RCRA Facility Investigation
Northwest Boundary Area

U.S. Army Garrison
Fort Buchanan, Puerto Rico

Prepared for

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ACRONYMS

3D	3-Dimensional
95UCLM	95th percentile Upper Confidence Level on the Mean
ADI	Average Daily Intake
AES	Atomic Emission Spectroscopy
ATSDR	Agency for Toxic Substances and Disease Registry
bgs	Below Ground Surface
cm	centimeter
CMS	Corrective Measures Study
COC	Constituent of Concern
COPC	Constituent of Potential Concern
CPR	Caribbean Petroleum Refinery
DCA	Dichloroethane
DNAPL	Dense Non-Aqueous Phase Liquid
DO	Dissolved Oxygen
DoD	Department of Defense
DPW	Directorate of Public Works
DQI	Data Quality Indicator
EA	EA Engineering, Science, and Technology, Inc.
EDD	Electronic Data Deliverable
EDS	Environmental Data Services, Inc.
EPC	Exposure Point Concentration
ERA	Ecological Risk Assessment
ERT	Earth Resources Technology
°F	Degrees Fahrenheit
FOD	Frequency of Detection
FORSCOM	U.S. Army Forces Command
ft	Foot/Feet
g	gram
GCMS	Gas Chromatography Mass Spectrometry
GIABS	Gastrointestinal Dermal Absorption Factor
GPR	Ground-Penetrating Radar
HEAST	Health Effects Assessment Summary Tables
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient

Acronyms, continued

IA	Installation Assessment
IAP	Installation Action Plan
ICAP	Inductively Coupled Argon Plasma
ID	Inner Diameter
IDM	Investigative Derived Material
IUR	Inhalation Unit Risk
K	hydraulic conductivity
kg	kilogram
km	kilometers
L	liter(s)
LADI	Lifetime Average Daily Intake
LCS	Laboratory Control Spike
LCSD	Laboratory Control Spike Duplicate
LOAEL	Lowest Observed Adverse Effect Level
LUC	Land Use Control
MCL	Maximum Contaminant Level
MDL	Method Detection Limit
MF	Modifying Factor
mg	milligram
MRL	Minimal Risk Level
mS	milliseimen
MS	Matrix Spike or Mass Spectrometry
MSD	Matrix Spike Duplicate
MW	Monitoring Well
NAPL	Non-Aqueous Phase Liquid
NCEA	National Center for Environmental Assessment
NOAEL	No Observed Adverse Effect Level
OD	Outside Diameter
OEHHA	Office of Environmental Health Hazard Assessment
ORP	Oxidation Reduction Potential
OSWER	Office of Solid Waste and Emergency Response
PAH	Polychlorinated Aromatic Hydrocarbon
PARCCS	Precision, Accuracy, Representativeness, Completeness, Comparability, and Sensitivity
PCB	Polychlorinated Biphenyl
PCE	Tetrachloroethene
PID	Photoionization Detector
PPE	Personal Protective Equipment

Acronyms, continued

ppm	Parts per million
PPRTV	Provisional Peer Reviewed Toxicity Value
PRASA	Puerto Rico Aqueduct and Sewage Authority
PREQB	Puerto Rico Environmental Quality Board
PRQL	Project Required Quantitation Limit
PVC	Polyvinyl Chloride
PX	Post Exchange
QAPP	Quality Assurance Project Plan
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RfC	Reference Concentration
RfD	Reference Dose
RFI	RCRA Facility Investigation
RL	Reporting Limit
ROTC	Reserve Officer Training Corps
RPD	Relative Percent Difference
RSL	Regional Screening Level
SDG	Sample Delivery Group
SF	Slope Factor
SIM	Selected Ion Monitoring
SLRA	Screening-Level Risk Assessment
SOP	Standard Operating Procedure
SQL	Structured Query Language
SSL	Soil Screening Level
SVOC	Semivolatile Organic Compound
SWMU	Solid Waste Management Unit
TAL	Target Analyte List
TCA	Trichloroethane
TCE	Trichloroethene
TOC	Total Organic Carbon
TPH-DRO	Total Petroleum Hydrocarbons-Diesel Range Organics
TPH-GRO	Total Petroleum Hydrocarbons-Gasoline Range Organics
UF	Uncertainty Factor
ug	microgram(s)
U.S.	United States
USACE	U.S. Army Corps of Engineers
USAEC	U.S. Army Environmental Command
USAERDC	U.S. Army Engineer Research and Development Center

Acronyms, continued

USARSO	U.S. Army South
USATHAMA	U.S. Army Toxic and Hazardous Material Agency
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
VOC	Volatile Organic Compound
WES	Waterways Experiment Station

EXECUTIVE SUMMARY

The investigation of the groundwater in the Northwest Boundary Area was initiated in response to concerns expressed by the United States Environmental Protection Agency (USEPA) over trichloroethene (TCE) detected in groundwater samples collected as part of a Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) completed for the adjacent Caribbean Petroleum Refinery (CPR) property (the CPR property was purchased and is currently operated by Puma Chemical). In addition to characterizing potential chemical contamination in the groundwater, this RFI included an investigation of potential source areas for the groundwater contamination.

RFI activities were conducted in seven phases, and additional data were generated from selected monitoring wells as part of a well integrity investigation. Activities conducted throughout the course of the RFI included

- Installation of monitoring wells,
- Collection of subsurface soil, groundwater, sediment pore water, and surface water samples for chemical analysis,
- Completion of a geophysical survey in a suspected source area, and
- Investigation of anomalies identified during the geophysical survey.

The potential for contamination from metals, pesticides, herbicides, polychlorinated biphenyls (PCBs), semivolatile organic compounds (SVOCs), and volatile organic compounds (VOCs) was evaluated. The data indicate that some elevated concentrations of metals, SVOCs, and one pesticide are present in the groundwater; however, the data are not indicative of overall groundwater contamination from these compounds. Groundwater contamination from some VOCs was identified. The primary contaminants of concern are tetrachloroethene (PCE) and TCE, and to a lesser extent 1,2-dichloroethene (DCE) and vinyl chloride. The horizontal extent of elevated concentrations of PCE, 1,2-DCE, and vinyl chloride is generally limited to Fort Buchanan; notable concentrations of these compounds were not detected in off-post wells. The horizontal extent of TCE is more widespread and extends northward of the Installation boundary. The northern extent of the TCE plume remains uncertain due to the impossibility of sampling groundwater north of the existing off-post wells. Wells MW-25, MW-26, and MW-15 (located in close proximity to each other) consistently had the highest concentrations of these PCE, TCE, and 1,2-DCE. A geophysical investigation was conducted in this area, and soil samples were collected from geophysical anomalies to assess the presence of a source of the groundwater contamination. No elevated soil VOC concentrations were reported during the investigation.

Groundwater contaminated with chlorinated VOCs can lead to contamination of other media such as surface water or air. Both of these potential transport pathways were evaluated. A quantitative evaluation of sediment pore water and surface water downgradient of the plume showed no impacts from chlorinated VOCs. A comparison of groundwater concentrations to screening levels for the groundwater to air pathway indicated that there is a potential for impacts to air. When the vapor intrusion pathway was evaluated in the human health risk assessment (HHRA), potential concerns for commercial workers who inhale indoor air due to vapor intrusion were identified. TCE is the primary contributor to hazards in indoor air.

The HHRA determined there are no potential concerns for human contact to soil and surface water potentially affected by activities within the Northwest Boundary Area. There are potential concerns for the commercial worker and off-post resident exposure to groundwater. For the commercial worker, there are potential concerns for inhalation of indoor air from vapor intrusion. As noted above, there are currently no buildings within the Northwest Boundary Area that are occupied on a regular basis. However, any buildings constructed within the Northwest Boundary Area should take into account potential vapor intrusion of VOCs from groundwater to the indoor spaces. There are potential risk concerns for off-post resident exposure to groundwater as a tap water source. The primary contributor to groundwater concerns is TCE.

1 INTRODUCTION

1.1 PURPOSE AND OBJECTIVES

The purpose of this RFI of the groundwater in the Northwest Boundary Area of Fort Buchanan is to document the activities performed in order to characterize the groundwater within this area. Investigations of the groundwater in the Northwest Boundary Area were initiated in response to concerns expressed by the USEPA over TCE detected in groundwater samples collected as part of a RFI completed for the adjacent CPR. In addition to characterizing potential chemical contamination in the groundwater, this RFI included an investigation of potential source areas for the TCE contamination.

There were four main objectives of the RFI:

1. Characterize the nature and extent of groundwater contamination within the Northwest Boundary Area and determine whether the contamination was originating from Fort Buchanan or from an area outside the installation.
2. Determine whether or not contaminated groundwater is impacting other media (e.g. surface water or air) and if so, characterize the nature and extent of those impacts.
3. Prepare a baseline risk assessment that evaluates the potential for impacts to human health from a potential contaminant source and from the contaminated groundwater.
4. Collect and evaluate natural attenuation data to assess geochemical conditions and to support remedial alternative selection and screening in a Corrective Measures Study (CMS) Work Plan and Report.

It should be noted that the scope of this RFI includes the groundwater of the Northwest Boundary Area and surface media in so far as they relate to 1) a potential source of contaminants and 2) potential migration of contaminated groundwater to the surface (e.g. discharge to the surface). Other media and other areas of Fort Buchanan are addressed in the Site Wide RFI, which is being prepared separately and was released as Draft Final in June 2010. The objectives of the Site Wide RFI include characterization of potential contaminants in surface/subsurface soil, surface water, sediment, and groundwater (that is not within the Northwest Boundary Area), and preparation of baseline risk assessments to assist in determining the future disposition of the sites. Many of the 14 sites involved in the Site Wide RFI are located adjacent to the old Directorate of Public Works (DPW) complex and are above the groundwater of the Northwest Boundary Area (Figure 1-1). Therefore it is important to distinguish between the different scopes and objectives of the two documents.

1.2 INVESTIGATION AND REPORT ORGANIZATION

The RFI consisted of seven phases. Phases I, II, III, and IV involved the installation of monitoring wells in the confined aquifer of the Northwest Boundary Area of Fort Buchanan. Phase V was a geophysical investigation of a suspected source area. Phase VI involved soil sampling and test pitting in the suspected source area, the installation of two monitoring wells in the suspected source area, and the installation of off-post wells to determine the downgradient extent of the identified TCE contamination. Phase VII entailed sediment pore water and surface water sampling at a downgradient lagoon-like water body north of Fort Buchanan to assist in further defining the extent of contamination and the potential for exposure of receptors to contamination. In addition to these seven phases, groundwater samples were collected from selected monitoring wells as part of a well integrity investigation that was completed after an explosion occurred at the adjacent CPR property.

The methodologies and findings of each phase are described in this document, which has been organized into the following Sections:

- *Section 1.0* presents the purpose and objectives of the investigation, outlines the report organization, and discusses the site and project background.
- *Section 2.0* provides information on the physical characteristics of the study area such as surface features, meteorology, geology, hydrogeology, etc.
- *Section 3.0* describes the specific methodology employed for each of the investigative activities of the RFI. This section also documents the various tasks accomplished under different phases of the investigation.
- *Section 4.0* discusses data quality and usability.
- *Section 5.0* discusses the nature and extent of contamination detected in various media such as groundwater, surface water, surface sediment, etc.
- *Section 6.0* presents a discussion on the fate and transport of the contaminants identified in Section 5.0.
- *Section 7.0* presents a Baseline Risk Assessment based on the data collected and the evaluations presented in the previous sections.
- *Section 8.0* includes a summary of the investigation findings and conclusions drawn from the findings.
- *Section 9.0* includes a list of all references used in preparing the RFI report.

1.3 SITE AND PROJECT BACKGROUND

1.3.1 INSTALLATION HISTORY

Camp Buchanan was established in 1923, originally located on a 300-acre tract of land approximately six miles south of San Juan Bay (Figure 1-2). From 1926 to 1930 Camp Buchanan was used as a maneuver training area and range by the regular Army, by National Guard troops, and as a Citizen Military Training Camp. In 1940 it was designated Fort

Buchanan and expanded to 1,514 acres, later expanding to 4,500 acres just after the end of World War II.

During World War II, Fort Buchanan housed a depot supplying the Army Antilles Department. It also processed local troops through its replacement center. The industrial complex included pier facilities, ammunition storage areas, and an extensive railroad network connecting it to the bay. After World War II, the Installation was gradually reduced in size to its present 746 acres. Until closure as an Army Installation in 1966, it remained a Command Depot with post facilities, a personnel center, and a special training center. With the deactivation of the Antilles Command in 1966, Fort Buchanan came under United States (U.S.) Navy control. A detachment of Army personnel remained as a residual element designated as U.S. Army Command Group and placed under command of the U.S. Army Forces Southern Command in Panama. This element consisted of a small command group and support detachment, Rodriguez U.S. Army Hospital (inactivated in 1971), and advisory groups for the U.S. Army Reserve, the National Guard, and the Reserve Officer Training Corps (ROTC). While not related to the command, an Armed Forces Examining and Entrance Station and Intelligence Corps Detachment (inactivated in 1971) also received support from the command.

In 1971, Fort Buchanan returned to U.S. Army control under the Third Army. It continued to support the Army Reserve, including support of seven Army Reserve Centers throughout Puerto Rico, serving as host to a number of tenant activities Navy, Coast Guard, Air Force Reserve components, and several non-military federal agencies.

In 1973, during reorganization, the installation was re-designated as U.S. Army Garrison, Fort Buchanan, under direct control of the U.S. Army Forces Command (FORSCOM). Fort Buchanan became a U.S. Army South (USARSO) installation in June 1997, and USARSO headquarters moved to the installation in 1999. In October 2003, Fort Buchanan was transferred from an active military installation under USARSO to a reserve installation under the U.S. Army Reserve Command.

Today, Fort Buchanan continues to support the reserve- and active-component soldiers in Puerto Rico and the U.S. Virgin Islands. Its principal mission is the mobilization, readiness and actual deployment of approximately 15,000 reserve-component soldiers in Puerto Rico and the U.S. Virgin Islands. The installation also provides support to Department of Defense (DoD) operations in the Caribbean area.

1.3.2 SITE DESCRIPTION

Fort Buchanan is located approximately 10 kilometers (km) southwest of the city of San Juan, Puerto Rico (Figure 1-2). The installation is bordered by PR-No.165 to the east, PR-No. 2 to the south, PR-No. 28 to the immediate northwest (with CPR beyond), and De Diego Expressway (PR-No. 28) to the north (Figure 1-3). The installation occupies approximately 746 acres within two municipalities, Bayamon and Guaynabo. Physiographically, Fort Buchanan is located on the northern coastal plain of Puerto Rico, which is about 8 km wide and slopes gently upward to a central mountain chain, the Cordillera Central.

1.3.3 SITE HISTORY/PREVIOUS INVESTIGATIONS

In 2004, chlorinated solvents, primarily TCE, were detected at concentrations up to 154 micrograms per liter (ug/L) in groundwater monitoring well samples collected within the CPR property, which is adjacent to Fort Buchanan. The U.S. Army Fort Buchanan was notified by the USEPA Region 2 that while conducting the required RFI investigation, CPR had detected TCE in the lower aquifer. As stated in USEPA's letter dated February 11, 2005, groundwater samples exceeded the Maximum Contaminant Level (MCL) for TCE. The letter further indicated that the area of detected TCE concentrations included the eastern portion of the CPR facility, extended beyond the CPR facility boundary, and may extend beyond the southwestern boundary of Fort Buchanan. The letter concluded that the source of the TCE concentrations in groundwater had not been determined and there was insufficient data to thoroughly evaluate the current site condition. For these reasons, potential source areas on the Fort Buchanan property needed to be assessed, and a determination of the extent of contamination needed to be made. Thus, this RFI was initiated.

1.3.3.1 Solid Waste Management Unit 3 Historical Investigations

During the Installation Assessment (IA) conducted in 1982 at Fort Buchanan, a suspected hazardous materials disposal site was identified (McMaster 1984). This site is now identified as Solid Waste Management Unit (SWMU) 3 and is located along the western boundary of Fort Buchanan, south of the CPR facility (Figure 1-3). This disposal site was believed to be a trench 6 feet (ft) deep, 30 ft wide, and 100 ft long that was reportedly used to dispose of one ton of dry pesticides in 1977, construction debris, and trees. The pesticides were suspected to be chlordane, DDE, and heptachlor. The trench was suspected to be along the perimeter road on the northwest corner of Fort Buchanan. Because of the location of SWMU 3 with respect to the CPR facility and the locations where TCE was detected, it was considered a potential source area for the TCE contamination. Therefore historic investigations relating to SWMU 3 were reviewed as part of this RFI. These investigations are summarized in the following paragraphs.

In 1980, the Puerto Rico Aqueduct and Sewage Authority (PRASA) installed a potable water supply main across the installation near SWMU 3. The main is 66 inches in diameter, buried 10 ft below ground surface (bgs), and supported by packed gravel underlayment. In 1983 the U.S. Army Toxic and Hazardous Material Agency (USATHAMA) sampled soil from 17 shallow borings and one deep boring. No firm evidence for the burial of pesticides was found during either of these activities. Subsequently, geophysical surveys using ground conductivity (quadrature, in-phase) and magnetic (total magnetic field, magnetic gradient) techniques were conducted. A copy of the 1984 USATHAMA report is included in Appendix A and Figure 1-4 shows the area included in the investigation.

In 1990, the Puerto Rico Environmental Quality Board (PREQB) completed a RCRA Facility Assessment (RFA) of Fort Buchanan. On the basis of this RFA, the USEPA determined there was potential for risk at SWMU 3. Consequently, in 1992-93, the U.S. Army Corps of Engineers (USACE) Waterways Experiment Station (WES) collected fifty-two soil samples from eight test pits (Figure 1-4, Llopis 1992 and Llopis 1993). No evidence of large-scale pesticide disposal or a burial trench was found. Low concentrations of DDT (to a maximum 3.28 micrograms per gram [ug/g]) were found in composite samples from a depth of 4 ft on the northern end of one of the test pits. In July 1995 the USEPA indicated their acceptance of the findings presented in the 1993 WES report, including the recommendation of no further action at the site, via a letter to the Deputy Installation Commander. A copy of the 1993 WES report and the USEPA acceptance letter are included in Appendix A. In response to the RFA, and in support of the Army Base Realignment and Closure Program, an Environmental Baseline Survey Report was published in 1997 (Woodward-Clyde 1997). This document is also included in Appendix A.

No new information was found to verify the correct depth or location of the suspected trench.

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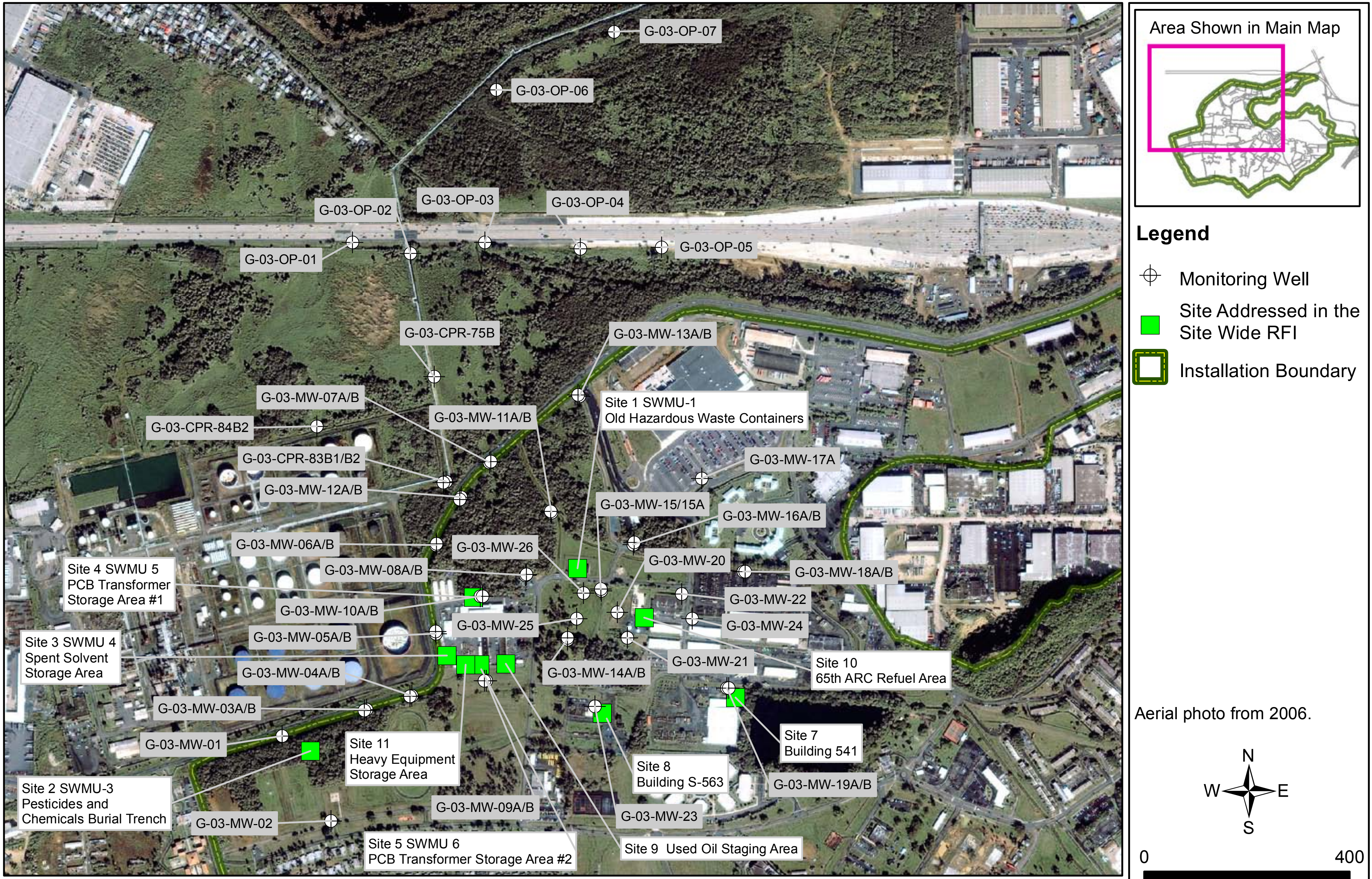

Locations of Northwest Boundary Area Monitoring Wells and Sites Being Addressed in the Fort Buchanan Site Wide RFI

Figure 1-1

Fort Buchanan, Puerto Rico

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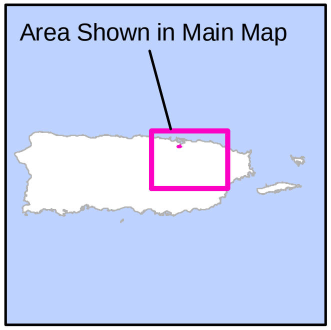

