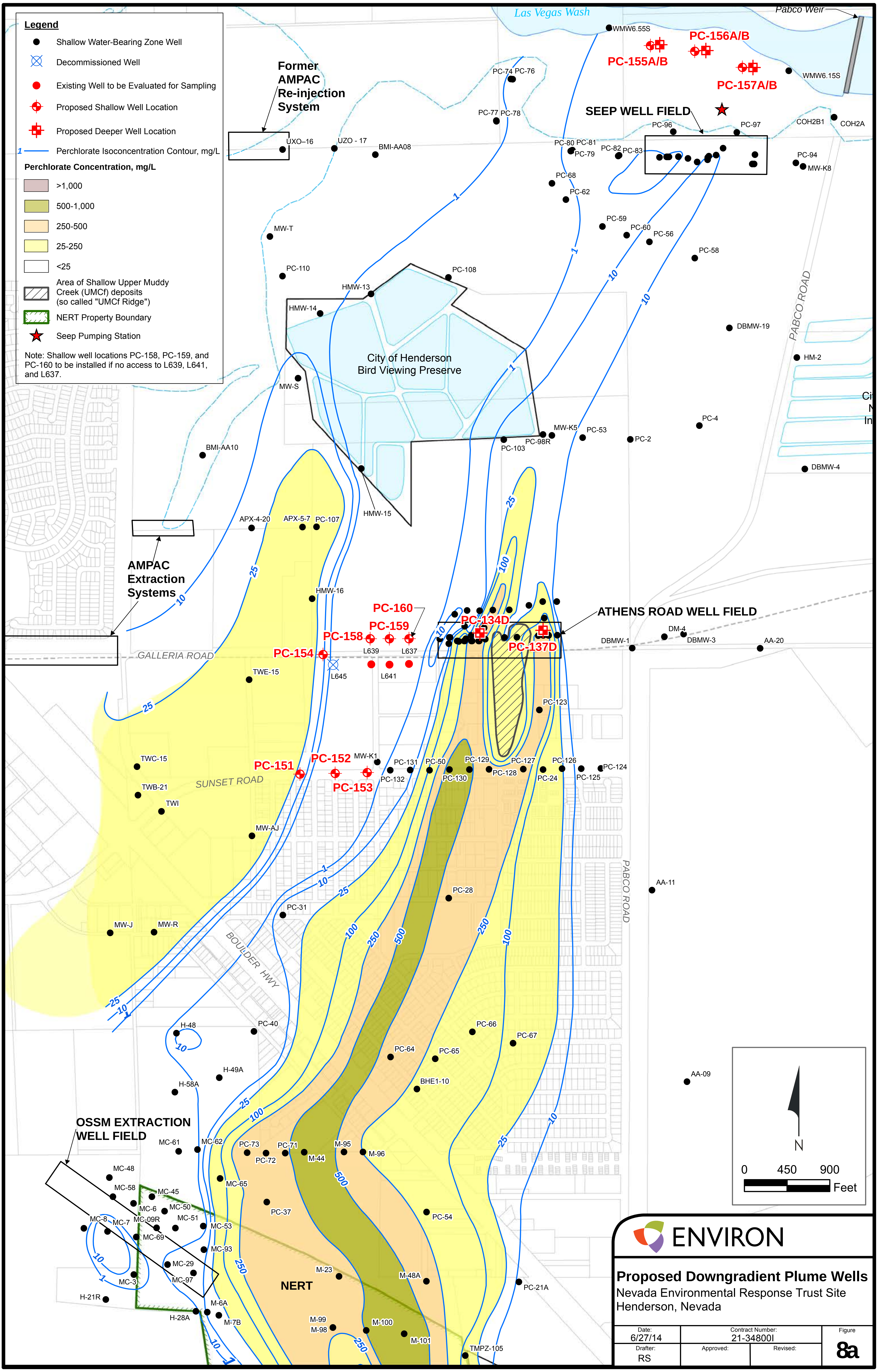
Trust Monitoring Program Wells to be Sampled for VOCs and Other COPCs

Nevada Environmental Response Trust Site, Henderson, Nevada

Figure

7

Drafter: RS Date: 1/24/2014 Contract Number: 21-34800I Approved by: Revised:



ENVIRON

Proposed Downgradient Plume Wells

Nevada Environmental Response Trust Site
Henderson, Nevada

Date:	Contract Number:		Figure
6/27/14	21-34800I		8a
Drafter: RS	Approved:	Revised:	

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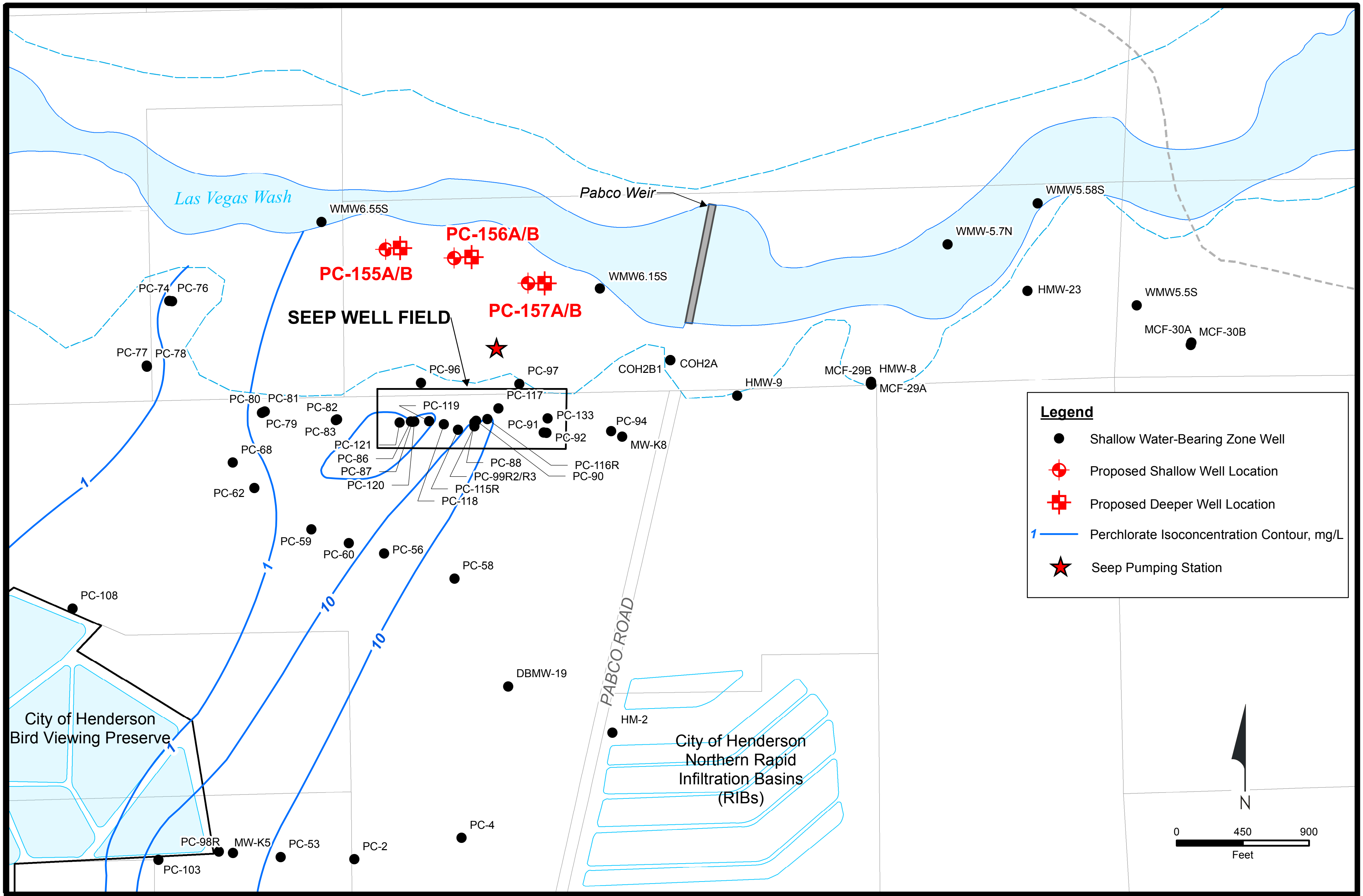


ENVIRON

Proposed Downgradient Plume Wells Near Las Vegas Wash

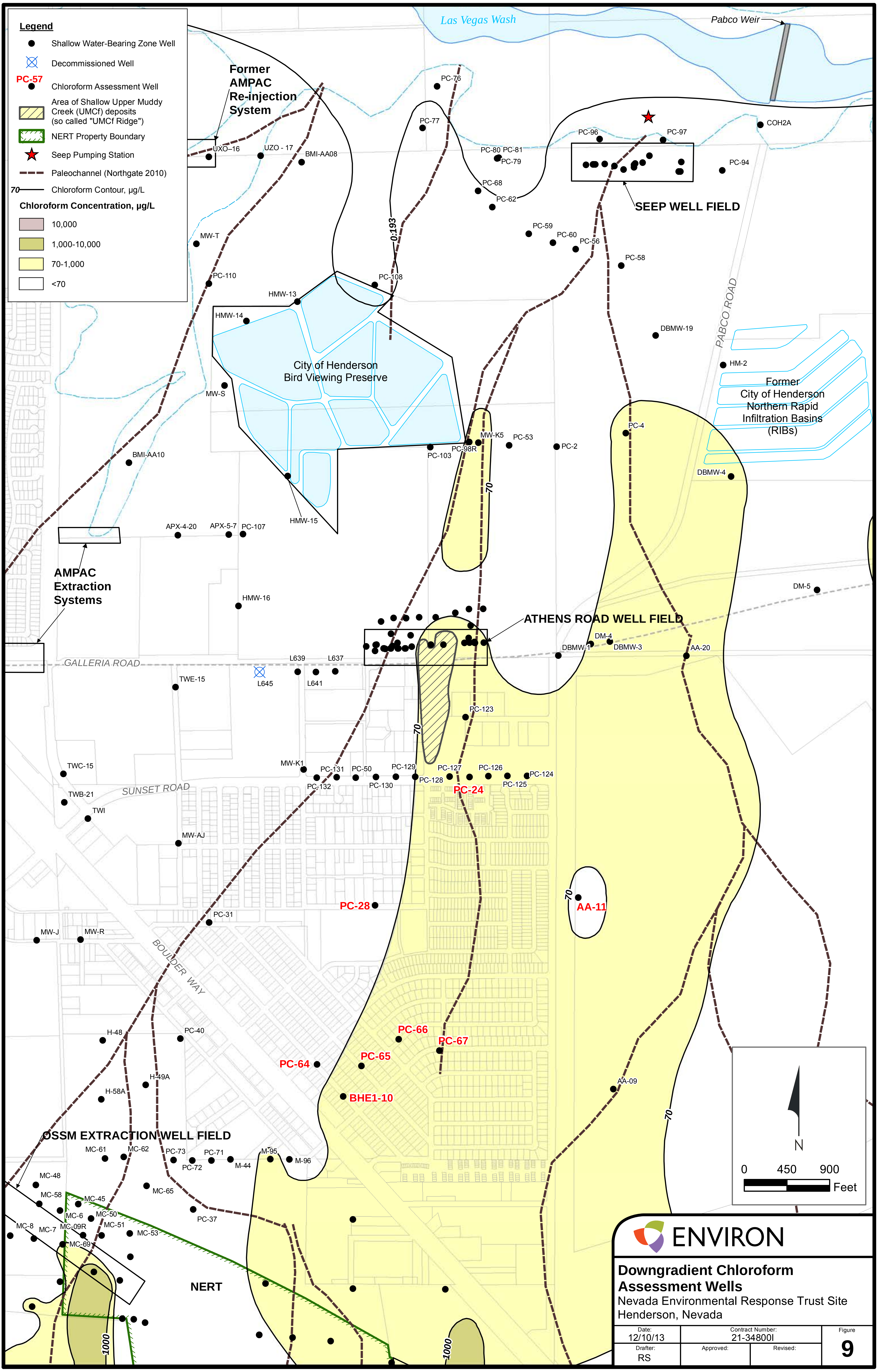
Nevada Environmental Response Trust Site
Henderson, Nevada

Figure

8b

Drafter: RS
Date: 7/11/2014
Contract Number: 21-34800I
Approved:
Revised:

Path: H:\LePetomane\NERT\Soil Excavation\GIS\2134800I\2134800I-WASHAREA-Plume Wells.mxd



ENVIRON

Downgradient Chloroform Assessment Wells

Nevada Environmental Response Trust Site
Henderson, Nevada

Date:	Contract Number:			Figure
12/10/13	21-34800I			9
Drafter:	Approved:		Revised:	
RS				

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Appendix A

Field Guidance Documents (FGDs)

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.

FIELD GUIDANCE DOCUMENT NO. 002
SOIL SAMPLING FOR CHEMICAL ANALYSIS AND PHYSICAL TESTING

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Effective date ……………………	January 24, 2014
Revision Notes …………………	0 First Issuance
Documents used as reference during preparation ……………..	United States Environmental Protection Agency (USEPA). *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846)*. Office of Solid Waste, Washington, DC 20460. Dated June 1997. USEPA Office of Solid Waste promulgated Method 5035, *Closed-System Purge-and-Trap Extraction for Volatile Organics in Soil and Waste Samples in SW-846, Test Methods for Evaluating Solid Waste, Physical / Chemical Methods, Update III and as updated in 2002.* Department of Toxic Substances Control (DTSC) California Environmental Protection Agency, *Guidance Document for the Implementation of United States Environmental Protection Agency Method 5035: Methodologies for Collection, Preservation, Storage, and Preparation of Soils to be Analyzed for Volatile Organic Compounds, dated November 2004.* ASTM D 4547-98. 1998. *Standard Guide for Sampling Waste and Soils for Volatile Organics. West Conshohocken, PA.*

Table of Contents

1.0 INTRODUCTION

This Field Guidance Document (FGD) describes the procedures for collecting soil samples for chemical analysis and physical properties testing 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 soil sampling 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 sampling is performed in a complete and safe manner, 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).

The laboratory must be certified by the appropriate regulating agency for the analyses to be performed. If required, permits will be acquired from the appropriate agency, and an underground utility check will be performed before drilling or excavating begins. An underground utility check will, at a minimum, consist of contacting the local utility alert service (e.g. USA DigAlert), if available, and a review of planned drilling locations by site representatives having knowledge of utilities at the site. Under certain circumstances, including at sites with deeply buried, unknown, or multiple underground utilities, as well as at high risk sites such as oil refineries and heavy industrial facilities, manual utility clearance using hand auger or air knife methods should also be performed. Additional subsurface clearing requirements may be described in the site-specific HASP.

2.0 EQUIPMENT/MATERIALS

Equipment and materials needed to conform to this FGD include:

- Health and Safety Plan
- Site information (maps, contact numbers, previous field logs, etc.)

- Photoionization Detector (PID) or Flame ionization detector (FID) for field screening for and monitoring of breathing zones for inhalation hazards
- Other monitoring equipment as specified in the Health and Safety Plan
- Logging assistance tools (e.g., grain size charts, Munsell color charts)
- Measuring tapes (both long weighted cloth type and small measuring tape, preferably marked in tenths and hundredths of a foot)
- Certified-clean sample liners and/or containers, sample labels, Ziploc™ bags
- Teflon® sheets and appropriately-sized plastic end caps for sample sleeves
- EnCore® samplers, Terra Core® samplers, or equivalent sampling devices
- Cooler with ice
- Decontamination supplies (e.g. phosphate-free detergent, distilled water)
- Drum labels
- Personal Protective Equipment (PPE), typically PPE will consist of:
  - Long-sleeved shirt and long pants
  - Steel-toed boots
  - Hardhat
  - Nitrile gloves
  - Safety glasses with side shields
  - Other as required by Health and Safety Plan
- Field Forms (If the project requires it, a project-specific Field Logbook may substitute for any or all of the following)
  - *Field Investigation Daily Log*
  - *Field Soil Boring Log*
  - *Equipment Calibration Log*
  - *Chain of Custody*

3.0 PROCEDURES

Soil samples may be collected using a variety of methods and equipment depending on the depth of the desired sample, the type of sample required, and the soil type. There are four general types of soil samples that can be collected: bulk samples, representative samples, undisturbed samples, and composite samples. Project planning documents should describe the type of soil samples required for the various objectives of the project.

- Bulk samples are usually collected with shovels or trowels from the ground surface, piles, or from boreholes and generally represent a highly disturbed sample for general characterization.
- Representative samples are generally collected in some form of drive rod or core tube and represent material from a specific discrete-depth interval. Accordingly, these are also sometimes called, "discrete-depth samples." Representative samples contain all the constituents of the selected interval, but may not necessarily be collected in a relatively undisturbed state. Representative samples are the most commonly collected soil samples for chemical analysis. In some cases and for some analyses, representative samples can be sub-sampled as needed.
- Relatively undisturbed samples are samples collected using soil sampling equipment and techniques to minimize the physical or chemical disturbance to the sample. Relatively undisturbed samples are necessary for some physical properties tests including hydraulic conductivity testing performed at a fixed laboratory.
- Composite samples are a blend or mix of several discrete samples or material from several sources (i.e., different boreholes or stockpiles). Composite samples are highly disturbed samples that are not appropriate in many situations; however, that can be useful for waste characterization purposes or for understanding general levels of contamination. Composite samples can be prepared in the field using decontaminated tools and containers, or may be performed in the laboratory.

Soil samples may be collected during drilling, during excavation and trenching activities, or directly from ground surface or from stockpiles. The following sections discuss the procedures to be used for the collection of soil samples under these different scenarios.

3.1 Sample Collection During Drilling

The drilling and logging of soil borings will be conducted in accordance with the FGD entitled Drilling and Destruction of Soil Borings. At selected locations, discrete soil samples may be collected. The procedures for collecting discrete soil samples are discussed in the sections below.

3.1.1 Direct-Push Drilling

Soil samples will be collected in new plastic liners contained within the stainless-steel drive rods (Geoprobe® or equivalent). The drive rods will generally be 2-inch- or 2.5-inch-diameter and 2-4 feet in length which are hammered or pushed into the soil to the selected sampling depth. The liner will slide out from the top of the drive rod. Discrete soil samples can be collected by cutting sections out of the liner itself using a clean hack saw. Alternatively, a subsample for chemical analyses may also be collected by driving a smaller diameter liner into the center of the larger core sample, taking care to reduce the potential for sample disturbance and air space within the liner, or by using the EnCore®/Terra Core® (or equivalent) sampling device. If the sample is to be analyzed for non-volatiles only, a loose sample may be placed in a glass jar. Samples to be analyzed for metals may be homogenized before analysis either in the field or by the laboratory to provide results representative of average concentrations in the sampling interval.

3.1.2 Sonic, Auger, and Rotary Drilling

Soil samples are generally collected in clean brass or stainless steel liners that have been washed with detergent-water solution and rinsed with potable water or steam-cleaned. The liners will generally be placed in a 2-inch- or 2.5-inch-diameter split-spoon sampler and then driven or pushed into the soil at the selected sampling depth. The sample will be parted at the joints between the liners using a clean, sharp stainless steel knife or spatula. Alternatively, a sub-sample for chemical analyses may also be collected by driving a smaller diameter liner into the center of the larger core sample, taking care to reduce the potential for sample disturbance and air space within the liner, or by using the EnCore®/Terra Core® (or equivalent) sampling device. If the sample is to be analyzed for non-volatiles only, a loose sample may be placed in a glass jar. Samples to be analyzed for metals may be homogenized before analysis either in the field or by the laboratory to provide results representative of average concentrations in the sampling interval.

3.2 Soil Field Screening

Soil may be screened using a field instrument such as a portable PID, FID, or other appropriate type of organic vapor meter (OVM). The purpose of the field screening is to assess the presence of VOCs in the soil.

The meter measures total VOCs in the air in parts per million (ppm) by volume in reference to a selected standard. The meter will be calibrated each day prior to soil sampling. The meter cannot specifically identify each VOC, but can be adjusted to be sensitive to selected VOCs. Before choosing a meter, the response factor of the meter to the chemicals of concern at the site should be considered. Soil should be screened as soon as possible after being exposed to the atmosphere. The general procedure for screening is as follows:

- Separate the liner(s) from the sampler.
- Insert the probe of the OVM into the end of the liner, taking care not to clog the probe with soil. Alternatively, headspace readings may be taken by placing soil in a covered (e.g., aluminum foil or Teflon® sheet) clear glass jar or plastic re-sealable bag, and after several minutes have elapsed, introducing the probe into the headspace area. No soil sample used for headspace screening will be submitted to the laboratory for chemical analysis.
- Record the results in ppm for PIDs and FIDs, and/or in percent of the LEL for specific chemicals.
- Ensure that the instrument returns to a zero measurement before the next reading. If necessary, move to an area without measurable organic vapors to zero-out the instrument.

3.3 EnCore® or Terra Core® Sampling for VOCs

If the sample is to be analyzed for VOCs, then the EnCore®/Terra Core® (or equivalent) sampling method may be performed in accordance with USEPA Method 5035. This protocol describes the procedures to be followed during collection of soil samples using sub-core samplers by Method 5035A, according to the Standard Guide for Sampling Waste and Soils for Volatile Organic Compounds (ASTM D 4547-98). The following section provides general descriptions of soil sampling using these devices in accordance with USEPA Method 5035. For specific procedures refer to the instructions provided with the sampling devices as well as the guidance documents identified on the cover of this FGD.

The EnCore® sampler is a commercially available device constructed of an inert composite polymer. EnCore® uses a coring/storage chamber to collect either a 5 gram (g) or 25g sample of in-situ soils or those collected from discrete depths in sample sleeves. It has a press-on cap with a hermetically vapor tight seal and a locking arm mechanism. The EnCore® sampler is a sampling device that can be used as both a simultaneous coring tool for cohesive soils and a transport device to send the sample to a support laboratory. The EnCore® sampler is intended to be a combined sampler/storage device for soils until a receiving laboratory can either immediately analyze the sample for VOC analysis, or preserve extruded soil aliquots for later VOC analysis. The sampler also has a vapor tight plunger for the non-disruptive extrusion of the sample into an appropriate container transferred by laboratory.

EnCore® samplers are disposable samplers; an individual EnCore® sampler is needed for each soil aliquot collected. Upon soil sample collection, the EnCore® sampler is stored at 4 ± 2° C until laboratory receipt within 48 hours. Upon laboratory receipt, soils aliquots are extruded into appropriate prepared VOA vials (ASTM D 4547-98). Alternatively, arrangements can be made with the laboratory to provide the appropriate prepared VOA vials for field preservation of soil samples as would be done with Terra Core® samples (discussed below).

The Terra Core® disposable plunger is a commercially available device constructed of an inert composite polymer. Terra Core® uses a coring/storage chamber to collect either a 5g or 10g sample of in-situ soils or those collected from discrete depths in sample sleeves. Terra Core® (or equivalent) disposable plungers are intended to be used for soils collection and immediate extrusion into pre-prepared 40 milliliter (ml) VOAs only. Terra Core® disposable plungers are not intended to be used for transport.

Terra Core® samplers are disposable samplers; an individual Terra Core® sampler is needed for each soil aliquot collected. Upon soil sample collection, soils are immediately extruded into pre-prepared 40ml VOA vials containing appropriate preservative for later VOC analysis. Generally, the preservative is methanol (for high level analysis) and sodium bisulfate (for low level analysis), but in certain cases it may be reagent grade water. However, if using reagent grade water hold times may be only 48 hours unless additional precautions are taken (see guidance documents if project calls for reagent water preservation). Preserved samples in VOAs must be immediately capped and stored on ice at 4 ± 2° C until laboratory receipt.

Some materials that require sampling may be too cohesive for sub-coring tools to penetrate. Examples of such materials include cemented soil, dense sand, stiff clay, or bedrock. Samples of these materials can be collected by exposing a fresh surface and using an appropriate tool such as a clean chisel or spatula to generate aggregates of a size that can be placed into a volatile organic analysis (VOA) vial. When transferring the aggregates, care must be taken to prevent compromise of the sealing surfaces and threads of the VOA vials. The VOA vial should be handled and preserved pursuant to USEPA 5035. When sampling under these conditions, the Field Geologist/Engineer should note the occurrence in their field logs. Although the inevitable disaggregation of the sample increases the possibility of VOC losses, there may be no alternative under these conditions.

3.4 Manual Collection of Surface and Near-Surface Soil Samples

Manual collection methods can be used primarily to collect surface and shallow subsurface soil samples. Surface soils are generally classified as soils between the ground surface and 6 to 12 inches below ground surface (bgs). The most common interval is 0 to 6 inches; however, the data quality objectives of the specific investigation task may dictate another interval, such as 0 to 3 inches for risk assessment purposes. The shallow subsurface interval may be considered to extend from approximately 12 inches below ground surface to a site-specific depth at which sample collection using manual collection methods becomes impractical (typically less than 5 feet bgs).

Surface soil samples may be collected using a clean stainless-steel trowel and placed in laboratory-supplied glass jars. Surface and near surface soil samples may also be collected using a hand-hammered stainless-steel core sampler with dedicated stainless-steel sleeves. This latter method provides a less disturbed sample.

Hand augers may be used to advance boreholes and collect soil samples in the surface and shallow subsurface intervals. Typically, 3-inch diameter stainless steel auger buckets with cutting heads are used. The bucket is advanced by simultaneously pushing and turning using an attached handle. Auger holes are advanced one bucket at a time until the sample depth is achieved. The practical depth of investigation using a hand auger depends upon the soil properties and depth of investigation. In sand, augering is usually easily performed, but the depth of collection is limited to the depth at which the sand begins to flow or collapse. Hand augers may also be of limited use in tight clays or cemented sands. In these soil types, the greater the depth attempted, the more difficult it is to recover a sample due to increased friction and torque of the hand auger extensions. At some point these problems become so severe that power equipment must be used.

Once the sample depth is achieved, the targeted soil interval may be collected using a hand-hammered stainless-steel core sampler with dedicated stainless-steel sleeves. A sample may also be collected using the hand auger bucket itself by collecting a sub-sample from the bottom of the auger using a clean trowel for non-volatile compounds, or an EnCore®/Terra Core® or similar sub-core sampling device consistent with USEPA 5035 for VOC analysis.

3.5 Sample Collection from Excavations, Trenches, and Stockpiles

Excavated soil may be sampled as required under the appropriate agency guidelines, if applicable, or as necessary to provide the data desired, such as the residual concentrations remaining after excavation of contaminated soils. Trenching, if conducted, is typically done to allow sampling or visual examination of subsurface soils, or to investigate for debris or other evidence of buried contamination. Trenches created by excavation with a backhoe offer the capability of collecting samples from very specific intervals and allow visual correlation with vertically and horizontally adjacent materials. If possible, the sample should be collected without entering the trench. Samples may be obtained from the trench wall or they may be obtained directly from the bucket at the surface.

The lateral and vertical dimensions of the excavation or trench, as well as the sample location and depth, should be mapped, and the volume estimated. If possible, samples will be collected from the backhoe or excavator bucket without entering the excavation. Samples may be collected directly from the walls or floor of the excavation, provided Occupational Safety and Health Administration (OSHA) regulations are followed before entering an excavation.

Some precision with respect to actual depth or location may be lost by sampling from the backhoe or excavator bucket, but if the soil to be sampled is uniquely distinguishable from the adjacent or nearby soils, it may be possible to characterize the material as to location and depth. In order to ensure representativeness, it is also advisable to dress the surface to be sampled by scraping off any smeared material that may cross-contaminate the sample.

Stockpiles may also be sampled after completion of excavation or trenching activities. If they are sampled, the stockpile location, dimensions, and sample locations will be mapped, and the stockpile volume will be estimated. For waste characterization purposes, evenly-distributed individual grab samples are typically composited to represent the entire stockpile. If compositing of soil samples containing VOCs is required, it will be performed by the analytical laboratory.

The soil from excavations or stockpiles will be sampled by scraping away 3 to 6 inches of surface soil or hand augering to a known depth. A brass tube, or stainless steel tube will be forced into the soil to completely fill the container, or a clean hand-hammered core sampler may be used in conjunction with brass or stainless steel liners. Alternatively, a clean stainless steel or disposable plastic trowel may be used to collect and containerize samples. An EnCore®/Terra Core® or similar sub-core sampling device consistent with USEPA 5035 may be used if VOC analysis will be performed.

3.6 Equipment Cleaning

The drilling rods, sampler, brass or stainless steel liners, spatula, and tools used in assembly and disassembly of the soil sampler will be cleaned before and after each use. All soil will be removed from the tools and parts, and the tools will be washed in laboratory-grade alconox detergent and water solution with a brush, followed by rinsing in deionized water, or steam-cleaned prior to and between sampling.

Decontamination water will be collected and stored on-site for future disposal by the client unless other arrangements have been made.

3.7 Quality Control Samples

All field Quality Control (QC) samples must be prepared the same as primary samples with regard to sample volume, containers, and preservation. The sample handling and chain-of-custody procedures for the QC samples will be identical to the primary samples. The following are QC samples that may be collected during soil sampling:

- A field duplicate is an independent sample collected as close as possible to the same time that the primary sample is collected and from the same source. Field duplicates are used to document sample precision. Field duplicates will be labeled and packaged in the same manner as primary samples so that the laboratory cannot distinguish between the primary sample and the duplicate sample. Field duplicates are analyzed for the same suite of parameters as the primary samples. The frequency of analysis of field duplicates is generally one for every 20 primary samples, but may vary depending on project requirements.
- Equipment blanks are obtained by running distilled or deionized water over or through the sample collection equipment after it has been decontaminated, and capturing the water in the appropriate sample containers for analysis. Equipment blanks are analyzed for the same suite of parameters as the primary samples. The frequency of analysis of equipment blanks is generally one for every day that non-dedicated sampling equipment is used, but may vary depending on project requirements.
- Field blanks are used to assess the presence of contaminants arising from field sampling procedures. Field blank samples are obtained by filling a clean sampling container with reagent-grade deionized water. Field blanks are analyzed for the same suite of parameters as the primary samples. Field blanks may or may not be incorporated into a groundwater sampling plan depending on project requirements.
- Trip blanks are sample containers that are used to evaluate sample cross-contamination of VOCs during shipment. For groundwater sampling, trip blanks consist of hydrochloric acid-preserved, analyte-free, deionized water prepared by the laboratory in VOA vials that will be carried to the field, stored with the samples, and returned to the laboratory for VOC analysis. Generally, one trip blank is required to accompany each sample shipping container or cooler that contains samples for VOC analysis; however, this may vary depending on project requirements.

The following is an additional type of QC sample that may be collected during soil sampling from boreholes:

- Control samples are samples of any materials (water, drilling mud, etc.) that are to be introduced to the borehole to aid in drilling or for any other valid reason. Generally, introducing any foreign materials into boreholes should be avoided; however, when environmentally acceptable and approved materials are used during drilling, samples should be collected and analyzed (at a minimum) for the same analyses to be performed on primary samples. The frequency of analysis is generally one for every material used.

3.8 Sample Handling and Custody

Samples 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.

3.8.1 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.

3.8.2 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.

3.8.3 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.

3.8.4 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.

3.8.5 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. If soil samples are to be analyzed for volatile organic compounds (VOCs), they should be collected in a manner that minimizes disturbance of the sample. This is most often accomplished by use of EnCore® or Terra Core® samplers or equivalent devices and procedures consistent with United States Environmental Protection Agency (USEPA) Method 5035. Samples for VOC analysis are not to be composited or homogenized in the field. Field preservation may be required for some samples with certain variations of Method 5035. The selection of sampling and preservation method depends on many factors and is not addressed in this SOP.

Special drilling, sampling, and handling procedures may be required for soil samples that are to be subjected to physical testing, such as air/water permeability and hydraulic conductivity. In these cases, undisturbed samples collected under strictly-controlled circumstances to minimize the physical or chemical disturbance may be necessary. If physical testing is specified, the Field Geologist/Engineer should consult with the Project Manager and the physical testing laboratory to verify the specific drilling, sampling, and handling requirements necessary to provide sufficiently undisturbed samples.

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 soil sampling 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 Leader, 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*
- *Field Soil Boring Log*
- *Equipment Calibration Log*
- *Chain-of-Custody*

A *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 the drillers and any other subcontractors 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 Leader, 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 *Field Soil Boring Log* will be used to record the locations and unique identification of soil samples collected from the soil borings. The Field Soil Boring Log will also be used to record lithological descriptions of the soils and rock types encountered.

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, LEL, OVM, measuring tapes, water level measuring device, 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 any samples collected from the surface of the site, from soil borings, or from excavations or stockpiles will be recorded on the *Field Investigation Daily Log, Field Soil Boring Log*, a site map, and/or other appropriate forms.

Samples 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.

FIELD GUIDANCE DOCUMENT NO. 003
DRILLING AND DESTRUCTION OF SOIL BORINGS

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Table of Contents

1.0 INTRODUCTION

This Field Guidance Document (FGD) describes the procedures for drilling and destruction of soil borings 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 drilling and destruction of soil borings 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 soil boring drilling and destruction is performed in a complete and safe manner, 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).

This FGD describes the procedures to be followed by a Field Geologist/Engineer during drilling and destruction of soil borings. The purpose of soil borings is to provide access to the subsurface at specified locations and depths. Soil borings allow for the inspection and sampling of subsurface materials as well as the installation of groundwater wells, soil vapor probes, and in-situ remediation systems. If the soil boring is to be used for discrete soil sampling, the FGD applicable to soil sampling should be followed as necessary. Likewise, if the soil boring is ultimately utilized for the collection of soil vapor or groundwater samples, the FGDs specific to those activities should be followed.

This FGD covers several of the most common drilling methods used for advancing soil borings for environmental purposes; however, it does not discuss how to select the appropriate drilling method for a given task. The selection of drilling method depends on many factors and each method has advantages as well as limitations. The Task Leader will select the drilling method best suited for the site and the objectives of the project based on professional judgment and past experience.

The drilling contractor, if used, shall be a licensed driller, in accordance with local and state requirements, and qualified for the drilling and destruction of soil borings for environmental purposes.

2.0 EQUIPMENT/MATERIALS

Equipment and materials needed to conform to this FGD include:

- Health and Safety Plan
- Site information (maps, contact numbers, previous field logs, etc.)
- Photoionization Detector (PID) or Flame ionization detector (FID) for field screening for VOCs and monitoring of breathing zones for inhalation hazards
- Other monitoring equipment such as Lower Explosion Limits (LEL) meter or combustible gas/methane meter as specified in the Health and Safety Plan
- Hand lens
- Logging assistance tools (e.g., grain size charts, Munsell color charts)
- Measuring tapes (both long weighted cloth type and small measuring tape, preferably marked in tenths and hundredths of a foot)
- Electronic water level indicator (Solinst or similar)
- Decontamination supplies (e.g. phosphate-free detergent, distilled water)
- Drum labels
- Personal Protective Equipment (PPE), typically PPE will consist of:
- Long-sleeved shirt and long pants
- Steel-toed boots
- Hardhat
- Nitrile gloves
- Safety glasses with side shields
- Other as required by Health and Safety Plan
- Field Forms (If the project requires it, a project-specific Field Logbook may substitute for any or all of the following)
  - *Field Investigation Daily Log*
  - *Field Soil Boring Log*
  - *Equipment Calibration Log*
  - *Chain of Custody*

Based on the field activity and project, the drilling contractor needs to provide:

- Drilling equipment (depends upon the type of drilling, e.g., proper diameter augers or drive rods, generators, compressors, steam cleaners, etc.)

- Drilling supplies (depends upon the type of drilling, e.g., drilling fluids, conductor casing, etc.)
- Sampling equipment (split-spoon sampler, sampling sleeves, etc.)
- Decontamination supplies
- Containers (drums or covered bins) for separate on-site containment of cuttings, drilling fluids, and purge/decontamination water
- Well construction supplies if wells are to be installed (screen, well casing, sand pack, bentonite chips, bentonite, cement mixture, water)
- Health and safety records required for working on-site
- Support vehicles
- PPE, typically:
  - Long-sleeved shirt and long pants
  - Steel-toed boots
  - Hardhat
  - Nitrile gloves when handling potentially contaminated materials
  - Leather work gloves when chemical exposures are not anticipated
  - Safety glasses with side shields
  - Other as required by Health and Safety Plan

3.0 PROCEDURES

The planned depth of each soil boring will be determined by the Task Leader or project-specific document before drilling. The Field Geologist/Engineer will specify to the drill rig operator the desired total depth of the boring, the depth of soil sample collection, method of sample retrieval, and other matters pertaining to the satisfactory completion of the borings. The Field Geologist/Engineer will anticipate the volume and nature of drill cuttings and arrange for appropriate handling and storage on-site including designating a secure and convenient storage area. Drill cuttings, unused soil samples, and drilling fluids—collectively referred to as Investigation-Derived Waste (IDW)—generated during drilling of soil borings will be stored properly for future disposal by the client, unless other arrangements have been made. When water or other materials are to be introduced to the borehole, arrangements will be made so that those materials are sampled and analyzed as control samples.

Prior to the start of drilling, drilling permits must be obtained and a utility survey must be conducted.

3.1 Pre-Drilling Activities

Soil borings may be advanced using any appropriate drilling technique. The type of equipment used depends upon the site geology, hydrology, equipment available, and monitoring design. Control of cuttings and other potentially contaminated materials at the drill site may influence drilling method selection. Depending upon equipment availability and site geology, more than one method may be combined to complete a particular monitoring well installation. Typically, soil borings will be continuously cored or cored at selected intervals. At selected locations, discrete soil samples may be collected.

3.2 Drilling Oversight

During drilling the Field Geologist/Engineer shall oversee field operations, document field activities, prepare boring logs, and oversee containment of the drilling residuals. The following section describes what the Field Geologist/Engineer should observe during drilling.

During the initial five feet of drilling:

- If surface is protected by asphalt or concrete, remove this material. Asphalt can usually be penetrated by augers or other drill tooling. However, if the surface is covered with concrete, it is advisable to arrange for a concrete cutter to provide access to the subsurface.
- The top five feet of soil should be hand-augered or cleared using air knife whenever possible, in case subsurface utilities are encountered.
- Observe surface soil type to determine the presence of fill or evidence of surface contamination (e.g., soil staining, odors).

During ensuing operation of the drilling rig and as drilling progresses, note and observe the following:

- Keep an accurate record of the drilling depth, depth at which samples are collected, sample condition and recovery, and blow counts. Blow counts are used in most drilling techniques other than DPT, and they represent the number of blows (by the 140-pound sampling hammer falling 30 inches, or equivalent auto-hammer) that are required to advance an 18-inch long split-spoon sampler and are recorded as three numbers. The first number is the number of blows required to advance the sampler the first 6 inches, and the second and third numbers are the number of blows required to advance the sampler from 6 to 12 inches and from 12 to 18 inches. Blow counts are used to estimate ground density and are used in many empirical geotechnical formulae.
- Observe depth(s) at which groundwater is encountered, including occurrence of perched water.
- Observe depth(s) at which obvious contamination is encountered (discolored soil, non-aqueous phase liquids [NAPLs]).
- Record relevant rig operations (e.g., leaks, breakdowns, fast or slow drilling, and rig chatter).
- Observe that drilling residuals are properly contained. If using drums, make sure that the drums are sealed, labeled with the date, boring location, and depth interval, and stored in the

designated waste storage area. Drilling residuals from one boring should not be mixed with those from another boring.

- Observe that proper rig decontamination procedures are followed and that the augers are not reused between borings until they have been decontaminated. Decontamination rinse water should be contained in drums. Drums should be sealed, labeled, and handled in the same manner as drums containing drilling residuals.
- Communicate with the Project Manager during field activities. Normally, the Field Geologist/Engineer should call the Project Manager once each day to provide a progress report. If unusual events or difficulties occur during drilling, the field staff should report to the Project Manager and discuss approaches for problem resolution, or the significance of unusual field events. Unusual field events that should be reported include (but are not limited to) unanticipated geologic conditions, unexpected groundwater conditions, and unexpected evidence of chemical contamination.

3.3 Drilling Methods

3.3.1 Direct-Push Technology

Direct-push technology (DPT), e.g., Geoprobe® (or equivalent), although not “drilling” in the traditional sense, is a commonly used technique for quickly advancing small-diameter tooling in shallow unconsolidated soils. DPT uses both static force and the dynamic percussion force of a soil-probing hammer to advance small diameter sampling tools. It rearranges particles in the subsurface by application of weight and percussion thereby advancing the tool string producing no cuttings in the process. Soil samples can be continuously collected from the center of some DPT tooling in sections of clear plastic sleeves for logging and sampling purposes. Because of the manner in which DPT tooling is advanced, the term “soil boring” may be a misnomer when referring to DPT; however, through common usage boreholes made by removing and displacing subsurface materials using DPT are generally included in discussions of soil borings.

3.3.2 Sonic Drilling

Sonic drilling utilizes high-frequency vibration, aided by downward pressure and rotation, to advance tooling in various subsurface formations. A sonic rig uses an oscillator or head with eccentric weights driven by hydraulic motors to generate high sinusoidal force in a rotating pipe drill. The frequency of vibration of the drill bit or core barrel can be varied to allow optimum penetration of subsurface materials. A dual string assembly, typically 10-feet in length, allows advancement of casing with the inner casing used to collect samples. Small amounts of air and water can be used to remove the material between the inner and outer casing. Bits used in sonic drilling can penetrate boulders, construction debris, and bedrock (to a limited depth). Excess formation material generated by the cutting face of the bit is forced into the borehole wall thus resulting in the generation of no cuttings during the drilling process other than the generated core sample. However, the vibratory action used during advancement of the sampling barrel into the subsurface and during removal of the sample from the sample barrel can stratify some formations and consolidate or loosen others, thereby resulting in disturbed samples in some cases.

3.3.3 Hollow-Stem Auger (HSA) Drilling

The hollow-stem, continuous-flight auger, or “hollow-stem auger” (HSA), is a commonly employed tool for drilling and installing wells in unconsolidated and semi-consolidated materials. Augers utilize a spiral tool form consisting of a long inclined plane with fixed mechanical advantage (“flighting”) wrapped around a central stem. Continuous flighting refers to a design in which the flights of the auger extend the entire length of the auger stem. Individual auger sections, typically 5-feet in length, are also called flights. HSA employs rotation of the flights to advance through the formation and remove drill cuttings. When drilling, a cutting head is attached to the first auger flight, and as the auger is rotated downward, additional auger flights are attached, one at a time, to the upper end of the previous auger flight. As the augers are advanced downward, the cuttings move upward outside of the hollow-stem along the continuous flighting. The hollow-stem or core of the auger allows drill rods and samplers to be inserted through the center of the augers. The hollow-stem of the augers also acts to temporarily case the borehole, so that well screen and casing may be inserted down through the center of the augers once the desired depth is reached. During drilling with the hollow stem auger, the drill cuttings will be discharged up through the open hole; the sediment will be shoveled and transferred into appropriate soil waste bins for transport and disposal.

3.3.4 Air-Rotary and Air-Rotary Casing Hammer Drilling

In rotary drilling, a drill rod with an attached bit is continuously rotated with downward pressure to disaggregate formation material into drill cuttings. Rotary drilling involves the use of circulating fluids (i.e., mud, water, or air) to remove the drill cuttings as drilling progresses. The use of any drilling fluids must be evaluated to ensure that their introduction into the subsurface will not adversely affect subsurface chemistry nor affect the ability to collect representative subsurface samples.

In the case of air-rotary drilling, compressed and filtered air is force down the drill pipe and back up the borehole to remove the drill cuttings. Air-rotary drilling is a very fast and efficient means of drilling. Rigs that are properly equipped and staffed can drill several hundred feet of hole per day. The air-rotary method can reach to several thousand feet in depth and create borehole diameters up to approximately 17 inches. Sediment sampling is supported both in poorly consolidated materials (by split-barrel samplers) and in consolidated rock (by coring). The use of air can result in an acute hazard when air rotary techniques are employed in contaminated formations because the air flow can transport vapors to the surface where they can become an inhalation hazard. Special attention must be paid to the monitoring of workers’ breathing zones during air-rotary drilling.

Air rotary rigs are sometimes fitted with a casing driver to overcome borehole instability problems in unconsolidated sediments. When equipped with such a casing, air-rotary rigs also minimize the potential for inter-aquifer contamination. The Air-Rotary Casing Hammer System (ARCH) is one such system consisting of a non-rotating flush-threaded casing driven in conjunction with a conventional air-rotary drill string. The casing, which is a heavy wall flush-threaded pipe, is driven with a pneumatic or hydraulic drill-through casing hammer. Cuttings are cleared from the hole by the bit rotation and air circulation as in traditional air-rotary. The material is discharged through a hose into a cyclone, which separates the air from the formation cuttings to facilitate sampling and containment of drill cuttings.

3.3.5 Mud Rotary

Mud-rotary operates by the same general principles as air-rotary except that the cuttings are removed by a drilling fluid (water or water mixed with clays or “mud”). Mud-rotary drilling is a very fast and efficient means of drilling. Efficient rigs can produce several hundred feet of hole per day. The mud-rotary method can reach to several thousand feet in depth and create borehole diameters to greater than 48 inches. The method is adaptable to a wide range of geologic conditions. Sediment sampling is broadly supported in mud-rotary drilling: standard split-barrel and thin-wall sampling are available for use in poorly consolidated materials while a broad range of coring apparatus are supported for consolidated rock.

While there are hydrogeological conditions where mud rotary drilling is the best option (e.g., where it is difficult to maintain a stable borehole), mud rotary creates a potential for affecting aquifer characteristics and groundwater quality. If the mud rotary method is used, the drilling mud(s) should not affect the chemistry of groundwater samples or samples from the borehole, or adversely impact the operation of an installed groundwater well.

Because drilling muds can invade permeable zones, mud-rotary drilling is generally not recommended for installing soil vapor probes or vapor wells. In cases where mud-rotary drilling is used to install groundwater wells, increased well development time will likely be required to remove drilling mud pushed into the formation during drilling.

3.4 Samples and Logging

The following sections describe the procedures for obtaining soil samples for lithologic logging of soils.

3.4.1 Obtaining Samples

Borings will be cored or sampled at depth intervals specified by the Project Manager and Task Leader, based on the intended use of the boring. Generally, samples and/or cuttings will be obtained for logging purposes at a minimum 5-foot interval for borings. The samples and/or drill cuttings will be collected, observed, and described by the Field Geologist/Engineer. A lithologic log of these samples will be recorded on the Field Soil Boring Log.

3.4.2 *Discrete Sampling*

For discrete sampling of auger borings, sampling will be accomplished by driving or pushing a split barrel sampler or Shelby tube. The Field Geologist/Engineer will record information on the Field Soil Boring Log pertaining to the sampling, such as rate of penetration, drive-hammer blow count, and sample recovery. In general, the split-barrel sampler will be opened for observation and logging of the retrieved core. At selected depth intervals, the split-barrel sampler may be fitted with brass or stainless steel liners for collection of soil samples for possible subsequent chemical or physical testing. Similarly, direct-push tooling can be utilized to collect discrete samples within plastic liners appropriately sized to fit within the tooling. Samples may be retained for future review and/or preserved for chemical and physical testing, as specified by the Task Leader and/or project-specific documents.

Any discrete samples collected will be stored and labeled to show project number, boring number, and cored interval denoted either by depth or a sequential numbering system.

3.4.3 *Logging of Soil Borings*

The observations of the field geologist/engineer will be recorded on a Field Soil Boring Log at the time of drilling. The drill rig operator and the Field Geologist/Engineer will discuss significant changes in material penetrated, drilling conditions, hydraulic pressure, and drilling action. The Field Geologist/Engineer will be present during drilling of soil borings and will observe and record such changes by time and depth.

Drill cuttings and core samples will be observed in the field. A lithologic description will be recorded on the Field Soil Boring Log using the Unified Soil Classification System (USCS) as described in the American Society of Testing and Materials (ASTM) Standard D 2488-90. This description will include the USCS soil type, grain sizes and estimated percentages of each, moisture content, color according to the Munsell color charts, plasticity for fine-grained materials, consistency, and other pertinent information, such as degree of induration, calcareous content, presence of fossil and other distinctive materials.

3.4.4 *Soil Screening*

Soil samples collected from the borings may be screened using a portable meter such as a photoionization detector (PID), a flame ionization detector (FID), a lower explosion limit (LEL) meter or other organic vapor meter (OVM). The meter may be used to assess the presence of volatile organic compounds (VOCs) or other gases in soil samples.

3.4.5 *Rock Coring*

Rock coring is performed to obtain relatively undisturbed samples of solid, fractured, or weathered rock formations using a conventional or wire-line coring system combined with diamond or carbide-bit drilling methodology, for environmental, geotechnical, or mineral exploration purposes. Rock coring requires the use of drilling fluids to cool the bit and circulate cuttings. The drilling fluid may affect the chemistry of groundwater in fractures and interstices, and it is difficult to avoid such effects if direct sampling of core materials is required. Depending on the type of fluid used, it is usually possible to collect representative groundwater samples following well development, if the borehole is to be converted into a well. A critical component of rock coring, however, is the description and characterization of rock types and fracture zones. Geologic descriptions will be recorded on the Field Soil Boring Log using a visual-manual identification and classification system based on ASTM Standard D5434 and describing the following factors: field hardness, weathering, color, grain size/texture, lithology, fracture types, characteristics/attitudes, bedding/foliation, and additional characteristics (e.g., rock continuity, rock quality designation [RQD], crystallinity, fossil content, etc. as required by project guidelines). For additional information of rock coring, see Classification of Rocks by Russell B. Travis, Quarterly of the Colorado School of Mines, Vol. 50, January 1955.

3.5 Destruction of Soil Borings

Soil borings that are not completed as monitoring wells or soil vapor probes will be destroyed by grouting the borings with a neat cement grout, cement/sand grout, or cement/bentonite grout or bentonite grout in accordance with the permit conditions, local ordinances, and/or State requirements. The following procedure is general in nature and may be superseded by any or all of these requirements.

The Field Geologist/Engineer will calculate the borehole volume and compare it to the volume of grout used to evaluate whether bridging has occurred. These calculations and the actual volume emplaced will be noted on the Field Soil Boring Log. In boreholes containing groundwater or any borehole greater than 80 feet in depth, the grout will be placed in continuous lifts from the bottom of boring to the ground surface using gravity pouring with a tremie pipe. In dry boreholes less than 80 feet in depth, grout may be placed by gravity pouring without a tremie pipe. In some situations, grout may be pumped into a borehole using a tremie pipe. After the borehole is grouted, additional grout will be added to the soil boring if significant settlement has occurred after the grout has set.

3.6 Post-Drilling Activities

Upon completion of grouting (if the borehole is completed as a monitoring well, or if it is abandoned), the grout should be allowed to cure for approximately 24 hours. At that time, the borehole site should be revisited, and additional grout should be added if necessary to bring the grout level to near surface. The ground surface should be restored to its original condition (e.g., asphalt, concrete, etc.) using material of a comparable quality and thickness to the original materials. The Field Geologist/Engineer should check that no cracks or openings are present, and that the completed surface is flush with the surrounding surface.

Once grouting and surface restoration have been completed, the boring location may be marked in the field. The Field Geologist/Engineer may drive nails for flagging or use paint to mark the boring location. The locations must be marked to allow surveyors to locate the borings when performing subsequent surveying activities.

In general, the Field Geologist/Engineer should arrange for a licensed surveyor to survey boring and well locations. Horizontal location coordinates are generally surveyed to the nearest 0.1 foot and referenced to the Nevada Coordinate System of 1983 (NAD83). Ground surface elevations are generally surveyed to the nearest 0.01 foot, and referenced to mean sea level datum (NAVD88).

3.7 Equipment Decontamination

The drill rods, drill pipe, hoses, bits, and other components that fluids and cuttings contact will be steam-cleaned before drilling at each boring location or alternatively washed in laboratory-grade alconox detergent and water solution using a brush, followed by rinsing in clean water. Only potable water from a municipal supply will be used for decontamination of drilling equipment.

Decontamination rinsate and water will be collected and stored on-site for future disposal by the client unless other arrangements have been made.

3.8 Site Clean-Up

ENVIRON staff should review the site with the drilling contractor after the work has been completed. The site should be left as clean as before the work was performed, and no residual safety hazards should remain as a result of the drilling. Specifically, the Field Geologist/Engineer should make sure that:

- If it is necessary to leave the rig on site overnight, the rig and all associated equipment are secured. The driller may want to hire a security guard. Safe-keeping of the rig and all associated equipment is the driller’s responsibility.
- All waste containers containing IDW are properly labeled, securely sealed, and stored safely in the pre-designated location. Waste containers should be counted by the Field Geologist/Engineer, and the number and type of containers and the nature of waste generated should be documented. If necessary, waste samples should be collected for waste profiling.
- All trash, debris, and equipment should be removed from the site or stored properly on-site.
- Drilling residuals should be removed from the ground surface. If the ground surface is covered by concrete or asphalt, the surface should be patched with like material and cleaned to remove residual soil.
- All surface conditions and stored containers or equipment should pose no danger to site employees, and should not interfere with business operations at the site.

After these conditions have been met, the Field Geologist/Engineer can sign the drilling contractor’s daily log. The Field Geologist/Engineer should leave the site only after the drilling contractor has departed.

