Prepared for
Nevada Environmental Response Trust

Project Number
21-38800C

Prepared by
Ramboll Environ
Emeryville, California

Date
May 2, 2016

TECHNICAL MEMORANDUM

REMEDIAL INVESTIGATION DATA EVALUATION

NEVADA ENVIRONMENTAL RESPONSE TRUST SITE HENDERSON, NEVADA

Technical Memorandum
Remedial Investigation Data Evaluation

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

Nevada Environmental Response Trust (NERT) Representative Certification
I certify that this document and all attachments submitted to the Division were prepared at the request of, or under the direction or supervision of NERT. Based on my own involvement and/or my inquiry of the person or persons who manage the 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 not individually, but solely as President

Signature: Jay A Steinberg, ____________, not individually, but solely in his representative capacity as President of the Nevada Environmental Response Trust Trustee

Name: Jay A. Steinberg, not individually, but solely in his representative capacity as President of the Nevada Environmental Response Trust Trustee

Title: Solely as President and not individually

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

Date: May 2, 2016

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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.

___________________________________ May 2, 2016________________________

John M. Pekala, PG
Senior Manager

Date

Certified Environmental Manager
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ACRONYMS AND ABBREVIATIONS

ACM	Asbestos-Containing Material
AMPAC	American Pacific Corporation
Angelo and Newton	Angelo & Newton, LLC
AOC	Administrative Order on Consent
AP&CC	American Potash and Chemical Company
AST	aboveground storage tank
AWF	Athens Road Well Field
bgs	below ground surface
BHRA	Baseline Health Risk Assessment
BMI	Basic Magnesium Incorporated, later Black Mountain Industrial
CD	compact disc
CEM	Certified Environmental Manager
COH	City of Henderson
COP	Continuous Optimization Program
COPC	Chemical of Potential Concern
CRC	Colorado River Commission
CSM	Conceptual Site Model
cy	cubic yard
DNAPL	dense non-aqueous phase liquid
DDT	dichlorodiphenyltrichloroethane
DVSR	Data Validation Summary Report
ECA	Excavation Control Area
EDD	Electronic Data Deliverable
Envirogen	Envirogen Technologies, Inc.
ENVIRON	ENVIRON International Corporation
FBR	fluidized bed reactors
FSP	Field Sampling Plan
ft/ft	feet/foot
gpm	gallons per minute
GWETS	Groundwater Extraction and Treatment System
GWTP	Groundwater Treatment Plant

Hardesty	Hardesty Chemical Company
HASP	Health and Safety Plan
HCB	Hexachlorobenzene
Industrial Supply	Industrial Supply Company
IWF	Interceptor Well Field
J. B. Kelley	Jack B. Kelley Trucking
KMCC	Kerr-McGee Chemical Corporation
Koch	Koch Materials Company
kWh	kilowatt hour
kWh/year	kilowatt hours per year
LBCL	Leaching-Based Basic Comparison Level
lbs/day	pounds per day
LF	linear feet
LOU	Letter of Understanding
MCL	Maximum Contaminant Level
mg/L	milligrams per liter
Montrose	Montrose Chemical Corporation
NDEP	Nevada Division of Environmental Protection
NERT	Nevada Environmental Response Trust
Northgate	Northgate Environmental Management, Inc.
OCP	Organochlorine Pesticide
OSSM	Olin Chlor-Alkali/Stauffer/Syngenta/Montrose
PCB	Polychlorinated Biphenyl
Pronto	Pronto Constructors
QAPP	Quality Assurance Project Plan
Qal	Quaternary alluvium
Ramboll Environ	Ramboll Environ US Corporation
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation and Feasibility Study
SAP	Sampling and Analysis Plan
Site	Nevada Environmental Response Trust Site
SMP	Site Management Plan

SNWA	Southern Nevada Water Authority
SRG	Soil Remediation Goal
State Industries	State Industries, Inc.
Stauffer	Stauffer Chemical Company
SWF	Seep Well Field
TDS	total dissolved solids
TEQ	Toxicity Equivalent
TestAmerica	TestAmerica Laboratories, Inc.
Tetra Tech	Tetra Tech, Inc.
TIMET	Titanium Metals Corporation
Tronox	Tronox LLC
Trust	Nevada Environmental Response Trust
TSS	total suspended solids
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
UST	underground storage tank
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
U.S. Vanadium	United States Vanadium Corporation
Valite	Valite Industries
Veolia	Veolia Water North America
VOC	Volatile Organic Compound
WECCO	Western Electrochemical Company
WBZ	water-bearing zone
xMCf	Transitional Muddy Creek Formation

1. INTRODUCTION

In accordance with the Interim Consent Agreement between the Nevada Environmental Response Trust (the Trust or NERT) and the Nevada Division of Environmental Protection (NDEP), Ramboll Environ US Corporation (Ramboll Environ) submits this technical memorandum to NDEP on behalf of the Trust for the Nevada Environmental Response Trust Site (the Site). The purpose of the technical memorandum is to provide a suumary of the results of the NERT Phase 1 RI Data Gap Investigation and to identify additional data gaps to be addressed by a Phase 2 Investigation. The results of the NERT Phase 1 and Phase 2 Investigations, the AECOM Downgradient Study Area effort, and the Tetra Tech Unit building investigation results will be incorporated into a comprehensive RI report currently slated to be submitted to NDEP in late 2018.

The Site, which was formerly owned and operated by Tronox LLC (Tronox), comprises approximately 346 acres located within the Black Mountain Industrial (BMI) Complex in unincorporated Clark County and is surrounded by the City of Henderson, Nevada. In conjunction with the settlement of Tronox's bankruptcy proceeding, the Trust took title to the Site and the groundwater extraction and treatment system (GWETS).[1] The effective date of the property transfer to the Trust and the Interim Consent Agreement between the Trust and NDEP was February 14, 2011. Tronox continues to conduct manufacturing operations on a portion of the Site leased from the Trust.

As part of the Remedial Investigation and Feasibility Study (RI/FS) Work Plan for the Site and associated downgradient plume to the north (collectively referred to as the "NERT RI Study Area") (ENVIRON 2014a), a data gap investigation was deemed to be necessary for areas that required further characterization to determine the nature and extent of chemicals of potential concern (COPCs) in soil and groundwater. Many of these areas were previously identified by NDEP as areas requiring further study. For purposes of additional soil characterization, four main areas were identified for collection of additional physical and chemical data from both shallow and deep soils. These areas include the AP-5 pond area, the debris pile, soil in the area between the debris pile and AP-5 Pond, and the area west of the Mn-1 pond. Additional data review and groundwater investigations were also proposed to address the following data gaps as part of the RI/FS: determination of background COPC concentrations, revision of the preliminary list of COPCs, COPC impact in the Middle Water-Bearing Zone/Muddy Creek Formation, the magnitude and extent of trespassing chemicals, the lateral and vertical extents of the downgradient plume in the northern portion of the NERT RI Study Area, chloroform within this same study area, and stream-aquifer interaction with the Las Vegas Wash. These data gaps are being addressed as part of the RI/FS process.

Also, additional data were needed to evaluate the Category 1 (i.e., soils in Excavation Control Areas) soil areas with limited soil characterization due to access constraints (e.g., soils beneath Unit buildings). Five shallow groundwater monitoring wells were installed

[1] Herein "GWETS" will be used to refer to the entirety of all systems and components of the groundwater extraction and treatment systems owned by the Trust, both on-site and off-site, including extraction well fields, treatment facilities, and groundwater conveyance systems.

in the area of the Unit Buildings 4, 5, and 6 as part of this RI Phase 1 Data Gap Investigation. Additional investigation of soil and groundwater beneath Unit Buildings 4 and 5 is being conducted separately. This work is in progress at the time of this report. When available, the Unit Buildings 4 and 5 investigation results will be incorporated into the forthcoming RI report along with the results from the Downgradient Study Area investigation.

The rationale and scope of work for the Phase RI Data Gap Investigation were described in the RI/FS Work Plan and the accompanying Sampling and Analysis Plan (SAP), which was comprised of the Field Sampling Plan (FSP), the Quality Assurance Project Plan (QAPP), and the Health and Safety Plan (HASP). The RI/FS Work Plan was approved by NDEP on July 2, 2014. The RI data gap field investigation was conducted between October 21, 2014 and May 10, 2015. This technical memorandum presents the results of the RI data gap investigation along with an evaluation of whether additional data are needed to complete the RI. The evaluations of the RI data also considered groundwater monitoring results presented in the 2015 Annual Remedial Performance Report for Chromium and Perchlorate (the 2015 Annual Performance Report; Ramboll Environ 2015b) as well as ongoing activities conducted as part of the Continuous Optimization Program (COP) for the Site.

1.1 RI Data Gap Investigation

The RI data gap field investigation activities discussed in this report were conducted between October 21, 2014 and May 10, 2015. RI activities included investigation of soil and groundwater data gaps within the RI Study Area shown on Figure 1-1 and additional groundwater modeling efforts that encompass the RI Study Area. These data have been validated in accordance with NDEP requirements, and supporting documentation for these data, including an Electronic Data Deliverable (EDD) and Data Validation Summary Report (DVSR), will be presented as part of the comprehensive soil and groundwater data compilation to be included in the forthcoming RI Report.

The RI soil data gap investigation was focused in eight investigation areas (Areas 1 through 8) as shown on Figure 1-2. Soil samples from Area 1 are scheduled to be collected upon the completion of the AP-5 pond decommissioning, currently estimated to be completed in 2017. In Areas 2 through 8, a total of approximately 450 analytical soil samples and 35 physical soil samples were collected from 55 soil borings, 8 on-site well pilot borings, and 3 test pits. In addition, one soil sample was collected from off-site well pilot boring PC-152 (see Figure 1-4) based on field observations of discolored soil.

The RI groundwater data gap investigation was comprised of 8 on-site monitoring well installations, 15 off-site monitoring well installations, 40 grab groundwater samples, 23 slug tests, 6 soil gas probe installations and sampling (3 locations), and sampling of approximately 190 groundwater monitoring wells. On-site and downgradient plume monitoring well sample locations are shown on Figures 1-3 and 1-4, respectively. A detail of downgradient plume monitoring wells sampled along the Las Vegas Wash is shown on Figure 1-5.

Drilling and monitoring well installation was conducted by National Exploration Wells & Pumps (National EWP) under the oversight of Ramboll Environ. All soil borings and monitoring well installations were completed using rotary sonic drilling methods. Soil gas probe installations were completed by National EWP using direct push methods. Each soil boring was logged by a Ramboll Environ geologist using the Unified Soil Classification System (USCS). Underground Service Alert North One-Call System was notified to identify the location of all public subsurface utilities prior to advancing the soil borings and well pilot borings. In addition, a private utility locator, Nevada Ground Penetrating Radar Systems, located and marked the traceable and identifiable private subsurface utilities in the work areas. Locations within the Tronox facility were additionally located and cleared by a designated Tronox Maintenance Supervisor.

Surveyed coordinates and elevations for the RI soil borings and new wells are presented in Table 1-1. Surveying was conducted by Licensed Land Surveyor Atkins North America, Inc., located in Henderson Nevada. Construction details for the new RI monitoring wells are presented in Table 1-2. Soil and groundwater analyses were conducted by TestAmerica Laboratories, Inc. located in Irvine, California. Soil asbestos analysis was conducted by EMSL Analytical, Inc. located in Cinnaminson, New Jersey. Soil physical testing was conducted by PTS Laboratories located in Santa Fe Springs, California. Data validation was performed by Laboratory Data Consultants located in Carlsbad, California.

1.2 Report Organization

This report is provided in both hard copy and electronic forms. Where electronic files are referenced or information is stated as provided on compact disc (CD), this information is contained on the CD attached to the hard copy report. Section 2 provides a summary of the Site operational history focusing on features related to the presence of COPCs in the subsurface soils and groundwater, along with a summary of interim measures that have been implemented to address impacted soil and groundwater. A summary of Site geology and hydrogeology updated to include the RI data gap investigation results is presented in Section 3. Section 4 presents the evaluation of the soil data gap investigation results, including an evaluation of soil COPCs based on potential for leaching impact to groundwater. The groundwater data gap investigation results are discussed in Section 5. Additional data gaps identified based on the soil and groundwater evaluations are discussed in Section 6, and the recommended scope of work for a Phase 2 RI data gap investigation is presented in Section 7.

Tables summarizing the RI data gap investigation soil and groundwater analytical results are included in Appendix A and Appendix B, respectively. Appendix C presents the methodology used for calculating leaching-based criteria for soils following NDEP procedures along with figures illustrating the extent of COPCs in soil. Subsurface cross-sections for both the NERT Site and the downgradient plume area are presented in Appendix D. Appendix E presents Site maps illustrating the distributions of less frequently detected COPCs in groundwater. Boring logs and wells construction diagrams for the borings and wells installed during the RI data gap investigation are include in Appendix F.

This RI data evaluation does not contain any results from the Downgradient Study Area investigation as it still ongoing.

2. SITE HISTORY

2.1 Summary of Site History

This section presents a summary of Site history going back to the initial industrial development in 1941. The information presented in this section was compiled from a review of several Site reports, including: ENVIRON 2011, ENSR 2005, KMCC 1996, Geraghty and Miller 1993, Kleinfelder 1993, BRC 2007, and Schumacher 1999. This historical review is based on the information presented in these documents and does not include independent review of the source documents. A reasonable attempt has been made to rectify conflicting information presented in these sources, and to match general descriptions of Site activities to operational areas at the Site. Additional details pertaining to this section, including tables and figures, will be incorporated into the forthcoming RI report.

A timeline summary of the Site's historical owners, operators, and products manufactured is shown on Figure 2-1.

2.1.1 Site History from 1941 to 1944

The BMI Complex (including the NERT site) was initially developed by the United States (U.S.) Government (under the Defense Plant Corporation) during World War II as a magnesium production facility. Facility construction began in 1941 under a contract with Basic Magnesium Incorporated (BMI) and the plant was operated from August 31, 1942 to November 15, 1944 in support of the war effort.

Figure 2-2 depicts major site operations between 1941 and 1944.

2.1.2 Site History from 1945 to Approximately 1950

Starting in 1945, the Western Electrochemical Company (WECCO) began leasing a portion of the complex from the U.S. Government. The converted magnesium plant was used by WECCO as a chlorate (sodium chlorate and potassium chlorate) and perchlorate (sodium chlorate and potassium perchlorate) production facility. In 1949, ownership of a majority of the overall industrial complex was transferred to the State of Nevada's Colorado River Commission (CRC).

The Hardesty Chemical Company (Hardesty; later the AMECCO Chemical Company) leased and operated out of eight buildings in the BMI Complex, including Unit Building 2, from approximately 1946 to 1949. Chemicals produced by Hardesty/AMECCO included chlorobenzol, soda arsenite, synthetic hydrochloric acid (muriatic acid), monochlorobenzene, paradichlorobenzene, orthodichlorobenzene, dichlorodiphenyltrichloroethane (DDT), and synthetic detergents. Hardesty also operated several tank farms north of Unit Building 2, including underground storage tanks (USTs) containing kerosene, benzene, and fuel oil and aboveground storage tanks (ASTs) containing electrolysis cells (chlorinated alcohols, sludges) and sulfuric acid. These tanks are no longer present on the Site.

Valite Industries, Inc. (Valite) leased a portion of the subject property starting in 1947 (end date unknown; but sometime prior to 1951) for operations that involved building materials and plastics. The leased facility was located north of Unit Buildings 5 and 6 in the current manganese Leach Plant area.

United States Vanadium Corporation (U.S. Vanadium) leased facilities within the BMI Complex for the production of refined tungsten compounds. Detailed information regarding the years and extent of operations within the Site have not been identified. In 1947, U.S. Vanadium operations were reported to involve reclaiming concentrates from settling ponds and production of synthetic scheelite, tungstic acid, molybdenum trisulphate, and ammonia parathustate. The U.S. Vanadium leased area has been reported as located north of Unit 6 in the current manganese Leach Plant area.

Figure 2-3 depicts major Site operations between 1945 and approximately 1950.

2.1.3 Site History from Approximately 1950 to 1967

In 1952, WECCO purchased portions of the BMI Complex from the CRC. The U.S. Government retained ownership of approximately 290 acres of the site. A new organization, Basic Management Inc. (also called BMI), was formed by the Site's tenants in the early 1950s to manage facilities and utilities common to all tenants at the complex.

In 1951, WECCO began operating an ammonium perchlorate plant on 290 acres that the Navy acquired from WECCO. WECCO also expanded its operations to include production of synthetic electrolytic manganese dioxide (a large pilot plant was placed in operation in 1951) and high purity manganese metal (beginning in 1953). Leach beds and tailings piles were operated north of Unit Buildings 5 and 6.

WECCO merged with American Potash and Chemical Company (AP&CC) in 1955[2] and continued production of ammonium perchlorate in addition to the production of potassium perchlorate, sodium chlorate, and potassium chlorate. In 1962, AP&CC purchased remaining areas of the subject property, including the ammonium perchlorate plant (located near the center of the Site), the sodium perchlorate plant (intermediate product), and half of the sodium chlorate plant, from the U.S. Government.

Figure 2-4 depicts major site operations between approximately 1951 and 1967. Onsite ponds operated during this time period are described in Table 2-2.

2.1.4 Site History from 1967 to 2005

Kerr-McGee Chemical Corporation (KMCC) acquired the Site in 1967 following a merger with AP&CC. KMCC produced the same chemical products as WECCO and AP&CC, but the following additional chemical products were also introduced: boron trichloride, elemental boron, sodium perchlorate (produced between approximately 1969 and 1990), magnesium perchlorate (produced between approximately 1969 and 1976), and a sodium chlorate-based bleaching agent known as Tumbleaf Defoliant® (produced between approximately 1975 and 1985). Production of chlorates (sodium chlorate and potassium chlorate) was conducted in Unit Buildings 3, 4, and 5. The production of perchlorates

2 Production accounting procedures use 1955 as the end date of WECCO production and 1956 as the start date of AP&CC production. AP&CC began acquiring WECCO stock in 1954.