Installation Data

🟪 Fort Buchanan

Base map was obtained from MapQuest

0 2 4 8

Kilometers

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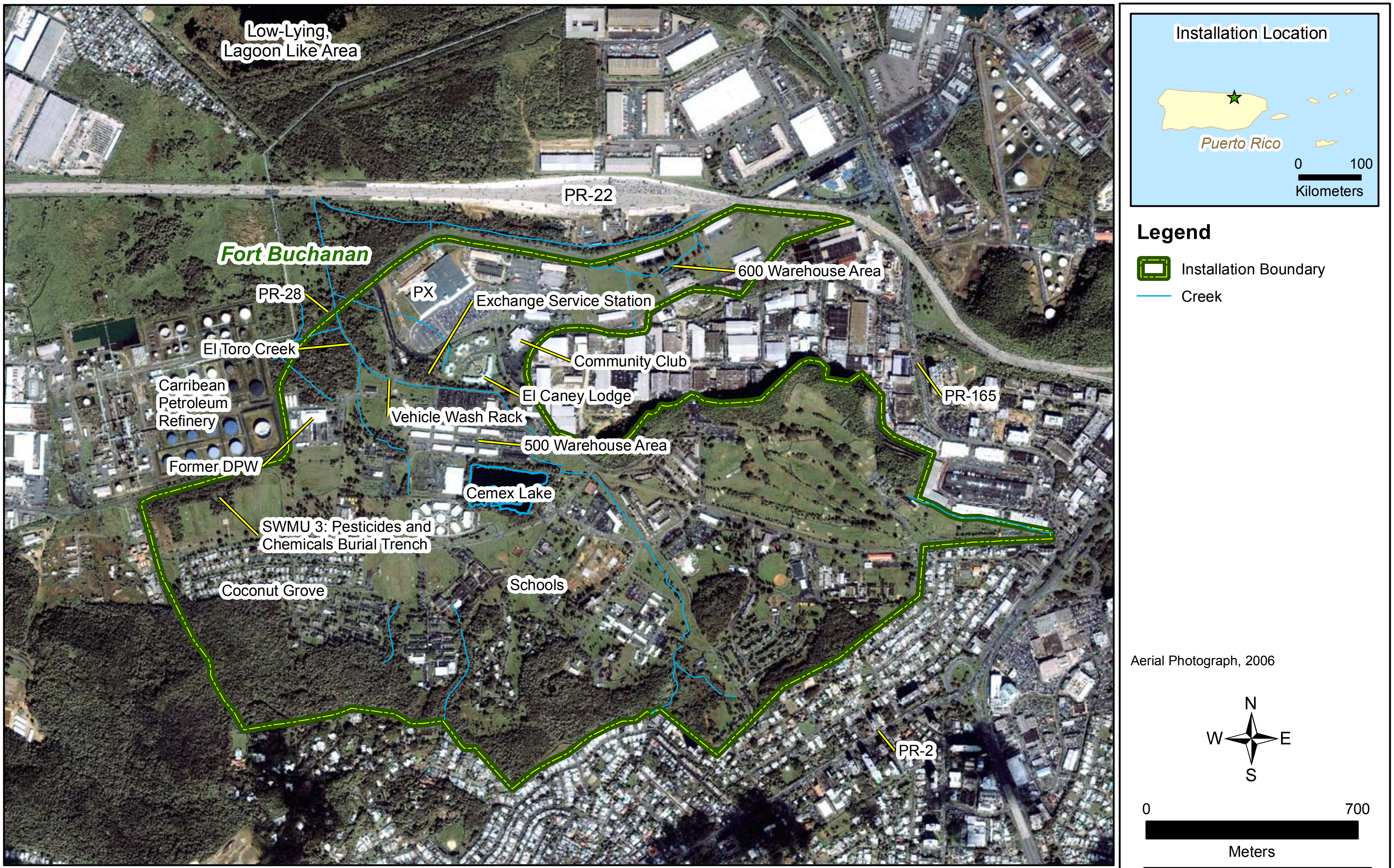
Fort Buchanan, Puerto Rico
Location map

Figure 1-2

Fort Buchanan, Puerto Rico

\\Edgewoodfp\projects\Universal GIS\Buchanan\MXDs\Figure 1-1 Location Map_new.mxd



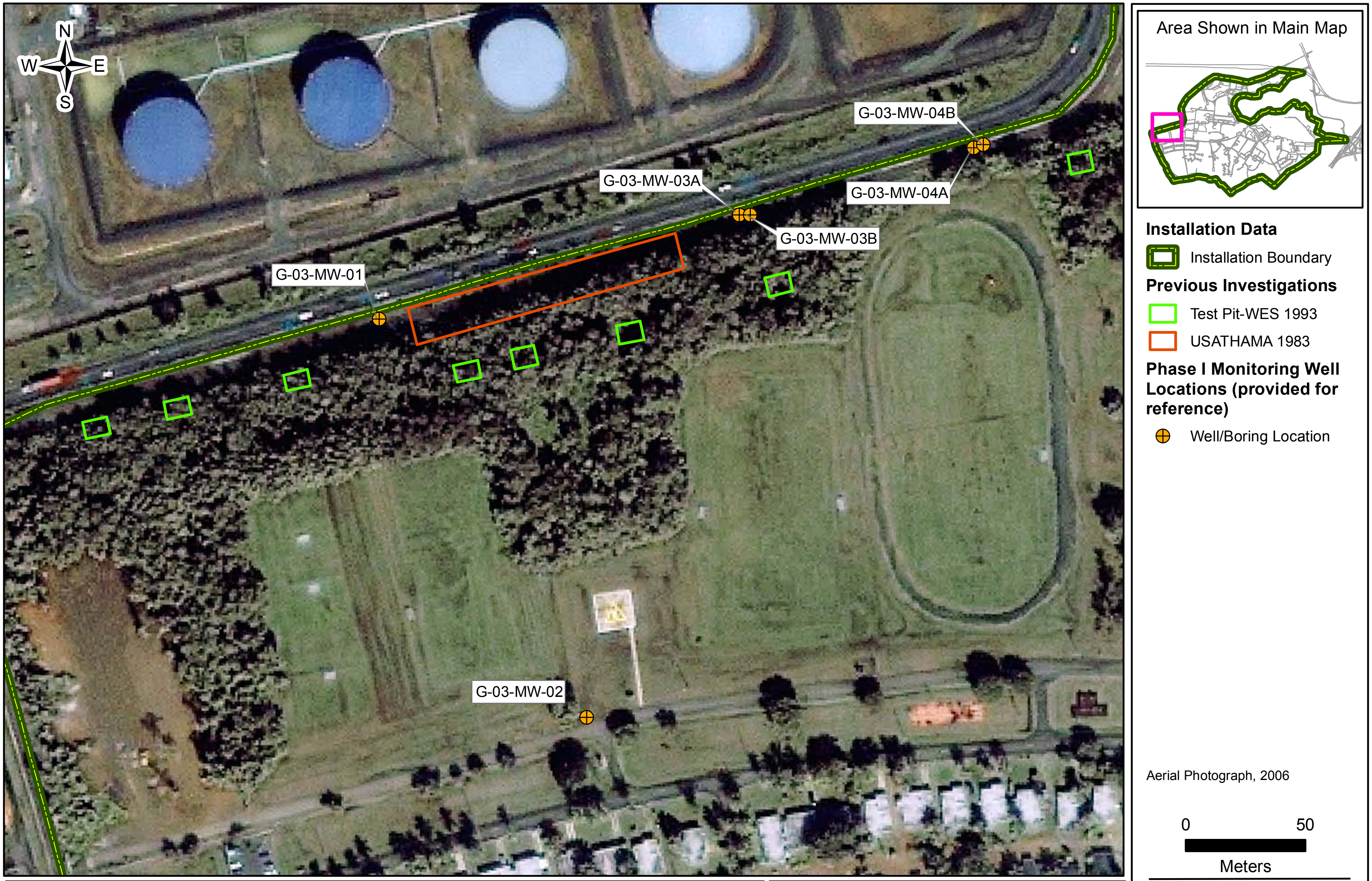
Fort Buchanan Site Features

Figure 1-3

Fort Buchanan, Puerto Rico

EA Engineering, Science, and Technology

\\Edgewood\Projects\Universal GIS\Buchanan\MXDs\Figure 1-2 TCE RFI_Site Features.mxd



Previous Investigations at SWMU 3

Figure 1-4

Fort Buchanan, Puerto Rico

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\\Edgewood\Projects\Universal GIS\Buchanan\MXDs\Figure 1-3 Site2-SWMU3.mxd

2 PHYSICAL SETTING AND SITE GEOLOGY/HYDROGEOLOGY

2.1 PHYSICAL SETTING

Fort Buchanan is located in the North Coast physiographic province. The province's land use is characterized mostly by agriculture, largely as pasture and small family owned farms mixed with some industrial and residential uses. Farmland occupies much of the high, rolling plain in the northern third and western part of the province. Forests occupy most of the karst uplands, which are relatively inaccessible, particularly in the area adjacent to the Rio Guajataca, and in the southwestern North Coast area. Wetlands are not extensive in the western portion of the province; however, large coastal wetlands are common on the coastal plain between Camuy and Manati.

Most residential areas, such as San Juan, are near the coast. While urban areas have expanded in recent years, they still occupy a small percentage of the land in the west and coastal portions of the province. Industrial development is not extensive in the western part of the province. It occurs mainly in association with military installations and urban areas, and as such characterizes the immediate vicinity of Fort Buchanan. Industrial areas are primarily concentrated in the urban areas along PR-No. 2, such as between Bayamon to Carolina. Residential, commercial, and industrial development will probably continue along the more level coastal areas throughout the North Coast province, especially near Guaynabo and Bayamon. The current and likely future land use of Fort Buchanan is a mixture of industrial, residential, and recreational. There are also child care and primary through secondary schooling facilities in the vicinity of and within Fort Buchanan.

2.2 CLIMATE

Fort Buchanan has a tropical marine climate. It is somewhat modified by the Cordillera Central mountain range, which lies approximately 20 miles south of the San Juan metropolitan area. Air circulation from the higher altitudes results in breezes that bring nighttime temperatures somewhat lower than those in daytime, especially during the winter. Temperatures are moderate and consistent, with few very hot days or very cold nights. Average maximum temperatures range from 74 degrees Fahrenheit (^{o}F) to 86^{o} F. Rainfall averages 59 inches to 75 inches annually and is seasonally distributed with a July to October maximum and January to April minimum. Wind patterns vary considerably, although winds generally come from the east and northeast during the day and the southeast at night.

Puerto Rico is in an area subject to hurricane activity. In the last 37 years, five significant hurricanes have caused more than $2 billion in damages and 100 deaths on the island. Most recently, Hurricane Hugo (September 1989) and Hurricane Georges (October 1998) passed over the island. Wind speeds during Hurricane Georges were recorded at 115 miles per hour.

2.3 SOILS

A soil survey was conducted to classify, categorize, describe, and map all soils by map unit. The survey was done in compliance with National Cooperative Soil Survey standards and procedures (USDA 2005).

Five soil series were delineated on Fort Buchanan (Almirante clay, Soller clay loam, Tanama clay, Vega Alta clay loam, and Vega Baja silty clay). These five series were further refined into their respective phases for a final delineation of seven soil types. The distribution of the soil types are presented on Figure 2-1 and are summarized in Table 2-1.

2.3.1 ALMIRANTE CLAY

The Almirante soils (2–12 percent slope) are deep, well-drained soils located on the rolling coastal plains between the limestone hills, derived from fine textured sediments (mostly clays). These soils are typically brown with variegated reds and gray and contain plinthite (a mixture of iron and aluminum oxides, clay, and sometimes quartz that changes irreversibly to "ironstone" upon exposure to repeated wetting and drying). Almirante soils are moderately limited for urban development by their clayey nature and shrink-swell potential.

2.3.2 SOLLER CLAY LOAM

The Soller soils (20–40 percent slope) are shallow (16–30 inches on Fort Buchanan), well-drained soils located on the hilltops and side slopes of the limestone hills. They are formed in fine textured residuum derived from the underlying limestone. Included in the mapping of the Soller soils are units of Colinas clay loam, as well as areas where erosion has left fragments of the underlying limestone bedrock exposed. Moderate to severe erosion is the primary limitation for possible development of Soller and Colinas soils.

2.3.3 TANAMA CLAY

The Tanama soils (20–60 percent slope) are shallow (4–16 inches on Fort Buchanan), well-drained soils formed in material weathered from underlying limestone occupying side slopes and hilltops of limestone hills. Controlling erosion of Tanama soils is of greatest concern relative to any development or management activities. Even minimal disturbance on these sensitive sites can have severe environmental implications.

2.3.4 VEGA ALTA CLAY LOAM

The Vega Alta soils (2–12 percent slope) are very deep, well-drained soils formed in iron-rich clays of the coastal plains. On Fort Buchanan, these soils occupy the coastal plain terrace adjacent to the nearly level drainage basin that bisects the installation. These soils, although somewhat lower in clay content than the Almirante soils, are still moderately limited for development by shrink-swell potential in addition to increased erosion hazard on slopes that are left unvegetated.

2.3.5 VEGA BAJA SILTY CLAY

The Vega Baja soils (0–2 percent slope), are very deep, and somewhat poorly drained soils on upper floodplain terraces in coastal plains. These soils have developed in the nearly level drainage basin of the installation in stratified loamy and clayey alluvial sediments. Vega Baja soils are moderately limited for development of soils.

2.3.6 SITE SPECIFIC LITHOLOGY

From October 2006 through February 2009, soils were logged and categorized prior to the installation of monitoring wells. In addition, two deep borings (B-3 and B-7) were installed prior to the wells to assess site lithology. Generally, the wells were installed in gently rolling to relatively flat terrain. While not uniform across the site, approximately 20 to 40 ft of clay overburden were logged prior to contact with the uppermost carbonate sand aquifer (the zones in which the well screens were constructed). The overburden tended to thicken as the investigation moved northward and the off-post wells were installed. Alternately, in the areas of MW-1 and MW-2, the material overlying the carbonate sands were thinner. These clays were highly mottled, ranging from soft to stiff, and fairly impervious to infiltration of rainwater.

Underlying the clays and silts were varying degrees and ranges of a carbonate sand unit comprised of fine to large gravel and coarse sands, mostly yellow to pale brown in color. Beneath the water table, these zones were mostly saturated. In many of the well borings, two distinct carbonate zones were found separated by approximately two to 20 ft of fine material. However, during installation of the northernmost wells (OP-1 through -7) one carbonate sand layer was observed. Underlying the carbonate layer was often a greenish gray silt material.

The underlying competent rock formations were not penetrated during either the Northwest Boundary Area RFI or the Site Wide RFI. The boreholes were terminated upon encountering a stiff clay or silt beneath the lower carbonate zone. Boring logs and well diagrams are provided in Appendix B and C, respectively.

2.4 GEOLOGY/HYDROGEOLOGY

2.4.1 REGIONAL GEOLOGY

Puerto Rico, the easternmost island of the Greater Antilles, is a volcanic island-arc terrane in which the geologic record spans about 150 million years. The island consists of volcaniclastic and epiclastic rocks of volcanic origin as well as other sedimentary rocks of Late Jurassic to Paleocene and Eocene age and intrusive mafic and felsic plutonic rocks of Late Cretaceous and early Tertiary age. These rocks are overlain unconformably by Oligocene and younger sedimentary rocks and sediments (Monroe 1973). Puerto Rico is bounded on the north by the Puerto Rico Trench, on the south by the Muertos Trough, on the east by the Anegada Passage and on the west by the Mona Canyon. The island is located in a seismically active region.

2.4.2 REGIONAL HYDROGEOLOGY

The North Coast limestone aquifer system underlies Fort Buchanan and 700 square miles that extend eastward from Rincón, in western Puerto Rico, to Loíza, in northeastern Puerto Rico. The aquifer system consists of a highly karstified carbonate platform sequence of middle Tertiary age and is drained by eight major rivers, including the Río de Bayamón. The North Coast limestone aquifer system consists of three hydrogeologic units: an upper aquifer, consisting of Aymamón limestone, an intervening confining unit of Aguada limestone, and a lower aquifer of Mucarbones Sand. The system is underlain by Pre-Mid-Oligocene bedrock.

The Aguada and Aymamon Limestones, along with the upper portions of the Cibao Formation, form a prolific water-table aquifer, which extends in a narrow band along the coast. The upper member of the Cibao Formation constitutes the confining unit for the aquifer. The aquifer's extent is limited by the saltwater interface on the coastal side, landward thinning, and eventual absence of the limestones. At Fort Buchanan, these limestones have been mostly removed by erosion, existing only as isolated mogotes. Mogotes are comprised of eroded sedimentary limestone, and appear mostly as rounded hills within karstic environments.

The lower portion of the Cibao Formation constitutes another aquifer that is under confined conditions in much of the San Juan area. Transmissivity values of 1,000 square feet per day and a storage coefficient of 1.3×10^{-4} are typical for this aquifer (Fort Buchanan 2005).

2.4.3 SITE SPECIFIC GEOLOGY

The surface geology of Fort Buchanan is described in two U.S. Geologic Survey (USGS) Quadrangle Maps: the Geologic Map of the Bayamon Quadrangle, Puerto Rico (1973); and the Geology of the San Juan Quadrangle, Puerto Rico (1977). The coastal plain, wherein Fort Buchanan lies, consists of sand, silt, and clay deposits overlying older formations of Tertiary age. Figure 2-2 shows the surface geology in and around the Fort Buchanan area, taken from the geologic maps described above. Figure 2-3 is a topographical map showing contour lines on Fort Buchanan.

Unconsolidated deposits of Quaternary Age alluvium consisting primarily of sands, silts, and clays characterize the northern two-thirds of the surface geology of Fort Buchanan and most of the relatively flat central valley installation areas (varying thickness up to 25 meters). A range of tertiary age limestone outcrops, known as Montes de Caneja, occurs along the northern boundary of Fort Buchanan, and a second ridge, which is part of the same formation, forms the southern boundary. Quaternary Age landslide deposits are also located along the southern ridge of the installation.

Cross sections detailing the area lithology are shown in Figures 2-4 through 2-9. These sections were created by the U.S. Army Engineer Research and Development Center (USAERDC) using boring logs from the current investigation, as well as logs from the adjacent CPR facility well installations. Monitoring wells are shown on the figures as reference points. The cross sections were produced as an output from a groundwater model developed for the site by the USAERDC (discussed further in Section 6.4 and Appendix D). Figure 2-4 represents an overview of the cross sections, with A-A’ oriented south to north, and B-B’, C-C’, D-D’, and E-E’ oriented west to east.

Figure 2-5 shows the cross section E-E’ located near the southern edge of the Northwest Boundary Area. The line runs from near the center of the storage tank field at the CPR facility, cuts a center line through the DPW complex, skirts the southern edge of the TCE plume, and terminates near the installation boundary to the east. This area lies in relative close proximity to the recharge area for the carbonate sands. As shown in the figure, the carbonate sand layers from the younger terrace material (CS 1 and CS 2) tend to thin as the southern edge of the plume area is approached. CS 1-OT, CS 2-OT, and CS 3-OT represent carbonate sand units in the older terrace. These materials supply the recharge for the younger terrace carbonate sands (CS 1 and CS 2, shown in yellow and blue respectively), which contain the TCE plume.

Figure 2-6 represents the cross section D-D’, which again is displayed west to east. The line runs from just north of the CPR tank field and terminates under the Commissary/Post Exchange (PX). As shown, the carbonate sand zones of the younger terrace represent the main subsurface aquifers. There are two carbonate sand zones, separated by a thin layer of silt. Towards the western edge, it appears that the two carbonate sand zones intersect, indicating some mixture of the two zones. The overburden is thicker here than it was in the southernmost cross section (E-E’). An area of channel fill is shown on the eastern side of the section. This fill was comprised of a fine to medium grained reddish sand, but did not influence the carbonate sand material in question.

Figure 2-7 summarizes the cross sectional lithology represented by C-C’, west to east. The C-C’ line essentially represents data from the boring logs associated with monitoring wells OP-1 through OP-5. As seen in the figure, the two carbonate zones overlap, with only very thin traces of a silty layer in between to the east and west. Here, the overburden is thicker than it is to the south, as the carbonate sands tend to dip slightly to the north. The figure clearly shows the communication between the carbonate sand zones, which essentially now represent one continuous aquifer.

Figure 2-8 shows the line from B-B’ near the northern edge of the TCE plume. Like C-C’, the overburden here is thick (40-50 ft) and there is little, if any, confining layers between the carbonate sand zones. The carbonate sands here are comprised of coarser sands and gravels than the southern cross sections.

Finally, Figure 2-9 shows A-A’ running the length of the area of investigation from north to south. This figure clearly shows the older terrace carbonate zones to the south (CS 1-OT, CS 2-OT, and CS 3-OT) and the younger terrace carbonate sands to the north (CS 1 and CS 2). The old terrace carbonate zones are unaffected by tides, where the younger terrace zones show tidal effects. Transducer data showing these tidal effects in groundwater are included in Appendix E.

2.4.4 SITE SPECIFIC HYDROGEOLOGY

Fort Buchanan lies in the recharge zone for the North Coast limestone aquifer system (Cibao Formation), since both the Mucarabones Sand and Cibao Formation outcrop on the installation. Groundwater flow is toward the coast on a regional scale; however, local perturbations exist due to the irregular topography and variable lithology of the sediments.

At Fort Buchanan, the Aguada Limestone has been mostly removed by erosion, existing only as mogotes. The lower portion of the Cibao Formation constitutes a deeper aquifer, which is under confined conditions in much of the San Juan area. Regional groundwater flow is from the southwest to the northeast; however, local variations in the direction of groundwater flow exist due to irregular topography. Carbonate sand aquifers underlying the clay overburden were the focus of this investigation. Geologic cross sections, presented in Figures 2-4 through 2-9, allow for an understanding of the lithology encountered. The USAERDC used boring logs from the current investigation, as well as logs from the adjacent CPR facility well installations, to model the stratigraphic nature of the subsurface throughout the study area. This was completed as a part of a groundwater model, which is discussed further in Section 6.4 and Appendix D. Through their work, it was observed that the study area consists of old terrace materials and young terrace materials. Essentially, it is a two-aquifer system that is connected, with the older terrace being the source for the recharge of the younger terrace. The older terrace occupies the southern end of the study area in the uplands, while the younger terrace represents the northern lowlands. Both aquifers are in the carbonate sands. Overburden covers all of the area, with low permeability; thereby preventing, or limiting, infiltration in the study area. The upland area to the south provides recharge to the study area. The overburden thins out in the southern uplands, and the aquifer surfaces there to recharge.

The older terrace material consists of alternating sand and silt, and lies below the younger terrace material in the area where the highest TCE concentrations were found. Based on the results of transducer data, it was determined that the older terrace material has a strong, immediate response to rain events, and is not affected by tides. The younger terrace forms the northern half of the study area. It communicates with the older terrace, but not excessively. It is also an alternating sand/silt one-to-two aquifer system. Based on the results of transducer data, it was determined that wells within the younger terrace have a lesser response to rainfall, and are affected by tides.