3.9 Quality Control Samples

All field Quality Control (QC) samples must be prepared the same as primary samples with regard to sample volume, containers, and preservation. The sample handling and chain-of-custody procedures for the QC samples will be identical to the primary samples. The following are QC samples that may be collected during soil sampling:

- A field duplicate is an independent sample collected as close as possible to the same time that the primary sample is collected and from the same source. Field duplicates are used to document sample precision. Field duplicates will be labeled and packaged in the same manner as primary samples so that the laboratory cannot distinguish between the primary sample and the duplicate sample. Field duplicates are analyzed for the same suite of parameters as the primary samples. The frequency of analysis of field duplicates is generally one for every 20 primary samples, but may vary depending on project requirements.
- Equipment blanks are obtained by running distilled or deionized water over or through the sample collection equipment after it has been decontaminated, and capturing the water in the appropriate sample containers for analysis. Equipment blanks are analyzed for the same suite of parameters as the primary samples. The frequency of analysis of equipment blanks is generally one for every day that non-dedicated sampling equipment is used, but may vary depending on project requirements.
- Field blanks are used to assess the presence of contaminants arising from field sampling procedures. Field blank samples are obtained by filling a clean sampling container with reagent-grade deionized water. Field blanks are analyzed for the same suite of parameters as the primary samples. Field blanks may or may not be incorporated into a groundwater sampling plan depending on project requirements.
- Trip blanks are sample containers that are used to evaluate sample cross-contamination of VOCs during shipment. For groundwater sampling, trip blanks consist of hydrochloric acid-preserved, analyte-free, deionized water prepared by the laboratory in VOA vials that will be carried to the field, stored with the samples, and returned to the laboratory for VOC analysis. Generally, one trip blank is required to accompany each sample shipping container or cooler that contains samples for VOC analysis; however, this may vary depending on project requirements.

The following is an additional type of QC sample that may be collected during soil sampling from boreholes:

- Control samples are samples of any materials (water, drilling mud, etc.) that are to be introduced to the borehole to aid in drilling or for any other valid reason. Generally, introducing any foreign materials into boreholes should be avoided; however, when environmentally acceptable and approved materials are used during drilling, samples should be collected and analyzed (at a minimum) for the same analyses to be performed on primary samples. The frequency of analysis is generally one for every material used.

3.10 Sample Handling and Custody

Samples 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.

3.10.1 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.

3.10.2 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.

3.10.3 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.

3.10.4 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.

3.10.5 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. 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). The drilling contractor shall be a licensed driller in accordance with local and state requirements, and a qualified drilling contractor for the installation of soil borings for environmental investigations.

Where required, permits will be obtained from the appropriate agency, and an underground utility check will be performed before drilling or excavating begins. An underground utility check will, at a minimum, consist of contacting the local utility alert service, e.g., Underground Service Alert (USA), if available. Typically, subsurface clearance should also be conducted by a private utility locating company contacted specifically to clear individual boring locations. Under certain circumstances, including at sites with deeply buried, unknown, or multiple underground utilities, as well as at high risk sites such as oil refineries and heavy industrial facilities, manual utility clearance using hand auger or air knife methods should also be performed. Additional subsurface clearing requirements may be described in the site-specific Health and Safety Plan.

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 drilling 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 Leader, 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*
- *Field Soil Boring Log*
- *Equipment Calibration Log*
- *Chain-of-Custody*

A *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 the drillers and any other subcontractors 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 Leader, 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 *Field Soil Boring Log* will be used to record the locations and unique identification of soil samples collected from the soil borings. The Field Soil Boring Log will also be used to record lithological descriptions of the soils and rock types encountered.

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, LEL, OVM, measuring tapes, water level measuring device, 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 any samples collected from the borings will be recorded on the *Field Investigation Daily Log, Field Soil Boring Log*, a site map, and/or other appropriate forms.

If samples are collected, samples 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.

FIELD GUIDANCE DOCUMENT NO. 004
ONE-TIME "GRAB" GROUNDWATER SAMPLING

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Applicable to ……………………..	Nevada Environmental Response Trust Site Henderson, Nevada
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Documents used as reference during preparation ……………..	

Table of Contents

1.0 INTRODUCTION

This Field Guidance Document (FGD) describes procedures for one-time (or "grab") groundwater sampling 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 grab groundwater sampling 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 sampling is performed in a safe and complete manner, 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).

2.0 EQUIPMENT/MATERIALS

Equipment and materials needed to conform to this FGD include:

- Health and Safety Plan
- Site information (maps, contact numbers, previous field logs, etc.)
- Electronic water level indicator (Solinst or similar)
- Photoionization Detector (PID) of Flame ionization detector (FID) if VOCs are suspected
- Sampling pump – peristaltic, submersible, or bladder pump with adjustable rate controls (the latter for low-flow sampling)
- Bladders for sample pump if applicable
- Sample tubing (Teflon® or Teflon®-lined tubing preferred for sampling organic compounds)
- Bailers and string if applicable

- Multi-parameter water quality meter capable of measuring (at a minimum) temperature, pH, and specific electrical conductance (SEC)
- Turbidity meter
- In-line filters (if required, e.g. for dissolved metals)
- Certified-clean sample containers and preservation supplies, sample labels, Ziploc™ bags
- Cooler with ice
- Decontamination supplies (e.g. phosphate-free detergent, distilled water)
- Tool kit with appropriate tools (socket wrench set, pry bar, Dolphin locks/keys)
- Drum(s) to collect purged water and decontamination water
- Drum labels
- Personal Protective Equipment (PPE), typically PPE will consist of:
  - Long-sleeved shirt and long pants
  - Steel-toed boots
  - Hardhat
  - Nitrile gloves
  - Safety glasses with side shields
  - Earplugs
  - Other as required by Health and Safety Plan
- Field Forms (If the project requires it, a project-specific Field Logbook may substitute for any of the following with the exception of the Chain of Custody)
  - *Field Investigation Daily Log*
  - *Field Soil Boring Log*
  - *Water Level Measurement Log*
  - *Water Purging Log and Sampling Log*
  - *Equipment Calibration Log*
  - *Chain-of-Custody*

3.0 METHODOLOGY

The HydroPunch, EnviroProbe, temporary well point, and other grab groundwater sampling methods can be used with various subsurface exploration methods, including direct-push drilling, hollow stem auger drilling, rotary drilling, and cone penetration testing (CPT). Selection of the appropriate sampling tool should be based on anticipated field conditions such as the site hydrogeology (e.g., depth of sampling location below the water table, soil grain size, and estimated permeability), and type of subsurface exploration method employed. The following sections discuss the methods that may be used for the collection of grab groundwater samples.

3.1 Hydropunch

The HydroPunch consists of a drive point, a stainless steel screen section, a sample reservoir integral with the tool body, and assorted o-rings and check valves to create watertight seals between the various components. Two models of the HydroPunch have been developed, each having slightly different designs and/or component parts. All components are made of stainless steel, Teflon, or other relatively inert materials. The tool can be disassembled easily for cleaning between sampling events.

3.2 EnviroProbe

The EnviroProbe consists of a stainless steel drive point with a retractable outer sleeve, a stainless steel wire-cloth filter, various viton rubber o-rings, and a flexible viton rubber seal (septum) at the upper end of the probe. The rubber septum provides a watertight seal that prevents water from readily entering or exiting the top of the probe. The filter is attached to the inside body of the probe and is protected by the retractable outer sleeve. The sample reservoir is part of a separate assembly. The tool can be disassembled readily for cleaning between sampling events.

3.3 Temporary Well Point

Temporary well points are similar to installing traditional monitoring wells in that there is a polyvinyl chloride (PVC) riser and slotted screen installed within a drilled borehole; however, for temporary well points, a well seal is not installed. The well points typically consist of 1-inch or 2-inch diameter well screen and riser, the well screen typically being 5-feet in length within the targeted water-bearing zone. A sand pack can be emplaced surrounding the well screen like a traditional monitoring well, or a pre-pack well (a well screen with an integral filter pack) can be installed. Alternatively, in certain cases, the temporary well point can be installed without a filter pack; however, turbidity may be significant.

3.4 Sampling from Drilling Augers or Drive Rods

If it is not feasible to obtain a grab groundwater sampling using either HydroPunch or temporary well points, grab groundwater samples also can be collected directly from inside the drilling augers or drive rods; however, turbidity may be significant.

4.0 PROCEDURES

Installation of the EnviroProbe or HydroPunch generally follows the same procedure. A target sample interval (target zone) is usually identified prior to collecting a sample. When sampling using conventional drilling methods, the soil boring is advanced to a depth immediately above the target zone prior to installing the sampling tool. The sampling tool is attached to one of several different types of standard drilling rods (minimum 1-inch inside diameter for the EnviroProbe), lowered to the bottom of the existing borehole, and advanced (driven or pushed) approximately 2 to 4 feet into undisturbed formation. Internal seals and/or check valves create a water tight sampling tool while in the closed position, so that the EnviroProbe or HydroPunch can be used in fluid filled boreholes.

After the sampling tool is emplaced at the target sample depth, the outer sleeve is retracted approximately 1 to 1.5 feet (generally 1 foot of retraction for the EnviroProbe and 1.5 feet of retraction for the HydroPunch). As the outer sleeve is retracted, subsurface friction keeps the drive point in place, exposing the screen section, and allowing water to enter the sampling tool.

4.1 Hydropunch

HydroPunch I groundwater samples are usually collected under hydrostatic conditions, whereby groundwater flows from the formation through the screened section and into the sample reservoir. Accordingly, HydroPunch I cannot be used at depths less than approximately 5 feet below the groundwater table. The sample reservoir is allowed to fill until groundwater enters the drive rod; the water level inside the drive rod can be measured using a water level indicator.

The actual sample collection time at each depth depends upon the physical properties of the target zone and the fluid pressure outside the probe. Once the sample reservoir is filled, the HydroPunch is returned to the surface. Although the sample reservoir is sealed at both ends by internal one way check valves, care must be taken to avoid cross-communication with transmissive units or borehole fluids at a higher potentiometric head than the target zone. Before retrieving the tool, deionized water should be added to the drive rod to a level that exceeds the highest potentiometric surface in the borehole.

HydroPunch II can be used below the water table, in a manner similar to HydroPunch I, or it can used at the water table in the "hydrocarbon mode." If HydroPunch II is used in the "hydrocarbon mode," the sample is collected by lowering a narrow diameter bailer through the drive rod (minimum 1- inch diameter) and bailing out the volume of water required for analysis. The screen and drive point are left in the hole as the HydroPunch II tool is removed. When the sample is retrieved to the surface, it is decanted into laboratory prepared sample containers suitable for the analysis desired. The HydroPunch is then disassembled for decontamination and preparation for subsequent sampling depths. The HydroPunch I can be continued in the same borehole to the next desired depth.

4.2 EnviroProbe

Groundwater samples are collected by lowering the appropriate groundwater monitoring system (GMS) tool down the drive rod (i.e., drill rod). The GMS tools consist of a pore pressure transducer unit (i.e., an in-situ pressure transducer with a cable of appropriate length and an electronic data logger or other type of read out unit) and a GMS groundwater sample collection kit. The GMS groundwater sample collection kit consists of sample vials, ranging in size from 35 to 1,000 milliliters (ml), and a sample vial housing assembly. The sample vial(s) are sealed with a flexible viton rubber septum and cap similar to the upper end of the probe.

Prior to collecting a groundwater sample, the pore pressure unit is connected in series with the sample vial housing via an arrangement of double-ended hypodermic needles. After the housing and pore pressure unit have been connected, the sample vial is evacuated with a hand vacuum pump. Sampling and pore pressure measurements are obtained by lowering the pressure transducer unit and housing assembly down the drive rod. The tools connect the EnviroProbe via a quick coupling system through the hypodermic needles, which provide a temporary, closed system, hydraulic connection. Groundwater samples are obtained directly from the EnviroProbe and into the pre-evacuated sample vials. The pressure transducer is used to monitor filling of the sample vial and to measure hydrostatic pressure of the formation after the sample vial has filled.

If needed, the pore pressure unit or the GMS groundwater sampling unit can be used independently. The time allowed to fill the vial depends on the physical properties of the target formation and the groundwater pressure at the depth of the probe.

After the sample vial has filled, the sample housing is withdrawn from the drive rods and the sample vial removed. The EnviroProbe is generally purged by removing one probe volume (approximately 15 ml) of groundwater prior to collecting a sample for preservation and transport to the laboratory. At locations where multiple sample containers must be filled, the probe can be sampled repeatedly at the same depth by repeating the sample collection procedures.

4.3 Hydropunch and EnviroProbe Constraints

The EnviroProbe require drive rods of a minimum 1-inch inside diameter. HydroPunch I and Hydropunch II ("in the groundwater mode") require drive rods of sufficient diameter to allow passage of the water level indicator, generally about ½ inch. HydroPunch II in the "hydrocarbon mode" (water table sampling) requires drive rods of a minimum of 1-1/8-inch diameter to allow passage of the 1-inch-outside-diameter bailer. As stated earlier, HydroPunch I (and HydroPunch II in the "groundwater mode") cannot be used at sampling depths less than 5 feet below the water table. HydroPunch I, when full, has a capacity of 500 ml; HydroPunch II, when full, has a capacity of 1250ml. The EnviroProbe system and HydroPunch II in the "hydrocarbon mode" allow for collection of unlimited sample volumes. The HydroPunch I can be assembled to allow samples to be bailed in a manner similar to hydrocarbon mode so that unlimited sample volume is available.

4.4 Temporary Well Point Sampling

After allowing sufficient water from the formation to enter the temporary well (typical times range from 15 minutes to 1 hour), a groundwater sample is collected by carefully and slowly lowering a new polyethylene bailer into the temporary well. After removal from the boring, fluid in the bailer will be carefully transferred to the appropriate sampling container. Samples obtained for volatile organic compound (VOC) analysis will be collected to minimize the potential for volatilization (e.g., slowly and carefully lowering the bailer into the temporary well and carefully transferring the water into VOC vials). Unless otherwise specified, for obtaining samples for analysis other than VOCs, or dissolved gases, a peristaltic pump may also be used for shallow groundwater sample collection. Once the groundwater sample has been collected, the temporary well is removed from the borehole.

Depending on field conditions, temporary well point purging may be conducted. If temporary well purging takes place, then 1 to 3 casing volume may be purged depending on the depth of the well, the depth to water, and the production of the temporary well point. Low-flow sampling techniques may be employed in temporary well points if deemed appropriate by the Task Leader. If so, see the FGD entitled, Low-Flow Groundwater Sampling.

4.5 Field Filtration

Field filtering of groundwater may be necessary for some analyses, such as dissolved metals. However, field filtering can negatively affect other analyses, therefore, it is critical to confirm with the Task Leader or project-specific document which samples and analyses require field filtration prior to sampling.

Typically, a high-capacity polyethersulfone filter with a pore size of 0.45 microns is used to field filter groundwater samples (e.g. Quickfilter® Model No. QF045). Filters of this type have a capacity of 100-500 milliliters per minute (ml/min) and can be used with a pump via clean flexible tubing or a bailer using an included bailer interface tube. The filter cartridge must be certified to exhibit non-detectable levels of the compounds for which the sampling and analysis is intended to investigate.

- Regulate flow of groundwater to between 100 and 500 ml/min.
- Remove unused filter cartridge from the factory packaging and connect to tubing orienting the filter such that the flow of water follows the arrow on the filter cartridge.
- Filter approximately 100 ml groundwater through filter and discard to purge water container.
- Filter into clean sample containers and preserve immediately according to analytical method requirements.

Groundwater filter cartridges are dedicated sampling equipment. A new cartridge should be used at each sampling location. Do not attempt to clean filter cartridges. If the filter becomes clogged or groundwater flow is too slowed, remove and replace with a new filter cartridge.

4.6 Equipment Decontamination

The EnviroProbe and HydroPunch are cleaned by complete disassembly, including o-rings and/or check valves, followed by a laboratory-grade detergent and potable water wash, followed by a deionized water rinse. All decontamination rinsate will be collected and stored properly for future off-site disposal. The condition of o-rings should be checked during each cleaning and replaced as necessary. The tool will be reassembled after cleaning, following the instructions provided in the appropriate sampling kits.

In case of a temporary well point, once the PVC is removed from the hole, it will be discarded and new dedicated PVC will be used on the next borehole. When collected a sample directly from drilling augers or drive rods, decontamination follows the same procedures as described in the FGD entitled Drilling and Destruction of Soil Borings.

4.7 Quality Control Samples

All field Quality Control (QC) samples must be prepared the same as primary samples with regard to sample volume, containers, and preservation. The sample handling and chain-of-custody procedures for the QC samples will be identical to the primary samples. The following are QC samples that may be collected during groundwater sampling:

- A field duplicate is an independent sample collected as close as possible to the same time that the primary sample is collected and from the same source. Field duplicates are used to document sample precision. Field duplicates will be labeled and packaged in the same manner as primary samples so that the laboratory cannot distinguish between the primary sample and the duplicate sample. Field duplicates are analyzed for the same suite of parameters as the primary samples. The frequency of analysis of field duplicates is generally one for every 20 primary samples, but may vary depending on project requirements.
- Equipment blanks are obtained by running distilled or deionized water over or through the sample collection equipment after it has been decontaminated, and capturing the water in the appropriate sample containers for analysis. Equipment blanks are analyzed for the same suite of parameters as the primary samples. The frequency of analysis of equipment blanks is generally one for every day that non-dedicated sampling equipment is used, but may vary depending on project requirements.
- Field blanks are used to assess the presence of contaminants arising from field sampling procedures. Field blank samples are obtained by filling a clean sampling container with reagent-grade deionized water. Field blanks are analyzed for the same suite of parameters as the primary samples. Field blanks may or may not be incorporated into a groundwater sampling plan depending on project requirements.
- Trip blanks are sample containers that are used to evaluate sample cross-contamination of VOCs during shipment. For groundwater sampling, trip blanks consist of hydrochloric acid-preserved, analyte-free, deionized water prepared by the laboratory in VOA vials that will be carried to the field, stored with the samples, and returned to the laboratory for VOC analysis. Generally, one trip blank is required to accompany each sample shipping container or cooler that contains samples for VOC analysis; however, this may vary depending on project requirements.

4.8 Sample Handling and Custody

Samples 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.

4.8.1 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.

4.8.2 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.

4.8.3 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.

4.8.4 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.

4.8.5 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.

5.0 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. 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).

The laboratory must be certified by the appropriate regulating agency for the analyses to be performed. If required, permits will be acquired from the appropriate agency, and an underground utility check will be performed before drilling or excavating begins. An underground utility check will, at a minimum, consist of contacting the local utility alert service, e.g., Underground Service Alert (USA), if available. Typically, subsurface clearance should also be conducted by a private utility locating company contacted specifically to clear individual boring locations. Under certain circumstances, including at sites with deeply buried, unknown, or multiple underground utilities, as well as at high risk sites such as oil refineries and heavy industrial facilities, manual utility clearance using hand auger or air knife methods should also be performed.

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 Health and Safety Plan must be prepared and approved by the Project Manager, Task Leader and Project Health and Safety Coordinator prior to initiating field work.

6.0 RECORDKEEPING

Information collected during groundwater sampling 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 Leader, 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*
- *Field Soil Boring Log*
- *Water Level Measurement Log*
- *Water Purging and Sampling 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 the drillers and any other subcontractors 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 Leader, 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 *Field Soil Boring Log* will be used to record information relating to the installation of soil borings for grab groundwater sampling including rig type, location, depths, and sampling methods.

The *Water Level Measurement Log* will be used to record water level measurements taken prior to and after groundwater sampling. The type, serial number, and calibration date for the water level measuring device will be included on this form.

The *Water Purging and Sampling Log* will be used to record the details of grab groundwater sampling information for each location including the sampling methods used at each location. This form will also be used to record all of the measurements of drawdown (if applicable) and water quality parameters.

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 water samples collected from the monitoring wells will be recorded on the *Field Investigation Daily Log, Field Soil Boring Log, Low-Flow Purging and Sampling Log,* a site map, and/or other appropriate forms.

Samples 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.

FIELD GUIDANCE DOCUMENT NO. 006
LOW-FLOW GROUNDWATER SAMPLING

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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 ……………	United States Environmental Protection Agency (USEPA) *Standard Operating Procedure for Low-Stress (Low Flow)/Minimal Drawdown Ground-Water Sample Collection*, dated 2002.

Table of Contents

1.0 INTRODUCTION

This Field Guidance Document (FGD) describes procedures for low-flow groundwater sampling 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 low-flow groundwater sampling 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 perform this work in a safe and competent manner, ENVIRON personnel involved in field activities should be sure that they are trained in those field activities they are tasked with, and 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 have project personnel review and sign the applicable HASP, and maintain the completed HASP and relevant project information 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).

2.0 EQUIPMENT/MATERIALS

Equipment and materials needed to conform to this FGD include:

- Health and Safety Plan
- Site information (maps, contact numbers, etc.)
- Well information (previous water levels, well depths and screen intervals, previous purge logs, etc.)
- Electronic water level meter (Solinst or similar)
- Photoionization Detector (PID) and/or Flame ionization detector (FID)
- Adjustable-rate sampling bladder pump capable of rates <0.5 liters per minute (e.g., QED Sample Pro); other pumps may be acceptable, but must be approved by the Project Manager and/or Task Leader prior to use
- Bladders for sample pump

- Pump controller with or without on-board air compressor (If no on-board compressor, have a stand-alone air compressor and/or nitrogen tanks for operating bladder pumps
- Sample tubing (Teflon® or Teflon®-lined tubing for sampling organic compounds)
- Multi-parameter meter (e.g. YSI 556 Multi-Parameter Meter or equivalent) with flow through cell capable of measuring (at a minimum) temperature, pH, specific electrical conductance (SEC), dissolved oxygen (DO), and oxidation-reduction potential (ORP)
- Turbidity meter
- In-line filters (if required, e.g., for dissolved metals)
- Certified-clean sample containers and preservation supplies, sample labels, Ziploc™ bags
- Cooler with ice
- Decontamination supplies (e.g. phosphate-free detergent, distilled water)
- Tool kit with appropriate tools (socket wrench set, pry bar, Dolphin locks/keys)
- Drum(s) to collect purged water and decontamination water
- Drum labels
- PPE typically will consist of:
  - Long-sleeved shirt and long pants
  - Steel-toed boots
  - Hardhat
  - Nitrile gloves
  - Safety glasses with side shields
  - Other as required by the site-specific Health and Safety Plan
- Field Forms
  - *Field Investigation Daily Log*
  - *Water Level Measurement Log*
  - *Low-Flow Purging and Sampling Log*
  - *Equipment Calibration Log*
  - *Chain-of-Custody*

3.0 METHODOLOGY

This FGD has been prepared in accordance with the United States Environmental Protection Agency (USEPA) Standard Operating Procedure for Low-Stress (Low Flow)/Minimal Drawdown Ground-Water Sample Collection, dated 2002. This guidance document is included as Attachment 3 of the Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers.

Unlike traditional purging methods, low-flow purging and sampling does not require the removal of an arbitrary volume of water from a well prior to sampling. Instead, low-flow purging and sampling relies on careful monitoring of water quality indicator parameters to determine when a representative groundwater sample can be collected. The low-flow methodology minimizes the effects on groundwater chemistry caused by the purging process by minimizing drawdown, reducing the amount of water removed from the well, and reducing the amount of turbidity in groundwater samples.

4.0 PROCEDURES

The following sections discuss the procedures to follow during low-flow purging and sampling of shallow monitoring wells with dedicated or non-dedicated equipment since both are employed. Where applicable and when possible, the purging and sampling techniques should remain consistent from one sampling event to the next.

Non-dedicated pumps made of inert materials may be used (see Section 2). To prevent cross-contamination, at least two separate pumps must be maintained for use at the Site: one for on-site wells with higher contaminant concentrations, and one for off-site wells having lower contaminant concentrations. All non-dedicated pumps must be easily decontaminated in the field. Tubing must be changed between each well. The reuse of tubing dedicated to a single well is encouraged to reduce waste between sampling events.

4.1 Pre-Sampling Activities

To the extent practical, sampling should begin at the well with the least contamination and proceed systematically to the wells with the higher expected concentrations. All measuring devices and monitoring equipment should be calibrated according to the manufacturer's instructions. Water quality meters must be calibrated daily before use. Equipment calibration details should be recorded in the *Equipment Calibration Log*.

If opening a well cap for sampling, the headspace at the top of the wells will be monitored for VOCs with a PID or FID. If VOCs are present, monitor worker breathing zones during purging/sampling and record measurements on field logs.

The proper procedure is as follows:

1. Unlock well and/or remove well cap. Note that wells may be flush-mount or above-grade completions.
2. Monitor the headspace at the top of the well for VOCs.
3. Measure the water level to obtain the static water level (see Section 4.2). Water levels should be measured to the nearest 0.01 foot relative to the TOC.

4. Use existing site information for total depth (TD) and the water level measurement to calculate the volume of water in the well.

4.2 Water Level Measurement

Water levels will be recorded on a *Water Level Measurement Log* and/or a *Water Purging and Sampling Log*.

Water levels can be measured by several techniques, but the most common method is using an electronic water level meter (e.g., Solinst). Other methods used at the site may include remote data logging via pressure transducers or from a pressure gauge at the top of artesian wells. Refer to manufacture's manuals for specific protocols for collecting data from remote water level measuring devices. For artesian wells, readings of pressure in pounds per square inch (psi) are recorded from a pressure gauge at the wellhead.

Water level meters must be decontaminated before initial use and after measurements are made in each well.

The proper sequence for water level measurement is as follows:

1. Turn water level meter on and check that its indicator is working.
2. Record the following information on the *Water Level Measurement Log* or the *Water Purging and Sampling Log*:
    - Well number
    - Top of casing elevation
    - Surface elevation, if available.
3. Use caution when opening the well. If pressure has developed inside the well casing, allow the well to stand without a cap for a few minutes until the water level stabilizes before taking a water level measurement. Record observance of positive or negative pressures in the well.
4. Inspect well for abnormalities (e.g., broken locks, damaged casing, blockages, etc.) and note on field logs. If there is dedicated tubing inside the well, it may have to be removed prior to gauging the well to avoid blocking the water level meter.
5. Lower the water level meter cable slowly into the well until the buzzer indicates a closed circuit. Raise and lower the electric cable slightly until the maximum response on the indicator is found. Record the static water level to the nearest hundredth (0.01) foot from the surveyed reference mark on the top edge of the well casing (TOC). If no reference mark is present, record in the log book where the measurement was taken (e.g., from the north side of the inner casing).

6. Repeat the measurement as necessary to confirm the level by raising and lowering the probe until the maximum response is observed.

7. Record the time and day of the measurement.

8. Compare measurement against historical measurements to perform a “reality check” of the measurement and recheck water level as needed.

9. The probe (or portion of the instrument that was immersed in ground water) will be cleaned with a solution of laboratory-grade phosphate-free detergent (e.g., Alconox™) and deionized water. The equipment will then be rinsed with deionized water and dried with a clean paper towel. Steam-cleaning is also an acceptable method of decontaminating the probe.

Water level measurements at the site will be taken as quickly as practically possible, to best represent the potentiometric surface across the site at a single time. Care will be taken not to drop foreign objects into the wells and not to allow the monitoring and sampling equipment to touch the ground or any other contaminating surfaces.

4.3 Purging and Sampling

1. If using a dedicated pump, attach sample tubing to the wellhead according to manufacturer’s procedures.

2. If there is dedicated tubing in the well, but no dedicated pump, using appropriate PPE, pull the tubing and keep it from kinking or knotting by using a reel or by hand coiling it. Inspect the tubing for damage while removing it from the well and protect the tubing from touching the ground or other contaminated surfaces. If necessary to store the tubing, place in a clean plastic bag. If there is no tubing, or the dedicated tubing needs replacement, use only new tubing.

3. If using a non-dedicated pump, attach the tubing to the pump according to manufacturer’s procedures, place the pump and support equipment at the well head and slowly lower the pump and tubing down into the monitoring well until the location of the pump intake is set at a predetermined location within the screen interval. Where possible, pre-measured tubing should be used to place the pump intake at the same depth as previous sampling events, or at a depth where there is known contamination within the screen interval. If there is no previous information for the well, the pump intake should be placed at the middle (or slightly above the middle) of the screen interval. Record the pump depth in the *Low-Flow Purging and Sampling Log*.

4. Measure depth to water to the nearest 0.01 feet relative to the reference measuring point on the TOC with an electronic water level indicator. Record depth to groundwater information in the *Low-Flow Purging and Sampling Log*. Leave water level indicator in the well.

5. Connect the discharge line from the pump to a flow-through cell that at a minimum measures temperature, pH, SEC, DO, and ORP. Turbidity measurements can be made using a separate turbidity meter. The discharge line from the flow-through cell must be directed to a container to hold purge water collected during purging and sampling of the well. Purge water will be collected in a portable tank (e.g., trailer-mounted polyethylene tank) and discharged to the on-site groundwater treatment system at the end of the sampling or when tank is full.

6. Connect the air lines to the flow controller and start pumping the well at a flow rate of between 0.1 and 0.5 liters per minute (L/min) and slowly increase the flow rate. (For new wells or wells with no purging history, start at the lower end of that range.) Check the water level. Maintain a steady flow rate while maintaining a drawdown of less than 0.3 feet. (Zero drawdown is optimal, but may not be achievable). If drawdown is greater than 0.3 feet, lower the flow rate; 0.3 feet is a goal to help guide with the flow rate adjustment. This goal will be difficult to achieve in some wells due to low hydraulic conductivities and limitations to the lowest flow rate a pump can produce while maintaining steady flow. See the Special Advisory at the end of these procedures.

7. Measure the discharge rate of the pump with a graduated cylinder and a stopwatch. Also, measure the water level and record both flow rate and water level on the *Low-Flow Purging and Sampling Log*. Continue purging, monitor and record water level and pump rate every 3 to 5 minutes. Purging rates should be kept at minimal flow to ensure minimal drawdown in the monitoring well.

8. A minimum of one tubing volume (including the volume of the water in the pump and flow cell) must be purged prior to recording the water quality indicator parameters. After this has been accomplished, monitor and record the water quality indicator parameters every three to five minutes in the *Low-Flow Purging and Sampling Log*. Stable readings of temperature, pH, SEC, DO, turbidity and ORP indicate when a representative sample can be collected. The stabilization criterion is based on three successive readings of the water quality indicator parameters as shown in Table 1. ORP may not always be an appropriate stabilization parameter and will depend on site-specific conditions. However, readings should be recorded because of its value for double-checking oxidizing conditions.

TABLE 1: Recommended Stabilization Criteria for Water Quality Indicator Parameters During Low-Flow Purging and Sampling

Parameter	Stabilization Criteria
Temperature	± 3% of reading (minimum of ±0.2° C)
pH	± 0.1 pH units
Specific Electrical Conductance (SEC)	± 3% S/cm
Dissolved Oxygen (DO)	± 0.3 milligrams per liter
Turbidity	± 10% NTUs (when turbidity is greater than 10 NTUs)
Oxidation-Reduction Potential (ORP)	± 10 millivolts

9. Once stabilization is achieved samples can be collected. Maintain the same pumping rate or reduce slightly for sampling as necessary in order to minimize disturbance of the water column. Disconnect the pump's tubing from the flow-through cell so that the samples are collected from the pump's discharge tubing. For samples collected for dissolved gases or VOC analyses, the pump tubing needs to be completely full of ground water to prevent the ground water from being aerated as it flows through the tubing. Generally, the sequence of the samples is immaterial unless filtered (dissolved) samples are collected. Filtered samples must be collected last (see below). All sample containers should be filled with minimal turbulence by allowing the ground water to flow from the tubing gently down the inside of the container. When filling VOC samples using volatile organic analysis (VOA) vials, a meniscus must be formed over the mouth of the VOA vial to eliminate the formation of air bubbles and head space prior to capping. Effervescence and colorimetric reactions should be recorded in the *Low-Flow Purging and Sampling Log.*

10. If a filtered (dissolved) metal sample is to be collected (or filtered samples for any other analyte are required), then an inline filter is fitted at the end of the discharge tubing and the sample is collected after the filter. The inline filter must first be flushed in accordance with manufacturer's recommendations and if there are no recommendations for flushing, a minimum of 0.5 to 1.0 liter of groundwater from the monitoring well must pass through the filter prior to sampling. (Note: Groundwater filter cartridges are dedicated sampling equipment. A new cartridge should be used at each sampling location. Do not attempt to clean filter cartridges. If the filter becomes clogged or groundwater flow is too slowed, remove and replace with a new filter cartridge.)

11. For non-dedicated systems, remove the pump from the monitoring well. Decontaminate the pump and hang the tubing within the well for the next sampling event. If tubing is damaged or otherwise needs replacing, remove and dispose of the tubing. For dedicated systems, disconnect the tubing that extends from the plate at the wellhead (or cap) and discard after use.
12. Close and lock the well.

Special Advisory: If a stabilized drawdown in the well can't be maintained at 0.3 feet and the water level is approaching the top of the screened interval, reduce the flow rate or turn the pump off (for 15 minutes) and allow for recovery. It should be noted whether or not the pump has a check valve. A check valve is required if the pump is to be shut off during purging. Under no circumstances should the well be pumped dry. Begin pumping at a lower flow rate, if the water draws down to the top of the screened interval again, turn pump off and allow for recovery. If two tubing volumes (including the volume of water in the pump and flow cell) have been removed during purging, then sampling can proceed next time the pump is turned on. This information should be noted in the *Low-Flow Purging and Sampling Log.* This behavior may necessitate an alternative purging and sampling procedure for subsequent sampling events.

4.4 Equipment Decontamination

The electronic water level meter and the water quality meters will be decontaminated by the following procedures:

1. The water level meter will be hand washed with phosphate-free detergent (e.g., Alconox™) and a scrubber, then triple rinsed with distilled water, or steam-cleaned.
2. The water quality meters and flow-through cell (if used) 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 the sampling event, the flow-through cell and sensors must be cleaned and maintained per the manufacturer's requirements.

Sample tubing will either be replaced or be dedicated to an individual well. Non-dedicated pumps will be decontaminated between monitoring wells and prior to moving off-site. The pump and discharge line (including support cable and electrical wires which were in contact with the groundwater in the well casing) must be decontaminated by the following procedure:

1. The outside of the pump, support cable, and electrical wires must be pressure-sprayed with soapy water, tap water and distilled water. Use bristle brush to help remove visible dirt and contaminants.
2. Place the sampling pump and discharge line in a bucket or in a short cylinder (e.g., a 4-inch diameter casing) with one end capped. The pump must be completely submerged in the water.

A small amount of phosphate-free detergent (e.g., Alconox™) must be added with the potable (tap) water.

3. Remove the pump from the bucket or 4-inch casing and scrub the outside of the pump housing and cable.
4. Place pump and discharge line back in the container, start pump and re-circulate soapy water for approximately 2 minutes. Add 5 gallons of potable (tap) water as needed.
5. Turn pump off and place pump into a second bucket of potable (tap) water. Turn on pump and allow to run until rinsed free of soapy water, adding tap water as necessary.
6. Turn off and place pump into a third bucket which contains 3 to 5 gallons of distilled/deionized water. Turn on pump and cycle water through until gone.
7. If hydrophobic contaminants are present (such as separate phase (i.e. LNAPL or DNAPL, high levels of PCBs, etc.) an additional decontamination step, or steps, may be required.
8. Decontamination water will be collected in a portable tank (e.g., trailer-mounted polyethylene tank) and discharged to the on-site groundwater treatment system.

Other decontamination procedures may be proposed, but must be reviewed and approved by the Trust prior to implementation.

4.5 Quality Control Procedures

All field Quality Control (QC) samples must be prepared the same as primary samples with regard to sample volume, containers, and preservation. The sample handling and chain-of-custody procedures for the QC samples will be identical to the primary samples. The following are QC samples that may be collected during groundwater sampling:

- A field duplicate is an independent sample collected as close as possible to the same time that the primary sample is collected and from the same source. Field duplicates are used to document sample precision. Field duplicates will be labeled and packaged in the same manner as primary samples so that the laboratory cannot distinguish between the primary sample and the duplicate sample. Field duplicates are analyzed for the same suite of parameters as the primary samples. The frequency of analysis of field duplicates is generally one for every 20 primary samples, but may vary depending on project requirements.
- Equipment blanks are obtained by running distilled or deionized water over or through the sample collection equipment after it has been decontaminated, and capturing the water in the appropriate sample containers for analysis. Equipment blanks are analyzed for the same suite of parameters as the primary samples. The frequency of analysis of equipment blanks is

generally one for every day that non-dedicated sampling equipment is used, but may vary depending on project requirements.

- Field blanks are used to assess the presence of contaminants arising from field sampling procedures. Field blank samples are obtained by filling a clean sampling container with reagent-grade deionized water. Field blanks are analyzed for the same suite of parameters as the primary samples. Field blanks may or may not be incorporated into a groundwater sampling plan depending on project requirements.
- Trip blanks are sample containers that are used to evaluate sample cross-contamination of VOCs during shipment. For groundwater sampling, trip blanks consist of hydrochloric acid-preserved, analyte-free, deionized water prepared by the laboratory in VOA vials that will be carried to the field, stored with the samples, and returned to the laboratory for VOC analysis. Generally, one trip blank is required to accompany each sample shipping container or cooler that contains samples for VOC analysis; however, this may vary depending on project requirements.

4.6 Sample Handling and Custody

Samples 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.

4.6.1 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.

4.6.2 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.

4.6.3 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.

4.6.4 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.

4.6.5 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

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- *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 the drillers and any other subcontractors 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 Leader, 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 *Water Level Measurement Log* will be used to record water level measurements for all wells. The type, serial number, and calibration date for the water level measuring device will be included on this form. Additionally, this form will be used to record general observations of the conditions of the wells, wellheads, well boxes, and/or monuments.

The *Low-Flow Purging and Sampling Log* will be used to record the details of purging and sampling information for each well including the depth of the pump, purge rates, and volume purged from each well. This form will also be used to record all of the measurements of drawdown and water quality indicator parameters used for evaluating stabilization.

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.

Samples 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.

FIELD GUIDANCE DOCUMENT NO. 007
GROUNDWATER WELL INSTALLATION

Prepared by ………………………..	Elysha Anderson, PE
Peer Reviewed by ………………	Dan Clark Ross Russell, PG
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 ……………..	United States Environmental Protection Agency (USEPA) *Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells*, dated 1991 USEPA Office of Solid Waste *RCRA Ground Water Monitoring: Draft Technical Guidance*, dated November 1992. F.G. Driscoll, *Groundwater and Wells*, Second Edition, published in 1986 by Johnson Filtration Systems, Inc., St Paul Minnesota *Water Well Standards: State of California,* December 1981, Department of Water Resources (DWR) Bulletin 74-81, the supplement California Well Standards, June 1991, DWR, DWR Bulletin 74-90.

Table of Contents

1.0 INTRODUCTION

This Field Guidance Document (FGD) describes procedures for groundwater well installation 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 groundwater well installation 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 well installation is performed in a safe and competent manner, 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.

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).

The drilling contractor shall be a licensed water well driller, in accordance with local and state requirements, and a qualified drilling contractor for the installation of groundwater monitoring wells for environmental purposes.

Before drilling begins, groundwater monitoring well permits must be obtained from the appropriate agency as necessary. Prior to the start of drilling, an underground utility check will be performed before drilling begins. An underground utility check will, at a minimum, consist of contacting the local utility alert service, e.g., Underground Service Alert (USA), if available. Typically, subsurface clearance should also be conducted by a private utility locating company contacted specifically to clear individual boring locations. Under certain circumstances, including at sites with deeply buried, unknown, or multiple underground utilities, as well as at high risk sites such as oil refineries and other heavy industrial facilities, manual utility clearance using hand auger or air knife methods should also be performed.

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.

2.0 EQUIPMENT/MATERIALS

Many materials are required for successfully completing the installation of groundwater wells. The drilling contractor often supplies much of the equipment and materials. However, the Field Geologist/Engineer should be aware of what is required to conduct the work so they have their own supplies and can provide technical expertise and competent oversight. Equipment and materials needed to conform to this FGD include:

- Health and Safety Plan
- Site information (maps, contact numbers, previous field logs, etc.)
- Well construction specifications and diagrams
- Drilling rig and associated equipment (supplied by drilling contractor)
- Monitoring well construction equipment (supplied by drilling contractor)
- Weighted, calibrated measuring tape (often provided by drilling contractor)
- Calibrated measuring tape to measure well construction materials
- Electronic water level indicator (Solinst or similar)
- Water-quality monitoring meter to measure pH, temperature, specific electrical conductance (SEC), and turbidity.
- Sample containers, preservation supplies, sample labels, Ziploc™ bags (if samples are specified)
- Cooler with ice (if samples are specified)
- Decontamination supplies (e.g. phosphate-free detergent [Alconox or similar])
- Drum(s) or roll-off bin(s)to collect soil cuttings and decontamination water (usually supplied by drilling contractor)
- Drum/bin labels
- Personal Protective Equipment (PPE), typically PPE will consist of:
  - Long-sleeved shirt and long pants
  - Steel-toed boots
  - Hardhat
  - Nitrile gloves
  - Safety glasses with side shields
  - Hearing protection
  - Other protective equipment as required by Health and Safety Plan
- Field Forms (if required, a project-specific Field Logbook may substitute for any of the following)
  - *Field Investigation Daily Log*
  - *Field Soil Boring Log*
  - *Field Well Completion Log*
  - *Equipment Calibration Log*

3.0 PROCEDURES

Construction of all monitoring wells will be in conformance with the provisions outlined in the following sections. After well installation, well completion report(s) will be completed and filed with the State Department of Water Resources and/or other appropriate agency.

Specific monitoring well design and installation procedures depend on project-specific objectives and subsurface conditions. When planning a well installation, the following particulars will need to be determined prior to mobilization:

- Borehole drilling method;
- Construction materials;
- Well depth;
- Screen length;
- Well construction materials;
- Location, thickness, and composition of annular seals; and
- Well completion and protection requirements.

All drill cuttings and fluids generated during well installation will be containerized pending analytical results and determination of disposal options as outlined in the FGD entitled, *Managing Investigation-Derived Waste* unless project-specific requirements specify otherwise. Waste containment and disposal will occur in a manner that will not result in contamination of the immediate area or result in a hazard to individuals who may come in contact with these materials.

3.1 Drilling

Several drilling methods are available for use in creating a borehole for groundwater well installation. These methods include hollow stem auger, rotosonic, air-rotary and air-rotary casing hammer (ARCH), mud-rotary, and cable tool, among others. The drilling method selected will be based on the physical properties of the subsurface materials and understandings of the advantages and limitations of each of the drilling methods considered. For procedures during drilling see the FGD entitled, *Drilling and Destruction of Soil Borings.*

In general, the borehole diameter must be a minimum of four (4) inches greater than the outside diameter of the well screen or riser pipe used to construct the well. This is necessary so that sufficient annular space is available to install filter packs and grout seals. For wells to be screened in deeper water-bearing zones, it is important to isolate shallower water-bearing zones. Using rotary sonic drilling, this isolation of shallower zones is accomplished by the outer drill casing. If other methods are to be used for groundwater monitoring well installation in deeper water bearing zones, a conductor casing will first be installed through the shallower water-bearing zone(s) and cemented into place in order to seal off the shallow water-bearing zone and prevent cross-contamination between shallower and deeper water-bearing zones. The installation of conductor casing requires a wider diameter drill tooling to be used for the portion of the borehole that is to be lined with conductor casing. After the installation of the conductor casing, a narrower diameter drill tooling is used to advance the well borehole through the conductor casing to the intended total depth of the well.

3.2 Borehole Logging and Sampling

Boreholes will be logged using cuttings and samples collected during drilling activities. Soil or rock samples will be logged and collected as described in the FGD entitled *Soil Sampling for Chemical Analysis and Physical Testing.*

Cuttings and soil and rock samples will be described at the frequency presented in the FSP. After drilling has been completed, the Field Geologist/Engineer will measure the total open depth of the borehole with a weighted, calibrated tape measure and document the depth. The Field Geologist/Engineer will then collaborate with the Task Leader or other designated professional by reviewing observed lithologic units, water levels, and other logged information to finalize the well construction details.

Boreholes/well locations should be clearly designated in the *Field Soil Boring Log* or Field Logbook using notes and a hand sketched layout to include the following information:

- Measurements of each boring/sample point relative to fixed objects (building, structures, etc);
- Boring/sample location with their identification number noted;
- North arrow or other compass directional indicator; and
- Other essential site features and/or investigation features (underground storage tanks, piping, above ground tanks, etc.).

3.3 Backfilling

If backfilling the borehole to the appropriate well installation depth is necessary, neat cement, bentonite grout, bentonite pellets or filter pack sand may be used. The backfill material selected for use will depend on site conditions, and lithology. Most often the borehole requires the complete sealing of lower layers, so neat cement, bentonite grout, or bentonite pellets are used. Adequate time should be given for the bottom seal to set prior to beginning well construction. The Field Geologist/Engineer should re-measure and verify that the bottom of the bore hole is exactly where it should be set before proceeding with well construction.

If neat cement or bentonite grout is used, a tremie pipe will be required to place the grout in the bottom of the hole. Grouting the borehole may be difficult to accomplish, if the portion of the borehole to be grouted is significantly lower than the groundwater level. Provisions will be necessary to support the screen and riser pipe to prevent them from sinking into the grout. Care will be taken to frequently measure the total borehole depth when adding grout to the bottom of the hole. Grout should have thickened to a hardened state before proceeding. The thickness of the grout will be calculated based on depth readings and recorded. If a well has been backfilled too much it may require reaming to clear out the overfilled material.

Depending upon the lithology some distance should be planned between the bottom seal (backfill) in a borehole and the bottom of the screened interval. Unless this distance would result in a breach confining layer, or the well screen requires setting directly on the impermeable zone due to observed site conditions, the bottom of the well screen should be set at a maximum of six (6) inches above the top of any backfill. The distance between the top of backfill and the bottom of the well screen should be filled with a fine sand buffer or sand pack.

Bentonite pellets should be carefully placed into the borehole to minimize the risk of pellets sticking to the side of the borehole when dropped through a water column.

3.4 Well Screen and Casing

Wells will consist of factory-sealed commercially available well screen and casing. Well screens and casing will typically be constructed of polyvinyl chloride (PVC), a type of plastic, but may also be constructed of stainless steel depending on subsurface conditions, expected contaminants and concentrations, or other site-specific factors. Regardless of material of construction, casing and screen shall meet applicable standards for use in groundwater monitoring wells.

Well screens shall be constructed of non-corrosive and non-reactive material for the chemicals to be encountered. Well screens shall be permanently joined to the well casing and shall be centered in the borehole. Casing will be connected by flush-threaded or coupled joints and will be completed with a bottom cap. A collection sump may be installed below the screen and will vary in length depending on lithology and project needs. The collection sump and bottom cap will be connected to the well screen by flush threaded or coupled joints. Plastic casing must have threaded joints and o-ring seals. Solvent, glue, or anti-seize compounds will not be used on the joints. With deep wells (greater than approximately 100 feet below grade), centralizers should be used to keep the well casing plumb and straight in the borehole. Centralizers should be placed at the approximate top and bottom of the screened interval and 40 foot intervals throughout the blank casing interval.

For water table wells, well screens should be placed such that some of the screened interval is above the water table, and some section is below the water table. This allows for seasonal fluctuations. The amount of split should be determined by the Task Leader and be based upon local conditions.

Casing and screen must be clean, free of rust, grease, oil or contaminants and be composed of materials that will not affect the quality of the water sample. All casing shall be watertight. The casing shall be centered in the borehole, be free of any obstructions and allow sampling devices to be lowered into the well. The well string shall be hung in the borehole during installation so that the well is sufficiently plumbed and straight after completion.

Well construction details (anticipated screen interval, casing diameter, screen slot size, etc.) will be provided by the Task Leader or in project-specific documents. Modification can be made in the field, but will be done in consultation with the Task Leader, or their designee.

3.5 Setting Screens and Riser Casing

Upon completion of drilling, the boring will be sounded to verify the total depth, and the well casing will be assembled and lowered into the boring.

Well casing materials will be measured to the nearest 0.1 foot and steam-cleaned before being lowered into the borehole. Steam cleaning is not necessary if well materials are in factory-sealed packaging prior to well assembly. The well assembly will be designed so that the well screen is placed within the formation target zone, such that the top of the screen is as high or higher than the highest estimated groundwater elevation, depending on project requirements. No PVC cement or other solvents will be used to fasten the well casing joints, well screen joints, or end caps.

The well casing will be allowed to hang by a wireline in the borehole prior to sand pack placement so that the well can be situated at the desired depth interval. As described above, for monitoring wells greater than approximately 100 feet in depth, centralizers should be used to stabilize the casing in the center of the borehole. Once the well has been situated at the desired depth, sand pack will be emplaced in a calculated quantity sufficient to fill the annular space from the bottom of the boring to the level above the top of the well screen as specified Table 4 of the FSP. Significant differences from the calculated sand pack volume should be noted and investigated. For example, a volume less than the calculated volume may indicate bridging and a volume greater than calculated may indicate large void spaces within the borehole. The depth to the top of the sand pack will be verified by measuring, using a tremie pipe or a weighted tape. Prior to final placement of the sand pack, a surge block will be repeatedly lowered and raised through the water column to promote sand pack material settlement firmly around the screen interval of the well. Following surging, additional sand will be added as required to bring the top of the sand surface to the level above the top of the well screen as specified in the FSP.

Once the depth to the top of the sand pack material has been verified, bentonite chips will be placed in the annular space above the sand pack as a transition seal between the filter material and the grout. A sufficient quantity of bentonite chips will be placed to fill the annular space to the level above the top of the filter pack as specified in the FSP. Bentonite chips will be placed in approximately 6-inch lifts. The completed bentonite transition seal will be allowed to hydrate for at least 30 minutes prior to placing the grout. The depth to the top of the transition seal will be verified by measuring, using the tremie pipe or a weighted tape. No work will be done on the monitoring well until after the grout has set at least 48 hours.

3.6 Sand Pack Material

Monitoring wells installed in unconsolidated material will be constructed with sand packs. When used, the sand pack will be the only material in contact with the well screen. The filter pack will consist of either a No. 2/12 or No. 3 sand. The sand used for sand pack material shall be sized to match the screen slot size and the surrounding lithology to prevent subsurface materials from penetrating through the sand or filter pack, and preventing the sand or filter pack from entering the well. The sand pack will extend approximately six (6) inches below the bottom of the screen to two (2) feet above the top of screen. The sand pack material may be placed in the well by pouring the sand into the open borehole, or tremied into place depending upon field conditions. However, in all cases, filter pack material should be added carefully with continuous measurements by the Field Geologist/Engineer to prevent bridging of the sand pack material.

The well will be gently bailed and surged with a bailer and surge block after the filter pack has been added to the borehole and before the seal is placed in the annular space. A surge block consists of a rubber or leather and metal plunger attached to a rod or pipe of sufficient length to reach the bottom of the screen. Surging should be maintained for at least five minutes and the entire length of saturated screen will be surged to help settle the sand pack. The top of the sand pack will need to be measured after surging and additional sand pack material may need to be added if settling has occurred.

Sometimes observed field conditions may require transition sand be emplaced above the main sand pack. This transition sand is usually much smaller grain size than the sand pack, and is emplaced to provide added protection that grout invasion into the sand pack will not occur when deep wells are installed. An alternative to transition sands is to use additional well seal material such as bentonite pellets.

3.7 Well Seal

Wells will have an annular space seal that extends from the top of the sand pack to the surface. The annular sealing material above the sand pack will prevent the migration of fluids into the water bearing zone from the surface and from other water-bearing zones. Sealing material will be chemically compatible with anticipated contaminants. Hydrated bentonite chips will be used as an annular seal directly above the filter pack. The annular seal should be a minimum of 2 feet thick unless observed field conditions dictate otherwise. For example, as mentioned above, deep wells may require additional sealant material between the sand pack and cement grout annular fill above to prevent grout invasion into the sand pack interval. Neat cement grout will be used as annular fill above the seal to within 2 feet of the surface. Grouting emplacement will occur using a tremie pipe so that the grout fills the annular space from the bottom to the surface without allowing air pockets to form. Only potable water will be used to prepare the grout. No work will be done on the monitoring well until after the grout has set at least 48 hours.

3.8 Surface Completion

In non-vehicle areas, an aboveground completion consisting of a tamper-resistant steel surface casing (extending to an approximately depth of five feet depth) and concrete apron will be installed with the top elevation of the casing at approximately three to four feet above surrounding grade, and the concrete apron slightly above the surrounding grade.

In addition, a "weep" hole should be drilled in the bottom of the steel surface casing. In areas where freezing may occur, placement of the weep hole is critical; little volume should exist in the steel surface casing above the weep hole where water could accumulate and freeze thereby damaging the well. A "V" notch or other permanent mark will be placed at the north edge of the top of the well casing that will be used as the reference point for well elevation surveying and water level monitoring.

In vehicle areas such as roadways or parking lots, a flush-mounted completion consisting of a tamper-resistant, traffic-rated vault box will be installed with an elevation about ½ inch above surrounding grade, and vault boxes will be clearly marked as "Monitoring Well". The well casing should extend approximately 3 inches above the sealant in the bottom of the well box. The surface completion should provide positive drainage away from the well box to prevent ponding around the well. In traffic areas and sidewalks, this positive drainage slope away from the box should be minimized to prevent physical hazards. As discussed above a reference mark should be placed on the top of the well casing for well elevation surveying and water level monitoring. All wells will be capped with a water-tight locking cap.

3.9 Surveying

Well locations and elevations will be surveyed by a licensed surveyor in Nevada and tied to an established state or county benchmark, site conditions permitting. Horizontal coordinates be surveyed to a horizontal accuracy of at least 0.1 foot and referenced to the Nevada Coordinate System of 1983 (NAD83). The vertical elevations survey will be accurate to 0.01 foot relative to mean sea level datum (NAVD88). The top of casing, top of rim, and ground surface elevation near the well will be surveyed for vertical control. The "V" notch cut on the north side of each well casing will be used as the surveyor's reference mark.

3.10 Equipment Decontamination

Cleaning of the drill rig and associated drilling equipment will follow the procedures discussed in the FGD entitled, *Drilling and Destruction of Soil Borings*.