(excluding ammonium perchlorate) was conducted in Unit Buildings 4 and 5. Production of ammonium perchlorate was conducted within the central portion of the Site. Production of high purity, battery active manganese dioxide was conducted in two areas: (1) the ore was prepared and leached in the Leach Plant area north of Unit Buildings 5 and 6, and (2) the resulting manganese sulfate solution was fed to electrolytic cells in Unit Building 6. Manganese tailings were stockpiled north of the Leach Plant between 1975 and 2004. KMCC began production of boron products (elemental boron, boron trichloride, and boron tribromide) in 1972 and conducted these activities in Unit Building 5, and later the Boron Plant north of Unit 4. Boron tribromide production was discontinued in 1994. KMCC discontinued production of sodium chlorate and ammonium perchlorate in 1997 and 1998, respectively. Perchlorate was reclaimed at the Site using existing equipment until early 2002.

Historical information suggests that various tenants leased space from KMCC, and later Tronox.

- State Industries, Inc. (State Industries) leased portions of the property from KMCC for the manufacture and storage of hot water heaters between 1969 and 1988. The area leased by State Industries included portions of Unit 1 and a large open area located south of Units 2 and 3 and approximately 0.25 miles north of Lake Mead Drive. From at least 1970 to 1972, State Industries reportedly conveyed various process wastes (sulfuric acid, borax, soda ash, phosphate) through the acid drain system to the Beta Ditch. The company also reportedly discharged liquid wastes containing cyanide to the Beta Ditch via the acid drain system between 1970 and 1971. State Industries operated two ponds, referred to as the Western and Eastern Surface Impoundments (SI), which received spent “pickling process water” generated during the manufacture of water heaters and are further described in Table 2-2. These ponds were located within the State Industries lease area south of the area visible in Figure 2-5.

- Jack B. Kelley Trucking (J. B. Kelley) leased an area approximately 0.1 miles north of Unit Building 1 between 1986 to the mid-1990s. Activities within the leased area included: washing truck interior and exteriors, vehicle fueling, and minor repair work (e.g., oil changes). J.B. Kelley operated a 10,000-gallon diesel UST and a 600-gallon UST for used oil. These tanks were removed in 1991 under Clark County oversight. Exterior truck wash water was reportedly conveyed to the Beta Ditch via the storm sewer system until 1988, when KMCC requested that J.B. Kelley end the practice. Interior truck wash water was discharged to several locations including metal ASTs, a system of concrete vaults, and the Beta Ditch via the storm sewer system. Known discharges to the Beta Ditch by J.B. Trucking are summarized in Table 2-2. Between 1980 and 1986, similar operations were conducted by the W.S. Hatch Company.

- The Koch Materials Company (Koch), also known as the Koch Asphalt Company, leased an area north of the J. B. Kelley leasehold from 1983 to the mid-1990s. Prior to Koch’s occupancy, the Burris Oil and Chemical Company (Burris Oil), conducted operations in the same area (1979 to 1983). Operations within the leased area historically included a plant for blending and packaging asphalt emulsions used in road construction and road sealing. While it does not appear Koch regularly discharged wastewater on-site in at least one documented instance from 1983, an oily liquid was discharged from Koch's operations to the Beta Ditch.

- Additional historical lessees appear to have only used the Site for office space or storage, including: Nevada Precast Concrete Products (1973-1978), Green Ventures International (1980-1981), Buckles Construction Company (steel fabrication and equipment storage, 1973-1989), Ebony Construction Company (construction management and staging, 1977-1978), Delbert Madsen (automobile storage and salvage yard, 1976 to mid-1990s), and Southern Nevada Auto Parts (SNAP) (automobile storage and salvage yard, 1972-present). Operations at Green Ventures International and Nevada Precast Concrete Products appear to have been limited to office space.

A hazardous waste landfill was operated in the northwest area of the Site between 1980 and 1983. Wastes disposed at the landfill included sodium chlorate filter cakes originating from the sodium chlorate process and materials (soils, pond liner, and dry pond contents) originating from the closure of the S-1 pond (Table 2-2). In addition, a debris pile containing demolition debris has been located in the northeast area of the Site since at least 1999.

Figure 2-5 depicts major Site operations between 1967 and 2005. Groundwater extraction and treatment facilities installed at the Site during this period to address impacted by chromium and perchlorate are discussed in detail in Section 2.3. Onsite ponds operated during this time period are described in Table 2-2.

2.1.5 Site History from 2005 to Present

In 2005, Tronox took ownership of the facility formerly operated by KMCC and operated it to produce electrolytic manganese dioxide for use in the manufacture of alkaline batteries; elemental boron for use as a component of automotive airbag igniters; and boron trichloride for use in the pharmaceutical and semiconductor industries and in the manufacture of high-strength boron fibers for products that include sporting equipment and aircraft parts. Over 280,000 tons of manganese tailings stockpiled north of the Leach Plant were removed between April and July of 2010.

In 2009, Tronox filed for Chapter 11 bankruptcy. The Trust took title to the Site on February 14, 2011, as a result of the settlement of Tronox's bankruptcy proceeding. Tronox currently has a long-term lease for approximately 114 acres of the Site, where it continues its manufacturing operations (identified on Figure 2-6 as "Tronox Operational Areas").

Current Site subtenants to Tronox include Pronto Constructors (Pronto), Angelo & Newton LLC (Angelo and Newton), and Industrial Supply Company (Industrial Supply). Pronto provides construction services and has leased space at the site since May 1, 2001. Angelo and Newton became a subtenant in July 2007 and provides Tronox with technical and managerial consulting services, specializing in chemical process plant safety compliance, regulatory compliance, and battery and energy systems. Industrial Supply has been a subtenant at the site since August 31, 2006 and provides warehousing of maintenance, repair, and operating (MRO) supplies that Tronox uses in its operations, as well as direct sales of tools and supplies used in manufacturing, construction, and utilities to third parties.

Veolia Water North America (Veolia), formerly US Filter Operating Services, operated the Groundwater Extraction and Treatment System (GWETS, see Section 2.3) at the Site on behalf of Tronox beginning in 2005. After the Trust took title to the Site, Veolia continued to serve as the GWETS operator until July 24, 2013. Envirogen Technologies, Inc. (Envirogen) currently operates and maintains the GWETS on behalf of the Trust.

Figure 2-6 depicts known current major Site operations between 2005 and 2016.

2.1.6 Historical Wastewater and Storm Water Disposal Practices

Initially, industrial wastewater generated from the Site's industrial processes was discharged to (1) the Trade Effluent Ponds via the Distribution Flume pipeline from the Acid Neutralization Plant or to (2) the Beta Ditch (configuration depicted on Figure 2-2).

The original Beta Ditch was an unlined east-west trending ditch constructed circa 1941 or 1942 that historically received a variety of wastes from various on-site process operations, in addition to receiving storm water and non-contact cooling water. The Beta Ditch extended east of the Site to a siphon inlet/pond location on what is now Titanium Metals Corporation (TIMET) property. The siphon, also referred to as the BMI Siphon (depicted on Figure 2-3), then transmitted flows from the Beta Ditch under Boulder Highway to a ditch along the southern edge of the Upper BMI ponds, where wastes were distributed within the Upper and Lower BMI ponds. Known liquids sent to the Beta Ditch and other site-related ditches are summarized in Table 2-1. The Beta Ditch and Beta Ditch Extension (depicted on Figure 2-5) on the Site were excavated between 2010 and 2011 as part of the Site's Interim Soil Removal Excavation (ENVIRON, 2012). Much of this excavated area now serves as an on-site storm water retention basin referred to as the Central Retention Basin, shown on Figure 2-6.

The western-most portion of the Beta Ditch, which is also referred to as the Beta Ditch Extension or Stauffer Effluent Ditch (depicted on Figure 2-5), was constructed to accommodate waste discharges from companies located west of KMCC (primarily Stauffer and Montrose) and was connected to the Beta Ditch in 1970. Stauffer Chemical Company (Stauffer), a chemical manufacturer (producer of chlorine, caustics, pesticides, and organic chemical products), discharged process effluents to the Beta Ditch between 1971 and 1976. Effluents historically discharged from Stauffer included wastewater and cooling water containing organics, effluent containing caustic from tank car, filter and floor washings, and cell liquor. Stauffer's effluent may have also contained sulfuric acid and magnesium oxide. Montrose Chemical Corporation (Montrose), a manufacturer of chlorinated benzenes, hydrochloric acid, chloroethane, pesticides, and polychlorinated biphenyls (PCBs), discharged wastewater to the Beta Ditch that contained sulfuric acid (possibly with trace DDT), hydrochloric acid containing various PCBs, and sulfonated metabolites of DDT. Site subtenants also discharged various wastes to the Beta Ditch as described in Table 2-1.

Two additional offsite ditches, the Northwest Ditch and Alpha Ditch, were occasionally used by onsite occupants. The Northwest Ditch was originally constructed by the U.S.

Government in the early 1940s to convey process effluents to the Lower BMI ponds. A portion of the Northwest Ditch can be seen on Figures 2-2 through 2-5. The Northwest Ditch drainage began near the BMI Siphon inlet and the ditch was located north of the Site near present-day Warm Springs Road. The US Government, Stauffer, and Montrose discharged wastewater to the Northwest Ditch. On occasion, KMCC discharges may have been diverted to the Northwest Ditch; however, such discharges were apparently small and infrequent and limited primarily to excess storm water flow.

The Alpha Ditch was constructed in approximately 1943 to convey non-contact cooling water to the Las Vegas Wash and, possibly, the Lower BMI ponds. Collection segments on the TIMET property directed flow north and north west, joined, then routed the combined flow northeast across the Boulder Highway to the main segment of the Alpha Ditch. A cross-over pipe enabled the ditch operators to divert flow between the Alpha and Beta Ditches. The Alpha Ditch was operated by the U.S. Government (1942 – 1948), the State of Nevada (1948 – 1952), and BMI (post-1952), with TIMET a significant user after 1950. TIMET discharged storm water, non-contact cooling water and wastewater to the Alpha Ditch. KMCC periodically discharged storm water and non-contact cooling water to the Alpha Ditch via the cross-over pipe after 1976. In the mid-1980's, the Alpha Ditch collection segments were tied into the newly constructed Pittman Bypass, a buried pipeline that conveys flow to Las Vegas Wash. Wastewater discharged to the Alpha Ditch was reported to be chemically similar to the influent BMI water supply under normal conditions.

The BMI ponds received slurried waste from the BMI Complex beginning in approximately 1942 or 1943 until the mid-1970s when each of the operating companies was required to effect zero discharge industrial wastewater management status. Between 1971 and 1976, KMCC altered its processes and constructed single- and double-lined on-site surface impoundments (for recycling and evaporation of wastewater) to achieve a "zero discharge" status for industrial wastewater. Impoundments were constructed to manage process liquids from the chlorate process, process liquids from the ammonium perchlorate process, potassium-bearing process fluids, and nonhazardous wastes including cooling tower liquids (current and former surface impoundments are summarized in Table 2-2).

2.2 Summary of On-Site Soil Interim Measures

Interim soil removal actions were conducted in response to an order issued by NDEP to Tronox in 2009 to remove impacted soil from the Site by the end of 2010 to minimize potential health risks associated with the continued presence of contaminated soil (NDEP 2009). The main contaminated portions of the Site were divided into five remediation zones based on geographic groupings of elevated detections of contaminants and conceptual site model (CSM) considerations (Northgate 2010b). For applicable remediation zones, the general removal action strategy consisted of excavation of soils within designated polygons, sampling of discolored soil, removal of discolored soil if COPCs were above worker soil remediation goals (SRGs) or otherwise deemed appropriate to remove, and designation of Excavation Control Areas (ECAs) for inaccessible areas, including areas with COPCs and/or discolored soil left in place.

The interim soil removal action was completed at the Site between August 2010 and November 2011, in which accessible soils with COPC concentrations greater than worker SRGs were removed down to maximum depth of 10 feet below ground surface (bgs). An estimated total of 567,770 cubic yards (cy) of contaminated soil (not including asbestos-containing material [ACM]) was removed from the Site during this time period. An estimated 11,026 cy of asbestos-containing soil and 1,419 linear feet (LF) of ACM piping were also removed and disposed of as part of the soil remediation program. Areas of the Site were partially backfilled and graded with clean fill from on- and offsite sources. The final grading plan included construction of two retention basins at the Site, the Central Retention Basin and the Northern Retention Basin, as shown on Figure 2-6. Areas of inaccessible soils (with COPC concentrations greater than SRGs) and incompletely characterized soils (due to access issues) were designated as ECAs. The removal activities and post-removal conditions at the Site are described in detail in the *Revised Interim Soil Removal Action Completion Report* (ENVIRON 2012), submitted to NDEP on September 28, 2012 and approved by NDEP on December 17, 2012 (NDEP 2012). A summary of the current ECAs at the Site is provided in Appendix A of the *Site Management Plan (SMP), Revision 2* (Ramboll Environ 2015a).

2.3 History of Site Groundwater Remediation Systems

Groundwater remediation has been conducted at the Site dating back to the mid-1980s. This subsection summarizes historical groundwater removal actions conducted at the Site to address chromium and perchlorate. The hexavalent chromium remediation system currently consists of the on-site Interceptor Well Field (IWF) and the related treatment system. The perchlorate remediation system currently consists of the on-site IWF, the off-site Athens Road Well Field (AWF), the off-site Seep Well Field (SWF) and the related treatment system.

2.3.1 Chromium Remediation and Treatment System

A groundwater investigation was initiated by KMCC in July 1981 to comply with federal Resource Conservation and Recovery Act (RCRA) standards associated with certain on-site impoundments. This investigation involved the installation of nine monitoring wells and identified elevated chromium concentrations in groundwater underlying the Site. In 1986, KMCC and NDEP entered into a Consent Order, which required additional groundwater characterization activities and the implementation of removal activities to address elevated concentrations of chromium in groundwater (NDEP 1986). Pursuant to the Consent Order, KMCC installed an additional 43 monitoring wells and a groundwater interceptor well field (the IWF) consisting of 11 groundwater extraction wells (I-A[3] through I-K) in the shallow WBZ in late 1986 (ENSR 2005).

The extracted groundwater is conveyed to a chromium treatment facility (called the Groundwater Treatment Plant or “GWTP”), constructed in 1986-87 along with the IWF, where hexavalent chromium is electrolytically reduced to trivalent chromium and then co-precipitated with iron oxide. Until 2010, the treated water from the GWTP was subsequently re-injected through two parallel recharge trenches located approximately

[3] Interceptor well I-A has since been plugged and abandoned.

250 feet downgradient (north) of the IWF line of wells. In 1999, re-injection of treated groundwater ceased, and instead the treated water was conveyed to the GW-11 pond and held for perchlorate treatment. Stabilized Lake Mead water was reinjected into the groundwater system via the recharge trenches to maintain groundwater levels. These re-injection trenches were removed in September 2010 to accommodate soil excavation and removal activities at the Site. The IWF, which still operates at the Site in an expanded configuration, is located in the central portion of the Site.

As discussed in Section 2.3.2, the off-site AWF began operating in 2002 to address perchlorate contamination. A small ferrous sulfate drip system was employed at the AWF lift station (Lift Station #3) to treat chromium present (at lower concentrations) in groundwater extracted by the AWF. This system ceased operation in August 2014 after it was determined that the low concentrations of hexavalent chromium from the AWF did not require treatment ahead of the perchlorate treatment system. The AWF is described in detail in Section 2.3.2.

2.3.2 Perchlorate Remediation and Treatment System

Following the discovery of perchlorate contamination in the vicinity of Las Vegas Wash, a seep capture sump and temporary single-use resin ion exchange (IX) system were installed near the Las Vegas Wash in 1999 to capture and treat the water discharged from the seep. After additional investigation of the seep was completed, KMCC constructed four extraction wells in the seep vicinity (PC-99R2, PC-99R3, PC-115, and PC-116)[4] in 2001, from which extracted groundwater was treated by the temporary IX system near the Wash and later also by a second temporary single-use resin IX system located on-site. The pumping from these additional wells began in July 2002.

Another Administrative Order on Consent (AOC), entered into by KMCC and NDEP on October 8, 2001, further defined removal requirements necessary to address the perchlorate contamination (NDEP, 2001). Pursuant to this AOC, KMCC commenced construction of the existing off-site AWF, the off-site SWF, and an on-site perchlorate remediation system (consisting of the GW-11 holding pond, the IWF, barrier wall, and biological treatment system).

The barrier wall was constructed at the Site in 2001 as a physical barrier across the higher concentration portion of the perchlorate/chromium plume. The barrier wall is approximately 1,600 feet in length and 60 feet deep and constructed to tie into approximately 30 feet of the Upper Muddy Creek Formation (UMCf). The IWF is situated south (upgradient) of the barrier wall.

The IWF, which has been expanded to now include 30 groundwater extraction wells, targets the highest concentrations of perchlorate at the Site. In general, perchlorate concentrations in groundwater downgradient of the IWF and barrier wall are significantly below concentrations observed in groundwater upgradient of these features. Seven of

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[4] PC-99R2 (a 6-inch diameter well) and PC-99R3 (an 8-inch diameter well) were combined into one extraction well. PC-115 and PC-116 (6-inch diameter wells) were subsequently replaced by PC-115R and PC-116R (8-inch diameter wells) to improve performance.

these wells (I-AA, I-AB, I-AC, I-AD, I-W, I-X, and I-Y) were activated as part of the 2013 GWETS Optimization Project (ENVIRON 2015). Following activation, extraction wells I-AB, I-AC, and I-AD were unable to achieve sustainable pumping rates and are currently idle.

The AWF was initially constructed as a series of 15 groundwater extraction wells screened in the Quaternary alluvial deposits (Qal) at seven paired and one standalone well location. The AWF spans approximately 1,200 feet across two alluvial paleochannels located on either side of an UMCf ridge. Construction of the AWF was completed in March 2002[5] and continuous pumping began in mid-October of that year. The well pairs act in concert with one well pumping while the adjacent well (the so called “buddy” well) is used to measure water levels and monitor the effect of pumping on the aquifer. In September 2006, ART-9, an additional standalone well screened deeper into the alluvial channel on the east side of the AWF began full-time operation. ART-9 replaced paired wells ART-6/6A after groundwater elevations at the AWF dropped below a level where these wells could operate effectively. Wells ART-7B and PC-150 were connected to the AWF during 2014 as part of the 2013 GWETS Optimization Project (ENVIRON, 2015). These two new wells were designed to address potential capture gaps that had been previously identified.