As presented in the cross sections, the older and younger terrace materials were subdivided into subunits, CS 1-OT, CS 2-OT, CS 3-OT (old terrace) and CS 1 and CS 2 (young terrace). A clear explanation of the subdivision process is not provided in the model documentation (Appendix D). The aquifer material is relatively uniform and there are no significant lithologic differences between the subunits. Therefore it is expected that depth was a primary factor in subunit classification.

For purposes of delineation, MW-17 and -18 are in the older terrace, while MW-13 was installed in the younger terrace material. MW-15, -25, and -26 are situated in the communication zone between the older terrace and the younger terrace. The source of water in the younger terrace is predominantly the older terrace; little, if any, direct infiltration occurs from the surface down.

2.5 SURFACE HYDROLOGY AND DRAINAGE

Puerto Rico is divided into two distinct hydrologic regions (watersheds) based on differences in the distribution of rainfall, particularly between the northern and southern regions that are separated by the Cordillera Central Mountains. Most of the perennial streams flow from the interior of the island to the north coast hydrologic region, due to the predominance of rainfall on the north-facing mountain slopes. Fort Buchanan is located in the North Coast hydrologic area of the island.

El Toro Creek, known as Quebrada Santa Catalina outside of Fort Buchanan, carries most of Fort Buchanan's drainage discharges through lined and unlined ditch systems or pipe and inlet systems. There are multiple branches of El Toro Creek that drain different areas of Fort Buchanan, but the main branch extends from the southern installation boundary and exits the installation on the northern side. El Toro Creek and its branches receive all runoff from the maintenance shop areas, the vehicle wash racks, and the exchange service station (Figure 1-3). To the north, and outside of the installation boundary, El Toro Creek joins the Malaria Control Canal, which runs southwest to north and discharges into the Bay of San Juan. It should be noted that Quebrada Santa Catalina originates in the town of Tintillo (south of Fort Buchanan); Tintillo discharges municipal storm water to the creek upstream of Fort Buchanan.

The northeast portion of Fort Buchanan, the 600 Warehouse Area, and the off-installation industrial area immediately south of the 600 Warehouse Area (Figure 1-3), drain via ditches to the north to San Juan Bay.

The manmade CEMEX Lake receives minor discharges from the natural and man-made storm water systems serving the installation. Additionally, it is probable that the lake is recharged in part from the southern highlands, and any groundwater aquifers that surface there and run downgradient to the lake. The lake was pumped for water used in the production of cement in the past, but it is no longer used for that purpose.

North of Fort Buchanan and downgradient of the groundwater plume being investigated is a low-lying area with surface water (Figure 1-3). This area is not well described on maps or other documentation, but is described as "swamp deposits" in the USGS Bayamon Geologic Quadrangle (1973). Aerial photographs suggest that the size of the area covered by water is highly variable. The potential for impacts from surfacing groundwater at this area was investigated as part of this RFI.

2.6 BIOTA

The following information was obtained from the Final Integrated Natural Resource Management Plan for Fort Buchanan (Fort Buchanan 2010).

Vegetation on Fort Buchanan consists of both ornamental plantings in the developed portions of the installation and semi-native forest located along the installation's south and northeast perimeters. The areas of forested vegetation consist of tropical semi-evergreen forest (170.6 acres) and seasonal swamp forest (1 acre). Of these forested areas, 36.72 acres (21.4 %) are classified as high disturbance, 111.20 acres (64.8 %) as moderate disturbance, and 23.68 (13.8 %) as low disturbance.

Tree species prevalent in the developed areas, primarily occurring along roads and adjacent to buildings, include the African tulip tree (*Spathodea campanulata*), queen-of-flowers (*Lagerstroemia speciosa*), flamboyant-tree (*Delonix regia*), coconut (*Cocos nucifera*), silk cotton tree (*Ceiba pentandra*), and mango (*Mangifera indica*). Because of development over much of the installation, Puerto Rico's native wildlife species are not well represented. The majority of wildlife inhabiting the installation occurs within the southern forested areas.

Mammals observed or documented to occur on Fort Buchanan are the house mouse (*Mus musculus*), black rat (*Rattus rattus alexandrinus*), Indian mongoose (*Herpestes auropunctatus*), and bats (unknown spp.). Feral dogs (*Canis familiaris*) and cats (*Felis domesticus*) also occur on the installation. Bats are the only native mammals on the island of Puerto Rico.

Various species of birds have been identified at Fort Buchanan, including the Puerto Rican lizard cuckoo (*Saurotheca vieilloti*), red-legged thrush (*Turdus plumbeus),* bananaquit (*Coereba flaveola*), stripe-headed tanager (*Spindalis zena*), black-faced grassquit (*Tiaris bicolor*), Puerto Rican bullfinch (*Loxigilla portoricensis*), zenaida dove (*Zenaida aurita*), Adelaide's warbler (*Dendroica adelaidae*), Puerto Rican woodpecker (*Melanerpes portoricensis*), loggerhead kingbird (*Tyrannus caudifasciatus*), and red-tailed hawk (*Buteo jamaicensis).*

At least eight species of reptiles and four amphibian species are known to occur on Fort Buchanan. Reptiles include the common Puerto Rican anole (*Anolis cristatellus*), pasture anole (*Anolis pulchellus*), saddled anole (*Anolis stratulus*), siguana or Puerto Rican giant ameiva (Ameiva exsul), common salamanquita (*Sphaerodactylus macrolepis*), salamanca (*Hemidactylus mabouia*), Puerto Rican boa (*Epicrates inornatus*), Puerto Rican slider turtle (*Trachemys stejnegeri*), and Puerto Rican racer snake (Alsophis portoricensis). Turtles (unknown species, probably *Trachemys stejnegeri*) inhabit the CEMEX Lake. Amphibian species include the marine toad (*Bufo marinus*), white-lipped frog (*Leptodactylus albilabris*), pasture coquí (*Eleutherodactylus antillensis*), and common coquí (*Eleutherodactylus coqui*).

No fish species have been recorded in the streams at Fort Buchanan, however, CEMEX Lake contains common species such as tilapia (*Tilapia nilotica*), catfish (unknown species), largemouth bass or lobina (*Micropterus salmoides*), and black bass (*Micropterus* sp.).

2.7 IDENTIFICATION OF POTENTIAL RECEPTORS

Residential exposure pathways are considered incomplete in the Northwest Boundary Area of Fort Buchanan because the Installation's Master Plan does not include residential development for the northern portion of the Fort. This is considered a de facto land use control (LUC) preventing residential development, and therefore onsite residents are not potential receptors. The residential exposure scenario is retained as potentially complete for exposure to groundwater, however, because the plume extends beyond the boundary of Fort Buchanan. Available information, discussed below, indicates that the groundwater of the Northwest Boundary Area is not being used as a drinking water source, and the installation of wells is not recommended by the USGS due to the water quality and the potential for saltwater intrusion. However, the potential for potable use cannot be ruled out because there is no legal restriction on the installation of wells in this area.

Based on communications with USGS water resource personnel in April 2009, no groundwater wells for human consumption are known to exist in the vicinity of Fort Buchanan. More recent research on adjacent wells based on USGS documentation and personnel indicate that there are no active wells downgradient of the installation. In 2011, PRASA confirmed that they have no wells within or downgradient of Fort Buchanan. The three closest PRASA wells are over one mile east of the center of the installation and are not in use (either abandoned or structurally compromised). In addition, there is a real potential for saltwater intrusion into groundwater, which is expected to deter the installation of wells downgradient of Fort Buchanan. Further discussion of USGS well documentation and saline intrusion is provided in Section 7. Copies of communications regarding well locations and a figure depicting the saltwater-freshwater interface (Figure F-1) are provided in Appendix F.

There is no evidence of a moratorium on well installation north of Fort Buchanan, and local groundwater may be used for irrigation purposes both on and off the Installation. In addition to potential exposure to groundwater via ingestion or direct contact, volatilization of VOCs from their dissolved phase and adsorbed soil phase could give rise to a soil gas phase that could potentially pose risk to aboveground receptors from inhalation (primarily within enclosed buildings). Based on the available information, exposure of industrial/construction workers and off-post residents to groundwater via ingestion, dermal contact, and vapor intrusion are considered potentially complete exposure pathways.

Soils at two potential source areas were investigated as part of this RFI. These areas are not currently used for residential purposes, and the Fort Buchanan Master Plan does not include residential development in these areas. Therefore residential exposure to soils is not a complete exposure pathway. However, there is a potential for trespassers and workers to be exposed to these soils. Therefore, exposure of trespassers, industrial/construction workers, and commercial workers to soil via ingestion, inhalation, and dermal contact are considered potentially complete exposure pathways.

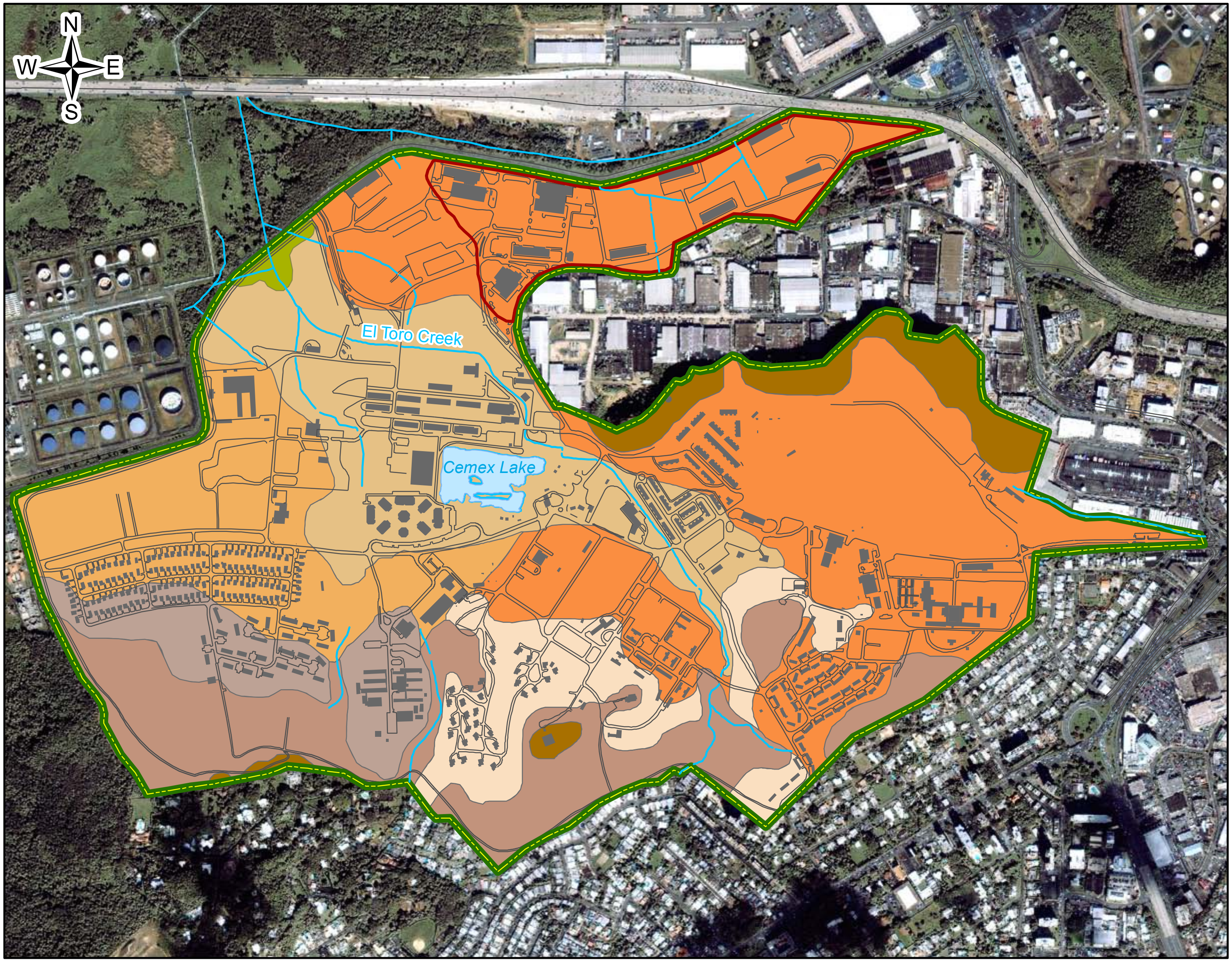
Surface water and sediment pore water were sampled as part of this RFI to examine the potential for impacts to these media where they interface with groundwater. Samples were collected off-site at the lagoon-like area north of Fort Buchanan (Figure 1-3). There is a potential for this area to be used recreationally. Therefore, exposure of off-post residents and recreational users to surface water via ingestion and dermal contact are considered potentially complete exposure pathways.

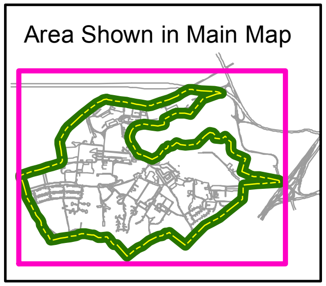
Ecological receptors are not identified for evaluation in this RFI. The primary media of concern addressed in this RFI is groundwater, and exposure pathways are not complete between groundwater and ecological receptors. There is a potentially complete pathway if groundwater is impacting surface water and receptors are then exposed to the impacted surface water. This potential was investigated in Phase VII (Sections 3.2.7 and 5.3), and it was found that surface water was not being impacted by contaminated groundwater. Therefore, there are no complete exposure pathways between ecological receptors and the contaminants in groundwater.

It should be noted that the Site Wide RFI includes an Ecological Risk Assessment (ERA) that evaluates the potential for risks to ecological receptors from exposure to contaminants in surface soil, surface water, and sediment.

Table 2-1
Soils Mapped on Fort Buchanan

Soil Type	Slope	Area (acres)	Percent of Installation
Almirante clay	2-5%	98	13%
Almirante clay	5-12%	45	6%
Soller clay loam	20-40%	103	14%
Tanama clay	20-60%	33	4%
Vega Alta clay loam	2-5%	280	38%
Vega Alta clay loam	5-12%	59	8%
Vega Baja silty clay	0-2%	127	17%





Installation Data

- 🟩 Installation Boundary
- ■ Buildings
- □ 600 Block Warehouse Area
- — Roads

Hydrology

- ● Waterbody
- ~ Surface Waterbody
- ● Wetland

Installation Soils

- ● AmB - Almirante, 2-5%
- ● AmC - Almirante, 5-12%
- ● TaF - Tanama, 20-60%
- ● SoE - Soller, 20-40%
- ● VaB - Vega Alta, 2-5%
- ● VaC - Vega Alta, 5-12%
- ● Vg - Vega Baja, 0-2%

Soil data was collected from the National Cooperative Soil Survey (US Army, 2005).

Aerial Photograph, 2006

0 300

Meters

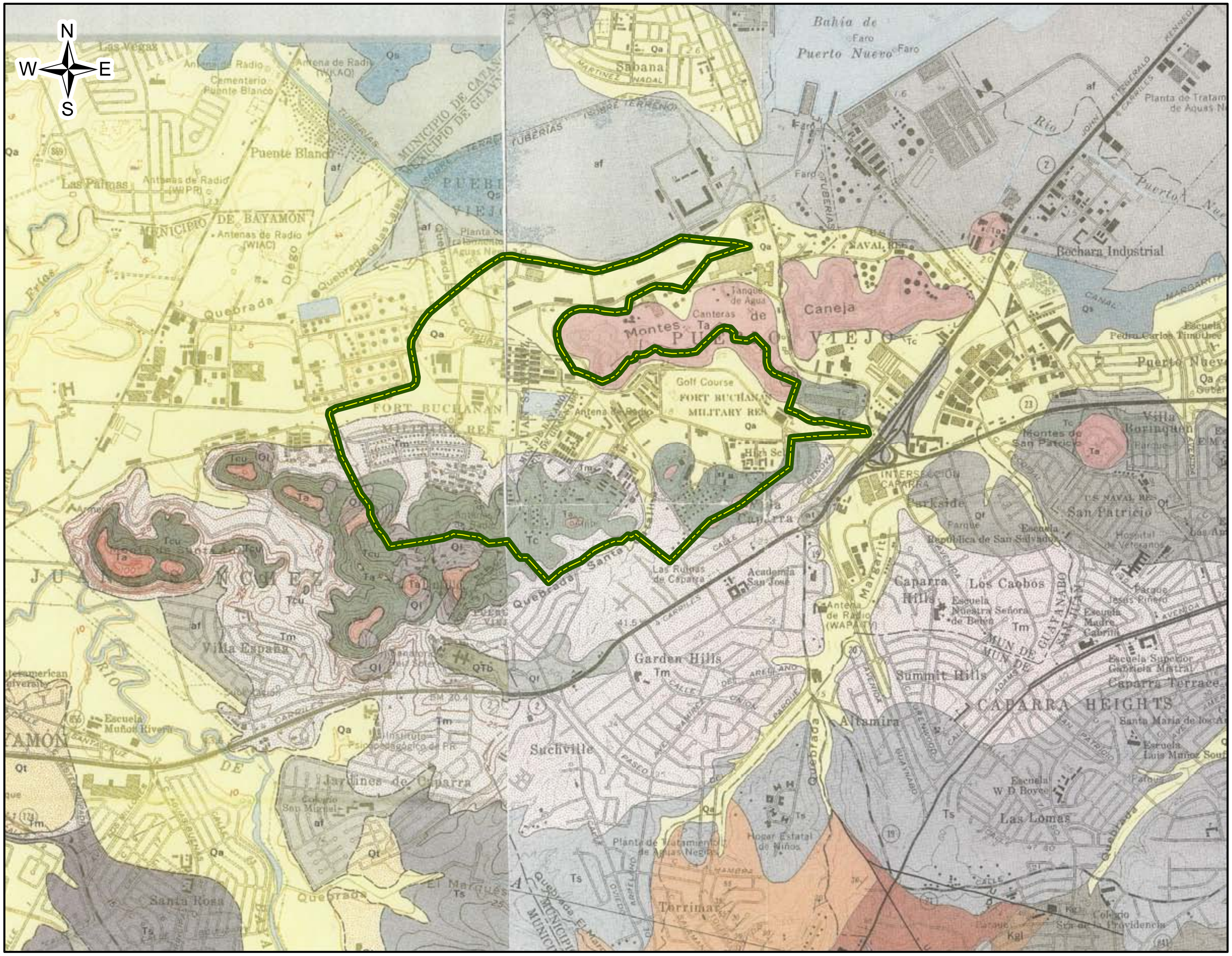
EA Engineering, Science, and Technology

Soils Map of Fort Buchanan

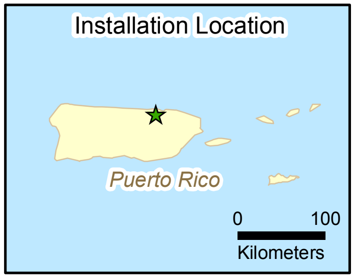
Figure 2-1

Fort Buchanan, Puerto Rico

\\Edgewoodfp\Projects\Universal GIS\Buchanan\MXDs\Figure 2-3 Soil Types.mxd



Installation Location



Installation Data

▭ Installation Boundary

Geology

Holocene

Qa = Alluvium; sand, clay and sandy clay.

Ql = Landslide deposits; masses of soil, calcereous clay, and limestone rubble.

Tertiary

Tm = Mucarabones Sand, crossbedded coarse quartz sand, containing lenses of greenish-gray sandy clay.

Tcu = Cibao formation; upper member. Chalk, soft limestone, and very pale orange sandy clay.

Ta = Aguada Limestone; alternating thick beds of indurated very pale orange to pink fine calcarenite and grayish-orange to very pale orange clayey and chalking limestone.

Sources:
USGS Bayamon Geologic Quadrangle (1973)
and San Juan Geologic Quadrangle (1977).