All well casing materials will be cleaned before they are installed. Well development equipment will also be cleaned before use. The following cleaning procedure has been found to be effective and will be used or adapted as appropriate for general conditions of materials or equipment to be cleaned. This procedure may be modified based on project requirements.

- Steam-rinse with potable water or rinse in deionized or organic-free water.

- Cover with clean plastic to protect materials and equipment from contact with chemical products, dust, or other contaminants.

Alternatively, well casing materials that have been steam-cleaned and sealed in individual airtight plastic bags by the factory can be used.

Decontamination rinsate will be collected and stored properly in labeled containers for future disposal by the client, unless other arrangements have been made. Drums or other containers must be constructed of materials that are compatible with any contaminants that may be potentially present in the rinsate.

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. 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). The drilling contractor shall be a licensed driller in accordance with local and state requirements, and a qualified drilling contractor for the installation of soil borings for environmental investigations.

Where required, permits will be obtained from the appropriate agency, and an underground utility check will be performed before drilling or excavating begins. An underground utility check will, at a minimum, consist of contacting the local utility alert service, e.g., Underground Service Alert (USA), if available. Typically, subsurface clearance should also be conducted by a private utility locating company contacted specifically to clear individual boring locations. Under certain circumstances, including at sites with deeply buried, unknown, or multiple underground utilities, as well as at high risk sites such as oil refineries and heavy industrial facilities, manual utility clearance using hand auger or air knife methods should also be performed. Additional subsurface clearing requirements may be described in the site-specific Health and Safety Plan.

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 Health and Safety Plan must be prepared and approved by the Project Manager and the local Health and Safety Coordinator prior to initiating field work.

5.0 RECORDKEEPING

Information collected during soil sampling 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. Following review by the Project 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*
- *Field Soil Boring Log*
- *Field Well Completion Log*
- *Equipment Calibration Log*

A *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 the drillers and any other subcontractors 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 Project 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 *Field Soil Boring Log* will be used to record the locations and unique identification of soil samples collected from the soil borings. The Field Soil Boring Log will also be used to record lithological descriptions of the soils and rock types encountered.

The *Field Well Construction Log* will be completed for each well and will include a diagram of the well showing the depths of the tops and bottoms of all well construction intervals including the well casing riser, well screen, sand filter pack, seal, etc. All materials used will be clearly and completely described as appropriate including type, manufacturer, sizes, specifications, etc.

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, LEL, OVM, measuring tapes, water level measuring device, 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 wells will be recorded on the *Field Investigation Daily Log*, *Field Soil Boring Log*, a site map, and/or other appropriate forms.

After well installation, well completion report(s) will be completed and filed with the State Department of Water Resources or other appropriate agency.

FIELD GUIDANCE DOCUMENT NO. 008
GROUNDWATER WELL DEVELOPMENT

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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 ……………..	United States Environmental Protection Agency (USEPA) *Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells*, dated 1991 USEPA Office of Solid Waste *RCRA Ground Water Monitoring: Draft Technical Guidance*, dated November 1992. *Water Well Standards: State of California, December 1981, Department of Water Resources (DWR) Bulletin 74-81, the supplement California Well Standards, June 1991, DWR, DWR Bulletin 74-90.*

Table of Contents

1.0 INTRODUCTION

This Field Guidance Document (FGD) describes the procedures for groundwater well development 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 groundwater well development 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 groundwater well installation is performed in a complete and safe manner, 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).

The well development contractor shall be a licensed water well driller, in accordance with local and state requirements, and a qualified drilling contractor for the installation and development of groundwater monitoring wells for environmental purposes.

2.0 EQUIPMENT/MATERIALS

Many materials are required for successfully completing the installation and development of groundwater wells. The drilling and/or well development contractor often supplies much of the equipment and materials. However, the Field Geologist/Engineer should be aware of what is required to conduct the work so they have their own supplies and can provide technical expertise and competent oversight. Equipment and materials needed to conform to this FGD include:

- Health and Safety Plan
- Site information (maps, contact numbers, previous field logs, etc.)
- Well construction specifications and diagrams

- Development rig and associated equipment (supplied by drilling contractor)
- Monitoring well development equipment (supplied by drilling contractor)
- Weighted, calibrated measuring tape
- Electronic water level indicator (Solinst or similar)
- Water-quality monitoring meter to measure pH, temperature, specific electrical conductance (SEC), and turbidity.
- Sample containers, preservation supplies, sample labels, Ziploc™ bags (if samples are specified)
- Cooler with ice (if samples are specified)
- Decontamination supplies (e.g. phosphate-free detergent [Alconox or similar])
- Drum(s) to collect soil cuttings and decontamination water
- Drum labels
- Personal Protective Equipment (PPE), typically PPE will consist of:
  - Long-sleeved shirt and long pants
  - Steel-toed boots
  - Hardhat
  - Nitrile gloves
  - Safety glasses with side shields
  - Other protective equipment as required by Health and Safety Plan
- Field Forms (if required, a project-specific Field Logbook may substitute for any of the following)
  - *Field Investigation Daily Log*
  - *Field Well Development Log*
  - *Equipment Calibration Log*

3.0 PROCEDURES

Development of monitoring wells will be in conformance with the provisions outlined in the following sections. After well installation, well completion report(s) will be completed and filed with the State Department of Water Resources and/or other appropriate agency.

All fluids generated during well development will be containerized pending analytical results and determination of disposal options as outlined in the FGD entitled *Managing Investigation-Derived Waste* unless project-specific requirements specify otherwise. Waste containment and disposal will occur in a manner that will not result in contamination of the immediate area or result in a hazard to individuals who may come in contact with these materials.

3.1 Well Development

The objectives of well development are to remove drilling induced formation smear from the borehole walls, and to remove sediment that may have accumulated during well installation, and to remove mud cake from the walls of the borehole if the wells were installed by a mud-rotary drill rig. Additional objectives include consolidation of the filter pack around the well screen, and to enhance the hydraulic connection between the formation target zone and the well. The appropriate development method will be selected for each project based on the lithology, objectives, and requirements of that project. Project-specific planning documents will identify the specific development method to be used.

When planning for well development, the following particulars will need to be identified for each well prior to mobilization:

- Borehole drilling method;
- Well depth;
- Screen length;
- Well construction materials;
- Location, thickness, and composition of annular seals; and

In general, most wells will be developed by using surge block and bailing methods to draw the coarse and/or fine material out of the sand pack. Other development methods that may be used include jetting, airlift, and submersible pump methods. These methods are discussed further below. Jetting is typically not used as a development method for environmental investigations, but is commonly used for water resource monitoring wells or production wells.

Well development should begin no sooner than 48 hours after well installation. However, if drilling muds are used during well installation, well development should occur approximately 24 hours following well installation so that the drilling mud does not set up in the well screen section.

Generally a phased process is used to develop wells, starting with a gentle bailing phase to remove sand, followed by a surging phase, and then a pumping phase after the well begins to clear up. The following paragraphs provide more detailed information.

After the well casing, screen, and filter pack are initially placed in the borehole, gentle bailing is used to remove water and sand from the well. The purpose of this technique is used to settle the sand pack. After further well sealant materials have been added and allowed to set for approximately 48 hours, bailing is resumed as part of well development. The purpose of bailing is to remove any fine material that may have accumulated in the well, and start pulling in natural material into the sand pack. Bailing is often conducted until the sand content in the removed water begins to decrease.

After the sand content begins to decrease, surging is conducted. A surge block is used to move sediments from the filter pack into the well casing. A surge block consists of a rubber (or leather) and metal plunger attached to a rod or pipe of sufficient length to reach the bottom of the well. All surge blocks will be constructed of materials that will not introduce contamination into the well. Surge blocks should have some manner of allowing pressure release to prevent casing collapse. The surge block is moved up and down the well screen interval and then removed, followed by a return to bailing to remove any sand brought into the well by the surging action. Care should be taken during surging to prevent casing deformation or collapse as the well screen interval is often the weakest part of a well. Surging should be followed by additional bailing to remove fine materials that may have entered the well during the surging effort.

After surging has been completed and the sand content of the bailed water has decreased, a submersible pump may be used to continue well development. The pump should be moved up and down the well screen interval until the obtained water from the entire screen interval is relatively clear. Well development will continue until the water in the well clarifies and monitoring parameters such as pH, specific electrical conductance (SEC), and temperature stabilize as defined in the project-specific planning documents. It should be noted that where very fine-grained formations are opposite the screened interval, continued well development until clear water is obtained might be impossible. Decisions regarding when to cease development where silty conditions exist should be made between the Field Geologist/Engineer and Project Manager.

During well development pH, specific conductivity, temperature, and turbidity should be monitored frequently to establish natural conditions and evaluate whether the well has been completely developed. Drawdown and recovery will be measured during and at the end of the development process, respectively, using an electric sounder. Water quality parameters and water levels will be recorded on the Well Development Log. The main criteria for well development is clear water (Nephelometric turbidity units or NTU of less than 5). As mentioned above, clear water can often be impossible to obtain with environmental monitoring wells. Further criteria for completed well development is that the other water quality parameters mentioned above stabilize to within 10 percent between readings over one well volume.

The minimum volume of water purged from the well during development will be approximately a minimum of three (3) borehole volumes (wells will typically not reach stabilization of water quality parameters before this condition is achieved and may not have reached stability even after this threshold has been achieved). The above is a general guideline for difficult well development. Project-specific planning documents should address project constraints on well development.

Development purge water will be stored in 55-gallon Department of Transportation (DOT) –approved drums and/or baker tanks depending upon the total volume of purge water removed from the newly installed wells. Drums or other containers must be constructed of materials that are compatible with any contaminants that may be potentially present in the development purge water.

3.2 Equipment Decontamination

Cleaning of the drill rig and associated drilling equipment will follow the procedures discussed in the SOP entitled, Drilling and Destruction of Soil Borings.

All well casing materials will be cleaned before they are installed. Well development equipment will also be cleaned before use. The following cleaning procedure has been found to be effective and will be used or adapted as appropriate for general conditions of materials or equipment to be cleaned. This procedure may be modified based on project requirements.

- Steam-rinse with potable water or rinse in deionized or organic-free water.
- Cover with clean plastic to protect materials and equipment from contact with chemical products, dust, or other contaminants.

Alternatively, well casing materials that have been steam-cleaned and sealed in individual airtight plastic bags by the factory can be used.

Decontamination rinsate will be collected and stored properly in labeled containers for future disposal by the client, unless other arrangements have been made. Drums or other containers must be constructed of materials that are compatible with any contaminants that may be potentially present in the rinsate.

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. 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). The drilling contractor shall be a licensed driller in accordance with local and state requirements, and a qualified drilling contractor for the installation of soil borings for environmental investigations.

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 Health and Safety Plan must be prepared and approved by the Project Manager and the local Health and Safety Coordinator prior to initiating field work.

5.0 RECORDKEEPING

Information collected during soil sampling 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. Following review by the Project 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*
- *Field Well Development Log*
- *Equipment Calibration Log*

A *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 the drillers and any other subcontractors 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 Project 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 *Field Well Development Log* will be completed for each well and will include the methods of well development used, time intervals for each development procedure (bailing, surging, pumpiong, etc.), volumes of water purged, and results of water quality monitoring.

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, LEL, OVM, measuring tapes, water level measuring device, 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 wells will be recorded on the *Field Investigation Daily Log,* a site map, and/or other appropriate forms.

FIELD GUIDANCE DOCUMENT NO. 009
GROUNDWATER AND FREE PRODUCT LEVEL MEASUREMENTS

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Effective date ……………………	January 24, 2014
Revision Notes …………………	0 First Issuance
Documents used as reference during preparation ……………	

Table of Contents

1.0 INTRODUCTION

This Field Guidance Document (FGD) presents general guidelines established by ENVIRON for groundwater level measurements (depth to water) and free product level measurements (depth of free product) in groundwater monitoring wells or piezometers 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 groundwater and free product level measurements 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 sampling is performed in a complete and safe manner, 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).

Groundwater level measurements are collected to determine the depth to groundwater within a well relative to ground surface, top of the well casing, and/or an established elevation datum. Similarly, free product measurements are collected to determine the depth to non-aqueous phase liquid (NAPL) accumulated within a well relative to an established elevation datum. The accumulated thickness of NAPL within a well can be determined if the bottom of the free product can be additionally measured. Properly collected and recorded measurements can be utilized for generation of potentiometric surface maps to establish groundwater flow direction, define horizontal and vertical hydraulic gradients, evaluate variations in groundwater elevations over time, evaluate NAPL mobility or recovery, and other project specific tasks.

2.0 EQUIPMENT/MATERIALS

Below is a general checklist of equipment that may be needed for typical groundwater level measurement efforts. This checklist only suggests general equipment that may be necessary for a project or task and should not be considered exhaustive.

1. General Water and Free Product Level Measurement Equipment Checklist
    - Electronic water level indicator
    - Electronic oil/water interface probe for wells containing known or suspected NAPL
    - GPS or other locating device
    - Site map showing locations of wells
    - Well construction records and previous water level measurements
2. Project or Task Specific Water and Free Product Level Measurement Equipment Checklist
    - Well lock keys
    - Steel tape measure or submersible water level meter for use in measuring total well depth
    - Decontamination supplies /equipment (non-ionic detergent, tub, brushes, etc.);
    - Wash bottles/bucket
    - Trash Bags - used to dispose of gloves and any other non-hazardous waste generated during sampling
    - Appropriate waste container – used to dispose of any Investigation Derived Wastes (IDW) and/or decontamination wastes
    - Socket wrench (manhole bolt sizes vary; most commonly require a 9/16” socket).
    - Water valve gate box key (for older style flush-mounted wells).
    - Pry bar (or other equivalent tool to assist in the removal of the flush mounted well cover or handhole).
    - Syringe (or other equivalent tool such as a turkey baster to assist in removing standing water in flush mounted wells).
    - Extra batteries for the water level meter (usually 9-volt).
3. Miscellaneous Additional Suggested Equipment
    - Extra vehicle keys
    - Metal locator (to find buried/obstructed flush mounted wells)
    - First aid kit
    - Mobile phone
    - Credit card for gas and emergencies
    - Road and site maps

- Chemical protective gloves and other personal protective equipment (PPE) as required by the HASP; and
- Field notebook and field data sheets
- Waterproof pens
- Bolt cutters (to remove rusted padlocks)
- Replacement padlocks
- Camera and extra batteries

3.0 PROCEDURES

3.1 Pre-Field Work Preparation Guidelines

At a minimum, the following tasks should be completed to prepare field staff for what may be expected during implementation of the work:

- Review and sign the a site-specific HASP;
- Coordinate and obtain permission for site access;
- Review project-specific Work Plan/sampling plan, where applicable;
- Review project-specific Quality Assurance Project Plan (QAPP), where applicable;
- Review and discuss with the PIC and/or PM the proposed activities or Work Plan/sampling plan;
- Review the standard instruction manual provided by the manufacturer of the specific equipment being used for water level monitoring and field screening;
- Inspect the water level meter(s) for any signs of damage and test for proper operation;
- Identify well locations and any specific order in which they are to be collected;
- Obtain copies of recent or historic (i.e., same season) water or free product level data to be able to anticipate the approximate depth of water or free product minimizing unnecessary wetting of the tape and as a check of the measured levels;
- Obtain copies of well construction records, as these can be used to confirm the well identification if not clearly identifiable; and
- Identify wells that are known or suspected to contain NAPL or other free product. An electronic oil/water interface meter must be used in these wells in lieu of an electronic water level indicator.

All significant field activity decisions will be approved by the PIC and/or PM before the initiation of associated field activities. The work plan/sampling plan will be designed for the collection of quality data that will best answer the questions and meet the goals of the study/monitoring program. The work plan/sampling plan will generally provide for some discretion in the field depending on encountered conditions; however, any significant departure from prescribed field activities should be approved by the PIC and/or PM).

Prior to the commencement of the field effort, inspect, test, and/or calibrate equipment that will be used to take field measurements.

3.2 General Water Level Measurement Guidelines

Water level measurements are generally taken in monitoring wells, piezometers, or boreholes using electronic water level indicators. There are different manufacturers of electronic water level indicators including Solinst, Keck, and Heron. Electronic water level indicators consist of a reel of dual conductor wire embedded within a pre-marked tape, a probe with an insulating gap between the wire attached to the end of the tape, and an indicator on the reel. Generally, tapes are marked every 1/100th of a foot and/or millimeter. When the probe comes into contact with water, the circuit is closed and the indicator signals this contact with an audible buzzer and/or an optical light. The meters usually use 9-volt batteries within the reel as a power source. Many water level meters include a sensitivity adjustment on the indicator. The sensitivity adjustment diminishes potential short circuiting of the probe in moist environments such as those encountered in a well.

The following provides a recommended list of practices for water and/or free product level measurement activities:

- Where applicable, contact the identified key site personnel upon arrival to the Site and assess proposed work areas.
- Because groundwater or free product depth can vary due to natural fluctuations, all measurements for a specific sampling event should be collected within as short of a time frame as possible.
- Although equipment will be decontaminated between uses, to further limit potential cross-contamination between wells, perform measurements from least to most contaminated locations.
- Complete depth to water or free product measurements prior to any planned withdrawals, sampling or disturbance of groundwater unless otherwise specified in the work plan/sampling plan.
- All water or free product level measurements should be made relative to an established reference datum and should be recorded in the field notes. The reference datum is usually marked, notched or etched on the well or casing at the time of installation on the north side of the inner casing. In the absence of a marked, notched or etched reference datum take water level and depth measurements from the north side of the inner casing and mark or etch it for future reference. In the case of a casing notched or etched at a distinct angle, the measurements should be made from the highest point in the casing. Note this procedure in the field book.

- Record in the field book the model name, number, and serial number of the electronic water level meter or interface probe being used.
- Identify the well to be measured and confirm by checking for proper identification markings on the well, comparing to a site map, and if needed historical water and/or product level measurements and well construction records. If the well cannot be positively identified, contact the Project Manager or Task Leader before proceeding.
- Decontaminate the water level meter probe, interface probe, and/or tape (if total well depth measurements are being conducted with a tape) prior to each use.
- Remove well cover or equivalent protective casing cover. Inspect the interior of the well box for insects, etc., that could present a biological hazard. If there is water in the well box, remove all water (at least to a level below the top of the inner well casing) prior to removing the well cap or plug. Indicate that water was removed from the well box and identify possible causes (e.g., missing bolts, damaged well cover, etc.).
- Remove the well cap or plug, noting well identification, time of day, and date in field book. Also note any abnormal conditions in the well (e.g., damaged inner casing, limited clearance between the bottom of the well box and the top of the inner well casing, absence of reference datum, etc.) If the top of the well casing has been damaged, the reference datum may no longer be accurate.
- If the wells are outfitted with expansion caps, these should be removed and the wells allowed to equilibrate for an appropriate period of time prior to the collection of water level measurements. This is especially critical for wells screened below the water table or in confined units. There are no set guidelines and appropriate equilibration times can range from minutes to hours depending on well recharge, local geology and topography, and project objectives.
- Record observance of positive or negative pressure in the well upon removal of the well cap. The presence of pressure/vacuum in the well could be qualitatively assessed during loosening and removal of an expansion cap (resulting in air either being audibly pushed out or drawn in to the well casing) or using a piece of paper or other light object (i.e., easily moved or displaced by light air flow) placed immediately above the inner well casing and observing its movement (i.e., if it adheres to well casing, there is a negative pressure in the well; if it moves from the well casing, there is a positive pressure in the well). If pressure was observed, the water level should be measured multiple times over a 5 to 10 minute period to allow time for equilibration and confirm that the water level has reached static conditions.
- Monitor the headspace of well with a field screening device in accordance with the applicable manufacturer instructions and FGD. Record field screening readings in field book. The necessity and methodology to conduct field screening should be detailed in the site-specific HASP, sampling plan or Work Plan.
- Check that the indicator is working properly by pushing the test button on the reel. Replace batteries in the electronic water level meter or product interface probe if testing or operation of

indicates the battery is not providing sufficient power. If the battery is replaced during a field measurement event this must be recorded in a field log book.

- Lower the probe slowly into the well taking care to minimize contact with the well casing. If significant kinks are observed in the tape, attempt to straighten manually and record observations in project field book or log.
- When a strong and steady signal from the indicator signals water or free product has been encountered slowly pull the tape up until the signal ceases.
- Manually lower and raise the probe to exactly locate the water or free product interface.
- At the point where the signal indicates free water or free product has been encountered, measure and record the depth of the probe using the marked tape.
- If free product is encountered, continue to manually lower the probe into the well until a strong and steady signal from the indicator signals that water has been encountered. Lower and raise the probe to exactly locate the water or free product interface. Measure and record the depth of the probe using the marked tape.
- Measurements should be referenced to the established reference datum.
- Repeat the measurement to verify accuracy. Measurement should be recorded to the nearest 0.01 feet and/or millimeter.
- Withdraw the probe from the well, replace the well cap, and re-secure the well.
- Total well depth measurements should be made in reference to the top of casing as well as the ground surface. These measurements should be performed after sampling, if positive well identification has be completed.
- Record in the field book any abnormal conditions within the well (e.g., evidence of blockage, root growth into the well casing, separated casing sections, etc.). Inform the PIC or PM so necessary maintenance, redevelopment or repairs are conducted before the next planned water level measurement event.
- To minimize potential cross-contamination of samples among stations, decontaminate the probe and portions of the tape that made contact with water, product, or well materials.

3.3 QA/QC

Quality Assurance/Quality Control (QA/QC) procedures described in the project-specific Work Plan/sampling plan and/or QAPP must be followed throughout the water level measurement process.

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. 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).

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 Health and Safety Plan must be prepared and approved by the Project Manager, Task Leader and Project Health and Safety Coordinator prior to initiating field work.

Additional precautions regarding methods for groundwater and free product level measurement are described below:

- Operate electronic water level meters and product interface probes in accordance with the manufacturer's instructions and recommendations.
- The protective casing of flush-mount wells often fills with run-off surface water. If upon removing the well cover, the top of inner well casing is submerged, utilize a syringe, turkey baster, or equivalent tool to remove the excess water before removing the well cap in order to avoid surface water flow into the well.
- Provided well keys may not work with rusted/outdated well locks; bolt cutters may be used to remove the lock, which should be replaced upon completion of water level measurement. Do not use petroleum based solvent sprays to free seized locks as this may impact water quality in the well.
- Wells with a water-tight cap may experience a buildup of pressure, especially if they are screened below the static water level. Keep your face and body from the top of the well when loosening or removing the cap.
- Ensure that the water level has reached the static level prior to recording the depth to water. Should the water level be in a state of flux due to pressure buildup, allow ample time for the water level to stabilize to static conditions before recording measurement.
- Indicator response may be indicative of potential faults that could be corrected in the field:
    - If the signal from the indicator is intermittent or weak it may be necessary to decrease the sensitivity since it may be short circuiting prior to encountering free water.
    - If there is no signal it may be necessary to increase the sensitivity since some water is less conductive and may not complete the circuit.
    - If the signal is still intermittent, weak, or absent then replace the battery and reattempt the measurement.

- Cascading water may interfere with the measurement of free water; particularly in boreholes or rock wells.

- Some well casings have sharp edges; care should be taken when lowering or withdrawing the tape to avoid damaging the tape of the water level meter.

- Oil or other product floating on the water column may insulate the contacts of the probe resulting in a misleading indication of the depth to free water. An oil/water level indicator should be used if there is known or suspected product in a well.

- It should be noted that some water level indicators will have a 2 to 3 inch weight on the tip of the probe which can displace water in a well before the water indicator detects it. These models also make it difficult to detect small amounts of water in wells, i.e. less than 3 inches. If this is expected to be a potential issue, then request a model with the water indicator located on the tip of the probe.

- Meters should be inspected periodically to ensure accurate readings. Electronic water level meters and interface probes may not function properly if the electric wire is broken, cut, or if insulation is removed exposing the wire (resulting in short circuiting). Repaired meters may have had sections of the tape removed and/or spliced and may not meet data quality objectives. Damaged tapes or tapes suspected of being damaged should be repaired by the manufacturer or replaced.

- If using the water level meter for total depth measurements, confirm that the probe is designed for total immersion and the maximum acceptable depth of immersion.

- Tape lengths can be confirmed using a calibrated steel tape periodically or as necessary to adhere to data quality objectives. Discrepancies in tape length must be noted in the field log book and/or field sheet.

- For high conductivity water (brine) decreasing the sensitivity control prevents bridging so a moist probe is not detected as being in water.

5.0 RECORDKEEPING

Information collected during drilling 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 Leader, 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*
- *Water Level Measurement Log*

A *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 the drillers and any other subcontractors 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 Leader, 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 *Water Level Measurement Log* will be used to record the monitoring well ID, time of measurement, total depth of well, depth to water, measuring point, presence of product, product thickness, and notes about the condition of the well.

FIELD GUIDANCE DOCUMENT NO. 010
SOIL GAS SAMPLING

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Documents used as reference during preparation ……………..	ASTM D5314-92 *Standard Guide for Soil Gas Monitoring in the Vadose Zone*. 1992. ASTM D7663-12 *Standard Practice for Active Soil Gas Sampling in the Vadose Zone for Vapor Intrusion Evaluations*. 2012. DTSC, Los Angeles Regional Water Quality Control Board (RWQCB), and San Francisco Bay RWQCB. *Advisory – Active Soil Gas Investigations*. April 2012

Table of Contents

1.0 INTRODUCTION

This Field Guidance Document (FGD) defines the procedures for soil gas sampling 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 soil gas sampling 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 perform this work in a safe and competent manner, ENVIRON personnel involved in field activities should be sure that they are trained in those field activities they are tasked with, and 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 have project personnel review and sign the applicable HASP, and maintain the completed HASP and relevant project information 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.

2.0 EQUIPMENT/MATERIALS

Equipment and materials needed to conform to this FGD include:

- Health and Safety Plan
- Site information (maps, contact numbers, previous field logs, etc.)
- Photoionization Detector (PID) or Flame ionization detector (FID) for field screening for and monitoring of breathing zones for inhalation hazards
- Other monitoring equipment as specified in the Health and Safety Plan
- 0.25-inch outside diameter (0.187-inch inside diameter) Teflon® tubing
- 0.25-inch Swagelok® (or equivalent) two-ferrule compression tube fittings (caps, plugs, unions
- Sintered stainless steel or Teflon® soil gas probe tip
- Soil gas sample point construction materials including kiln-dried Monterrey 30-mesh sand, granular bentonite, tap water for hydrating bentonite
- Sample containers (1-liter Summa® canisters, individually certified by the laboratory to the requested analytical reporting limits)

- Sampling manifolds (with purge port, vacuum gauges, and integrated sample flow controller limiting flow to approximately 100-200 milliliters per minute, individually certified by the laboratory to the requested analytical reporting limits)
- Purging pump (manual or electrical) and/or dedicated 6-liter Summa® canisters designated for purging (purge canisters need not be certified clean)
- Leak check tracer gas supplies (compressed helium tank, helium detectors, sample shroud, and appropriate fittings, to be supplied by the analytical laboratory)
- Purge syringe
- Tubing cutters
- Tool kit with appropriate tools (9/16” and 1/2” open-ended and box wrenches , scissors)
- Decontamination supplies (e.g. phosphate-free detergent, distilled water)
- Drum labels
- Personal Protective Equipment (PPE), typically PPE will consist of:
  - Long-sleeved shirt and long pants
  - Steel-toed boots
  - Hardhat
  - Nitrile gloves
  - Safety glasses with side shields
  - Other as required by Health and Safety Plan
- Field Forms (If the project requires it, a project-specific Field Logbook may substitute for any of the following with the exception of the Chain of Custody)
  - *Field Investigation Daily Log*
  - *Soil Vapor Purging and Sampling Log*
  - *Equipment Calibration Log*
  - *Chain-of-Custody*

3.0 METHODOLOGY

This FGD has been prepared in general accordance with ASTM guidance for active soil gas investigations, as well as California-specific guidance for active soil gas investigations, which establish field-tested procedures for performing active soil gas investigations. Reference information for these documents is provided on the cover of this FGD.

While several methods exist for the collection of soil gas samples, the selected method for use at the NERT Site will be the installation of temporary soil gas probes, referred to herein as soil gas sampling points. Soil gas sampling points are preferred because of their general reliability for quality soil gas data, their relative ease of installation, the ability to be left in place to decouple installation from sampling, and their ability to be converted from temporary soil gas sampling points into permanent soil gas monitoring points if future sampling events may be necessary, by adding a surface vault box. For locations identified for permanent soil gas monitoring points, construction may also be modified to use cement grout for the annular seal, but this is a modification that would need prior approval by the Project Manager and/or Task Leader.

4.0 INSTALLATION AND DECOMMISSIONING PROCEDURES

Construction and decommissioning of all soil gas sampling points will be in conformance with the provisions outlined in the following sections.

4.1 Drilling Methods

Soil gas probe installation will be performed in accordance with applicable standards for the area of the investigation, this FGD, and the project-specific planning documents. Drilling methods employed to pilot the borehole for soil gas probe installation will be dependent on the physical nature of the subsurface materials at the site (e.g., unconsolidated materials or consolidated materials, subsurface lithology) as well as the nature of the drilling site in general (e.g., access constraints). For the purposes of this FGD, it is assumed that wells are to be installed in unconsolidated overburden materials using direct push technology (DPT). Limited access to some of locations may necessitate drilling by hand auger rather than by direct push. If field conditions warrant an alternative drilling method, the design and construction of soil gas sample points would need to be modified accordingly and such modifications would need prior approval by the Project Manager and/or Task Leader. Sonic, hollow stem auger (HSA), air rotary may be used with prior approval, but these methods are expected to significantly disrupt soil equilibrium; therefore, longer equilibration times are necessary prior to sampling. Mud rotary drilling methods are not appropriate for soil gas sampling under any circumstances.

Wherever possible, soil borings will be advanced using direct-push tooling consisting of two-inch diameter drive rods. All borings will be continuously-cored to avoid compressing the surrounding formation. The soil cores will be collected in acetate sleeves to observe the soil conditions and adjust the soil gas probe depth as necessary. Soil may be screened using a field instrument such as a portable PID, FID, or other appropriate type of organic vapor meter (OVM). The purpose of the field screening is to assess the presence of volatile organic compounds (VOCs) in the soil (see also Field Guidance Document No. 002 Soil Sampling for Chemical Analysis and Physical Testing for guidance on field screening).

4.2 Installation of Soil Gas Sampling Points

Temporary soil gas sampling points will be constructed by installing a new half-inch sintered stainless steel filter onto new 0.25-inch outside diameter (0.187-inch inside diameter) Teflon® tubing and lowering the assembly to the target depth through the center of the drilling rod, a PVC casing used to prevent borehole collapse during installation, or into an open hole. The tubing will extend in one piece to approximately four feet above the ground surface. The filter will be emplaced within approximately one foot of sand pack comprised of clean, kiln-dried Monterrey 30-mesh sand. Approximately two inches of dry (un-hydrated) granular bentonite will be emplaced on top of the sand pack to ensure that the sand pack will not be plugged when the remaining borehole is sealed with hydrated granular bentonite. The dry granular bentonite may be increased up to 12 inches for soil gas sample depths greater than 10 feet with prior approval of the Project Manager and/or Task Manager. Granular bentonite that is hydrated with potable water will seal the boring to the surface. The tubing will be labeled at the surface for the location and depth. A gas-tight Swagelok® fitting will cap the sampling tube and allow the direct attachment of the sampling train. As necessary, the surface of the temporary soil gas probes will be completed to allow coiling of the tubing for storage and a protective flush-mount cap. See the attached Figure 1 for a schematic of a typical soil gas sampling point.

Care should be taken to install soil gas sampling points in soil zones that will yield soil gas, and the installation should be tested to ensure recovery of soil gas at the time of completion. To test for recoverable soil gas, a gas-tight syringe used to qualitatively determine if a high vacuum soil condition is present. If a high vacuum condition is present due to low permeability soil, the suction will be felt while the plunger on the syringe is being withdrawn. If low permeability conditions are encountered where a vacuum of 100 inches of water is exceeded during purging, the soil gas sampling point may be sampled using alternative techniques or an alternative location may be specified, but either alternative would require prior approval of the Project Manager and/or Task Leader.

4.3 Decommissioning of Soil Gas Sampling Points

Decommissioning of soil gas sampling points will should prevent the tubing and associated borehole from becoming a conduit to the subsurface. The following decommissioning steps should be followed:

1) Squeeze sealant, such as grout, into the exposed tubing until the tubing is filled with material;

2) Pull the tubing out if possible. If tubing breaks, cut the tubing as far below grade as possible;

3) Fill the open hole with grout to within one foot of the surface grade;

4) Fill the last foot of the hole with compacted native material; and,

5) Restore pavement and vegetation to original conditions, if needed.

If the Project Manager or Task Leader specifies over-drilling for certain locations, a casing guide should be used to prevent the drill bit from drifting during the decommissioning. A casing guide will allow the drill bit to remain aligned on the top of the well casing, allowing for effective removal of the well material. Once the well material is removed, the borehole should be backfilled with bentonite grout in accordance with Field Guidance Document No. 003 Drilling and Destruction of Soil Borings. Where soil gas sampling points penetrate clay confining units, consideration should be given to over-drilling rather than abandonment in place in order to prevent potential contaminant migration.

4.4 Decontamination

Decontamination procedures, aside from decontamination procedures used to clean drilling equipment used to advance soil borings (see Field Guidance Document No. 003 Drilling and Destruction of Soil Borings), are typically not required for soil gas sampling using implants and Summa canisters for sample collection, because construction materials are dedicated and disposable. Sample containers are decontaminated and certified by the analytical laboratory prior to sampling. Laboratory-provided sampling equipment including sampling manifolds, sample canisters, and leak detection equipment should be wiped clean with a water-dampened cloth to remove dust or dirt that may accumulate while the equipment is in use in the field.

5.0 SOIL GAS SAMPLING

5.1 Equilibration Time

Subsurface conditions are disturbed during drilling and installation of soil gas sampling points. To allow for the subsurface to equilibrate back to representative conditions, the following equilibration times are recommended before proceeding with soil gas sampling:

- For soil gas sample points installed using DPT, do not conduct the purge volume test, leak test and soil gas sampling (as described in the following sections) for at least 30 minutes following installation.
- For soil gas sample points installed with hand auger, do not conduct the purge volume test, leak test and soil gas sampling for at least 48 hours after installation.
- For other drilling methods, including HAS, sonic, and air rotary, equilibration times will be approved in advance by the Project Manager and/or Task Leader.

Soil gas sampling point installation method and equilibration time should be recorded in the field logbook or the *Soil Vapor Purging and Sampling Form*.

5.2 Soil Gas Assembly Testing

Following equilibration, complete shut-in, leak, and purge volume tests before collecting soil gas samples as described in the following sections.

5.2.1 Shut-In Testing

Prior to purging or sampling, a shut-in test should be conducted to check for leaks in the above-ground sampling system, which includes the sampling manifold and connection to the sample canister. To conduct a shut-in test, assemble the above-ground valves, lines and fittings downstream from the soil gas sampling point, and close the valve between the sample train and the soil gas sampling point. Attach a purge pump or purge canister to the purge port on the sampling manifold and evacuate the system to a minimum measured vacuum of at least 100 inches of water, then close the purge valve. The test is conducted while the sampling canister is attached with its valve in the closed position. Observe the vacuum gauge connected to the system for at least 10 minutes. If there is any observable loss of vacuum, the fittings should be adjusted until the vacuum in the sample train does not noticeably dissipate. The shut-in test may need to be repeated if fittings are disconnected for adjustment or checks. After the shut-in test is successful, the sampling train should not be altered.

5.2.2 Leak Tracer Testing During Purging and Sampling

A leak tracer test is used to evaluate whether ambient air is introduced into the soil gas sample during the collection process. A leak test should be conducted at every soil gas sampling point each time a soil gas sample is collected to evaluate the integrity of the sample. Introducing ambient air may result in an underestimation of actual site contaminant concentrations or, alternatively, may introduce external contaminants into samples from ambient air. The leak check compound to be used at the NERT Site will be helium. Compressed helium, helium detectors and sampling shrouds will be provided by the analytical laboratory.

Prior to purging or sampling, a sampling shroud should be set up around the top of the soil gas sampling point such that it makes a relatively good seal against the ground surface. Foam rubber weather stripping can help to seal around the sample shroud. The shroud will be connected to a compressed helium tank. A helium detector will be attached to the shroud such that it measures the concentration of helium within the shroud. A second helium detector should be placed in line between the soil gas sample point and the purge pump or purge canister. After the helium concentration in the shroud is detected and can be monitored by the field technician, a constant concentration of helium between 20 and 30% should be maintained. The helium in the shroud should be kept within ± 10% of its target value, and if not achieved then its lowest measured value should be used for leak calculation purposes. Once purging is initiated and as purging progresses, the helium detector downstream of the soil gas sample point will indicate if any of the helium contained within the sampling shroud is being detected in the sample air. If a leak is detected, fittings in the sample train should be adjusted and the bentonite sealing material in the soil gas sample point should be re-hydrated if necessary.

The intent of the leak check compound is to enhance the integrity of the soil gas sample by demonstrating that minimal or no ambient air breakthrough during sampling is occurring. Although it is preferable not to have any tracer gas breakthrough, minor amounts of breakthrough may be acceptable with the approval of the Project Manager and Task Leaders. Detections of a leak check compound indicate potential field problems such as poor quality fittings, stripped, over tightened, dirty or worn threads, or excessive sampling train connections. Field problems may also be related to the porosity of the subsurface and depth of the sample interval. If the concentration of the tracer compound in the purge sample is greater than or equal to five percent of the tracer compound concentration in the shroud, corrective action is necessary to either remedy the leak or relocate the soil gas sampling point prior to collecting a soil gas sample.

A soil gas sampling point should be decommissioned if a leak cannot be corrected. Replacement soil gas sampling points should be installed at least five feet from the location where the original was decommissioned due to a confirmed leak.

5.3 Purge/Sample Flow Rate And Applied Vacuum

Flow rates between 100 to 200 milliliters per minute (mL/min) and vacuums less than 100 inches of water should be maintained during purging and sampling to minimize stripping (partitioning of vapors from pore water to soil gas), and to prevent ambient air from diluting the soil gas samples. Maintaining these flow rates and vacuums will increase the likelihood that representative samples will be collected. A vacuum gauge should be used between the soil gas sample tubing and the soil gas purging device to verify that a vacuum of 100 inches of water or less is maintained during sampling. The pressure gauge used to measure vacuum should be calibrated and in good working order. If low permeability conditions are encountered where a vacuum of 100 inches of water is exceeded during purging, the soil gas sampling point may be sampled using alternative techniques or an alternative location may be specified, but either alternative would require prior approval of the Project Manager and/or Task Leader.

5.4 Soil Gas Purging and Sampling

Following successful soil gas assembly testing as described in Section 5.2, and adhering to the guidelines for flow rates and applied vacuum as described in Section 5.3, the soil gas sample point will be purged of three pore volumes using a purge pump, syringe, or purge canister attached to the purge port on the sampling manifold. One pore volume includes the following:

- The internal volume of tubing;
- The void space of the sand pack around the probe tip; and
- The void space of the dry bentonite in the annular space.

To calculate the void space of the sand and dry bentonite a porosity of 30% will be assumed.

After purging is complete, the purge port will be closed and the sample canister valve will be opened to allow sample air to flow into the sample canister. The sample canister should be filled until approximately three to five inches of mercury vacuum pressure remain in the canister. After sampling is completed, the sample canister valve will be closed and the canister will be removed and sealed with a threaded dust cap.

5.5 Quality Control Procedures

All field Quality Control (QC) samples must be prepared the same as primary samples as much as possible. The sample handling and chain-of-custody procedures for the QC samples will be identical to the primary samples. The following are QC samples that may be collected during soil gas sampling:

- A field duplicate is an independent sample collected as close as possible to the same time that the primary sample is collected and from the same source. Field duplicates are used to document sample precision. Field duplicates will be labeled and packaged in the same manner as primary samples so that the laboratory cannot distinguish between the primary sample and the duplicate sample. Field duplicates are analyzed for the same suite of parameters as the primary samples. The frequency of analysis of field duplicates is one for every 20 primary samples.

- Equipment blanks are obtained by running distilled or deionized water over or through the sample collection equipment after it has been decontaminated, and capturing the water in the appropriate sample containers for analysis. Equipment blanks are analyzed for the same suite of parameters as the primary samples. The frequency of analysis of equipment blanks is generally one for every day that non-dedicated sampling equipment is used.

- Field blanks are used to assess the presence of contaminants arising from field sampling procedures. Field blank samples are obtained by filling a clean sampling container with ambient air. Field blanks are analyzed for the same suite of parameters as the primary samples. For soil gas sampling, field blanks will be analyzed at the discretion of the Project Manager and Task Leader.

- Trip blanks are sample containers that are used to evaluate sample cross-contamination of VOCs during shipment. For soil gas sampling, trip blanks consist of laboratory-certified air filled Summa canisters that will be transported to the field, stored with the samples, and returned to the laboratory for analysis. For soil gas sampling, trip blanks will be analyzed at the discretion of the Project Manager and Task Leader.

6.0 SAMPLE HANDLING AND CUSTODY

Samples will be collected, handled, and stored in such a manner that they are representative of their original condition and chemical composition. For soil gas samples collected in Summa™ canisters, this generally means that the containers are free of leaks before, during, and after sampling. The occurrence of leaks will be mitigated through the use of proper tools and tightening canister fittings according to manufacture specifications. Leaks will be identified through the use of vacuum checks before and after sampling as well as before and after transport to the laboratory.

6.1 Sample Handling and Custody

Samples 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.

6.1.1 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.

6.1.2 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
- 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.

6.1.3 Containers, Preservation, and Hold Time

Sampling containers will be certified as contaminant-free by the laboratory.

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.

6.1.4 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;
- The sample container will be labeled before or immediately after sampling;
- Sample canisters will be wrapped in bubble wrap as necessary to minimize the potential for breakage during shipment;
- Sample canisters will contained in cardboard boxes, or other suitable shipping containers rated for the weight of samples;
- The *Chain-of-Custody* form will be placed in a separate plastic bag and placed inside the shipping box. A custody seal will be affixed to the box 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.

6.1.5 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 the shipping container, and the container 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.

7.0 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.

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).

The laboratory must be certified by the appropriate regulating agency for the analyses to be performed. If required, permits will be acquired from the appropriate agency, and an underground utility check will be performed before drilling begins. An underground utility check will, at a minimum, consist of contacting the local utility alert service, e.g., Underground Service Alert (USA), if available. Typically, subsurface clearance should also be conducted by a private utility locating company contacted specifically to clear individual boring locations. Under certain circumstances, including at sites with deeply buried, unknown, or multiple underground utilities, as well as at high risk sites such as oil refineries and heavy industrial facilities, manual utility clearance using hand auger may be performed.

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 Health and Safety Plan must be prepared and approved by the Project Manager and the local Health and Safety Coordinator prior to initiating field work.

Rainfall decreases the air-filled porosity of the shallow soil, thereby limiting diffusional transport of volatile contaminants. Also, soil gas contaminants may partition into the clean infiltrating rainwater, both of which may potentially bias soil gas sampling results. Hence, soil gas sampling should not occur during a significant rain event and should not occur immediately after significant rain event. A significant rain event is defined as 1/2 inch or greater of rainfall during a 24-hour period. The waiting period is based upon soil drainage. Irrigation or watering of soil should stop at least five days prior to the soil gas sampling event. Likewise, areas subject to soil gas sampling should be free of standing or ponded water for at least five days prior to sampling. Locations of soil gas sampling points should avoid swales or depressions where water might accumulate. However, soil gas sampling after rainfall can proceed where infiltration has not occurred, such as under buildings or beneath high-integrity pavement.

Barometric pressure fluctuations associated with the passage of frontal systems can introduce atmospheric air into the shallow vadose zone. Therefore, soil gas sampling should be delayed until frontal systems have passed the area.

8.0 RECORDKEEPING

Information collected during soil gas sampling 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 Project 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*
- *Soil Vapor Purging and Sampling Log*
- *Equipment Calibration Log*
- *Chain-of-Custody*

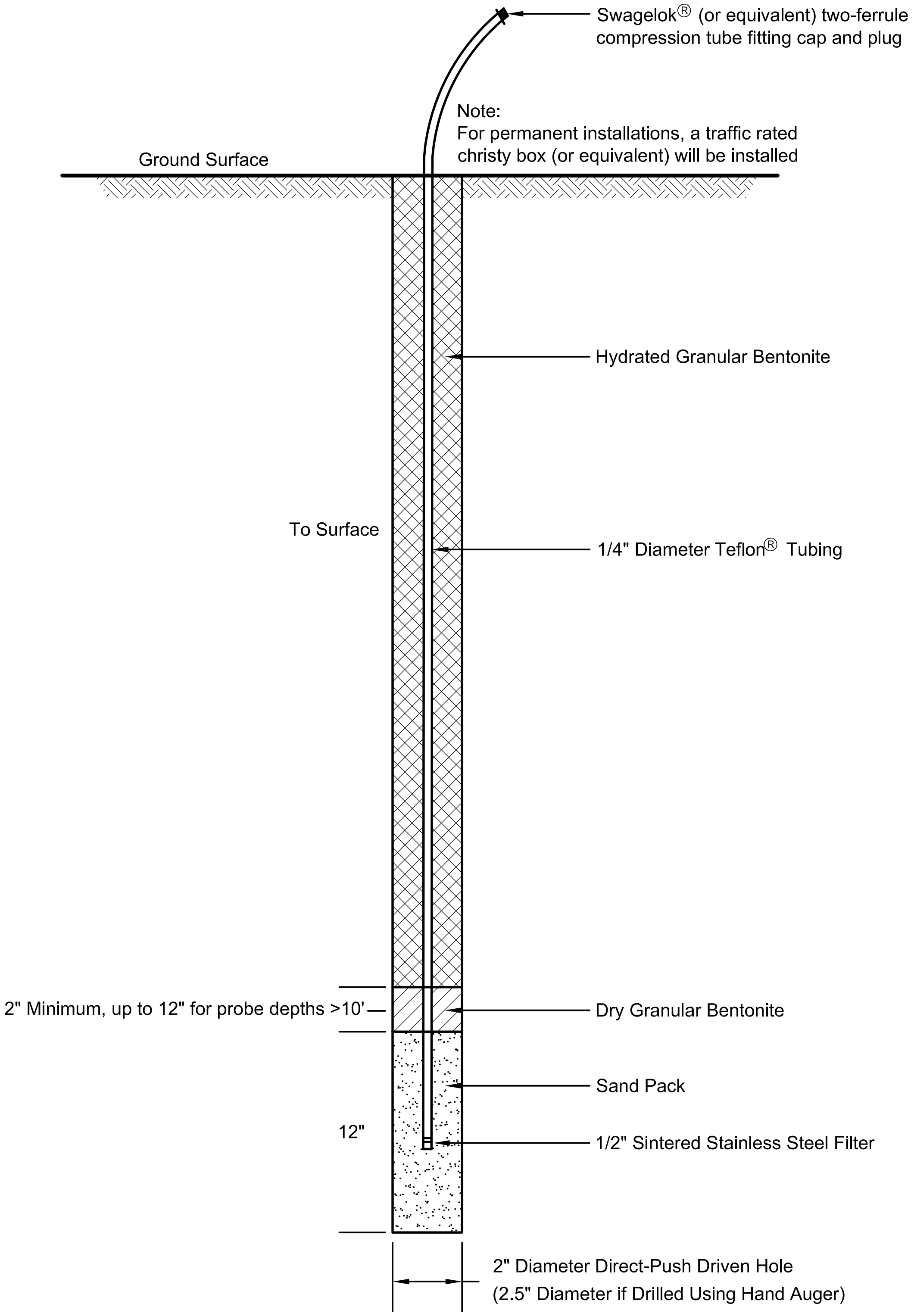
A *Field Investigation Daily Log* will be completed for each day of fieldwork containing (at a minimum) the times and descriptions of the work performed, the activities of the drillers and any other subcontractors or visitors on-site, arrival and departure times for all involved, and any other pertinent information. For larger projects, or when otherwise deemed appropriate by the Project 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 *Soil Vapor Purging and Sampling Log* will be used to record soil gas sample point construction details, results of soil gas assembly testing, soil gas purging information, and soil gas sampling information.

The *Equipment Calibration Log* will be used to document the calibration and status of any measuring instruments used in the field, e.g., helium detectors. 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.

Samples 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.

ATTACHMENTS RELATED TO FGD



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NOT TO SCALE

ENVIRON

Soil Gas Sample Point
Nevada Environmental Response Trust Site
Clark County, Nevada

Figure
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Drafter: RS
Date: 1/21/14
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Revised:

FIELD GUIDANCE DOCUMENT NO. 011
AQUIFER HYDRAULIC TESTING

Prepared by …………………………	Jessica Watkins
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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 ……………..	American Society for Testing and Materials (ASTM). 2010. Standard Guide for Selection of Aquifer Test Method in Determining Hydraulic Properties by Well Techniques. ASTM D4043-96(2010)e1, West Conshohocken, Pennsylvania. American Society for Testing and Materials (ASTM). 2008. *Standard Test Method (Field Procedure) for Instantaneous Change in Head (Slug) Tests for Determining Hydraulic Properties of Aquifers*. ASTM D4044-96(2008), West Conshohocken, Pennsylvania. Butler, James J. Jr. 1998. The Design, Performance, and Analysis of Slug Tests. CRC Press LLC, Boca Raton, Florida. Butler, James J. Jr. 2013. Slug Tests in Wells Screened Across the Water Table: Some Additional Considerations. *Groundwater*. February. Duffield, G.M. 2007. AQTESOLV for Windows Version 4.5 User's Guide. HydroSOLVE, Inc. Reston, VA. Midwest Geosciences Group. 2009. Field Guide for Slug Testing

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Table of Contents

1.0 INTRODUCTION

This Field Guidance Document (FGD) defines the recommended procedures established by ENVIRON for performing the following types of aquifer hydraulic tests: (1) slug tests, (2) aquifer pumping tests, and (3) recovery tests. Although this document describes procedures for typical projects, it should be understood that for certain projects more or less prescriptive procedures may be warranted based on the project-specific data quality objectives. To ensure that high-quality data is obtained, 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).

2.0 EQUIPMENT/MATERIALS

A list of common equipment and materials needed to conform to this FGD and pertinent to all aquifer tests include:

- Site-specific HASP, and any personal protective or other equipment required by the HASP
- Site information (maps, contact numbers, etc.)
- Well information (previous water levels, well depths and screen intervals, previous purge logs, etc.)
- Electronic water level meter to take manual measurements (Solinst or similar)
- Data-logging pressure transducers (e.g., Solinst Levellogger^{TM})
- Direct-read transducer cables and/or low-stretch nylon or Kevlar cord for hanging transducers
- Steel measuring tape
- Laptop computer
- Decontamination supplies (e.g. phosphate-free detergent, deionized water)

- Well keys (if necessary)
- Stopwatch (this functionality is available on many newer cell phones)
- Duct tape or other adhesive tape
- Extra batteries
- Field Forms and/or Field Logbook
    - *Field Investigation Daily Log*
    - *Water Level Measurement Log*
    - *Equipment Calibration Log*

Additional equipment pertinent to slug tests, pumping tests, and recovery tests are discussed in those particular sections.

3.0 SLUG TESTING PROCEDURES

This section provides guidance for performing slug tests. This section does not cover the analysis of slug test results.

A slug test is a single-well testing method that is commonly used as a quick and cost-effective means to estimate the hydraulic conductivity of an aquifer or water-bearing zone in close proximity to the well. A slug test is performed by instantaneously raising or lowering the water level in the well by inserting or removing a “slug” of known volume and then monitoring and recording the recovery of hydraulic head to the initial level.

There are a variety of methods by which the water level in the well can be lowered or raised by a “slug” composed of air, water, or a solid material. The use of slugs made up of air is complicated due to the need for special equipment to apply pressure or a vacuum to the well. In addition, the well screen must be entirely below the static water level to avoid short-circuiting of air to the surrounding formation. The use of slugs made up of water is often infeasible because of (1) the need to dispose of contaminated groundwater pumped from the well, (2) the difficulty of instantaneously removing a slug of water from a well, and (3) the potential bias in groundwater sampling results due to the dilution of groundwater with the addition of clean slug water. For practical purposes, this section focuses on slug tests conducted using a solid slug.

In addition to being more quick and cost-effective, slug tests are often chosen instead of pumping tests because they can be performed in lower permeability zones not appropriate for pumping tests and do not require the disposal of large, potentially hazardous quantities of water. Some disadvantages of slug tests are that hydraulic conductivity estimates (1) are sensitive to near-well conditions (e.g., poor well development, gravel pack, and skin effects), (2) only apply to the immediate vicinity of the well, and (3) are not able to identify boundary conditions, hydraulic anisotropy, storage coefficients, or pumping characteristics of the well.

3.1 Planning and Design Considerations

Aquifer characteristics and well construction details should be evaluated prior to the start of testing to ensure wells selected for testing will adequately characterize the aquifer. At a minimum, the conceptual site model should include whether the aquifer is confined or unconfined, wells fully or partially penetrate the aquifer, the water table intersects or lies above the well screen, and the permeability of the aquifer.

The slug size should be determined using procedures specified in Butler (2013) to ensure that the formation response will be sufficient to enable analysis of the response data. In general, an initial displacement of the water column of one to three feet is sufficient to enable analysis of the response data. Smaller displacements may not yield a sufficient response in the aquifer and larger displacements may result in large frictional losses and unnecessarily long test durations. In very high conductivity formations, larger displacements may be needed to reduce the effects of nonlinear response mechanisms. Larger slugs may also be required for wells screened across the water table to account for the effects of filter pack drainage.