The SWF is located approximately 4,500 feet north (downgradient) of the AWF near the Las Vegas Wash. As discussed above, when pumping began in July 2002, the SWF consisted of four extraction wells situated over the deepest part of the alluvial channel and a seep capture sump. Five additional wells (PC-117 to PC-121) were installed in February 2003, and an additional well (PC-133) was installed in December 2004 to complete the SWF.

With regard to the perchlorate treatment system, KMCC initially designed and constructed an 825 gpm regenerable resin IX (ISEP®/catalytic destruction process) treatment plant. Due to difficulties in commissioning the regenerable resin IX system, a temporary single-use resin IX system was placed in service on-site to supplement the seep area temporary IX system (ENSR 2005). The permanent on-site ISEP/catalytic destruction process treatment system eventually proved to be unworkable and was abandoned in favor of a biological treatment system employing fluidized bed reactor (FBR) technology (ENSR 2005). Construction of a biological treatment plant was completed in early 2004. Optimization of the plant operations continued into the fourth quarter of 2004. The temporary IX system at Las Vegas Wash near the SWF was shut down in June 2004, and the on-site temporary IX system was shut down in the first quarter of 2004.

The GWETS has continued to operate in essentially the same configuration since 2005. The GW-11 pond receives extracted groundwater from the AWF and SWF, and groundwater extracted by the IWF and treated for chromium by the GWTP. The FBR

[5] Eight extraction wells (ART-1 through ART-8) were completed between October 2001 and January 2002 allowing pumping to begin from these wells in March 2002. Seven additional extraction wells (ART-1A, 2A, 3A, 4A, 6A, 7A, and 8A) were installed in February through March 2003. ART-5 does not have a buddy well.

treatment plant receives influent from the GW-11 pond and discharges treated water to Las Vegas Wash.

The perchlorate treatment system underwent a process modification in 2014. The GW-11 pond, which had served as a holding area for untreated groundwater and off-specification effluent, was altered to function as an influent equalization basin starting on March 27, 2014. The change was designed to provide hydraulic retention upstream of the GWETS process units and dampen fluctuations in influent loading. However, plugging of filtration equipment proved to be a significant hindrance to the modification and the use of GW-11 pond as an equalization basin was temporarily suspended on August 6, 2014. Envirogen, the Trust's operator for the GWETS, subsequently implemented modifications to the filtration system, including the use of automatic filters. GW-11 pond began operating as an equalization basin again on January 6, 2015.

3. SITE SUBSURFACE CONDITIONS

This section presents a summary of background information presented in the RI/FS Work Plan (ENVIRON 2014a) supplemented by recent groundwater monitoring results presented in the 2015 Annual Performance Report (Ramboll Environ 2015b) and data developed during this RI data gap investigation. Summaries of the soil physical properties testing results are presented in Tables 3-1a, 3-1b, and 3-1c. Groundwater elevations recorded in three well clusters where deeper wells were installed are presented in Table 3-2. Slug testing results for the on-site Middle Water-Bearing Zone wells tested during this investigation are presented in Table 3-3. A potentiometric surface map depicting shallow groundwater elevations during the May-June 2015 timeframe is presented on Plate 1 (Ramboll Environ 2015b).

3.1 Physical Setting

Elevations across the Site range from 1,677 to 1,873 feet above mean sea level. The land surface across the Site generally slopes toward the north at a gradient of approximately 0.02 feet per foot (ft/ft). The developed portions of the Site have been modified by grading to accommodate building foundations, surface impoundments, and access roads. Further modifications to the Site were made as part of the Interim Soil Removal Action (ENVIRON 2012) in which soils were typically excavated to depths of up to 10 ft below ground surface (bgs). In some cases, depths were extended to greater than 10 ft to remove discolored soils. Not all excavations were completely backfilled following excavation, resulting in some areas with depressions with 3:1 side slopes. Off-site to the north, the topographic surface continues at approximately the same gradient to approximately Sunset Road, at which point it flattens to a gradient of approximately 0.01 ft/ft to the Las Vegas Wash (ENSR 2005).

3.2 Geology and Hydrogeology

The following subsections provide a summary of regional geology, local geology, and local hydrogeology.

3.2.1 Regional Geology

The Site is located within the Las Vegas Valley, which occupies a topographic and structural basin trending northwest-southeast and extending approximately 55 miles from near Indian Springs on the north to Railroad Pass on the south. The valley is bounded by the Las Vegas Range, Sheep Range, and Desert Range to the north; by Frenchman and Sunrise Mountains to the east; by the McCullough Range and River Mountains to the south and southeast; and the Spring Mountains to the west. The mountain ranges bounding the east, north, and west sides of the valley consist primarily of Paleozoic and Mesozoic sedimentary rocks (limestones, sandstones, siltstones, and fanglomerates), whereas the mountains on the south and southeast consist primarily of Tertiary volcanic rocks (basalts, rhyolites, andesites, and related rocks) that overlie Precambrian metamorphic and granitic rocks (ENSR 2007a).

In the Las Vegas Valley, eroded Tertiary and Quaternary sedimentary and volcanic rocks comprise the unconsolidated basin deposits, which can be up to 13,000 feet thick (ENSR 2007a). The valley floor consists of fluvial, paludal (swamp), playa, and lacustrine deposits surrounded by more steeply sloping alluvial fan aprons derived from erosion of the surrounding mountains. Generally, the deposits grade finer with increasing distance from their source and with decreasing elevation. The structure within the Quaternary and Tertiary-aged basin fill is characterized by a series of generally north-south trending fault scarps.

3.2.2 Local Geology

The local geology and hydrogeology are defined by data collected from more than 2,000 borings and wells that have been installed in the area. The following descriptions are summarized from the RI/FS Work Plan (ENVIRON 2014a).

Alluvium. The Site is located on Quaternary alluvial deposits (Qal) that slope north toward Las Vegas Wash. The alluvium consists of a reddish-brown heterogeneous mixture of well-graded sand and gravel with lesser amounts of silt, clay, and caliche. Clasts within the alluvium are primarily composed of volcanic material. Boulders and cobbles are common. Due to the mode of deposition, no distinct beds or units are continuous over the area.

A major feature of the alluvial deposits is the stream-deposited sands and gravels that were laid down within paleochannels eroded into the surface of the Muddy Creek Formation during infrequent flood runoff periods. These deposits vary in thickness and are narrow and generally linear. These generally uniform sand and gravel deposits exhibit higher permeability than the adjacent, well-graded deposits. In general, these paleochannels trend northeastward.

The thickness of the alluvial deposits ranges from less than 1 foot to more than 50 feet beneath the Site. Soil types identified in on-site soil borings include poorly sorted gravel, silty gravel, poorly sorted sand, well sorted sand, and silty sand. The thickness of the alluvium, as well as the top of the underlying Muddy Creek Formation, was mapped to locate these paleochannels.

Transitional (or reworked) Muddy Creek Formation. Where present, Transitional Muddy Creek Formation (xMCf) is encountered at the base of the alluvium. The Transitional Muddy Creek Formation consists of reworked sediments derived from the Muddy Creek Formation, which is described below. Therefore, the xMCf appears similar to the Muddy Creek Formation, but it consists of reworked, less consolidated and indurated sediments.

Muddy Creek Formation. The Upper Muddy Creek Formation (UMCf) of Pleistocene age occurs in the Las Vegas Valley as valley-fill deposits that are coarse-grained near mountain fronts and become progressively finer-grained toward the center of the valley. Where encountered beneath the Site, the Muddy Creek Formation is composed of at least two thicker units of fine-grained sediments of clay and silt (the first and second fine-grained facies) interbedded with at least two thinner units of coarse-grained sediments of sand, silt, and gravel (the first and second coarse-grained facies). Except for the southernmost 1,000 feet adjacent to Lake Mead Parkway, the first fine-grained facies (UMCf-fg1) separates the first coarse-grained facies (UMCf-cg1) from the overlying Quaternary alluvium at the Site. Within the southern 1,000 feet of the Site, the Muddy

Creek Formation's UMCf-fg1 pinches out along a roughly west-northwesterly trending line. South of this line, the UMCf-cg1 directly underlies the Quaternary alluvium (see Figure 3-1a).

Locally, the Muddy Creek Formation represents deposition in an alluvial apron environment from the Spring Mountains to the west, grading into fluvial, paludal (swamp), playa, and lacustrine environments further out into the valley center. On the Site, the Muddy Creek does not crop out but instead subcrops beneath a veneer of Quaternary alluvium. Since the Site is located closer to the mountains, the upper portion of the UMCf-fg1 unit tends to have zones of sandy silt/silty fine sand as well as a greater number of thin, discontinuous layers of silty sand than in the downgradient plume area, which is farther from the mountains and more toward the interior of the depositional basin.

In on-site borings, the contact between the Quaternary alluvium and the Muddy Creek Formation (UMCf-fg1) is typically marked by the appearance of a well-compacted, moderate brown silt-to-sandy silt or stiff clay-to-sandy clay, whereas near the Las Vegas Wash, the contact is marked by gray-green to yellow-green gypsiferous clays and silts. Often, a layer of calichified sediments is observed at the contact.

The Site hydrostratigraphic units are illustrated on Subsurface Cross-Section A-A', shown on Figures 3-1a and 3-1b. In addition, detailed subsurface cross-sections have been developed that incorporate data from the RI data gap investigation. The locations of on-site cross-sections A-A' through F-F' are shown on Figures 3-2a and 3-2b. The locations of cross-sections G-G' through L-L' in the downgradient plume area shown on Figures 3-3a and 3-3b. The cross-sections are presented in Appendix D.

3.2.3 Local Hydrogeology

Background information is described in detail in the 2005 CSM report (ENSR 2005). In Second Quarter 2015, the depth to groundwater ranged from about 20 to 50 ft bgs and is generally deepest in the southernmost portion of the Site, becoming shallower as it approaches the Las Vegas Wash to the north. North of the Site, beyond Boulder Highway, shallow groundwater is generally encountered between four and 30 feet bgs, becoming shallower as it approaches the Las Vegas Wash. A potentiometric surface map depicting shallow groundwater elevations during the May-June 2015 timeframe is presented on Plate 1 (Ramboll Environ 2015b). The groundwater gradient averages 0.015 to 0.02 ft/ft south of the Athens Road well field (AWF), flattening to 0.007 to 0.010 ft/ft north of the well field. The groundwater flow direction at the Site is generally north to north-northwesterly, whereas north of the Site the direction changes slightly to the north-northeast. This generally uniform flow pattern may be modified locally by subsurface alluvial channels cut into the underlying UMCf (paleochannels), the on-site bentonite-slurry groundwater barrier wall, localized areas of recharge from on-site storm water retention basins (discussed below), on- and off-site artificial groundwater highs or "mounds" created around the former on-site recharge trenches when they were in use and City of Henderson Water Reclamation Facility Bird Viewing Preserve Ponds, by depressions created by the groundwater extraction wells at the three groundwater extraction well fields, and nearby groundwater extraction conducted by OSSM, TIMET, and AMPAC.

NDEP has defined three water-bearing zones (WBZs) that are of interest in the BMI Complex: the Shallow WBZ, which is defined by the first occurrence of groundwater in either the Qal, xMCf, or the UMCf where the xMCf is missing, is unconfined to partially confined, and is considered the “water table aquifer” (within the depth interval from 0 to 90 ft bgs); the Middle WBZ, which extends from approximately 90 to 300 ft bgs; and the Deep WBZ, which is defined as the contiguous WBZ that is generally encountered between 300 to 400 ft bgs (NDEP 2009a). Environmental investigations at the Site have primarily focused on the Shallow WBZ, although recent investigations have included a number of Middle WBZ wells to improve vertical delineation of hydrogeology and chemical constituent distribution.

Shallow WBZ. At the Site, the Shallow WBZ is comprised of the saturated portions of the alluvium and the uppermost portion of the UMCf to depths of approximately 90 ft bgs. Historically, the alluvium was saturated below the northern portion of the Site. However, recent groundwater elevations measured during the annual groundwater monitoring events show that except for a few small areas, the alluvium has become dewatered and first groundwater now occurs within the UMCf.

Beneath the central portion of the Site, groundwater is first encountered within the Shallow WBZ in the UMCf-fg1 and can be more than 50 ft bgs, as documented in historic water level measurements. South of where UMCf-fg1 pinches out beneath the southern portion of the Site, the first groundwater encountered occurs within the UMCf-cg1 and can be more than 70 ft bgs as documented in historical water level measurements from well M-103 and further confirmed from water level measurements from wells M-120 and M-121, which were installed as part of the upgradient investigation (ENSR 2007b).

In the offsite downgradient plume area, the first groundwater encountered occurs within the alluvium at depths of 30 ft bgs or more and shallows northward, occurring near the ground surface at Las Vegas Wash. In the alluvial aquifer, groundwater flows towards the north-northeast with minor variations, generally mimicking the slope of the ground surface. The results of a 1998 pump test in the Athens Road area indicate a permeability of 6.7 feet per day (ft/day), a transmissivity of 170 ft^2/day, and a groundwater velocity of 220 feet per year (ft/yr) for groundwater in the alluvial aquifer (KMCC 1998). However, significantly higher groundwater velocities, ranging from approximately 600 to 2,500 ft/yr, have been calculated based on alluvial well pumping and slug tests (KMCC 1998), and a groundwater velocity of over 12,000 ft/yr was reported based on a tracer test conducted in the alluvial channel between the Athens Road area and the Las Vegas Wash (Errol Montgomery and Associates 2000). A summary of the available aquifer testing results was prepared under the Continuous Optimization Program (COP) and was included in the Trust’s 2015 Annual Summary Report (NERT 2016). The Phase 4 Groundwater Model has also been used to estimate groundwater velocities. In the area between the northern NERT Site boundary and the AWF, the average groundwater velocity is estimated to be within the range of 1,700 to 3,300 ft/yr. In the area between the AWF and the SWF, the average groundwater velocity is estimated to be within the range of 2,800 to 6,000 ft/yr. These groundwater velocities estimated using the model are equivalent to travel times of 2.6-5.2 years from the NERT Site boundary to the AWF, and 0.9-1.8 years from the AWF to the SWF.

The gradient of the potentiometric surface in both UMCf-fg1 and UMCf-cg1 (south of where UMCf-fg1 pinches out) mimics the ground surface and the flow direction is to the north-northeast with minor variations. Both the horizontal and vertical hydraulic conductivities of the UMCf are one or more magnitudes of order less than those of the Qal (ENSR 2005).

Middle WBZ. Investigations of the Middle WBZ at the Site and surrounding sites indicate, with a few exceptions, a vertical upward gradient between the Middle and Shallow Zones that generally increases with depth. In the vicinity of the area immediately downgradient of the IWF, vertical head differences between Middle and Shallow Zone wells ranged from 5 feet to 13 feet during the Second Quarter 2015, with calculated vertical gradients ranging between 0.05 and 0.2 ft/ft in the upward direction. Upward vertical gradients were generally more prominent near the western and central portions of the barrier wall. At the AWF, two wells are screened within the UMCf, PC-134A and PC-137, to depths of 70 and 73.6 feet, respectively. During the Second Quarter 2015, the vertical head differences measured between PC-134A and PC-137 and corresponding wells screened within the Qal were 0.7 feet and 1.7 feet, respectively, with small downward vertical gradients of 0.03 and 0.05 ft/ft. Vertical gradients have not been evaluated near the SWF due to a lack of wells screened below the Qal.

<u>Additional Evaluation of Vertical Head Differences.</u> During the RI data gap investigation, three new Middle WBZ wells (M-161D, M-162D, and M-186D) were installed as part of three existing monitoring well clusters. The groundwater elevations measured in these clustered wells are presented in Table 3-2, and a summary of vertical gradients based on Second Quarter 2015 water elevations is presented in Table 3-3. At all three wells clusters, there is a consistent upward vertical head difference with the highest groundwater elevation measured in the deepest Middle WBZ well. The information from the new well locations will be incorporated into the RI report.

<u>Additional Hydraulic Characterization.</u> At the Site, the sediments within the Middle WBZ consist predominantly of the UMCf-fg1. In order to better characterize hydraulic properties in the Middle WBZ UMCf fine-grained unit, slug tests were conducted in all the existing and new Trust-owned wells completed in this unit. Slug testing was conducted in 20 wells located at the Site in January 2015. A planned test could not be conducted in well M-155 since flowing artesian conditions were encountered at the time of testing. The slug testing results are presented in Table 3-4, and the spatial distribution of the hydraulic conductivity is shown on Figure 3-4.

Based on the slug testing results, the hydraulic conductivities for the 16 wells screened in silt were very low, ranging from 0.00093 ft/day (3.3×10^{-7} cm/sec) to 0.084 ft/day (3.0×10^{-5} cm/sec). For four wells screened in sandy silt lenses, the hydraulic conductivities were higher, ranging from 0.22 ft/day (7.8×10^{-5} cm/sec) to 0.44 ft/day (1.6×10^{-4} cm/sec). Two wells (TR-7 and TR-9) screened in the deeper UMCf-cg2 were also tested. The hydraulic conductivities in these wells were 1.2 ft/day (4.2×10^{-4}

cm/sec) and 2.9 ft/day (1 x 10^{-3} cm/sec), respectively. These data will be incorporated into the numerical model 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 and evaluation of alternative remedial approaches.

UMCf-cg2. The UMCf-cg2 occurs below the fine-grained unit at the base of the Middle WBZ, roughly between approximate depths of 280-300 ft bgs. The UMCf-cg2 unit has been defined below the western portion of the Site by six deep wells (TR-1, TR-5, TR-7, TR-9, TR-11, and TR-12). The UMCf-cg2 unit is confined, as indicated by artesian groundwater elevations consistently measured in these wells. The hydraulic conductivities calculated based on slug tests in wells TR-7 and TR-9 were 1.2 ft/day and 2.9 ft/day, respectively.

3.3 Surface Water

The Site is located in a very arid region with few natural surface water bodies; however, surface water is present at the Site, primarily in surface water impoundments receiving process wastewater. Surface water is also present following storm events.