0 500 Meters

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Geologic Map of Fort Buchanan and Surrounding Area

Figure 2-2

Fort Buchanan, Puerto Rico

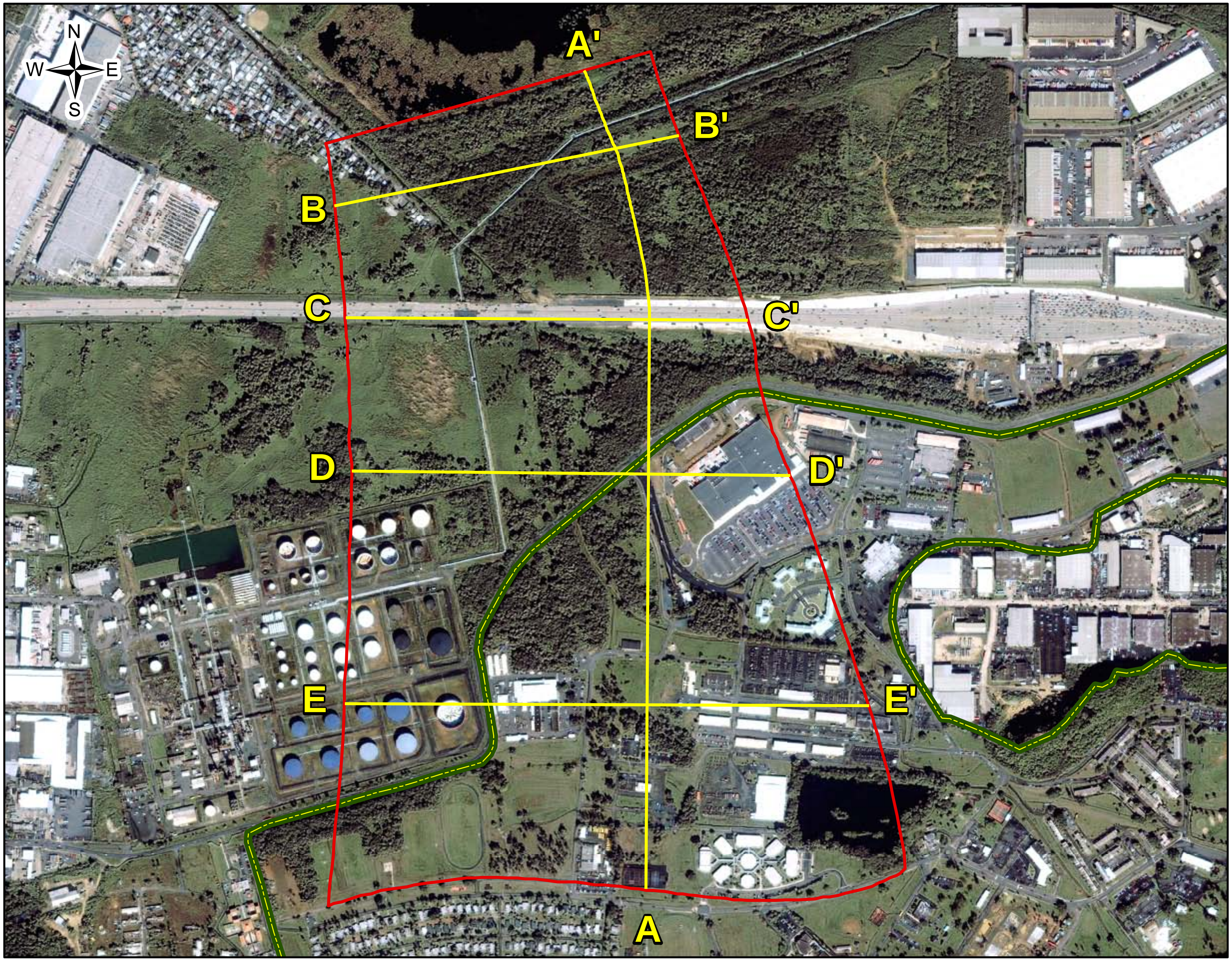
\\Edgewood\Projects\Universal GIS\Buchanan\MXDs\CMS\Figure 2-1 Geologic Map.mxd

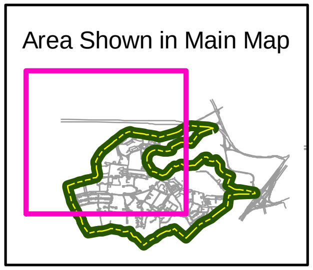
Fort Buchanan, Puerto Rico

Figure 2-3
Topographic Map of Fort Buchanan

EA Engineering, Science, and Technology

\\Edgewood\projects\Universal GIS\Buchanan\MXDs\RFI MXDs\RFI Fig 2-1 topography - 11x17.mxd





Installation Data

🟩 Installation Boundary

Geology

🟥 Geological Survey Area

— Geological Cross Sections

Aerial Photograph, 2006

0 200

Meters

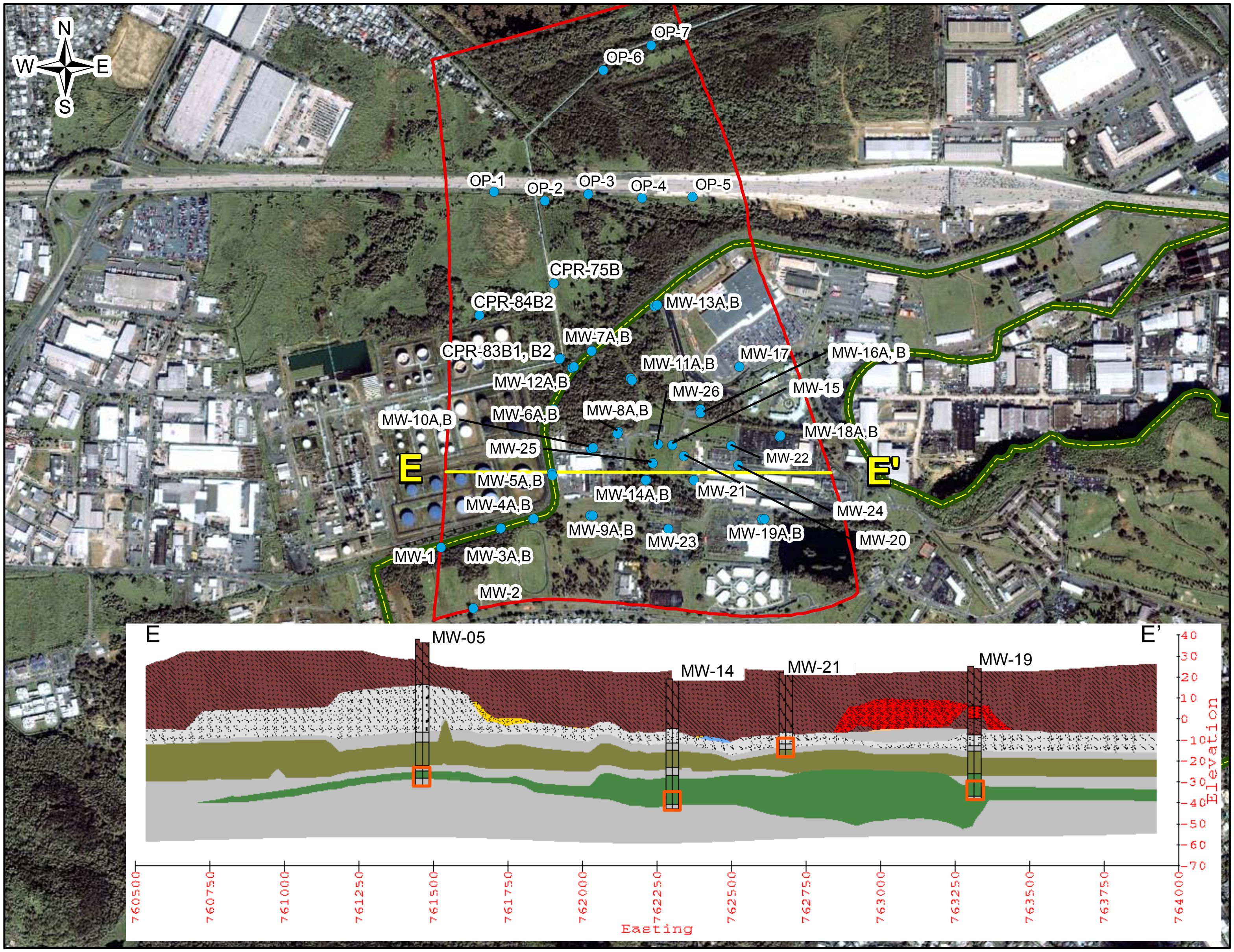
EA Engineering, Science, and Technology

Northwest Boundary Investigation Cross Sectional Overview

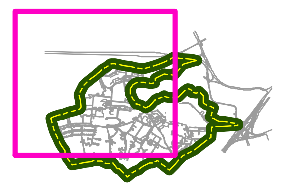
Figure 2-4

Fort Buchanan, Puerto Rico

\\Edgewoodfp\Projects\Universal GIS\Buchanan\MXDs\Figure 2-4 Geologic Cross Sections.mxd



Area Shown in Main Map



Installation Data

▭ Installation Boundary

● Monitoring Well Locations

Geology

▭ Geological Survey Area

— Cross Section E-E'

▭ Screened Interval

▨ Overburden

▨ Channel Fill

▨ CS 1

▨ CS 2

▨ Carbonate Silt

▨ Overburden - OT

▨ Carbonate Silt - OT

▨ CS 1 - OT

▨ CS 2 - OT

▨ CS 3 - OT

Elevations are in feet above mean sea level.

Aerial photograph from 2006

0 300 Meters

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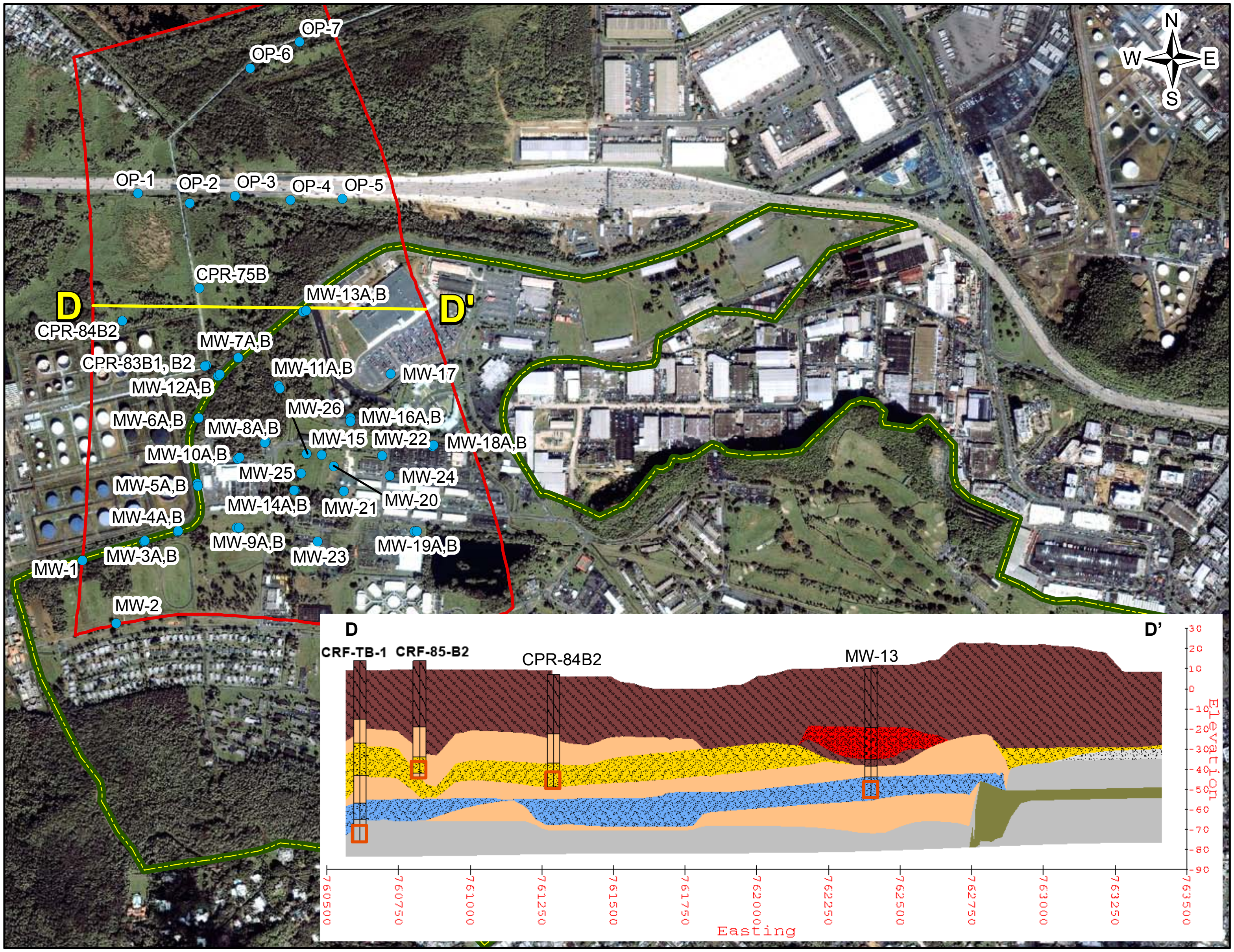
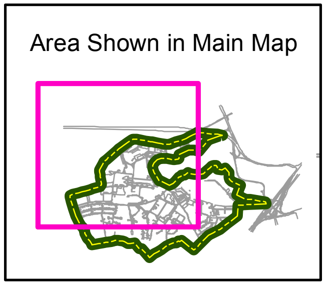
Geologic Cross Section E-E'

Figure 2-5

Fort Buchanan, Puerto Rico

\\Edgewoodfp\Projects\Universal GIS\Buchanan\MXDs\Figure 2-5 Cross Section E-E'.mxd





Installation Data

- ▭ Installation Boundary
- ● Monitoring Well Locations

Geology

- ▭ Geological Survey Area
- ― Cross Section D-D'
- ▭ Screened Interval
- ▨ Overburden
- ▨ Channel Fill
- ▨ Carbonate Silt
- ▨ CS 1
- ▨ CS 2
- ▨ Overburden - OT
- ▨ Carbonate Silt - OT
- ▨ CS 1 - OT
- ▨ CS 2 - OT
- ▨ CS 3 - OT

Elevations are in feet above mean sea level.

Aerial photograph from 2006

0 300 Meters

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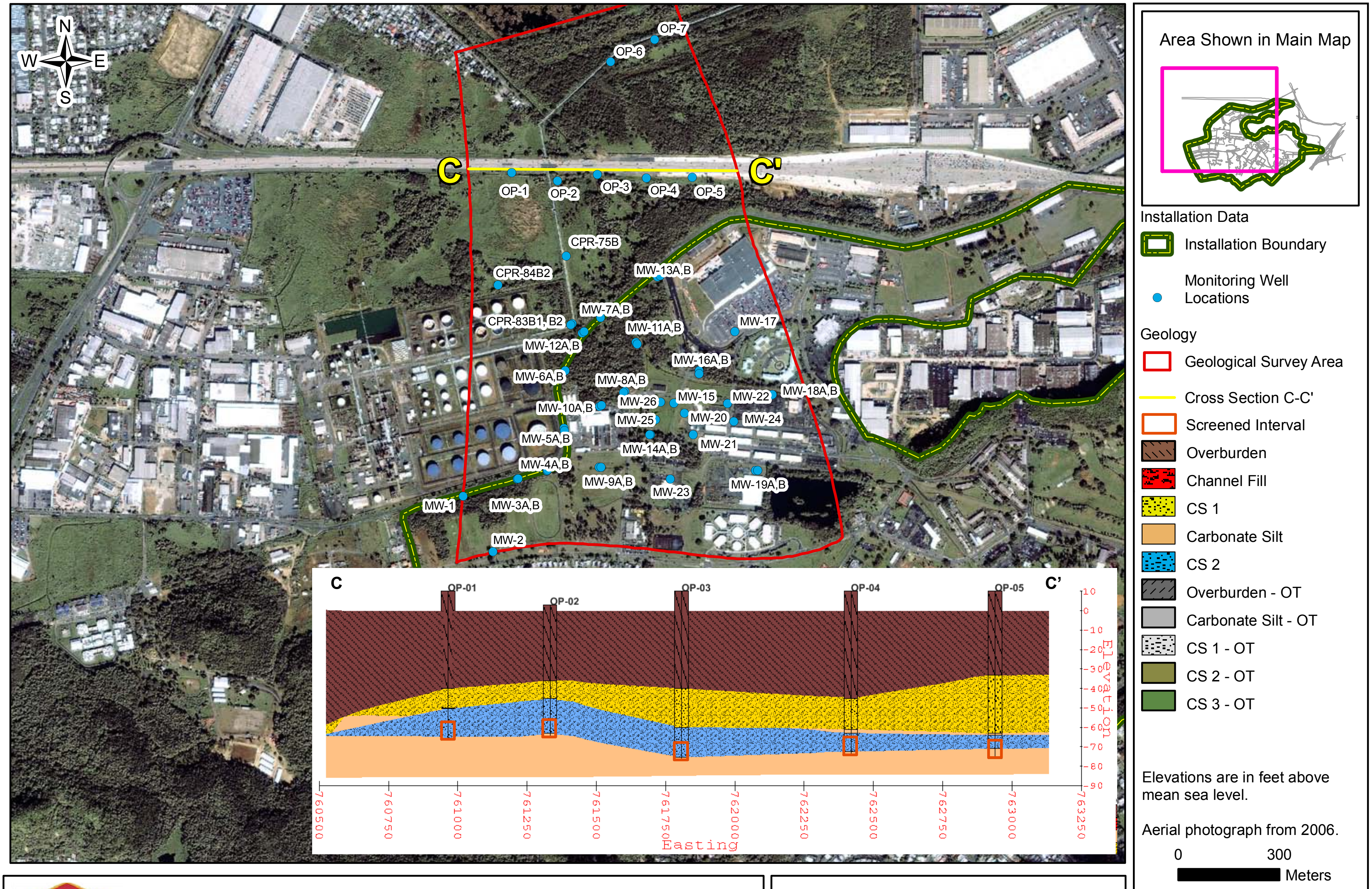
Geologic Cross Section D-D'

Figure 2-6

Fort Buchanan, Puerto Rico

\\Edgewoodfp\Projects\Universal GIS\Buchanan\MXDs\Figure 2-6 Cross Section D-D'.mxd



Elevations are in feet above mean sea level.

Aerial photograph from 2006.

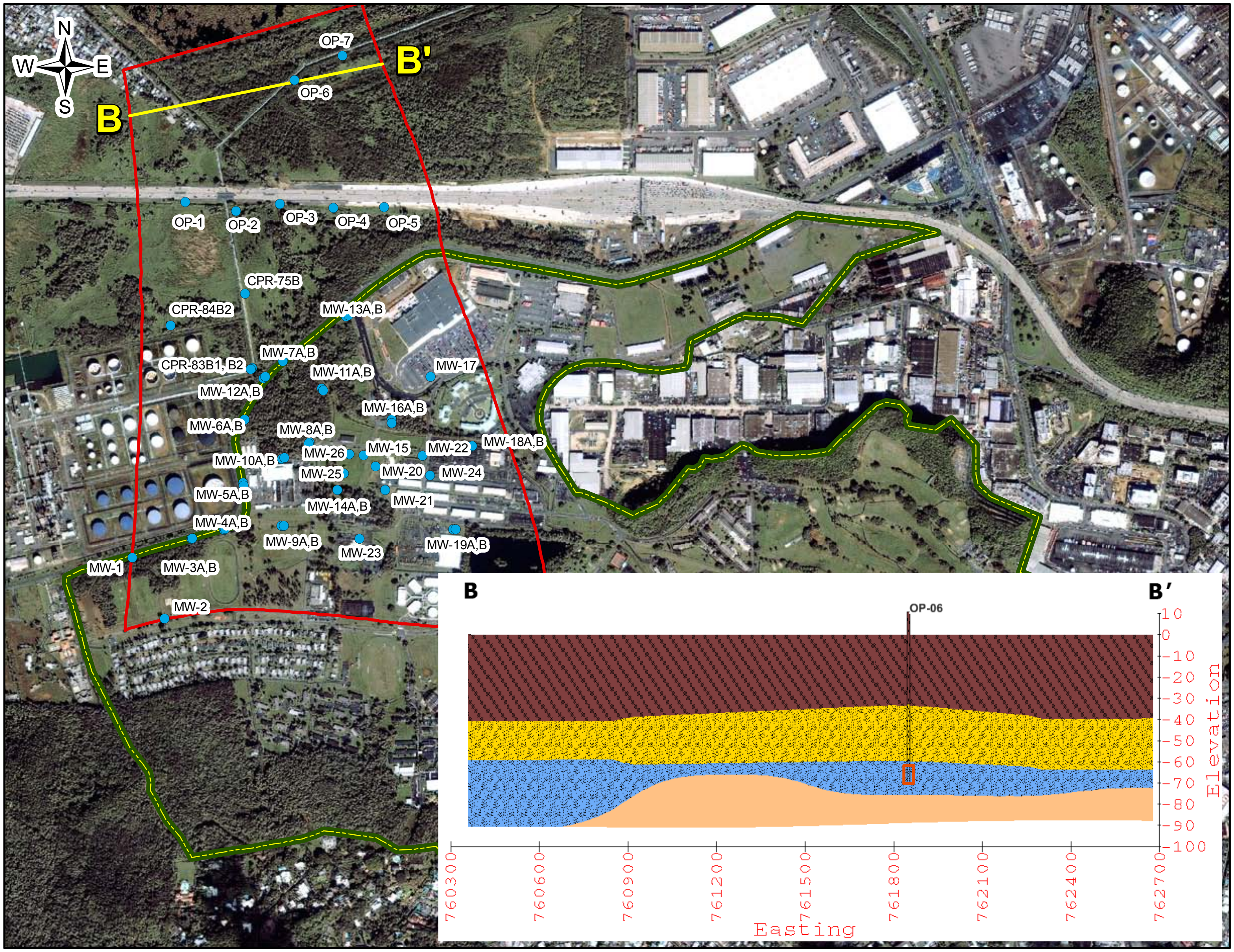
Geologic Cross Section C-C'

Figure 2-7

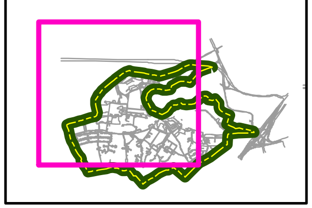
Fort Buchanan, Puerto Rico

EA Engineering, Science, and Technology

\\Edgewoodfp\Projects\Universal GIS\Buchanan\MXDs\Figure 2-7 Cross Section C-C'.mxd



Area Shown in Main Map



Installation Data

🟩 Installation Boundary

● Monitoring Well Locations

Geology

🟥 Geological Survey Area

— Cross Section B-B'

☐ Screened Interval

▨ Overburden

▨ Channel Fill

▨ CS 1

▨ CS 2

▨ Carbonate Silt

▨ Overburden - OT

▨ Carbonate Silt - OT

▨ CS 1 - OT

▨ CS 2 - OT

▨ CS 3 - OT

Elevations are in feet above mean sea level.

Aerial photograph from 2006.

0 300 Meters

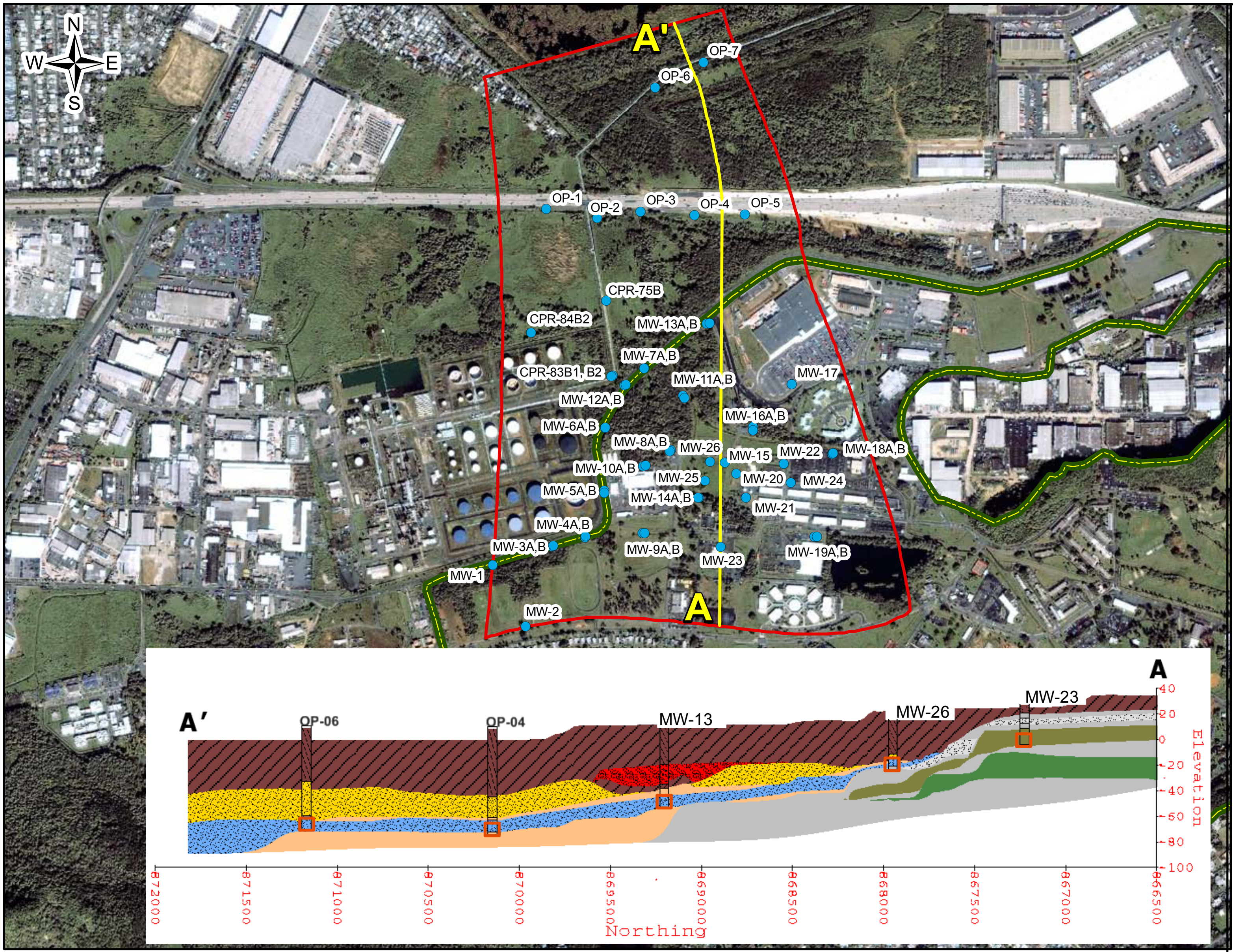
Geologic Cross Section B-B'

Figure 2-8

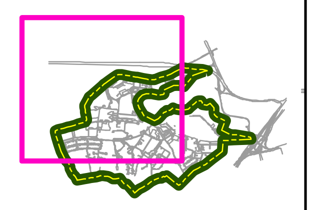
Fort Buchanan, Puerto Rico

EA Engineering, Science, and Technology

\\Edgewoodfp\Projects\Universal GIS\Buchanan\MXDs\Figure 2-8 Cross Section B-B'.mxd



Area Shown in Main Map



Installation Data

- 🟩 Installation Boundary
- ● Monitoring Well Locations

Geology

- 🟥 Geological Survey Area
- — Cross Section A-A'
- 🟧 Screened Interval
- ▨ Overburden
- ▨ Channel Fill
- ▨ Carbonate Silt
- ▨ CS 1
- ▨ CS 2
- ▨ Overburden - OT
- ▨ Carbonate Silt - OT
- ▨ CS 1 - OT
- ▨ CS 2 - OT
- ▨ CS 3 - OT

Elevations are in feet above mean sea level.