If practical, it is desirable to confirm the reproducibility of the results by repeating the slug test either with the same slug or with a slug that produces an initial displacement that differs by at least a factor of two; however, this is not always achievable in the field.

3.2 Performing the Slug Test

This section describes the protocol for performing a slug test. Prior to conducting a slug test, field personnel will be provided a field sheet specifying the well to be tested, the well construction, the anticipated water column height within the well, the slug dimensions to be used, the anticipated initial displacement, the suggested transducer placement depth, the suggested transducer data acquisition rates, and whether background measurements and/or barometric pressure measurements are required.

3.2.1 Equipment

In addition to the equipment specified in Section 2.0, the following equipment shall be used while conducting slug tests:

- Pulley system with static nylon or coated-steel cord to raise and lower slugs
- Solid slugs or other equipment for initiating slug tests
- Pressure transducer(s)
- Field computer
- Polyethylene sheeting

- Field Forms:
  - *Daily Field Investigation Log*
  - *Slug Test Field Log*

3.2.2 *Water Level Measurement*

- Prior to initiating the slug test, a pressure transducer with integral data loggers should be installed in the test well. The transducer should be securely deployed by a direct-read cable if real-time viewing of data is needed. Otherwise, transducers should be deployed using inert, low-stretch nylon or Kevlar cord. The transducer should be installed above the bottom of the well with enough room to accommodate the slug to avoid damage to the transducer. The transducer should be installed at an appropriate depth for which it is calibrated accounting not only for the static hydraulic head, but also for the rise and fall of the hydraulic head during testing. Record the depth of the transducer.
  Verify the total well depth with the electronic water level meter or steel tape and record the result. It is not uncommon to measure well depths that differ from as-built well depths in well construction tables.

- Allow water levels to stabilize. The static water level in the well should be measured and monitored long enough to evaluate whether or not any trends exist that could interfere with testing. In general, pre-test water levels should be monitored and recorded for at least a period longer than the duration of the test (ASTM, 2008). One or more background transducers may be specified to record background data for an extended period prior to and during the course of aquifer testing. Background transducers may be situated such that external influences that may influence the testing results will be recorded. Ultimately, the pre-test monitoring program will be based on field conditions and the project-specific data quality objectives.

- Confirm data and settings from previous tests have been cleared. Program data loggers to record water level measurements during the test period. Generally, the measurement schedule is selected to have an initially high rate, followed by a period of reduced measurement frequency as the test progresses. The initial frequency at the time the test is initiated must be sufficient to record the initial displacement produced by insertion of the slug. A high frequency is also required for the period when the slug is removed. For the remainder of the test, the measurement frequency selected will depend on the conductivity of the formation tested, with higher frequencies required for tests in more conductive formations. Tests in less conductive formations will require longer test durations, and the limits of the data logger will need to be taken into account.

- Collect manual water level measurements using an electronic water level indicator with gradations to the nearest 0.01 foot before testing to determine static water levels as well as during the tests to confirm the transducer data. Wristwatches used to record the time of manual water level measurements should be synchronized with the computer used to program the data loggers.

- After the completion of the test(s), download the water level data from the transducer data logger for analysis and ensure the file is saved. This is routinely stored in .txt, .csv, or .xls file formats for importation into Microsoft Excel®, or similar spreadsheet programs. It is also useful to download any time-series figures created by the data logger software during the test; these typically include graphs of pressure head versus time and temperature versus time.

- Pressure readings from the transducer will be adjusted for changes in barometric pressure as necessary. A transducer dedicated to record atmospheric pressure should be placed within one of the test wells or in close proximity and at similar elevation to the tested well. Atmospheric pressure should also be recorded when static levels are recorded.

3.2.3 Slug Insertion and Withdrawal

- Securely attach the cord in the pulley system to the eyelet drilled into one end of the slug. More than one slug may need to be connected end-to-end in order to achieve the desired volume.

- Measure and mark the cord with a permanent pen or secure tape to indicate when the bottom of the slug has been lowered to just above the water table.

- Lower the slug into position in the well just above the water table. Be careful not to hit the pressure transducer cable as you lower the slug and record any disturbances.

- Ensure that a transducer is installed in the well below the water table and has started logging. Start logging if necessary and allow for pre-test data collection.

- Upon collection of suitable pre-test data, initiate the falling-head test by rapidly introducing the solid slug into the well, simulating an instantaneous change in water level. Care should be taken not to drop the slug, but to quickly lower the slug, to avoid excessive splash. Secure the slug during testing to prevent movement. The falling-head test start time shall be recorded.

- Compare the estimate of initial displacement based on well dimensions with the observed initial displacement in the field, which can be calculated from the pressure head versus time graph displayed with the real-time viewing data logger software. Record the observed initial displacement. If values are significantly different, the casing diameter will be measured and used to recalculate the initial displacement. Field staff should also inspect the real-time data collected by the data logger at the start of the test to see if the slug insertion was clean and rapid enough to allow the initial displacement to be identified. If the discrepancy cannot be explained, or the early data is too noisy, the well may require re-testing (check with project manager).

- Continue to monitor progress with the real-time viewing data logger software if available or by frequently checking the water level using an electronic water level indicator until water levels have returned to equilibrium.

- Before initiating the rising-head test, download the data from the falling-head test and re-program the measurement frequency schedule on the data logger. Allow at least one minute to pass after reprogramming before initiating the rising-head test. More time may be allowed as necessary to gather pre-test data.

- Initiate the rising-head test by rapidly removing the slug from the well and secure the slug above the pre-determined static water level by tying off the cord. Removal of the slug should be done in a gentle manner similar to the method of slug insertion described above. The rising-head test start time and observed initial displacement shall be recorded.

- The slug test will continue until water levels have recovered to the static water level measured prior to the test, or until the water level is changing less than 0.01 feet over 10 minutes. Rising head data is unusable for analysis if there hasn't been at least 95% recovery from the falling head test. For tests in low conductivity materials where recovery occurs over an extended period of time, it is preferable to continue the falling head test to the point of 80% recovery than to initiate the rising head test.

- If time permits, both the falling-head and rising-head tests should be repeated.

3.2.4 Equipment Decontamination

All equipment should be decontaminated prior to and after contacting groundwater by washing with a non-phosphate detergent solution (Alconox or equivalent) followed by rinsing with deionized water or by using a steam cleaner if available. Decontamination water will be collected and stored in labeled sealed buckets or drums on-site for future disposal by the client unless other arrangements have been made.

4.0 AQUIFER PUMPING TEST PROCEDURES

This section provides guidance regarding the design and performance of step-drawdown and constant-rate aquifer pumping tests. This section does not cover analysis of aquifer pumping test results.

Step-Drawdown Pumping Tests

A step-drawdown test is performed by pumping a well at a set of sequentially increasing pumping rates and measuring the change in water level in the pumping well, and optionally, in one or more observation wells. At least three pumping steps should be used, with each pumping step maintained ideally until the drawdown in the pumping well has stabilized (this may be impractical for tests in low conductivity formations). Data from step-drawdown pumping tests are used to predict the potential yield of an extraction well, identify performance criteria such as well loss and well efficiency, and provide estimates of the hydraulic conductivity of the surrounding formation.

Constant-Rate Pumping Tests

A constant-rate pumping test is performed by pumping an aquifer for an extended period of time and recording water level changes at the pumping well and in nearby observation wells. The goal of a constant-rate pumping test is to estimate the hydraulic properties of an aquifer including transmissivity, hydraulic conductivity and storativity. In addition, the extended period of pumping allows for the potential identification of aquifer boundaries such as flow barriers (e.g. faults, impermeable materials) and hydraulic connections to sources of recharge (e.g. surface water features). Generally, a step-drawdown test is performed prior to a constant-rate test to establish the flow rate to be used.

4.1 Planning and Design Considerations

Aquifer characteristics and well construction details should be evaluated prior to the start of testing to ensure selected pumping and observation wells will adequately characterize the aquifer in accordance with the test objectives. The conceptual site model should incorporate: whether the aquifer is confined or unconfined; whether wells fully or partially penetrate the aquifer; whether the water table intersects or lies above the well screen; previously determined aquifer characteristics (e.g., permeability, transmissivity, thickness, hydraulic gradients); the location and type of aquifer boundaries; surface water features; and the presence of nearby pumping or injection wells. Knowledge of site conditions will help determine which analytical method to use (ASTM, 2010). This FGD does not cover analysis of aquifer pumping test results, but the chosen analytical method may prescribe specific requirements with regard to well selection; these requirements should be observed.

The well development and construction history of wells should also be evaluated prior to selection of the well network to ensure there are no issues that might interfere with interpretation of test results. For example, an improperly developed well can yield hydraulic conductivity estimates that are biased low due to interference by drilling mud or formation fines.

Once potential wells are identified for the testing program, preliminary estimates of drawdown should be made based on known or estimated site conditions. In general, pumping wells should have an adequate number of potential observation wells nearby that are expected to exhibit significant drawdown. Observation well locations may also be chosen in order to identify aquifer boundaries or anisotropy.

It is also necessary to identify nearby extraction and injection wells that could interfere with the pumping test. These wells should either be turned off well in advance or operated at a constant rate for the duration of the test. It may be prudent to disable automatic pump controls.

The pumping rate(s) selected for the pumping well should be sufficient to stress the aquifer but prevent the well from becoming dry for the duration of the test. Drawing the water level below the perforations in the screen has adverse effects (e.g., cascading water and air entrainment in the well). It is essential to maintain a constant pumping rate for the duration of each pumping step or pumping period. If pumping stops or deviates significantly from the target pumping rate, it is necessary to restart the test after the aquifer has fully recovered. In general, the pumping rate should not be allowed to vary by more than 5 to 10% (ASTM, 2008).

The pumping rate should be monitored very closely at the beginning of each pumping step and then adjusted less often as the test progresses. An instantaneous flow meter is typically used to monitor the pumping rate and should be verified with manual measurements using a graduated cylinder or bucket and a stopwatch. The magnitude of the target pumping rate will determine what types of controls are used to regulate the pumping rate. Higher flow rates generally necessitate both a primary valve installed on the discharge line and a second valve that can be used to make finer adjustments to the flow rate. Lower flow rates can be manipulated with a rheostatic control on the pump, a valve installed in the discharge line, or both of these mechanisms.

Consider installing a “stilling tube” (a small-diameter PVC pipe) to encase the pressure transducer and electronic water level meter tape in order to reduce interference caused by turbulence in the well due to pumping and cascading water. This is particularly important for pumping at higher flow rates.

ENVIRON typically coordinates with a subcontractor to operate the pumps for the well testing, but it is important to confirm that the power supply and pumping equipment are capable of maintaining a constant pumping rate for the duration of the test. In some cases it may be warranted to obtain a backup generator (when using a diesel or gasoline generator) and in exceptional cases it may be warranted to have the local power company provide a power drop (long-term tests in residential areas).

The pump should be sized to operate for sustained periods at the range of flows necessary to perform the tests. The pump should have a maximum capacity higher than the maximum anticipated pumping rate, but should also be able to cool itself properly at the lowest anticipated pumping rate to avoid heat-induced pump failure during the test. A check valve should be installed that prevents backflow of water into the well once pumping is stopped in order to ensure high quality data is obtained at the beginning of the recovery period.

Plans must be made to contain, store, transport, and/or discharge/dispose of the water generated during pump tests in accordance with local, state, and federal laws as well as in accordance with project-specific requirements. Handling investigation-derived waste is a critical task that must be planned in advance particularly for pump testing projects where large volumes of water are to be generated.

4.2 Performing the Pumping Test

This section describes the protocol for performing a pumping test. Prior to conducting a pumping test, field personnel will be provided a field sheet specifying the pumping and observation wells, well construction for these wells, the anticipated water column height within the pumping and observation wells, the pumping rates and step durations to be used, the suggested transducer data acquisition rates, the suggested pump and transducer placement depths, and whether background measurements and/or barometric pressure measurements are required.

4.3 *Equipment*

Equipment needs vary based on the field activity and project. ENVIRON typically collaborates with subcontractors to perform aquifer pumping tests, thus eliminating the need to obtain certain types of equipment such as submersible pumps and holding tanks. In addition to the equipment specified in Section 2.0, the following equipment shall be used to conduct pumping tests:

- Graduated cylinders or buckets
- Field Forms:
    - *Field Investigation Daily Log*
    - *Pump Test Field Log*
- Submersible pump with flow regulator, and tubing
- Pressure transducer(s)
- Field computer
- Generator (if electricity is not available)
- Flow meters
- Heavy duty extension cords
- Polyethylene sheeting
- Large capacity barrels or trailer-mounted holding tanks and/or other means to store and transport pumped groundwater

4.3.1 Water Level Measurement

- Prior to initiating the pumping test, pressure transducers with integral data loggers should be installed in the test well and surrounding observation wells to be monitored and the water level allowed to stabilize. The transducers may be securely deployed by a direct-read cable allowing real-time viewing of data. Confirm data and settings from previous tests have been cleared and that new settings have been programmed. Record the depths of the transducers.

- The static water level in each well should be measured and recorded long enough to evaluate whether or not any trends exist. In general, pre-test water levels should be monitored and recorded for at least one week or a period longer than the duration of the test (ASTM, 2008; USEPA, 1993). Ultimately, the duration of pre-test monitoring will be based on field conditions and the project-specific data quality objectives.

- Program data loggers to record water level measurements during the test period. Generally, the measurement schedule is selected to have an initially high rate, followed by a period of reduced measurement frequency as the test progresses. The frequency selected must be sufficient to record the initial displacement produced at the start of each pumping step and at the start of the recovery period, but not so frequent that the storage limits of the data logger will be exceeded. Similar measurement frequencies should be chosen for the pumping and recovery periods. The following table of measurement frequencies can be used as a general guideline; however, more frequent measurements are typically made (ASTM, 2008):

Elapsed Time	Measurement Frequency
0 to 3 minutes	Every 30 seconds
3 to 15 minutes	Every minute
15 to 60 minutes	Every 5 minutes
60 to 120 minutes	Every 10 minutes
2 to 3 hours	Every 20 minutes
3 to 15 hours	Every hour
• 15 to 60 hours	• Every 5 hours

- Manual water level measurements shall be collected from the test well and monitoring wells immediately prior to the start of each pumping test and recorded on the appropriate field forms or logbook. Manual water level measurements should be recorded periodically for the duration of the test. These measurements should be collected using an electronic water level indicator with gradations to the nearest 0.01 foot. Wristwatches used to record the time of manual water level measurements should be synchronized with the computer used to program the data loggers.

- After the completion of the test(s), download the water level data from the transducer data logger for analysis. This is routinely stored in .txt, .csv, or .xls file formats for importation into Microsoft Excel®, or similar spreadsheet programs. Verify the file is saved. It is also useful to download any time-series figures created by the data logger software during the test; these typically include graphs of pressure head and temperature versus time.

- Pressure readings from the transducer should be compensated for changes in barometric pressure as necessary. A transducer dedicated to record atmospheric pressure should be placed within one of the test wells or in close proximity and at similar elevation to the tested well. Atmospheric pressure should also be recorded when static levels are recorded.

4.3.2 Pumping Period

- At the start of each test, the initial volume of the water in the pump discharge tank will be measured and recorded.

- A properly-sized submersible pump will be set in the pumping well with the intake set two feet above the base of the well screen.

- After the pump is initially placed in the well, field personnel will monitor the water level in the well to ensure that the head change caused by displacement of casing water by the pump and tubing has dissipated. The pump should not be turned on until the static water level has returned to the initial level prior to insertion of the pump.

- During step drawdown or constant rate testing, the flow rate will be continually measured and adjusted to maintain the pumping rate for each step within 10% of the design pumping rate. If the flow rates to be used are low (less than 1.0 gallon per minute [gpm]), the most reliable method of measuring them will be by filling graduated cylinders over 5, 10, 20, or 30-second time intervals. For flows over 1.0 gpm, a calibrated inline flow meter may be used to monitor flow rate. Multiple means of measuring flow are recommended in order to confirm results. Along with flow rate measurements, record the exact time of each pumping rate change.

- For step drawdown tests, each pumping step shall be maintained until the drawdown in the pumping well has stabilized, however this may be impractical for tests in low conductivity formations. For constant rate pumping tests, pumping shall continue for the duration specified for the test to meet established project-specific data quality objectives.

4.3.3 Recovery Period

- After the final pumping step, the pump will be switched off and water levels will be allowed to recover.

- Water level monitoring will continue during the recovery period. Ideally, the recovery period should continue until full recovery (> 90% of long-term drawdown) has been achieved; however, this is not always feasible in low permeability geologic materials.

Equipment Decontamination

At the end of each test, all field equipment that has contacted groundwater will be decontaminated by washing with a detergent solution (Alconox or equivalent) followed by rinsing with deionized water or a steam cleaner if available. Decontamination water will be collected and stored in labeled sealed buckets or drums on-site for future disposal by the client unless other arrangements have been made.

5.0 RECOVERY TESTING PROCEDURES

This section discusses recovery testing conducted as a standalone test at an operating extraction well. Recovery testing conducted as part of the recovery phase of an aquifer pumping test is discussed in Section 5.0. Recovery test results assist in the determination of hydraulic conductivity and storativity of the formation, while also providing information on the extent to which cones of depression may overlap for neighboring wells.

5.1 Planning and Design Considerations

Wells are selected for recovery testing based on a review of long-term pumping rates for each extraction well. Recovery tests should only be conducted at extraction wells where recent pumping rates are relatively stable.

Prior to initiating each recovery test, the long-term drawdown at the extraction well should be estimated by comparing historical water levels trends at the test well and neighboring cross-gradient monitoring wells, and/or by modeling the long-term drawdown based on the average pumping rate and previous estimates of hydraulic conductivity in the vicinity of the extraction well. This information is required to compute the residual drawdown during the course of the test.

5.2 Performing the Recovery Test

This section describes the protocol for performing a recovery test.

5.2.1 Equipment

In addition to the equipment specified in Section 2.0, the following equipment shall be used to conduct recovery tests:

- Field Forms:
  - *Field Investigation Daily Log*
  - *Pump Test Field Log*

5.2.2 Water Level Measurement

- Prior to conducting the recovery test, pressure transducers with integral data loggers should be installed in the test well (if possible) and in one or more monitoring wells in proximity to the test well. The transducers should be securely deployed by direct-read cables allowing real-time viewing of data if possible. Otherwise, transducers should be deployed using inert, low-stretch nylon or Kevlar cord. Record the depths of the transducers. Water levels shall be allowed to stabilize.

- Data loggers shall be programmed to record water level measurements during the test period at the specified frequency. The frequency selected must be sufficient to record the initial displacement produced at the start of the recovery test, but not so frequent that the storage limits of the data logger will be exceeded. The following table of measurement frequencies can be used as a general guideline; however, more frequent measurements are typically made (ASTM, 2008):

Elapsed Time	Measurement Frequency
0 to 3 minutes	Every 30 seconds
3 to 15 minutes	Every minute

15 to 60 minutes	Every 5 minutes
60 to 120 minutes	Every 10 minutes
2 to 3 hours	Every 20 minutes
3 to 15 hours	Every hour
15 to 60 hours	Every 5 hours

- Manual water level measurements shall be collected from the test well and monitoring wells immediately prior to the start of each recovery test and recorded on the appropriate field forms and/or logbook. Manual water level measurements should be recorded periodically for the duration of the test. These measurements should be collected using an electronic water level indicator with gradations to the nearest 0.01 foot.

- Initiate the recovery test by shutting off the extraction well pump. Record the exact pump shutdown time and depth to water.

- Ideally, the recovery test should continue until full recovery (> 90% of long-term drawdown) has been achieved; however, this is not always feasible in low permeability geologic materials.

- Upon completion of the recovery test, restart the pump and record the exact time and depth to water on the Pump Test Field Log.

- After the completion of the test(s), download the water level data from the transducer data loggers for analysis and verify the file is saved. This is routinely stored in .txt, .csv, or .xls file formats for importation into Microsoft Excel®, or similar spreadsheet programs. It is also useful to download any time-series figures created by the data logger software during the test; these typically include graphs of pressure head and temperature versus time.

- Pressure readings from the transducer should be compensated for changes in barometric pressure as necessary. A transducer dedicated to record atmospheric pressure should be placed within one of the test wells or in close proximity and at similar elevation to the tested well. Atmospheric pressure should also be recorded when static levels are recorded.

5.2.3 Equipment Decontamination

At the end of each test, all field equipment that has contacted groundwater should be decontaminated by washing with a detergent solution (Alconox or equivalent) followed by rinsing with deionized water or steam cleaning if available. Decontamination water will be collected and stored in labeled sealed buckets or drums on-site for future disposal by the client unless other arrangements have been made.

6.0 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 Health and Safety Plan must be prepared and approved by the Project Manager and the local Health and Safety Coordinator prior to initiating field work.

7.0 RECORD-KEEPING

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*
- *Slug Test Field Log*
- *Pump Test Field Log*

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.

The *Slug Test Field Log* will be used to document the procedures, parameters, and results of the slug test.

The *Pump Test Field Log* will be used to document the procedures, parameters and results of the pump test.

Locations and unique identification of samples collected will be recorded on the *Field Investigation Daily Log*, a site map, and/or other appropriate forms.

FIELD GUIDANCE DOCUMENT NO. 012
TRENCHING AND EXCAVATION

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Table of Contents

1.0 INTRODUCTION

This Field Guidance Document (FGD) describes the procedures for trenching and excavation 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 trenching and excavation 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 trenching and excavation are performed in a safe manner, 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.

A trench or trench excavation is defined as: a narrow excavation (in relation to its length) made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench is not greater than 15 feet. Selection of the appropriate trenching equipment, (i.e. earth moving excavator or equivalent), will be based on anticipated field conditions such as: accessibility to the trenching area, site geology, site hydrogeology (e.g., depth of the water table, soil grain size, and estimated permeability); and, weather conditions (such as rain). If required, permits for trenching will be acquired from the appropriate agency or agencies before the trenching is initiated. An underground utility check will be performed by contacting a local utility alert service. Trenching activities will proceed with caution.

2.0 EQUIPMENT/MATERIALS

Equipment and materials needed to conform to this FGD include:

- Personal protective equipment (Level D)
- Photoionization detector/Flame ionization detector/Lower explosion limit meter
- Trenching equipment (i.e. earth moving excavator)
- Underground utility check

- Field Forms (If the project requires it, a project-specific Field Logbook may substitute for any or all of the following)
  - *Field Investigation Daily Log*
  - *Equipment Calibration Log*
  - *Chain of Custody*

Based on the field activity and project, the following also may be needed:

- Dust monitor
- Organic vapor monitor
- Trenching permits

3.0 PROCEDURES

3.1 Trenching

An experienced field geologist or engineer will be placed in charge of trenching activities. The field person will conduct visual inspection as dictated by the work being done in and around the trench. Observations will made of the open trench and the surface area adjacent to the trench concerning tension cracks, underground structures, water seeping from the trench sides, slumping soil caused by vibrating machinery, undercutting, movement in adjacent structures, or similar conditions occurring. No person will be in the trench while heavy equipment is digging.

Field personnel working in the vicinity of the operating heavy equipment will be required to wear reflective vests marked with high visibility material and must wear a hard hat. Field personnel will not be allowed to work under lifted loads or loads being moved by heavy equipment. Field personnel will be required to stand away from equipment that is being excavated.

Field personnel will periodically screen the soil using a portable meter such as a photoionization detector (PID) or a flame ionization detector (FID), and/or a lower explosion limit (LEL) meter. The meter(s) will be used to assess the presence of total volatile organic compounds (VOCs) or other gases in soil. In addition, a dust monitor will be placed downwind to measure the amount of dust particles created by trenching activities. If the dust becomes visible, water will be sprayed on the area being trenched to minimize dust emissions. If watering does not work to contain the dust, trenching will cease until such time as the dust is no longer an issue.

Stockpiling of excavated soils from the trench will not be closer than 2 feet from the edge of the trench. Soil will be stockpiled separately from objects. If soil appears to be discolored or stained, or exhibits other field evidence of contamination (such as odors or elevated [organic vapor monitor] OVM readings), it will be stockpiled separately on plastic sheeting, and covered with plastic sheeting at the end of each day. Objects that may be unearthed during excavation will be separated and stockpiled pending appropriate disposal. If any hazardous material is excavated during trenching, such as drums, it will be stockpiled on plastic sheeting pending appropriate disposal.

3.2 Excavation

Excavation will be conducted using heavy earth equipment. Excavation is defined as any man-made cut, cavity trench, or depression in the earth's surface formed by earth removal. The appropriate earth moving equipment will be lowered gently taking care not to over excavate. Field personnel will direct the operator on how and where to place the equipment. Documentation of the excavation will follow the same procedures as the trenching. The soil generated from the excavation will be stockpiled on a flat surface adjacent to the excavation and profiled pending appropriate disposal, as discussed in Section 4.3.

3.3 Stockpile Sampling

In some cases, once trenching is completed, samples will be collected from the bottom or sides of the trench. Samples will be selected in the field in areas of visible discoloration, staining, odors, and/or elevated PID readings. If discoloration, staining, and other field evidence of contamination are not obvious, then the samples will be randomly selected.

In addition to collecting soil samples from the bottom and sides of the trenches, any stockpiled materials will be profiled for characterization and appropriate disposal by collecting samples from each stockpile. The soil samples will be collected in glass jars, placed on ice, and shipped under appropriate chain-of-custody procedures to a certified laboratory. Analytical requirements for the stockpiled samples will be selected on receipt of the sample results from the soil samples collected from the bottom and sidewalls of the trenches.

3.4 Stockpile Disposal

If the results of the stockpile samples show no contamination, or detected concentrations of chemicals within acceptable regulatory limits, then the soil will be redistributed within the trench. If soil is deemed contaminated, then it will be disposed off-site.

3.5 Quality Control Samples

All field Quality Control (QC) samples must be prepared the same as primary samples with regard to sample volume, containers, and preservation. The sample handling and chain-of-custody procedures for the QC samples will be identical to the primary samples. The following are QC samples that may be collected during soil sampling:

- A field duplicate is an independent sample collected as close as possible to the same time that the primary sample is collected and from the same source. Field duplicates are used to document sample precision. Field duplicates will be labeled and packaged in the same manner as primary samples so that the laboratory cannot distinguish between the primary sample and the duplicate sample. Field duplicates are analyzed for the same suite of parameters as the primary samples. The frequency of analysis of field duplicates is generally one for every 20 primary samples, but may vary depending on project requirements.

- Equipment blanks are obtained by running distilled or deionized water over or through the sample collection equipment after it has been decontaminated, and capturing the water in the appropriate sample containers for analysis. Equipment blanks are analyzed for the same suite of parameters as the primary samples. The frequency of analysis of equipment blanks is generally one for every day that non-dedicated sampling equipment is used, but may vary depending on project requirements.
- Field blanks are used to assess the presence of contaminants arising from field sampling procedures. Field blank samples are obtained by filling a clean sampling container with reagent-grade deionized water. Field blanks are analyzed for the same suite of parameters as the primary samples. Field blanks may or may not be incorporated into a groundwater sampling plan depending on project requirements.
- Trip blanks are sample containers that are used to evaluate sample cross-contamination of VOCs during shipment. For groundwater sampling, trip blanks consist of hydrochloric acid-preserved, analyte-free, deionized water prepared by the laboratory in VOA vials that will be carried to the field, stored with the samples, and returned to the laboratory for VOC analysis. Generally, one trip blank is required to accompany each sample shipping container or cooler that contains samples for VOC analysis; however, this may vary depending on project requirements.

3.6 Sample Handling and Custody

Samples 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.

3.6.1 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.

3.6.2 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.

3.6.3 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.

3.6.4 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.

3.6.5 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. 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). The trenching contractor shall be a licensed environmental contractor in accordance with local and state requirements, and qualified to conduct excavations and trenching for environmental investigations.

Where required, permits will be obtained from the appropriate agency, and an underground utility check will be performed before excavating begins. An underground utility check will, at a minimum, consist of contacting the local utility alert service, e.g., Underground Service Alert (USA), if available. Typically, subsurface clearance should also be conducted by a private utility locating company contacted specifically to clear individual boring locations. Under certain circumstances, including at sites with deeply buried, unknown, or multiple underground utilities, as well as at high risk sites such as oil refineries and heavy industrial facilities, manual utility clearance using hand auger or air knife methods should also be performed. Additional subsurface clearing requirements may be described in the site-specific Health and Safety Plan.

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.

Additional precautions include the following:

- Trenches four feet deep or deeper will not be entered by field personnel unless they have been evaluated by a competent person and have been appropriately benched, shored, and/or sloped according to the procedures and requirements set forth by OSHA. Surface crossing of trenches will not be made. If bedrock is reached shallower than a depth of 4 feet, then benching will not be necessary.

5.0 RECORDKEEPING

Information collected during trenching 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 Leader, 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*
- *Field Trenching Log*
- *Equipment Calibration Log*
- *Chain-of-Custody*

A *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 the drillers and any other subcontractors 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 Leader, 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 *Field Trenching Log* will be used to record the locations and unique identification of soil samples collected from the trench. The *Field Trenching Log* will also be used to create a sketch and record lithological descriptions of the soils, rock types, and any debris that is encountered.

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, LEL, OVM, measuring tapes, water level measuring device, 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 any samples collected from the surface of the site, from trenches, or from stockpiles will be recorded on the *Field Investigation Daily Log, Field Trenching Log*, a site map, and/or other appropriate forms.

Samples 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.

Appendix B

Example Field Data Sheets

PAGE ____of ____

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FIELD INVESTIGATION DAILY LOG
PRELIMINARY FIELD DRAFT - REVIEW PENDING

PROJECT NAME: ______________________________ FIELD PERSON: ______________________________

PROJECT NUMBER: ______________________________ PROJECT MANAGER: ______________________________

PROJECT LOCATION: ______________________________ DATE: ______________________________

DAILY SUMMARY: ______________________________

WEATHER CONDITIONS: ______________________________

VISITORS/SUBCONTRACTORS: ______________________________

MILITARY TIME	ACTIVITIES

Prepared By (name/signature): ______________________________ Date: ____________________

Reviewed By (name/signature): ______________________________ Date: ____________________

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EQUIPMENT CALIBRATION LOG

PRELIMINARY FIELD DRAFT REVIEW PENDING

PAGE ____ of ____

PROJECT NAME: ______________________________

FIELD PERSON: ______________________________

PROJECT NUMBER: ______________________________

PROJECT MANAGER: ______________________________

PROJECT LOCATION: ______________________________

FORM DATES: FROM ____________________ TO ____________________

DATE	EQUIPMENT MODEL/TYPE	SERIAL NUMBER	TEMP. (°C)	STANDARD	PRECALIBRATED READING	CALIBRATED READING

PAGE 1 of ____

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FIELD SOIL BORING LOG

PRELIMINARY FIELD DRAFT - REVIEW PENDING

PROJECT NAME: ______________________

PROJECT NUMBER: ______________________

PROJECT LOCATION: ______________________

FIELD PERSON: ______________________

PROJECT MANAGER: ______________________

DATE: ______________________

BORING LOCATION MAP

SOIL BORING NUMBER:

DRILLING CONTRACTOR:

DRILLER:

RIG TYPE:

OTHER EQUIPMENT:

SAMPLING METHODS:

HAMMER WEIGHT: DROP:

TOTAL DEPTH: BOREHOLE DIAMETER:

START TIME: STOP TIME: (DATE IF NEC.)

BACKFILL TIME: DATE: BY:

COMMENTS

SAMPLE DEPTH	SAMPLER TYPE	BLOWS IN 6 INCHES	FEET DRIVEN	FEET RECOVERED	PID/FID (TOVs)	SAMPLE NUMBER	TIME	DEPTH IN FEET	USGS CODE/ CONTACT	DEPTH IN FEET	SAMPLE DESCRIPTION
								1			
								2			
								3			
								4			
								5			
								6			
								7			
								8			
								9			
								10			

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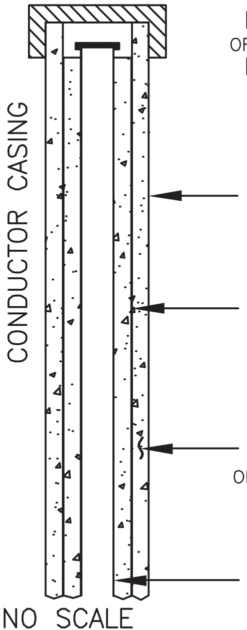
PAGE ____of ____

FIELD WELL COMPLETION LOG
PRELIMINARY FIELD DRAFT - REVIEW PENDING

PROJECT NAME: ______________________________
FIELD PERSON: ______________________
PROJECT NUMBER: ______________________________
PROJECT MANAGER.: ______________________
PROJECT LOCATION: ______________________________
DATE: ______________________



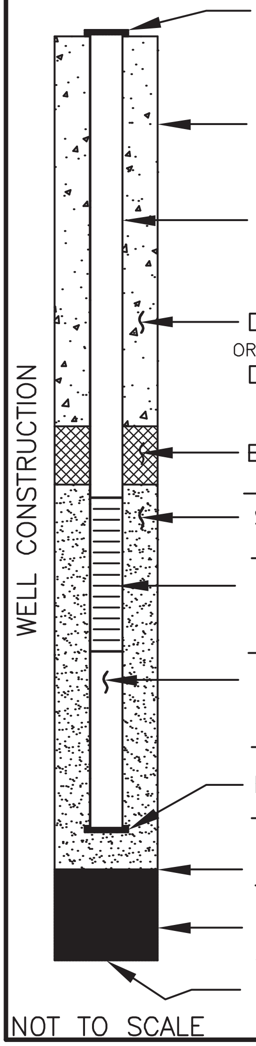
☐ CHRISTY BOX
OR
☐ LOCKING STEEL COVER ______FEET ☐ ABOVE ☐ BELOW GROUND LEVEL

______ in. DIAMETER BOREHOLE
_____ TO _____ FEET

______ in. DIAMETER STEEL CONDUCTOR CASING
_____ TO _____ FEET

☐ BENTONITE–CEMENT SEAL
OR
☐ SAND–CEMENT SEAL
_____ TO _____ FEET

(BLANK CASING)



TOP OF CASING AT ______FEET
☐ ABOVE ☐ BELOW GROUND LEVEL

______ in. DIAMETER BOREHOLE
_____ TO _____ FEET

______ in. DIAMETER BLANK CASING
_____ TO _____ FEET

☐ BENTONITE–CEMENT SEAL
OR
☐ SAND–CEMENT SEAL
_____ TO _____ FEET

BENTONITE PELLET SEAL
_____ TO _____ FEET

SANDPACK
_____ TO _____ FEET

_____ in. DIAMETER SLOTTED SCREEN
_____ TO _____ FEET

_____ in. DIAMETER BLANK SILT TRAP
_____ TO _____ FEET

BOTTOM WELL CAP
FEET
TYPE______________

HOLE CLEANED OUT
TO __________ FEET

BACKFILL MATERIAL
____

BOTTOM OF BOREHOLE
______________ FEET

WELL NUMBER: ______________________________
WELL LOCATION: ______________________________
DRILLING COMPANY: ______________________________
DRILLER: ______________________________
DRILLING METHOD: ______________________________
GALLONS OF WATER USED DURING DRILLING: ______________
METHOD OF DECONTAMINATION: ______________________

WATER CONTAINMENT:

☐ GROUND SURFACE
☐ STORM SEWER
☐ DRUM
☐ TANK TRUCK
☐ STORAGE TANK
☐ OTHER: ______________

BEFORE DEVELOPMENT:

DEPTH TO WATER: ______________________ FEET BGS
DATE: ____________________ TIME:____________________

MATERIALS USED:

LENGTH OF ____________ IN CONDUCTOR CASING: __________ FEET
LENGTH OF ____________ IN SLOTTED SCREEN: __________ FEET
MATERIAL: ______________________________
SLOT SIZE: ______________________________
LENGTH OF ____________ IN BLANK CASING: __________ FEET
MATERIAL: ______________________________

NUMBER OF (_____ LB) SACKS OF SAND: ______________
SAND NAME/NUMBER: ______________________

POUNDS OF BENTONITE PELLETS: ______________________
PELLET SIZE: ______________________________

NUMBER OF (_____ LB) SACKS OF CEMENT: ______________

NUMBER OF (_____ LB) SACKS OF POWDERED BENTONITE: __________
AMOUNT OF GROUT: ______________________________ (LBS)

AMOUNT OF REDIMIX CEMENT–SAND ORDERED: ______________ (YD^3)

AMOUNT OF REDIMIX CEMENT–SAND USED: ______________ (YD^3)

NUMBER OF (_____ LB) SACKS OF REDIMIX USED: ______________

CONCRETE PUMP USED: ______________________________

NOTES:

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WELL DEVELOPMENT

PRELIMINARY FIELD DRAFT
REVIEW PENDING

METHOD(S)	PUMP	BAILER	SURGE BLOCK
TYPE			
MATERIAL			
DIMENSION			
OTHER			

PROJECT		WELL NO.
JOB NO.	SITE	PREPARED BY

DEVELOPMENT CRITERIA

DECONTAMINATION METHOD

HOLE DIAMETER d_h =

WELL CASING

INSIDE DIAMETER d_w =

CASING STICKUP SU=

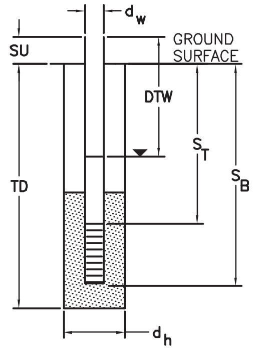
DEPTH TO:

WELL LEVEL DTW=

TOP SCREEN $SU+S_T$ =

BASE SCREEN $SU+S_g$ =

BOTTOM WELL SU+TD=



CASING VOLUME CALCULATION (USE CONSISTENT UNITS)

CASING VOLUME = $V_C = \pi\left(\frac{d_w}{2}\right)^2 (TD-H)$ =

FIELD EQUIPMENT CALIBRATIONS

EQUIPMENT MODEL/TYPE			
SERIAL NO.			
DATE CALIBRATED			
TEMP (°C)			
STANDARD/ACTUAL			

DEVELOPMENT LOG:

DATE	TIME		METHOD	WATER REMOVED (gal)	CUMULATIVE TOTAL REMOVED		WATER CHARACTER				COMMENTS:
	BEGIN	FINISH			GAL.	CASING VOLUMES	pH	CONDUCTIVITY	TEMP.(C°)	TURBIDITY	

PAGE 1 of ____

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WATER LEVEL MEASUREMENT LOG
PRELIMINARY FIELD DRAFT REVIEW PENDING

PROJECT NAME: ____________________

MEASUREMENT DATE: ____________________

CONTRACT NUMBER: ____________________

FIELD PERSON: ____________________

EQUIPMENT MODEL/TYPE	SERIAL NUMBER	LAST CALIBRATION DATE

MEASURING POINTS AND DATUM USED: ____________________

WELL NUMBER	TIME	MEASURING POINT	DEPTH TO GROUNDWATER (FT BGS)	DEPTH TO FREE PRODUCT (FT BGS)	FREE PRODUCT THICKNESS (FT)	CONDITION OF WELL

PAGE ____of ____

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LOW-FLOW WATER PURGING & SAMPLING LOG

PRELIMINARY FIELD DRAFT
REVIEW PENDING

PROJECT NAME: ______________________________

FIELD PERSON: ______________________________

PROJECT NUMBER: ______________________________

PROJECT MANAGER: ______________________________

PROJECT LOCATION: ______________________________

DATE: ______________________________

PUMP / TUBING TYPE:

EQUIPMENT CLEANING METHOD:

PURGE WATER DISPOSAL:

WELL NUMBER:

CASING RADIUS:______________________________(in.)

TOTAL DEPTH (TD):______________________________(ft.)

DEPTH TO WATER (DTW):______________________________(ft.)

SCREENED INTERVAL:______________________________(ft.)

PURGE START TIME:

PUMP SET AT (ft.)

TIME	PURGE RATE (ml/min)	VOLUME PURGED (ml)	DTW (ft)	TEMP (°C)	pH	COND. (µS/cm)	DO (mg/L)	ORP (mV)	TURB. (NTU)	

PURGE STOP TIME:

SAMPLE TIME:

LAB NAME:

SAMPLE ID:

OBSERVATIONS/COMMENTS (NOTE TIMES):

FILE: LOG FORMS\em–Water Purging & Sampling Log–10–20–09.dwg

PAGE ____ of ____

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VAPOR PURGING AND SAMPLING LOG

PRELIMINARY FIELD DRAFT REVIEW PENDING

PROJECT NAME: ____________________ FIELD PERSON: ____________________
PROJECT NUMBER: ____________________ PROJECT MANAGER: ____________________
PROJECT LOCATION: ____________________ DATE: ____________________

PURGING / SAMPLING METHOD:	**SAMPLING LOCATION:**
EQUIPMENT CLEANING METHOD:	TUBING RADIUS (TR): ____________ (in.) TOTAL LENGTH OF TUBING (TL): ________ (in.) TUBING VOLUME: ____________ (in.^{3}) (TL)(TR)^2(3.14)= TUBING VOLUME: ____________ (cc) TV (in.^{3}) x 16.39=
DECON. WATER DISPOSAL:	
TYPE OF CANISTER(S): ____________	CANISTER ID NUMBER: ____________
PURGE START TIME: ________	PURGE STOP TIME: ________
PURGE VOLUME: ________	PURGE RATE: ________
SAMPLE COLLECTION START TIME: ________ INITIAL VACUUM: ________ (psi / mmHg) SAMPLE DEPTH: ________	SAMPLE COLLECTION STOP TIME: ________ FINAL VACCUM: ________ (psi / mmHg)
LAB NAME: ____________	SAMPLE ID: ____________
OBSERVATIONS / COMMENTS:	

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PAGE ____ of ____

SLUG TEST FIELD LOG

PRELIMINARY FIELD DRAFT REVIEW PENDING

PROJECT NAME: ____________________
PROJECT NUMBER: ____________________
PROJECT LOCATION: ____________________
FIELD PERSON: ____________________
PROJECT MANAGER: ____________________
DATE: ____________________

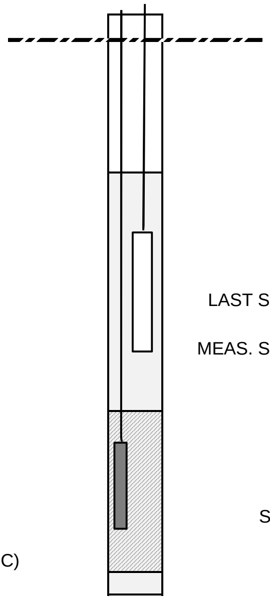
WELL NAME: ☐

SLUG 1
DIMENSIONS: ____________
PRED. DISPLACEMENT: ____________ (ft)
OBS. DISPLACEMENT: ____________ (ft)

SLUG 2
DIMENSIONS: ____________
PRED. DISPLACEMENT: ____________ (ft)
OBS. DISPLACEMENT: ____________ (ft)

TRANSDUCER MODEL: ____________

EST. TRANSDUCER DEPTH: ____________ (ft bTOC)



CAS. DIAM: 2 (in)
LAST DTW: ____________ (ft bgs)
MEAS. DTW: ____________ (ft bgs)
LAST STAT. WC. HT. ____________ (ft)
MEAS. STAT. WC. HT. ____________ (ft)
TOS: ____________ (ft bgs)
BOS: ____________ (ft bgs)
SCR. LENGTH: ____________ (ft)
TD: ____________ (ft bgs)

TIME	DEPTH TO WATER (feet bTOC)	TRANSDUCER READING (ft)	NOTES `

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Page______of______

Investigation Derived Waste (IDW) Log

Project Name: ____ Field Person: ______________________________
Project Number: _______________________________________ Project Manager: __________________________
Project Location: _______________________________________ Date(s): ____________________________________

Container Type Drum, Bucket, Poly Tank, etc	**Content Type** Soil Cuttings, Purge Water, Decon Water, etc	**# of Containers**	**Quantity** yards, feet^3, gallons	**Profiled** Yes/No	**Hazardous/ Non-Hazardous**	**Date Removed**

Generator Name: ______________________________________

Generator Address: ______________________________________

____

Site Contact Name/#: ______________________________________

Site Address: ______________________________________

____

EPA-ID #: ______________________________________

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Appendix C

Copies of QAPP Tables for Field Reference

TABLE 1. ANALYTICAL METHODS AND LABORATORIES
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

ANALYTES	MATRIX	ANALYTICAL METHOD	ANALYTICAL LABORATORY	SOPs REVIEW DATE[1]
Volatile Organic Compounds (VOCs) [2]	Water	EPA Method 8260B	TestAmerica (Irvine, CA)	November 4, 2013
	Soil	EPA Method 8260B		
	Water	EPA Method 8260B SIM	TestAmerica (Irvine, CA)	July 26, 2013
	Soil	EPA Method 8260B SIM		
	Soil Gas	EPA Method TO-15	McCampbell Analytical (Pittsburg, CA)	December 16, 2013
Semivolatile Organic Compounds (SVOCs)	Water	EPA Method 8270C	TestAmerica (Irvine, CA)	November 18, 2013
	Soil	EPA Method 8270C		
Phthalic Acid[3]	Water	EPA Method 8270C	TestAmerica (Denver, CO)	January 31, 2014
	Soil	EPA Method 8270C		
Polyaromatic Hydrocarbons (PAHs)	Water	EPA Method 8270 SIM	TestAmerica (Irvine, CA)	July 19, 2013
	Soil	EPA Method 8270 SIM		
4-chlorobenzenesulfonic acid (p-CBSA)	Water	EPA Method 8321A	TestAmerica (Sacramento, CA)	October 5, 2012
Volatile Fatty Acids	Water	Lab SOP by Ion Chromatography SOP No. BF-MB-009, Rev 3	TestAmerica (Buffalo, NY)	February 3, 2014
Organochlorine Pesticides	Water	EPA Method 8081A	TestAmerica (Irvine, CA)	February 28, 2013
	Soil	EPA Method 8081A		
Organophosphorus Pesticides	Water	EPA Method 8141A	TestAmerica (Denver, CO)	July 15, 2013
	Soil	EPA Method 8141A		
PCBs as Aroclors	Water	EPA Method 8082	TestAmerica (Irvine, CA)	August 5, 2013
	Soil	EPA Method 8082		
PCBs as Congeners	Water	EPA Method 1668A	TestAmerica (Sacramento, CA)	May 10, 2013
	Soil	EPA Method 1668A		
Dioxins/Furans	Water	EPA Method 8290	TestAmerica (Sacramento, CA)	April 19, 2013
	Soil	EPA Method 8290		
Gasoline Range Organics (GROs)	Water	EPA Method 8015B	TestAmerica (Irvine, CA)	August 27, 2012
	Soil	EPA Method 8015B		
Diesel/Oil Range Organics (DROs/OROs)	Water	EPA Method 8015B	TestAmerica (Irvine, CA)	October 31, 2012
	Soil	EPA Method 8015B		

TABLE 1. ANALYTICAL METHODS AND LABORATORIES
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

ANALYTES	MATRIX	ANALYTICAL METHOD	ANALYTICAL LABORATORY	SOPs REVIEW DATE$^{(1)}$
Methane	Water	Method RSK 175	TestAmerica (Irvine, CA)	December 5, 2013
Metals$^{(4)}$	Water	EPA Method 200.7 / 6010	TestAmerica (Irvine, CA)	May 17, 2013
	Soil	EPA Method 200.7 / 6010		
Metals$^{(5)}$	Water	EPA Method 200.8 / 6020	TestAmerica (Irvine, CA)	August 30, 2013
	Soil	EPA Method 200.8 / 6020		
Rare Earth Metals$^{(6)}$	Water	EPA Method 6020A	TestAmerica (St. Louis, MO)	August 27, 2013
	Soil	EPA Method 6020A		
Arsenic III/V	Water	EPA Method 1632	ALS (Kelso, Washington)	Febraury 15, 2014
Mercury	Water	EPA Method 7470A	TestAmerica (Irvine, CA)	June 21, 2013
	Soil	EPA Method 7471A		
Hexavalent Chromium	Water	EPA Method 7199	TestAmerica (Irvine, CA)	September 9, 2013
	Soil	EPA Method 7199		
Alkalinity and Carbonate	Water	SM 2320B	TestAmerica (Irvine, CA)	October 14, 2013
	Soil	SM 2320B		
Hardness	Water	SM 2340C	TestAmerica (Irvine, CA)	March 7, 2014
Ammonia	Water	SM 4500-NH_3 D	TestAmerica (Irvine, CA)	August 30, 2013
	Soil	SM 4500-NH_3 D		
Total Kjedahl Nitrogen (TKN)	Water	EPA Method 351.2	TestAmerica (Irvine, CA)	June 13, 2014
Inorganic Anions$^{(7)}$	Water	EPA Method 300.0	TestAmerican (Irvine, CA)	September 27, 2013
	Soil	EPA Method 300.0		
Chlorate	Water	EPA Method 300.1	TestAmerican (Irvine, CA)	September 30, 2013
	Soil	EPA Method 300.1		
Cyanide	Water	EPA Method 9014B	TestAmerica (Irvine, CA)	June 21, 2013
	Soil	EPA Method 9014B		
Formaldehyde	Water	EPA Method 8315A	TestAmerica (Irvine, CA)	October 29, 2013
	Soil	EPA Method 8315A		

TABLE 1. ANALYTICAL METHODS AND LABORATORIES
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

ANALYTES	MATRIX	ANALYTICAL METHOD	ANALYTICAL LABORATORY	SOPs REVIEW DATE[1]
Phosphorus	Water	EPA Method 365.3	TestAmerica (Irvine, CA)	September 7, 2013
Sulfide	Water	EPA Method 4500	TestAmerica (Irvine, CA)	October 31, 2012
Perchlorate	Water	Sterile Filtered[8] EPA Method 314.0	TestAmerica (Irvine, CA)	October 2, 2013
	Soil	EPA Method 314.0		
pH	Soil	EPA Method 9045C	TestAmerica (Irvine, CA)	December 2, 2013
Specific Conductance	Water	EPA Method 120.1 / SM 2510B	TestAmerica (Irvine, CA)	September 3, 2013
	Soil	EPA Method 120.1 / SM 2510B		
Total Dissolved Solids (TDS)	Water	SM 2540C	TestAmerica (Irvine, CA)	September 30, 2013
Total and/or Dissolved Organic Carbon	Water	SM 5310B	TestAmerica (Irvine, CA)	September 17, 2013
	Soil	SM 5310B		
Surfactants	Soil	SM 5540C	TestAmerica (Irvine, CA)	October 31, 2012
Radium 226	Water	EPA Method 903.0	TestAmerica (St. Louis, MO)	July 16, 2013
	Soil	EPA Method 903.0		
Radium 228	Water	EPA Method 904.0	TestAmerica (St. Louis, MO)	August 21, 2013
	Soil	EPA Method 904.0		
Thorium 228, 230, 232 and Uranium 234, 235, and 238	Water	DOE EML HASL 300 A-01-R (alpha spectroscopy)	TestAmerica (St. Louis, MO)	July 16, 2013
	Soil	DOE EML HASL 300 A-01-R (alpha spectroscopy)		
Asbestos	Soil	EPA Method 540-R-97-028 modified per Berman & Kolk (2000)	EMSL Analytical (Cinnaminson, NJ)	June 11, 2010
Helium	Soil Gas	ASTM D1946	McCampbell Analytical (Pittsburg, CA)	July 1, 2011

Notes:

ASTM = American Society for Testing and Materials	EPA = United States Environmental Protection Agency
DOE = Department of Energy	KPA = Kinetic Phosphorescense Analyzer

TABLE 1. ANALYTICAL METHODS AND LABORATORIES
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

ANALYTES	MATRIX	ANALYTICAL METHOD	ANALYTICAL LABORATORY	SOPs REVIEW DATE[1]

GS = gas chromatography
GC/MS = gas chromatography-mass spectrometry
HASL = Health and Safety Laboratory
HPLC = High-performance liquid chromatography
EML = Environmental Measurements Laboratory
SIM = Single Ion Monitoring
SM = Standard Method

(1) The Standard Operating Procedures (SOPs) Review Date is the date of the laboratory's current approved SOPs that will be implemented for this project. Laboratories are responsible for notifying ENVIRON of any revisions to the SOPs referenced above. The use of revised SOPs are subject to approval.

(2) 1,4 dioxane and 1,2,3-Trichloropropane will be run by EPA Method 8260B SIM.

(3) TestAmerica's Irvine office is in the process of bringing phthalic acid online so that it can be analyzed with the SVOCs by EPA Method 8270C. Revisions to the SOP will be based on the SOP for EPA Method 8270C provided by TestAmerica's Denver office.

(4) Silicon and phosphorus can also analyzed by this method.

(5) Certain metals will be analyzed by EPA Method 200.8 / 6020 to overcome matrix interference from saltine groundwater and/or to achieve lower PQLs and MDLs.

(6) Niobium, palladium, sulfur and/or uranium

(7) Fluoride, chloride, bromide, sulfate, ortho-phosphate as PO_4, nitrate, and/or nitrate.

(8) Water samples analyzed for perchlorate must be field filtered using sterile 20-millilter (mL) syringes and sterile surfactant free cellulose acetate 0.2 micrometer (µm) filters into sterile sample containers (125-mL sterile high density polyethylene bottles).   Additional perchlorate sampling requirements are detailed in Nevada Division of Environmental Protection (NDEP) guidance documents (2010).

Sources:

Berman, Q.W. and Kolk, A.J. 2000. Modified Elutriator Method for the Determination of Asbestos in Soil and Bulk Materials, Revision 1. Submitted to the U.S. Environmental Protection Agency, Region 8, May 23.

NDEP. 2010. Email from Sara Rairick, Lab Certification Officer, Nevada Division of Environmental Protection, re: Sterile Filtration Required for Perchlorate Sampling. July 9.