During the 2011-2012 interim soil removal action, the Site was graded such that storm water would be retained on-site. Two retention basins and a drainage channel were constructed: 1) the Central Retention Basin, located approximately 800 feet south (upgradient) of the IWF, and 2) the Northern Retention Basin, located approximately 300 feet north (downgradient) of the IWF. A shallow channel located along the eastern side of the Site connects the two retention basins and conveys overflow from the Central Retention Basin into the Northern Retention Basin.

Surface runoff from on-site areas and a majority of water collected by the storm sewer network within the Tronox-leased area are directed to the Central Retention Basin. Previously, the west end of the former Beta Ditch at the Site (the Beta Ditch Extension) continued to receive storm water drainage from the neighboring property to the west during major storm events. The former Beta Ditch Extension and associated volatile organic compound (VOC) and chloroform-impacted soil was excavated in 2010. Given the current topography along the western property boundary, there is the potential for a small volume of storm water to enter the Site from the west through surface flow, which is collected in topographic depressions on the Site and/or in the Central Retention Basin. Surface runoff from north of the former Beta Ditch is directed to the Northern Retention Basin. The design capacities of the Central and Northern Retention Basins are approximately 1.3 and 1.2 million cubic feet, respectively (RCI Engineering 2010).

The retention basins have altered the location and extent of infiltration at the Site and thereby have had significant effects on groundwater conditions. Following a series of storm events between August and October 2012, storm water collected in the Central Retention Basin, altering local infiltration pathways and influencing downgradient groundwater conditions at the IWF. The effects included elevated water levels in and around the IWF, which resulted in the mobilization of perchlorate previously bound to vadose zone soils. Mobilized perchlorate migrated to underlying groundwater and was subsequently captured in the IWF, resulting in increased perchlorate mass removal from the Site. The groundwater elevations in the vicinity of the barrier wall that were elevated during portions of 2013 generally have returned to pre-November 2012 levels. However, it is anticipated that similar effects may be seen in the future following large storm events.

Surface water in the Off-Site NERT RI Study Area occurs infrequently as storm runoff in shallow washes and flows to the north toward Las Vegas Wash. The City of Henderson Water Reclamation Facility Bird Viewing Preserve Ponds are also located south of Las Vegas Wash. Las Vegas Wash is a tributary to Lake Mead and it is the only channel through which the valley's excess water flows to this lake. Lake Mead is a major reservoir on the Colorado River.

4. VADOSE ZONE SOIL

4.1 Summary of Soil Data Gap Investigation Results

Several data gaps were identified in the RI/FS Work Plan based on a review completed of the post-2010/2011 soil removal soil analytical data set. Additional physical and chemical data were needed in both shallow and deep soils in the areas described in this section. Sixty soil borings (including 5 on-site well pilot borings) and 3 test pits were installed to address soil data gaps. Soil investigation areas, numbered 1 through 8, are shown on Figure 1-2 and described below. Table 4-1 presents a summary of the soil and groundwater grab sample analytical results for the key constituents being evaluated for potential leaching impact on groundwater (perchlorate, chlorate, chromium, and chloroform). The complete soil and grab groundwater analytical results are included in Appendix A.

Area 1 – Former 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 pond) 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 is currently in-progress and is anticipated to be completed by the end of the first quarter 2017. 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 1-2; however the soil boring locations will be designated following pond decommissioning.

Area 2 – Area Between Debris Pile and AP-5. Relatively high concentrations of perchlorate and chromium have been detected in groundwater in this area. Fifteen soil borings (RISB-15 through RISB-29) were drilled in this area at the locations shown on Figure 1-2. Soil samples were 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 was collected from each boring via a temporary PVC well casing. Soil and grab groundwater samples were analyzed for chlorates and metals.

Area 3 – Debris Pile. Data were 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 test pits (RIT-1 through RIT-3) were excavated within the debris pile to observe the materials in the debris pile. Five grab soil samples were collected for analysis from each of the exploratory test pits to evaluate if COPCs and asbestos are present. In addition, six soil borings (RISB-9 through RISB-14) were drilled around the perimeter of the debris pile at the locations shown on Figure 1-2. Samples were collected at the ground surface, at intervals of five feet, and at any depth where field screening or observations indicated potential impacts, with the deepest sample collected at the capillary fringe above the groundwater table. A grab groundwater sample was collected from each boring via a temporary PVC well casing.

Area 4 – Area West of Mn-1 Pond. Relatively high concentrations of perchlorate, chromium, and chloroform were identified in groundwater in the area west of the Mn-1 pond. Eight soil borings (RISB-30 through RISB-37) were drilled in this area at the locations shown on Figure 1-2. Samples were 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 was collected from each boring via a temporary PVC well casing. Soil and grab groundwater samples were analyzed for chlorates, metals, and VOCs. Tronox reportedly plans to decommission the Mn-1 pond and evaluate potential impacts to soil beneath the pond as requested by the Trust and under the direction of NDEP; however, the timeframe for pond decommissioning by Tronox is currently unknown.

Areas 5 and 6 – Additional Characterization of Category 3 Soils. Additional characterization of Category 3 soils (those soils less than 10 feet bgs and outside of Excavation Control Areas (ECAs) where COPCs are present at concentrations above soil remediation goals for the site) was identified as a data gap in conjunction with the ongoing review of available soil data for the upcoming Baseline Health Risk Assessment (BHRA). The areas that required additional characterization are summarized below.

<u>Area 5 – North of WC-East Pond.</u> Relatively high concentrations of dioxins and furans were identified in surface soil in Area 5 (Figure 1-2). Additional characterization of this area was needed to confirm dioxin/furan toxicity equivalents (TEQ) concentrations in surface soils. In addition, characterization was needed to further delineate potential dioxin/furan contamination. Seven soil borings (RISB-38 through RISB-49) were drilled in this area at the locations shown on Figure 1-2. Soil samples for chemical analysis were collected at the surface and five feet bgs from all seven borings; in boring RISB-49 a sample from 10 feet bgs was also tested based on field screening observations.

<u>Area 6 – Southwest of GW-11 Pond.</u> Relatively high concentrations of dioxins/furans and hexachlorobenzene (HCB) have been identified in post-excavation near-surface soils in Area 6 (Figure 1-2). Additional characterization of this area was needed to confirm dioxin/furan TEQ concentrations in surface and near-surface soils. In addition, characterization was needed to further delineate potential dioxin/furan and HCB contamination. Three soil borings (RISB-50 through RISB-52) were drilled in this area, at the locations shown on Figure 1-2. Soil samples were collected at the surface and at depths of 5 feet and 10 feet bgs. Samples were analyzed for dioxins/furans and organochlorine pesticides (OCPs).

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 2010d) identified relatively high chloroform concentrations in soil gas in two areas where 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 2013b) does not appear to be consistent with this relationship in other areas of the Site. Both Areas 7 and 8, shown on Figure 1-2, 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 was needed to evaluate the potential source(s) of the chloroform detected in soil gas in these areas.

<u>Area 7 – Northwest of L'Hoist.</u> Three soil borings (RISB-53, RISB-54, RISB-55) were drilled in this area at the locations shown on Figure 1-2. Soil samples were 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 was collected from each boring via a temporary PVC well casing. Samples were analyzed for VOCs.

<u>Area 8 – North of Unit Buildings.</u> Two soil borings (RISB-56, RISB-57) were drilled in this area at the locations shown on Figure 1-2. Soil samples were 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 was collected from each boring via a temporary PVC well casing. Samples were analyzed for VOCs. Additional soil sampling within Area 8 (for purposes other than assessment of potential chloroform sources) is described in the following paragraph.

Area 8 – Investigation Near Unit Buildings and Leach Plant. In addition to assessment of potential source areas in soil for chloroform impacts to soil gas in Area 8, 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 1-2).

<u>Area 8 – Monitoring Well Pilot Borings Near Unit Buildings.</u> 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 1-2). 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. Although chloroform has been detected at concentrations above the groundwater BCL in several shallow monitoring wells located downgradient of Units 4 and 5 and within the Leach Plant, there are no written records of chloroform having been used at the Site. As described in Section 1, a separate detailed investigation of soil and groundwater beneath Units 4 and 5 is in progress. These data will be reported in the forthcoming RI Report.

For the RI data gap investigation, five new shallow groundwater monitoring wells (M-189 through M-193) were installed in the vicinity of Units 4 and 5 at the locations shown on Figure 1-2. Soil samples for chemical testing were collected at 5 feet intervals from ground surface to first groundwater. Groundwater data are available from sampling of the new wells conducted in March 2015.

Area 8 – Leach Plant. 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. Six soil borings were drilled in the Leach Plant area, at the locations shown on Figure 1-2. Two borings (RISB-58 and RISB-61) were 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 (RISB-59, RISB-60, RISB-62, RISB-63) were located within the Leach Plant. Soil samples for chemical testing were collected at 5 feet intervals from the ground surface to first groundwater (at the capillary fringe). A grab groundwater sample was collected from each boring via a temporary PVC well casing.

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

The results of the soil data gap investigation were evaluated along with the extensive body of existing soil data to refine the identification of soil COPCs remaining in the vadose zone that could pose a potential threat to groundwater, as described in Section 4.2.

4.2 Identification of Soil COPCs

As described in Section 5.1.4.1 of the RI/FS Work Plan and discussed with NDEP, soil COPCs were identified based on a comparison of vadose zone soil concentrations against leaching-based BCLs (LBCLs) using a soil dataset that was revised to incorporate changes resulting from the interim soil removal action. The soil data were not compared to the human health based BCLs since the Baseline Human Risk Assessment (BHRA) for Onsite Soil is currently underway. Preliminary evaluation of the soil data under the BHRA indicate that sufficient data exist to select COPCs for the human health exposure pathways and evaluate risk. As such, the focus of the soil data analysis in this report is limited to a comparison against LBCLs.

The overall objective of this screening was to identify COPCs in soil that may have the potential to impact groundwater. In addition, the soil dataset was reviewed to identify areas of elevated concentrations in soil that could be potential “sources” of releases to groundwater. If areas of elevated soil concentrations were identified, then the data were reviewed to identify if additional data were needed to determine the horizontal and vertical extent of the elevated soil concentrations.

The revised leaching-based screening was conducted on vadose zone soil samples collected within the alluvium at the Site since 2006 that were not excavated as part of the interim removal action. The soil dataset included soil samples from previous investigations as well as the soil samples collected during the RI soil data gap investigation. Depths were re-adjusted in areas where soil was excavated during the interim removal action but not backfilled to the pre-excavation grade. Specifically, sampling depths were revised to represent the depth below grade based on the elevation *after* completion of soil excavation.

Soil concentrations were compared to the LBCLs (and, in some cases, to the lowest human health BCLs for industrial land use) published by NDEP (https://ndep.nv.gov/bmi/docs/bcl_calculations_February_2015.pdf) to develop a list of soil COPCs. If no NDEP LBCL was available, Ramboll Environ estimated a generic LBCL using the approach presented in NDEP guidance (see Appendix C-1). As an initial screen, only soil concentrations from soil samples collected at depths from the surface (post-excavation) to 10 feet bgs were used in the screening for the following reasons:

- Sources of spills or releases would impact the shallow depth horizons first; and
- The number of soil samples analyzed was greatest from the shallow depth horizons.

Table 4-2 presents a statistical summary of the detections in soil in the top 10 feet of soil in comparison to the LBCLs at the Site.

As described in Section 5.1.4.1 of the RI/FS Work Plan, soil COPCs will be identified as any chemicals detected in at least 5% of samples and having at least one detection exceeding the LBCLs. Consistent with USEPA guidance, the essential nutrients calcium, potassium, and sodium were not included as COPCs. Additionally, the following macronutrients and salts were not included as COPCs: silicon, sulfur, ammonia, bicarbonate, chloride, fluoride, orthophosphate, and sulfate. Lithium was also not included as there are fewer than 15 samples analyzed for lithium from depths less than 10 feet bgs. For inorganics, additional comparisons were made to background datasets. Detected concentrations of aluminum, palladium and zirconium were below the maximum concentration of the background datasets; as a result, these compounds are not included as soil COPCs.

The initial comparison screening results are summarized in Table 4-3. A discussion of the initial list of soil COPCs is presented below. Figures showing the horizontal extent of the COPCs above LBCLs across the Site within different depth intervals are included in Appendix C-2.

4.2.1 Chlorates in Soil

As expected, both perchlorate and chlorate were detected in soil at a frequency greater than 5% with concentrations above the LBCLs and are considered soil COPCs. Figure 4-1 shows the concentration of perchlorate in soil versus sample depth. This figure shows that perchlorate is elevated at concentrations above LBCLs at all depths across the Site. Using colored grid cells, Figure 4-2 shows the extent of perchlorate concentrations above 100 mg/kg in the upper 10 feet of soil across the Site. The color of each cell is based on the maximum concentration of all the samples in the grid cell to a depth of 10 feet. Cells that are orange or red represent areas that have a maximum concentration in at least one soil sample above 1,000 or 10,000 mg/kg, respectively. This figure shows that the highest concentrations of perchlorate in the upper 10 feet of soil generally correspond to the locations of historic perchlorate use and wastewater pond areas (see Figures 2-3, 2-4, and 2-5).

4.2.2 Metals in Soil

The following metals were detected in soil at concentrations above the LBCL and at detection frequencies exceeding 5% (Table 4-3): aluminum, antimony, arsenic, barium, boron, cadmium, chromium VI, cobalt, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, niobium, phosphorus (total), silver, strontium, thallium, tungsten, and zirconium. The general distribution of these metals are discussed below and illustrated in the figures presented in Appendix C-2.

In Figures 4-12 through 4-34, the soil concentrations for the above metals were also compared to the concentration range of background datasets[6] to determine whether the concentrations found on-site are consistent with background concentrations or indicative of a release from an anthropogenic source.

Detected concentrations of aluminum (Figure 4-12), lithium (Table 4-2), palladium (Table 4-2) and zirconium (Figure 4-34) in soil samples were below the maximum concentration of the background dataset concentration range. With the exception of one sample, detected concentrations of niobium (Figure 4-28) were below the maximum of the background dataset concentration range.

Detected concentrations of antimony (Figure 4-13), copper (Figure 4-20), iron (Figure 4-21), molybdenum (Figure 4-26), nickel (Figure 4-27), phosphorous (Figure 4-29), strontium (Figure 4-31), and thallium (Figure 4-32) in soil samples collected from the upper 10 feet were also below the maximum of the background dataset range with the exception of a few samples (less than 10). Detected concentrations of silver (Figure 4-30) and tungsten (Figure 4-33) from soil samples were below the LBCLs with the exception of a few samples (less than 10). Silver detections decreased with depth, and tungsten concentrations were well below LBCLs at depths below 5 feet bgs.

Concentrations of arsenic, barium, boron, cadmium, hexavalent chromium, cobalt, lead, magnesium, manganese, and mercury are present in soil samples from the upper 10 feet of soil at concentrations above the background dataset. Cadmium (Figure 4-17), cobalt (Figure 4-19), lead (Figure 4-22), and mercury (Figure 4-25) concentrations in soil decreased with depth. Cadmium and cobalt soil concentrations were also below the BCLs for industrial land use. Lead and mercury soil concentrations were above the BCLs for industrial land use.

[6] Background data are from: 1) NDEP, 2010. *NDEP Response to Background Issues and Determination of Background Dataset for TRX*. August 17; and 2) TIMET/BRC, 2007. *Background Shallow Soil Summary Report, BMI Complex and Common Areas Vicinity.*

At depths below 10 feet, concentrations of arsenic (Figure 4-14), barium (Figure 4-15), boron (Figure 4-16), hexavalent chromium (Figure 4-18), magnesium (Figure 4-23) and manganese (Figure 4-24) remain above the LBCLs and background dataset concentration range.

4.2.3 Nitrate in Soil

Since a LBCL does not exist for nitrite, to be conservative, all nitrate, nitrite, and nitrate/nitrite analyses were compared to the LBCL for nitrate. Nitrate concentrations in soil were above the LBCL as shown in Figure 4-11. Nitrate has also been detected above naturally-occurring concentrations in groundwater and is generally elevated in areas where perchlorate concentrations are elevated

4.2.4 Radionuclides in Soil

Several radionuclides were detected at a frequency exceeding 5% and exceeding their respective LBLC: Radium-226, Radium-228, Thorium-228, Thorium-228, Thorium-230, and Thorium -232. For radionuclides, soil concentrations of parent radionuclides Thorium-232 and Uranium-238 were compared to background datasets to determine whether the concentrations found on-site are consistent with background. The comparisons are shown on Figures 4-10a and 4-10b. Soil concentrations from these two radionuclides were generally within typical background ranges at depths above 10 feet bgs (which was where the RZ-A background dataset was collected). In addition, the concentration of total uranium in soil samples collected at depths above 10 feet was below the LBCL.

4.2.5 VOCs in Soil

Only two VOCs were detected in soil at a frequency exceeding 5% and exceeding their respective LBCL: chloroform and methylene chloride. Chloroform detections in soil were above the LBCL, although the majority of concentrations above the LBCL were at depths greater than 20 feet (see Figure 4-3). Chloroform has also been detected at elevated concentrations in groundwater in the western and central portions of the Site (see Figure 5-10c). Additional soil data are needed beneath the Unit buildings 4 and 5 (LOUs 43 and 61) to assess whether there may be onsite sources of chloroform in shallow soil potentially impacting groundwater in this area of the Site.

Methylene chloride is a common laboratory chemical and often a lab contaminant in environmental samples. Figure 4-4 shows the soil concentration of methylene chloride versus sample depth. This figure shows that the concentration of methylene chloride in the top 10 feet of soil is within the soil concentration range from upgradient Parcel RZ-A. In addition, the detected concentration distribution in soil is widely distributed across depth; this distribution and the fact that the concentrations in soil are within the range of upgradient Parcel RZ-A suggests that there is not a specific source/release of methylene chloride at the Site and that the methylene chloride found in samples may be related to laboratory contamination.

4.2.6 SVOCs in Soil

Two SVOCs are considered COPCs: hexachlorobenzene and 1-methylnaphthalene. Hexachlorobenzene was detected in soil at concentrations above the LBCL and human health BCLs for industrial land use. Concentrations of hexachlorobenzene are also above the LBCL at depths below 20 feet bgs, so it is also possible that hexachlorobenzene is a COPC in groundwater. Figure 4-5 shows the soil concentration of hexachlorobenzene versus sample depth.