Aerial photograph from 2006.

0 300 Meters

Geologic Cross Section A-A'

Figure 2-9

Fort Buchanan, Puerto Rico

EA Engineering, Science, and Technology

\\Edgewoodfp\Projects\Universal GIS\Buchanan\MXDs\Figure 2-9 Cross Section A-A'.mxd

3 FIELD ACTIVITIES AND METHODOLOGY

3.1 FIELD ACTIVITIES

This section summarizes field activities that were performed as part of the RFI for the Northwest Boundary Area. RFI activities were conducted in seven phases, and additional data were generated from selected monitoring wells as part of a well integrity investigation that was completed in August 2011 following an explosion that occurred at the adjacent CPR property. A work plan and Quality Assurance Project Plan (QAPP) were developed prior to the initial phase of field work that began in October 2006 (EA 2006). Individual work plan addendums were then developed and submitted for each subsequent work phase. The methodologies followed for each of the phases are described in detail below.

3.2 METHODOLOGY

3.2.1 PHASE I

Monitoring wells and associated soil borings were advanced as part of Phase I. Locations MW-1, MW-2, MW-3 (A and B), and MW-4 (A and B) were positioned in the vicinity of SWMU 3 and locations MW-5 (A and B), MW-6 (A and B), MW-7 (A and B), and MW-8 (A and B) were distributed along the northwest boundary of Fort Buchanan (Figure 3-1).

3.2.1.1 Soil Borings

Two continuous soil borings were advanced at the MW-3 and MW-7 well cluster locations to assess site lithology (Figure 3-1). This work occurred in October 2006 and was conducted under the initial work plan and QAPP (EA 2006). At each location, the soil borings were advanced to a depth of 90 ft bgs and were continuously sampled by split spoon through nominal 4-inch inner diameter (ID) and 8-inch outside diameter (OD) hollow stem augers. Lithologic information was recorded by the field geologist from each split spoon and this information was used to determine the screened intervals of the monitoring wells. Both soil borings were abandoned following installation. Soil boring logs are included in Appendix B.

3.2.1.2 Monitoring Wells

A total of 14 monitoring wells (two shallow wells at MW-1 and MW-2 and six well clusters at MW-3 through MW-8) were installed along the northwest boundary of Fort Buchanan bordering the CPR property, from October to December 2006, under the initial work plan (Figure 3-1). Each well cluster consisted of one shallow (A) and one deep (B) monitoring well, which were installed utilizing nominal 4-inch ID and 8-inch OD hollow stem augers. Soil samples were collected continuously during the installation of each deep well (except locations MW-3 and -7; which had a separate deep soil boring as described in the Soil Borings section above) and were examined by the field geologist to determine the depth for the well screens and to provide a stratigraphic log. Continuous split spoon soil samples were also collected during the installation of the two shallow wells (MW-1 and MW-2). Spoons from 18 inches to 4 ft in length were used during the soil sampling process. The screened interval for the other shallow monitoring well was determined based on observations made during the deep well installations. All of the wells were installed in confined aquifers, except for MW-6A and -8A which were installed in the overburden. To confirm the assumed lithology, the screened intervals of the shallow monitoring wells were also sampled. The boring logs for all of the monitoring wells are included in Appendix B.

The monitoring wells were constructed of 2-inch ID schedule 40 polyvinyl chloride (PVC) risers and screen, with flush joint threads. Wells were completed with 10-ft long No. 10 slot size continuous-slot screens. Subsequent to installation, the monitoring well locations were surveyed by a Puerto Rico licensed surveyor, to within ±0.1 ft horizontally and ±0.01 ft vertically. Detailed well construction information is presented on Table 3-1, and well construction diagrams are included in Appendix C.

The wells were developed according to the standard operating procedures (SOPs) in the work plan and QAPP. Well development logs are included in Appendix G.

3.2.1.3 Soil Samples

During monitoring well installation, the split spoon soil samples were field screened using a photoionization detector (PID) and the results were recorded by the field geologist on the boring logs. A soil sample was collected at each well location from the 4 to 6-ft bgs interval and the 2-ft interval immediately above the first encountered groundwater, for a total of 16 soil samples (only one set of samples were collected per well cluster, from the deep boring). The soil samples were submitted to Accutest Laboratories of Orlando, Florida, for analysis of Target Analyte List (TAL) metals via SW846 6010B; VOCs via SW846 8260; semi-volatile organic compounds (SVOCs) via SW846 8270; pesticides via SW846 8081A; herbicides via SW846 8151A; PCBs via SW846 8082; and total petroleum hydrocarbons (TPH) gasoline range organics (GRO) and diesel range organics (DRO) via SW846 8015B.

The primary objectives of the samples from locations MW-1 through MW-4 were to determine whether SWMU 3 is a possible source of contamination to groundwater along the northwest boundary of Fort Buchanan and to identify the potential existence of the burial trench. The other samples provide characterization data for the groundwater in the area.

3.2.1.4 Groundwater Samples

Synoptic water level measurements were taken from a surveyed reference mark on each shallow monitoring well on 11 January 2007, and from each deep monitoring well on 21 January 2007. Groundwater elevations were then calculated.

Groundwater samples were collected from the monitoring wells in January 2007, two weeks following installation and development of the last monitoring well. During purging and sampling, low-flow sampling techniques were employed. Water quality parameters, including temperature, pH, dissolved oxygen (DO), conductivity, oxidation reduction potential (ORP), and turbidity were also recorded during sampling activities. Appendix H contains purge sheets for each groundwater sampling event.

Groundwater samples were submitted to Accutest Laboratories for analysis of the following: TAL metals (total and dissolved) via SW846 6010B; VOCs via SW846 8260B; SVOCs via SW846 8270C; pesticides via SW846 8081A; herbicides via SW846 8151A; and PCBs via SW846 8082.

Following groundwater sample collection, a dedicated pressure transducer was installed in each monitoring well to continuously monitor and record groundwater water levels. The transducers collected groundwater level data from 12 January to 1 February 2007.

3.2.2 PHASE II

3.2.2.1 Monitoring Wells

A total of 10 additional monitoring wells (consisting of five clusters) were installed in the vicinity of the northwest boundary of Fort Buchanan bordering the CPR property: MW-9, MW-10, MW-11, MW-12, and MW-13 (Phase II wells, Figure 3-1). This second phase of field work occurred from April through May 2007. The installation of the 10 new wells brought the total number to 24 wells installed as part of the Northwest Boundary Area RFI. The work associated with the second phase of the investigation is detailed in the *Addendum #1 to the Northwest Boundary Investigation Work Plan* (EA 2007a). Each new well cluster consisted of one shallow and one deep monitoring well, which were installed utilizing nominal 4-inch ID and 8-inch OD hollow stem augers. Split-spoon soil samples were collected continuously during the installation of each deep well and were examined by the field geologist to determine the depth for the well screens and to provide a stratigraphic log. The screen interval for the other shallow monitoring well was determined based on observations made during the deep well installations. An exception to this occurred at the MW-12 cluster, as the shallow well (MW-12A) was installed prior to the deep well (MW-12B) upon encountering an ideal lithology (i.e., carbonate sand) for the shallow well during the initial drilling.

To confirm the assumed lithology found in the deep well, the screened interval of the shallow monitoring wells were also sampled. The boring logs for the 10 additional monitoring wells are included in Appendix B.

The monitoring wells were constructed of 2-inch ID schedule 40 PVC risers and screen, with flush joint threads. Wells were completed with 10-ft long No. 10 slot size continuous-slot screens. Subsequent to installation, the monitoring well locations were surveyed by a Puerto Rico licensed surveyor to within ±0.1 ft horizontally and ±0.01 ft vertically. Detailed well construction information, including survey results, is presented on Table 3-1 and well construction diagrams are included in Appendix C.

The wells were developed according to the SOPs in the work plan and QAPP. Well development logs are included in Appendix G.

3.2.2.2 Soil Samples

During monitoring well installation, the split spoon soil samples were field screened using a PID and the results were recorded by the field geologist on the boring logs. Based on the PID readings (all below 100 parts per million [ppm]), no soil samples were submitted for laboratory analysis.

3.2.2.3 Groundwater Samples

Synoptic water level measurements were taken from a surveyed reference mark on each monitoring well the date they were sampled.

Groundwater samples were collected from the monitoring wells in June 2007, two weeks following development of the last monitoring well. During purging and sampling, low-flow sampling techniques were employed. Water quality parameters including temperature, pH, DO, conductivity, ORP, and turbidity were also recorded during sampling activities. Appendix H contains purge sheets for each groundwater sampling event.

Groundwater samples for the 10 new wells were submitted to Accutest Laboratories for analysis of the following: TAL metals (total and dissolved) via SW846 6010B; VOCs via SW846 8260B; SVOCs via SW846 8270C; pesticides via SW846 8081A; herbicides via SW846 8151A; and PCBs via SW846 8082. In addition, groundwater samples from the 14 previously installed wells (Phase I) were collected and analyzed for VOCs only.

Following groundwater sample collection, a dedicated pressure transducer was installed in each monitoring well to continuously monitor and record groundwater water levels.

3.2.3 PHASE III

3.2.3.1 Monitoring Wells

A total of 10 additional monitoring wells were installed in the northwest area of Fort Buchanan, to the east of the DPW complex (Phase III wells, Figure 3-1). These wells consisted of four two-well clusters (MW-14A, B; MW-16A, B; MW-18A, B; and MW-19A, B) and two single wells (MW-15 and MW-17). The installation of the 10 new wells brought the total number to 34 wells installed as part of the TCE Investigation. The work associated with the third phase of the investigation occurred in November and December 2007, and is detailed in the *Addendum #2 to the Northwest Boundary Investigation Work Plan* (EA 2007b).

Each new well cluster consisted of one shallow (A) and one deep (B) monitoring well, which were installed utilizing nominal 4-inch ID and 8-inch OD hollow stem augers. Split-spoon soil samples were collected continuously during the installation of each deep well and were examined by the field geologist to determine the depth for the well screens and to provide a stratigraphic log. The screened interval for the other shallow monitoring well was determined based on observations made during the deep well installations. Exceptions to this occurred at MW-15 and MW-17, where only one continuous aquifer (i.e., carbonate sand) for the shallow well was identified during drilling. In each case, borings were installed and sampled until it was determined by the field geologist that the deeper aquifer would not be intercepted. The initial boring for MW-15B was installed to 69 ft; for MW-17B, 65 ft. Since no deep aquifer was observed in either location, single wells (MW-15, -17) were installed in the range of the shallow aquifer.

To confirm the assumed lithology found in the deep well for the well cluster locations, the screened interval of the shallow monitoring wells were also sampled. The boring logs for the monitoring wells are included in Appendix B.

The monitoring wells were constructed of 2-inch ID schedule 40 PVC risers and screen, with flush joint threads. Wells were completed with 10-ft long No. 10 slot size continuous-slot screens. Subsequent to installation, the monitoring well locations were surveyed by a Puerto Rico licensed surveyor, to within ±0.1 ft horizontally and ±0.01 ft vertically. Detailed well construction information, including survey results, is presented on Table 3-1 and well construction diagrams are included in Appendix C.

The wells were developed according to the SOPs in the work plan and QAPP. Well development logs are included in Appendix G.

3.2.3.2 Soil Samples

During monitoring well installation, the split spoon soil samples were field screened using a PID and the results were recorded by the field geologist on the boring logs. Based on the PID readings (all below 100 ppm), no soil samples were submitted for laboratory analysis.

3.2.3.3 Groundwater Samples

Synoptic water level measurements were taken from a surveyed reference mark on each monitoring well the date they were sampled.

Groundwater samples were collected from the monitoring wells in January 2008, two weeks following development of the last monitoring well. During purging and sampling, low-flow sampling techniques were employed. Water quality parameters, including temperature, pH, DO, conductivity, ORP, and turbidity were also recorded during sampling activities. Appendix H contains purge sheets for each groundwater sampling event.

Groundwater samples for the 10 new wells were submitted to Accutest Laboratories for analysis of the following: TAL metals (total and dissolved) via SW846 6010B; VOCs via SW846 8260B; SVOCs via SW846 8270C; pesticides via SW846 8081A; herbicides via SW846 8151A; and PCBs via SW846 8082. In addition, groundwater samples from the previously installed wells (Phase I and II) were collected and analyzed for VOCs only.

Following groundwater sample collection, a dedicated pressure transducer was installed in each monitoring well to continuously monitor and record groundwater water levels.

3.2.4 PHASE IV

The fourth phase of the investigation, detailed in the third Work Plan Addendum, involved the installation of five additional monitoring wells. The objective of the fourth phase was to further define the TCE plume within the area east of the DPW complex. The five additional monitoring wells (MW-20 through MW-24) were installed in the vicinity of the northwest area of Fort Buchanan to the east of the DPW complex (Phase IV wells, Figure 3-1). The installation of these wells brought the total number to 39 wells installed as part of the Northwest Boundary Investigation. The work associated with the fourth phase of the investigation occurred in April 2008 and is detailed in the *Addendum #3 to the Northwest Boundary Investigation Work Plan* (EA 2008a). Each new well was installed utilizing nominal 4-inch ID and 8-inch OD hollow stem augers. Split-spoon soil samples were collected continuously during the installation of each well and were examined by the field geologist to determine the depth for the well screens and to provide a stratigraphic log. The boring logs for the seven additional monitoring wells are included in Appendix B.

The monitoring wells were constructed of 2-inch ID schedule 40 PVC risers and screen, with flush joint threads. Wells were completed with 10-ft long No. 10 slot size continuous-slot screens. Subsequent to installation, the monitoring well locations were surveyed by a Puerto Rico licensed surveyor to within ±0.1 ft horizontally and ±0.01 ft vertically. Detailed well construction information for each well installed to date is presented on Table 3-1 and well construction diagrams for wells MW-20 through -24 are included in Appendix C.

The wells were developed according to the SOPs in the work plan and QAPP. Well development logs are included in Appendix G.

3.2.4.1 Groundwater Samples

Groundwater samples were collected from a total of 23 monitoring wells in May 2008. Sampling was conducted two weeks following the development of wells MW-20 through MW-24. Low-flow sampling techniques were employed during purging and sampling. Water quality parameters, including temperature, pH, DO, conductivity, ORP, and turbidity were also recorded during sampling activities. Appendix H contains purge sheets for each groundwater sampling event.

Groundwater samples for the five wells installed in Phase IV were submitted to Accutest Laboratories for analysis of the following: TAL metals (total and dissolved) via SW846 6010B; VOCs via SW846 8260B; SVOCs via SW846 8270C; pesticides via SW846 8081A; herbicides via SW846 8151A; and PCBs via SW846 8082. The samples collected from the select previously-installed wells (wells that exhibited TCE impacts previously or were only sampled once to date) were analyzed for VOCs only. The select 18 wells included MW-6B, -7B, -11A, -11B, -12A, -12B, -13A, -13B, -14A, -14B, -15, -16A, -16B, -17 -18A, -18B, -19A and -19B.

Synoptic water level measurements were taken from a surveyed reference mark on each monitoring well prior to sampling.

3.2.5 PHASE V

The fifth phase of the investigation detailed in the *Addendum #4 to the Northwest Boundary Investigation Work Plan* (EA 2008b) consisted of a geophysical investigation of a potential source area for TCE that was identified, in part, based on the results of groundwater sampling conducted during the previous phases. As part of the source investigation, historical aerials were reviewed in great detail by the Army. Additionally, during Installation Action Plan (IAP) meetings with all stakeholders including Fort Buchanan, the USEPA, and PREQB, aerial photographs from the 1930s through the 1990s were examined for activities that may have occurred in the field to the east of the DPW complex. In aerial photographs from the 1960s and 1970s, it is apparent that this open area was used possibly for the staging of equipment and parking of vehicles. Ground scars are visible, and a railroad line is shown that ran from north to south through the field. It is possible that some of the maintenance activities that occurred in this area contributed to the source of the groundwater plume. In an effort to characterize subsurface anomalies in this area, the Phase V geophysical investigation was performed.

The field investigation was performed 21-23 July 2008 and was conducted by EA and Earth Resources Technology, Inc. (ERT). An approximately 300-by-300 ft grid (Figure 3-2) was laid out over the area prior to conducting three phases of geophysics—a magnetometer sweep, followed by an electromagnetic survey (EM-31), and finally a ground-penetrating radar (GPR) survey to further define any anomalies found in the first two surveys. Figure 3-2 depicts an aerial background from 1967, clearly showing some activity within the geophysical investigation area. The gridded area was then displayed on a map with site features that could potentially interfere with the survey or explain certain anomalous findings.

3.2.6 PHASE VI

3.2.6.1 Monitoring Wells

Nine additional monitoring wells (MW-25 and-26; OP-1 through OP-7) were installed as part of Phase VI (Figure 3-1). MW-25 and -26 were installed in September 2008, OP-1 through OP-5 were installed in December 2008, and OP-6 and OP-7 were installed in February 2009. MW-25 and -26 were installed in the vicinity of the northwest area of Fort Buchanan to the east of the DPW complex; while OP-1 through OP-5 were installed on the southern side of PR-No. 22 to the north of Fort Buchanan, and OP-6 and -7 were installed north of PR-No. 22 along the CPR pipeline. The installation of the nine new wells increased the total number to 48 wells installed as part of the Northwest Boundary Area RFI.

The work associated with the sixth phase of the investigation is detailed in the *Addendum #5 to the Northwest Boundary Investigation Work Plan* (EA 2008c). Each new well was installed utilizing nominal 4-inch ID and 8-inch OD hollow stem augers. Split-spoon soil samples were collected continuously during the installation of MW-25, -26, and OP-5 to determine the depth for the well screens and to provide a stratigraphic log. The other five wells were drilled after these three wells, and they were drilled to a depth of 35 to 45 ft prior to taking split-spoon samples since the screened interval was already estimated for each well. The boring logs for the nine additional monitoring wells are included in Appendix B.

The monitoring wells were constructed of 2-inch ID schedule 40 PVC risers and screen, with flush joint threads. Wells were completed with 10-ft long No. 10 slot size continuous-slot screens. Subsequent to installation, the monitoring well locations were surveyed by a Puerto Rico licensed surveyor, to within ±0.1 ft horizontally and ±0.01 ft vertically. Detailed well construction information for each well installed to date, including survey data, is presented on Table 3-1 and well construction diagrams for wells MW-25, -26, and OP-1 through OP-7 are included in Appendix C.

The wells were developed according to the SOPs in the work plan and QAPP. Well development logs are included in Appendix G.

3.2.6.2 Groundwater Samples—January 2009

Groundwater samples were collected from a total of 24 monitoring wells in January 2009, and prior to the installation of OP-6 and -7. Sampling was conducted two weeks following the development of wells OP-1 through OP-5. Low-flow sampling techniques were employed during purging and sampling. Water quality parameters including temperature, pH, DO, conductivity, ORP, and turbidity were also recorded during sampling activities. Table 3-2 lists final water quality parameters prior to the sampling of each monitoring well installed during every phase of this investigation. Appendix H contains purge sheets from each groundwater sampling event.

Groundwater samples for the seven wells installed in Phase VI (MW-25, -26, and OP-1 through OP-5) were submitted to Accutest Laboratories for analysis of the following: TAL metals (total and dissolved) via SW846 6010B; VOCs via SW846 8260B; SVOCs via SW846 8270C; pesticides via SW846 8081A; herbicides via SW846 8151A; and PCBs via SW846 8082. The samples collected from the select previously-installed wells (wells that exhibited TCE impacts previously or were only sampled once to date) were analyzed for VOCs only. These wells were MW-6B, -7B, -11A, -11B, -12A, -12B, -13A, -13B, -15, -16A, -16B, -18A, -20, -21, -22, -23, and -24.

Groundwater from seven select monitoring wells (MW-7B, -11A, -15, -22, OP-1, OP-2, and OP-5) within the TCE plume were analyzed for nitrate, sulfate, total organic carbon (TOC), and dissolved gases (ethane, methane, and ethene). These wells were chosen for natural attenuation parameter assessment because they cover a large portion of the length of the plume, extending from upgradient (MW-22) to downgradient (OP wells) locations. This data and the field groundwater geochemistry data (collected during well purging) was then utilized to assess the feasibility of natural attenuation or other alternatives that rely on in-situ biodegradation.

3.2.6.3 Groundwater Samples—March 2009

Another groundwater sampling event was conducted in March 2009, and included the nine newest (MW-25, MW-26; OP-1 through OP-7) wells, four existing CPR wells (CPR-75B; CPR-83B1; CPR-83-B2; and CPR-84B2) and six previously installed wells (MW-5A, -6B, 8-B, 10-A, 10-B, and 14A). The samples collected from OP-6 and OP-7 were submitted for TAL metals (total and dissolved) via SW846 6010B; VOCs via SW846 8260B; SVOCs via SW846 8270C; pesticides via SW846 8081A; herbicides via SW846 8151A; and PCBs via SW846 8082. The samples collected from the select 17 previously-installed wells were analyzed for VOCs only. Appendix H contains purge sheets for each groundwater sampling event.

3.2.6.4 Groundwater Samples—April 2009

A third sampling event occurred on 14 April 2009 and consisted of the re-sampling of OP-6 and OP-7. These wells were analyzed for VOCs only. Appendix H contains purge sheets for each groundwater sampling event.