TABLE 2. SOIL ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS[2]					
				Practical Quantitation Limit	Method Detection Limit	Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
ANALYTES	**CAS Number**	**Screening Level**	**Screening Level Source[1]**	**(PQL)**	**(MDL)**	**%R**	**RPD**	**%R**	**RPD**	**%R**	**RPD**
Metals (mg/kg)											
EPA Method 200.7 / 6010											
Aluminum	7429-90-5	100,000	NDEP 2013	10	5	-- --	50	75 - 125	20	80 - 120	20
Antimony	7440-36-0	454	NDEP 2013	10	5	-- --	50	75 - 125	20	80 - 120	20
Barium	7440-39-3	100,000	NDEP 2013	1.5	0.75	-- --	50	75 - 125	20	80 - 120	20
Beryllium	7440-41-7	2,228	NDEP 2013	0.50	0.25	-- --	50	75 - 125	20	80 - 120	20
Boron	7440-42-8	100,000	NDEP 2013	5	2.5	-- --	50	75 - 125	20	80 - 120	20
Cadmium	7440-43-9	1,114	NDEP 2013	0.5	0.25	-- --	50	75 - 125	20	80 - 120	20
Calcium	7440-70-2	--	NDEP 2013	25	12.5	-- --	50	75 - 125	20	80 - 120	20
Chromium (total)	7440-47-3	100,000	NDEP 2013	1	0.5	-- --	50	75 - 125	20	80 - 120	20
Cobalt	7440-48-4	337	NDEP 2013	1	0.5	-- --	50	75 - 125	20	80 - 120	20
Copper	7440-50-8	42,178	NDEP 2013	2	1	-- --	50	75 - 125	20	80 - 120	20
Iron	7439-89-6	100,000	NDEP 2013	10	5	-- --	50	75 - 125	20	80 - 120	20
Lead	7439-92-1	800	NDEP 2013	2	1	-- --	50	75 - 125	20	80 - 120	20
Magnesium	7439-95-4	100,000	NDEP 2013	10	5	-- --	50	75 - 125	20	80 - 120	20
Manganese	7439-96-5	24,927	NDEP 2013	2	1	-- --	50	75 - 125	20	80 - 120	20
Molybdenum	7439-98-7	5,678	NDEP 2013	2	1	-- --	50	75 - 125	20	80 - 120	20
Nickel	7440-02-0	21,770	NDEP 2013	2	1	-- --	50	75 - 125	20	80 - 120	20
Phosphorus	7723-14-0	--	NDEP 2013	5.00	2.50	-- --	50	75 - 125	20	80 - 120	20
Potassium	7440-09-7	--	NDEP 2013	62.5	30	-- --	50	75 - 125	20	80 - 120	20
Silicon	7440-21-3	--	NDEP 2013	10.0	5.00	-- --	50	75 - 125	20	80 - 120	20
Silver	7440-22-4	5,678	NDEP 2013	1.5	0.75	-- --	50	75 - 125	20	80 - 120	20
Sodium	7440-23-5	--	NDEP 2013	62.5	30	-- --	50	75 - 125	20	80 - 120	20
Strontium	7440-24-6	100,000	NDEP 2013	5	2.5	-- --	50	75 - 125	20	80 - 120	20
Thallium	7440-28-0	75	NDEP 2013	10	5	-- --	50	75 - 125	20	80 - 120	20
Tin	7440-31-5	100,000	NDEP 2013	10	2.5	-- --	50	75 - 125	20	80 - 120	20
Titanium	7440-32-6	100,000	NDEP 2013	2	1	-- --	50	75 - 125	20	80 - 120	20
Tungsten	7440-33-7	8,513	NDEP 2013	10	5	-- --	50	75 - 125	20	80 - 120	20
Vanadium	7440-62-2	5,678	NDEP 2013	1	0.5	-- --	50	75 - 125	20	80 - 120	20

TABLE 2. SOIL ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

ANALYTES	CAS Number	Screening Level	Screening Level Source(1)	Practical Quantitation Limit (PQL)	Method Detection Limit (MDL)	QUALITY CONTROL LIMITS(2) Surrogate		Duplicate	Matrix Spike		Blank Spike/LCS	
						%R		RPD	%R	RPD	%R	RPD
Zinc	7440-66-6	100,000	NDEP 2013	5	2.5	--	--	50	75 - 125	20	80 - 120	20
EPA Method 200.8 / 6020												
Arsenic	7440-38-2	7	NDEP 2013	0.500	0.250	--	--	50	80 - 120	20	80 - 120	20
Selenium	7782-49-2	5,678	NDEP 2013	1.00	0.500	--	--	50	80 - 120	20	80 - 120	20
Zirconium(3)	7440-67-7	--	NDEP 2013	--	--	--	--	50	75 - 125	20	80 - 120	20
EPA Method 6020A												
Niobium	7440-03-1	--	NDEP 2013	2.50	0.380	--	--	50	75 - 125	30	80 - 120	20
Palladium	7440-05-3	--	NDEP 2013	0.100	0.0110	--	--	50	75 - 125	30	80 - 120	20
Sulfur	7704-34-9	--	NDEP 2013	500	81.1	--	--	50	75 - 125	30	80 - 120	20
Total Uranium	7440-61-1	3,400	NDEP 2013	0.1	0.0199	--	--	50	75 - 125	30	80 - 120 20	
EPA Method 7199												
Chromium (hexavalent)	18540-29-9	1,226	NDEP 2013	0.800	0.150	--	--	50	55 - 110	20	65 - 110	20
EPA Method 7471A												
Mercury	7439-97-6	182	NDEP 2013	0.0200	0.0120	--	--	50	70 - 130	20	80 - 120	20
Volatile Organic Compounds (mg/kg)												
EPA Method 8260B												
1,1,1,2-Tetrachloroethane	630-20-6	20	NDEP 2013	2.00	0.001	--	--	50	65 - 145	20	70 - 130	20
1,1,1-Trichloroethane	71-55-6	1,385	NDEP 2013	0.001	0.0005	--	--	50	65 - 145	20	65 - 135	20
1,1,2,2-Tetrachloroethane	79-34-5	3	NDEP 2013	0.002	0.001	--	--	50	40 - 160	30	55 - 140	30
1,1,2-Trichloroethane	79-00-5	6	NDEP 2013	0.001	0.0005	--	--	50	65 - 140	30	65 - 135	20
1,1-Dichloroethane	75-34-3	21	NDEP 2013	0.001	0.0005	--	--	50	65 - 135	25	70 - 130	20
1,1-Dichloroethene	75-35-4	1,274	NDEP 2013	0.002	0.0005	--	--	50	65 - 135	25	70 - 125	20
1,1-Dichloropropene	563-58-6	--	NDEP 2013	0.001	0.0005	--	--	50	65 - 135	20	70 - 130	20
1,2,3-Trichlorobenzene	87-61-6	110	NDEP 2013	0.002	0.001	--	--	50	45 - 145	30	60 - 130	20
1,2,3-Trichloropropane	96-18-4	111	NDEP 2013	0.01	0.001	--	--	50	50 - 150	30	60 - 135	25
1,2,4-Trichlorobenzene	120-82-1	112	NDEP 2013	0.01	0.001	--	--	50	50 - 140	30	70 - 135	20
1,2,4-Trimethylbenzene	95-63-6	604	NDEP 2013	0.002	0.001	--	--	50	65 - 140	25	70 - 125	20
1,2-Dibromo-3-Chloropropane	96-12-8	0.053	NDEP 2013	0.005	0.002	--	--	50	40 - 150	30	50 - 135	30

TABLE 2. SOIL ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS(2)					
				Practical Quantitation Limit	Method Detection Limit	Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
ANALYTES	CAS Number	Screening Level	Screening Level Source(1)	(PQL)	(MDL)	%R	RPD	%R	RPD	%R	RPD
1,2-Dibromoethane (EDB)	106-93-4	0.177	NDEP 2013	0.001	0.0005	-- --	50	65 - 140	25	70 - 130	20
1,2-Dichlorobenzene	95-50-1	373	NDEP 2013	0.001	0.0005	-- --	50	70 - 130	25	75 - 120	20
1,2-Dichloroethane	107-06-2	2	NDEP 2013	0.001	0.0005	-- --	50	60 - 150	25	60 - 140	20
1,2-Dichloropropane	78-87-5	4	NDEP 2013	0.001	0.0005	-- --	50	65 - 130	20	70 - 130	20
1,3,5-Trimethylbenzene	108-67-8	246	NDEP 2013	0.002	0.001	-- --	50	65 - 135	25	70 - 125	20
1,3-Dichlorobenzene	541-73-1	373	NDEP 2013	0.001	0.0005	-- --	50	70 - 130	25	75 - 125	20
1,3-Dichloropropane	142-28-9	65	NDEP 2013	0.001	0.0005	-- --	50	65 - 140	25	70 - 125	20
1,4-Dichlorobenzene	106-46-7	14	NDEP 2013	0.001	0.0005	-- --	50	70 - 130	25	75 - 120	20
2,2-Dichloropropane	594-20-7	--	NDEP 2013	0.002	0.001	-- --	50	65 - 150	25	60 - 145	20
2-Butanone	78-93-3	34,092	NDEP 2013	0.01	0.005	-- --	50	25 - 170	40	40 - 145	35
2-Chlorotoluene	95-49-8	511	NDEP 2013	0.002	0.001	-- --	50	60 - 135	25	70 - 125	20
2-Hexanone	591-78-6	1,933	NDEP 2013	0.010	0.005	-- --	50	35 - 160	40	40 - 150	35
4-Chlorotoluene	106-43-4	--	NDEP 2013	0.002	0.001	-- --	50	65 - 135	25	75 - 125	20
4-Methyl-2-pentanone	108-10-1	17,196	NDEP 2013	0.01	0.0025	-- --	50	40 - 155	40	40 - 145	35
Acetone	67-64-1	100,000	NDEP 2013	0.020	0.008	-- --	50	20 - 145	40	25 - 145	30
Benzene	71-43-2	4	NDEP 2013	0.001	0.0005	-- --	50	65 - 130	20	65 - 120	20
Bromobenzene	108-86-1	695	NDEP 2013	0.002	0.001	-- --	50	65 - 140	25	75 - 120	20
Bromochloromethane	74-97-5	--	NDEP 2013	0.002	0.001	-- --	50	65 - 145	25	70 - 135	20
Bromodichloromethane	75-27-4	3	NDEP 2013	0.001	0.0005	-- --	50	65 - 145	20	70 - 135	20
Bromoform	75-25-2	242	NDEP 2013	0.002	0.001	-- --	50	50 - 145	30	55 - 135	25
Bromomethane	74-83-9	39	NDEP 2013	0.002	0.001	-- --	50	60 - 155	25	60 - 145	20
Carbon Tetrachloride	56-23-5	4	NDEP 2013	0.002	0.0005	-- --	50	60 - 145	25	65 - 140	20
Chlorobenzene	108-90-7	695	NDEP 2013	0.001	0.0005	-- --	50	70 - 130	25	75 - 120	20
Chloroethane	75-00-3	1,096	NDEP 2013	0.002	0.001	-- --	50	60 - 150	25	60 - 140	25
Chloroform	67-66-3	2	NDEP 2013	0.001	0.0005	-- --	50	65 - 135	20	70 - 130	20
Chloromethane	74-87-3	8	NDEP 2013	0.002	0.001	-- --	50	40 - 145	25	45 - 145	25
cis-1,2-Dichloroethene	156-59-2	737	NDEP 2013	0.001	0.0005	-- --	50	65 - 135	25	70 - 125	20
cis-1,3-Dichloropropene	10061-01-5	--	NDEP 2013	0.001	0.0005	-- --	50	70 - 135	25	75 - 125	20
Dibromochloromethane	124-48-1	6	NDEP 2013	0.001	0.0005	-- --	50	60 - 145	25	65 - 140	20

TABLE 2. SOIL ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS(2)					
				Practical Quantitation Limit	Method Detection Limit	Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
ANALYTES	**CAS Number**	**Screening Level**	**Screening Level Source(1)**	**(PQL)**	**(MDL)**	**%R**	**RPD**	**%R**	**RPD**	**%R**	**RPD**
Dibromomethane	74-95-3	191	NDEP 2013	0.001	0.0005	-- --	50	65 - 140	25	70 - 130	20
Dichlorodifluoromethane	75-71-8	340	NDEP 2013	0.002	0.001	-- --	50	30 - 160	35	35 - 160	30
Diisopropyl ether (DIPE)	108-20-3	--	NDEP 2013	0.002	0.001	-- --	50	60 - 150	25	60 - 140	20
Ethylbenzene	100-41-4	20	NDEP 2013	0.001	0.0005	-- --	50	70 - 135	25	70 - 125	20
Ethyl-tert-butyl ether (ETBE)	637-92-3	--	NDEP 2013	0.002	0.001	-- --	50	60 - 145	30	60 - 140	20
Hexachlorobutadiene	87-68-3	25	NDEP 2013	0.002	0.001	-- --	50	50 - 145	35	60 - 135	20
Isopropyl benzene	98-82-8	647	NDEP 2013	0.001	0.0005	-- --	50	70 - 145	25	75 - 130	20
m,p-Xylene(6)	179601-23-1	214	NDEP 2013	0.002	0.001	-- --	50	70 - 130	25	70 - 125	20
Methylene Chloride	75-09-2	59	NDEP 2013	0.01	0.005	-- --	50	55 - 145	25	55 - 135	20
Methyl-tert-butyl ether (MTBE)	1634-04-4	208	NDEP 2013	0.00	0.001	-- --	50	55 - 155	35	60 - 140	25
Naphthalene	91-20-3	16	NDEP 2013	0.002	0.001	-- --	50	40 - 150	40	55 - 135	25
n-Butylbenzene	104-51-8	237	NDEP 2013	0.002	0.001	-- --	50	55 - 145	30	70 - 130	20
n-Propylbenzene	103-65-1	237	NDEP 2013	0.001	0.0005	-- --	50	65 - 140	25	70 - 130	20
o-Xylene	95-47-6	282	NDEP 2013	0.001	0.0005	-- --	50	65 - 130	25	70 - 125	20
p-Isopropyltoluene	99-87-6	647	NDEP 2013	0.001	0.0005	-- --	50	60 - 140	25	75 - 125	20
sec-Butylbenzene	135-98-8	223	NDEP 2013	0.002	0.001	-- --	50	60 - 135	25	70 - 125	20
Styrene	100-42-5	1,734	NDEP 2013	0.001	0.0005	-- --	50	70 - 140	25	75 - 130	20
tert-Amyl-methyl ether (TAME)	994-05-8	--	NDEP 2013	0.002	0.001	-- --	50	60 - 150	25	60 - 145	20
tert-Butyl alcohol (TBA)	75-65-0	21,283	NDEP 2013	0.050	0.01	-- --	50	65 - 145	30	70 - 135	20
tert-Butylbenzene	98-06-6	393	NDEP 2013	0.002	0.001	-- --	50	60 - 140	25	70 - 125	20
Tetrachloroethene	127-18-4	3	NDEP 2013	0.001	0.0005	-- --	50	65 - 135	25	70 - 125	20
Toluene	108-88-3	521	NDEP 2013	0.001	0.0005	-- --	50	70 - 130	20	70 - 125	20
trans-1,2-Dichloroethene	156-60-5	547	NDEP 2013	0.001	0.0005	-- --	50	70 - 135	25	70 - 125	20
trans-1,3-Dichloropropene	10061-02-6	--	NDEP 2013	0.001	0.0005	-- --	50	60 - 145	25	70 - 135	20
Trichloroethene	79-01-6	5	NDEP 2013	0.00	0.0005	-- --	50	65 - 140	25	70 - 125	20
Trichlorofluoromethane	75-69-4	1,983	NDEP 2013	0.002	0.001	-- --	50	55 - 155	25	60 - 145	25
Vinyl chloride	75-01-4	2	NDEP 2013	0.002	0.001	-- --	50	55 - 140	30	55 - 135	25
4-Bromofluorobenzene (Surr)	460-00-4	--	--	--	--	79 - 120	--	-- --	--	-- --	--

TABLE 2. SOIL ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS$^{(2)}$					
				Practical Quantitation Limit	Method Detection Limit	Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
ANALYTES	**CAS Number**	**Screening Level**	**Screening Level Source$^{(1)}$**	**(PQL)**	**(MDL)**	**%R**	**RPD**	**%R**	**RPD**	**%R**	**RPD**
Dibromofluoromethane (Surr)	1868-53-7	--	--	--	--	60 - 120	--	-- --	--	-- --	--
Toluene-d8 (Surr)	2037-26-5	--	--	--	--	79 - 123	--	-- --	--	-- --	--
EPA Method 8260B SIM											
1,2,3-Trichloropropane	96-18-4	0.11	NDEP 2013	0.01	0.004	-- --	50	50 - 150	30	6(- 135	25
1,4-dioxane	123-91-1	19	NDEP 2013	0.01	0.0011	-- --	50	70 - 130	30	70 - 130	30
Dibromofluoromethane (Surr)	1868-53-7	--	--	--	--	80 - 125	--	-- --	--	-- --	--
Semi-Volatile Organic Compounds (mg/kg)											
EPA Method 8270C											
1-Methylnaphthalene	90-12-0	--	NDEP 2013	0.35	0.15	-- --	50	60 - 140	30	60 - 140	30
2,4,5-Trichlorophenol	95-95-4	--	NDEP 2013	0.33	0.13	-- --	50	45 - 120	20	50 - 120	20
2,4,6-Trichlorophenol	88-06-2	--	NDEP 2013	0.33	0.075	-- --	50	45 - 120	25	50 - 120	20
2,4-Dichlorophenol	120-83-2	--	NDEP 2013	0.33	0.067	-- --	50	45 - 120	25	45 - 120	20
2,4-Dimethylphenol	105-67-9	--	NDEP 2013	0.33	0.13	-- --	50	30 - 120	25	40 - 120	20
2,4-Dinitrophenol	51-28-5	--	NDEP 2013	0.66	0.33	-- --	50	20 - 120	25	25 - 120	25
2,4-Dinitrotoluene	121-14-2	--	NDEP 2013	0.33	0.08	-- --	50	50 - 125	25	55 - 125	20
2,6-Dinitrotoluene	606-20-2	--	NDEP 2013	0.33	0.095	-- --	50	50 - 125	20	55 - 125	20
2-Chloronaphthalene	91-58-7	--	NDEP 2013	0.33	0.067	-- --	50	45 - 120	20	45 - 120	20
2-Chlorophenol	95-57-8	--	NDEP 2013	0.33	0.07	-- --	50	40 - 120	20	40 - 120	20
2-Methylnaphthalene	91-57-6	--	NDEP 2013	0.33	0.07	-- --	50	40 - 120	20	45 - 120	20
2-Methylphenol	95-48-7	--	NDEP 2013	0.33	0.08	-- --	50	40 - 120	25	40 - 120	20
2-Nitroaniline	88-74-4	--	NDEP 2013	0.33	0.067	-- --	50	45 - 120	25	50 - 125	20
2-Nitrophenol	88-75-5	--	NDEP 2013	0.33	0.133	-- --	50	40 - 120	25	45 - 120	20
3,3'-Dichlorobenzidine	91-94-1	--	NDEP 2013	0.83	0.15	-- --	50	20 - 130	25	20 - 130	25
3-Methylphenol + 4-Methylphenol	106-44-5	--	NDEP 2013	0.33	0.133	-- --	50	50 - 120	25	50 - 120	20
3-Nitroaniline	99-09-2	--	NDEP 2013	0.33	0.133	-- --	50	30 - 120	25	35 - 120	25
4-Bromophenyl phenyl ether	101-55-3	--	NDEP 2013	0.33	0.075	-- --	50	45 - 120	20	45 - 120	20

TABLE 2. SOIL ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS(2)					
				Practical Quantitation Limit	Method Detection Limit	Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
ANALYTES	CAS Number	Screening Level	Screening Level Source(1)	(PQL)	(MDL)	%R	RPD	%R	RPD	%R	RPD
4-Chloro-3-methylphenol	59-50-7	--	NDEP 2013	0.33	0.07	-- --	50	50 - 125	25	50 - 125	20
4-Chloroaniline	106-47-8	--	NDEP 2013	0.33	0.133	-- --	50	20 - 120	30	20 - 120	30
4-Chlorophenyl phenyl ether	7005-72-3	--	NDEP 2013	0.33	0.085	-- --	50	50 - 120	25	55 - 120	20
4-Nitroaniline	100-01-6	--	NDEP 2013	0.83	0.133	-- --	50	40 - 125	30	45 - 125	20
4-Nitrophenol	100-02-7	--	NDEP 2013	0.83	0.14	-- --	50	35 - 125	30	40 - 125	20
Acenaphthene	83-32-9	2,351	NDEP 2013	0.33	0.067	-- --	50	45 - 120	25	50 - 120	20
Acenaphthylene	208-96-8	147	NDEP 2013	0.33	0.07	-- --	50	45 - 120	20	50 - 120	20
Aniline	62-53-3	--	NDEP 2013	0.42	0.085	-- --	50	25 - 120	30	25 - 120	20
Anthracene	120-12-7	9,060	NDEP 2013	0.33	0.08	-- --	50	55 - 120	25	55 - 120	20
Benzidine	92-87-5	--	NDEP 2013	0.66	0.66	-- --	50	20 - 120	30	20 - 120	30
Benzo[a]anthracene	56-55-3	2.34	NDEP 2013	0.33	0.07	-- --	50	50 - 120	25	55 - 120	20
Benzo[a]pyrene	50-32-8	0.23	NDEP 2013	0.33	0.067	-- --	50	45 - 125	25	50 - 125	20
Benzo[b]fluoranthene	205-99-2	2.34	NDEP 2013	0.33	0.067	-- --	50	45 - 125	30	45 - 125	25
Benzo[g,h,i]perylene	191-24-2	34,067	NDEP 2013	0.33	0.11	-- --	50	25 - 130	30	35 - 130	25
Benzo[k]fluoranthene	207-08-9	23	NDEP 2013	0.33	0.07	-- --	50	45 - 125	30	45 - 125	25
Benzoic acid	65-85-0	--	NDEP 2013	0.83	0.15	-- --	50	20 - 120	30	20 - 120	30
Benzyl alcohol	100-51-6	--	NDEP 2013	0.33	0.2	-- --	50	20 - 120	30	35 - 120	25
Bis(2-chloroethoxy)methane	111-91-1	--	NDEP 2013	0.33	0.133	-- --	50	45 - 120	25	45 - 120	20
Bis(2-chloroethyl)ether	111-44-4	--	NDEP 2013	0.33	0.06	-- --	50	35 - 110	25	35 - 120	25
Bis(2-ethylhexyl) phthalate	117-81-7	137	NDEP 2013	0.33	0.09	-- --	50	45 - 130	25	50 - 130	20
Butyl benzyl phthalate	85-68-7	240	NDEP 2013	0.33	0.08	-- --	50	45 - 125	25	50 - 125	20
Chrysene	218-01-9	234	NDEP 2013	0.33	0.075	-- --	50	55 - 120	25	55 - 120	20
Dibenz(a,h)anthracene	53-70-3	0.23	NDEP 2013	0.42	0.10	-- --	50	25 - 135	30	40 - 135	25
Dibenzofuran	132-64-9	--	NDEP 2013	0.33	0.067	-- --	50	50 - 120	25	55 - 120	20
Diethyl phthalate	84-66-2	100,000	NDEP 2013	0.33	0.095	-- --	50	50 - 125	25	50 - 125	20
Dimethylphthalate	131-11-3	100,000	NDEP 2013	0.33	0.067	-- --	50	45 - 125	25	50 - 125	20
Di-n-butyl phthalate	84-74-2	68,407	NDEP 2013	0.33	0.09	-- --	50	50 - 125	25	50 - 125	20

TABLE 2. SOIL ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS(2)					
				Practical Quantitation Limit	Method Detection Limit	Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
ANALYTES	**CAS Number**	**Screening Level**	**Screening Level Source(1)**	**(PQL)**	**(MDL)**	**%R**	**RPD**	**%R**	**RPD**	**%R**	**RPD**
Di-n-octyl phthalate	117-84-0	--	NDEP 2013	0.33	0.09	-- --	50	50 - 135	25	50 - 135	20
Fluoranthene	206-44-0	24,447	NDEP 2013	0.33	0.07	-- --	50	45 - 120	25	55 - 120	20
Fluorene	86-73-7	3,438	NDEP 2013	0.33	0.07	-- --	50	50 - 120	25	55 - 120	20
Hexachlorobenzene	118-74-1	1.20	NDEP 2013	0.33	0.07	-- --	50	50 - 120	25	50 - 120	20
Hexachlorocyclopentadiene	77-47-4	--	NDEP 2013	0.83	0.133	-- --	50	20 - 125	30	30 - 125	25
Hexachloroethane	67-72-1	--	NDEP 2013	0.33	0.133	-- --	50	35 - 120	30	40 - 120	20
Indeno[1,2,3-cd]pyrene	193-39-5	2.34	NDEP 2013	0.33	0.13	-- --	50	20 - 130	30	30 - 135	25
Isophorone	78-59-1	--	NDEP 2013	0.33	0.067	-- --	50	40 - 120	25	40 - 120	20
Naphthalene	91-20-3	16	NDEP 2013	0.33	0.067	-- --	50	40 - 120	25	45 - 120	20
Nitrobenzene	98-95-3	14	NDEP 2013	0.33	0.07	-- --	50	40 - 120	25	45 - 120	20
N-Nitrosodi-n-propylamine	621-64-7	--	NDEP 2013	0.25	0.07	-- --	50	35 - 120	25	40 - 120	20
N-Nitrosodiphenylamine	86-30-6	--	NDEP 2013	0.33	0.08	-- --	50	45 - 125	25	50 - 120	20
Octachlorostyrene	29082-74-4	--	NDEP 2013	3.30	2.3	-- --	50	60 - 140	30	60 - 140	30
Pentachlorophenol	87-86-5	--	NDEP 2013	0.83	0.15	-- --	50	30 - 120	25	40 - 120	20
Phenanthrene	85-01-8	25	NDEP 2013	0.33	0.067	-- --	50	50 - 120	25	50 - 120	20
Phenol	108-95-2	--	NDEP 2013	0.33	0.09	-- --	50	40 - 120	25	40 - 120	20
Pyrene	129-00-0	19,340	NDEP 2013	0.33	0.08	-- --	50	40 - 125	30	45 - 125	25
Pyridine	110-86-1	667	NDEP 2013	0.20	0.07	-- --	50	25 - 130	30	25 - 130	30
2-Fluorophenol (Surr)	367-12-4	--	--	--	--	35 - 120	--	-- --	--	-- --	--
2,4,6-Tribromophenol (Surr)	118-79-6	--	--	--	--	35 - 120	--	-- --	--	-- --	--
Nitrobenzene-d5 (Surr)	4165-60-0	--	--	--	--	35 - 120	--	-- --	--	-- --	--
Terphenyl-d14 (Surr)	1718-51-0	--	--	--	--	35 - 120	--	-- --	--	-- --	--
Phenol-d6 (Surr)	13127-88-3	--	--	--	--	35 - 120	--	-- --	--	-- --	--
EPA Method 8315A											
Formaldehyde	50-00-0	66,980	NDEP 2013	1.00	0.600	-- --	50	50 - 150	20	50 - 150	20

TABLE 2. SOIL ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

ANALYTES	CAS Number	Screening Level	Screening Level Source(1)	Practical Quantitation Limit (PQL)	Method Detection Limit (MDL)	QUALITY CONTROL LIMITS(2) Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
						%R	RPD	%R	RPD	%R	RPD
Polycyclic Aromatic Hydrocarbons (mg/kg)											
EPA Method 8270 SIM											
Acenaphthene	83-32-9	2,351	NDEP 2013	0.03	0.004	-- --	50	45 - 120	25	50 - 120	20
Acenaphthylene	208-96-8	147	NDEP 2013	0.03	0.004	-- --	50	45 - 120	20	50 - 120	20
Anthracene	120-12-7	9,060	NDEP 2013	0.03	0.004	-- --	50	55 - 120	25	55 - 120	20
Benzo(a)anthracene	56-55-3	2.3	NDEP 2013	0.03	0.004	-- --	50	50 - 120	25	55 - 120	20
Benzo(a)pyrene	50-32-8	0.23	NDEP 2013	0.03	0.004	-- --	50	45 - 125	25	50 - 125	20
Benzo(b)fluoranthene	205-99-2	2.3	NDEP 2013	0.03	0.004	-- --	50	45 - 125	30	45 - 125	25
Benzo(g,h,i)perylene	191-24-2	34,067	NDEP 2013	0.03	0.004	-- --	50	25 - 130	30	35 - 130	25
Benzo(k)fluoranthene	207-08-9	23	NDEP 2013	0.03	0.004	-- --	50	45 - 125	30	45 - 125	25
Chrysene	218-01-9	234	NDEP 2013	0.03	0.004	-- --	50	55 - 120	25	55 - 120	20
Dibenz(a,h)anthracene	53-70-3	0.23	NDEP 2013	0.03	0.004	-- --	50	25 - 135	30	40 - 135	25
Fluoranthene	206-44-0	24,447	NDEP 2013	0.03	0.004	-- --	50	45 - 120	25	55 - 120	20
Fluorene	86-73-7	3,438	NDEP 2013	0.03	0.004	-- --	50	50 - 120	25	55 - 120	20
Indeno(1,2,3-cd)pyrene	193-39-5	2.3	NDEP 2013	0.03	0.004	-- --	50	20 - 130	30	30 - 135	25
Naphthalene	91-20-3	16	NDEP 2013	0.03	0.004	-- --	50	40 - 120	25	45 - 120	20
Phenanthrene	85-01-8	25	NDEP 2013	0.03	0.004	-- --	50	50 - 120	25	50 - 120	20
Pyrene	129-00-0	19,340	NDEP 2013	0.03	0.004	-- --	50	40 - 125	30	45 - 125	25
2-Fluorobiphenyl (Surr)	321-60-8	--	--	--	--	35 - 120	--	-- --	--	-- --	--
Nitrobenzene-d5 (Surr)	4165-60-0	--	--	--	--	30 - 120	--	-- --	--	-- --	--
Terphenyl-d14 (Surr)	1718-51-0	--	--	--	--	13 - 100	--	-- --	--	-- --	--
Organophosphorous Pesticides (mg/kg)											
EPA Method 8141A											
Atrazine	1912-24-9	--	NDEP 2013	0.07	0.0121	-- --	50	49 - 115	50	49 - 115	50
Azinphos-methyl	86-50-0	--	NDEP 2013	0.01	0.0035	-- --	50	51 - 122	43	51 - 122	43
Bolstar (Sulprofos)	35400-43-2	--	NDEP 2013	0.01	0.00424	-- --	50				
Chlorpyrifos	2921-88-2	2,052	NDEP 2013	0.02	0.00646	-- --	50	38 - 130	37	38 - 130	37
Coumaphos	56-72-4	--	NDEP 2013	0.01	0.0028	-- --	50	50 - 119	27	50 - 119	27

TABLE 2. SOIL ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

ANALYTES	CAS Number	Screening Level	Screening Level Source(1)	Practical Quantitation Limit (PQL)	Method Detection Limit (MDL)	QUALITY CONTROL LIMITS(2)					
						Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
						%R	RPD	%R	RPD	%R	RPD
Demeton, Total	8065-48-3	--	NDEP 2013	0.04	0.00752	-- --	50	36 - 115	47	36 - 115	47
Demeton-O	298-03-3	--	NDEP 2013	0.04	0.00529	-- --	50				
Demeton-S	126-75-0	--	NDEP 2013	0.02	0.00486	-- --	50				
Diazinon	333-41-5	616	NDEP 2013	0.02	0.00727	-- --	50	53 - 115	40	53 - 115	40
Dichlorvos	62-73-7	7	NDEP 2013	0.02	0.0074	-- --	50	43 - 139	77	43 - 139	77
Dimethoate	60-51-5	--	NDEP 2013	0.02	0.00708	-- --	50	25 - 138	98	25 - 138	98
Disulfoton	298-04-4	27	NDEP 2013	0.05	0.00773	-- --	50	29 - 115	40	29 - 115	40
EPN (Ethyl P-Nitrophenyl Benzenethiophosphate)	2104-64-5	--	NDEP 2013	0.01	0.00368	-- --	50	58 - 131	50	58 - 131	50
Ethoprop	13194-48-4	--	NDEP 2013	0.02	0.00493	-- --	50	53 - 115	54	53 - 115	54
Famphur	52-85-7	--	NDEP 2013	0.01	0.00322	-- --	50	49 - 140	31	49 - 140	31
Fensulfothion	115-90-2	--	NDEP 2013	0.03	0.00815	-- --	50	52 - 121	49	52 - 121	49
Fenthion	55-38-9	--	NDEP 2013	0.03	0.00874	-- --	50	45 - 115	43	45 - 115	43
Malathion	121-75-5	13,681	NDEP 2013	0.02	0.00464	-- --	50	50 - 122	53	50 - 122	53
Merphos	150-50-5	--	NDEP 2013	0.03	0.00514	-- --	50	19 - 115	50	19 - 115	50
Mevinphos	7786-34-7	--	NDEP 2013	0.02	0.00462	-- --	50	10 - 226	78	10 - 226	78
Naled	300-76-5	1,368	NDEP 2013	0.07	0.0226	-- --	50	10 - 115		10 - 115	
Parathion-ethyl	56-38-2	4,104	NDEP 2013	0.02	0.00529	-- --	50	24 - 163	47	24 - 163	47
Parathion-methyl	298-00-0	171	NDEP 2013	0.02	0.00637	-- --	50	46 - 119	53	46 - 119	53
Phorate	298-02-2	--	NDEP 2013	0.02	0.0057	-- --	50	40 - 115	40	40 - 115	40
Ronnel	299-84-3	34,203	NDEP 2013	0.05	0.0152	-- --	50	43 - 118	41	43 - 118	41
Simazine	122-34-9	--	NDEP 2013	0.07	0.0221	-- --	50	11 - 179	58	11 - 179	58
Stirphos (Tetrachlorovinphos)	22248-79-9	80	NDEP 2013	0.02	0.00436	-- --	50	44 - 118	24	44 - 118	24
Sulfotepp	3689-24-5	--	NDEP 2013	0.02	0.00626	-- --	50	55 - 115	40	55 - 115	
Thionazin	297-97-2	--	NDEP 2013	0.02	0.00557	-- --	50	46 - 115	40	46 - 115	40
Tokuthion	34643-46-4	--	NDEP 21013	0.02	0.00391	-- --	50				
Trichloronate	327-98-0	--	NDEP 2013	0.02	0.00625	-- --	50	27 - 115	43	27 - 115	43
Chlormefos (Surr)	24934-91-6	--	--	--	--	42 - 132	--	-- --	--	-- --	--
Triphenylphosphate (Surr)	115-86-6	--	--	--	--	47 - 161	--	-- --	--	-- --	--

TABLE 2. SOIL ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS(2)					
				Practical Quantitation Limit	Method Detection Limit	Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
ANALYTES	**CAS Number**	**Screening Level**	**Screening Level Source(1)**	**(PQL)**	**(MDL)**	**%R**	**RPD**	**%R**	**RPD**	**%R**	**RPD**
Organochlorine Pesticides (mg/kg)											
EPA Method 8081A											
2,4'-DDE	3424-82-6	--	NDEP 2013	0.01	0.0015	-- --	50	35 - 130	30	60 - 120	30
4,4'-DDD	72-54-8	11.1	NDEP 2013	0.01	0.0015	-- --	50	40 - 130	30	60 - 120	30
4,4'-DDE	72-55-9	7.8	NDEP 2013	0.01	0.0015	-- --	50	35 - 130	30	60 - 120	30
4,4'-DDT	50-29-3	7.8	NDEP 2013	0.01	0.0015	-- --	50	35 - 130	30	65 - 120	30
Aldrin	309-00-2	0.11	NDEP 2013	0.01	0.0015	-- --	50	40 - 115	30	50 - 115	30
alpha-BHC	319-84-6	270	NDEP 2013	0.01	0.0015	-- --	50	40 - 115	30	60 - 115	30
alpha-Chlordane	57-74-9	7.2	NDEP 2013	0.05	0.01	-- --	50	60 - 140	30	60 - 140	30
beta-BHC	319-85-7	54	NDEP 2013	0.01	0.0015	-- --	50	40 - 120	30	60 - 115	30
delta-BHC	319-86-8	270	NDEP 2013	0.01	0.0015	-- --	50	45 - 120	30	60 - 115	30
Dieldrin	60-57-1	0.12	NDEP 2013	0.01	0.0015	-- --	50	40 - 125	30	65 - 115	30
Endosulfan I	959-98-8	4,104	NDEP 2013	0.01	0.0015	-- --	50	40 - 120	30	40 - 120	30
Endosulfan II	33213-65-9	4,104	NDEP 2013	0.01	0.0015	-- --	50	40 - 125	30	55 - 120	30
Endosulfan sulfate	1031-07-8	4,104	NDEP 2013	0.01	0.002	-- --	50	45 - 120	30	65 - 115	30
Endrin	72-20-8	205	NDEP 2013	0.01	0.0015	-- --	50	45 - 125	30	55 - 120	30
Endrin aldehyde	7421-93-4	205	NDEP 2013	0.01	0.0015	-- --	50	30 - 120	30	55 - 115	30
Endrin Ketone	53494-70-5	205	NDEP 2013	0.01	0.002	-- --	50	40 - 120	30	65 - 115	30
gamma-BHC (Lindane)	58-89-9	9.0	NDEP 2013	0.01	0.0015	-- --	50	40 - 120	30	55 - 115	30
gamma-Chlordane	57-74-9	7.2	NDEP 2013	0.05	0.01	-- --	50	60 - 140	30	60 - 140	30
Heptachlor	76-44-8	0.43	NDEP 2013	0.01	0.002	-- --	50	40 - 115	30	55 - 115	30
Heptachlor epoxide	1024-57-3	0.21	NDEP 2013	0.01	0.002	-- --	50	45 - 115	30	55 - 115	30
Methoxychlor	72-43-5	3,420	NDEP 2013	0.01	0.0015	-- --	50	40 - 135	30	65 - 120	30
Toxaphene	8001-35-2	1.7	NDEP 2013	0.2	0.05	-- --	50	60 - 140	30	60 - 140	30
Decachlorobiphenyl (Surr)	2051-24-3	--	--	--	--	45 - 120	--	-- --	--	-- --	--

TABLE 2. SOIL ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS(2)					
				Practical Quantitation Limit	Method Detection Limit	Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
ANALYTES	**CAS Number**	**Screening Level**	**Screening Level Source(1)**	**(PQL)**	**(MDL)**	**%R**	**RPD**	**%R**	**RPD**	**%R**	**RPD**
Dioxins/Furans (pg/g)(5)											
EPA Method 8290											
2,3,7,8- TCDD	1746-01-6	1000	NDEP 2013	1	EDL(4)	-- --	50	60 - 138	20	60 - 138	20
OCDF	39001-02-0	--	NDEP 2013	10	EDL(4)	-- --	50	63 - 141	20	63 - 141	20
OCDD	3268-87-9	--	NDEP 2013	10	EDL(4)	-- --	50	70 - 128	20	70 - 128	20
1,2,3,4,6,7,8-HpCDF	67562-39-4	--	NDEP 2013	5	EDL(4)	-- --	50	71 - 134	20	71 - 134	20
1,2,3,4,6,7,8-HpCDD	35822-46-9	--	NDEP 2013	5	EDL(4)	-- --	50	71 - 128	20	71 - 128	20
1,2,3,4,7,8,9-HpCDF	55673-89-7	--	NDEP 2013	5	EDL(4)	-- --	50	68 - 129	20	68 - 129	20
1,2,3,4,7,8-HxCDF	70648-26-9	--	NDEP 2013	5	EDL(4)	-- --	50	74 - 128	20	74 - 128	20
1,2,3,4,7,8-HxCDD	39227-28-6	--	NDEP 2013	5	EDL(4)	-- --	50	60 - 138	20	60 - 138	20
1,2,3,6,7,8-HxCDF	57117-44-9	--	NDEP 2013	5	EDL(4)	-- --	50	67 - 140	20	67 - 140	20
1,2,3,6,7,8-HxCDD	57653-85-7	--	NDEP 2013	5	EDL(4)	-- --	50	68 - 136	20	68 - 136	20
1,2,3,7,8,9-HxCDF	72918-21-9	--	NDEP 2013	5	EDL(4)	-- --	50	72 - 134	20	72 - 134	20
1,2,3,7,8,9-HxCDD	19408-74-3	309	NDEP 2013	5	EDL(4)	-- --	50	68 - 138	20	68 - 138	20
1,2,3,7,8-PeCDF	57117-41-6	--	NDEP 2013	5	EDL(4)	-- --	50	69 - 134	20	69 - 134	20
1,2,3,7,8-PeCDD	40321-76-4	--	NDEP 2013	5	EDL(4)	-- --	50	70 - 122	20	70 - 122	20
2,3,4,6,7,8-HxCDF	60851-34-5	--	NDEP 2013	5	EDL(4)	-- --	50	71 - 137	20	71 - 137	20
1,2,3,6,7,8-HxCDF	57117-44-9	--	NDEP 2013	5	EDL(4)	-- --	50	67 - 140	20	67 - 140	20
2,3,7,8-TCDF	51207-31-9	--	NDEP 2013	1	EDL(4)	-- --	50	56 - 158	20	56 - 158	20
PCBs as Congeners (mg/kg) (5)											
EPA Method 1668A											
Total PCBs	1336-36-3	0.83	NDEP 2013	0.0002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2-MoCB (PCB-1)	2051-60-7	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
3-MoCB (PCB-2)	2051-61-8	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
4-MoCB (PCB-3)	2051-62-9	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2'-DiCB (PCB-4)	13029-08-8	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3-DiCB (PCB-5)	16605-91-7	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3'-DiCB (PCB-6)	25569-80-6	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50

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QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS(2)					
				Practical Quantitation Limit	Method Detection Limit	Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
ANALYTES	CAS Number	Screening Level	Screening Level Source(1)	(PQL)	(MDL)	%R	RPD	%R	RPD	%R	RPD
2,4-DiCB (PCB-7)	33284-50-3	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,4'-DiCB (PCB-8)	34883-43-7	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,5-DiCB (PCB-9)	34883-39-1	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,6-DiCB (PCB-10)	33146-45-1	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
3,3'-DiCB (PCB-11)	2050-67-1	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
3,4-DiCB (PCB-12)	2974-92-7	0.83	NDEP 2013	0.00004	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
3,4'-DiCB (PCB-13)	2974-90-5	0.83	NDEP 2013	0.00004	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
3,5-DiCB (PCB-14)	34883-41-5	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
4,4'-DiCB (PCB-15)	2050-68-2	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',3-TrCB (PCB-16)	38444-78-9	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',4-TrCB (PCB-17)	37680-66-3	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',5-TrCB (PCB-18)	37680-65-2	0.83	NDEP 2013	0.00004	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',6-TrCB (PCB-19)	38444-73-4	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,3'-TrCB (PCB-20)	38444-84-7	0.83	NDEP 2013	0.00004	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,4-TrCB (PCB-21)	55702-46-0	0.83	NDEP 2013	0.00004	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,4'-TrCB (PCB-22)	38444-85-8	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,5-TrCB (PCB-23)	55720-44-0	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,6-TrCB (PCB-24)	55702-45-9	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3',4-TrCB (PCB-25)	55712-37-3	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3',5-TrCB (PCB-26)	38444-81-4	0.83	NDEP 2013	0.00004	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3',6-TrCB (PCB-27)	38444-76-7	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,4,4'-TrCB (PCB-28)	7012-37-5	0.83	NDEP 2013	0.00004	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,4,5-TrCB (PCB-29)	15862-07-4	0.83	NDEP 2013	0.00004	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,4,6-TrCB (PCB-30)	35693-92-6	0.83	NDEP 2013	0.00004	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,4',5-TrCB (PCB-31)	16606-02-3	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,4',6-TrCB (PCB-32)	38444-77-8	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2',3,4-TrCB (PCB-33)	38444-86-9	0.83	NDEP 2013	0.00004	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2',3,5-TrCB (PCB-34)	37680-68-5	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
3,3',4-TrCB (PCB-35)	37680-69-6	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50

TABLE 2. SOIL ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS(2)					
				Practical Quantitation Limit	Method Detection Limit	Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
ANALYTES	CAS Number	Screening Level	Screening Level Source(1)	(PQL)	(MDL)	%R	RPD	%R	RPD	%R	RPD
3,3',5-TrCB (PCB-36)	38444-87-0	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
3,4,4'-TrCB (PCB-37)	38444-90-5	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
3,4,5-TrCB (PCB-38)	53555-66-1	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
3,4',5-TrCB (PCB-39)	38444-88-1	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',3,3'-TeCB (PCB-40)	38444-93-8	0.83	NDEP 2013	0.00004	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',3,4-TeCB (PCB-41)	52663-59-9	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',3,4'-TeCB (PCB-42)	36559-22-5	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',3,5-TeCB (PCB-43)	70362-46-8	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',3,5'-TeCB (PCB-44)	41464-39-5	0.83	NDEP 2013	0.00006	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',3,6-TeCB (PCB-45)	70362-45-7	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',3,6'-TeCB (PCB-46)	41464-47-5	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',4,4'-TeCB (PCB-47)	2437-79-8	0.83	NDEP 2013	0.00006	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',4,5-TeCB (PCB-48)	70362-47-9	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',4,5'-TeCB (PCB-49)	41464-40-8	0.83	NDEP 2013	0.00004	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',4,6-TeCB (PCB-50)	62796-65-0	0.83	NDEP 2013	0.00004	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',4,6'-TeCB (PCB-51)	68194-04-7	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',5,5'-TeCB (PCB-52)	35693-99-3	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',5,6'-TeCB (PCB-53)	41464-41-9	0.83	NDEP 2013	0.00004	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',6,6'-TeCB (PCB-54)	15968-05-5	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,3',4'-TeCB (PCB-55)	74338-24-2	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,3',4'-TeCB (PCB-56)	41464-43-1	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,3',5-TeCB (PCB-57)	70424-67-8	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,3',5'-TeCB (PCB-58)	41464-49-7	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,3',6-TeCB (PCB-59)	74472-33-6	0.83	NDEP 2013	0.00006	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,4,4'-TeCB (PCB-60)	33025-41-1	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,4,5-TeCB (PCB-61)	33284-53-6	0.83	NDEP 2013	0.00008	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,4,6-TeCB (PCB-62)	54230-22-7	0.83	NDEP 2013	0.00006	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,4',5-TeCB (PCB-63)	74472-34-7	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,4',6-TeCB (PCB-64)	52663-58-8	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50

TABLE 2. SOIL ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS[2]					
				Practical Quantitation Limit	Method Detection Limit	Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
ANALYTES	**CAS Number**	**Screening Level**	**Screening Level Source[1]**	**(PQL)**	**(MDL)**	**%R**	**RPD**	**%R**	**RPD**	**%R**	**RPD**
2,3,5,6-TeCB (PCB-65)	33284-54-7	0.83	NDEP 2013	0.00006	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,3',4,4'-TeCB (PCB-66)	32598-10-0	0.83	NDEP 2013	0.00002	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,3',4,5-TeCB (PCB-67)	73575-53-8	0.83	NDEP 2013	0.00002	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,3',4,5'-TeCB (PCB-68)	73575-52-7	0.83	NDEP 2013	0.00002	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,3',4,6-TeCB (PCB-69)	60233-24-1	0.83	NDEP 2013	0.00004	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,3',4',5-TeCB (PCB-70)	32598-11-1	0.83	NDEP 2013	0.00008	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,3',4',6-TeCB (PCB-71)	41464-46-4	0.83	NDEP 2013	0.00004	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,3',5,5'-TeCB (PCB-72)	41464-42-0	0.83	NDEP 2013	0.00002	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,3',5',6-TeCB (PCB-73)	74338-23-1	0.83	NDEP 2013	0.00002	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,4,4',5-TeCB (PCB-74)	32690-93-0	0.83	NDEP 2013	0.00008	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,4,4',6-TeCB (PCB-75)	32598-12-2	0.83	NDEP 2013	0.00006	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2',3,4,5-TeCB (PCB-76)	70362-48-0	0.83	NDEP 2013	0.00008	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
3,3',4,4'-TeCB (PCB-77)	32598-13-3	0.83	NDEP 2013	0.00000	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
3,3',4,5-TeCB (PCB-78)	70362-49-1	0.83	NDEP 2013	0.00002	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
3,3',4,5'-TeCB (PCB-79)	41464-48-6	0.83	NDEP 2013	0.00002	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
3,3',5,5'-TeCB (PCB-80)	33284-52-5	0.83	NDEP 2013	0.00002	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
3,4,4',5-TeCB (PCB-81)	70362-50-4	0.83	NDEP 2013	0.000002	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,2',3,3',4-PeCB (PCB-82)	52663-62-4	0.83	NDEP 2013	0.000020	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,2',3,3',5-PeCB (PCB-83)	60145-20-2	0.83	NDEP 2013	0.000020	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,2',3,3',6-PeCB (PCB-84)	52663-60-2	0.83	NDEP 2013	0.000020	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,2',3,4,4'-PeCB (PCB-85)	65510-45-4	0.83	NDEP 2013	0.000060	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,2',3,4,5-PeCB (PCB-86)	55312-69-1	0.83	NDEP 2013	0.000120	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,2',3,4,5'-PeCB (PCB-87)	38380-02-8	0.83	NDEP 2013	0.000120	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,2',3,4,6-PeCB (PCB-88)	55215-17-3	0.83	NDEP 2013	0.000040	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,2',3,4,6'-PeCB (PCB-89)	73575-57-2	0.83	NDEP 2013	0.000020	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,2',3,4',5-PeCB (PCB-90)	68194-07-0	0.83	NDEP 2013	0.000060	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,2',3,4',6-PeCB (PCB-91)	68194-05-8	0.83	NDEP 2013	0.000040	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,2',3,5,5'-PeCB (PCB-92)	52663-61-3	0.83	NDEP 2013	0.000020	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,2',3,5,6-PeCB (PCB-93)	73575-56-1	0.83	NDEP 2013	0.000040	EDL[4]	-- --	50	50 - 150	50	50 - 150	50

TABLE 2. SOIL ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS(2)					
				Practical Quantitation Limit	Method Detection Limit	Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
ANALYTES	CAS Number	Screening Level	Screening Level Source(1)	(PQL)	(MDL)	%R	RPD	%R	RPD	%R	RPD
2,2',3,5,6'-PeCB (PCB-94)	73575-55-0	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',3,5',6-PeCB (PCB-95)	38379-99-6	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',3,6,6'-PeCB (PCB-96)	73575-54-9	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',3',4,5-PeCB (PCB-97)	41464-51-1	0.83	NDEP 2013	0.000120	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',3',4,6-PeCB (PCB-98)	60233-25-2	0.83	NDEP 2013	0.000040	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',4,4',5-PeCB (PCB-99)	38380-01-7	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',4,4',6-PeCB (PCB-100)	39485-83-1	0.83	NDEP 2013	0.000040	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',4,5,5'-PeCB (PCB-101)	37680-73-2	0.83	NDEP 2013	0.000060	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',4,5,6'-PeCB (PCB-102)	68194-06-9	0.83	NDEP 2013	0.000040	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',4,5,'6-PeCB (PCB-103)	60145-21-3	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',4,6,6'-PeCB (PCB-104)	56558-16-8	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,3',4,4'-PeCB (PCB-105)	32598-14-4	0.83	NDEP 2013	0.000002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,3',4,5-PeCB (PCB-106)	70424-69-0	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,3',4',5-PeCB (pCB-107)	70424-68-9	0.83	NDEP 2013	0.000040	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,3',4,5'-PeCB (PCB-108)	70362-41-3	0.83	NDEP 2013	0.000120	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,3',4,6-PeCB (PCB-109)	74472-35-8	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,3',4',6-PeCB (PCB-110)	38380-03-9	0.83	NDEP 2013	0.000040	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,3',5,5'-PeCB (PCB-111)	39635-32-0	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,3',5,6-PeCB (PCB-112)	74472-36-9	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,3',5',6-PeCB (PCB-113)	68194-10-5	0.83	NDEP 2013	0.000060	EDL(4)	-- --	50	50 - 150	50	50 - 150	50

TABLE 2. SOIL ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

ANALYTES	CAS Number	Screening Level	Screening Level Source(1)	Practical Quantitation Limit (PQL)	Method Detection Limit (MDL)	QUALITY CONTROL LIMITS(2) Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike/LCS %R	Blank Spike/LCS RPD
2,3,4,4',5-PeCB (PCB-114)	74472-37-0	0.83	NDEP 2013	0.000002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,4,4',6-PeCB (PCB-115)	74472-38-1	0.83	NDEP 2013	0.000040	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,4,5,6-PeCB (PCB-116)	18259-05-7	0.83	NDEP 2013	0.000060	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,4',5,6-PeCB (PCB-117)	68194-11-6	0.83	NDEP 2013	0.000060	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3',4,4',5-PeCB (PCB-118)	31508-00-6	0.83	NDEP 2013	0.000002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3',4,4',6-PeCB (PCB-119)	56558-17-9	0.83	NDEP 2013	0.000120	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3',4,5,5'-PeCB (PCB-120)	68194-12-7	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3',4,5,'6-PeCB (PCB-121)	56558-18-0	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2',3,3',4,5-PeCB (PCB-122)	76842-07-4	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2',3,4,4',5-PeCB (PCB-123)	65510-44-3	0.83	NDEP 2013	0.000002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2',3,4,5,5'-PeCB (PCB-124)	70424-70-3	0.83	NDEP 2013	0.000040	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2',3,4,5,6'-PeCB (PCB-125)	74472-39-2	0.83	NDEP 2013	0.000120	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
3,3',4,4',5-PeCB (PCB-126)	57465-28-8	0.83	NDEP 2013	0.000002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
3,3',4,5,5'-PeCB (PCB-127)	39635-33-1	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',3,3',4,4'-HxCB (PCB-128)	38380-07-3	0.83	NDEP 2013	0.000040	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',3,3',4,5-HxCB (PCB-129)	55215-18-4	0.83	NDEP 2013	0.000060	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',3,3',4,5'-HxCB (PCB-130)	52663-66-8	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',3,3',4,6-HxCB (PCB-131)	61798-70-7	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50