1-Methylnaphthalene was detected in soil at concentrations above the LBCL in 3 samples (Figure 4-6). There are no BCLs for industrial land use for 1-methylnaphthalene, and only 60 samples were analyzed for 1-methylnaphthalene versus over 1,000 samples for hexachlorobenzene (Table 4-3).

No LBCL could be estimated for octachlorostyrene as there is limited toxicity data available for this compound. Additional evaluation of this SVOC will be performed in the final RI Report.

4.2.7 PAHs in Soil

Several PAHs were detected in soil at concentrations above the LBCL and at detection frequencies exceeding 5%: benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, and phenanthrene. Concentrations of these PAHs generally decreased to below LBCLs at depth (see Figures 4-6a through 4-6e). In addition, because of their low solubility and high affinity for organic carbon, PAHs are primarily found sorbed to particles and are at a low risk for migration to groundwater. Except for benzo (a) pyrene (from less than 10 near-surface soil samples), the concentrations of these PAHs were also below BCLs for industrial land use.

4.2.8 PCBs in Soil

Aroclor 1260 (a PCB) was detected in soil at concentrations above the LBCL and at detection frequencies exceeding 5% (see Table 4-3). As shown on Figure 4-8, concentrations decreased to below LBCLs at depth. In addition, because of its low solubility and high affinity for organic carbon, Aroclor 1260 is primarily found sorbed to particles and is at a low risk for migration to groundwater. The concentration of Aroclor 1260 was also below BCLs for industrial land use.

4.2.9 Dioxins/Furans in Soil

Dioxins/furans were detected in soil at concentrations above the LBCL and at detection frequencies greater than 5% (see Table 4-3). The concentrations of dioxins/furans were also above BCLs for industrial land use. Limited data were available for dioxins/furans at depths below 10 feet bgs (see Figure 4-7). However, because of their low solubility and high affinity for organic carbon, dioxins/furans are primarily found sorbed to particles and are considered to be a low risk for migration to groundwater. Although the likelihood is low, further groundwater sampling from monitoring wells is needed to confirm that dioxins/furans have not migrated to deeper soil depths and/or impacted groundwater.

4.2.10 Organochlorine Pesticides in Soil

Three organochlorine pesticides, beta-BHC, 4-4'-DDE, and 4-4'-DDT, were detected in soil at concentrations above the LBCL and at detection frequencies exceeding 5% (see Table 4-3). Concentrations of these constituents decreased to below LBCLs at depth (see Figures 4-9a, 4-9b, and Figure 4-9c). In addition, because of their low solubility and high affinity for organic carbon, these organochlorine pesticides are primarily found sorbed to particles and are at a low risk for migration to groundwater. The concentrations of these organochlorine pesticides were also below BCLs for industrial land use.

4.2.11 Petroleum Hydrocarbons in Soil

Table 4-2 summarizes the detections of petroleum hydrocarbons in soil at depths above 10 feet bgs. Petroleum indicators (e.g., TPH) were not carried forward as COPCs, consistent with NDEP guidance (NDEP 2015b). NDEP recommends evaluating indicator chemicals for petroleum hydrocarbon mixtures (i.e., benzene, toluene, ethylbenzene, and total xylenes, frequently referred to as BTEX; methyl tertiary butyl ether (MTBE); and PAHs). These indicator chemicals were included in the analyses conducted on soil. As shown in Table 4-2, over 500 samples were analyzed for PAHs, and over 300 samples were analyzed for BTEX and MTBE in soil samples collected from depths above 10 feet bgs.

4.2.12 Summary of Updated Soil COPCs

Based on detection frequency and a comparison to LBCLs, the COPCs for soil at the Site are summarized in Table 4-3.

5. GROUNDWATER DATA GAP INVESTIGATION RESULTS

5.1 Site COPCs

The preliminary list of groundwater COPCs that was presented in the RI/FS Work Plan is shown in Table 5-1a. This list was based on screening of groundwater data collected since 2006. As part of the RI data evaluation, Ramboll Environ has updated the list of COPCs using recent groundwater data from September 2014 through December 2015 while considering the soil COPCs identified in Section 4.2 above.

Groundwater concentrations from samples collected between September 2014 and December 2015 were compared to residential groundwater screening levels to develop an updated list of groundwater COPCs. Groundwater residential screening levels were the lowest screening level using the following hierarchy of criteria:

1. Maximum Contaminant Level (MCL): Primary United States Environmental Protection Agency (USEPA) maximum contaminant level (40 CFR Part 141);
2. Basic Contaminant Level (BCL): Residential water basic comparison levels in NDEP February 2015 BCL Table (NDEP 2015b);
3. Regional Screening Level (RSL): Tap water regional screening levels in USEPA Pacific Southwest, Region 9, Regional Screening Levels Chemical Specific Parameters table, November 2015. The screening levels were selected as the minimal values of carcinogenic screening level and noncarcinogenic screening level (USEPA 2015);
4. Secondary Maximum Contaminant Level (2^{nd} MCL): National Secondary Drinking Water Regulations (40 CFR Part 143); or
5. Where no MCL or BCL is available from NDEP, BCLs were calculated as described in Appendix C-1.

Table 5-1b presents the results of this comparison. As described in Section 5.1.4.1 of the RI/FS Work Plan, COPCs will be identified as those chemicals detected in at least 5% of samples and have at least one detection exceeding screening levels. Consistent with USEPA guidance, the essential nutrients calcium, potassium, and sodium were not included as COPCs. Additionally, the following macronutrients and salts were not included as COPCs: silicon, ammonia, bicarbonate, carbon, chloride, sulfide, and sulfate. Furthermore, since total organic halides and recoverable phenolics are a group of compounds, a screening level could not be estimated and as a result, these compounds are not included as COPCs.

5.2 On-Site Groundwater

This section presents the results for major Site-related COPCs based on use in historic or current manufacturing, as well as widespread presence and mobility in Site groundwater as evidenced by previous groundwater monitoring results. These major Site-related COPCs include perchlorate, chlorate (a major component of TDS), chromium, manganese, boron, and nitrate (a component of TDS). As discussed in the RI/FS Work Plan, the NERT Site is affected by trespassing VOCs originating at the adjacent OSSM site. The results for chloroform, the most mobile of the trespassing VOCs detected at the adjacent OSSM site, are also included in this evaluation. While this section discusses the distribution of the major Site-related COPCs in groundwater, the figures in Appendix E display the distribution of the other COPCs in groundwater. A summary of the analytical results for these chemicals in the Trust Site monitoring program wells sampled as part of the RI data gap investigation is presented in Table 5-2. Results for the VOCs identified as COPCs are presented in Table 5-3, and the complete groundwater analytical results are presented in Appendix B.

5.2.1 COPCs in On-Site Shallow Groundwater

The Shallow WBZ has been defined by NDEP as the depth interval between 0–90 feet bgs. At the Site, the Shallow WBZ is comprised of the saturated portions of the alluvium and the uppermost portion of the UMCf to depths of approximately 90 ft bgs. Historically, the alluvium was saturated below the northern portion of the Site. However, recent groundwater elevations measured during the annual groundwater monitoring events show that except for a few small areas, the alluvium has become dewatered and first groundwater now occurs within the UMCf.

Perchlorate. Based on the wide distribution of perchlorate throughout the Shallow WBZ and its high concentrations, this constituent is considered a major Site-related COPC. The distribution of perchlorate in Site groundwater based on data from May 2004 is shown along with potential perchlorate source areas on Figure 5-1. The results from January-June 2015 are presented on Figure 5-2a with additional detail areas shown on Figures 5-2b and 5-2c. In May 2004, the highest perchlorate concentrations (above 1,000 mg/L) extended from the area downgradient (north) of Unit building 4 to the IWF/Barrier Wall, and in the area between the Barrier Wall and the former injection trenches, which were operational at that time (1,400 mg/L and 1,700 mg/L in wells M-71 and M-72, respectively).

In contrast, in 2015 the perchlorate concentrations above 1,000 mg/L were limited to a smaller area between the former Beta Ditch and the IWF/Barrier Wall (up to 2,500 mg/L at RISB-18) and between the Barrier Wall and the former injection trenches (1,100 mg/L and 1,200 mg/L in wells M-71 and M-72, respectively). Perchlorate concentrations in wells located in the area between the Unit buildings and the Beta Ditch have generally decreased by an order of magnitude since 2004. For example, in well M-12A located north of Unit 4, the perchlorate concentration in May 2004 was 1,100 mg/L, decreasing to 230 mg/L in May 2015. Similarly, in well M-31A located on the north side of the Leach Plant, perchlorate decreased from 2,100 mg/L in May 2004 to 770 mg/L in May 2015. Other wells in this area of the Site exhibited similar decreases in perchlorate concentrations over this time period.

Chlorate. Chlorate was not analyzed for in the sampling conducted in May 2004. However, it is a significant component of the TDS in Site groundwater. Figure 5-3 presents the May 2004 isoconcentration map for specific conductivity, which shows the potential source areas for chlorate along with other ponds that could be additional sources of TDS. The distribution of chlorate based on the January-June 2015 groundwater sampling results is shown on Figure 5-4a, with additional detail areas shown on Figures 5-4b and 5-4c. The current distribution of chlorate in Site groundwater is generally similar to perchlorate and as such, is considered a major Site-related groundwater COPC. The highest concentrations are found in the area between the former Beta Ditch and the IWF/Barrier Wall, and in the area between the Barrier Wall and the former injection trenches.

Chromium. Chromium is also widely distributed in the Shallow WBZ with relatively high concentrations in groundwater making it a major Site-related groundwater COPC. The distribution of chromium in Site groundwater based on data from May 2004 is shown on Figure 5-5 in units of mg/L along with potential source areas. To be consistent with the 2015 Annual Performance report, the results from January-June 2015 are presented in units of µg/L on Figure 5-6a, with additional detail areas shown on Figures 5-6b and 5-6c. Similar to perchlorate, in May 2004 the highest chromium concentrations (above 10 mg/L/10,000 µg/L) extended from the area downgradient (north) of Unit building 4 to the IWF/Barrier Wall, and in the area between the Barrier Wall and the former injection trenches. The highest concentration was 55 mg/L/55,000 µg/L in well M-50, which has since been decommissioned.

Again similar to perchlorate, in 2015 the highest chromium concentrations above 20,000 µg/L are limited to the area between the former Beta Ditch and the IWF/Barrier Wall (up to 25,000 µg/L in extraction well I-T). Chromium concentrations in the six wells on the north side of the barrier wall are lower, ranging from 1,400 µg/L in well M-74 to 8,800 µg/L in well M-72. Chromium concentrations in wells located between the Unit buildings and the Beta Ditch have generally decreased since 2004. For example, in May 2004 the chromium concentration was 18,000 µg/L in both wells M-12A and M-31A. In May 2015, the chromium concentration decreased to 10,000 µg/L in well M-12A and 5,900 µg/L in well M-31A.

Manganese. The distribution of manganese in Site groundwater based on May 2003 data is shown along with potential source areas on Figure 5-7. The results from January-June 2015 are presented on Figure 5-8a with a Site detail area on Figure 5-8b. In May 2003, the highest manganese concentrations were detected in the area downgradient of Unit 6 and the Leach Plant, where manganese ore and tailings were handled. The groundwater concentrations in that area ranged from 2.1 mg/L to 13 mg/L in well M-32, with one higher concentration of 440 mg/L in well M-29 located in the basement of Unit 6 (well M-29 is currently inaccessible).

In 2015, the highest manganese concentrations were encountered in wells and grab groundwater samples from borings located in the area of the Leach Plant. However, concentrations are lower than in 2003, ranging 1.3 to 3.8 mg/L. In well M-32 the manganese concentration has decreased from 13 mg/L in 2003 to 0.25 mg/L. Downgradient of the Barrier Wall, manganese was not detected or was detected at low concentrations below the groundwater BCL of 0.02 mg/L, with the exception of one well (0.031 mg/L in well M-80).

Boron. The boron results from January-June 2015 are presented on Figure 5-9a with a Site detail area on Figure 5-9b. Boron concentrations above the groundwater BCL of 6.67 mg/L were detected in wells and grab groundwater samples located between the

Leach Plant and the IWF/Barrier Wall. The highest concentration (21 mg/L) was detected in a grab groundwater samples from RISB-14 near the IWF/barrier wall. Boron was detected above the BCL in two wells located on the downgradient side of the Barrier Wall (M-72, 12 mg/L; M-73, 14J mg/L). Boron concentrations were below the BCL in the ten other wells located downgradient of the Barrier Wall.

5.2.2 COPCs with Previous Localized Exceedances of Screening Criteria

Five of the COPCs identified in Table 5-1a exceeded groundwater screening levels only in localized areas. The five COPCs with localized exceedances are alpha-BHC, heptachlor epoxide, bis(2ethyhexyl)phthalate (BEHP), 4-chlorobenzenesulfonic acid (4-CBSA), and total cyanide. To further assess the presence of these chemicals in groundwater, a focused analytical program was conducted that included sampling in wells located near the previous exceedances.

The results of the focused sampling are presented in Table 5-4. Alpha-BHC and heptachlor epoxide were analyzed in groundwater collected from four wells (M-126, M-128, MC-3, and M-14A). Alpha BHC was not detected in groundwater samples collected from wells M-128 and M-14A, and the 2015 results for samples collected from wells M-126 and MC-3 were below the groundwater BCL of 10 µg/L. Heptachlor epoxide was not detected in any of these wells. BEHP was not detected in the four wells tested (M-38, M-66, M-22A, and M-65). 4-CBSA was analyzed in three wells (M-5A, M-125, and M-126). The 2015 results ranged from 130 µg/L to 23,000 µg/L (J qualified), all below the groundwater BCL of 33,400 µg/L. Total cyanide was analyzed in one well, M-55. Cyanide was not detected (ND<0.13 µg/L); however, this result was R qualified (rejected) due to a QC issue.

Based on the 2015 sampling results, alpha-BHC, BEHP, and 4-CBSA are not present in Site groundwater above screening criteria. Total cyanide was not detected in the sample from well M-55. However, since QC issues affected this result, well M-55 should be resampled for total cyanide.

5.2.3 Further Investigation of Trespassing Chemicals from Neighboring Properties

The results for chloroform, the most mobile of the trespassing VOCs detected at the adjacent OSSM site, are discussed in this section. There have been two comprehensive groundwater sampling events that provide data to evaluate chloroform distributions in shallow groundwater. In 2008-2009, groundwater sampling was conducted by Tronox for an extensive suite of constituents, including chloroform and other VOCs, as part of the Phase A and Phase B Site investigations. Other BMI complex wells were also sampled for VOCs during this time period. The second comprehensive sampling for VOCs include the NERT soil and groundwater sampling results from Fall 2014 and Spring 2015 (conducted as part of the RI data gap investigation) and the OSSM groundwater monitoring results from annual sampling events conducted in April-May 2013 and 2014.

The 2008-2009 chloroform data were compiled by Ramboll Environ during preparation of the RI/FS Work Plan. The distribution of chloroform in shallow groundwater during this period is shown on Figure 10a. The highest chloroform concentrations at the OSSM properties are within the 10,000 µg/L concentration contour and encroach across the western NERT property boundary in the vicinity of the former Beta Ditch. As explained previously, wastewater from the OSSM facilities was conveyed through the unlined Beta Ditch to the ponds in the BMI Common Area east of Pabco Road. At the OSSM properties, chloroform concentrations were higher than 10,000 µg/L in groundwater samples from 10 OSSM wells, ranging from 14,000 µg/L in well AA-MW-21 to 100,000 µg/L in well H-38. Across the western NERT Site boundary, where chloroform is clearly trespassing onto the NERT site, chloroform concentrations in groundwater were 28,000 µg/L in the sample from well MW-123, 18,000 µg/L in the sample from well M-125, 9,100 µg/L in groundwater from well M-127, and 6,100 µg/L in the sample from well M-126. In other areas of the Site, chloroform concentrations were 1-2 orders of magnitude lower. In general, the highest chloroform concentrations were in the vicinity and downgradient of the former Beta Ditch, ranging from 1,400 µg/L in groundwater at well M-89 to 2,200 µg/L in groundwater from well M-17A. The chloroform distribution in the off-site downgradient plume area appears to be related to infiltration from the former Beta Ditch and the BMI Common Area ponds where the wastewater was conveyed.

The distribution of chloroform in 2013-2015 is shown on Figure 5-10b. The overall distribution pattern is generally similar. Within the OSSM properties, seven wells sampled in 2013-2014 had concentrations ranging from 12,000 µg/L in groundwater at well AA-MW-21 to 120,000 µg/L in groundwater at MW-02. Across the western NERT Site boundary, chloroform concentrations in groundwater were 11,000 µg/L in the sample from well M-123, 17,000 µg/L in the sample from well M-125, and 16,000 µg/L in the sample from well MW-26 (well M-127 was destroyed during soil remediation excavation activities). The 2015 chloroform concentrations in groundwater from the other Site wells (both on-Site and downgradient) are generally lower than in 2008-2009. However, similar to 2008-2009, the highest concentrations are generally in the vicinity and downgradient of the former Beta Ditch, ranging from 1,200 µg/L in groundwater at well M-182 to 1,400 µg/L in groundwater at wells M-22A, M-65, and M-66.

<u>Unit Building Area.</u> Chloroform distribution in shallow groundwater in the Site area, including the area near the Unit Buildings and Leach Plant, is illustrated on Figure 5-10c. In the area of the Site near the Unit Buildings, the alluvium is dewatered except in the deepest portions of the paleochannels, and first groundwater occurs within the UMCf-fg1. The concentration contours shown on Figure 5-10c are based on groundwater grab sample results collected during the investigation of potential sources along with the groundwater monitoring wells sampled in January-March 2015 and the recent groundwater grab samples collected from the four boring drilled for the Unit 4 and 5 Buildings investigation first mobilization. Chloroform concentrations in shallow groundwater from the wells around the Unit Buildings range from 0.48 µg/L in groundwater at well M-139 to 55 µg/L in groundwater at well M-11. Higher concentrations were observed in the samples from boring U4U5-2 (110 µg/L) located outside of Unit Building 4 near its northwest corner, and well M-12A (560 µg/L) located north of the boron production facility and Unit Building 4. Within the Leach Plant area, chloroform concentrations ranged from 6.8 µg/L in the groundwater sample from well M-148A to 520 µg/L in the sample from well M-141A. North of the Leach Plant, chloroform concentrations increased at locations closer to the former Beta Ditch (900 µg/L in groundwater at well M-2A). These chloroform concentrations are two to three orders of magnitude lower than concentrations at the OSSM properties. Additional investigation is

necessary at the Unit 4 and 5 Buildings to better understand the distribution of chloroform in this area. This work was begun in early 2016 and will continue into 2017. The Unit 4 and 5 investigation results will be incorporated into the NERT RI report.