Synoptic water level measurements were taken from a surveyed reference mark on each monitoring well sampled as part of the March 2009 event.

3.2.6.5 Slug Testing

In addition to the groundwater sampling, EA conducted slug tests at each of the monitoring well locations to further evaluate aquifer parameters. The data collected as part of the slug testing provides additional valuable data that will further define the subsurface hydraulic properties and assess the potential transport of chemicals in groundwater. The field data was analyzed with AQTESOLV software for estimates of hydraulic conductivity (K).

Two slug tests, consisting of a rising head and a falling head test, were conducted to estimate *in-situ* hydraulic conductivity of the screened interval at each well location. The static water level in the monitoring well was measured with a water level indicator prior to the initial insertion of the slug. A clean slug constructed from a 1-inch diameter by 10-ft length of PVC pipe filled with sand and sealed on both ends was then utilized to displace the water for the assessment.

In performing a falling head test, the slug was quickly submerged into the groundwater in the well when an elapsed time count began. Water levels were automatically monitored by a (AquiStar PT2X Smart Sensor) data logger until the groundwater level recovered to no less than 90 percent of the original static level. After the water level re-equilibrated, the rising head test was performed by quickly removing the slug from the well and automatic monitoring was repeated until the water level had returned to the original static level.

Slug testing was performed in January 2007 for MW-1 through MW-8B (Phase I wells). Wells MW-9 through MW-26 were slug-tested in September 2008; the off-post wells (OP-1 through OP-7) were slug tested in January and February, 2009. Slug tests were not completed at MW-14A and MW-14B because the well cluster was inaccessible.

3.2.6.6 Test Pits and Sewer Line Investigation

Three anomalies, 'A' and 'B' and a linear anomaly, were detected during the July 2008 geophysical investigation, which was performed under *Addendum #4 to the Northwest Boundary Investigation Work Plan*. The geophysical survey identified the anomalies in the shallow subsurface (Figure 3-3). Anomaly A was a large disturbance located in the northwest corner of the survey area and Anomaly B was a small, localized disturbance to the south of MW-20. The linear anomaly ran approximately east-west, terminating in a concrete lined drainage ditch at the west end. A manhole was observed upgradient of and in line with the anomaly. The linear feature was thought to be a potential storm sewer line, although such a line was not observed during sampling. Findings were consistent with both the electromagnetic survey and the GPR for these areas. Appendix I contains detailed survey results in a 7 August 2008 letter report.

Anomalies A and B were test-pitted using an excavator on 16 September 2008. Three pits (TP-1, -2, -3) were performed in the area of Anomaly A and one pit (TP-4) was excavated in the area of Anomaly B (Figure 3-3). A field geologist recorded the findings in a field book, and soils were screened with a PID throughout the process. Soil samples were collected from Test Pits 1, 3, and 4. All of the test pits were backfilled with the excavator once the logging and sampling were complete. The disturbed areas were then seeded.

Soil samples were collected at four locations (1-4) along the linear feature/storm sewer line. A direct push technology rig was used to collect split-spoon soil samples at each location, and attempts were made to sample adjacent to the line (approximately 3 ft bgs) and beneath the line (approximately 5 ft bgs). Between locations, the split spoons were decontaminated in accordance with the work plan.

3.2.6.7 Soil Samples

During monitoring well installation, continuous split spoon soil samples were field screened using a PID and the results were recorded by the field geologist on the boring logs. Based on the PID readings (all below 100 ppm), no soil samples were submitted for laboratory analysis.

One soil sample for laboratory analysis was collected from each of three Test Pits (Test Pits 1, 3, and 4). Also, two samples were collected from each of four locations along the storm sewer line (for a total of eight samples). Samples were screened with a PID during the test pitting and collection of soil samples. Each soil sample was analyzed for TAL metals, VOCs, SVOCs, pesticides, herbicides, and PCBs.

3.2.7 PHASE VII

On 9 and 10 December 2010, six sediment pore water samples and one surface water sample were collected off-post of Fort Buchanan in a downgradient water body (lagoon-like basin). The sample locations are depicted on Figure 3-4. During a 29 October 2010 site visit by representatives from Fort Buchanan and the USEPA, the lagoon was discovered to be bounded on the south by a dike. However, surface water was also observed south of the dike in the direction of OP-6 and OP-7. Based on these observations, sample locations included four pore water samples north of the dike, and two to the south.

Sample locations were accessed by wading, and efforts were made to limit the amount that the surface water and underlying sediment are disturbed. Using push point samplers fitted with a screen, the sampler was pushed below the water surface and into the underlying sediment using a section of 1-inch PVC. After the push point was in place, sand was poured into the PVC to fall around the screen of the sampler, followed by a small amount of bentonite powder to seal off surface water from above. The PVC was then pulled up and the bentonite left to hydrate for several minutes. Tubing was then run through a peristaltic pump and the appropriate sample jars filled.

One surface water sample was collected from the center of southern edge of the lagoon (Figure 3-5) in accordance with SOP 007 from the QAPP (EA 2006).

The pore water and surface water samples were analyzed for VOCs only. For quality control purposes, one duplicate sample was collected and a trip blank was submitted with the samples.

3.3 TRANSDUCER DATA

Throughout the investigation, pressure transducers were used to track changes in water levels, temperature, and barometric pressure in the monitoring wells. Generally, the transducers were installed in the wells after they were developed, and wells were vented to the atmosphere to allow the water columns to rise and fall freely. Transducers were left in the wells for several weeks to two months. Once removed, the data from the transducers were used to identify patterns in the groundwater elevation. Hydrographs generated from transducer data from June-July 2007 and March 2009 are included in Appendix E. Table 3-3 presents the wells in which transducers were placed and the dates the transducers were present.

3.4 FIELD DECONTAMINATION

Decontamination procedures of equipment used during the Northwest Boundary Investigation are detailed in the QAPP (EA 2006).

Between well installations, the drill rig was taken to the DPW compound and decontaminated using a steam cleaner. Decontamination water and soil cuttings were drummed and stored at the DPW complex for proper characterization and disposal in accordance with the QAPP (EA 2006).

During groundwater sampling events, submersible pumps and water level indicators were decontaminated as detailed in the QAPP (EA 2006). All decontamination water was contained and emptied into drums for analysis and disposal.

3.5 MANAGEMENT OF INVESTIGATIVE DERIVED MATERIAL

Investigative Derived Material (IDM) includes soil cuttings from borings, decontamination water, and personal protective equipment (PPE). IDM handling and disposal procedures are described extensively in Chapter 6 of the QAPP (EA 2006).

Soil cuttings from soil borings and well installations were either contained in 55-gallon drums, or spread onsite (off-post wells only). Drums containing soil were labeled, sampled for Full RCRA Waste Characterization, and staged at Fort Buchanan pending analytical results, which are included in Appendix J. Purge water from wells were containerized in separate drums, labeled, sampled for RCRA Waste Characterization, and staged at Fort Buchanan. Drums were eventually removed and properly disposed at a non-hazardous waste disposal facility.

Manifests for the shipped drums are provided in Appendix K.

3.6 WELL INTEGRITY INVESTIGATION

A well integrity investigation was completed independently of the RFI as a result of the 23 October 2009 explosion of 21 fuel storage tanks at the CPR. The explosion reportedly caused seismic activity exceeding 2.9 on the Richter scale and created extraordinary heat from the associated fires. There was concern that monitoring wells in the vicinity of the refinery may have been damaged by the explosion; as such, a well integrity investigation was completed (EA 2010b) to assess the structural integrity of the wells and monitor groundwater. The investigation included inspection and re-surveying of the 48 wells installed as part the RFI effort and collection of groundwater samples from 20 of the wells. The selection of the wells that were sampled was based on well depth and their proximity to the CPR complex. The wells sampled included: OP-1 through OP-6, MW-1, -3, -4A and B, -5A, -6A, -7A, -11A, -12A and B, -13A and B, -25, and -26. It should be noted that sampling OP-7 was proposed, but the well was inaccessible and thus was not sampled.

The sampling was conducted in accordance with the *Northwestern Boundary Investigation Area Work Plan*, the QAPP, and the Site Health and Safety Plan (EA 2006). Field methodologies and findings of the inspection were presented in a letter report (EA 2010b). Analytical results for the samples collected as part of the integrity investigation are presented herein, and the report is included in Appendix L.

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Table 3-1
Monitoring Well Construction Specifications - Northwestern Boundary Area Investigation

Well ID	Date Installed	Elevation of Top of Casing (ft amsl*)	Latitude (NAD 83 ft)	Longitude (NAD 83 ft)	Well Depth (ft bgs**)	Casing Diameter (inches)	Screen Slot Size (inch)	Screen Length (ft)	Elevation of Top and Bottom of Screen (ft amsl)		Depth to Top and Bottom of Screen (ft bgs)		Filterpack Interval (ft)	Deep/ Shallow?	Carbonate Zone?
									Top	**Bottom**	**Top**	**Bottom**			
MW-01	12/04/06	33.23	867063.26	760469.08	32	2"	0.01	10	11.23	1.23	22	32	18.5-32	Shallow	Y
MW-02	12/07/06	61.05	866516.94	760773.70	40	2"	0.01	10	31.05	21.05	30	40	27-40	Shallow	Y
MW-03A	10/27/06	36.49	867224.75	761011.49	34	2"	0.01	10	12.49	2.49	24	34	22-34	Shallow	Y
MW-03B	10/26/06	36.22	867219.90	760997.56	55	2"	0.01	10	-8.78	-18.78	45	55	43-55	Deep	Y
MW-04A	11/30/06	42.00	867307.44	761301.34	41	2"	0.01	10	11.00	1.00	31	41	29-41	Shallow	Y
MW-04B	11/17/06	41.88	867304.94	761290.88	66	2"	0.01	10	-14.12	-24.12	56	66	54-66	Deep	Y
MW-05A	11/10/06	38.10	867702.22	761461.54	40	2"	0.01	10	8.10	-1.90	30	40	28-40	Shallow	Y
MW-05B	11/09/06	37.85	867716.60	761458.35	66	2"	0.01	10	-18.15	-28.15	56	66	54-66	Deep	Y
MW-06A	11/07/06	13.53	868268.25	761468.57	18	2"	0.01	10	5.53	-4.47	8	18	6 to 18	Shallow	N
MW-06B	11/06/06	13.25	868277.70	761473.77	50	2"	0.01	10	-26.75	-36.75	40	50	38-50	Deep	Y
MW-07A	11/01/06	9.17	868789.89	761817.53	36	2"	0.01	10	-16.83	-26.83	26	36	24-36	Shallow	Y
MW-07B	10/31/06	9.24	868796.37	761825.39	73.67	2"	0.01	10	-54.43	-64.43	63.67	73.67	60-73.67	Deep	Y
MW-08A	12/07/06	19.92	868068.71	762036.57	28	2"	0.01	10	1.92	-8.08	18	28	16-28	Shallow	N
MW-08B	12/06/06	19.66	868073.87	762044.56	52	2"	0.01	10	-22.34	-32.34	42	52	39.5-52	Deep	Y
MW-09A	05/11/07	39.12	867399.53	761776.50	43	2"	0.01	10	6.12	-3.88	33	43	30-43	Shallow	Y
MW-09B	05/10/07	38.90	867399.57	761765.01	67	2"	0.01	10	-18.10	-28.10	57	67	54-67	Deep	Y
MW-10A	04/26/07	29.48	867936.54	761748.49	40	2"	0.01	10	-0.52	-10.52	30	40	28-40	Shallow	Y
MW-10B	04/25/07	29.32	867937.12	761760.62	52	2"	0.01	10	-12.68	-22.68	42	52	40-52	Deep	Y
MW-11A	05/15/07	11.93	868463.45	762208.24	30	2"	0.01	10	-8.07	-18.07	20	30	18-30	Shallow	Y
MW-11B	05/14/07	11.40	868472.99	762204.53	52.5	2"	0.01	10	-31.10	-41.10	42.5	52.5	39-52.5	Deep	Y
MW-12A	04/27/07	10.51	868572.11	761632.83	34	2"	0.01	10	-13.49	-23.49	24	34	22.5-34	Shallow	Y
MW-12B	05/01/07	10.58	868558.58	761625.20	56	2"	0.01	10	-35.42	-45.42	46	56	44-56	Deep	Y
MW-13A	05/08/07	10.25	869204.47	762397.50	40	2"	0.01	10	-19.75	-29.75	30	40	27.5-40	Shallow	N
MW-13B	5/4/2007	10.31	869213.05	762389.97	64	2"	0.01	10	-43.69	-53.69	54	64	51-64	Deep	Y
MW-14A	12/13/07	22.16	867653.23	762300.50	44	2"	0.01	10	-11.84	-21.84	34	44	32-44	Shallow	Y
MW-14B	12/12/07	21.71	867665.24	762299.44	62	2"	0.01	10	-30.29	-40.29	52	62	48-62	Deep	Y
MW-15A	11/26/07	19.95	867972.17	762517.27	40	2"	0.01	10	-10.05	-20.05	30	40	27-40	Shallow	Y
MW-16A	12/3/07	20.26	868253.74	762728.02	45	2"	0.01	10	-14.74	-24.74	35	45	32-45	Shallow	Y
MW-16B	12/3/07	20.90	868266.63	762732.99	62	2"	0.01	10	-31.1	-41.1	52	62	50-62	Deep	Y
MW-17A	12/6/07	15.92	868669.72	763170.59	46	2"	0.01	10	-20.08	-30.08	36	46	33.5-46	Shallow	Y
MW-18A	12/17/07	19.45	868072.43	763428.87	45	2"	0.01	10	-15.55	-25.55	35	45	32.5-45	Shallow	Y
MW-18B	12/17/07	19.57	868070.50	763439.44	62	2"	0.01	10	-32.43	-42.43	52	62	50-62	Deep	Y
MW-19A	11/29/07	28.31	867330.27	763313.61	36	2"	0.01	10	2.31	-7.69	26	36	23-36	Shallow	Y
MW-19B	11/28/07	28.25	867329.04	763325.48	57	2"	0.01	10	-18.75	-28.75	47	57	43-57	Deep	Y
MW-20	4/23/08	23.90	867822.86	762620.31	50	2"	0.01	10	-16.1	-26.1	40	50	37.5-50	N/A	Y
MW-21	4/15/08	25.12	867660.55	762681.55	40	2"	0.01	10	-4.88	-14.88	30	40	28.5-40	N/A	Y
MW-22	4/17/08	22.41	867935.43	763032.73	45	2"	0.01	10	-12.59	-22.59	35	45	31.5-45	N/A	Y
MW-23	4/21/08	28.45	867224.90	762468.16	33	2"	0.01	10	5.45	-4.55	23	33	21-33	N/A	Y
MW-24	4/18/08	22.05	867774.70	763098.21	31	2"	0.01	10	1.05	-8.95	21	31	26-31	N/A	Y
MW-25	9/18/08	19.96	867786.26	762360.99	35	2"	0.01	10	-5.04	-15.04	25	35	22.5-35	N/A	Y
MW-26	9/17/08	19.93	867949.24	762407.02	40	2"	0.01	10	-10.07	-20.07	30	40	29-40	N/A	Y
OP-1	12/16/08	16.41	870207.58	760963.87	65	2"	0.01	10	-38.59	-48.59	55	65	51-65	N/A	Y
OP-2	12/18/08	6.47	870134.43	761332.24	73	2"	0.01	10	-56.53	-66.53	63	73	59.5-73	N/A	Y
OP-3	12/11/08	13.43	870195.85	761807.61	84	2"	0.01	10	-60.57	-70.57	74	84	71-84	N/A	Y
OP-4	12/9/08	9.56	870146.82	762418.06	80	2"	0.01	10	-60.44	-70.44	70	80	66-80	N/A	Y
OP-5	12/4/08	9.73	870147.92	762937.16	70	2"	0.01	10	-50.27	-60.27	60	70	54-70	N/A	Y

Table 3-1
Monitoring Well Construction Specifications - Northwestern Boundary Area Investigation

Well ID	Date Installed	Elevation of Top of Casing (ft amsl*)	Latitude (NAD 83 ft)	Longitude (NAD 83 ft)	Well Depth (ft bgs**)	Casing Diameter (inches)	Screen Slot Size (inch)	Screen Length (ft)	Elevation of Top and Bottom of Screen (ft amsl)		Depth to Top and Bottom of Screen (ft bgs)		Filterpack Interval (ft)	Deep/ Shallow?	Carbonate Zone?
									Top	**Bottom**	**Top**	**Bottom**			
OP-6	2/18/09	13.47	871169.78	761896.63	75	2"	0.01	10	-51.53	-61.53	65	75	61-70	N/A	Y
OP-7	2/20/09	14.24	871527.88	762653.40	70	2"	0.01	10	-45.761	-55.761	60	70	56-70	N/A	Y

*amsl = above mean sea level.

**bgs = below ground surface.

Table 3-2
Water Quality Parameters

Well Number	Sample Date[1]	Volume (L) purged prior to sampling	Turbidity (NTU)	Oxidation-Reduction Potential (mV)	Conductivity (ms/cm)	Dissolved Oxygen (mg/L)	pH	Temperature (ºC)
MW-1	06/12/07	35	16	123	0.869	0.29	5.98	27.10
MW-2	06/13/07	26	2	186.7	0.714	0.30	5.73	28.72
MW-3A	06/12/07	38	3	881.4	0.789	0.09	7.71	27.41
MW-3B	06/12/07	47	4	368.1	0.644	0.12	8.85	27.61
MW-4A	06/12/07	36	18	-112	0.487	0.33	6.77	28.03
MW-4B	06/12/07	28	6	-214	0.840	0.21	6.94	27.85
MW-5A	06/13/07	15	30	129.7	0.778	2.14	6.65	31.41
MW-5B	06/13/07	25	31	143.6	0.877	0.26	5.86	28.72
MW-6A	06/13/07	23	0	219	0.532	0.17	4.85	29.43
MW-6B	06/13/07	34	13	189	0.658	0.10	5.84	27.55
MW-7A	06/13/07	13	47	99	0.731	0.16	6.58	27.17
MW-7B	06/13/07	25	5	79.1	1.392	0.19	6.39	26.04
MW-8A	06/13/07	14	>1000	-124	0.584	0.11	6.88	31.42
MW-8B	06/13/07	23	10	99.8	0.774	0.20	6.17	29.09
MW-9A	06/12/07	34	3	372	0.660	0.11	9.60	27.75
MW-9B	06/12/07	26	9	-213	0.752	0.18	7.02	27.49
MW-10A	06/12/07	55	20	123.6	0.813	0.17	6.67	28.73
MW-10B	06/12/07	15	15	128.3	0.763	0.89	6.23	29.49
MW-11A	06/12/07	36	10	-46	0.877	0.16	6.82	26.36
MW-11B	06/12/07	40	3	-9	0.668	0.23	6.83	25.84
MW-12A	06/12/07	30	2	147	0.844	1.16	6.68	27.03
MW-12B	06/12/07	40	18	116	0.861	0.21	6.45	26.80
MW-13A	06/12/07	53	3	37.4	0.636	0.11	7.37	29.35
MW-13B	06/12/07	45	5	49.8	0.976	0.11	8.05	28.07
MW-14A	01/09/08	28	7	50	0.797	0.16	6.94	26.71
MW-14B	01/09/08	36	40	-87	0.837	0.13	6.86	26.25
MW-15A	01/08/08	40	10	7	0.928	0.31	6.42	27.72
MW-16A	01/08/08	20	19	114.4	1.415	1.42	6.72	27.55
MW-16B	01/08/08	20	7	-47	1.294	0.76	7.45	27.49
MW-17A	01/08/08	48	3	77.6	3.492	0.69	7.78	29.25
MW-18A	01/09/08	28	8	-113.6	1.360	0.74	7.60	29.89
MW-18B	01/09/08	10	40	-180.6	1.732	0.54	8.04	30.30
MW-19A	01/08/08	24	11	-43.7	1.504	0.74	7.13	27.64
MW-19B	01/08/08	22	12	-100.7	1.529	0.84	7.37	27.80
MW-20	01/07/09	9	21	-35.9	0.867	0.57	6.98	27.89
MW-21	01/07/09	8	10	65	0.754	0.12	6.91	27.04
MW-22	01/06/09	9	39	134.8	0.500	0.17	6.75	29.15
MW-23	01/07/09	21	2	-49.9	1.169	0.01	6.79	29.17
MW-24	01/06/09	8	4	53.1	0.516	0.33	7.32	30.08
MW-25	01/07/09	36	7	10	1.037	0.12	6.68	26.88
MW-26	01/07/09	36	270	-43	0.957	0.09	6.76	27.48
OP-1	01/06/09	29	90	61.9	1.220	0.01	7.04	25.92
OP-2	01/06/09	40	39	-48	1.528	0.16	7.05	25.74
OP-3	01/06/09	11	5	140.3	1.220	0.10	6.89	26.22