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QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS(2)						
				Practical Quantitation Limit	Method Detection Limit	Surrogate		Duplicate	Matrix Spike		Blank Spike/LCS	
ANALYTES	CAS Number	Screening Level	Screening Level Source(1)	(PQL)	(MDL)	%R		RPD	%R	RPD	%R	RPD
2,2',3,3',4,6'-HxCB (PCB-132)	38380-05-1	0.83	NDEP 2013	0.000020	EDL(4)	--	--	50	50 - 150	50	50 - 150	50
2,2',3,3',5,5'-HxCB (PCB-133)	35694-04-3	0.83	NDEP 2013	0.000020	EDL(4)	--	--	50	50 - 150	50	50 - 150	50
2,2',3,3',5,6-HxCB (PCB-134)	52704-70-8	0.83	NDEP 2013	0.000040	EDL(4)	--	--	50	50 - 150	50	50 - 150	50
2,2',3,3',5,6'-HxCB (PCB-135)	52744-13-5	0.83	NDEP 2013	0.000040	EDL(4)	--	--	50	50 - 150	50	50 - 150	50
2,2',3,3',6,6'-HxCB (PCB-136)	38411-22-2	0.83	NDEP 2013	0.000020	EDL(4)	--	--	50	50 - 150	50	50 - 150	50
2,2',3,4,4',5-HxCB (PCB-137)	35694-06-5	0.83	NDEP 2013	0.000020	EDL(4)	--	--	50	50 - 150	50	50 - 150	50
2,2',3,4,4',5'-HxCB (PCB-138)	35065-28-2	0.83	NDEP 2013	0.000060	EDL(4)	--	--	50	50 - 150	50	50 - 150	50
2,2',3,4,4',6-HxCB (PCB-139)	56030-56-9	0.83	NDEP 2013	0.000040	EDL(4)	--	--	50	50 - 150	50	50 - 150	50
2,2',3,4,4',6'-HxCB (PCB-140)	59291-64-4	0.83	NDEP 2013	0.000040	EDL(4)	--	--	50	50 - 150	50	50 - 150	50
2,2',3,4,5,5'-HxCB (PCB-141)	52712-04-6	0.83	NDEP 2013	0.000020	EDL(4)	--	--	50	50 - 150	50	50 - 150	50
2,2',3,4,5,6-HxCB (PCB-142)	41411-61-4	0.83	NDEP 2013	0.000020	EDL(4)	--	--	50	50 - 150	50	50 - 150	50
2,2',3,4,5,6'-HxCB (PCB-143)	68194-15-0	0.83	NDEP 2013	0.000040	EDL(4)	--	--	50	50 - 150	50	50 - 150	50
2,2',3,4,5',6-HxCB (PCB-144)	68194-14-9	0.83	NDEP 2013	0.000020	EDL(4)	--	--	50	50 - 150	50	50 - 150	50
2,2',3,4,6,6'-HxCB (PCB-145)	74472-40-5	0.83	NDEP 2013	0.000020	EDL(4)	--	--	50	50 - 150	50	50 - 150	50
2,2',3,4',5,5'-HxCB (PCB-146)	51908-16-8	0.83	NDEP 2013	0.000020	EDL(4)	--	--	50	50 - 150	50	50 - 150	50
2,2',3,4',5,6-HxCB (PCB-147)	68194-13-8	0.83	NDEP 2013	0.000040	EDL(4)	--	--	50	50 - 150	50	50 - 150	50
2,2',3,4',5,6'-HxCB (PCB-148)	74472-41-6	0.83	NDEP 2013	0.000020	EDL(4)	--	--	50	50 - 150	50	50 - 150	50
2,2',3,4',5',6-HxCB (PCB-149)	38380-04-0	0.83	NDEP 2013	0.000040	EDL(4)	--	--	50	50 - 150	50	50 - 150	50

TABLE 2. SOIL ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

ANALYTES	CAS Number	Screening Level	Screening Level Source(1)	Practical Quantitation Limit (PQL)	Method Detection Limit (MDL)	QUALITY CONTROL LIMITS(2) Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
						%R	RPD	%R	RPD	%R	RPD
2,2',3,4',6,6'-HxCB (PCB-150)	68194-08-1	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',3,5,5',6-HxCB (PCB-151)	52663-63-5	0.83	NDEP 2013	0.000040	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',3,5,6,6'-HxCB (PCB-152)	68194-09-2	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',4,4',5,5'-HxCB (PCB-153)	35065-27-1	0.83	NDEP 2013	0.000040	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',4,4',5',6-HxCB (PCB-154)	60145-22-4	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',4,4',6,6'-HxCB (PCB-155)	33979-03-2	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,3',4,4',5-HxCB (PCB-156)	38380-08-4	0.83	NDEP 2013	0.000004	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,3',4,4',5'-HxCB (PCB-157)	69782-90-7	0.83	NDEP 2013	0.000004	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,3',4,4',6-HxCB (PCB-158)	74472-42-7	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,3',4,5,5'-HxCB (PCB-159)	39635-35-3	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,3',4,5,6-HxCB (PCB-160)	41411-62-5	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,3',4,5',6-HxCB (PCB-161)	74472-43-8	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,3',4',5,5'-HxCB (PCB-162)	39635-34-2	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,3',4',5,6-HxCB (PCB-163)	74472-44-9	0.83	NDEP 2013	0.000060	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,3',4',5',6-HxCB (PCB-164)	74472-45-0	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,3',5,5',6-HxCB (PCB-165)	74472-46-1	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,4,4',5,6-HxCB (PCB-166)	41411-63-6	0.83	NDEP 2013	0.000040	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3',4,4',5,5'-HxCB (PCB-167)	52663-72-6	0.83	NDEP 2013	0.000002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50

TABLE 2. SOIL ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

ANALYTES	CAS Number	Screening Level	Screening Level Source[1]	Practical Quantitation Limit (PQL)	Method Detection Limit (MDL)	QUALITY CONTROL LIMITS[2] Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
						%R	RPD	%R	RPD	%R	RPD
2,3',4,4',5',6-HxCB (PCB-168)	59291-65-5	0.83	NDEP 2013	0.000040	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
3,3',4,4',5,5'-HxCB (PCB-169)	32774-16-6	0.83	NDEP 2013	0.000002	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,2',3,3',4,4',5-HpCB (PCB-170)	35065-30-6	0.83	NDEP 2013	0.000020	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,2'3,3',4,4',6-HpCB (PCB-171)	52663-71-5	0.83	NDEP 2013	0.000040	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,2',3,3',4,5,5'-HpCB (PCB-172)	52663-74-8	0.83	NDEP 2013	0.000020	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,2',3,3',4,5,6-HpCB (PCB-173)	68194-16-1	0.83	NDEP 2013	0.000040	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,2',3,3',4,5,6'-HpCB (PCB-174)	38411-25-5	0.83	NDEP 2013	0.000020	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,2',3,3',4,5',6-HpCB (PCB-175)	40186-70-7	0.83	NDEP 2013	0.000020	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,2',3,3',4,6,6'-HpCB (PCB-176)	52663-65-7	0.83	NDEP 2013	0.000020	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,2',3,3',4',5,6-HpCB (PCB-177)	52663-70-4	0.83	NDEP 2013	0.000020	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,2',3,3',5,5',6-HpCB (PCB-178)	52663-67-9	0.83	NDEP 2013	0.000020	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,2',3,3',5,6,6'-HpCB (PCB-179)	52663-64-6	0.83	NDEP 2013	0.000020	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,2',3,4,4',5,5'-HpCB (PCB-180)	35065-29-3	0.83	NDEP 2013	0.000040	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,2',3,4,4',5,6-HpCB (PCB-181)	74472-47-2	0.83	NDEP 2013	0.000020	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,2',3,4,4',5,6'-HpCB (PCB-182)	60145-23-5	0.83	NDEP 2013	0.000020	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,2',3,4,4',5',6-HpCB (PCB-183)	52663-69-1	0.83	NDEP 2013	0.000020	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,2',3,4,4',6,6'-HpCB (PCB-184)	74472-48-3	0.83	NDEP 2013	0.000020	EDL[4]	-- --	50	50 - 150	50	50 - 150	50
2,2',3,4,5,5',6-HpCB (PCB-185)	52712-05-7	0.83	NDEP 2013	0.000020	EDL[4]	-- --	50	50 - 150	50	50 - 150	50

TABLE 2. SOIL ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS(2)					
				Practical Quantitation Limit	Method Detection Limit	Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
ANALYTES	CAS Number	Screening Level	Screening Level Source(1)	(PQL)	(MDL)	%R	RPD	%R	RPD	%R	RPD
2,2',3,4,5,6,6'-HpCB (PCB-186)	74472-49-4	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',3,4',5,5',6-HpCB (PCB-187)	52663-68-0	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',3,4',5,6,6'-HpCB (PCB-188)	74487-85-7	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,3',4,4',5,5'-HpCB (PCB-189)	39635-31-9	0.83	NDEP 2013	0.000002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,3',4,4',5,6-HpCB (PCB-190)	41411-64-7	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,3',4,4',5',6-HpCB (PCB-191)	74472-50-7	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,3',4,5,5',6-HpCB (PCB-192)	74472-51-8	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,3',4',5,5',6-HpCB (PCB-193)	69782-91-8	0.83	NDEP 2013	0.000040	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',3,3',4,4',5,5'-OcCB (PCB-194)	35694-08-7	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',3,3',4,4',5,6-OcCB (PCB-195)	52663-78-2	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',3,3',4,4',5,6'-OcCB (PCB-196)	42740-50-1	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',3,3',4,4',6,6'-OcCB (PCB-197)	33091-17-7	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',3,3',4,5,5',6-OcCB (PCB-198)	68194-17-2	0.83	NDEP 2013	0.000040	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',3,3',4,5,5',6'-OcCB (PCB-199)	52663-75-9	0.83	NDEP 2013	0.000040	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',3,3',4,5,6,6'-OcCB (PCB-200)	52663-73-7	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',3,3',4,5',6,6'-OcCB (PCB-201)	40186-71-8	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',3,3',5,5',6,6'-OcCB (PCB-202)	2136-99-4	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',3,4,4',5,5',6-OcCB (PCB-203)	52663-76-0	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50

TABLE 2. SOIL ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

ANALYTES	CAS Number	Screening Level	Screening Level Source(1)	Practical Quantitation Limit (PQL)	Method Detection Limit (MDL)	QUALITY CONTROL LIMITS(2) Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
						%R	RPD	%R	RPD	%R	RPD
2,2',3,4,4',5,6,6'-OcCB (PCB-204)	74472-52-9	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3,3',4,4',5,5',6-OcCB (PCB-205)	74472-53-0	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',3,3',4,4',5,5',6-NoCB (PCB-206)	40186-72-9	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',3,3',4,4',5,6,6'-NoCB (PCB-207)	52663-79-3	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,2',3,3',4,5,5',6,6'-NoCB (PCB-208)	52663-77-1	0.83	NDEP 2013	0.000020	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
DeCB (PCB-209)	2051-24-3	0.83	NDEP 2013	0.00002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
PCBs as Aroclors (mg/kg)											
EPA Method 8082											
Aroclor 1260	11096-82-5	0.83	NDEP 2013	0.05	0.02	-- --	50	50 - 125	30	65 - 115	30
DCB Decachlorobiphenyl (Surr)	2051-24-3	--	--	--	--	45 - 120	--	-- --	--	-- --	--
Organic Acids (mg/kg)											
EPA Method 8270C											
Phthalic acid(7)	88-99-3	--	--	2.5	0.76	-- --	50	-- --	--	-- --	--
2-fluorobiphenyl (Surr)	321-60-8			--	--	29 - 120	--	-- --	--	-- --	--
Total Petroleum Hydrocarbons (mg/kg)											
EPA Method 8015B											
Gasoline Range Organics (C6-C10)	TPH-gasoline	100	ENVIRON 2012(8)	0.40	0.15	-- --	50	60 - 140	30	70 - 135	20
4-Bromofluorobenzene (Surr)	460-00-4	--	--	--	--	65 - 140	--	-- --	--	-- --	--
Diesel Range Organics (C10-C28)	TPH-oil	100	ENVIRON 2012(8)	5.00	2.50	-- --	50	40 - 120	30	45 - 115	25
Oil Range Organics (C28-C40)	TPH-diesel	100	ENVIRON 2012(8)	5.00	2.50	-- --	50	40 - 120	30	45 - 115	25
n-Octacosane (Surr)	630-02-4	--	--	--	--	40 - 140	--	-- --	--	-- --	--

TABLE 2. SOIL ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

ANALYTES	CAS Number	Screening Level	Screening Level Source[(1)]	Practical Quantitation Limit (PQL)	Method Detection Limit (MDL)	QUALITY CONTROL LIMITS[(2)] Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
						%R	RPD	%R	RPD	%R	RPD
Wet Chemistry and Miscellanous Analytes (mg/kg except as noted)											
SM 2320B											
Alkalinity as CaCO$_3$	--	--	NDEP 2013	500	--	-- --	50	-- --	--	90 - 110	20
Bicarbonate as HCO$_3^-$	--	--	NDEP 2013	610	--	-- --	50	-- --	--	-- --	--
Carbonate as CO$_3^-$	--	--	NDEP 2013	300	--	-- --	50	-- --	--	-- --	--
Hydroxide as OH$^-$	14280-30-9	--	NDEP 2013	170	--	-- --	50	-- --	--	-- --	--
SM 4500-NH3 D											
Ammonia as NH$_3$	7664-41-7	100,000	NDEP 2013	12.0	2.40	-- --	50	75 - 125	15	85 - 115	15
EPA Method 300.0											
Bromide	24959-67-9	100,000	NDEP 2013	5.00	3.50	-- --	50	80 - 120	20	90 - 110	20
Chloride	16887-00-6	--	NDEP 2013	5.00	4.00	-- --	50	80 - 120	20	90 - 110	20
Fluoride	16984-48-8	41,044	NDEP 2013	5.00	3.50	-- --	50	80 - 120	20	90 - 110	20
Nitrate	14797-55-8	100,000	NDEP 2013	1.10	0.800	-- --	50	80 - 120	20	90 - 110	20
Nitrite	14797-65-0	100,000	NDEP 2013	1.50	1.10	-- --	50	80 - 120	20	90 - 110	20
Orthophosphate as PO$_4$	14265-44-2	--	NDEP 2013	5.00	4.00	-- --	50	80 - 120	20	90 - 110	20
Sulfate	14808-79-8	--	NDEP 2013	5.00	4.00	-- --	50	80 - 120	20	90 - 110	20
EPA Method 300.1											
Chlorate	7790-93-4	34,067	NDEP 2013	0.2	0.1	-- --	50	75 - 125	25	75 - 125	25
Dichloroacetic acid (Surr)	79-43-6	--	--	--	--	90 - 115	--	-- --	--	-- --	--
EPA Method 314.0											
Perchlorate	14797-73-0	795	NDEP 2013	0.0400	0.00950	-- --	50	80 - 120	20	85 - 115	15
EPA Method 9014B											
Cyanide (total)	57-12-5	27.8	NDEP 2013	0.500	0.430	-- --	50	70 - 115	15	90 - 110	10
EPA Method 120.1 / SM 2510B											
Conductivity (μmho/cm)	--	--	NDEP 2013	10.0	--	-- --	50	-- --	--	90 - 110	20
EPA Method 9045C (SU)											
pH	--	--	NDEP 2013	0.100	--	-- --	50	-- --	--	-- --	--
SM 5540C											
Surfactants (MBAS)	--	--	NDEP 2013	1.00	0.500	-- --	50	50 125	20	90 - 110	20

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QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS(2)					
				Practical Quantitation Limit	Method Detection Limit	Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
ANALYTES	CAS Number	Screening Level	Screening Level Source(1)	(PQL)	(MDL)	%R	RPD	%R	RPD	%R	RPD
SM 5310B											
Total Organic Carbon	7440-44-0	--	NDEP 2013	1.00	0.750	-- --	50	80 - 120	20	90 - 110	20
Radionuclides (pCi/g)(9)											
See Table 1 for Individual Methods											
Radium-226	13982-63-3	0.023	NDEP 2013	1	--	-- --	50	72 - 140	40	65 - 140	40
Radium-228	15262-20-1	0.041	NDEP 2013	1	--	-- --	50	30 - 150	40	61 - 139	40
Thorium-228	14274-82-9	0.025	NDEP 2013	1	--	-- --	50	70 - 130	40	70 - 130	40
Thorium-230	14269-63-7	8.3	NDEP 2013	1	--	-- --	50	76 - 115	40	81 - 118	40
Thorium-232	7440-29-1	7.4	NDEP 2013	1	--	-- --	50	70 - 130	40	70 - 130	40
Uranium-234	13966-29-5	11	NDEP 2013	1	--	-- --	50	70 - 130	40	84 - 120	40
Uranium-235	15117-96-1	0.35	NDEP 2013	1	--	-- --	50	-- --	40	-- --	40
Uranium-238	7440-61-1	1.4	NDEP 2013	1	--	-- --	50	70 - 130	40	82 - 122	40
Asbestos (protocol structures)											
EPA Method 540-R-97-028 modified per Berman & Kolk (2000)											
Total Amphibole Protocol Structures	1332-21-4	--	--	Fiber Count(10)		-- --	50	-- --	--	-- --	--
Long Amphibole Protocol Structures	1332-21-4	1 or more	NDEP (2010)	Fiber Count(10)		-- --	50	-- --	--	-- --	--
Total Chrysotile Protocol Structures	1332-21-4	--	--	Fiber Count(10)		-- --	50	-- --	--	-- --	--
Long Chrysotile Protocol Structures	1332-21-4	More than 5	NDEP (2010)	Fiber Count(10)		-- --	50	-- --	--	-- --	--
Total Asbestos Protocol Structures	1332-21-4	--	--	Fiber Count(10)		-- --	50	-- --	--	-- --	--
Long Asbestos Protocol Structures	1332-21-4	--	--	Fiber Count(10)		-- --	50	-- --	--	-- --	--

Notes:

Shaded PQLs and MDLs exceed the lowest screening criteria.

-- = no value

µg/kg = milligram per kilogram

TABLE 2. SOIL ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

ANALYTES	CAS Number	Screening Level	Screening Level Source[1]	Practical Quantitation Limit (PQL)	Method Detection Limit (MDL)	QUALITY CONTROL LIMITS[2] Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike/LCS %R	Blank Spike/LCS RPD

mg/kg = milligram per kilogram

pCi/g = picoCurie per gram

pg/g = picogram per gram

protocol structure = asbestos protocol structures greater than 10 micrometers (µm) in length and less than 0.4 µm in width that is most responsible for asbestos related disease (NDEP 2011).

Surr = Surrogate

TEQ = toxicity equivalence

EPA = United States Environmental Protection Agency

SM = Standard Method

(1) Screening values obtained from (a) NDEP (2013) and are the lower of the indoor and outdoor industrial/commercial worker soil Basic Comparison Levels (BCLs); and (b) NDEP (2010) and are site-specific levels for indoor and outdoor industrial/commercial workers or based on regional background concentrations.

(2) QC Limits = Quality Control Limits for %R (Percent Recovery) of spiked compounds in Laboratory Control Samples (LCS) and surrogate compounds and Relative Percent Difference (RPD) between Matrix Spike (MS) and MS Duplicate (MSD) samples and LCS and LCS duplicate (LCSD) samples. Laboratory historical control limits are subject to change as a result of periodic re-evaluation. Limits in use at the time of sample analysis are available from the laboratory. Duplicate RPDs apply to sample duplicates and field duplicates.

(3) PQLs and MDLs for zirconium are under development by the laboratory and are not yet available.

(4) EDL = Estimated Detection Limit. For each dioxin, furan, or PCB not detected, an EDL is calculated. The sample specific EDL is an estimate made by the laboratory of the concentration of a given chemical that would have to be present to produce a signal with a peak height of at least 2.5 times the background signal level. The estimate is specific to a particular analysis of the sample and will be affected by sample size, dilution, and so forth. Because of the toxicological significance of dioxins, the EDL value is reported for non-detected chemicals rather than reporting the MDL.

(5) Dioxins and PCB congeners shall be reported to the estimated detection limit (EDL). Dioxin toxicity equivalents (TEQ) will be calculated for the 16 dioxin and furan congeners and 12 PCB congeners with toxicity equivalent factors (TEFs) defined by the World Health Organization (Van den Berg et al. 2006) substituting half of the EDL for the congeners not detected.

(6) The screening level for m-xylene is used for m,p-xylene.

(7) Phthalic acid will be run with the SVOCs by EPA Method 8270C.

(8) A total TPH value of 100 mg/kg was used in the Interim Soil Removal Actions Report (ENVIRON 2012) and the Site Management Plan, Revision 1 (SMP) (2013).

(9) Radionuclide PQLs and MDLs are based on minimum detectable activity (MDA) values. The measured values are reported regardless of sample-specific MDA.

(10) Asbestos data will be reported as raw asbestos fiber counts per sample (NDEP 2008). There are no PQLs for this method, but sensitivity is calculated by the concentration of protocol structures per volume of PM10.

<u>Sources:</u>

ENVIRON. 2012. Interim Soil Removal Action , Nevada Environmental Response Trust Site, Henderson, Nevada, August 2010-November 2011. Revised September 2012. NDEP approved December 17, 2012.

TABLE 2. SOIL ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS[2]					
				Practical Quantitation Limit	Method Detection Limit	Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
ANALYTES	CAS Number	Screening Level	Screening Level Source[1]	(PQL)	(MDL)	%R	RPD	%R	RPD	%R	RPD

ENVIRON. 2013. Site Management Plan, Revision 1, Nevada Environmental Response Trust Site, Henderson, Nevada. October 31.

NDEP. 2008. NDEP. 2008. NDEP Detection Limits and Data Reporting for the BMI Plant Sites and Common Areas Projects, Henderson, Nevada. December.

NDEP. 2010. Letter to Tronox LLC re: Response to: Results of Bioaccessibility Study for Dioxin/Furans in Soil, Tronox LLC, Henderson, Nevada (Revised), Dated May 24, 2010. May 25, 2010.

NDEP. 2011. Technical Guidance for the Calculation of Asbestos Related Risk in Soils for the Basic Management Incorporated (BMI) Complex and Common Areas. February.

NDEP. 2013. User’s Guide and Background Technical Document for NDEP Basic Comparison Levels (BCLs) for Human Health for the BMI Complex and Common Areas. Revision 12, August.

Van den Berg et al., 2006. The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. May 20.

TABLE 3. SOIL GAS ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

ANALYTES	CAS Number	Screening Level	Screening Level Source(1)	Practical Quantitation Limit (PQL)	Method Detection Limit (MDL)	QUALITY CONTROL LIMITS(2) Surrogate	QUALITY CONTROL LIMITS(2) Duplicate	QUALITY CONTROL LIMITS(2) Blank Spike/LCS	
						%R	RPD	%R	RPD
Soil Gas Analytes ($\mu g/m^3$)									
EPA Method TO-15									
Acetone	67-64-1	4.12E+08	ENVIRON 2013	60	8.938	-- --	50	60 - 140	25
Acrolein	107-02-8	--	ENVIRON 2013	1.16	0.2331	-- --	50	60 - 140	25
Acrylonitrile	107-13-1	5.59E+02	ENVIRON 2013	1.1	0.6105	-- --	50	60 - 140	25
Benzene	71-43-2	6.20E+03	ENVIRON 2013	1.6	0.2597	-- --	50	60 - 140	25
Benzyl chloride	100-44-7	1.27E+03	ENVIRON 2013	2.65	0.3783	-- --	50	60 - 140	25
Bromodichloromethane	75-27-4	3.19E+03	ENVIRON 2013	3.5	0.01098	-- --	50	60 - 140	25
Bromoform	75-25-2	2.01E+05	ENVIRON 2013	5.25	0.2214	-- --	50	60 - 140	25
Bromomethane	74-83-9	9.97E+04	ENVIRON 2013	1.95	0.35814	-- --	50	60 - 140	25
1,3-Butadiene	106-99-0	1.47E+03	ENVIRON 2013	1.1	0.5535	-- --	50	60 - 140	25
2-Butanone (MEK)	78-93-3	9.02E+07	ENVIRON 2013	75	3.8542	-- --	50	60 - 140	25
Carbon Disulfide	75-15-0	1.07E+07	ENVIRON 2013	1.6	0.41785	-- --	50	60 - 140	25
Carbon Tetrachloride	56-23-5	8.82E+03	ENVIRON 2013	3.2	0.0115	-- --	50	60 - 140	25
Chlorobenzene	108-90-7	9.95E+05	ENVIRON 2013	2.35	0.1584	-- --	50	60 - 140	25
Chloroethane	75-00-3	8.61E+07	ENVIRON 2013	1.34	0.3462	-- --	50	60 - 140	25
Chloroform	67-66-3	1.86E+03	ENVIRON 2013	2.45	0.01512	-- --	50	60 - 140	25
Chloromethane	74-87-3	2.08E+04	ENVIRON 2013	1.05	0.1218	-- --	50	60 - 140	25
Cyclohexane	110-82-7	1.11E+08	ENVIRON 2013	17.5	0.3815	-- --	50	60 - 140	25
Dibromochloromethane	124-48-1	6.38E+03	ENVIRON 2013	4.35	0.0048	-- --	50	60 - 140	25
1,2-Dibromo-3-chloropropane	96-12-8	1.83E+01	ENVIRON 2013	0.123	0.0056	-- --	50	60 - 140	25
1,2-Dibromoethane (EDB)	106-93-4	2.61E+02	ENVIRON 2013	3.9	0.00374	-- --	50	60 - 140	25
1,2-Dichlorobenzene	95-50-1	4.16E+06	ENVIRON 2013	3.05	0.16448	-- --	50	60 - 140	25
1,3-Dichlorobenzene	541-73-1	4.15E+06	ENVIRON 2013	3.05	0.25811	-- --	50	60 - 140	25
1,4-Dichlorobenzene	106-46-7	5.29E+03	ENVIRON 2013	3.05	0.6161	-- --	50	60 - 140	25
Dichlorodifluoromethane	75-71-8	2.14E+06	ENVIRON 2013	2.5	0.5586	-- --	50	60 - 140	25

TABLE 3. SOIL GAS ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

ANALYTES	CAS Number	Screening Level	Screening Level Source(1)	Practical Quantitation Limit (PQL)	Method Detection Limit (MDL)	QUALITY CONTROL LIMITS(2)			
						Surrogate	Duplicate	Blank Spike/LCS	
						%R	RPD	%R	RPD
Soil Gas Analytes ($\mu g/m^3$)									
1,1-Dichloroethane	75-34-3	3.44E+04	ENVIRON 2013	2.05	1.8354	-- --	50	60 - 140	25
1,2-Dichloroethane	107-06-2	1.65E+03	ENVIRON 2013	2.05	0.00624	-- --	50	60 - 140	25
1,1-Dichloroethene	75-35-4	3.40E+06	ENVIRON 2013	2	0.3104	-- --	50	60 - 140	25
cis-1,2-Dichloroethene	156-59-2	1.19E+06	ENVIRON 2013	2	0.5626	-- --	50	60 - 140	25
trans-1,2-Dichloroethene	156-60-5	1.22E+06	ENVIRON 2013	2	0.2073	-- --	50	60 - 140	25
1,2-Dichloropropane	78-87-5	5.28E+03	ENVIRON 2013	2.35	0.0103	-- --	50	60 - 140	25
cis-1,3-Dichloropropene	10061-01-5	1.57E+04	ENVIRON 2013	2.3	0.0041	-- --	50	60 - 140	25
trans-1,3-Dichloropropene	10061-02-6	1.57E+04	ENVIRON 2013	2.3	0.2622	-- --	50	60 - 140	25
1,2-Dichloro-1,1,2,2-tetrafluoroethane	76-14-2	5.67E+08	ENVIRON 2013	3.55	0.10668	-- --	50	60 - 140	25
Diisopropyl ether (DIPE)	108-20-3	1.53E+07	ENVIRON 2013	2.1	0.3496	-- --	50	60 - 140	25
1,4-Dioxane	123-91-1	5.49E+03	ENVIRON 2013	1.85	0.1279	-- --	50	60 - 140	25
Ethanol	64-17-5	8.34E+08	ENVIRON 2013	96	10.626	-- --	50	60 - 140	25
Ethyl acetate	141-78-6	1.27E+07	ENVIRON 2013	1.85	0.3645	-- --	50	60 - 140	25
Ethyl tert-butyl ether (ETBE)	637-92-3	2.35E+05	ENVIRON 2013	2.1	0.7985	-- --	50	60 - 140	25
Ethylbenzene	100-41-4	2.18E+04	ENVIRON 2013	2.2	0.1793	-- --	50	60 - 140	25
4-Ethyltoluene	622-96-8	8.72E+06	ENVIRON 2013	2.5	0.0802	-- --	50	60 - 140	25
Heptane	142-82-5	7.06E+07	ENVIRON 2013	21	5.683	-- --	50	60 - 140	25
Hexachlorobutadiene	87-68-3	3.12E+03	ENVIRON 2013	5.4	0.1456	-- --	50	60 - 140	25
Hexane	110-54-3	7.06E+06	ENVIRON 2013	18	0.4914	-- --	50	60 - 140	25
2-Hexanone	591-78-6	5.24E+05	ENVIRON 2013	2.1	0.1617	-- --	50	60 - 140	25
Methylene chloride	75-09-2	4.37E+06	ENVIRON 2013	1.75	0.4445	-- --	50	60 - 140	25
Methyl methacrylate	80-62-6	1.33E+07	ENVIRON 2013	2.08	0.4163	-- --	50	60 - 140	25
4-Methyl-2-pentanone (MIBK)	108-10-1	5.80E+07	ENVIRON 2013	2.1	0.1255	-- --	50	60 - 140	25
Methyl-t-butyl ether (MTBE)	1634-04-4	1.66E+05	ENVIRON 2013	1.85	0.506	-- --	50	60 - 140	25
Naphthalene	91-20-3	1.93E+03	ENVIRON 2013	5.3	0.028	-- --	50	60 - 140	25

TABLE 3. SOIL GAS ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

ANALYTES	CAS Number	Screening Level	Screening Level Source(1)	Practical Quantitation Limit (PQL)	Method Detection Limit (MDL)	QUALITY CONTROL LIMITS(2)			
						Surrogate	Duplicate	Blank Spike/LCS	
						%R	RPD	%R	RPD
Soil Gas Analytes ($\mu g/m^3$)									
Propene	115-07-1	--	ENVIRON 2013	88	18.519	-- --	50	60 - 140	25
Styrene	100-42-5	2.03E+07	ENVIRON 2013	2.15	0.2025	-- --	50	60 - 140	25
tert-Amyl methyl ether (TAME	994-05-8	2.35E+05	ENVIRON 2013	2.1	1.247	-- --	50	60 - 140	25
t-Butyl alcohol (TBA)	75-65-0	4.92E+08	ENVIRON 2013	31	16.771	-- --	50	60 - 140	25
1,1,1,2-Tetrachloroethane	630-20-6	7.69E+03	ENVIRON 2013	3.5	0.00704	-- --	50	60 - 140	25
1,1,2,2-Tetrachloroethane	79-34-5	9.78E+02	ENVIRON 2013	3.5	0.00765	-- --	50	60 - 140	25
Tetrachloroethene	127-18-4	2.17E+05	ENVIRON 2013	3.45	0.0077	-- --	50	60 - 140	25
Tetrahydrofuran	109-99-9	3.64E+07	ENVIRON 2013	1.5	0.2068	-- --	50	60 - 140	25
Toluene	108-88-3	8.70E+07	ENVIRON 2013	1.9	0.2566	-- --	50	60 - 140	25
1,2,4-Trichlorobenzene	120-82-1	8.39E+04	ENVIRON 2013	3.75	0.1731	-- --	50	60 - 140	25
1,1,1-Trichloroethane	71-55-6	9.45E+07	ENVIRON 2013	2.75	0.3454	-- --	50	60 - 140	25
1,1,2-Trichloroethane	79-00-5	3.30E+03	ENVIRON 2013	2.75	0.0121	-- --	50	60 - 140	25
Trichloroethene	79-01-6	1.28E+04	ENVIRON 2013	2.75	0.0412	-- --	50	60 - 140	25
Trichlorofluoromethane	75-69-4	1.22E+07	ENVIRON 2013	2.85	0.3579	-- --	50	60 - 140	25
1,1,2-Trichloro trifluoroethane (Freon 113)	76-13-1	5.67E+08	ENVIRON 2013	3.9	0.1558	-- --	50	60 - 140	25
1,2,4-Trimethylbenzene	95-63-6	1.61E+05	ENVIRON 2013	2.5	0.2508	-- --	50	60 - 140	25
1,3,5-Trimethylbenzene	108-67-8	1.62E+05	ENVIRON 2013	2.5	0.3499	-- --	50	60 - 140	25
Vinyl Acetate	108-05-4	3.54E+06	ENVIRON 2013	1.8	0.6113	-- --	50	60 - 140	25
Vinyl Chloride	75-01-4	9.60E+03	ENVIRON 2013	1.3	0.00754	-- --	50	60 - 140	25
Xylenes, Total	1330-20-7	1.91E+06	ENVIRON 2013	6.6	0.8331	-- --	50	60 - 140	25
1,2-Dichloroethane-D4 (Surr)	17060-07-0	--	ENVIRON 2013	--	--	60 - 140	--	-- --	--
Toluene-d8 (Surr)	2037-26-5	--	ENVIRON 2013	--	--	60 - 140	--	-- --	--
4-Bromofluorobenzene (Surr)	460-00-4	--	ENVIRON 2013	--	--	60 - 140	--	-- --	--
ASTM D1946									
Helium	7440-59-7	--	--	50	--	-- --	50	70 - 130	--

TABLE 3. SOIL GAS ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS(2)			
						Surrogate	Duplicate	Blank Spike/LCS	
ANALYTES	CAS Number	Screening Level	Screening Level Source(1)	Practical Quantitation Limit (PQL)	Method Detection Limit (MDL)	%R	RPD	%R	RPD
Soil Gas Analytes ($\mu g/m^3$)									

Notes:

Shaded PQLs and MDLs exceed the lowest screening criteria.

-- = no value

$\mu g/m^3$ = micrograms per cubic meter

Surr = Surrogate

(1) ENVIRON derived risk-based concentrations (RBCs) using the inputs to the Johnson and Ettinger model and values for exposure assumptions and toxicity criteria presented in the NDEP-approved Soil Gas Investigation and Human Health Risk Assessment Work Plan for Parcels C, D, F, G, and H (ENVIRON 2013).

(2) QC Limits = Quality Control Limits for %R (Percent Recovery) of spiked compounds in Laboratory Control Samples (LCS) and surrogate compounds and Relative Percent Difference (RPD) between LCS and LCS Duplicate (LCSD) samples. Matrix spikes (MS) are not performed on soil gas samples. Laboratory historical control limits are subject to change as a result of periodic re-evaluation. Limits in use at the time of sample analysis are available from the laboratory. Duplicate RPDs apply to sample duplicates and field duplicates.

Sources:

ENVIRON. 2013. Soil Gas Investigation and Human Health Risk Assessment Work Plan for Parcels C, D, F, G, and H. Nevada Environmental Response Trust, Henderson, Nevada. March 18, 2013. Approved by NDEP April 9, 2013.

TABLE 4. LEACHING-BASED SOIL ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS(2)					
						Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
ANALYTES	CAS Number	Screening Level	Screening Level Source(1)	Practical Quantitation Limit (PQL)	Method Detection Limit (MDL)	%R	RPD	%R	RPD	%R	RPD
Metals (mg/kg)											
EPA Method 200.7 / 6010											
Aluminum	7429-90-5	75	BCL	10	5	-- --	50	75 - 125	20	80 - 120	20
Antimony	7440-36-0	0.30	BCL	10	5	-- --	50	75 - 125	20	80 - 120	20
Barium	7440-39-3	82	BCL	1.5	0.75	-- --	50	75 - 125	20	80 - 120	20
Beryllium	7440-41-7	3	BCL	0.5	0.25	-- --	50	75 - 125	20	80 - 120	20
Boron	7440-42-8	23	BCL	5	2.5	-- --	50	75 - 125	20	80 - 120	20
Cadmium	7440-43-9	0.40	BCL	0.5	0.25	-- --	50	75 - 125	20	80 - 120	20
Calcium	7440-70-2	--	--	25.0	12.5	-- --	50	75 - 125	20	80 - 120	20
Chromium (total)	7440-47-3	180,000	RSL	1	0.5	-- --	50	75 - 125	20	80 - 120	20
Cobalt	7440-48-4	0.50	BCL	1	0.5	-- --	50	75 - 125	20	80 - 120	20
Copper	7440-50-8	46	BCL	2	1	-- --	50	75 - 125	20	80 - 120	20
Iron	7439-89-6	7.6	BCL	10	5	-- --	50	75 - 125	20	80 - 120	20
Lead	7439-92-1	14	RSL	2	1	-- --	50	75 - 125	20	80 - 120	20
Magnesium	7439-95-4	973	BCL	10	5	-- --	50	75 - 125	20	80 - 120	20
Manganese	7439-96-5	1.3	BCL	2	1	-- --	50	75 - 125	20	80 - 120	20
Molybdenum	7439-98-7	3.7	BCL	2	1	-- --	50	75 - 125	20	80 - 120	20
Nickel	7440-02-0	7.0	BCL	2	1	-- --	50	75 - 125	20	80 - 120	20
Phosphorus	7723-14-0	0.0011	RSL	5	3	-- --	50	75 - 125	20	80 - 120	20
Potassium	7440-09-7	--	--	5	3	-- --	50	75 - 125	20	80 - 120	20
Silicon	7440-21-3	--	--	10	5	-- --	50	75 - 125	20	80 - 120	20
Silver	7440-22-4	0.85	BCL	1.5	0.75	-- --	50	75 - 125	20	80 - 120	20
Sodium	7440-23-5	--	--	62.5	30.00	-- --	50	75 - 125	20	80 - 120	20
Strontium	7440-24-6	330	RSL	5	2.5	-- --	50	75 - 125	20	80 - 120	20
Thallium	7440-28-0	0.40	BCL	10	5.0	-- --	50	80 - 120	20	80 - 120	20
Tin	7440-31-5	2,300	RSL	10	2.5	-- --	50	81 - 120	20	80 - 120	20
Titanium	7440-32-6	146,000	BCL	2	1.0	-- --	50	81 - 120	20	80 - 120	20
Tungsten	7440-33-7	41	BCL	10	5	-- --	50	75 - 125	20	80 - 120	20
Vanadium	7440-62-2	300	BCL	1	1	-- --	50	75 - 125	20	80 - 120	20

TABLE 4. LEACHING-BASED SOIL ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS(2)					
				Practical Quantitation Limit	Method Detection Limit	Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
ANALYTES	**CAS Number**	**Screening Level**	**Screening Level Source(1)**	**(PQL)**	**(MDL)**	**%R**	**RPD**	**%R**	**RPD**	**%R**	**RPD**
Zinc	7440-66-6	620	BCL	5	2.5	-- --	50	75 - 125	20	80 - 120	20
EPA Method 200.8 / 6020											
Arsenic	7440-38-2	0.29	RSL	0.5	0.25	-- --	50	80 - 120	20	80 - 120	20
Selenium	7782-49-2	0.30	BCL	1	0.5	-- --	50	80 - 120	20	80 - 120	20
Zirconium(3)	7440-67-7	3.7	RSL	--	--	-- --	50	75 - 125	20	80 - 120	20
EPA Method 6020A											
Niobium	7440-03-1	1.3	BCL	2.5	0.38	-- --	50	75 - 125	30	80 - 120	20
Palladium	7440-05-3	--	--	0.1	0.01	-- --	50	75 - 125	30	80 - 120	20
Sulfur	7704-34-9	--	--	500	21.7	-- --	50	75 - 125	30	80 - 120	20
Uranium	7440-61-1	13.5	BCL	0.1	0.0199	-- --	50	75 - 125	30	80 - 120	20
EPA Method 7199											
Chromium (hexavalent)	18540-29-9	2.0	BCL	0.8	0.15	-- --	50	55 - 110	20	65 - 110	20
EPA Method 7471A											
Mercury	7439-97-6	0.10	BCL	0.02	0.012	-- --	50	70 - 130	20	80 - 120	20
Volatile Organic Compounds (µg/kg)											
EPA Method 8260B											
1,1,1,2-Tetrachloroethane	630-20-6	0.2	RSL	2000	1.0	-- --	50	65 - 145	20	70 - 130	20
1,1,1-Trichloroethane	71-55-6	100	BCL	1	0.5	-- --	50	65 - 145	20	65 - 135	20
1,1,2,2-Tetrachloroethane	79-34-5	0.2	BCL	2	1.0	-- --	50	40 - 160	30	55 - 140	30
1,1,2-Trichloroethane	79-00-5	0.9	BCL	1	0.5	-- --	50	65 - 140	30	65 - 135	20
1,1-Dichloroethane	75-34-3	1000	BCL	1	0.5	-- --	50	65 - 135	25	70 - 130	20
1,1-Dichloroethene	75-35-4	3	BCL	2	0.5	-- --	50	65 - 135	25	70 - 125	20
1,1-Dichloropropene	563-58-6	--	--	1	0.5	-- --	50	65 - 135	20	70 - 130	20
1,2,3-Trichlorobenzene	87-61-6	15	RSL	2	1	-- --	50	45 - 145	30	60 - 130	20
1,2,3-Trichloropropane	96-18-4	0.0003	RSL	10	1.0	-- --	50	50 - 150	30	60 - 135	25
1,2,4-Trichlorobenzene	120-82-1	300	BCL	5	1.0	-- --	50	50 - 140	30	70 - 135	20
1,2,4-Trimethylbenzene	95-63-6	21	RSL	2	1	-- --	50	65 - 140	25	70 - 125	20
1,2-Dibromo-3-Chloropropane	96-12-8	0.1	RSL	5	2.0	-- --	50	40 - 150	30	50 - 135	30
1,2-Dibromoethane (EDB)	106-93-4	0.014	RSL	1	0.5	-- --	50	65 - 140	25	70 - 130	20

TABLE 4. LEACHING-BASED SOIL ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

				Practical Quantitation Limit	Method Detection Limit	QUALITY CONTROL LIMITS[2]					
ANALYTES	CAS Number	Screening Level	Screening Level Source[1]	(PQL)	(MDL)	Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike/LCS %R	Blank Spike/LCS RPD
1,2-Dichlorobenzene	95-50-1	900	BCL	1	0.5	-- --	50	70 - 130	25	75 - 120	20
1,2-Dichloroethane	107-06-2	1	BCL	1	0.5	-- --	50	60 - 150	25	60 - 140	20
1,2-Dichloropropane	78-87-5	1	BCL	1	0.5	-- --	50	65 - 130	20	70 - 130	20
1,3,5-Trimethylbenzene	108-67-8	120	RSL	2	1.0	-- --	50	65 - 135	25	70 - 125	20
1,3-Dichlorobenzene	541-73-1	50.8	CAL	1	0.5	-- --	50	70 - 130	25	75 - 125	20
1,3-Dichloropropane	142-28-9	1	BCL	1	0.5	-- --	50	65 - 140	25	70 - 125	20
1,4-Dichlorobenzene	106-46-7	100	BCL	1	0.5	-- --	50	70 - 130	25	75 - 120	20
2,2-Dichloropropane	594-20-7	--	--	2	1.0	-- --	50	65 - 150	25	60 - 145	20
2-Butanone	78-93-3	1000	RSL	10	5	-- --	50	25 - 170	40	40 - 145	35
2-Chlorotoluene	95-49-8	170	RSL	2	1.0	-- --	50	60 - 135	25	70 - 125	20
4-Chlorotoluene	106-43-4	180	RSL	2	1.0	-- --	50	65 - 135	25	75 - 125	20
Benzene	71-43-2	2	BCL	1	0.5	-- --	50	65 - 130	20	65 - 120	20
Bromobenzene	108-86-1	36	RSL	2	1.0	-- --	50	65 - 140	25	75 - 120	20
Bromochloromethane	74-97-5	21	RSL	2	1.0	-- --	50	65 - 145	25	70 - 135	20
Bromodichloromethane	75-27-4	30	BCL	1	0.5	-- --	50	65 - 145	20	70 - 135	20
Bromoform	75-25-2	40	BCL	2	1.0	-- --	50	50 - 145	30	55 - 135	25
Bromomethane	74-83-9	10	BCL	2	1.0	-- --	50	60 - 155	25	60 - 145	20
Carbon tetrachloride	56-23-5	3	BCL	2	0.5	-- --	50	60 - 145	25	65 - 140	20
Chlorobenzene	108-90-7	70	BCL	1	0.5	-- --	50	70 - 130	25	75 - 120	20
Chloroethane	75-00-3	5900	RSL	2	1.0	-- --	50	60 - 150	25	60 - 140	25
Chloroform	67-66-3	30	BCL	1	0.5	-- --	50	65 - 135	20	70 - 130	20
Chloromethane	74-87-3	49	RSL	2	1.0	-- --	50	40 - 145	25	45 - 145	25
cis-1,2-Dichloroethene	156-59-2	20	BCL	1	0.5	-- --	50	65 - 135	25	70 - 125	20
cis-1,3-Dichloropropene	10061-01-5	--	--	1	0.5	-- --	50	70 - 135	25	75 - 125	20
Dibromochloromethane	124-48-1	20.0	BCL	1	0.5	-- --	50	60 - 145	25	65 - 140	20
Dibromomethane	74-95-3	1.9	RSL	1	0.5	-- --	50	65 - 140	25	70 - 130	20
Dichlorodifluoromethane	75-71-8	300	RSL	2	1.0	-- --	50	30 - 160	35	35 - 160	30
Ethyl tert-butyl ether	637-92-3	--	--	2	1	-- --	50	60 - 145	30	60 - 140	20
Ethylbenzene	100-41-4	700	BCL	1	0.5	-- --	50	70 - 135	25	70 - 125	20
Hexachlorobutadiene	87-68-3	100	BCL	2	1.0	-- --	50	50 - 145	35	60 - 135	20

TABLE 4. LEACHING-BASED SOIL ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

ANALYTES	CAS Number	Screening Level	Screening Level Source(1)	Practical Quantitation Limit (PQL)	Method Detection Limit (MDL)	QUALITY CONTROL LIMITS(2)					
						Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
						%R	RPD	%R	RPD	%R	RPD
Isopropyl benzene	98-82-8	640	RSL	1	0.5	-- --	50	70 - 145	25	75 - 130	20
m,p-Xylene	179601-23-1	10	BCL	2	1.0	-- --	50	70 - 130	25	70 - 125	20
Methylene chloride	75-09-2	1	BCL	10	5	-- --	50	55 - 145	25	55 - 135	20
Naphthalene	91-20-3	4000	BCL	2	1.0	-- --	50	40 - 150	40	55 - 135	25
n-Butylbenzene	104-51-8	2500	RSL	2	1.0	-- --	50	55 - 145	30	70 - 130	20
n-Propylbenzene	103-65-1	990	RSL	1	0.5	-- --	50	65 - 140	25	70 - 130	20
o-Xylene	95-47-6	10000	BCL	1	0.5	-- --	50	65 - 130	25	70 - 125	20
p-Isopropyltoluene	99-87-6	3910	CAL	1	0.5	-- --	50	60 - 140	25	75 - 125	20
sec-Butylbenzene	135-98-8	4600	RSL	2	1.0	-- --	50	60 - 135	25	70 - 125	20
Styrene	100-42-5	200	BCL	1	0.5	-- --	50	70 - 140	25	75 - 130	20
tert-Butylbenzene	98-06-6	1100	RSL	2	1.0	-- --	50	60 - 140	25	70 - 125	20
Tetrachloroethene	127-18-4	3	BCL	1	0.5	-- --	50	65 - 135	25	70 - 125	20
Toluene	108-88-3	600	BCL	1	0.5	-- --	50	70 - 130	20	70 - 125	20
trans-1,2-Dichloroethene	156-60-5	30	BCL	1	0.5	-- --	50	70 - 135	25	70 - 125	20
trans-1,3-Dichloropropene	10061-02-6	--	--	1	0.5	-- --	50	60 - 145	25	70 - 135	20
Trichloroethene	79-01-6	3.0	BCL	1	0.5	-- --	50	65 - 140	25	70 - 125	20
Trichlorofluoromethane	75-69-4	690	RSL	2	1.0	-- --	50	55 - 155	25	60 - 145	25
Vinyl chloride	75-01-4	0.7	BCL	2	1.0	-- --	50	55 - 140	30	55 - 135	25
4-Bromofluorobenzene (Surr)	460-00-4	--	--	--	--	79 - 120	--	-- --	--	-- --	--
Dibromofluoromethane (Surr)	1868-53-7	--	--	--	--	60 - 120	--	-- --	--	-- --	--
Toluene-d8 (Surr)	2037-26-5	--	--	--	--	79 - 123	--	-- --	--	-- --	--
EPA Method 8260B SIM											
1,2,3-Trichloropropane	96-18-4	0.00028	RSL	0.01	0.004	-- --	50	50 - 150	30	60 - 135	25
1,4-Dioxane	123-91-1	0.14	RSL	5	1.1	-- --	50	70 - 130	30	70 - 130	30
Dibromofluoromethane (Surr)	1868-53-7	--	--	--	--	80 - 125	--	-- --	--	-- --	--

TABLE 4. LEACHING-BASED SOIL ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS[2]					
				Practical Quantitation Limit	Method Detection Limit	Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
ANALYTES	**CAS Number**	**Screening Level**	**Screening Level Source[1]**	**(PQL)**	**(MDL)**	**%R**	**RPD**	**%R**	**RPD**	**%R**	**RPD**
Semi-volatile Organic Compounds (mg/kg)											
EPA Method 8270C											
1-Methylnaphthalene	90-12-0	0.0051	RSL	0.35	0.15	-- --	50	60 - 140	30	60 - 140	30
2,4,5-Trichlorophenol	95-95-4	14	BCL	0.3	0.13	-- --	50	45 - 120	20	50 - 120	20
2,4,6-Trichlorophenol	88-06-2	0.01	BCL	0.3	0.075	-- --	50	45 - 120	25	50 - 120	20
2,4-Dichlorophenol	120-83-2	0.05	BCL	0.33	0.067	-- --	50	45 - 120	25	45 - 120	20
2,4-Dimethylphenol	105-67-9	0.4	BCL	0.33	0.13	-- --	50	30 - 120	25	40 - 120	20
2,4-Dinitrophenol	51-28-5	0.01	BCL	0.66	0.33	-- --	50	20 - 120	25	25 - 120	25
2,4-Dinitrotoluene	121-14-2	0.00004	BCL	0.33	0.08	-- --	50	50 - 125	25	55 - 125	20
2,6-Dinitrotoluene	606-20-2	0.00003	BCL	0.33	0.095	-- --	50	50 - 125	20	55 - 125	20
2-Chloronaphthalene	91-58-7	2.9	RSL	0.33	0.067	-- --	50	45 - 120	20	45 - 120	20
2-Chlorophenol	95-57-8	0.2	BCL	0.33	0.07	-- --	50	40 - 120	20	40 - 120	20
2-Methylnaphthalene	91-57-6	0.14	RSL	0.33	0.07	-- --	50	40 - 120	20	45 - 120	20
2-Methylphenol	95-48-7	0.8	BCL	0.33	0.08	-- --	50	40 - 120	25	40 - 120	20
2-Nitroaniline	88-74-4	0.06	RSL	0.33	0.067	-- --	50	45 - 120	25	50 - 125	20
2-Nitrophenol	88-75-5	--	--	0.33	0.133	-- --	50	40 - 120	25	45 - 120	20
3,3'-Dichlorobenzidine	91-94-1	0.0003	BCL	0.83	0.15	-- --	50	20 - 130	25	20 - 130	25
3-Methylphenol + 4-Methylphenol	106-44-5	--	--	0.33	0.133	-- --	50	50 - 120	25	50 - 120	20
3-Nitroaniline	99-09-2	--	--	0.33	0.133	-- --	50	30 - 120	25	35 - 120	25
4-Bromophenyl phenyl ether	101-55-3	--	--	0.33	0.075	-- --	50	45 - 120	20	45 - 120	20
4-Chloro-3-methylphenol	59-50-7	1.3	RSL	0.33	0.07	-- --	50	50 - 125	25	50 - 125	20
4-Chloroaniline	106-47-8	0.03	BCL	0.33	0.133	-- --	50	20 - 120	30	20 - 120	30
4-Chlorophenyl phenyl ether	7005-72-3	--	--	0.33	0.085	-- --	50	50 - 120	25	55 - 120	20
4-Nitroaniline	100-01-6	0.0014	RSL	0.83	0.133	-- --	50	40 - 125	30	45 - 125	20
4-Nitrophenol	100-02-7	--	--	0.83	0.14	-- --	50	35 - 125	30	40 - 125	20
Acenaphthene	83-32-9	29	BCL	0.33	0.067	-- --	50	45 - 120	25	50 - 120	20

TABLE 4. LEACHING-BASED SOIL ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