5.2.4 Middle Water-Bearing Zone

The Middle WBZ has been defined by NDEP as the depth interval between 90–300 feet bgs. At the Site, the soils within the Middle WBZ consist predominantly of the UMCf-fg1. The UMCf-cg2 occurs below the fine-grained unit at the base of the Middle WBZ. There are currently 27 on-site monitoring wells completed in the Middle WBZ. Three of these wells (M-161D, M-162D, M-186D) were installed in fall 2014 as part of the RI data gap investigation. Three of the existing wells located at the Site (MC-MW-18, MC-MW-39, MC-MW-42) are owned by Montrose and were installed to assess the extent of dense non-aqueous phase liquid (DNAPL) originating at the OSSM property west of the Site. The DNAPL is a trespassing chemical and is discussed further below.

The 24 Trust-owned wells at the Site were sampled as part of the RI data gap investigation, and the complete analytical results are included in Appendix B. Three off-site Trust-owned wells (M-152, M-156, and TR-12) were sampled as part of the 2015 annual groundwater sampling event. A summary of the analytical results for these wells focused on the major COPCs found in Site groundwater is presented in Table 5-2, and results for the VOCs identified as COPCs are presented in Table 5-3.

Lateral Extent of COPCs. The Middle WBZ well locations are shown on Figures 5-11a and 5-11b along with the recent sampling results for perchlorate and chromium. Results for chloroform, which is the most soluble of the VOCs found in the DNAPL, are also shown. Other COPCs detected at concentrations above BCLs in one or more Middle WBZ wells include chlorate, TDS, arsenic, manganese, total phosphorus, and thorium 230. Figures showing the distributions of these less frequently detected COPCs are presented in Appendix E.

Figure 5-11a shows data for 20 wells screened within the upper portion of the Middle WBZ (roughly 90 -150 feet bgs). The Middle WBZ wells with perchlorate and/or chromium above groundwater BCLs are located in the eastern and central portions of the NERT Site in the area between the Unit buildings and the IWF. The January-June 2015 chloroform results for the 24 NERT Middle WBZ wells and the May 2013 results for Montrose wells MC-MW-12, MC-MW-17, MC-MW-18, MC-MW-39, and MC-MW-42 are also presented on Figure 5-11a. As can be seen in the figure, the five Middle WBZ wells impacted by chloroform on the Site are all located east of the lobe of DNAPL that extends onto the Site and are screened within a depth interval of about 70 to 120 feet bgs. These include Montrose-owned wells MC-MW-17, MC-MW-18, MC-MW-39 and NERT wells M-149 and M-186. The chloroform concentrations range from 43,000 µg/L in the sample from well MC-MW-18 within the DNAPL plume on the west side of the Site to 540 µg/L in the sample from well M-186 located across the Site near the eastern boundary. In other areas of the Site, chloroform was detected at very low concentrations in groundwater samples collected from two wells (MC-MW-42, 0.93J µg/L; M-165, 0.47J µg/L). Chloroform was not detected in groundwater samples collected from the 19 other Middle WBZ wells sampled at the Site.

Figure 5-11b shows the sampling results for 12 deeper wells screened within the deeper portion of the Middle WBZ (roughly 150-300 feet bgs). Except for recently installed well M-186D, which may be affected by residual effects of drilling, perchlorate, chromium, and chloroform are either not detected, or are detected at concentrations very close to or below groundwater screening levels. The vertical extent of COPCs is discussed in the next paragraphs.

Vertical Extent of COPCs in the UMCf Fine-grained Unit 1. The vertical extent of Site-related chemicals 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 IWF. To further delineate vertical extent, three deeper wells were installed at three Site locations to add a deeper well to existing well clusters:

- New well M-161D was installed adjacent to Middle WBZ monitoring well M-161 located on the north-central side of the barrier wall and IWF.
- New well M-162D was installed adjacent to Middle WBZ monitoring well M-162 located on the north side of the barrier wall and IWF at its western end.
- New well M-186D was installed adjacent to Middle WBZ monitoring well M-186 located on the eastern Site boundary.

Wells M-161D and M-162D are located on the downgradient side of IWF/Barrier Wall (see Figure 5-11a). Both wells are screened from 130-140 feet bgs, and they were installed primarily to delineate the vertical extent of perchlorate in the UMCf. In March 2015, the perchlorate concentrations were 0.110 mg/L and 0.0061 mg/L in wells M-161D and M-162D, respectively. Chromium concentrations were below the groundwater BCL, and chloroform was not detected in either well. Subsurface cross-section E-E' illustrating vertical perchlorate isoconcentration contours is presented on Plate D-4b in Appendix D. Based on these data, perchlorate concentrations above 0.015 mg/L extend to depths of about 120 to 140 feet bgs in this area of the Site.

Chemicals detected in well M-186D during sampling events conducted in January and March 2015 may be an artifact of drilling. Perchlorate was initially detected at concentrations of 2.0 mg/L and 2.2 mg/L in January and March, respectively. However, well M-186D was sampled again in February 2016, and the perchlorate concentration had decreased to 0.84 mg/L. Chloroform was initially reported at low concentrations of 1.3 µg/L and 1.1 µg/L in January and March 2015, respectively, but chloroform was not detected (ND<0.50 µg/L) in February 2016. Chromium concentrations were below the MCL in all three sampling events. Subsurface cross-section C-C' illustrating vertical perchlorate isoconcentration contours is presented on Plate D-2b in Appendix D. Based on these data, perchlorate concentrations above 0.015 mg/L extend to depths of about 170 to 180 feet bgs in this area of the Site.

UMCf Coarse-grained Unit 2. The top of the UMCf-cg2 unit varies in depth depending on location; it has been encountered at depths ranging from 200 feet bgs to as deep as 272 feet bgs. The UMCf-cg2 unit has been defined below the western portion of the Site by six deep wells (TR-1, TR-5, TR-7, TR-9, TR-11, TR-12) and below the northern portion of the Site by one deep well (M-155). The UMCf-cg2 unit is confined, as indicated by artesian groundwater elevations consistently measured in these wells. These seven wells were sampled for perchlorate and chromium in May 2012. Perchlorate was not detected (ND<0.0003 mg/L) in groundwater samples collected from any of the wells. Total chromium concentrations in groundwater samples were all below the MCL of 100 µg/L; the detected chromium concentrations ranged from 13 to 48 µg/L.

In January-June 2015, perchlorate was not detected (ND<0.00095 mg/L) groundwater samples collected from wells M-155, TR-7, and TR-11. In groundwater samples collected from three wells, perchlorate was reported at very low concentrations below the groundwater BCL of 0.018 mg/L and the federal PRG of 0.015 mg/L (0.0022J mg/L in well TR-5, 0.0035J mg/L in well TR-12, and 0.0058 mg/L in well TR-1). In well TR-9 located near the southwest (upgradient) Site boundary, the reported perchlorate concentration was 0.018 mg/L in June 2015. Total chromium results were all below the MCL of 100 µg/L, ranging from 12 to 22 µg/L. Hexavalent chromium results were also below the groundwater BCL of 100 µg/L, ranging from 12 to 20 µg/L. VOCs, including chloroform, were not detected in groundwater samples collected from the on-site wells sampled in January 2015. These results indicate that the UMCf-cg2 unit at the base of the Middle WBZ is not impacted by the primary Site-related chemicals or VOCs found in the upper portion of the overlying UMCf-fg1 unit.

5.3 Off-Site NERT RI Study Area

5.3.1 RI Data Gap Investigation Results

A total of eleven shallow groundwater monitoring wells and two deeper wells were installed as part of the RI groundwater data gap investigation in the Off-Site NERT RI Study Area. In addition, seven existing wells were sampled for chloroform (one well scheduled for sampling (AA-11) was found to be dry). The well locations are shown on Figure 1-4, and the groundwater analytical results are presented in Appendix B. Construction details for the new wells are presented in Table 1-2.

Lateral Plume Extent. In order to obtain additional data to help distinguish between two perchlorate plumes in groundwater (the Trust plume and the AMPAC plume to the west), three new shallow wells (PC-151, PC-152, PC-153) were installed along Sunset Road, and four new shallow wells (PC-154, PC-158 PC-159, PC-160) were installed along Galleria Road west of the AWF. The data from these new wells were incorporated into the isoconcentration contour maps presented in the 2015 Annual Performance Report. The groundwater perchlorate distribution in the downgradient plume area is presented on Figure 5-12. Along with data from existing wells, the sampling results for the new wells along Sunset Road confirmed separation of the two plumes (as delineated by the 1 mg/L contour). Along Galleria Road, the perchlorate concentrations in the four new wells were above 1 mg/L, ranging from 37 mg/L to 49 mg/L, indicating that commingling of the plumes may be occurring in the area immediately west of the AWF.

Vertical Plume Extent. The vertical extent of perchlorate in the Upper Muddy Creek formation beneath the AWF extraction wells was investigated through the installation of two deeper monitoring wells. New well PC-134D is located adjacent to existing well PC-134A, and new well PC-137D is located adjacent to existing well PC-137. Both new wells are screened between 80-90 feet bgs. The new wells were sampled in January

2015. The perchlorate results were 0.0011J mg/L in well PC-134D and 0.0072 mg/L in well PC-137D. These results are below both the groundwater BCL (0.018 mg/L) and the federal PRG (0.015 mg/L) and indicate that the vertical extent of perchlorate has been adequately delineated beneath the AWF. The vertical extent of perchlorate at the PC-134/PC-134D well cluster is illustrated on Subsurface Cross-Section L-L', shown on Plate D-11b in Appendix D.

5.3.2 Investigation of Stream-Aquifer Interaction at Las Vegas Wash

Three pairs of groundwater monitoring wells (PC-155A/PC-155B, PC-156A/PC-156B, and PC-157A/PC-157B) were installed between the Seep Well Field (SWF) and Las Vegas Wash. At each well pair, the shallow well was screened from approximately 10 to 30 feet, and the deeper well was screened from approximately 30 to 50 feet. The specific screened intervals were adjusted based on conditions encountered and are shown in Table 1-2. The groundwater elevations and monitoring data from these new well pairs will be evaluated as part of the separate evaluations of surface water and groundwater interaction in the downgradient plume adjacent to Las Vegas Wash. An analysis of the inflow sources to the Seep Well Field will be completed during the summer of 2016. The stream-aquifer interaction is also a major component of the Downgradient Study Area investigation and the results will be reported in the forthcoming comprehensive RI Report.

5.3.3 Further Investigation of Chloroform in the Downgradient Plume

Ten shallow groundwater wells located between North Boulder Highway and the Athens Road Well Field were sampled for VOCs to assess the current chloroform concentrations in shallow groundwater. The well locations (AA-11, BHE1-10, PC-21A, PC-24, PC-28, PC-54, PC-64, PC-65, PC-66, and PC-67) are shown on Figure 5-13. Well AA-11 could not be sampled since it was dry, so an alternative well, PC-21A, was sampled in its place. Results for off-site well PC-54 are also shown on Figure 5-13. In groundwater samples from five wells (BHE1-10, PC-54, PC-64, PC-65, and PC-66) chloroform results ranged from 2.3 to 3.5 μg/L. The chloroform concentration was 80 μg/L in well PC-28. In wells PC-21A, PC-24, and PC-67, the chloroform concentrations were 180 μg/L, 390 μg/L, and 1,000 μg/L, respectively. In addition, the initial sampling for seven new off-site wells constructed during the RI (PC-151 through PC-154 and PC-158 through PC-160) were sampled and the subsequent analysis included VOCs. Chloroform results in these new wells ranged from 0.28J μg/L to 1.0 μg/L.

As described in the Field Sampling Plan, soil gas samples were collected adjacent to the three chloroform assessment wells with the highest chloroform concentrations. Soil gas sampling location SG-1 is adjacent to well PC-67, SG-2 is adjacent to well PC-24, and SG-3 is adjacent to well PC-21A. Soil gas samples were collected from depths of 5 feet and 13 feet at SG-1 and from depths of 5 feet and 15 feet at SG-2 and SG-3 using temporary soil gas probes. The samples were collected in March 2015 in accordance with the procedures described in the Field Sampling Plan. At location SG-1, the soil gas chloroform concentrations were 3,700 $\mu g/m^3$ at 5 feet and 8,900 $\mu g/m^3$ at 13 feet just above the water table. At location SG-2, the soil gas chloroform concentrations were 4,400 $\mu g/m^3$ at 5 feet and 7,100 $\mu g/m^3$ at 15 feet, closer to groundwater. At location

SG-3, the soil gas chloroform concentrations were 7,000 μg/m^3 at 5 feet and 7,200 μg/m^3 at 15 feet.

Preliminary risk-based screening levels were calculated for chloroform in soil gas and groundwater (see Table 5-5). Based on this analysis, the soil gas concentrations measured at the five-foot depth interval in the three chloroform assessment wells (SG-1, SG-2, and SG-3) correspond to a residential cancer risk ranging from 2×10^{-5} to 3×10^{-5}.

5.4 Updated Evaluations of Site Groundwater and the Off-Site NERT RI Study Area

The distributions of chemicals in both Site groundwater and in the Off-Site NERT RI Study Area based on data collected between January-June 2015 were presented in 2015 Annual Remedial Performance Report for Chromium and Perchlorate (the "2015 Annual Performance Report") (Ramboll Environ 2015b). Annual groundwater sampling (completed in the second calendar quarter) is a coordinated sampling event with several neighboring companies participating. Data from groundwater samples collected by neighboring companies are incorporated and evaluated along with data from the NERT site. For the 2015 Annual Performance Report, the Trust received information from American Pacific Corporation (AMPAC), Olin/Stauffer/Syngenta/Montrose (OSSM), Southern Nevada Water Authority (SNWA), and Titanium Metals Corporation (TIMET). Their data were integrated into the development of the groundwater elevation and plume maps for chromium and perchlorate. Data from the BMI database were integrated into the development of plume maps for additional chemicals that have been analyzed in off-site groundwater by neighboring companies, including chlorate and chloroform. Based on previous evaluations, many of the other NERT Site COPCs were not identified for inclusion in the monitoring programs for off-site wells conducted by NERT or neighboring companies. The groundwater elevation map is presented on Plate 1, and isoconcentration maps for perchlorate, chlorate, chromium, and chloroform are presented on Plates 2 through 5, respectively.

6. KEY FINDINGS

6.1 Key Findings of the RI Data Gap Investigation

Based on the results of the RI data gap investigation and the evaluations discussed in previous sections of this technical memorandum, several key issues have been identified that will affect ongoing interim remedial actions, including the COP and the future feasibility study evaluations to support selection of the final remedy. This analysis also considered the Downgradient Study Area investigation currently underway by AECOM at the direction of NDEP. Accordingly, Ramboll Environ has identified the necessity for a Phase 2 data gap investigation (described in Section 7). These key issues are described below.

Key Issues

- In the conceptual model developed for the site, lateral transport of perchlorate and other COPCs towards the Las Vegas Wash occurs mainly within the alluvium, which has significantly higher hydraulic conductivity than the UMCf. As a result, most previous investigations have focused on delineating perchlorate and other COPC impacts within the alluvium. The presence of high concentrations of COPCs in the alluvium prior to the start of groundwater remediation over the long period of Site operations would have caused the diffusion of COPCs downward into the underlying UMCf. In addition, downward transport of COPCs would have been caused by infiltration in areas with unlined ponds and ditches and by density-driven flow in areas with very high TDS. Once the COPC concentrations in the alluvium were reduced as a result of groundwater remediation, the mass of COPCs in the UMCf began migrating back upwards into the alluvium as a result of diffusion and upward flow under natural upward vertical gradient. This back diffusion and upward flow is likely the cause of the relatively slow decline in alluvial concentrations even though groundwater remediation has been on-going for many years. In order to estimate the time required to achieve groundwater cleanup goals, a better delineation of the extent of COPCs in the UMCf is needed. In the Phase 2 data gap investigation, the mass and vertical extent of COPCs within the UMCf will be investigated at key locations both at the Site and in the Off-Site NERT RI Study Area where the alluvium is already well characterized.

- Within the past 4-5 years, the previously saturated alluvium in the northern portion of the Site has become dewatered except in a few small areas. This is likely the result of a combination of factors, including shut down of the injection trenches located north of the IWF in September 2010 along with the extended drought conditions affecting the entire southwest. As a result, the existing shallow monitoring wells screened in alluvium along the future Site boundary are now dry, and deeper wells completed in the UMCf are needed to complete the downgradient boundary monitoring network. In addition, the dewatered conditions in the alluvium reduce the amount of impacted groundwater available to the IWF extraction wells. A soil flushing pilot study is being conducted in the Central Retention Basin. The treatability study was conducted in 2015-2016, and a larger scale pilot study will be conducted in 2016-2017. The expanded pilot study area could mobilize and transport perchlorate in the vadose zone to groundwater and add water to the alluvium upgradient of the IWF. Elevated perchlorate was also found in the vadose zone soils in Area 2, north of the Central Retention Basin between the AP-6 pond and the IWF. Targeting this area for soil flushing could be successful in increasing perchlorate mass removal from the vadose zone and shallow groundwater at the IWF. Additional characterization of the vertical extent of perchlorate and other COPCs is also needed in this area upgradient of the IWF to improve mass estimates and better assess the potential for impacts from back diffusion.

- The extent of the dissolved VOC “halo” around the trespassing DNAPL plume in the ~90-120 feet depth interval has not been delineated to the east of the DNAPL impacted area. Additional well clusters are needed to characterize the extent of the soluble DNAPL constituents, particularly chloroform, into the Site. Although historic chloroform use has not been documented at the Site, the potential presence of chloroform in soil and/or groundwater in the Unit building area is currently being evaluated as part of the separate investigation currently in progress at Units 4 and 5. When available, these results will be incorporated into the RI report.