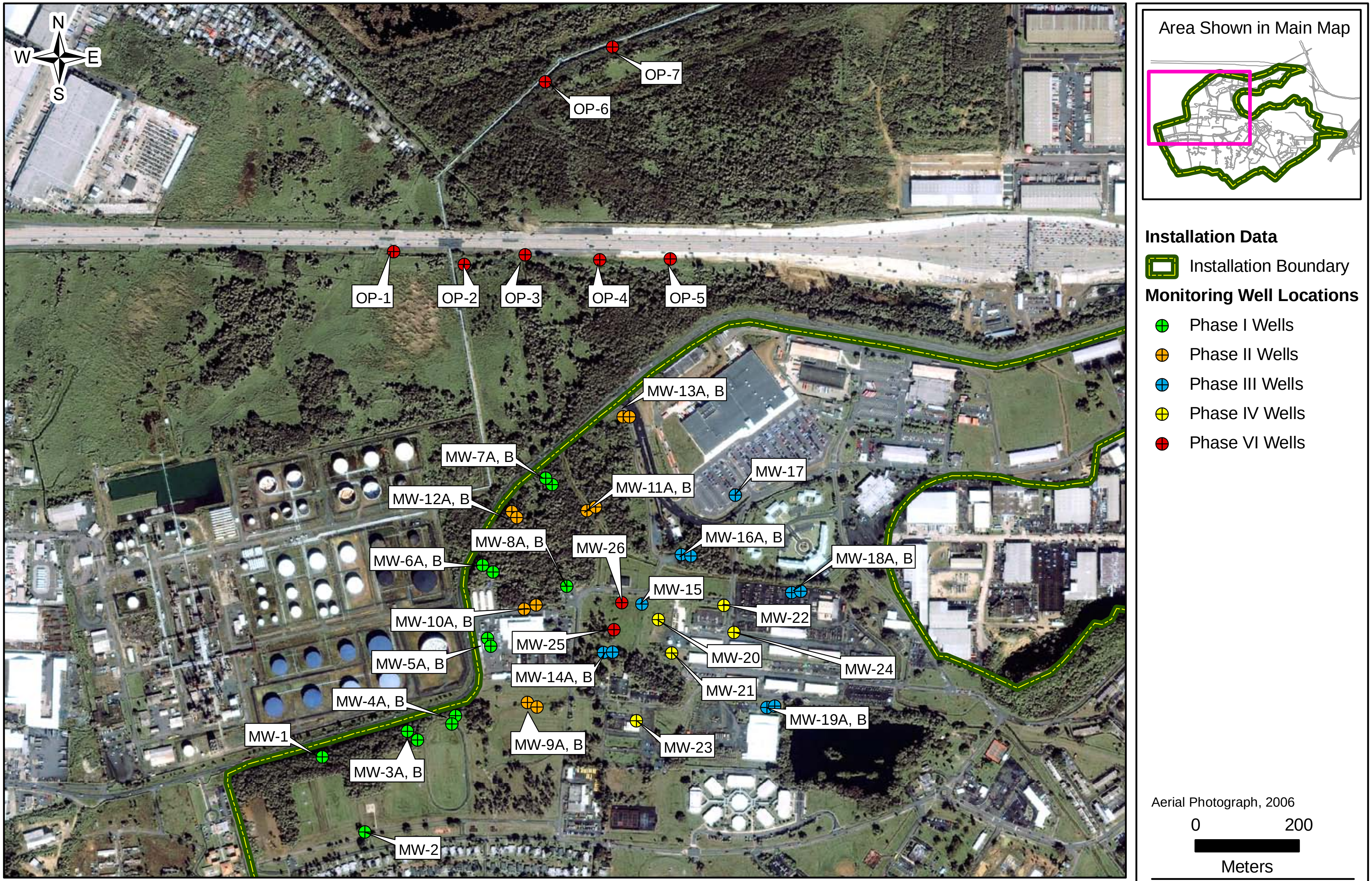
Table 3-2
Water Quality Parameters

Well Number	Sample Date[1]	Volume (L) purged prior to sampling	Turbidity (NTU)	Oxidation-Reduction Potential (mV)	Conductivity (ms/cm)	Dissolved Oxygen (mg/L)	pH	Temperature (ºC)
OP-4	01/06/09	25	9	58.3	1.524	0.02	7.01	25.30
OP-5	01/06/09	9	269	189.6	1.050	0.08	6.96	27.38
OP-6	03/10/09	48	50	72	3.831	0.26	7.02	25.65
OP-7	03/10/09	64	80	-107	8.021	0.17	6.75	25.89
CPR-75B	03/11/09	36	9	206	0.800	0.20	6.40	26.32
CPR-83B1	03/11/09	24	9	96	0.769	0.25	6.79	26.50
CPR-83B2	03/11/09	28	20	82	1.075	0.19	6.85	26.36
CPR-84B	03/11/09	32	58	-23	0.701	0.18	6.91	26.98

[1] Wells were sampled more than once, one representative sample date given and chosen randomly from Appendix G

Table 3-3
Dates and Locations Transducers were Installed in Monitoring Wells

Dates	Wells
January 11 to February 1, 2007	MW-6B, -7B, -8B
June 13 to July 11, 2007	MW-3B, -4A, -4B, -5A, -5B, -6A, -6B, -7A, -7B, -8A, -8B, -9A, -9B, -10A, -10B, -11A, -11B, -12A, -12B, -13A, -13B; CPR-75B, CPR-83B1, CPR-83B2, CPR-84B2, CPR-85B2
January 10 to February 27, 2008	MW-6B, -7A, -7B, -8B, -9A, -9B, -10A, -10B, -11B, -12A, -12B, -13A, -13B, 14A, -14B, -15A, -16A, -16B, -17A, -18A, -18B, -19A, -19B
February 18 to March 11, 2009	MW-11B, -13B, -19A, -21, -25; OP-1, OP-5, OP-6, OP-7; CPR-75B



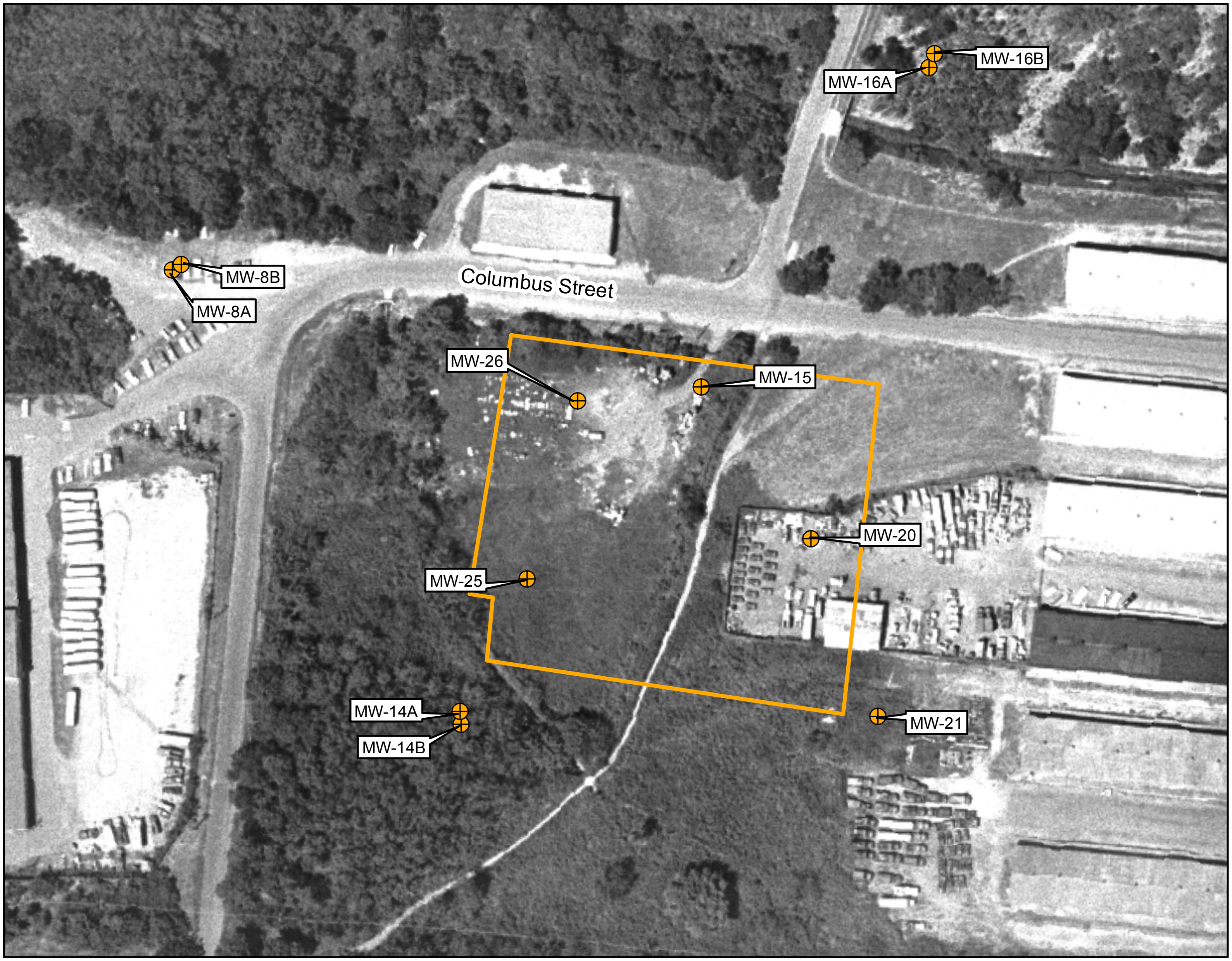
Phase I through VI Monitoring Well Locations

Figure 3-1

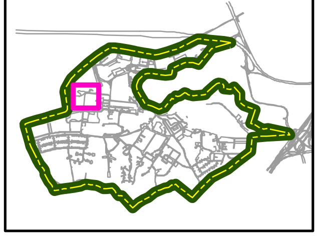
Fort Buchanan, Puerto Rico

EA Engineering, Science, and Technology

\\Edgewoodfp\Projects\Universal GIS\Buchanan\MXDs\Figure 3-1_Well Location Map.mxd



Area Shown in Main Map



Installation Data

🟩 Installation Boundary

▭ Geophysical Investigation Site

⊕ Monitoring Wells

Aerial Photograph, 1967

Geophysical Investigation Location Map and Site Features Circa 1967

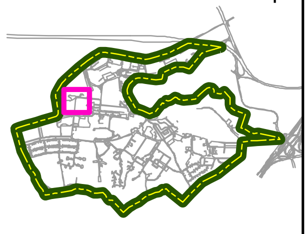
Figure 3-2

Fort Buchanan, Puerto Rico

EA Engineering, Science, and Technology

\\Edgewood\Projects\Universal GIS\Buchanan\MXDs\Figure 3-2 Geophysical Investigation Loc Map.mxd

Area Shown in Main Map



Installation Data

🟩 Installation Boundary

▭ Geophysical Investigation Site

⊕ Monitoring Wells

Data acquired using G-858 magnetometer.

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Meters

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1967 Aerial Photograph and Geophysical Results

Figure 3-3

Fort Buchanan, Puerto Rico

\\Edgewood\Projects\Universal GIS\Buchanan\Figure 3-3 Geophysical Results.mxd

Source Area Phase VI
Investigation Location Map

Figure 3-4

Fort Buchanan, Puerto Rico

EA Engineering, Science, and Technology

\\Edgewood\Projects\Universal GIS\Buchanan\MXDs\Figure 3-4 Source Area Phase VI Investigation Location Map.mxd

Locations of Surface Water and Sediment Pore Water Samples Collected December 2010

Figure 3-5

Fort Buchanan, Puerto Rico

EA Engineering, Science, and Technology

\\Edgewood\projects\Universal GIS\Buchanan\MXDs\Figure 3-5 PoreWaterSampleLocs.mxd

4 DATA QUALITY, ASSURANCE, USABILITY, AND ADEQUACY

Soil, groundwater, sediment pore water, and surface water samples were collected and analyzed to characterize the groundwater of the Northwest Boundary Area and to evaluate whether or not groundwater contamination is impacting surface water due to groundwater discharge. Samples evaluated in the RFI were collected from January 2007 through December 2010. A work plan and QAPP were developed prior to the initial phase of field work and individual work plan addendums were developed for each subsequent work phase. Laboratory analyses were conducted in accordance with the QAPP (EA 2006).

The purpose of this section is to evaluate the data quality of the soil and water data sets. The data set evaluation includes:

- Defining the data sets (Section 4.1)
- Data quality evaluation (Section 4.2)
- Data management (Section 4.3)

4.1 DATA SETS

Data for the RFI were generated from soil, groundwater, sediment pore water, and surface water samples. Each of these datasets is discussed below.

4.1.1 SOIL

Sixteen soil samples and two duplicates were collected from October through December 2006 during installation of the Phase I monitoring wells. Eleven soil samples and one duplicate were collected in September 2008 from a potential source area identified after Phase V of the RFI, where the geophysical investigation was completed (Section 3.2.5). Sampling methods are described in Section 3. The analytical reports provided by the laboratory and the data validation reports are included in Appendix J, and the specific soil samples included in this RFI are identified in Table 4-1.

4.1.2 GROUNDWATER

Data from 157 groundwater samples and 19 duplicates, collected from 52 wells, were included in the RFI. Samples were collected between January 2007 and August 2010 during six phases of the RFI and a well integrity investigation (Sections 3.2 and 3.6, and Table 4-1). The monitoring wells were installed at strategic locations with respect to the groundwater plume and potential plume source areas. When metals analyses were run, both total and dissolved metals were measured. The analytical reports provided by the laboratory for all groundwater data included in the RFI and the data validation reports are included in Appendix J.

It should be noted that some of the wells are located on sites addressed in the Site Wide RFI, specifically Sites 1, 2, 3, 4, 7, 8, and 10. The data generated as part of this Northwest Boundary Area RFI that were collected from wells on these sites are included in the Site Wide RFI.

4.1.3 SEDIMENT PORE WATER AND SURFACE WATER

Data from six sediment pore water samples and one surface water sample collected from the downgradient, lagoon-like water body north of Fort Buchanan and north of wells OP-6 and OP-7 were included in the RFI (Section 3.2.7 and Table 4-1). These samples were collected in December 2010 to determine whether or not contamination in groundwater was impacting surface water through groundwater discharge. These samples were analyzed for VOCs. The analytical reports provided by the laboratory for all pore water and surface water data included in the RFI and the data validation reports are included in Appendix J.

4.2 DATA QUALITY EVALUATION

This section presents the data quality assessment for the analytical data included in this RFI. Data were generated by Accutest Laboratories and validated by one of two third-party validators, either Mr. Rafael Infante Mendez or Environmental Data Services, Inc. (EDS). Data validation was completed in accordance with USEPA Region 2 data validation guidelines as cited in the data validation memoranda included in Appendix J. It should be noted that due to an oversight, subsurface soil data for the general chemistry parameters cyanide and sulfide were not validated.

Tables 4-2 through 4-5 present the specific results of the data quality evaluation as reported by the data validators. The laboratory and validation reports are contained in Appendix J. The following text discusses each of the Data Quality Indicators (DQIs) identified in the project QAPP (EA 2006): precision, accuracy, representativeness, completeness, comparability, and sensitivity (PARCCS).

4.2.1 PRECISION

Precision measures the reproducibility of measurements. It is strictly defined as the degree of mutual agreement among independent measurements as the result of repeated application of the same process under similar conditions. *Analytical* precision is the measurement of the variability associated with duplicate (two) or replicate (more than two) analyses. The duplicate sample is used to determine the precision of the analytical method. If the recoveries of analytes in the duplicate samples are within established control limits, then precision is within limits. *Total* precision is the measurement of the variability associated with the entire sampling and analysis process. It is determined by analysis of duplicate or replicate field samples and measures variability introduced by both the laboratory and field operations.

Matrix spike duplicate (MSD) samples and field duplicate samples are analyzed to assess analytical and total precision, respectively. The precision measurement is determined using the relative percent difference (RPD) between the parent and duplicate sample results. RPD is calculated using the following equation, where X1 and X2 are the duplicate values:

$$\text{RPD} = \frac{|X1 - X2|}{(X1 + X2)/2} \times 100$$

Tables 4-2 and 4-3 present the specific results where RPD values between matrix spike (MS) /MSD samples and parent/field duplicate samples were outside of quality control criteria. As presented in Table 4-2, the RPD values that were outside criteria were generally within twice the criteria value. Exceptions include vinyl acetate in sample JA1114-6, endosulfan sulfate and iron in sample JA1046-11, copper and 2-methylnaphthalene in sample J43547-1, 3,3’-dimethylbenzidine and o-toluidine in sample J80982-6, acetonitrile in samples JA13996-4, JA14171-1, and JA5419-13. None of the RPD values for MS/MSD samples resulted in the rejection of data; all data were sufficiently precise for use.

The RPD values for parent and field duplicate samples were within criteria for all analyte groups except metals and for all but three sample pairs. Table 4-3 presents the samples and analytes with RPD values outside criteria. The RPD values for aluminum and iron found in samples J51095-9 and J51095-6 (G-03-07-MW-05B and 07-JA-09-DP) were extremely high and resulted in rejection of the data for those two samples.

Overall, the precision evaluation for these data show a low proportion of qualified data due to RPD issues in MS/MSD and parent/field duplicate samples.

4.2.2 ACCURACY

Accuracy is a statistical measurement of correctness and includes components of random error (variability due to imprecision) and systemic error. Therefore, it reflects the total error associated with a measurement. A measurement is accurate when the value reported does not differ from the true value or known concentration of the spike or standard. To determine accuracy, a sample which has been spiked with a known concentration is analyzed by the laboratory as the MS, MSD, Laboratory Control Spike (LCS), or Laboratory Control Spike Duplicate (LCSD). Both accuracy and precision are calculated for each analytical batch, and the associated sample results are interpreted by considering these specific measurements. It should be noted that samples analyzed prior to the fall of 2008 did not include post-digestion spikes when recoveries in the MS and MSD samples exceeded acceptance limits. This was a laboratory error in the setup of the specifications for the project.

Accuracy is expressed as percent recovery (%R), and was evaluated by the data validator via the following equation where X is the found concentration, B is the background concentration, and T is the true or assumed concentration.

$$\%R = \frac{X - B}{T} \times 100$$

Table 4-4 presents the specific %R results that were outside criteria for the MS and MSD samples. Many of the organic compounds with %Rs outside of criteria were not detected, and the %Rs were typically low. Acrolein consistently had high %R across numerous sample delivery groups (SDGs) although most samples were non-detect and only two samples received J qualifiers. Other analytes sporadically had either high or low %Rs, although none of the values resulted in rejection of data.

Table 4-5 presents the specific %R results that were outside criteria for the LCS samples. Data for four compounds in SDG J52214, sixteen compounds in SDG J45720, ten compounds in SDG J46678, two compounds in SDG J48688, two compounds in SDG J80982, one compound in SDG J90784, and four compounds in SDG JA13996 were R qualified because of low %Rs. Acrolein had consistently high %Rs, although most results were non-detect and thus not qualified. High %Rs for acrolein did result in the rejection of 17 data points in SDG J63697 and 14 data points in SDG J63716.

Overall, the accuracy evaluation for these data show a low proportion of qualified data due to %R issues in MS, MSD, and LCS samples.

4.2.3 REPRESENTATIVENESS

Representativeness expresses the degree to which data accurately and precisely represent site conditions, a characteristic of a population, or parameter variations at a sampling point. Representativeness is achieved through proper development of the field sampling program and use of standard and accepted SOPs. All samples were collected and analyzed following appropriate and accepted SOPs and methods in order to best represent the actual concentrations of chemicals at the sites.

Samples were collected as outlined in the work plan and addendums with two minor exceptions. During installation of the well cluster MW-6A and MW-6B it was determined that the aquifer was continuous; there were not two distinct carbonate zones as were found at most other well locations (see Section 2.6). Therefore, rather than both wells being screened in the aquifer, MW-6B was screened in the aquifer and MW-6A was screened in the water table to provide information about whether or not impacts to the water table had occurred. Similarly, when MW-15 was installed, the aquifer was found to be continuous. Therefore only a single well rather than a well cluster was installed at that location.

As discussed above, the wide majority of the data met the data quality objectives for precision and accuracy. Therefore the data generated for the project are considered representative of site conditions. Data that may not be representative of the site were not used (R qualified).

4.2.4 COMPLETENESS

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions. Percent completeness (%C) of the data set is determined by the following equation, where N is the number of valid data and S is the total number of results.

$$C = \frac{N}{S} \times 100$$

For completeness requirements, valid results are all results not qualified as unusable (not R qualified). For any instances of samples that could not be analyzed for any reason (holding time violations in which re-sampling and analysis were not possible, samples spilled or broken, etc.), the numerator of this calculation becomes the number of valid results minus the number of possible results not reported. The goal for completeness was 90 percent (EA 2006). There were a total of 32,528 analyte results included in this RFI, and 390 were rejected; therefore, the completeness indicator is 98.8 percent and the completeness measurement quality objective was met.

4.2.5 COMPARABILITY

Comparability is the confidence with which one data set can be compared to another data set. Comparability is achieved by using standard methods for sampling and analysis, reporting data in standard units, normalizing results to standard conditions, and using standard and comprehensive reporting formats. For this RFI, standard methods for sampling and analyses were followed as documented in the QAPP and work plans, and provide a technically sound basis for data comparisons in the future should additional information become available.

4.2.6 SENSITIVITY

Sensitivity is a measure of the screening criteria as they compare to detection limits. The project required quantitation limits (PRQLs) were set to equal the selected screening criteria (EA 2006), and there may be some laboratory quantitation limits that are not low enough to meet the PRQLs due to limitations of the analytical methods. The laboratory and prime contractor worked together to try to meet the PRQLs for as many compounds as possible through accepted published analytical methods including trace inductively coupled argon plasma (ICAP) atomic emission spectroscopy (AES) and mass spectrometry (MS) for metals, and gas chromatography mass spectrometry (GCMS) using both full scan and selected ion monitoring (SIM) for organic chemicals. The laboratory reported detected analytes between the reporting limit (RL) and method detection limit (MDL) as estimated (J flagged) results. Therefore, most of the screening levels were achieved.

Tables 4-6 through 4-8 present a comparison of maximum MDLs of non-detected compounds to the screening criteria. In general, a low percentage of the compounds analyzed for in soil and pore water/surface water had maximum MDLs that were greater than screening criteria: nine analytes in soil (4.4%) and nine analytes in pore water/surface water (16%). A higher percentage of compounds analyzed for in groundwater had maximum MDLs that were greater than tap water regional screening levels (41%), but only 11% of the compounds with MCLs had MDLs that were greater than the MCL. There is no absolute certainty that these non-detect analytes are present at concentrations that could pose a risk to humans or ecological receptors at Fort Buchanan. Consequently, while the data are usable, the results for these analytes do not achieve the DQI for this project.

The screening criteria that were used in this RFI are different from the criteria identified in the QAPP (EA 2006). The QAPP indicated that screening criteria would be derived from USEPA Region 9 Residential Soil and Tap Water Preliminary Remediation Goals. However, in the time period between the QAPP and the RFI, the USEPA developed Regional Screening Levels (RSLs) under an interagency agreement between the USEPA and the Department of Energy's Oak Ridge National Laboratory as an update of the USEPA Region 3 Risk Based Concentration Table, Region 6 Human Health Media-Specific Screening Level Table, and the Region 9 Preliminary Remedial Goals Table.

The June 2011 USEPA RSLs were downloaded from the USEPA website (http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm), and are the values used in this report. The screening levels for non–carcinogenic compounds were divided by 10 to account for potential occurrence of adverse non-carcinogenic health effects due to exposure to multiple non-carcinogens. For pore water and surface water the groundwater screening values were increased by a factor of 10 to account for the reduced exposure to these media as compared to exposure to tap water. Industrial soil screening levels were used for soil because, as described in Section 2.8, residential land use is not in the Master Plan for Fort Buchanan.

In addition to the RSLs, groundwater data were also compared to MCLs and groundwater to air screening values from Table 2c of the USEPA Vapor Intrusion Guidance (USEPA 2002b). Soil data were also compared to site-specific background comparison values (EA 2011).

4.3 DATA MANAGEMENT

Project field and laboratory data are stored using the EQuIS Environmental Data Management System, which is a Structured Query Language (SQL) database management system. EQuIS allows automatic import of electronic data deliverables (EDDs). This minimizes human error in transcribing analytical data. Only the database managers have writing permission to the database. This database is read-only to all other data users to avoid errors. Custom queries of analytical chemistry data can be written by all data users and tied into various data analysis tools to create various maps and figures as needed.

4.3.1 ANALYTICAL CHEMICAL DATA

Chemical data are submitted electronically via e-mail to the data manager by the laboratory. The EDD is generated automatically by direct instrument download of data into the laboratory's respective data management systems, which assists in the elimination of data transcription errors. The EDD file format is compatible with the project database.

Data collected as part of the RFI were validated in accordance with criteria specified in the QAPP and flagged with data qualifiers consistent with those defined in the USEPA Region 2 Guideline SOPs. After data validation is completed, the data qualifiers are entered into the EDD file. Site identifications are added by the data manager and compared 100 percent to site identifications listed in the project database. Only after completing these checks is the EDD file prepared for import into the project database by the data manager. During the import process, the new data are checked against existing data to maintain database integrity.