ANALYTES	CAS Number	Screening Level	Screening Level Source$^{(1)}$	Practical Quantitation Limit (PQL)	Method Detection Limit (MDL)	QUALITY CONTROL LIMITS$^{(2)}$					
						Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
						%R	RPD	%R	RPD	%R	RPD
Acenaphthylene	208-96-8	0.01	CAL	0.33	0.07	-- --	50	45 - 120	20	50 - 120	20
Aniline	62-53-3	0.004	RSL	0.42	0.085	-- --	50	25 - 120	30	25 - 120	20
Anthracene	120-12-7	590	BCL	0.33	0.08	-- --	50	55 - 120	25	55 - 120	20
Benzidine	92-87-5	--	--	0.66	0.66	-- --	50	20 - 120	30	20 - 120	30
Benzo(a)anthracene	56-55-3	0.08	BCL	0.33	0.07	-- --	50	50 - 120	25	55 - 120	20
Benzo(a)pyrene	50-32-8	0.4	BCL	0.33	0.067	-- --	50	45 - 125	25	50 - 125	20
Benzo(b)fluoranthene	205-99-2	0.2	BCL	0.33	0.067	-- --	50	45 - 125	30	45 - 125	25
Benzo(g,h,i)perylene	191-24-2	--	--	0.33	0.11	-- --	50	25 - 130	30	35 - 130	25
Benzo(k)fluoranthene	207-08-9	2	BCL	0.33	0.07	-- --	50	45 - 125	30	45 - 125	25
Benzoic acid	65-85-0	20	BCL	0.83	0.15	-- --	50	20 - 120	30	20 - 120	30
Benzyl alcohol	100-51-6	0.37	RSL	0.33	0.2	-- --	50	20 - 120	30	35 - 120	25
Bis(2-chloroethoxy)methane	111-91-1	0.01	RSL	0.33	0.133	-- --	50	45 - 120	25	45 - 120	20
Bis(2-chloroethyl)ether	111-44-4	0.00002	BCL	0.33	0.06	-- --	50	35 - 110	25	35 - 120	25
Bis(2-ethylhexyl) phthalate	117-81-7	180	BCL	0.33	0.09	-- --	50	45 - 130	25	50 - 130	20
Butyl benzyl phthalate	85-68-7	810	BCL	0.33	0.08	-- --	50	45 - 125	25	50 - 125	20
Chrysene	218-01-9	8	BCL	0.33	0.075	-- --	50	55 - 120	25	55 - 120	20
Dibenz(a,h)anthracene	53-70-3	0.08	BCL	0.42	0.1	-- --	50	25 - 135	30	40 - 135	25
Dibenzofuran	132-64-9	0.11	RSL	0.33	0.067	-- --	50	50 - 120	25	55 - 120	20
Diethyl phthalate	84-66-2	4.7	RSL	0.33	0.095	-- --	50	50 - 125	25	50 - 125	20
Dimethylphthalate	131-11-3	--	--	0.33	0.067	-- --	50	45 - 125	25	50 - 125	20
Di-n-butyl phthalate	84-74-2	270	BCL	0.33	0.09	-- --	50	50 - 125	25	50 - 125	20
Di-n-octyl phthalate	117-84-0	44	RSL	0.33	0.09	-- --	50	50 - 135	25	50 - 135	20
Fluoranthene	206-44-0	210	BCL	0.33	0.07	-- --	50	45 - 120	25	55 - 120	20
Fluorene	86-73-7	28	BCL	0.33	0.07	-- --	50	50 - 120	25	55 - 120	20
Hexachlorobenzene	118-74-1	0.1	BCL	0.33	0.07	-- --	50	50 - 120	25	50 - 120	20
Hexachlorocyclopentadiene	77-47-4	20	BCL	0.83	0.133	-- --	50	20 - 125	30	30 - 125	25
Hexachloroethane	67-72-1	0.02	BCL	0.33	0.133	-- --	50	35 - 120	30	40 - 120	20
Indeno[1,2,3-cd]pyrene	193-39-5	0.7	BCL	0.33	0.13	-- --	50	20 - 130	30	30 - 135	25
Isophorone	78-59-1	0.03	BCL	0.33	0.067	-- --	50	40 - 120	25	40 - 120	20

TABLE 4. LEACHING-BASED SOIL ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS[2]					
						Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
ANALYTES	CAS Number	Screening Level	Screening Level Source[1]	Practical Quantitation Limit (PQL)	Method Detection Limit (MDL)	%R	RPD	%R	RPD	%R	RPD
Naphthalene	91-20-3	4	BCL	0.33	0.067	-- --	50	40 - 120	25	45 - 120	20
Nitrobenzene	98-95-3	0.01	BCL	0.33	0.07	-- --	50	40 - 120	25	45 - 120	20
N-Nitrosodi-n-propylamine	621-64-7	0.000002	BCL	0.25	0.07	-- --	50	35 - 120	25	40 - 120	20
N-Nitrosodiphenylamine	86-30-6	0.06	BCL	0.33	0.08	-- --	50	45 - 125	25	50 - 120	20
Octachlorostyrene	29082-74-4	--	--	3.30	2.3	-- --	50	60 - 140	30	60 - 140	30
Pentachlorophenol	87-86-5	0.001	BCL	0.8	0.15	-- --	50	30 - 120	25	40 - 120	20
Phenanthrene	85-01-8	0.02	CAL	0.3	0.067	-- --	50	50 - 120	25	50 - 120	20
Phenol	108-95-2	5	BCL	0.3	0.09	-- --	50	40 - 120	25	40 - 120	20
Pyrene	129-00-0	210	BCL	0.3	0.08	-- --	50	40 - 125	30	45 - 125	25
2-Fluorophenol (Surr)	367-12-4	--	--	--	--	35 - 120	--	-- --	--	-- --	--
2,4,6-Tribromophenol (Surr)	118-79-6	--	--	--	--	35 - 120	--	-- --	--	-- --	--
Nitrobenzene-d5 (Surr)	4165-60-0	--	--	--	--	35 - 120	--	-- --	--	-- --	--
Terphenyl-d14 (Surr)	1718-51-0	--	--	--	--	35 - 120	--	-- --	--	-- --	--
Phenol-d6 (Surr)	13127-88-3	--	--	--	--	35 - 120	--	-- --	--	-- --	--
EPA Method 8315A											
Formaldehyde	50-00-0	0.62	RSL	1	0.6	-- --	50	50 - 150	20	50 - 150	20
Polycyclic Aromatic Hydrocarbons (mg/kg)											
EPA Method 8270 SIM											
Acenaphthene	83-32-9	29	BCL	0.03	0.004	-- --	50	45 - 120	25	50 - 120	20
Acenaphthylene	208-96-8	0.0106	CAL	0.03	0.004	-- --	50	45 - 120	20	50 - 120	20
Anthracene	120-12-7	590	BCL	0.03	0.004	-- --	50	55 - 120	25	55 - 120	20
Benzo(a)anthracene	56-55-3	0.08	BCL	0.03	0.004	-- --	50	50 - 120	25	55 - 120	20
Benzo(a)pyrene	50-32-8	0.40	BCL	0.03	0.004	-- --	50	45 - 125	25	50 - 125	20
Benzo(b)fluoranthene	205-99-2	0.20	BCL	0.03	0.004	-- --	50	45 - 125	30	45 - 125	25
Benzo(g,h,i)perylene	191-24-2	--	--	0.03	0.004	-- --	50	25 - 130	30	35 - 130	25
Benzo(k)fluoranthene	207-08-9	2	BCL	0.03	0.004	-- --	50	45 - 125	30	45 - 125	25
Chrysene	218-01-9	8	BCL	0.03	0.004	-- --	50	55 - 120	25	55 - 120	20
Dibenz(a,h)anthracene	53-70-3	0.08	BCL	0.03	0.004	-- --	50	25 - 135	30	40 - 135	25
Fluoranthene	206-44-0	210	BCL	0.03	0.004	-- --	50	45 - 120	25	55 - 120	20

TABLE 4. LEACHING-BASED SOIL ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

				Practical Quantitation Limit	Method Detection Limit	QUALITY CONTROL LIMITS(2)					
						Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
ANALYTES	**CAS Number**	**Screening Level**	**Screening Level Source(1)**	**(PQL)**	**(MDL)**	**%R**	**RPD**	**%R**	**RPD**	**%R**	**RPD**
Fluorene	86-73-7	28	BCL	0.03	0.004	-- --	50	50 - 120	25	55 - 120	20
Indeno(1,2,3-cd)pyrene	193-39-5	0.7	BCL	0.03	0.004	-- --	50	20 - 130	30	30 - 135	25
Naphthalene	91-20-3	4	BCL	0.03	0.004	-- --	50	40 - 120	25	45 - 120	20
Phenanthrene	85-01-8	0.024	CAL	0.03	0.004	-- --	50	50 - 120	25	50 - 120	20
Pyrene	129-00-0	210.0000	BCL	0.03	0.004	-- --	50	40 - 125	30	45 - 125	25
2-Fluorobiphenyl (Surr)	321-60-8	--	--	--	--	35 - 120	--	-- --	--	-- --	--
Nitrobenzene-d5 (Surr)	4165-60-0	--	--	--	--	35 - 120	--	-- --	--	-- --	--
Terphenyl-d14 (Surr)	1718-51-0	--	--	--	--	35 - 120	--	-- --	--	-- --	--
Organophosphorus Pesticides (mg/kg)											
EPA Method 8141A											
Atrazine	1912-24-9	--	--	0.067	0.0121	-- --	50	49 - 115	50	49 - 115	50
Chlorpyrifos	2921-88-2	0.09200	RSL	0.020	0.00646	-- --	50	38 - 130	37	38 - 130	37
Coumaphos	56-72-4	--	--	0.013	0.0028	-- --	50	50 - 119	27	50 - 119	27
Demeton, Total	8065-48-3	--	--	0.039	0.00752	-- --	50	36 - 115	47	36 - 115	47
Diazinon	333-41-5	0.04900	RSL	0.022	0.00727	-- --	50	53 - 115	40	53 - 115	40
Dichlorvos	62-73-7	0.00007	RSL	0.023	0.0074	-- --	50	43 - 139	77	43 - 139	77
Dimethoate	60-51-5	0.00070	RSL	0.022	0.00708	-- --	50	25 - 138	98	25 - 138	98
Disulfoton	298-04-4	0.00071	RSL	0.048	0.00773	-- --	50	29 - 115	40	29 - 115	40
EPN	2104-64-5	0.00210	RSL	0.013	0.00368	-- --	50	58 - 131	50	58 - 131	50
Ethoprop	13194-48-4	--	--	0.015	0.00493	-- --	50	53 - 115	54	53 - 115	54
Ethyl Parathion	56-38-2	0.33000	RSL	0.018	0.00529	-- --	50	24 - 163	47	24 - 163	47
Famphur	52-85-7	--	--	0.013	0.00322	-- --	50	49 - 140	31	49 - 140	31
Fensulfothion	115-90-2	--	--	0.025	0.00815	-- --	50	52 - 121	49	52 - 121	49
Fenthion	55-38-9	--	--	0.033	0.00874	-- --	50	45 - 115	43	45 - 115	43
Malathion	121-75-5	0.07900	RSL	0.015	0.00464	-- --	50	50 - 122	53	50 - 122	53
Merphos	150-50-5	0.04600	RSL	0.030	0.00514	-- --	50	19 - 115	50	19 - 115	50
Methyl parathion	298-00-0	0.00570	RSL	0.020	0.00637	-- --	50	46 - 119	53	46 - 119	53
Mevinphos	7786-34-7	--	--	0.015	0.00462	-- --	50	10 - 226	78	10 - 226	78
Phorate	298-02-2	0.00260	RSL	0.020	0.0057	-- --	50	40 - 115	40	40 - 115	40
Ronnel	299-84-3	2.70000	RSL	0.046	0.0152	-- --	50	43 - 118	41	43 - 118	41

TABLE 4. LEACHING-BASED SOIL ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS(2)						
				Practical Quantitation Limit	Method Detection Limit	Surrogate		Duplicate	Matrix Spike		Blank Spike/LCS	
ANALYTES	**CAS Number**	**Screening Level**	**Screening Level Source(1)**	**(PQL)**	**(MDL)**	**%R**		**RPD**	**%R**	**RPD**	**%R**	**RPD**
Simazine	122-34-9	--	--	0.067	0.0221	--	--	50	11 - 179	58	11 - 179	58
Stirophos	22248-79-9	--	--	0.015	0.00436	--	--	50	44 - 118	24	44 - 118	24
Sulfotepp	3689-24-5	0.00390	RSL	0.020	0.00626	--	--	50	55 - 115	40	55 - 115	
Thionazin	297-97-2	--	--	0.018	0.00557	--	--	50	46 - 115	40	46 - 115	40
Trichloronate	327-98-0	--	--	0.020	0.00625	--	--	50	27 - 115	43	27 - 115	43
Chlormefos (Surr)	24934-91-6	--	--	--	--	42	132	--	-- --	--	-- --	--
Triphenylphosphate (Surr)	115-86-6	--	--	--	--	47	161	--	-- --	--	-- --	--
Organochlorine Pesticides (mg/kg)												
EPA Method 8081A												
2,4'-DDE	3424-82-6	--	--	0.005	0.0015	--	--	50	35 - 130	30	60 - 120	30
4,4'-DDD	72-54-8	1	BCL	0.005	0.0015	--	--	50	40 - 130	30	60 - 120	30
4,4'-DDE	72-55-9	3	BCL	0.005	0.0015	--	--	50	35 - 130	30	60 - 120	30
4,4'-DDT	50-29-3	2	BCL	0.005	0.0015	--	--	50	35 - 130	30	65 - 120	30
Aldrin	309-00-2	0.02	BCL	0.005	0.0015	--	--	50	40 - 115	30	50 - 115	30
alpha-BHC	319-84-6	0.029	BCL	0.005	0.0015	--	--	50	40 - 115	30	60 - 115	30
alpha-Chlordane	57-74-9	0.50	BCL	0.050	0.01	--	--	50	60 - 140	30	60 - 140	30
beta-BHC	319-85-7	0.006	BCL	0.005	0.0015	--	--	50	40 - 120	30	60 - 115	30
delta-BHC	319-86-8	30.80	BCL	0.010	0.0015	--	--	50	45 - 120	30	60 - 115	30
Dieldrin	60-57-1	0.00020	BCL	0.005	0.0015	--	--	50	40 - 125	30	65 - 115	30
Endosulfan I	959-98-8	--	--	0.005	0.0015	--	--	50	40 - 120	30	40 - 120	30
Endosulfan II	33213-65-9	--	--	0.005	0.0015	--	--	50	40 - 125	30	55 - 120	30
Endosulfan sulfate	1031-07-8	--	--	0.01	0.002	--	--	50	45 - 120	30	65 - 115	30
Endrin	72-20-8	0.05	BCL	0.005	0.0015	--	--	50	45 - 125	30	55 - 120	30
Endrin aldehyde	7421-93-4	--	--	0.005	0.0015	--	--	50	30 - 120	30	55 - 115	30
Endrin ketone	53494-70-5	--	--	0.005	0.002	--	--	50	40 - 120	30	65 - 115	30
gamma-BHC (Lindane)	58-89-9	0.0005	BCL	0.005	0.0015	--	--	50	40 - 120	30	55 - 115	30
gamma-Chlordane	57-74-9	0.50	BCL	0.050	0.01	--	--	50	60 - 140	30	60 - 140	30
Heptachlor	76-44-8	1.00	BCL	0.005	0.002	--	--	50	40 - 115	30	55 - 115	30
Heptachlor epoxide	1024-57-3	0.03	BCL	0.005	0.002	--	--	50	45 - 115	30	55 - 115	30

TABLE 4. LEACHING-BASED SOIL ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS(2)					
						Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
ANALYTES	**CAS Number**	**Screening Level**	**Screening Level Source(1)**	**Practical Quantitation Limit (PQL)**	**Method Detection Limit (MDL)**	**%R**	**RPD**	**%R**	**RPD**	**%R**	**RPD**
Methoxychlor	72-43-5	8.00	BCL	0.005	0.0015	-- --	50	40 - 135	30	65 - 120	30
Toxaphene	8001-35-2	2.00	BCL	0.200	0.05	-- --	50	60 - 140	30	60 - 140	30
Decachlorobiphenyl (Surr)	2051-24-3	--	--	--	--	45 - 120	--	-- --	--	-- --	--
Dioxin/Furans (µg/kg) (5)											
EPA Method 8290											
2,3,7,8-Tetrachloro dibenzo-p-dioxin	1746-01-6	0.015	RSL	0.001	EDL(4)	-- --	50	60 - 138	20	60 - 138	20
1,2,3,7,8-PeCDD	40321-76-4	--	--	0.005	EDL(4)	-- --	50	70 - 122	20	70 - 122	20
1,2,3,4,7,8-HxCDD(6)	39227-28-6	0.015	RSL	0.005	EDL(4)	-- --	50	60 - 138	20	60 - 138	20
1,2,3,4,7,8-HxCDD(6)	57653-85-7	0.015	RSL	0.005	EDL(4)	-- --	50	68 - 136	20	68 - 136	20
1,2,3,4,7,8-HxCDD(6)	19408-74-3	0.015	RSL	0.005	EDL(4)	-- --	50	68 - 138	20	68 - 138	20
1,2,3,4,6,7,8-HpCDD	35822-46-9	--	--	0.005	EDL(4)	-- --	50	71 - 128	20	71 - 128	20
OCDD	3268-87-9	--	--	0.01	EDL(4)	-- --	50	70 - 128	20	70 - 128	20
2,3,7,8-TCDF	51207-31-9	--	--	0.001	EDL(4)	-- --	50	56 - 158	20	56 - 158	20
1,2,3,7,8-PeCDF	57117-41-6	--	--	0.005	EDL(4)	-- --	50	69 - 134	20	69 - 134	20
2,3,4,7,8-PeCDF	57117-31-4	--	--	0.005	EDL(4)	-- --	50	70 - 131	20	70 - 131	20
1,2,3,4,7,8-HxCDF	70648-26-9	--	--	0.005	EDL(4)	-- --	50	74 - 128	20	74 - 128	20
1,2,3,6,7,8-HxCDF	57117-44-9	--	--	0.005	EDL(4)	-- --	50	67 - 140	20	67 - 140	20
1,2,3,7,8,9-HxCDF	72918-21-9	--	--	0.005	EDL(4)	-- --	50	72 - 134	20	72 - 134	20
2,3,4,6,7,8-HxCDF	60851-34-5	--	--	0.005	EDL(4)	-- --	50	71 - 137	20	71 - 137	20
1,2,3,4,6,7,8-HpCDF	67562-39-4	--	--	0.005	EDL(4)	-- --	50	71 - 134	20	71 - 134	20
1,2,3,4,7,8,9-HpCDF	55673-89-7	--	--	0.005	EDL(4)	-- --	50	68 - 129	20	68 - 129	20
OCDF	39001-02-0	--	--	0.01	EDL(4)	-- --	50	63 - 141	20	63 - 141	20

TABLE 4. LEACHING-BASED SOIL ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

ANALYTES	CAS Number	Screening Level	Screening Level Source(1)	Practical Quantitation Limit (PQL)	Method Detection Limit (MDL)	QUALITY CONTROL LIMITS(2) Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike/LCS %R	Blank Spike/LCS RPD
PCBs as Congeners (µg/kg) (5)											
EPA Method 1668A											
Total PCBs	1336-36-3	78	RSL	0.2	EDL(4)	-- --	50	-- --	--	-- --	--
3,4,4',5-TeCB (PCB-81)	70362-50-4	0.27	RSL	0.002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
2,3',4,4',5-PeCB (PCB-118)	31508-00-6	4.4	RSL	0.002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
3,3',4,4',5-PeCB (PCB-126)	57465-28-8	0.0013	RSL	0.002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
3,3',4,4',5,5'-HxCB (PCB-169)	32774-16-6	0.0072	RSL	0.002	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
DeCB (PCB-209)	2051-24-3	78	RSL	0.02	EDL(4)	-- --	50	50 - 150	50	50 - 150	50
PCBs as Aroclors (µg/kg)											
EPA Method 8082											
Aroclor-1260	11096-82-5	24	RSL	50	17	-- --	50	50 - 125	30	65 - 115	30
DCB Decachlorobiphenyl (Surr)	2051-24-3	--	--	--	--	45 - 120	--	-- --	--	-- --	--
Organic Acids (mg/kg)											
EPA Method 8270C											
Phthalic acid(7)	88-99-3	--	--	2.5	0.76	-- --	50	-- --	--	-- --	--
2-fluorobiphenyl (Surr)	321-60-8	--	--	--	--	29 - 120	--	-- --	--	-- --	--
Total Petroleum Hydrocarbons (mg/kg)											
EPA Method 8015B											
Total petroleum hydrocarbon-gasoline	TPH-gasoline	--	--	0.4	0.15	-- --	50	60 - 140	30	70 - 135	20
4-Bromofluorobenzene (Surr)	460-00-4	--	--	--	--	65 - 140	--	-- --	--	-- --	--
Oil Range Organics	TPH-oil	--	--	5	2.5	-- --	50	40 - 120	30	45 - 115	25
Total petroleum hydrocarbon-diesel	TPH-diesel	--	--	5	2.5	-- --	50	40 - 120	30	45 - 115	25
n-Octacosane (Surr)	630-02-4	--	--	--	--	40 140	--	-- --	--	-- --	--

TABLE 4. LEACHING-BASED SOIL ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS[2]					
				Practical Quantitation Limit	Method Detection Limit	Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
ANALYTES	CAS Number	Screening Level	Screening Level Source[1]	(PQL)	(MDL)	%R	RPD	%R	RPD	%R	RPD
Others (mg/kg)											
SM 2320B											
Alkalinity as $CaCO_3$	--	--	--	500	--	-- --	50	-- --	--	90 110	20
Bicarbonate as HCO_3^-	--	--	--	610	--	-- --	50	-- --	--	-- --	--
Carbonate as CO_3^-	--	--	--	300	--	-- --	50	-- --	--	-- --	--
Hydroxide as OH^-	14280-30-9	--	--	170	--	-- --	50	-- --	--	-- --	--
SM 4500-NH3 D											
Ammonia as NH_3	7664-41-7	--	--	12	2.4	-- --	50	75 - 125	15	85 - 115	15
EPA Method 300.0											
Bromide	24959-67-9	--	--	5	3.5	-- --	50	80 - 120	20	90 - 110	20
Chloride	16887-00-6	--	--	5	4	-- --	50	80 - 120	20	90 - 110	20
Fluoride	16984-48-8	93.00	RSL	5	3.5	-- --	50	80 - 120	20	90 - 110	20
Nitrate	14797-55-8	7.0	BCL	1.1	0.8	-- --	50	80 - 120	20	90 - 110	20
Nitrite	14797-65-0	--	--	1.5	1.1	-- --	50	80 - 120	20	90 - 110	20
Ortho-Phosphate as PO_4	14265-44-2	--	--	5	4	-- --	50	80 - 120	20	90 - 110	20
Sulfate	14808-79-8	--	--	5	4	-- --	50	80 - 120	20	90 - 110	20
EPA Method 300.1											
Chlorate	7790-93-4	--	--	0.2	0.05	-- --	50	75 - 125	25	75 - 125	25
Dichloroacetic acid (Surr)	79-43-6	--	--	--	--	90 - 115	--	-- --	--	-- --	--
EPA Method 314.0											
Perchlorate	14797-73-0	0.019	BCL	0.04	0.0095	-- --	50	80 - 120	20	85 - 115	15
EPA Method 9045C (SU)											
pH	STL00204	--	--	0.1	--	-- --	50	-- --	--	-- --	--
Radionuclides (pCi/g)[8]											
See Table 1 for Individual Methods											
Radium-226	13982-63-3	0.016	RAD	1	--	-- --	50	72 - 140	40	65 - 140	40
Radium-228	15262-20-1	0.016	RAD	1	--	-- --	50	30 - 150	40	61 - 139	40
Thorium-228	14274-82-9	0.11	BCL	1	--	-- --	50	70 - 130	40	70 - 130	40

TABLE 4. LEACHING-BASED SOIL ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS(2)					
						Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
ANALYTES	**CAS Number**	**Screening Level**	**Screening Level Source(1)**	**Practical Quantitation Limit (PQL)**	**Method Detection Limit (MDL)**	**%R**	**RPD**	**%R**	**RPD**	**%R**	**RPD**
Thorium-230	14269-63-7	0.042	BCL	1	--	-- --	50	76 - 115	40	81 - 118	40
Thorium-232	7440-29-1	0.14	BCL	1	--	-- --	50	70 - 130	40	70 - 130	40
Uranium-234	13966-29-5	0.012	RAD	1	--	-- --	50	70 - 130	40	84 - 120	40
Uranium-235	15117-96-1	0.012	RAD	1	--	-- --	50	-- --	40	-- --	40
Uranium-238	7440-61-1	0.012	RAD	1	--	-- --	50	70 - 130	40	82 - 122	40
Asbestos (protocol structures)											
Total Amphibole Protocol Structures	1332-21-4	--	--	Fiber Count(9)		-- --	50	-- --	--	-- --	--
Long Amphibole Protocol Structures	1332-21-4	--	--	Fiber Count(9)		-- --	50	-- --	--	-- --	--
Total Chrysotile Protocol Structures	1332-21-4	--	--	Fiber Count(9)		-- --	50	-- --	--	-- --	--
Long Chrysotile Protocol Structures	1332-21-4	--	--	Fiber Count(9)		-- --	50	-- --	--	-- --	--
Total Asbestos Protocol Structures	1332-21-4	--	--	Fiber Count(9)		-- --	50	-- --	--	-- --	--
Long Asbestos Protocol Structures	1332-21-4	--	--	Fiber Count(9)		-- --	50	-- --	--	-- --	--

Notes:

Shaded PQLs and MDLs exceed the lowest screening criteria.

µg/kg = micrograms per kilogram

mg/kg = milligrams per kilogram
pCi/g = picoCurie per gram

Surr = Surrogate

EPA = United States Environmental Protection Agency

SM = Standard Method

TABLE 4. LEACHING-BASED SOIL ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

ANALYTES	CAS Number	Screening Level	Screening Level Source[(1)]	Practical Quantitation Limit (PQL)	Method Detection Limit (MDL)	QUALITY CONTROL LIMITS[(2)] Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike/LCS %R	Blank Spike/LCS RPD

(1) Soil screening levels were selected according to the following hierarchy of criteria:

(a) Basic Comparison Level (BCL): Leaching-based basic comparison levels (LBCL) with dilution attenuation factor (DAF) of 1 in the most recent version of Nevada Division of Environmental Protection (NDEP) documents (August 2013 for non-radionuclides and April 2009 for radionuclides).

(b) Regional Screening Level (RSL): United States Environmental Protection Agency (USEPA) Regional Screening Levels (RSL) for groundwater protection (May 2013), with the maximum contaminant level (MCL) based screening levels selected over the risk-based screening levels, if available (USEPA 2013a).

(c) Radiation Criteria (RAD): USEPA Screening criteria from Soil Screening Guidance for Radionuclides: User's Guide, 2000 (USEPA 2013b).

(d) Calculated Criteria (CAL): Generic leaching-based BSLs (LBCLs) calculated using the approach presented in NDEP guidance (NDEP 2013).

All other individual or grouped dioxins or furans don't have screening levels.

All other individual or grouped PCBs use MCL-based screening levels for low risk PCBs in RSL table.

(2) QC Limits = Quality Control Limits for %R (Percent Recovery) of spiked compounds in Laboratory Control Samples (LCS) and surrogate compounds and Relative Percent Difference (RPD) between Matrix Spike (MS) and MS Duplicate (MSD) samples and LCS and LCS duplicate (LCSD) samples. Laboratory historical control limits are subject to change as a result of periodic re-evaluation. Limits in use at the time of sample analysis are available from the laboratory. Duplicate RPDs apply to sample duplicates and field duplicates.

(3) PQLs and MDLs for zirconium are under development by the laboratory and are not yet available.

(4) EDL = Estimated Detection Limit. For each dioxin, furan, or PCB not detected, an EDL is calculated. The sample specific EDL is an estimate made by the laboratory of the concentration of a given chemical that would have to be present to produce a signal with a peak height of at least 2.5 times the background signal level. The estimate is specific to a particular analysis of the sample and will be affected by sample size, dilution, and so forth. Because of the toxicological significance of dioxins, the EDL value is reported for non-detected chemicals rather than reporting the MDL.

(5) Dioxins and PCBs should be reported to the estimated detection limit (EDL). Dioxin toxicity equivalents (TEQ) will be calculated for the 16 dioxin and furan congeners and 12 PCB congeners with toxicity equivalent factors (TEFs) defined by the World Health Organization (Van den Berg et al. 2006) substituting half the EDL for the congeners not

(6) The total hexachlorodibenzo-p-dioxin (HxCDD) will be compared to an RSL of 0.015 μg/kg.

(7) Phthalic acid will be run with the SVOCs by EPA Method 8270C.

(8) Radionuclide PQLs and MDLs are based on minimum detectable activity (MDA) values. The measured values are reported regardless of sample-specific MDA.

(9) Asbestos data will be reported as raw asbestos fiber counts per sample (NDEP 2008). There are no PQLs for this method, but sensitivity is calculated by the concentration of protocol structures per volume of PM10.

Sources:

NDEP. 2009b. Guidance for Evaluating Radionuclide Data, BMI Plant Sites and Common Areas Projects, Henderson, Nevada. February 6.

NDEP. 2013. User’s Guide and Background Technical Document for NDEP Basic Comparison Levels (BCLs) for Human Health for the BMI Complex and Common Areas. Revision 12, August.

USEPA. 2013a. Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites. November.

USEPA. 2013b. Preliminary Remediation Goals for Radionuclides. On-line calculator. http://epa-prgs.ornl.gov/cgi-bin/radionuclides/rprg_search

Van den Berg et al. 2006. The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. May 20.

TABLE 5. GROUNDWATER ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS$^{(2)}$					
				Practical Quantitation Limit	Method Detection Limit	Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
ANALYTES	CAS Number	Screening Level	Screening Level Source$^{(1)}$	(PQL)	(MDL)	%R	RPD	%R	RPD	%R	RPD
Metals (µg/L)											
EPA Method 200.7 / 6010											
Aluminum	7429-90-5	50	BCL	50	25	-- --	30	75 - 125	20	80 - 120	20
Antimony	7440-36-0	6	MCL	10	7	-- --	30	75 - 125	20	80 - 120	20
Barium	7440-39-3	2,000	MCL	10	6	-- --	30	75 - 125	20	80 - 120	20
Boron	7440-42-8	7,300	BCL	50	25	-- --	30	75 - 125	20	80 - 120	20
Beryllium	7440-41-7	4	MCL	4	0.9	-- --	30	75 - 125	20	80 - 120	20
Cadmium	7440-43-9	5	MCL	5	2	-- --	30	75 - 125	20	80 - 120	20
Calcium	7440-70-2	--	--	100	50	-- --	30	75 - 125	20	80 - 120	20
Chromium (total)	7440-47-3	100	MCL	5	2	-- --	30	75 - 125	20	80 - 120	20
Cobalt	7440-48-4	11	BCL	10	2	-- --	30	75 - 125	20	80 - 120	20
Copper	7440-50-8	1,300	MCL	10	3	-- --	30	75 - 125	20	80 - 120	20
Iron	7439-89-6	300	BCL	40	20	-- --	30	75 - 125	20	80 - 120	20
Lead	7439-92-1	15	MCL	5	4	-- --	30	75 - 125	20	80 - 120	20
Magnesium	7439-95-4	207,000	BCL	20	10	-- --	30	75 - 125	20	80 - 120	20
Manganese	7439-96-5	20	BCL	20	7	-- --	30	75 - 125	20	80 - 120	20
Molybdenum	7439-98-7	183	BCL	20	2	-- --	30	75 - 125	20	80 - 120	20
Nickel	7440-02-0	730	BCL	10	2	-- --	30	75 - 125	20	80 - 120	20
Phosphorus	7723-14-0	0.73	BCL	40	20	-- --	30	75 - 125	20	80 - 120	20
Potassium	7440-09-7	--	--	500	250	-- --	30	75 - 125	20	80 - 120	20
Silicon	7440-21-3	--	--	50	13	-- --	30	75 - 125	20	80 - 120	20
Silver	7440-22-4	100	BCL	10	6	-- --	30	75 - 125	20	80 - 120	20
Sodium	7440-23-5	--	--	500	250	-- --	30	75 - 125	20	80 - 120	20
Strontium	7440-24-6	21,900	BCL	20	5	-- --	30	75 - 125	20	80 - 120	20
Thallium	7440-28-0	2	MCL	10	8	-- --	30	75 - 125	20	80 - 120	20
Tin	7440-31-5	21,900	BCL	100	12	-- --	30	75 - 125	20	80 - 120	20
Titanium	7440-32-6	146,000	BCL	5	2	-- --	30	75 - 125	20	80 - 120	20
Tungsten	7440-33-7	274	BCL	1000	500	-- --	30	75 - 125	20	80 - 120	20
Vanadium	7440-62-2	183	BCL	10	3	-- --	30	75 - 125	20	80 - 120	20

TABLE 5. GROUNDWATER ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

QUALITY CONTROL LIMITS[2]

						Surrogate	**Duplicate**	**Matrix Spike**		**Blank Spike/LCS**	
ANALYTES	**CAS Number**	**Screening Level**	**Screening Level Source**[1]	**Practical Quantitation Limit (PQL)**	**Method Detection Limit (MDL)**	**%R**	**RPD**	**%R**	**RPD**	**%R**	**RPD**
Zinc	7440-66-6	11,000	BCL	20	9	-- --	30	75 - 125	20	80 - 120	20
EPA Method 200.8 / 6020											
Arsenic	7440-38-2	10	MCL	1.0	0.50	-- --	30	75 - 125	20	80 - 120	20
Selenium	7782-49-2	50	MCL	2	0.5	-- --	30	75 - 125	20	80 - 120	20
Zirconium	7440-67-7	2.92	BCL	0.2	--	-- --	30	75 - 125	20	80 - 120	20
EPA Method 6020A											
Niobium	7440-03-1	3.65	BCL	25	2.23	-- --	30	75 - 125	20	80 - 120	20
Palladium	7440-05-3	--	--	0.5	0.09	-- --	30	75 - 125	20	80 - 120	20
Sulfur	7704-34-9	--	--	5000	267	-- --	30	75 - 125	20	80 - 120	20
Uranium	7440-61-1	30	MCL	1.00	0.231	-- --	30	75 - 125	20	80 - 120	20
EPA Method 7199											
Chromium (hexavalent)	18540-29-9	100	BCL	1	0.25	-- --	30	90 - 110	10	90 - 110	10
EPA Method 7470A											
Mercury	7439-97-6	2	MCL	0.2	0.1	-- --	30	70 - 130	20	80 - 120	20
EPA Method 1632											
Arsenic III	7440-38-2	--	--	0.02	0.003	-- --	30	30 - 170	35	40 - 160	25
Total Inorganic Arsenic[3]	7440-38-2	10	MCL	0	0.003	-- --	30	80 - 120	35	60 - 140	25
Volatile Organic Compounds (µg/L)											
EPA Method 8260B											
1,1,1,2-Tetrachloroethane	630-20-6	0.524	BCL	0.5	0.25	-- --	30	60 - 149	20	60 - 141	20
1,1,1-Trichloroethane	71-55-6	200	MCL	0.5	0.25	-- --	30	70 - 130	20	70 - 130	20
1,1,2,2-Tetrachloroethane	79-34-5	0.0671	BCL	0.5	0.25	-- --	30	63 - 130	30	63 - 130	25
1,1,2-Trichloroethane	79-00-5	5	MCL	0.5	0.25	-- --	30	70 - 130	25	70 - 130	20
1,1-Dichloroethane	75-34-3	2.42	BCL	0.5	0.25	-- --	30	65 - 130	20	64 - 130	20
1,1-Dichloroethene	75-35-4	7	MCL	0.5	0.25	-- --	30	70 - 130	20	70 - 130	20
1,1-Dichloropropene	563-58-6	--	--	0.5	0.25	-- --	30	64 - 130	20	70 - 130	20
1,2,3-Trichlorobenzene	87-61-6	5.2	RSL	1.0	0.4	-- --	30	60 - 140	20	60 - 140	20
1,2,3-Trichloropropane	96-18-4	0.00224	BCL	0.5	0.25	-- --	30	60 - 130	30	63 - 130	20

TABLE 5. GROUNDWATER ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS(2)					
				Practical Quantitation Limit	Method Detection Limit	Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
ANALYTES	CAS Number	Screening Level	Screening Level Source(1)	(PQL)	(MDL)	%R	RPD	%R	RPD	%R	RPD
1,2,4-Trichlorobenzene	120-82-1	70	MCL	1.0	0.4	-- --	30	60 - 140	20	60 - 140	20
1,2,4-Trimethylbenzene	95-63-6	14.6	BCL	0.5	0.25	-- --	30	70 - 130	25	70 - 135	20
1,2-Dibromo-3-Chloropropane	96-12-8	0.2	MCL	1.0	0.5	-- --	30	48 - 140	30	52 - 140	30
1,2-Dibromoethane (EDB)	106-93-4	0.05	MCL	0.5	0.25	-- --	30	70 - 131	25	70 - 130	20
1,2-Dichlorobenzene	95-50-1	600	MCL	0.5	0.5	-- --	30	70 - 130	20	70 - 130	20
1,2-Dichloroethane	107-06-2	5	MCL	0.5	0.25	-- --	30	56 - 146	20	57 - 138	20
1,2-Dichloropropane	78-87-5	5	MCL	0.5	0.25	-- --	30	69 - 130	20	67 - 130	20
1,3,5-Trimethylbenzene	108-67-8	14.5	BCL	0.5	0.25	-- --	30	70 - 130	20	70 - 136	20
1,3-Dichlorobenzene	541-73-1	86.7	BCL	0.5	0.25	-- --	30	70 - 130	20	70 - 130	20
1,3-Dichloropropane	142-28-9	8.25	BCL	0.5	0.25	-- --	30	70 - 130	25	70 - 130	20
1,4-Dichlorobenzene	106-46-7	75	MCL	0.5	0.25	-- --	30	70 - 130	20	70 - 130	20
2,2-Dichloropropane	594-20-7	--	--	1.0	0.25	-- --	30	69 - 138	25	68 - 141	25
2-Butanone	78-93-3	7,060	BCL	5.0	2.5	-- --	30	48 - 140	40	44 - 150	35
2-Chlorotoluene	95-49-8	91.3	BCL	0.5	0.25	-- --	30	70 - 130	20	70 - 130	20
4-Chlorotoluene	106-43-4	190	RSL	0.5	0.25	-- --	30	70 - 130	20	70 - 130	20
Benzene	71-43-2	5	MCL	0.5	0.25	-- --	30	66 - 130	20	68 - 130	20
Bromobenzene	108-86-1	87.6	BCL	0.5	0.25	-- --	30	70 - 130	20	70 - 130	20
Bromochloromethane	74-97-5	83	RSL	0.5	0.25	-- --	30	70 - 130	25	70 - 130	20
Bromodichloromethane	75-27-4	0.117	BCL	0.5	0.25	-- --	30	70 - 138	20	70 - 132	20
Bromoform	75-25-2	8.51	BCL	1.0	0.25	-- --	30	59 - 150	25	60 - 148	25
Bromomethane	74-83-9	8.66	BCL	0.5	0.25	-- --	30	62 - 131	25	64 - 139	20
Carbon tetrachloride	56-23-5	5	MCL	0.5	0.25	-- --	30	60 - 150	25	60 - 150	25
Chlorobenzene	108-90-7	100	MCL	0.5	0.25	-- --	30	70 - 130	20	70 - 130	20
Chloroethane	75-00-3	23.2	BCL	0.5	0.25	-- --	30	68 - 130	25	64 - 135	20
Chloroform	67-66-3	0.193	BCL	0.5	0.25	-- --	30	70 - 130	20	70 - 130	20
Chloromethane	74-87-3	2.7	BCL	0.5	0.25	-- --	30	39 - 144	25	47 - 140	25
cis-1,2-Dichloroethene	156-59-2	70	MCL	0.5	0.25	-- --	30	70 - 130	20	70 - 133	20
cis-1,3-Dichloropropene	10061-01-5	--	--	0.5	0.25	-- --	30	70 - 133	20	70 - 133	25

TABLE 5. GROUNDWATER ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS(2)					
				Practical Quantitation Limit	Method Detection Limit	Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
ANALYTES	**CAS Number**	**Screening Level**	**Screening Level Source(1)**	**(PQL)**	**(MDL)**	**%R**	**RPD**	**%R**	**RPD**	**%R**	**RPD**
Dibromochloromethane	124-48-1	0.147	BCL	0.5	0.25	-- --	30	70 - 148	25	69 - 145	20
Dibromomethane	74-95-3	8.16	BCL	0.5	0.25	-- --	30	70 - 130	25	70 - 130	20
Dichlorodifluoromethane	75-71-8	395	BCL	0.5	0.25	-- --	30	25 - 142	30	29 - 150	30
Ethyl ter-butyl ether (ETBE)	637-92-3	--	--	0.5	0.25	-- --	30	70 - 130	25	60 - 136	20
Ethylbenzene	100-41-4	700	MCL	0.5	0.25	-- --	30	70 - 130	20	70 - 130	20
Hexachlorobutadiene	87-68-3	0.862	BCL	0.5	0.25	-- --	30	10 - 150	20	10 - 150	20
Isopropyl benzene	98-82-8	679	BCL	0.5	0.25	-- --	30	70 - 132	20	70 - 136	20
m,p-Xylene	179601-23-1	10,000	MCL	1.0	0.5	-- --	30	70 - 133	25	70 - 130	20
Methylene chloride	75-09-2	5	MCL	2.0	0.88	-- --	30	52 - 130	20	52 - 130	20
Naphthalene	91-20-3	0.143	BCL	1.0	0.4	-- --	30	60 - 140	30	60 - 140	25
n-Butylbenzene	104-51-8	254	BCL	1.0	0.4	-- --	30	61 - 149	20	65 - 150	20
n-Propylbenzene	103-65-1	254	BCL	0.5	0.25	-- --	30	66 - 135	20	67 - 139	20
o-Xylene	95-47-6	10,000	MCL	0.5	0.25	-- --	30	70 - 133	20	70 - 130	20
p-Isopropyltoluene	99-87-6	834	BCL	0.5	0.25	-- --	30	70 - 130	20	70 - 132	20
sec-Butylbenzene	135-98-8	254	BCL	0.5	0.25	-- --	30	67 - 134	20	70 - 138	20
Styrene	100-42-5	100	MCL	0.5	0.25	-- --	30	29 - 150	35	70 - 134	20
tert-Butylbenzene	98-06-6	254	BCL	0.5	0.25	-- --	30	70 - 130	20	70 - 130	20
Tetrachloroethylene (PCE)	127-18-4	5	MCL	0.5	0.25	-- --	30	70 - 137	20	70 - 130	20
Toluene	108-88-3	1,000	MCL	0.5	0.25	-- --	30	70 - 130	20	70 - 130	20
trans-1,2-Dichloroethene	156-60-5	100	MCL	0.5	0.25	-- --	30	70 - 130	20	70 - 130	20
trans-1,3-Dichloropropene	10061-02-6	--	--	0.5	0.25	-- --	30	70 - 138	25	70 - 132	20
Trichloroethylene (TCE)	79-01-6	5	MCL	0.5	0.25	-- --	30	70 - 130	20	70 - 130	20
Trichlorofluoromethane	75-69-4	1,290	BCL	0.5	0.25	-- --	30	60 - 150	25	60 - 150	20
Vinyl chloride	75-01-4	2	MCL	0.5	0.25	-- --	30	50 - 137	30	59 - 133	30
4-Bromofluorobenzene (Surr)	460-00-4	--	--	--	--	80 - 120	--	-- --	--	-- --	--
Dibromofluoromethane (Surr)	1868-53-7	--	--	--	--	76 - 132	--	-- --	--	-- --	--
Toluene-d8 (Surr)	2037-26-5	--	--	--	--	80 - 128	--	-- --	--	-- --	--
EPA Method 8260B SIM											

TABLE 5. GROUNDWATER ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS$^{(2)}$					
				Practical Quantitation Limit	Method Detection Limit	Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
ANALYTES	**CAS Number**	**Screening Level**	**Screening Level Source$^{(1)}$**	**(PQL)**	**(MDL)**	**%R**	**RPD**	**%R**	**RPD**	**%R**	**RPD**
1,2,3-Trichloropropane	96-18-4	0.00224	BCL	0.005	0.0035	-- --	30	55 - 135	30	60 - 130	20
1,4-Dioxane	123-91-1	0.672	BCL	2	0.5	-- --	30	70 - 130	30	70 - 125	30
Dibromofluoromethane (Surr)	1868-53-7	--	--	--	--	80 - 120	--	-- --	--	-- --	--
Semi Volatile Organic Compounds (µg/L)											
EPA Method 8270C											
1,2,4-Trichlorobenzene	120-82-1	70	MCL	1	0.5	-- --	30	45 - 120	20	44 - 120	20
1,2-Dichlorobenzene	95-50-1	600	MCL	1	0.1	-- --	30	40 - 120	25	43 - 120	25
1,2-Diphenylhydrazine(as Azobenzene)	103-33-3	0.125	BCL	1	0.2	-- --	30	60 - 120	25	59 - 124	25
1,3-Dichlorobenzene	541-73-1	86.7	BCL	1	0.3	-- --	30	35 - 120	25	41 - 120	25
1,4-Dichlorobenzene	106-46-7	75	MCL	1	0.3	-- --	30	35 - 120	25	41 - 120	25
1-Methylnaphthalene	90-12-0	0.97	RSL	10	3.5	-- --	30	55 - 120	30	60 - 140	35
2,4,5-Trichlorophenol	95-95-4	3,650	BCL	2	1.0	-- --	30	55 - 120	30	20 - 138	30
2,4,6-Trichlorophenol	88-06-2	6.11	BCL	1	0.5	-- --	30	55 - 120	30	20 - 139	30
2,4-Dichlorophenol	120-83-2	110	BCL	2	1.0	-- --	30	55 - 120	25	21 - 132	20
2,4-Dimethylphenol	105-67-9	730	BCL	2	1.0	-- --	30	40 - 120	25	51 - 120	25
2,4-Dinitrophenol	51-28-5	73	BCL	5	2.5	-- --	30	40 - 120	25	20 - 134	25
2,4-Dinitrotoluene	121-14-2	0.217	BCL	5	2.0	-- --	30	65 - 120	25	54 - 121	20
2,6-Dinitrotoluene	606-20-2	36.5	BCL	5	1.0	-- --	30	65 - 120	20	54 - 121	20
2-Chloronaphthalene	91-58-7	2.08	BCL	1	0.2	-- --	30	60 - 120	20	54 - 120	20
2-Chlorophenol	95-57-8	66.4	BCL	1	0.2	-- --	30	45 - 120	25	20 - 122	25
2-Methylnaphthalene	91-57-6	27	RSL	1	0.5	-- --	30	55 - 120	20	55 - 120	20
2-Methylphenol	95-48-7	1,830	BCL	2	1.0	-- --	30	50 - 120	25	47 - 120	20
2-Nitroaniline	88-74-4	110	BCL	5	1.0	-- --	30	65 - 120	25	46 - 126	20
2-Nitrophenol	88-75-5	--	--	2	1.0	-- --	30	50 - 120	25	21 - 132	25
3,3'-Dichlorobenzidine	91-94-1	0.149	BCL	5	2.0	-- --	30	45 - 135	25	25 - 135	25

TABLE 5. GROUNDWATER ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

QUALITY CONTROL LIMITS$^{(2)}$

ANALYTES	CAS Number	Screening Level	Screening Level Source$^{(1)}$	Practical Quantitation Limit (PQL)	Method Detection Limit (MDL)	Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
						%R	RPD	%R	RPD	%R	RPD
3-Methylphenol + 4-Methylphenol	106-44-5	--	--	5	1.0	-- --	30	50 - 120	25	50 - 120	20
3-Nitroaniline	99-09-2	--	--	5	2.0	-- --	30	60 - 120	25	42 - 122	25
4,6-Dinitro-2-methylphenol	534-52-1	--	--	5	0.3	-- --	30	45 - 120	25	22 - 147	25
4-Bromophenyl phenyl ether	101-55-3	--	--	1	0.5	-- --	30	60 - 120	25	58 - 120	25
4-Chloro-3-methylphenol	59-50-7	1,100	RSL	2	0.2	-- --	30	60 - 120	25	46 - 123	25
4-Chloroaniline	106-47-8	0.336	BCL	2	1.0	-- --	30	55 - 120	25	52 - 120	25
4-Chlorophenyl phenyl ether	7005-72-3	--	--	1	0.2	-- --	30	65 - 120	25	50 - 122	20
4-Nitroaniline	100-01-6	3.3	RSL	5	2.0	-- --	30	55 - 125	25	46 - 126	20
4-Nitrophenol	100-02-7	292	BCL	5	2.5	-- --	30	45 - 120	30	20 - 151	30
Acenaphthene	83-32-9	6.24	BCL	1	0.2	-- --	30	60 - 120	25	57 - 120	20
Acenaphthylene	208-96-8	6.22	BCL	1	0.2	-- --	30	60 - 120	25	60 - 120	20
Aniline	62-53-3	11.8	BCL	10	0.3	-- --	30	35 - 120	30	53 - 120	30
Anthracene	120-12-7	6.25	BCL	1	0.2	-- --	30	65 - 120	25	62 - 120	20
Benzidine	92-87-5	--	--	5	1.0	-- --	30	30 - 160	35	20 - 168	35
Benzo[a]anthracene	56-55-3	0.0921	BCL	5	2.0	-- --	30	65 - 120	20	62 - 120	20
Benzo[a]pyrene	50-32-8	0.2	MCL	2	1.0	-- --	30	55 - 130	25	58 - 103	25
Benzo[b]fluoranthene	205-99-2	0.0921	BCL	2	1.0	-- --	30	55 - 125	25	46 - 125	25
Benzo[g,h,i]perylene	191-24-2	1,100	BCL	5	2.0	-- --	30	45 - 135	30	52 - 136	25
Benzo[k]fluoranthene	207-08-9	0.921	BCL	1	0.3	-- --	30	55 - 125	30	61 - 127	20
Benzoic acid	65-85-0	146,000	BCL	5	3.0	-- --	30	25 - 125	30	20 - 120	30
Benzyl alcohol	100-51-6	18,300	BCL	5	0.1	-- --	30	40 - 120	30	50 - 120	20
bis (2-chloroisopropyl) ether	108-60-1	0.323	BCL	1	0.2	-- --	30	45 - 120	25	45 - 120	20
Bis(2-chloroethoxy)methane	111-91-1	46	RSL	1	0.2	-- --	30	50 - 120	25	57 - 120	20
Bis(2-chloroethyl)ether	111-44-4	0.0119	BCL	1	0.2	-- --	30	50 - 120	25	54 - 120	20

TABLE 5. GROUNDWATER ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS(2)					
						Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
ANALYTES	CAS Number	Screening Level	Screening Level Source(1)	Practical Quantitation Limit (PQL)	Method Detection Limit (MDL)	%R	RPD	%R	RPD	%R	RPD
Bis(2-ethylhexyl) phthalate	117-81-7	6	MCL	5	2.0	-- --	30	65 - 130	25	57 - 124	20
Butyl benzyl phthalate	85-68-7	35.4	BCL	5	2.0	-- --	30	55 - 130	25	57 - 129	20
Chrysene	218-01-9	9.21	BCL	1	0.2	-- --	30	65 - 120	25	63 - 109	20
Dibenz(a,h)anthracene	53-70-3	0.00921	BCL	1	0.3	-- --	30	45 - 135	30	56 - 124	25
Dibenzofuran	132-64-9	73	BCL	1	0.2	-- --	30	65 - 120	25	59 - 109	20
Diethyl phthalate	84-66-2	29,200	BCL	1	0.5	-- --	30	55 - 120	30	44 - 131	30
Dimethyl phthalate	131-11-3	365,000	BCL	1	0.3	-- --	30	30 - 120	30	33 - 140	30
Di-n-butyl phthalate	84-74-2	3,650	BCL	2	1.0	-- --	30	60 - 125	25	60 - 126	20
Di-n-octyl phthalate	117-84-0	160	RSL	5	2.0	-- --	30	65 - 135	20	56 - 117	20
Fluoranthene	206-44-0	1,460	BCL	1	0.2	-- --	30	60 - 120	25	64 - 120	20
Fluorene	86-73-7	6.23	BCL	1	0.2	-- --	30	65 - 120	25	52 - 120	20
Hexachlorobenzene	118-74-1	1	MCL	1	0.5	-- --	30	60 - 120	25	60 - 105	20
Hexachlorobutadiene	87-68-3	0.862	BCL	2	0.5	-- --	30	40 - 120	25	34 - 120	25
Hexachlorocyclopentadiene	77-47-4	50	MCL	5	2.0	-- --	30	25 - 120	30	23 - 120	30
Hexachloroethane	67-72-1	4.8	BCL	3	0.5	-- --	30	35 - 120	25	34 - 120	25
Indeno[1,2,3-cd]pyrene	193-39-5	0.0921	BCL	2	1.0	-- --	30	40 - 135	30	59 - 128	25
Isophorone	78-59-1	70.8	BCL	1	0.5	-- --	30	50 - 120	25	50 - 120	20
Naphthalene	91-20-3	0.143	BCL	1	0.5	-- --	30	55 - 120	25	52 - 120	20
Nitrobenzene	98-95-3	0.122	BCL	1	0.5	-- --	30	55 - 120	25	52 - 120	25
N-Nitrosodi-n-propylamine	621-64-7	0.0096	BCL	2	1.0	-- --	30	45 - 120	25	60 - 120	20
N-Nitrosodiphenylamine	86-30-6	13.7	BCL	1	0.5	-- --	30	60 - 120	25	58 - 120	20
Octachlorostyrene	29082-74-4	--	--	20	6.5	-- --	30	60 - 140	30	60 - 140	30
Pentachlorophenol	87-86-5	1	MCL	2	1.0	-- --	30	24 - 121	25	20 - 137	25
Phenanthrene	85-01-8	6.22	BCL	1	0.2	-- --	30	65 - 120	25	62 - 120	20
Phenol	108-95-2	11,000	BCL	1	0.5	-- --	30	40 - 120	25	20 - 120	25
Pyrene	129-00-0	6.22	BCL	1	0.2	-- --	30	55 - 125	25	54 - 120	25