6.2 Identification of Additional Data Gaps

Ramboll Environ has identified the necessity to conduct a Phase 2 investigation. The purpose of a Phase 2 investigation is to obtain data to support ongoing and planned interim remedial measures at the Site, including the COP, and the future feasibility study evaluations to support selection of the final remedy. The following is a summary of data gaps to be addressed in a Phase 2 RI data gap investigation. The Phase 2 Work Plan follows in Section 7 of this document.

NERT Site:

- To support the proposed longer term Remedial Action Objective (RAO) of On-Site Groundwater Control, deeper monitoring wells screened in the UMCf are needed at the downgradient Site boundary (existing shallow downgradient boundary wells M-98 through M-101 screened in the alluvium have been dry since ~2011).
- In the area downgradient of the barrier wall and the former injection trenches to the site boundary, characterization of perchlorate and other COPCs in soil (both in the alluvium and UMCf) and in groundwater is needed to assess whether additional soluble COPC mass (particularly perchlorate) could be removed between the IWF and the downgradient Site boundary.
- Deeper onsite UMCf wells are needed in the area on the upgradient side of the IWF to better delineate vertical extent of perchlorate where shallow well concentrations are high.
- Evaluation of COPCs in shallow groundwater where soil impacts have been identified on the north side of Avenue F (existing shallow well M-21 is dry).
- Investigation of soil and groundwater is needed in the area west and northwest of the GW-11 pond where the alluvium is unsaturated and few data are available.

- Selected shallow wells should be sampled for dioxins and furans to confirm that these chemicals, which are present in soil above leaching criteria, do not pose a threat to groundwater at the Site.
- Well M-55 should be resampled for total cyanide to confirm the absence of this constituent (the Phase 1 RI result was qualified as R (rejected) due to laboratory QC issues).
- In the Middle WBZ, additional VOC delineation is needed within the 90-120 feet depth interval in the area between Montrose DNAPL wells MC-MW-12 and MC-MW-18 and NERT well M-186. The results of the Unit Buildings 4 and 5 investigation in progress will also provide additional data to address this issue.

Off-Site NERT RI Study Area:

- Additional monitoring wells are needed in the downgradient Pittman neighborhood, both shallow and deeper, to better delineate perchlorate mass in the UMCf such that NERT can gain a greater understanding of the approximate duration of groundwater remediation. This will include the area of relatively higher perchlorate concentrations between Warm Springs Road and Boulder Highway.
- The potential for vapor intrusion of chloroform in the residential neighborhood is not well understood. The new monitoring wells should be sampled for VOCs to better understand the extent of chloroform impacts to shallow groundwater in the downgradient plume area.
- Slug testing of wells in the downgradient plume area outside of the paleochannels is needed to provide hydraulic characterization in the areas outside the paleochannels where perchlorate concentrations are highest.
- Groundwater monitoring well sampling for potential “tracer” chemicals (e.g., chlorate or nitrate) could be useful for plume quantification purposes.

Area near the Seep Well Field and Las Vegas Wash:

- An area of perchlorate impacts to soil that is not well characterized in the vadose zone soils near the seep. When the seep was flowing, it would have contaminated these soils. There also appear to be areas to the east of the seep with finer-grained soils in the alluvium that have higher concentrations of perchlorate.

The scope of work for a Phase 2 RI investigation to address these data gaps is presented in Section 7.

7. PHASE 2 RI DATA GAP INVESTIGATION

This section presents the scope of work for the Phase 2 RI Data Gap Investigation ("Phase 2 Investigation"). The purpose of a Phase 2 Investigation is to obtain data to support ongoing and planned interim remedial measures at the Site and future feasibility study evaluations to support the selection of the final remedy. The scope of work to address the data gaps identified in Section 6 is described in the following sections. The Phase 2 Investigation activities will be conducted in accordance with the NDEP-approved SAP, HASP, FSP, and QAPP developed for the NERT Site (ENVIRON 2014a).

This Phase 2 Investigation addresses the NERT RI Study Area, which includes the NERT Site and Off-Site NERT RI Study Area. While the NERT RI will also incorporate the results of the ongoing effort in the Downgradient Study Area being conducted by AECOM, this scope of work does not contemplate data gaps that may exist at the conclusion of the AECOM investigation. Additional data gaps identified in the Downgradient Study Area, or additional study areas as identified by NDEP, will be presented under separate cover.

The scope of work presented in this section includes borings and monitoring wells that will provide data to complement the existing NERT well network. The majority of the new wells will be screened in the UMCf where existing data are not available.

7.1 NERT Site

As discussed in Section 6 of this report, the Phase 2 Investigation to be conducted at the NERT Site will include the following:

- Installation of additional monitoring wells at the future downgradient Site boundary
- Investigation of soil and groundwater in the area between the IWF/barrier wall and the downgradient Site boundary
- Installation of deeper wells in the upper and lower portions of the UMCf in the area upgradient of the IWF
- Investigation of soil and groundwater in the UMCf in the area west of the GW-11 pond
- Characterization of VOCs and other COPCs in the Middle WBZ
- Analytical parameters for groundwater will include perchlorate, chlorate, dissolved metals, VOCs, PCBs, radionuclides, major ions, and geochemical parameters. All soil samples will be analyzed for perchlorate, chlorate, total chromium, nitrate, nitrite, VOCs, and moisture content. In addition, on-site soil samples collected from the vadose zone will be analyzed for soil COPCs including an expanded list of the metals identified as COPCs, SVOCs, PAHs, PCBs, dioxins/furans, organochlorine pesticides, and radionuclides. The specific analytes for the on-site and off-site investigation locations are presented in Tables 7-1 through 7-3.
- Focused groundwater sampling (dioxins/furans and total cyanide)
- Hydraulic testing of the new wells

7.1.1 Downgradient Site Boundary Monitoring Well Network

As described in Section 6, the previously saturated alluvium in the northern portion of the Site has become dewatered except in a few small areas. As a result, four of the six existing monitoring wells screened in alluvium along the future downgradient Site boundary are now dry. Eleven new wells will be installed at seven locations to provide an expanded monitoring network at the future downgradient Site boundary (following the sale of Parcels C and D). As shown on Figure 7-1a, the monitoring network will include well clusters at three of these locations.

- Well M-204 will be a Middle WBZ well installed adjacent to existing shallow wells M-6A and M-7B to form a well cluster near the western Site boundary.
- Well M-205 will be a shallow well screened in the upper portion of the UMCf east of existing well M-7B.
- Well M-206 will be screened in the upper portion of the UMCf adjacent to alluvium well M-98, which is dry.
- Well M-207 will be screened in the upper portion of the UMCf adjacent to alluvium well M-99, which is dry.
- New wells M-208, M-209, and M-210 will be screened at various depths in the Shallow WBZ UMCf and will be part of a well cluster with alluvium well M-100 (currently dry) and Middle WBZ wells M-151 and M-155.
- New wells M-211, M-212, and M-213 will be screened at various depths in the UMCf and will form a well cluster with alluvium well M-101 (currently dry). M-211 and M-212 will be screened in the Shallow WBZ UMCf, and M-213 will be screened in the Middle WBZ.
- Well M-214 will be screened in the upper portion of the UMCf adjacent to former shallow well M-102, which was decommissioned.

The planned well construction details are presented in Table 7-1 along with the analytical parameters for the initial well sampling that will be conducted as part of this Phase 2 investigation. The planned laboratory analysis is based on the results of the Phase 1 RI results and is designed to improve NERT's understanding of groundwater quality at the future property boundary.

7.1.2 Additional Characterization in the Northern Area of the Site

As described in Section 6, the presence of COPC mass in the UMCf results in diffusion upward into shallow groundwater. The mass and vertical extent of COPCs within the UMCf will be investigated to provide data to improve mass estimates and better assess the potential for impacts from upward diffusion. Investigative activities will focus on the areas in the vicinity of the IWF/barrier wall as shown on Figure 7-1b.

Information on the vertical extent of COPCs in groundwater in this area is available from five existing well clusters:

- Two well clusters south (upgradient) of the IWF (see Plate D-4b, Subsurface Cross-Section D-D' in Appendix D):

  - Shallow well M-36 (damaged) and Middle WBZ wells M-150 and M-154
  - Deep Shallow WBZ well M-182 and Middle WBZ well M-181

- Three well clusters on the north (downgradient) side of the barrier wall (see Plate D-5b, Subsurface Cross-Section E-E' in Appendix D):
  - West end: Shallow WBZ wells M-135/ M-134/ M-136, and Middle WBZ wells M-161/ M-161D
  - Center: Shallow WBZ wells M-71/ M-164/ M-163, and Middle WBZ wells M-162/ M-162D
  - East end: Shallow WBZ wells M-74/ M-133/ M-132, and Middle WBZ well M-165

The barrier wall was installed to an approximate depth of 60 feet bgs. Data at these five well clusters indicate that perchlorate concentrations above 1 mg/L generally extend below the depth of the barrier wall to approximate depths between 80-90 feet bgs (to the base of the Shallow WBZ). One exception is at the center well cluster on the north side of the barrier wall, where perchlorate is below 1 mg/L in well M-163 screened from 80 to 90 feet bgs but is detected at higher concentrations in the adjacent deeper Middle WBZ well M-162 screened from 100-110 feet bgs. It is not clear whether the source of perchlorate in the deeper well is via lateral migration in a deeper sandy silt lens that may extend below the barrier wall.

The other 20-25 monitoring wells in this area of the Site on both sides of the IWF/barrier wall are screened across the water table and do not provide information on COPC concentrations and vertical extent in the UMCf. Deeper wells are needed in the area upgradient of the IWF to evaluate contaminant mass in the UMCf, the potential for back diffusion into shallow groundwater, and if significant mass is present at depths greater than 60 feet, the potential for lateral flow beneath the barrier wall in sandy silt layers that may be present in the UMCf.

In the area downgradient of the barrier wall in the vicinity of the former injection trenches, additional data are needed to delineate the lateral and vertical extent of perchlorate and other COPCs in the UMCf in order to evaluate the potential for back diffusion into shallow groundwater and currently uncontrolled COPC migration toward and past the downgradient Site boundary. Several of the shallow monitoring wells, notably M-83, have exhibited increasing perchlorate concentration trends since the shutdown of the former injection trenches in 2010.

The vertical extent of COPC impacts in the low permeability UMCf will be investigated using a combination of deep soil borings followed by well installations. The planned deep soil borings will be drilled to an approximate depth of 90 feet bgs and soil samples will be collected for chemical analysis at 10 feet intervals to provide perchlorate and other COPC data to support vertical delineation and mass estimates. The soil concentrations will be used to calculate a groundwater concentration based on the mass in the soil sample and the water content. Because of its very high solubility, the perchlorate mass measured in a soil sample should be about the same as the mass measured in a groundwater sample collected from the same depth. For other COPCs such as chromium and VOCs, dissolved mass would be calculated from the total mass estimated from the soil data using partitioning assumptions. To support this calculation, selected soil samples will be tested for fraction organic carbon (foc), porosity, and bulk density to provide site-specific soil properties that will be used to improve the partitioning assumptions and resulting mass estimates. The planned investigation is discussed in the following sections.

Area Downgradient (North) of the Barrier Wall and Former Injection Trenches

In the area downgradient of the barrier wall and the former injection trenches to the Site boundary, characterization of perchlorate and other COPCs in soil (both in the alluvium and the UMCf) and in groundwater is needed to assess whether additional soluble COPC mass (particularly perchlorate) could be removed between the IWF and the downgradient Site boundary. This area potentially poses a long-term source for off-site groundwater contamination and as such, requires additional characterization. The lateral and vertical extent of perchlorate and other COPCs in the UMCf will be investigated by installing a combination of deep soil borings and additional monitoring wells to supplement the existing wells in this part of the Site. The planned soil boring and monitoring well locations are shown on Figure 7-1b. Well construction details are presented in Table 7-1 along with the analytical parameters for the initial well sampling. The planned laboratory analysis is based on the results of the Phase 1 RI Data Gap Investigation and is designed to improve NERT's understanding of groundwater quality. The proposed investigative activities are:

- 19 deep soil borings (RIDB-8 through RIDB-26) will be drilled and sampled to a total depth of 90 feet bgs. Soil samples will be collected for chemical analysis from ground surface (0-0.5 feet), 5 feet, 10 feet, and then at intervals of 10 feet to the total boring depth. The soil samples will be analyzed for the soil COPCs listed in Table 7-2.
- Three (3) deep soil borings (RIDB-27, RIDB-28, and RIDB-29) will be installed to determine the vertical extent of COPCs at the northeast property boundary. The borings will be drilled to a total depth of 90 feet bgs and soil samples will be collected for chemical analysis from ground surface (0-0.5 feet), 5 feet, 10 feet, and then at intervals of 10 feet to the total boring depth. The soil samples will be analyzed for the soil COPCs listed in Table 7-2.
- A total of 5 new wells will be installed along a transect north of the former injection trenches. Since the alluvium is expected to be dewatered in this area, the three new shallow monitoring wells (M-215, M-216, and M-219) will extend into the UMCf and straddle the contact with the alluvium. At well location M-216, two deeper wells will also be installed to form a vertical well cluster. Well M-217 will be screened from 60-70 feet in the deeper portion of the Shallow WBZ, and well M-218 will be screened from 100-110 feet bgs in the Middle WBZ.
- Four deeper wells will be installed adjacent to existing shallow monitoring wells M-72, M-81, M-82, and M-140. New wells M-72D, M-81D, M-83D, and M-140D will be screened from 60-70 feet bgs to provide additional data at depth below the barrier wall.

- Well M-220 will be installed near the eastern Site boundary close to the TIMET extraction wells and barrier wall, where mounding in shallow groundwater has been observed during recent monitoring events. Well M-220 will be screened from 60-70 feet bgs in the deeper portion of the Shallow WBZ to help evaluate the combined effects of the NERT and TIMET extraction systems on groundwater flow in this area.

Area Upgradient (South) of the IWF/Barrier Wall

Six deeper wells will be installed adjacent to existing shallow monitoring wells to better delineate the vertical extent of perchlorate and other COPCs in the area upgradient of the IWF/Barrier Wall.

- Three deeper wells will be installed adjacent to existing shallow monitoring wells M-22, M-36, and M-66. New wells M-22D and M-36D will be screened from 55-65 feet bgs, an interval where a sandy silt lens may be present based on the boring log for nearby well M-150. Well M-66D will be screened from 60-70 feet bgs. The new wells will provide additional data to evaluate the extent of perchlorate and other COPCs in the UMCf at depths below the barrier wall on the upgradient side.
- Three deeper wells (M-65D, M-221, and M-222) will be installed adjacent to M-65 to evaluate the vertical extent of perchlorate and whether it is present in groundwater at this depth on the upgradient (south) side of the barrier wall. Existing shallow well M-65 is located on the south side of the barrier wall across from Middle WBZ well M-162 on the north side. Perchlorate has been detected in well M-162, which is screened from 100-110 ft bgs. To provide a vertical profile, well MW-65D will be screened from 60-70 feet bgs and well M-221 will be screened from 80-90 feet bgs in the deeper portion of the Shallow WBZ. Well M-222 will be screened from 100-110 feet bgs in the Middle WBZ.

The planned well locations are shown on Figure 7-1b, and well construction details are presented in Table 7-1 along with the analytical parameters for the initial well sampling.

7.1.3 Area West of the GW-11 Pond

The alluvium is unsaturated in the area west of the GW-11 Pond. Soil samples have been collected from the vadose zone and soil beneath a former small on-site disposal area that was excavated as part of the 2010-2011 soil remediation activities. However, the presence of COPCs in groundwater in the saturated UMCf has not been investigated. The presence and extent of perchlorate and other COPCs in the UMCf will be investigated by installing seven deep soil borings. In addition, one monitoring well will be installed to supplement the existing wells in this part of the Site. The locations of the planned soil borings and monitoring well are shown on Figure 7-1a. The proposed Phase 2 activities are:

- Seven (7) deep soil borings (RIDB-1 through RIDB-7) will be drilled and sampled to a total depth of 90 feet bgs. Soil samples will be collected for chemical analysis from ground surface (0-0.5 feet), 5 feet, 10 feet, and then at intervals of 10 feet to the total boring depth. The soil samples will be tested for the soil COPCs listed in Table 7-2.

- One new shallow monitoring well (M-203) will be installed in this area. Since the alluvium is expected to be dewatered, monitoring well M-203 be completed in the UMCf with a screened interval of 30-50 feet bgs. The planned well construction details are presented in Table 7-1 along with the analytical parameters for the initial well sampling.

7.1.4 Central Area of the Site

Additional VOC delineation is needed in the central area of the Site within the Middle WBZ. The particular area of interest is located between Montrose wells MC-MW-12 and MC-MW-18 (where DNAPL has been identified below the western part of the NERT Site) and NERT well M-186 (located at the eastern site boundary). As described in Section 5.2.4, chloroform, which is the most soluble of the DNAPL constituents, has been detected in several Site wells. Recent chloroform concentrations range from 43,000 µg/L (in a sample from well MC-MW-18 within the DNAPL plume on the west side of the Site) to 540 µg/L (in a sample from well M-186 located across the Site near the eastern Site boundary). The DNAPL and dissolved VOC impacted zone in the Middle WBZ occurs within the 90-120 feet depth interval. The elevated VOCs have been detected within a thin silty sand unit and in the fine-grained silt beneath the silty sand.

The presence and extent of dissolved VOCs in the Middle WBZ will be investigated at 28 investigation locations. Deep soil borings will be drilled and sampled at each location. Based on the initial soil screening and sampling results, monitoring wells will be installed at approximately nine of the investigation locations. The proposed investigation activities are:

- 28 deep soil borings (RI-1 through R-28) will be drilled at the RI investigation locations shown on Figure 7-2. The borings will be drilled to an approximate depth of 130 feet bgs. The soil core retrieved from the borings will be monitored using FID and PID meters at approximate 2 feet intervals to provide a screening level indication of the presence of VOCs. Soil samples for chemical analysis will be collected 10 feet intervals. The soil samples will be tested for VOCs, perchlorate, chlorate, and total chromium as outlined in Table 7-2.
- Two of the planned investigation borings (RI-27 and RI-28) will be located in the basement area of former Unit 1 and Unit 2, assuming a ramp can be constructed to provide access for drilling equipment to descend into the former building basements.