TABLE 5. GROUNDWATER ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS[2]					
						Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
ANALYTES	**CAS Number**	**Screening Level**	**Screening Level Source[1]**	**Practical Quantitation Limit (PQL)**	**Method Detection Limit (MDL)**	**%R**	**RPD**	**%R**	**RPD**	**%R**	**RPD**
2,4,6-Tribromophenol (Surr)	118-79-6	--	--	--	--	40 - 120	--	-- --	--	-- --	--
2-Fluorophenol (Surr)	367-12-4	--	--	--	--	30 - 120	--	-- --	--	-- --	--
Nitrobenzene-d5 (Surr)	4165-60-0	--	--	--	--	45 - 120	--	-- --	--	-- --	--
Terphenyl-d14 (Surr)	1718-51-0	--	--	--	--	37 - 144	--	-- --	--	-- --	--
Phenol-d6	13127-88-3	--	--	--	--	35 - 120	--	-- --	--	-- --	--
EPA Method 8315A											
Formaldehyde	50-00-0	7,300	BCL	10	5	-- --	30	50 - 150	20	50 - 150	20
Polycyclic Aromatic Hydrocarbons (µg/L)											
EPA Method 8270 SIM											
Acenaphthene	83-32-9	6.24	BCL	0.2	0.05	-- --	30	60 - 120	25	60 - 120	20
Acenaphthylene	208-96-8	6.22	BCL	0.2	0.05	-- --	30	60 - 120	25	60 - 120	20
Anthracene	120-12-7	6.25	BCL	0.2	0.05	-- --	30	65 - 120	25	65 - 120	20
Benzo(a)anthracene	56-55-3	0.0921	BCL	0.2	0.05	-- --	30	65 - 120	20	65 - 120	20
Benzo(a)pyrene	50-32-8	0.2	MCL	0.2	0.05	-- --	30	55 - 130	25	55 - 130	25
Benzo(b)fluoranthene	205-99-2	0.0921	BCL	0.2	0.05	-- --	30	55 - 125	25	55 - 125	25
Benzo(g,h,i)perylene	191-24-2	1,100	BCL	0.2	0.05	-- --	30	45 - 135	30	45 - 135	25
Benzo(k)fluoranthene	207-08-9	0.921	BCL	0.2	0.05	-- --	30	55 - 125	30	50 - 125	20
Chrysene	218-01-9	9.21	BCL	0.2	0.05	-- --	30	65 - 120	25	65 - 120	20
Dibenz(a,h)anthracene	53-70-3	0.00921	BCL	0.2	0.05	-- --	30	45 - 135	30	50 - 135	25
Fluoranthene	206-44-0	1,460	BCL	0.2	0.05	-- --	30	60 - 120	25	60 - 120	20
Fluorene	86-73-7	6.23	BCL	0.2	0.05	-- --	30	65 - 120	25	65 - 120	20
Indeno(1,2,3-cd)pyrene	193-39-5	0.0921	BCL	0.2	0.05	-- --	30	40 - 135	30	45 - 135	25
Naphthalene	91-20-3	0.143	BCL	0.2	0.05	-- --	30	55 - 120	25	55 - 120	20
Phenanthrene	85-01-8	6.22	BCL	0.2	0.05	-- --	30	65 - 120	25	65 - 120	20
Pyrene	129-00-0	6.22	BCL	0.2	0.05	-- --	30	55 - 125	25	55 - 125	25
2-Fluorobiphenyl (Surr)	321-60-8	--	--	--	--	50 - 120	--	-- --	--	-- --	--
Nitrobenzene-d5	4165-60-0	--	--	--	--	45 - 120	--	-- --	--	-- --	--
Terphenyl-d14	1718-51-0	--	--	--	--	17 - 100	--	-- --	--	-- --	--

TABLE 5. GROUNDWATER ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

ANALYTES	CAS Number	Screening Level	Screening Level Source[1]	Practical Quantitation Limit (PQL)	Method Detection Limit (MDL)	QUALITY CONTROL LIMITS[2] Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
						%R	RPD	%R	RPD	%R	RPD
Organophosphorus Peticides (µg/L)											
EPA Method 8141A											
Atrazine	1912-24-9	--	--	10.0	0.293	-- --	30	49 - 116	50	49 - 116	50
Bolstar	35400-43-2	--	--	1.0	0.314	-- --	30			61 - 108	
Chlorpyrifos	2921-88-2	110	BCL	1.5	0.360	-- --	30	35 - 124	34	35 - 124	34
Coumaphos	56-72-4	--	--	1.0	0.135	-- --	30	39 - 126	43	39 - 126	43
Demeton, Total	8065-48-3	--	--	3.0	0.209	-- --	30	31 - 123	50	31 - 123	50
Diazinon	333-41-5	32.9	BCL	0.5	0.147	-- --	30	46 - 115	40	46 - 115	40
Dichlorvos	62-73-7	0.232	BCL	0.5	0.162	-- --	30	33 - 151	49	33 - 151	49
Dimethoate	60-51-5	3.1	RSL	1.5	0.449	-- --	30	36 - 127	50	36 - 127	50
Disulfoton	298-04-4	1.46	BCL	1.0	0.322	-- --	30	36 - 115	40	36 - 115	40
EPN	2104-64-5	0.066	RSL	1.2	0.149	-- --	30	54 - 138	50	54 - 138	50
Ethoprop	13194-48-4	--	--	1.5	0.177	-- --	30	51 - 120	36	51 - 120	36
Ethyl Parathion	56-38-2	219	BCL	1.0	0.144	-- --	30	25 - 175	40	25 - 175	40
Famphur	52-85-7	--	--	1.0	0.179	-- --	30	43 - 146	88	43 - 146	88
Fensulfothion	115-90-2	--	--	2.5	0.544	-- --	30	36 - 124	62	36 - 124	62
Fenthion	55-38-9	--	--	2.5	0.154	-- --	30	34 - 120	41	34 - 120	41
Malathion	121-75-5	730	BCL	2.0	0.133	-- --	30	41 - 134	28	41 - 134	28
Merphos	150-50-5	0.47	RSL	5.0	0.174	-- --	30	10 - 123	50	10 - 123	50
Methyl parathion	298-00-0	9.13	BCL	4.0	0.141	-- --	30	42 - 130	30	42 - 130	30
Mevinphos	7786-34-7	--	--	6.2	0.460	-- --	30	10 - 229	40	10 - 229	40
Phorate	298-02-2	2.3	RSL	1.2	0.154	-- --	30	36 - 115	40	36 - 115	40
Ronnel	299-84-3	1,830	BCL	10.0	0.116	-- --	30	33 - 126	39	33 - 126	39
Simazine	122-34-9	--	--	10.0	0.223	-- --	30	27 - 186	31	27 - 186	31
Stirphos (Tetrachlorovinphos)	22248-79-9	--	--	3.5	0.124	-- --	30	27 - 131	40	27 - 131	40
Sulfotepp	3689-24-5	5.3	RSL	1.5	0.168	-- --	30	48 - 123	40	48 - 123	40

TABLE 5. GROUNDWATER ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS(2)					
						Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
ANALYTES	**CAS Number**	**Screening Level**	**Screening Level Source(1)**	**Practical Quantitation Limit (PQL)**	**Method Detection Limit (MDL)**	**%R**	**RPD**	**%R**	**RPD**	**%R**	**RPD**
Thionazin	297-97-2	--	--	1.0	0.312	-- --	30	48 - 115	40	48 - 115	40
Trichloronate	327-98-0	--	--	1.5	0.242	-- --	30	14 - 118	38	14 - 118	38
Chlormefos (Surr)	24934-91-6	--	--	--	--	49 - 171	--	-- --	--	-- --	--
Triphenylphosphate (Surr)	115-86-6	--	--	--	--	60 - 154	--	-- --	--	-- --	--
Organochlorine Pesticides (µg/L)											
EPA Method 8081A											
2,4'-DDE	3424-82-6	--	--	0.1	0.02	-- --	30	45 - 125	30	50 - 120	30
4,4'-DDD	72-54-8	0.28	BCL	0.0	0.00	-- --	30	50 - 125	30	55 - 120	30
4,4'-DDE	72-55-9	0.198	BCL	0.005	0.003	-- --	30	45 - 125	30	50 - 120	30
4,4'-DDT	50-29-3	0.198	BCL	0.01	0.004	-- --	30	50 - 125	30	55 - 120	30
Aldrin	309-00-2	0.00395	BCL	0.01	0.002	-- --	30	35 - 120	30	40 - 115	30
alpha-BHC	319-84-6	11	BCL	0.005	0.0025	-- --	30	40 - 120	30	45 - 115	30
beta-BHC	319-85-7	2.19	BCL	0.01	0.004	-- --	30	50 - 120	30	55 - 115	30
delta-BHC	319-86-8	11	BCL	0.005	0.0035	-- --	30	50 - 120	30	55 - 115	30
Dieldrin	60-57-1	0.0042	BCL	0.005	0.002	-- --	30	50 - 120	30	55 - 115	30
Endosulfan I	959-98-8	--	--	0.005	0.003	-- --	30	50 - 120	30	55 - 115	30
Endosulfan II	33213-65-9	--	--	0.005	0.0020	-- --	30	50 - 125	30	55 - 120	30
Endosulfan Sulfate	1031-07-8	--	--	0.01	0.003	-- --	30	55 - 125	30	60 - 120	30
Endrin	72-20-8	2	MCL	0.005	0.0020	-- --	30	50 - 120	30	55 - 115	30
Endrin aldehyde	7421-93-4	--	--	0.010	0.0020	-- --	30	45 - 125	30	50 - 120	30
Endrin Ketone	53494-70-5	--	--	0.01	0.007	-- --	30	50 - 125	30	55 - 120	30
gamma-BHC	58-89-9	0.2	MCL	0.01	0.003	-- --	30	40 - 120	30	45 - 115	30
gamma-chlordane	57-74-9	2	MCL	0.10	0.080	-- --	30	60 - 140	30	60 - 140	30
Heptachlor	76-44-8	0.4	MCL	0.01	0.003	-- --	30	40 - 120	30	45 - 115	30
Heptachlor epoxide	1024-57-3	0.2	MCL	0.005	0.0025	-- --	30	50 - 120	30	55 - 115	30
Methoxychlor	72-43-5	40	MCL	0.005	0.0035	-- --	30	55 - 125	30	60 - 120	30
Toxaphene	8001-35-2	3	MCL	0.500	0.2500	-- --	30	60 - 140	30	60 - 140	30
DCB Decachlorobiphenyl (Surr)	2051-24-3	--	--	--	--	45 - 120	--	-- --	--	-- --	--

TABLE 5. GROUNDWATER ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS(2)					
						Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
ANALYTES	CAS Number	Screening Level	Screening Level Source(1)	Practical Quantitation Limit (PQL)	Method Detection Limit (MDL)	%R	RPD	%R	RPD	%R	RPD
PCBs as Congeners (µg/L)(5)											
EPA Method 1668A											
Total PCBs	1336-36-3	0.5	MCL	0.000002	EDL(4)	-- --	30	-- --	--	-- --	--
3,4,4',5-TeCB (PCB-81)	70362-50-4	0.0017	RSL	0.00000002	EDL(4)	-- --	30	50 - 150	50	50 - 150	50
2,3',4,4',5-PeCB (PCB-118)	31508-00-6	0.017	RSL	0.00000002	EDL(4)	-- --	30	50 - 150	50	50 - 150	50
3,3',4,4',5-PeCB (PCB-126)	57465-28-8	0.0000052	RSL	0.00000002	EDL(4)	-- --	30	50 - 150	50	50 - 150	50
3,3',4,4',5,5'-HxCB (PCB-169)	32774-16-6	0.000017	RSL	0.00000002	EDL(4)	-- --	30	50 - 150	50	50 - 150	50
DeCB (PCB-209)	2051-24-3	0.5	RSL	0.0000002	EDL(4)	-- --	30	50 - 150	50	50 - 150	50
PCBs as Aroclors (µg/L)											
EPA Method 8082											
Aroclor 1260	11096-82-5	0.0336	BCL	0.500	0.2500	-- --	30	55 - 125	25	60 - 120	25
Dioxins/Furans (pg/L)(5)											
EPA Method 8290											
2,3,7,8- TCDD	1746-01-6	30	MCL	10.0	EDL(4)	-- --	30	72 - 144	20	72 - 144	20
OCDF	39001-02-0	--	--	100	EDL(4)	-- --	30	65 - 145	20	65 - 145	20
OCDD	3268-87-9	--	--	100	EDL(4)	-- --	30	80 - 129	20	80 - 129	20
1,2,3,4,6,7,8-HpCDF	67562-39-4	--	--	50.0	EDL(4)	-- --	30	81 - 135	20	81 - 135	20
1,2,3,4,6,7,8-HpCDD	35822-46-9	--	--	50.0	EDL(4)	-- --	30	81 - 132	20	81 - 132	20
1,2,3,4,7,8,9-HpCDF	55673-89-7	--	--	50.0	EDL(4)	-- --	30	72 - 140	20	72 - 140	20
1,2,3,4,7,8-HxCDF	70648-26-9	--	--	50.0	EDL(4)	-- --	30	86 - 126	20	86 - 126	20
1,2,3,4,7,8-HxCDD	39227-28-6	--	--	50.0	EDL(4)	-- --	30	65 - 144	20	65 - 144	20
1,2,3,6,7,8-HxCDF	57117-44-9	--	--	50.0	EDL(4)	-- --	30	79 - 137	20	79 - 137	20
1,2,3,6,7,8-HxCDD	57653-85-7	--	--	50.0	EDL(4)	-- --	30	78 - 137	20	78 - 137	20
1,2,3,7,8,9-HxCDF	72918-21-9	--	--	50.0	EDL(4)	-- --	30	72 - 145	20	72 - 145	20

TABLE 5. GROUNDWATER ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS(2)					
				Practical Quantitation Limit	Method Detection Limit	Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
ANALYTES	**CAS Number**	**Screening Level**	**Screening Level Source(1)**	**(PQL)**	**(MDL)**	**%R**	**RPD**	**%R**	**RPD**	**%R**	**RPD**
1,2,3,7,8,9-HxCDD	19408-74-3	10.8	BCL	50.0	EDL(4)	-- --	30	74 - 142	20	74 - 142	20
1,2,3,7,8-PeCDF	57117-41-6	--	--	50.0	EDL(4)	-- --	30	79 - 137	20	79 - 137	20
1,2,3,7,8-PeCDD	40321-76-4	--	--	50.0	EDL(4)	-- --	30	79 - 125	20	79 - 125	20
2,3,4,6,7,8-HxCDF	60851-34-5	--	--	50.0	EDL(4)	-- --	30	80 - 138	20	80 - 138	20
1,2,3,6,7,8-HxCDF	57117-44-9	--	--	50.0	EDL(4)	-- --	30	79 - 137	20	79 - 137	20
2,3,7,8-TCDF	51207-31-9	--	--	10.0	EDL(4)	-- --	30	73 - 150	20	73 - 150	20
Organic Acids (µg/L)											
EPA Method 8321A											
4-Chlorobenzenesulfonic aci	98-66-8	36,500	BCL	1	0.097	-- --	30	60 - 127	20	60 - 127	20
4-Bromobenzenesulfonic Acid (Surr)	79326-93-5	--	--	--	--	63 - 123	--	-- --	--	-- --	--
EPA Method 8270C											
Phthalic Acid(6)	88-99-3	73,000	BCL	400	5.84	-- --	30	-- --	--	-- --	--
2-fluorobiphenyl (Surr)	321-60-8	--	--	--	--	29 - 120	--	-- --	--	-- --	--
Total Petroleum Hydrocarbons and Fuel Alcohols (mg/L)											
EPA Method 8015B											
Gasoline Range Organics (C6-C10)	TPH-gasoline	--	--	0.05	0.025	-- --	30	65 - 140	20	80 - 120	20
4-Bromofluorobenzene (Surr)	460-00-4	--	--	--	--	80 - 120	--	-- --	--	-- --	--
Diesel Range Organics (C10-C28)	TPH-oil	--	--	0.05	0.025	-- --	30	40 - 120	30	40 - 115	25
Oil Range Organics (C28-C40)	TPH-diesel	--	--	0.0500	0.0250	-- --	30	40 - 120	30	40 - 115	25
n-Octacosane (Surr)	630-02-4	--	--	--	--	45 - 120	--	-- --	--	-- --	--
Methane (mg/L)											
Method RSK 175											
Methane (FID)	74-82-8	--	--	0.000990	0.000250	-- --	30	-- --	--	80 - 120	20

TABLE 5. GROUNDWATER ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS[(2)]					
ANALYTES	CAS Number	Screening Level	Screening Level Source[(1)]	Practical Quantitation Limit (PQL)	Method Detection Limit (MDL)	Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike/LCS %R	Blank Spike/LCS RPD
Methane (TCD)	74-82-8	--	--	1.00	0.500	-- --	30	-- --	--	80 - 120	20
Others (µg/L)											
SM 2320B											
Alkalinity as CaCO$_3$	--	--	--	4000	--	-- --	30	-- --	--	90 - 110	20
Bicarbonate as HCO$_3^-$	--	--	--	4800	--	-- --	30	-- --	--	-- --	--
Carbonate as CO$_3^-$	--	--	--	2400	--	-- --	30	-- --	--	-- --	--
Hydroxide as OH$^-$	--	--	--	1400	--	-- --	30	-- --	--	-- --	--
SM 4500-NH3 D											
Ammonia	7664-41-7	209	BCL	1200	240	-- --	30	75 - 125	15	85 - 115	15
EPA Method 300.0											
Bromide	24959-67-9	--	--	500	250	-- --	30	80 - 120	20	90 - 110	20
Chloride	16887-00-6	250,000	2nd MCL	500	250	-- --	30	80 - 120	20	90 - 110	20
Fluoride	16984-48-8	4,000	MCL	500	250	-- --	30	80 - 120	20	90 - 110	20
Total Nitrogen	7727-37-9	--	--	260	70	-- --	30	80 - 120	20	90 - 110	20
Nitrate	14797-55-8	10,000	MCL	110	55	-- --	30	80 - 120	20	90 - 110	20
Nitrite	14797-65-0	1,000	MCL	150	70	-- --	30	80 - 120	20	90 - 110	20
Sulfate	14808-79-8	250,000	2nd MCL	500	250	-- --	30	80 - 120	20	90 - 110	20
Orthophosphate as PO$_4$	14265-44-2	--	--	500	250	-- --	30	80 - 120	20	90 - 110	20
EPA Method 300.1											
Chlorate	7790-93-4	--	--	20	8	-- --	30	75 - 125	25	75 - 125	25
Chlorite	14998-27-7	1000	MCL	20	8	-- --	30	75 - 25	25	85 - 115	25
EPA Method 314.0											
Perchlorate	14797-73-0	18	BCL	4	0.95	-- --	30	80 - 120	20	85 - 115	15
SM 2340C											
Hardness as CaCO$_3$	STL00009	--	--	0.004	--	-- --	30	-- --	--	-- --	--
EPA Method 351.2											
Total Kjeldahl Nitrogen	7727-37-9	--	--	500	100	-- --	30	90 - 110	20	90 - 110	20

TABLE 5. GROUNDWATER ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS(2)					
ANALYTES	**CAS Number**	**Screening Level**	**Screening Level Source(1)**	**Practical Quantitation Limit (PQL)**	**Method Detection Limit (MDL)**	**Surrogate %R**	**Duplicate RPD**	**Matrix Spike %R**	**Matrix Spike RPD**	**Blank Spike/LCS %R**	**Blank Spike/LCS RPD**
EPA Method 4500											
Sulfide	18496-25-8	--	--	0.5	0.02	-- --	30	70 - 130	30	80 120	20
Sulfide, Dissolved	18496-25-8	--	--	0.5	0.02	-- --	30	70 - 130	30	80 120	20
EPA Method 9014B											
Cyanide (total)	57-12-5	200	MCL	25	17	-- --	30	70 - 115	15	90 - 110	10
EPA Method 365.3											
Phosphorus (total)	7723-14-0	0.73	BCL	0.05	0.050	-- --	30	75 - 125	20	80 - 120	20
SM 5310B											
Total Organic Carbon	7440-44-0	--	--	1000	650	-- --	30	80 - 120	20	90 - 110	20
Dissolved Organic Carbon	7440-44-0	--	--	1000	650	-- --	30	80 - 120	20	90 - 110	20
SM 2540C											
Total Dissolved Solids	10-33-3	500,000	2nd MCL	10000	5000	-- --	30	-- --	--	90 - 110	10
Volatile Fatty Acids (mg/L)											
Lab SOP by Ion Chromatography SOP No. BF-MB-009, Rev 3											
Acetic acid	64-19-7	--	--	1.00	0.150	-- --	30	80 - 120	20	80 - 120	20
Formic-acid	64-18-6	--	--	1.00	0.110	-- --	30	80 - 120	20	80 - 120	20
Lactic acid	50-21-5	--	--	1.00	0.140	-- --	30	80 - 120	20	80 - 120	20
n-Butyric Acid	107-92-6	--	--	1.00	0.160	-- --	30	80 - 120	20	80 - 120	20
Propionic acid	79-09-4	--	--	1.00	0.170	-- --	30	80 - 120	20	80 - 120	20
Pyruvic Acid	127-17-3	--	--	1.00	0.0800	-- --	30	80 - 120	20	80 - 120	20
Radionuclides (pCi/L)											
See Table 1 for Individual Methods											
Radium-226	13982-63-3	5(7)	MCL	1.00	--	-- --	30	75 - 138	40	68 - 137	40
Radium-228	15262-20-1	5(7)	MCL	1.00	--	-- --	30	45 - 150	40	56 - 140	40
Thorium-228	14274-82-9	0.11	Other	1.00	--	-- --	30	70 - 130	40	70 - 130	40
Thorium-230	14269-63-7	0.042	Other	1.00	--	-- --	30	82 - 139	40	81 - 125	40
Thorium-232	7440-29-1	0.14	Other	1.00	--	-- --	30	70 - 130	40	70 - 130	40
Uranium-234	13966-29-5	187,000	Other	1.00	--	-- --	30	65 - 146	40	84 - 120	40

TABLE 5. GROUNDWATER ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS[2]					
				Practical Quantitation Limit	Method Detection Limit	Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
ANALYTES	CAS Number	Screening Level	Screening Level Source[1]	(PQL)	(MDL)	%R	RPD	%R	RPD	%R	RPD
Uranium-235	15117-96-1	64.8	Other	1.00	--	-- --	30	-- --	40	-- --	40
Uranium-238	7440-61-1	10.1	Other	1.00	--	-- --	30	68 - 143	40	83 - 121	40

Notes:

Shaded PQLs and MDLs exceed the lowest screening criteria.

-- = no value

µg/L = micrograms per liter

pCi/L = picoCurie per liter

FID = flame ionization detector

TCD = thermal conductivity detector

(1) Groundwater screening levels were selected according to the following hierarchy of criteria:

(a) Maximum Contaminant Level (MCL): Primary United States Environmental Protections Agency (USEPA) maximum contaminant level (USEPA 40 CFR Part 141).

(b) Basic Contaminant Level (BCL): Residential water basic comparison levels in NDEP August 2013 BCL Spreadsheet (NDEP 2013).

(c) Regional Screening Level (RSL): Tap water regional screening levels in USEPA Pacific Southwest, Region 9, Regional Screening Levels Chemical Specific Parameters table, Nov 2013. The screening levels were selected as the minimal values of carcinogenic screening level and noncarcinogenic screening level (USEPA 2013a).

(d) 2nd Maximum Contaminant Level (2nd MCL): National Secondary Drinking Water Regulations (USEPA, 40 CFR Part 143).

(e) Other criteria for radionuclides, including target activities for radium and thorium isotopes (NDEP, 2009) and for uranium isotopes (USEPA 2013b).

(2) QC Limits = Quality Control Limits for %R (Percent Recovery) of spiked compounds in Laboratory Control Samples (LCS) and surrogate compounds and Relative Percent Difference (RPD) between Matrix Spike (MS) and MS Duplicate (MSD) samples and LCS and LCS duplicate (LCSD) samples. Laboratory historical control limits are subject to change as a result of periodic re-evaluation. Limits in use at the time of sample analysis are available from the laboratory. Duplicate RPDs apply to sample duplicates and field duplicates.

(3) According to the laboratory's standard operating procedure (SOP) Arsenate (Arsenic V) is determined by calculating the difference between Total Inorganic Arsenic and Arsenic III.

(4) EDL = Estimated Detection Limit. For each dioxin, furan, or PCB not detected, an EDL is calculated. The sample specific EDL is an estimate made by the laboratory of the concentration of a given chemical that would have to be present to produce a signal with a peak height of at least 2.5 times the background signal level. The estimate is specific to a particular analysis of the sample and will be affected by sample size, dilution, and so forth. Because of the toxicological significance of dioxins, the EDL value is reported for non-detected chemicals rather than reporting the MDL.

(5) Dioxins and PCB congeners shall be reported to the estimated detection limit (EDL). Dioxin toxicity equivalents (TEQ) will be calculated for the 16 dioxin and furan congeners and 12 PCB congeners with toxicity equivalent factors (TEFs) defined by the World Health Organization (Van den Berg et al. 2006) substituting half of the EDL for the congeners not detected.

TABLE 5. GROUNDWATER ANALYTES AND ANALTICAL QUALITY CONTROL CRITERIA
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust Site; Henderson, Nevada

						QUALITY CONTROL LIMITS(2)					
				Practical Quantitation Limit	Method Detection Limit	Surrogate	Duplicate	Matrix Spike		Blank Spike/LCS	
ANALYTES	CAS Number	Screening Level	Screening Level Source(1)	(PQL)	(MDL)	%R	RPD	%R	RPD	%R	RPD

(6) Phthalic acid will be run with the other SVOCs by EPA Method 8270C.

(7) The screening level listed for Radium-226 and Radium-228 is the BCL for a combination of Radium-226 and Radium-228.

Sources:

NDEP. 2009b. Guidance for Evaluating Radionuclide Data, BMI Plant Sites and Common Areas Projects, Henderson, Nevada. February 6.

NDEP. 2013. User's Guide and Background Technical Document for NDEP Basic Comparison Levels (BCLs) for Human Health for the BMI Complex and Common Areas. Revision 12, August.

USEPA. 2013a. Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites. November.

USEPA. 2013b. Preliminary Remediation Goals for Radionuclides. On-line calculator. http://epa-prgs.ornl.gov/cgi-bin/radionuclides/rprg_search

USEPA. National Primary Drinking Water Regulations. Code of Federal Regulations, 40 CFR Part 141.

USEPA. National Secondary Drinking Water Regulations. Code of Federal Regulations, 40 CFR Part 143.

Van den Berg et al., 2006. The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. May 20.

TABLE 6. FREQUENCY OF QA/QC SAMPLES
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust; Henderson, Nevada

SAMPLE TYPE	FREQUENCY OF ANALYSIS
Contamination Control Samples	
Laboratory Method Blank	One per each analytical method. One in every batch of samples (not to exceed 20 samples).
Trip Blank	One per cooler/shipment if VOCs are tested; analyze for VOCs only.
Equipment Blank	One per each analytical method. One in every batch of samples (not to exceed 20 samples).
Field Blank	One per each analytical method. One in every batch of samples (not to exceed 20 samples).
Accuracy Control Samples	
Laboratory Control Samples	One per each analytical method. One in every preparation batch (not to exceed 20 samples).
Surrogate Spiked Samples	For methods that use surrogate(s), the surrogate(s) will be spiked and analyzed in all samples and in all blanks. (1)
Matrix Spike Samples(2)	Analyzed in each batch, where applicable to the method (not to exceed 20 samples).
Precision Control Samples	
Field Duplicate Sample	One per each analytical method. One in every batch of samples collected (not to exceed 10 samples).
Laboratory Control Sample Duplicates	One per each analytical method. One in every preparation batch (not to exceed 20 samples).
Matrix Spike Duplicate Samples(2)	Analyzed in each batch, where applicable to the method (not to exceed 20 samples).

NOTE:

(1) Not all methods use surrogates. See Tables 2, 3, 4, and 5 for specific surrogates to be used.

(2) Not all analytical methods or sample matrices have Matrix Spikes.

TABLE 7. SAMPLE PRESERVATION, CONTAINERS, AND HOLDING TIMES
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust; Henderson, Nevada

						HOLD TIME[3]	
MATRIX	**ANALYTES**	**ANALYTICAL METHOD**	**PRESERVATION**	**CONTAINER[1][2]**	**TAT**	**Prior to Extraction**	**After Extraction**
Water	Metals	EPA Method 200.7 / 6010	HNO_3 to pH <2; 4 ˚C	500 mL HDPE	10d	180d	
Water	Metals	EPA Method 200.8 / 6020	HNO_3 to pH <2; 4 ˚C	500 mL HDPE	10d	180d	
Water	Rare Earth Metals[4]	EPA Method 6020A	HNO_3 to pH <2; 4 ˚C	500 mL HDPE	11d	180d	
Water	Arsenic III/V	EPA Method 1632	Cool to <4 °C	1L glass with Teflon-lined septum caps	10d	14d	40d
Water	Mercury	EPA Method 7470A	HNO_3 to pH <2; 4 ˚C	500 mL HDPE	10d	28d	
Water	Hexavalent chromium	EPA Method 7199	Cool to <4 °C	500 mL HDPE	10d	24h	7d
Water	Volatile Organic Compounds (VOCs)	EPA Method 8260B and 8260 SIM	HCl to pH <2; no headspace; cool to <4 ˚C	3 x 40 mL glass vials with Teflon-lined septum caps	10d	14d	
Water	Semivolatile Organic Compounds (SVOCs) and Phthalic Acid	EPA Method 8270C	Cool to <4 °C	2 x 1 L amber glass with Teflon-lined lids	10d	7d	40d
Water	Formaldehyde	EPA Method 8315A	Cool to <4 °C	1 x 1 L amber glass with Teflon-lined lids	10d	14d	40d
Water	Polyaromatic Hydrocarbons (PAHs)	EPA Method 8270 SIM	Cool to <4 °C	2 x 1 L amber glass with Teflon-lined lids	10d	7d	40d
Water	Organophosphorus Pesticides	EPA Method 8141A	Cool to <4 °C	2 x 1 L amber glass with Teflon-lined lids	11d	7d	40d
Water	Organochlorine Pesticides	EPA Method 8081A	Cool to <4 °C	2 x 1 L amber glass with Teflon-lined lids	10d	7d	40d
Water	PCBs as Congeners	EPA Method 1668A	Cool to <4 °C	2 x 1 L amber glass with Teflon-lined lids	20d	1y	45d[8]
Water	PCBs as Aroclors	EPA Method 8082	Cool to <4 °C	2 x 1 L amber glass with Teflon-lined lids	10d	7d	40d

TABLE 7. SAMPLE PRESERVATION, CONTAINERS, AND HOLDING TIMES
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust; Henderson, Nevada

MATRIX	ANALYTES	ANALYTICAL METHOD	PRESERVATION	CONTAINER(1)(2)	TAT	HOLD TIME(3)	
						Prior to Extraction	After Extraction
Water	4-chlorobenzenesulfonic acid (p-CBSA)	EPA Method 8321A	Cool to <4 °C	2 x 1 L amber glass with Teflon-lined lids	10d	7d	40d
Water	Volatile Fatty Acids	Lab SOP by Ion Chromatography SOP No. BF-MB-009, Rev 3	Cool to 4 °C	2 x 100 mL amber glass with Teflon-lined lids	10d	28d	
Water	Gasoline Range Organics (GROs)	EPA Method 8015B	HCl to pH <2; no headspace; cool to <4 ˚C	3 x 40 mL glass vials with Teflon-lined septum caps	10d	14d	
Water	Diesel/Oil Range Organics (DROs/OROs)	EPA Method 8015B	HCl to pH <2; no headspace; cool to <4 ˚C	3 x 40 mL glass vials with Teflon-lined septum caps	10d	14d	
Water	Methane	Method RSK 175	HCl to pH <2; no headspace; cool to <4 ˚C	3 x 40 mL glass vials with Teflon-lined septum caps	10d	14d	
Water	Alkalinity and Carbonate	SM 2320B	Cool to <4 °C	500 mL HDPE	10d	14d	
Water	Ammonia	SM 4500-NH3 D	H_2SO_4 to pH <2; 4 ˚C	500 mL HDPE	10d	28d	
Water	Inorganic anions(5)	EPA Method 300.0	H_2SO_4 to pH <2; 4 ˚C	500 mL HDPE	10d	28d or 48h(6)	
Water	Chlorate	EPA Method 300.1	H_2SO_4 to pH <2; 4 ˚C	500 mL HDPE	10d	28d	
Water	Perchlorate	Sterile Filtered(7) EPA Method 314.0	Cool to <4 °C	500 mL HDPE	10d	28d	
Water	Hardness	SM 2340C	HNO_3 to pH <2; 4 ˚C	500 mL HDPE	10d	180d	
Water	Total Kjeldahl Nitrogen	EPA Method 351.2	H_2SO_4 to pH <2; 4 ˚C	500 mL HDPE	10d	28d	
Water	Cyanide	EPA Method 9014B	NaOH to pH >12; 4 ˚C	1 x 1L HDPE	10d	14d	
Water	Phosphorus	EPA Method 365.3	H_2SO_4 to pH <2; 4 ˚C	500 mL HDPE	10d	28d	

TABLE 7. SAMPLE PRESERVATION, CONTAINERS, AND HOLDING TIMES
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust; Henderson, Nevada

						HOLD TIME[3]	
MATRIX	ANALYTES	ANALYTICAL METHOD	PRESERVATION	CONTAINER[1][2]	TAT	Prior to Extraction	After Extraction
Water	Sulfide	EPA Method 4500	4 drops of $2NZn(C_2H_3O_2)_2$ and NaOH to pH >9; cool to <4˚C	500 mL HDPE	10d	7d	
Water	Total Dissolved Solids (TDS)	SM 2540C	Cool to <4 °C	500 mL HDPE	10d	7d	
Water	Total and/or Dissolved Organic Carbon	SM 5310B	HCl to pH <2; cool to <4 ˚C	1 x 1 L amber glass with Teflon-lined lids	10d	28d	
Water	Radium 226	EPA Method 903.0	None	2 x 1 L HDPE	22d	180d	
Water	Radium 228	EPA Method 904.0	None	2 x 1 L HDPE	22d	180d	
Water	Thorium 228, 230, 232 and Uranium 234, 235, and 238	DOE EML HASL 300 A-01-R (alpha spectroscopy)	None	500 mL HDPE	22d	180d	
Soil	Metals	EPA Method 200.7 / 6010	Cool to <4 °C	1 X 4 oz glass jar with Teflon-lined cap	10d	180d	
Soil	Metals	EPA Method 200.8 / 6020	Cool to <4 °C	1 X 4 oz glass jar with Teflon-lined cap	10d	180d	
Soil	Rare Earth Metals[4]	EPA Method 6020A	Cool to <4 °C	1 X 2 oz glass jar with Teflon-lined cap	11d	180d	
Soil	Hexavalent chromium	EPA Method 7199	Cool to <4 °C	1 X 4 oz glass jar with Teflon-lined cap	10d	30d to digestion; 7d from digestion to analysis	
Soil	Mercury	EPA Method 7471A	Cool to <4 °C	1 X 4 oz glass jar with Teflon-lined cap	10d	28d	
Soil	Volatile Organic Compounds (VOCs)	EPA Method 8260B and 8260 SIM	Cool to <4 °C	Preserved in Accordance with EPA Method 5035	10d	Frozen or preserved within 48h of collection, 14d from preservation to analysis	

TABLE 7. SAMPLE PRESERVATION, CONTAINERS, AND HOLDING TIMES
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust; Henderson, Nevada

MATRIX	ANALYTES	ANALYTICAL METHOD	PRESERVATION	CONTAINER(1)(2)	TAT	HOLD TIME(3) Prior to Extraction	After Extraction
Soil	Semivolatile Organic Compounds (SVOCs) and Phthalic Acid	EPA Method 8270C	Cool to <4 °C	1 X 8 oz glass jar with Teflon-lined cap	10d	14d	40d
Soil	Formaldehyde	EPA Method 8315A	Cool to <4 °C	1 X 8 oz glass jar with Teflon-lined cap	10d	14d	40d
Soil	Polyaromatic Hydrocarbons (PAHs)	EPA Method 8270 SIM	Cool to <4 °C	1 X 8 oz glass jar with Teflon-lined cap	10d	14d	40d
Soil	Organophosphorus Pesticides	EPA Method 8141A	Cool to <4 °C	1 X 8 oz glass jar with Teflon-lined cap	10d	14d	40d
Soil	Organochlorine Pesticides	EPA Method 8081A	Cool to <4 °C	1 X 8 oz glass jar with Teflon-lined cap	10d	14d	40d
Soil	PCBs as Congeners	EPA Method 1668A	4 °C, from field, lab storage < -10 °C	1 X 8 oz glass jar with Teflon-lined cap	20d	1y	45d(8)
Soil	PCBs as Aroclors	EPA Method 8082	Cool to <4 °C	1 X 8 oz glass jar with Teflon-lined cap	10d	14d	40d
Soil	Dioxins/Furans	EPA Method 8290	Cool to <4 °C	1 X 8 oz glass jar with Teflon-lined cap	15d	30d(8)	45d(8)
Soil	Gasoline Range Organics (GROs)	EPA Method 8015B	Cool to <4 °C	Preserved in Accordance with EPA Method 5035	10d	Frozen or preserved within 48h of collection, 14d from preservation to analysis	
Soil	Diesel/Oil Range Organics (DROs/OROs)	EPA Method 8015B	Cool to <4 °C	1 X 8 oz glass jar with Teflon-lined cap	10d	14d	40d
Soil	Alkalinity and Carbonate	SM 2320B	Cool to <4 °C	1 X 4 oz glass jar with Teflon-lined cap	10d	None for soil. Use water holding time for leachates.	
soil	Ammonia	SM 4500-NH3 D	Cool to <4 °C	1 X 4 oz glass jar with Teflon-lined cap	10d	None for soil. Use water holding time for leachates.	

TABLE 7. SAMPLE PRESERVATION, CONTAINERS, AND HOLDING TIMES
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust; Henderson, Nevada

MATRIX	ANALYTES	ANALYTICAL METHOD	PRESERVATION	CONTAINER(1)(2)	TAT	HOLD TIME(3) Prior to Extraction	HOLD TIME(3) After Extraction
Soil	Inorganic Anions(5)	EPA Method 300.0	4 °C	1 X 4 oz glass jar with Teflon-lined cap	10d	None for soil. Use water holding time for leachates.	
Soil	Chlorate	EPA Method 300.1	Cool to <4 °C	1 X 4 oz glass jar with Teflon-lined cap	10d	None for soil. Use water holding time for leachates.	
Soil	Perchlorate	EPA Method 314.0	Cool to <4 °C	1 X 4 oz glass jar with Teflon-lined cap	10d	28d	
Soil	Cyanide	EPA Method 9014B	Cool to <4 °C	1 X 4 oz glass jar with Teflon-lined cap	10d	14d	
Soil	pH	EPA Method 9045C	Cool to <4 °C	1 X 4 oz glass jar with Teflon-lined cap	10d	Immediate	
Soil	Specific Conductance	EPA Method 120.1 / SM 2510B	Cool to <4 °C	1 X 4 oz glass jar with Teflon-lined cap	10d	None for soil. Use water holding time for leachates.	
Soil	Surfactants	SM 5540C	Cool to <4 °C	1 X 4 oz glass jar with Teflon-lined cap	10d	None for soil. Use water holding time for leachates.	
Soil	Total and Dissolved Organic Carbon	SM 5310B	Cool to <4 °C	1 X 4 oz glass jar with Teflon-lined cap	10d	28d	
Soil	Radium 226	EPA Method 903.0	None	1 X 500 mL HDPE	22d	180d	
Soil	Radium 228	EPA Method 904.0	None	1 X 500 mL HDPE	22d	180d	
Soil	Thorium 228, 230, 232 and Uranium 234, 235, and 238	DOE EML HASL 300 A-01-R (alpha spectroscopy)	None	1 X 50 mL HDPE	22d	180d	
Soil	Asbestos	EPA Method 540-R-97-028 modified per Berman & Kolk (2000)	None	1 X 250 mL glass with Teflon-lined cap	30d	None established for soil.	

TABLE 7. SAMPLE PRESERVATION, CONTAINERS, AND HOLDING TIMES
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust; Henderson, Nevada

MATRIX	ANALYTES	ANALYTICAL METHOD	PRESERVATION	CONTAINER(1)(2)	TAT	HOLD TIME(3) Prior to Extraction	After Extraction
Soil Gas	Volatile Organic Compounds (VOCs)	EPA Method TO-15	None	SUMMA canister	5d	30d	
Soil Gas	Helium	ASTM D1946	None	SUMMA canister	5d	30d	

Notes:

ASTM = American Society for Testing and Materials
DOE = Department of Energy
HDPE = high-density polyethylene
HASL = Health and Safety Laboratory
EML = Environmental Measurements Laboratory
EPA = United States Environmental Protection Agency
KPA = Kinetic Phosphorescense Analyzer
SIM = Single Ion Monitoring
SM = Standard Method
TAT = Turnaround Time

HCL = Hydrochloric Acid
H_2SO_4 = Sulfuric Acid
HNO_3 = Nitric Acid
NaOH = Sodium Hydroxide

d = day(s)
h = hours
mL = milliliters
L = liter
oz = ounces
y = year

(1) Additional volume will be collected for MS/MSD samples.

(2) Laboratory may provide alternate containers as long as the containers meet the requirements of the method and allow the collection of sufficient volume to perform the analysis.

(3) Holding time begins from date of sample collection. Leachate holding times must conform to water holding time or the requirements of EPA Method 1312.

(4) Niobium, palladium, sulfur and/or total uranium

(5) Fluoride, chloride, bromide, sulfate, ortho-phosphate as PO_4, nitrite, and nitrate.

(6) 28 days for fluoride, chloride, bromide, and sulfate; 48 hours for nitrate, nitrate, and orthophosphate

(7) Water samples analyzed for perchlorate must be field filtered using sterile 20-millilter (mL) syringes and sterile surfactant free cellulose acetate 0.2 micrometer (µm) filters into sterile sample containers (125-mL sterile high density polyethylene bottles). Additional perchlorate sampling requirements are detailed in Nevada Division of Environmental Protection (NDEP) guidance documents.

(8) With proper storage, hold times for unextracted and extracted PCBs and dioxins/furans can be extended to one year. The hold times listed here correspond to those listed in the laboratory's standard operating procedure (SOP).

Immediate means within 15 minutes from sampling or field test

TABLE 8. CALIBRATION AND MAINTENANCE OF FIELD EQUIPMENT
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust; Henderson, Nevada

INSTRUMENT	TASK	FREQUENCY
Organic Vapor Meter OVM(1)	(a) Inspect and calibrate (b) Charge batteries	(a) Daily (b) Each night prior to operation
Particulate monitor(2)	(a) Inspect and calibrate (b) Charge batteries	(a) Daily (b) Each night prior to operation
Asbestos monitor(3)	(a) Inspect and calibrate (b) Charge batteries	(a) Daily (b) Each night prior to operation
Conductivity, Dissolved Oxygen (DO), Oxygen Reduction Potential (ORP), pH, and Temperature Meter(4)	(a) Inspect and calibrate (b) Test batteries	(a) Daily (b) Each night prior to operation
Turbidity Meter(5)	(a) Inspect and calibrate (b) Test batteries	(a) Daily (b) Each night prior to operation
Alkalinity Test Kit(6)	(a) Inspect kit integrity	(a) Daily prior to testing
Ferrous Iron Test Kit(7)	(a) Inspect kit integrity	(a) Daily prior to testing
Sulfide Test Kit(8)	(a) Inspect kit integrity	(a) Daily prior to testing
Water Level Indicator(9)	(a) Inspect (b) Test batteries (c) Calibrate	(a) Daily (b) Each night prior to operation (c) Annually with steel tape
Low flow adjustable-rate sampling pump(10)	(a) Change bladder (b) Change tubing(11)	(a) Each sample location (b) Each sample location
Low flow adjustable-rate sampling pump	(a) Inspect (b) Calibrate	(a) Individually prior to operation (b) Factory calibrated prior to shipment to site
Pressure Transducers(12)	(a) Inspect data log (b) Check batteries and o-rings (c) Perform depth and drift tests (d) Calibrate	(a) Daily (b) Prior to installation (c) Prior to installation (d) Factory calibrated prior to shipment to site

Notes:

(1) MiniRAE 2000 Photoionization Detector (PID) with 10.6 eV lamp or similar

(2) DataRAM pDR-1000AN or similar

(3) Gilian BDX II Personal Abatement Air Sampler or similar

(4) YSI 556 MPS or similar

(5) HACH 2100P Turbidity Meter or similar

(6) HACH Digital Titrator or similar

(7) HACH, CHEMetrics, or similar. Method based on ASTM D 1068-77.

(8) HACH, CHEMetrics, or similar. Method based on USEPA Method 376.2 and Apha Method 4500-S ^{2}-D.

(9) Solinst Water Level Indicator or similar having gradations marked at 0.01-foot intervals.

(10) QED Sample Pro or similar

(11) Teflon® or Teflon®-lined

(12) In Situ Level Troll 500 vented water level/temperature monitor or similar.

TABLE 9. ANALYTICAL LABORATORY CALIBRATION FREQUENCIES
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust; Henderson, Nevada

		QUALITY CONTROL CHECK(1)	
LABORATORY ANALYSIS	**ANALYTICAL METHOD**	**Initial Calibration Type/Frequency**	**Continuing Calibration Type/Frequency**
Volatile Organic Compounds (VOCs) by EPA 8260B	Gas Chromatography/ Mass Spectroscopy	Minimum five points on an as needed basis with daily verification before sample analysis.	Standard analyzed at the beginning of every sequence.
Semivolatile Organic Compounds (SVOCs) by EPA Method 8270C	Gas Chromatography/ Mass Spectroscopy	Minimum five points on an as needed basis with daily verification before sample analysis.	Standard analyzed at beginning of the sequence.
Organochlorine Pesticides by EPA Method 8081A	Gas Chromatography	Minimum five point calibration daily prior to analysis.	Standard analyzed prior to each 12-hour shift, at least once every 20 samples, and at the end of the sequence.
PCBs as Aroclors by EPA Method 8082	Gas Chromatography	Seven point calibration on an as needed basis with daily verification before sample analysis.	Standard analyzed prior to each 12-hour shift, at least once every 20 samples, and at the end of the sequence.
Gasoline Range Organics by EPA Method 8015B	Gas Chromatography	Minimum five point calibration daily prior to analysis.	Standard analyzed after every 10 sample-injections or 12 hours, which ever is sooner and at the end of the sequence.
Diesel Range Organics by EPA Method 8015B	Gas Chromatography	Minimum five point calibration daily prior to analysis.	Standard analyzed prior to each 12-hour shift, at least once every 20 samples, and at the end of the sequence.
Metals by EPA Method 6010B	Inductively Coupled Plasma Atomic Emission Spectroscopy	Minimum two point and a blank calibration daily prior to analysis.	Standard analyzed at a minimum after every 10 samples and end of the sequence.
Metals by EPA Method 6020	Inductively Coupled Plasma/ Mass Spectroscopy	Four point (three standard + blank) calibration daily prior to analysis.	Standard analyzed after every 10 samples.
Rare Earth Metals by EPA Method 6020A	Inductively Coupled Plasma/ Mass Spectroscopy	Four point (three standard + blank) calibration daily prior to analysis.	Standard analyzed after every 10 samples.
PCBs as Congeners by EPA Method 1668A	High-Resolution Gas Chromatography/High-Resolution Mass Spectrometry	Minimium five point calibration daily prior to analysis.	Standard analyzed at the beginning of and after each 12-hour shift.
Organophosphorus Pesticides by EPA Method 8141A	High-Resolution Gas Chromatography/High-Resolution Mass Spectrometry	Minimium five point calibration daily prior to analysis.	Standard analyzed at the beginning of and after each 12-hour shift.
Dioxins/Furans by EPA Method 8290	High-Resolution Gas Chromatography/High-Resolution Mass Spectrometry	Five point calibration daily prior to analysis.	Standard analyzed at the beginning of and after each 12-hour shift.
Mercury by EPA Method 7471A and 7470A	Cold-Vapor Atomic Absorption Spectroscopy	Minimum three points plus a blank daily prior to analysis	Standard analyzed after every 10 samples and end of the sequence.
Inorganic Anions by EPA Method 300.0 and 300.1	Ion Chromatography	Minimum three points plus a blank on an as needed basis with daily verification before sample analysis.	Standard analyzed after every 10 samples and end of sequence.

TABLE 9. ANALYTICAL LABORATORY CALIBRATION FREQUENCIES
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust; Henderson, Nevada

		QUALITY CONTROL CHECK[1]	
LABORATORY ANALYSIS	**ANALYTICAL METHOD**	**Initial Calibration Type/Frequency**	**Continuing Calibration Type/Frequency**
Hexavalent Chromium by EPA Method 7199	Ion Chromatography	Minimum three points plus a blank on an as needed basis with daily verification before sample analysis.	Standard analyzed at least once every 10 samples and end of the sequence.
Perchlorate by EPA Method 314.0	Ion Chromatography	Minimum five points plus a blank on an as needed basis with daily verification before sample analysis.	Standard analyzed after every 10 samples and end of the sequence.
Volatile Fatty Acids by Lab SOP by Ion Chromatography	Ion Chromatography	Minimum five points plus a blank at a minimum of once every six months.	Standard analyzed at least once every 10 samples and end of the sequence.
Total Kjedahl Nitrogen by EPA Method 351.2	Spectroscopy	Minimum three points plus a blank on an as needed basis with daily verification before sample analysis.	Standard analyzed at least once every 10 samples and end of the sequence.
Surfactants by SM 5540C	Spectroscopy	Minimum five points plus a blank on an as needed basis with daily verification before sample analysis.	Standard analyzed at least once every 10 samples and end of the sequence.
Phosphorus by EPA Method 365.3	Spectroscopy	Minimum three points plus a blank on an as needed basis with daily verification before sample analysis.	Standard analyzed at least once every 10 samples and end of the sequence.
Cyanide by EPA Method 9014B	Spectroscopy	Minimum three points plus a blank on an as needed basis with daily verification before sample analysis.	Standard analyzed at least once every 10 samples and end of the sequence.
Sulfide by EPA Method 4500	Spectroscopy	Minimum six points plus a blank on an as needed basis with daily verification before sample analysis.	Standard analyzed at least once every 10 samples and end of the sequence.
Alkalinity by SM 2320B	Titration	Minimum three points on an as needed basis with daily verification before sample analysis.	Standard analyzed at least once every 10 samples and end of the sequence.
4-chlorobenzenesulfonic acid by EPA 8321A	Gas Chromatography/ Mass Spectroscopy	Minimum five point calibration daily prior to analysis.	Standard analyzed at the beginning of and after each 12-hour shift.
Formaldehyde by EPA Method 8315A	High-Performance Liquid Chromatography-Ultraviolet Detection	Minimum five point calibration daily prior to analysis.	Standard analyzed at least once every 10 samples, not to exceed 12 hours, and end of the sequence.
Specific Conductance by EPA Method 120.1	Conductivity Bridge with platinum electrode	Two point calibration daily prior to analysis	Standard analyzed after every 10 samples and end of the sequence.
Ammonia by SM 4500-NH_3	Determined Potentiometrically with an Ion Selective Ammonia Electrode	Minimum five points plus a blank on an as needed basis with daily verification before sample analysis.	Standard analyzed at least once every 10 samples and end of the sequence.
Total Organic Carbon and Dissolved Organic Carbon	Non-Dispersive Infrared Analyzer	Minimum three points plus a blank on an as needed basis with daily verification before sample analysis.	Standard analyzed daily.

TABLE 9. ANALYTICAL LABORATORY CALIBRATION FREQUENCIES
QUALITY ASSURANCE PROJECT PLAN
Nevada Environmental Response Trust; Henderson, Nevada

		QUALITY CONTROL CHECK[1]	
LABORATORY ANALYSIS	**ANALYTICAL METHOD**	**Initial Calibration Type/Frequency**	**Continuing Calibration Type/Frequency**
pH by EPA Method 9045C	Electrometric	Standard analyzed on an as needed basis with daily verification before sample analysis.	Standard analyzed after every 10 samples and end of the sequence.
Radium 226 by EPA Method 903.0	Gamma Spectroscopy	Annual calibration against standards with daily verification before sample analysis.	Source standard analyzed daily.
Radium 228 by EPA Method 904.0	Gamma Spectroscopy	Annual calibration against standards with daily verification before sample analysis.	Source standard analyzed daily.
Uranium 234, 235, 238, and Thorium 228, 230, 232 by Method HASL 300 modified	Alpha Spectroscopy	Annual calibration against standards with daily verification before sample analysis.	Source standard analyzed daily.

Notes:

ASTM = American Society for Testing and Materials

EPA = United States Environmental Protection Agency

HASL = Health and Safety Laboratory

KPA = Kinetic Phosphorescense Analyzer

SM = Standard Method

(1) These Quality Control checks are to be considered the minimum frequency and scope of checks and calibrations to be performed. Laboratories may have more stringent requirements as part of their Standard Operating Procedures.