Based on the investigation boring results, approximately nine monitoring wells will be installed to monitor the Middle WBZ in the central area of the Site. At some locations, shallow WBZ wells may also be installed to form well clusters. Preliminary well cluster locations are shown on Figure 7-2.

Four additional Shallow WBZ wells screened in the UMCf are planned in the central area of the Site.

- A deeper well will be installed adjacent to shallow well M-21, which is currently dry. Well M-21D will be screened from 40-55 feet bgs.

- A deeper well will be installed adjacent to shallow well M-125. Well M-125D will be screened from 65-75 feet bgs, the depth interval where elevated PID/FID readings were measured in the soil core from Montrose boring RB-15.
- Well M-201 will be installed adjacent to Montrose Middle WBZ well MC-MW-39. Well M-201 will be screened from 62-72 feet bgs, a depth interval where elevated PID/FID readings were measured in the soil core from the well MC-MW-39 pilot boring.
- Well M-202 will be located downgradient of Montrose boring RB-40, where elevated PID/FID readings were measured in the soil core from depths between 35 and 65 feet. Well M-202 will be screened within this depth interval from 40-55 feet bgs.

The well locations are shown on Figure 7-2, and the well construction details and the initial sampling parameters are presented in Table 7-1.

Additional groundwater characterization is also necessary in the vicinity of the Leach Plant due to the presence of chloroform and perchlorate in the Middle WBZ. Well M-186 is located downgradient of the Unit buildings near the eastern site boundary. This well is screened from 100-115 feet bgs in an interval that contains thin silty sand layers. Both chloroform and perchlorate have been detected in this well. The results of the ongoing Unit Buildings 4 and 5 investigation will provide additional data to evaluate the presence of COPCs in the Middle WBZ beneath the Unit Buildings. As part of the RI Phase 2, six new Middle WBZ wells (M-194 through M-199) will be installed between the Unit Buildings and well M-186 to better characterize the presence of the silty sand unit and the potential presence and extent COPCs. A seventh Middle WBZ well (M-200) will installed adjacent to existing shallow well M-147, which is located downgradient of well M-186. The well locations are shown on Figure 7-2, and the well construction details and the initial sampling parameters are presented in Table 7-1.

7.1.5 Site-Wide Focused Sampling for Less Frequently Detected COPCs

Dioxins and Furans

Selected shallow wells will sampled for dioxins and furans to confirm that these chemicals, which are present in soil above leaching criteria, have not impacted groundwater quality at the Site. A total of 15 new and existing shallow wells have been identified for sampling based on their proximity to, or location downgradient of, soil borings with relatively high concentrations of dioxins and furans. The proposed sampling program is:

- Ten existing wells will be sampled (M-11, M-12A, M-13, MW-16, M-22A, M-25, M-37, M-75, M-79, and M-135).
- Five of the proposed wells will be sampled (M-21D, M-203, M-204, M-211, and M-216).

Total Cyanide

Well M-55 will be resampled for total cyanide to confirm the absence of this constituent (the Phase 1 RI results were qualified as R (rejected) due to laboratory QC issues).

7.1.6 Site-Wide Hydraulic Characterization

In order to provide additional hydraulic characterization of the UMCf, slug testing will be conducted in all the new Phase 2 monitoring wells. The slug testing and data analyses will be conducted following procedures described in the SAP. This hydraulic data will be incorporated into the groundwater model and support subsurface mass and remediation duration estimates.

7.2 Off-Site NERT RI Study Area

The purpose of the Phase 2 RI in the Off-Site NERT RI Study Area is to further characterize the lateral and vertical extent of COPCs and chloroform in groundwater. Additional shallow monitoring wells will be installed to better define lateral extent in the alluvium. A combination of deep soil borings and additional deeper monitoring wells in areas where perchlorate concentrations are high will be used to better delineate vertical extent of COPCs, particularly perchlorate, in the underlying UMCf. Slug testing will be conducted in new and existing wells to obtain additional hydraulic characterization data. In addition, shallow soil samples will be collected from a topographic low area around the seep sump near the Las Vegas Wash to assess the potential presence of perchlorate in shallow soil.

The planned Phase 2 Investigation locations are shown on Figure 7-3a along with the most recent perchlorate isoconcentration map. A detail of the southern portion of the Off-Site NERT RI Study Area is shown on Figure 7-3b. The same investigation locations are shown relative to the most recent chloroform isoconcentration map on Figure 7-3c. The planned monitoring well construction details and the groundwater analytical testing program for the new wells are presented in Table 7-3a, and the soil analytical testing program is presented in Table 7-3b. The planned scope of work is described below.

7.2.1 Lateral Extent of COPCs in Shallow Groundwater

A total of 17 shallow wells screened in the alluvium will be installed to provide better delineation of the lateral extent of COPCs in shallow groundwater. Sixteen of the wells will be in the area between the NERT Site boundary and Sunset Road, and one well will be located northwest of the AWF. As illustrated on Figure 7-3a, nine wells are positioned to provide better delineation of the western NERT perchlorate plume. The other eight shallow wells will provide data within both the perchlorate plume and the chloroform plume where they are present in the Off-Site RI Study Area (see Figure 7-3c).

7.2.2 Vertical Extent of Perchlorate in the UMCf

The vertical extent of perchlorate and other COPCs in the UMCf will be investigated by installing a combination of deep soil borings and deeper monitoring wells within the Shallow WBZ. The planned deep soil borings (target depth of 90 feet bgs) will have soil samples collected for chemical analysis at 10 feet intervals to provide perchlorate and other COPC data to support vertical delineation and mass estimates. The soil concentrations will be used to calculate a groundwater concentration based on the mass in the soil sample and the water content. Because of its very high solubility, perchlorate mass measured in a soil sample should be approximately the same as the mass measured in a groundwater sample collected from the same depth. For other COPCs such as chromium and VOCs, dissolved mass would be calculated from the total mass estimated from the soil data using partitioning assumptions. To support this calculation, selected soil samples will be tested for fraction organic carbon (foc), porosity, and bulk density to provide site-specific soil properties that will be used to improve the partitioning assumptions and resulting mass estimates. The planned investigation includes a total of 14 deep soil borings. Three borings (PCDB-1 through PCDB-3) are located upgradient of the Seep Well Field. Two borings (PCDB-4 and PCDB-5) are located downgradient of the AWF, and two additional borings (PCDB-6 and PCDB-7) are located upgradient of the AWF near Sunset Road. Six borings (PCDB-8 through PCDB-14) are located within the area where relatively high perchlorate concentrations have been detected in shallow groundwater between the Site boundary and well PC-65. The borings will be advanced to an approximate depth of 90 feet bgs, and soil samples for chemical analysis will be collected at 10 feet intervals. These borings will provide data to evaluate the vertical extent of COPCs in the UMCf.

A total of 14 deeper monitoring wells will also be installed in the UMCf to improve NERT's understanding of the vertical extent of COPCs in groundwater:

- Two wells (PC176 and PC-177) will be located between Sunset Road and the AWF.
- Well PC-178 will be located adjacent to shallow well MW-K5 near the junction of two paleochannels between the AWF and the SWF.
- Well PC-179 will be installed adjacent to shallow well PC-64 north of Boulder Highway.
- Ten wells will be installed at six locations in the area between Warm Springs Road and Boulder Highway, where the highest off-site perchlorate concentrations are present in shallow groundwater (see Figure 7-3b). Two well clusters will be installed near existing monitoring wells to vertically delineate VOCs in this area. Wells PC-180, PC-181, and PC-182 will form a new well cluster between existing shallow wells PC-71 and PC-72. The second well cluster will include existing shallow well M-44, three new wells (PC-183, PC-184, and PC-185), and Middle WBZ wells M-152 and M-156. Wells PC-183,PC-184, and PC-185 will be installed in the deeper portion of the Shallow WBZ to assess the vertical extent of COPCs within the depth interval between 35 and95 feet bgs. Deeper well PC-186 will be installed adjacent to existing well M-96, which is currently dry. Well PC-187 will be installed along the paleochannel north of Warm Springs Road, and wells PC-188 and PC-189 will be located north of Warm Springs Road in areas where perchlorate is likely present.

7.2.3 Area Near the Seep Well Field and Las Vegas Wash

In order to determine if groundwater seeping to the surface adjacent to the seep sump has impacted surface soil, NERT proposes to collect soil samples at 10 locations. While this area is close the sample collection activities planned by AECOM, the proposed scope of work is very different and necessary to assess soil conditions in this area. The area surrounding the seep sump is lower in elevation than adjacent areas, as depicted on Figure 7-3a. When the seep is flowing, groundwater containing perchlorate accumulates in this low-lying area prior to percolating back into the ground. To assess whether residual perchlorate is present in shallow soil, soil samples will be collected at approximately 10 locations within this area. Two samples will be collected at each location, one from the ground surface where white salts are observed, and a second from 1.0-1.5 feet if feasible using hand tools (e.g., hand auger, drive sampler). The shallow soil samples will be analyzed for perchlorate. The specific soil sample locations within this area will be chosen based on an initial field reconnaissance prior to sampling.

7.2.4 Off-Site Hydraulic Characterization

In order to provide more complete hydraulic characterization in the areas outside the paleochannels, slug testing will conducted in all the new Phase 2 monitoring wells, as well as in 10 nearby existing Trust owned wells that have not been tested previously. The slug testing and data analyses will be conducted following procedures described in the SAP. This hydraulic data will be incorporated into the groundwater model and support subsurface mass and remediation duration estimates.

7.3 Anticipated Schedule for Investigation and Reporting

The Phase 2 Investigation field work is anticipated to be implemented, following NDEP approval of this work plan, in 4th Quarter 2016 and 1st Quarter 2017. Groundwater sampling will be scheduled to occur shortly before the annual groundwater monitoring sampling event in May 2017 such that a comprehensive groundwater sampling data set (resulting from the annual sampling and Phase 2 activities) can be used in preparation of the RI Report. Based on the current schedule for completion of the Downgradient Study Area investigation, an additional comprehensive round of groundwater sampling completed in May 2018 will also be integrated into the RI Report. Following data collection, Ramboll Environ will complete data validation and reduction activities. The results of the NERT Phase 1 Data Gap Investigation, this Phase 2 Investigation, the AECOM Downgradient Study Area effort, and the Tetra Tech Unit building investigation results will be incorporated into a comprehensive RI report currently slated to be submitted to NDEP in late 2018. If additional data gaps are identified following the AECOM Downgradient Study Area effort, or if additional study areas are defined by NDEP, the date may need to be adjusted.

8. REFERENCES

Basic Remediation Company (BRC). 2007. BRC Closure Plan, BMI Common Areas, Clark County Nevada. May.

ENSR Corporation (ENSR), 2005. Conceptual Site Model, Kerr-McGee Facility, Henderson, Nevada. February. NDEP requested response to comments during the next monthly meeting October 22, 2005.

ENSR, 2007a. Phase A Source Area Investigation Results Report, Tronox LLC Facility, Henderson, Nevada. September. NDEP approved November 30, 2007.

ENSR, 2007b. Upgradient Investigation Results, Tronox Facility, Henderson, Nevada. Revised September. NDEP commented March 4, 2008; no revised submittal or response to comments requested.

ENSR, 2008a. Phase B Source Area Investigation Work Plan, Area I (Northern LOUs), Tronox LLC Facility, Henderson, Nevada. April. NDEP conditionally approved May 6, 2008.

ENVIRON International Corporation (ENVIRON), 2011. Phase I Environmental Site Assessment of Tronox LLC, Clark County, Nevada. January.

ENVIRON, 2012. Interim Soil Removal Action Completion Report, Nevada Environmental Response Trust Site, Henderson, Nevada, August 2010 – November 2011. January. Revised September 28. NDEP approved December 17, 2012.

ENVIRON, 2013a. Inventory of Resources, Materials, Activities, and Services for Environmental Footprint Analysis Groundwater Removal Action; NERT Site; Henderson, Nevada. August 8. Under NDEP review.

ENVIRON, 2013b. Soil Gas Investigation Report and Health Risk Assessment for Parcels C, D, F, G, and H, Revision 0, Nevada Environmental Response Trust Site, Henderson, Nevada. July 25. NDEP commented September 30, 2013.

ENVIRON, 2013c. 2013 GWETS Optimization Project Work Plan, Revision 1, Nevada Environmental Response Trust Site; Henderson, Nevada. November 22. NDEP approved December 3, 2013.

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

ENVIRON, 2014b. Annual Remedial Performance Report for Chromium and Perchlorate, Nevada Environmental Response Trust Site; Henderson, Nevada; July 2013 – June 2014. October 31. NDEP approved on December 26, 2014.

ENVIRON, 2015. 2013 GWETS Optimization Project Report. Nevada Environmental Response Trust Site; Henderson, Nevada; April 30.

Errol Montgomery & Associates, 2000. Analysis of Rate of Groundwater Movement Based on Results of Tracer and Hydraulic Tests Conducted Between Pittman Lateral and Seep Area.

Geraghty and Miller, 1993. Phase I Environmental Conditions Assessment for the Basic Management Inc. Industrial Complex, Clark County, Nevada. April 14.

Kerr-McGee Chemical Corporation (KMCC), 1996. KMCC Phase II Written Response to Letter of Understanding. October 2.

KMCC, 1998. Preliminary Report on a Hydrologic Investigation of Channel-Fill Alluvium at the Pittman Lateral, Henderson, Nevada. October 19.

Kleinfelder, Inc., 1993. Environmental Conditions Assessment, Kerr-McGee Chemical Corporation, Henderson, Nevada Facility. April.

Nevada Division of Environmental Protection (NDEP), 1986. Consent Order Between NDEP and Kerr-McGee. September 9.

NDEP, 1994. Phase II Letter of Understanding between NDEP and Kerr-McGee. August 15.

NDEP, 2001. Administrative Order on Consent between NDEP and Kerr-McGee. October 8.

NDEP, 2009a. BMI Plant Sites and Common Areas Project, Henderson, Nevada: Hydrogeologic and Lithologic Nomenclature Unification. January 6.

NDEP, 2009b. Finding of Alleged Violation and Order. December 14.

NDEP, 2012. NDEP Response to: *Interim Soil Removal Action Completion Report, Nevada Environmental Response Trust Site, Henderson, Nevada, August 2010 – November 2011, Dated: September 2012 (Revised) and Response to NDEP Comments.* December 17.

NDEP, 2013a. Nevada Division of Environmental Protection (NDEP) Response to: Hydrogeologic Flow Model, Supporting Documentation, and Response to Comments on the Model for the Nevada Environmental Response Trust Site; Henderson, Nevada; Dated April 25, 2012 and updated February 21, 2013. April 4.

NDEP, 2015a. Requirements for Continued Optimization of GWETS System. January 7.

NDEP, 2015b. User's Guide and Background Technical Document for NDEP Basic Comparison Levels (BCLs) for Human Health for the BMI Complex and Common Areas. December 2008, Revision 13, February 2015.

NDEP, 2015c. Seep Interim Measures Report Approval. April 9.

Nevada Environmental Response Trust (NERT), 2015a. Response to NDEP's letter dated January 7, 2015 "Requirements for Continued Optimization of GWETS System" (the "Letter"). February 27.

NERT, 2015b. Las Vegas Wash Seep Interim Measures Report. April 7. Approved by NDEP on April 9, 2015.

NERT, 2016. Nevada Environmental Response Trust Continuous Optimization Program 2015 Annual Summary Report. January 25.

Northgate Environmental Management, Inc. (Northgate), 2010a. Interim Groundwater Capture Evaluation and Vertical Delineation Report, Tronox LLC, Henderson, Nevada. March 23. NDEP commented on April 30, 2010. Northgate submitted a Response to Comments on May 17, 2010. NDEP approved response to comments on May 20, 2010.

Northgate, 2010b. Final Revised Pre-Confirmation Sampling Work Plan Remediation Zones RZ-A through RZ-E Phase B Investigation, Tronox Facility, Henderson, Nevada. March 25. NDEP approved March 30, 2010.

Northgate, 2010c. Capture Zone Evaluation Report, Henderson, Nevada. December 10. ENVIRON resubmitted the NERT Site groundwater model on February 21, 2013. NDEP approved April 4, 2013.

Northgate, 2010d. Site-Wide Soil Gas Human Health Risk Assessment, Tronox LLC, Henderson, Nevada. November 22. Not reviewed by NDEP.

Ramboll Environ US Corporation (Ramboll Environ), 2015a. Site Management Plan, Revision 2, Nevada Environmental Response Trust Site, Henderson, Nevada. July 17. Approved by NDEP on August 8, 2015.

Ramboll Environ, 2015b. Annual Remedial Performance Report for Chromium and Perchlorate, Nevada Environmental Response Trust Site, Henderson, Nevada. October 30. Approved by NDEP on December 30, 2015.

RCI Engineering, 2010. Technical drainage study for Tronox soil remediation treatment basins. RCI Engineering, Las Vegas, NV. October.

Schumacher, J.C., 1999. History of Establishing a Source of Potassium and Ammonium Perchlorates for Use in Solid Propellant Rockets. 35th AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit, Los Angeles, California. AIAA Paper 99-2926. June.

Tetra Tech, Inc. (Tetra Tech), 2014a. GWETS Enhanced Operational Metrics Proposal, Nevada Environmental Response Trust Site; Henderson, Nevada. August 20.

Tetra Tech, 2014b. Personal Communication from Frank John's on the 2013-2014 Annual Performance Report for Chromium and Perchlorate. October 31.

Tetra Tech, 2015. Groundwater Bioremediation Pilot Test Work Plan, Nevada Environmental Response Trust Site; Henderson, Nevada. January 6.

Tetra Tech. 2015b. November 2014 NDEP GWETS Metrics. January 23.

Tetra Tech. 2015c. June 2015 NDEP GWETS Metrics. July 20.

Tetra Tech. 2015d. Infrastructure Audit and Data Accessibility Report; Nevada Environmental Response Trust; Henderson, Nevada. August 25.

TIMET/BRC. 2007. Background Shallow Soil Summary Report, BMI Complex and Common Areas Vicinity.

United States Environmental Protection Agency (USEPA), 2015. Regional Screening Levels for Chemical Contaminants at Superfund Sites. November.