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Table 4-1
Samples Included in the Northwest Boundary Area RFI

Sample Count	Sampling Phase	Location	Sample Name	Sample Date	Field Duplicate Sample ID
Soil Samples					
1	Phase I	MW-7	SB-03-06-07-(5-6)	10/10/2006	
2	Phase I	MW-7	SB-03-06-07-(16-17)	10/10/2006	
3	Phase I	MW-3	SB-03-06-03-(4-8)	10/20/2006	
4	Phase I	MW-3	SB-03-06-03-(20-22)	10/20/2006	
5	Phase I	MW-6	SB-03-06-06-(4-8)	11/2/2006	
6	Phase I	MW-6	SB-03-06-06-(32-36)	11/3/2006	
7	Phase I	MW-5	SB-03-06-05-(4-8)	11/8/2006	06-NO-08-DP
8	Phase I	MW-5	SB-03-06-05-(28-32)	11/8/2006	
9	Phase I	MW-4	SB-03-06-04-(4-8)	11/13/2006	
10	Phase I	MW-4	SB-03-06-04-(37-36)	11/13/2006	
11	Phase I	MW-1	SB-03-06-01-(4-8)	12/1/2006	
12	Phase I	MW-1	SB-03-06-01-(20-24)	12/1/2006	
13	Phase I	MW-8	SB-03-06-08-(12-16)	12/4/2006	06-DE-04-DP
14	Phase I	MW-8	SB-03-06-08-(16-20)	12/4/2006	
15	Phase I	MW-2	SB-03-06-02-(4-8)	12/6/2006	
16	Phase I	MW-2	SB-03-06-02-(26-28)	12/6/2006	
1	Phase VI	TP-1	TP-1-4	9/16/2008	
2	Phase VI	TP-3	TP-3-4	9/16/2008	
3	Phase VI	TP-4	TP-4-4	9/16/2008	
4	Phase VI	SL-1	SL-1-3	9/17/2008	
5	Phase VI	SL-1	SL-1-5	9/17/2008	
6	Phase VI	SL-2	SL-2-3	9/17/2008	
7	Phase VI	SL-2	SL-2-5	9/17/2008	08-SE-17-DP
8	Phase VI	SL-3	SL-3-3	9/17/2008	
9	Phase VI	SL-3	SL-3-5	9/17/2008	
10	Phase VI	SL-4	SL-4-3	9/17/2008	
11	Phase VI	SL-4	SL-4-5	9/17/2008	
Groundwater Samples					
1	Phase I	MW-3A	G-03-07-MW-03A	1/9/2007	
2	Phase I	MW-3B	G-03-07-MW-03B	1/9/2007	
3	Phase I	MW-4A	G-03-07-MW-04A	1/9/2007	
4	Phase I	MW-4B	G-03-07-MW-04B	1/9/2007	
5	Phase I	MW-5A	G-03-07-MW-05A	1/9/2007	
6	Phase I	MW-5B	G-03-07-MW-05B	1/9/2007	07-JA-09-DP
7	Phase I	MW-6A	G-03-07-MW-06A	1/9/2007	
8	Phase I	MW-6B	G-03-07-MW-06B	1/9/2007	
9	Phase I	MW-1	G-03-07-MW-01	1/10/2007	
10	Phase I	MW-2	G-03-07-MW-02	1/10/2007	
11	Phase I	MW-7A	G-03-07-MW-07A	1/10/2007	G-07-JA-10-DP
12	Phase I	MW-7B	G-03-07-MW-07B	1/10/2007	
13	Phase I	MW-8A	G-03-07-MW-08A	1/10/2007	
14	Phase I	MW-8B	G-03-07-MW-08B	1/10/2007	
1	Phase II	MW-1	G-03-07-MW-01	6/12/2007	
2	Phase II	MW-3A	G-03-07-MW-03A	6/12/2007	
3	Phase II	MW-3B	G-03-07-MW-03B	6/12/2007	
4	Phase II	MW-4A	G-03-07-MW-04A	6/12/2007	
5	Phase II	MW-4B	G-03-07-MW-04B	6/12/2007	
6	Phase II	MW-9A	G-03-07-MW-09A	6/12/2007	
7	Phase II	MW-9B	G-03-07-MW-09B	6/12/2007	
8	Phase II	MW-10B	G-03-07-MW-10B	6/12/2007	

Table 4-1
Samples Included in the Northwest Boundary Area RFI

Sample Count	Sampling Phase	Location	Sample Name	Sample Date	Field Duplicate Sample ID
9	Phase II	MW-11A	G-03-07-MW-11A	6/12/2007	
10	Phase II	MW-11B	G-03-07-MW-11B	6/12/2007	
11	Phase II	MW-12A	G-03-07-MW-12A	6/12/2007	07-JN-12-DP2
12	Phase II	MW-12B	G-03-07-MW-12B	6/12/2007	
13	Phase II	MW-13A	G-03-07-MW-13A	6/12/2007	
14	Phase II	MW-13B	G-03-07-MW-13B	6/12/2007	07-JN-12-DP1
15	Phase II	MW-2	G-03-07-MW-02	6/13/2007	07-JN-13-DP-3
16	Phase II	MW-5A	G-03-07-MW-05A	6/13/2007	
17	Phase II	MW-5B	G-03-07-MW-05B	6/13/2007	
18	Phase II	MW-6A	G-03-07-MW-06A	6/13/2007	
19	Phase II	MW-6B	G-03-07-MW-06B	6/13/2007	
20	Phase II	MW-7A	G-03-07-MW-07A	6/13/2007	
21	Phase II	MW-7B	G-03-07-MW-07B	6/13/2007	
22	Phase II	MW-8A	G-03-07-MW-08A	6/13/2007	
23	Phase II	MW-8B	G-03-07-MW-08B	6/13/2007	
24	Phase II	MW-10A	G-03-07-MW-10A	6/13/2007	
1	Phase III	MW-7A	G-03-08-MW-07A	1/8/2008	
2	Phase III	MW-7B	G-03-08-MW-07B	1/8/2008	
3	Phase III	MW-10A	G-03-08-MW-10A	1/8/2008	
4	Phase III	MW-10B	G-03-08-MW-10B	1/8/2008	
5	Phase III	MW-13A	G-03-08-MW-13A	1/8/2008	
6	Phase III	MW-13B	G-03-08-MW-13B	1/8/2008	
7	Phase III	MW-15A	G-03-08-MW-15A	1/8/2008	
8	Phase III	MW-16A	G-03-08-MW-16A	1/8/2008	
9	Phase III	MW-16B	G-03-08-MW-16B	1/8/2008	
10	Phase III	MW-17A	G-03-08-MW-17A	1/8/2008	08-JA-08-DP
11	Phase III	MW-19A	G-03-08-MW-19A	1/8/2008	
12	Phase III	MW-19B	G-03-08-MW-19B	1/8/2008	
13	Phase III	MW-6B	G-03-08-MW-06B	1/9/2008	08-JA-09-DP2
14	Phase III	MW-8B	G-03-08-MW-08B	1/9/2008	08-JA-09-DP1
15	Phase III	MW-9A	G-03-08-MW-09A	1/9/2008	
16	Phase III	MW-9B	G-03-08-MW-09B	1/9/2008	
17	Phase III	MW-11A	G-03-08-MW-11A	1/9/2008	
18	Phase III	MW-11B	G-03-08-MW-11B	1/9/2008	
19	Phase III	MW-12A	G-03-08-MW-12A	1/9/2008	
20	Phase III	MW-12B	G-03-08-MW-12B	1/9/2008	
21	Phase III	MW-14A	G-03-08-MW-14A	1/9/2008	
22	Phase III	MW-14B	G-03-08-MW-14B	1/9/2008	
23	Phase III	MW-18A	G-03-08-MW-18A	1/9/2008	
24	Phase III	MW-18B	G-03-08-MW-18B	1/9/2008	
1	Phase IV	MW-14A	G-03-08-MW-14A	5/13/2008	
2	Phase IV	MW-14B	G-03-08-MW-14B	5/13/2008	
3	Phase IV	MW-16A	G-03-08-MW-16A	5/13/2008	
4	Phase IV	MW-16B	G-03-08-MW-16B	5/13/2008	
5	Phase IV	MW-17A	G-03-08-MW-17A	5/13/2008	08-MA-13-DP2
6	Phase IV	MW-18A	G-03-08-MW-18A	5/13/2008	
7	Phase IV	MW-18B	G-03-08-MW-18B	5/13/2008	
8	Phase IV	MW-19A	G-03-08-MW-19A	5/13/2008	
9	Phase IV	MW-19B	G-03-08-MW-19B	5/13/2008	
10	Phase IV	MW-20	G-03-08-MW-20	5/13/2008	
11	Phase IV	MW-21	G-03-08-MW-21	5/13/2008	
12	Phase IV	MW-22	G-03-08-MW-22	5/13/2008	08-MA-13-DP1

Table 4-1
Samples Included in the Northwest Boundary Area RFI

Sample Count	Sampling Phase	Location	Sample Name	Sample Date	Field Duplicate Sample ID
13	Phase IV	MW-23	G-03-08-MW-23	5/13/2008	
14	Phase IV	MW-24	G-03-08-MW-24	5/13/2008	
15	Phase IV	MW-6B	G-03-08-MW-06B	5/14/2008	
16	Phase IV	MW-7B	G-03-08-MW-7B	5/14/2008	
17	Phase IV	MW-11A	G-03-08-MW-11A	5/14/2008	
18	Phase IV	MW-11B	G-03-08-MW-11B	5/14/2008	
19	Phase IV	MW-12A	G-03-08-MW-12A	5/14/2008	
20	Phase IV	MW-12B	G-03-08-MW-12B	5/14/2008	
21	Phase IV	MW-13A	G-03-08-MW-13A	5/14/2008	08-MA-14-DP3
22	Phase IV	MW-13B	G-03-08-MW-13B	5/14/2008	
23	Phase IV	MW-15A	G-03-08-MW-15A	5/14/2008	
1	Phase VI	MW-6B	G-03-09-MW-06B	1/6/2009	09-JA-06-DP1
2	Phase VI	MW-7B	G-03-09-MW-7B	1/6/2009	
3	Phase VI	MW-11A	G-03-09-MW-11A	1/6/2009	
4	Phase VI	MW-11B	G-03-09-MW-11B	1/6/2009	
5	Phase VI	MW-22	G-03-09-MW-22	1/6/2009	
6	Phase VI	MW-24	G-03-09-MW-24	1/6/2009	
7	Phase VI	OP-1	G-03-09-OP-1	1/6/2009	
8	Phase VI	OP-2	G-03-09-OP-2	1/6/2009	
9	Phase VI	OP-3	G-03-09-OP-3	1/6/2009	
10	Phase VI	OP-4	G-03-09-OP-4	1/6/2009	
11	Phase VI	OP-5	G-03-09-OP-5	1/6/2009	
12	Phase VI	MW-7B	G-03-09-MW-7B	1/7/2009	
13	Phase VI	MW-11A	G-03-09-MW-11A	1/7/2009	
14	Phase VI	MW-12A	G-03-09-MW-12A	1/7/2009	
15	Phase VI	MW-12B	G-03-09-MW-12B	1/7/2009	
16	Phase VI	MW-13A	G-03-09-MW-13A	1/7/2009	
17	Phase VI	MW-13B	G-03-09-MW-13B	1/7/2009	
18	Phase VI	MW-15A	G-03-09-MW-15	1/7/2009	09-JA-07-DP2
19	Phase VI	MW-16A	G-03-09-MW-16A	1/7/2009	
20	Phase VI	MW-16B	G-03-09-MW-16B	1/7/2009	
21	Phase VI	MW-18A	G-03-09-MW-18A	1/7/2009	
22	Phase VI	MW-20	G-03-09-MW-20	1/7/2009	
23	Phase VI	MW-21	G-03-09-MW-21	1/7/2009	
24	Phase VI	MW-22	G-03-09-MW-22	1/7/2009	
25	Phase VI	MW-23	G-03-09-MW-23	1/7/2009	
26	Phase VI	MW-25	G-03-09-MW-25	1/7/2009	
27	Phase VI	MW-26	G-03-09-MW-26	1/7/2009	09-JA-07-DP1
28	Phase VI	OP-1	G-03-09-OP-1	1/7/2009	
29	Phase VI	OP-2	G-03-09-OP-2	1/7/2009	
30	Phase VI	OP-5	G-03-09-OP-5	1/7/2009	
31	Phase VI	MW-15A	G-03-09-MW-15	1/8/2009	09-JA-08-DP
1	Phase VI	MW-6B	G-03-09-MW-6B	3/10/2009	
2	Phase VI	MW-8B	G-03-09-MW-8B	3/10/2009	
3	Phase VI	MW-10A	G-03-09-MW-10A	3/10/2009	
4	Phase VI	MW-10B	G-03-09-MW-10B	3/10/2009	
5	Phase VI	MW-14A	G-03-09-MW-14A	3/10/2009	
6	Phase VI	OP-1	G-03-09-OP-1	3/10/2009	9-MR-10-DP1
7	Phase VI	OP-3	G-03-09-OP-3	3/10/2009	
8	Phase VI	OP-4	G-03-09-OP-4	3/10/2009	
9	Phase VI	OP-5	G-03-09-OP-5	3/10/2009	
10	Phase VI	OP-6	G-03-09-OP-6	3/10/2009	

Table 4-1
Samples Included in the Northwest Boundary Area RFI

Sample Count	Sampling Phase	Location	Sample Name	Sample Date	Field Duplicate Sample ID
11	Phase VI	OP-7	G-03-09-OP-7	3/10/2009	
12	Phase VI	MW-5A	G-03-09-MW-5A	3/11/2009	
13	Phase VI	MW-25	G-03-09-MW-25	3/11/2009	
14	Phase VI	MW-26	G-03-09-MW-26	3/11/2009	
15	Phase VI	OP-2	G-03-09-OP-2	3/11/2009	9-MR-11-DP1
16	Phase VI	CPR-75B	G-03-09-CPR-75B	3/11/2009	
17	Phase VI	CPR-83B1	G-03-09-CPR-83B1	3/11/2009	
18	Phase VI	CPR-83B2	G-03-09-CPR-83B2	3/11/2009	
19	Phase VI	CPR-84B2	G-03-09-CPR-84B2	3/11/2009	
20	Supplemental Phase VI	OP-6	G-03-09-OP-6	4/14/2009	
21	Supplemental Phase VI	OP-7	G-03-09-OP-7	4/14/2009	
1	Well Integrity Inves.	MW-1	G-03-10-MW-01	8/17/2010	
2	Well Integrity Inves.	MW-3A	G-03-10-MW-03A	8/17/2010	
3	Well Integrity Inves.	MW-4A	G-03-10-MW-04A	8/18/2010	
4	Well Integrity Inves.	MW-4B	G-03-10-MW-04B	8/18/2010	
5	Well Integrity Inves.	MW-5A	G-03-10-MW-05A	8/17/2010	
6	Well Integrity Inves.	MW-6A	G-03-10-MW-06A	8/17/2010	
7	Well Integrity Inves.	MW-7A	G-03-10-MW-07A	8/17/2010	
8	Well Integrity Inves.	MW-11A	G-03-10-MW-11A	8/18/2010	10-AUG-18-DP2
9	Well Integrity Inves.	MW-12A	G-03-10-MW-12A	8/18/2010	
10	Well Integrity Inves.	MW-12B	G-03-10-MW-12B	8/18/2010	
11	Well Integrity Inves.	MW-13A	G-03-10-MW-13A	8/18/2010	
12	Well Integrity Inves.	MW-13B	G-03-10-MW-13B	8/18/2010	
13	Well Integrity Inves.	MW-25	G-03-10-MW-25	8/18/2010	
14	Well Integrity Inves.	MW-26	G-03-10-MW-26	8/18/2010	
15	Well Integrity Inves.	OP-1	G-03-10-OP-1	8/17/2010	
16	Well Integrity Inves.	OP-2	G-03-10-OP-2	8/17/2010	
17	Well Integrity Inves.	OP-3	G-03-10-OP-3	8/17/2010	
18	Well Integrity Inves.	OP-4	G-03-10-OP-4	8/17/2010	
19	Well Integrity Inves.	OP-5	G-03-10-OP-5	8/17/2010	10-AUG-17-DP1
20	Well Integrity Inves.	OP-6	G-03-10-OP-6	8/18/2010	
Sediment Pore Water and Surface Water					
1	Phase VII	PORE-1	G-03-09-MW-6B	12/9/2010	DUP-1
2	Phase VII	PORE-2	G-03-09-MW-8B	12/9/2010	
3	Phase VII	PORE-3	G-03-09-MW-10A	12/9/2010	
4	Phase VII	PORE-4	G-03-09-MW-10B	12/9/2010	
5	Phase VII	PORE-5	G-03-09-MW-14A	12/10/2010	
6	Phase VII	PORE-6	G-03-09-OP-1	12/10/2010	
7	Phase VII	SW-1	G-03-09-OP-3	12/9/2010	

Table 4-2
Compounds with Relative Percent Difference Values Outside of Quality Control Limits
Matrix Spike and Matrix Spike Duplicate Samples

QC Sample ID	Compound	MS Result	MSD Result	Result Units	RPD	RPD Criteria	Affected Samples	Validator's Action
SDG JA1046								
JA1114-6 MS/MSD	Ethyl methacrylate	33.6	22.5	ug/kg	40	≤ 32	JA1046-6	None, all ND
	Vinyl acetate	6.6	ND	ug/kg	200	≤ 31		
JA1046-11 MS/MSD	Hexachlorophene	1400	949	ug/kg	38	≤ 34	1 thru 5, 7 thru 12	J in Sample JA1046-11; all samples ND
JA1046-11 MS/MSD	alpha-BHC	27.6	16.6	ug/kg	50	≤ 41	1 thru 5, 7 thru 12	None, high RPD due to low concentration of MSD for all but endrin ketone
	beta-BHC	25.4	13.1	ug/kg	64	≤ 48		
	delta-BHC	25.1	10.5	ug/kg	82	≤ 48		
	gamma-BHC	24.5	12.1	ug/kg	68	≤ 40		
	Dieldrin	25.7	12.9	ug/kg	66	≤ 42		
	4,4'-DDD	26.1	14.9	ug/kg	55	≤ 44		
	4,4'-DDE	25.6	14.1	ug/kg	58	≤ 41		
	4,4'-DDT	26.4	13.2	ug/kg	67	≤ 47		
	Endrin	28	15.3	ug/kg	59	≤ 43		
	Endosulfan sulfate	23.9	8.1	ug/kg	99	≤ 48		
	Endrin aldehyde	18.9	6.8	ug/kg	94	≤ 48		
	Endosulfan-I	25.1	13	ug/kg	64	≤ 43		
	Endosulfan-II	24.8	10.9	ug/kg	78	≤ 43		
	Heptachlor epoxide	24	18.8	ug/kg	24	≤ 44		
	Methoxychlor	26.5	11.3	ug/kg	80	≤ 48		
	Endrin Ketone	31.5	12.4	ug/kg	87	≤ 46		
JA1046-11 MS/MSD	Iron	45400	28900	mg/kg	44.4	≤ 20	1 thru 12	None
	Manganese	532	373	mg/kg	35.1	≤ 20		J
SDG J51095								
J51095-5 MS/MSD	gamma-chlordane	0.21	0.34	ug/L	47	≤ 25	1 thru 9	No action based on RPD alone
	4,4'-DDE	1.8	1.4	ug/L	25	≤ 21		None, sample ND
SDG J43547								
J43547-1 MS/MSD	Antimony	43.8	35.8	mg/kg	26	≤ 20	1 thru 2	J/UJ
	Copper	177	168	mg/kg	127	≤ 20		J
	2-Methylnaphthalene	844	1490	ug/kg	55	≤ 11		No action based on RPD alone
SDG J44840								
J44840-1 MS/MSD	Antimony	35.3	36.3	mg/kg	32	≤ 20	1 thru 2	J/UJ

Table 4-2
Compounds with Relative Percent Difference Values Outside of Quality Control Limits
Matrix Spike and Matrix Spike Duplicate Samples

QC Sample ID	Compound	MS Result	MSD Result	Result Units	RPD	RPD Criteria	Affected Samples	Validator's Action
SDG J45720								
J45720-1 MS/MSD	Benzo (b) fluoranthene	1380	2310	ug/kg	50	≤ 33	1 thru 2	No action based on RPD alone
SDG J48688								
J48688-1 MS/MSD	Vanadium	427	324	mg/kg	27.4	≤ 20	1 thru 2	J
SDG J63697								
J63697-5 MS/MSD	Benzo (b) fluoranthene	46.7	27.7	ug/l	53	≤ 31	1 thru 9 and 15,16	No Action Based on MS/MSD Results
	Benzo (k) Fluoranthene	15.9	28.7	ug/l	57	≤ 31		
SDG J63716								
OP28091-MD/MSD	Hexachlorocyclopentadiene	185	118	ug/l	44	≤ 38	10,12,13	No Action
J63709-1 MS/MSD	trans-1,4-dichloro-2-Butene	31	18.6	ug/l	3	≤ 31	1,3,4,5,6,8	No Action Based on MS/MSD Results
SDG J80982								
J80982-6 MS/MSD	3,3'-dimethylbenzidine	14.8	19.2	ug/l	26	≤ 10	1 thru 6, 8,14,15,26,27	J
	Famphur	245	273	ug/l	11	≤ 10		No Action
	Hexachloropropene	23.4	22.9	ug/l	2	≤ 10		J
	Methapyrilene	31.7	36.7	ug/l	15	≤ 10		J
	o-toluidine	54	39.9	ug/l	30	≤ 10		No Action
SDG J90784								
J90784-1 MS/MSD	1,4-Dioxane	1610	1450	ug/l	31	≤ 26	1	No Action
J90784-19 MS/MSD	Mercury	2.6	1.9	mg/l	31.1	≤ 20	2 thru 15 and 19	No Action
SDG JA9388								
OP36417 MS/MSD	MCPA	83.8	85.7	ug/l	2	≤ 31	17	J
	Dalapon	2.2	2.7	ug/l	20	≤ 46		
SDG JA13996								
JA13996-4 MS/MSD	Acetonitrile	543	933	ug/l	53	≤ 18	4 thru 14 and 1,2	Accept NDs
JA14171-1 MS/MSD	Acetonitrile	10900	16900	ug/l	43	≤ 18	15,16	No Action

Table 4-2
Compounds with Relative Percent Difference Values Outside of Quality Control Limits
Matrix Spike and Matrix Spike Duplicate Samples

QC Sample ID	Compound	MS Result	MSD Result	Result Units	RPD	RPD Criteria	Affected Samples	Validator's Action
SDG JA54314								
OP45253 MS/MSD	TPH-DRO (C10-C28)	0.782	0.436	mg/l	57	≤ 31	21,23	No Action
JA5419-13 MS/MSD	1,4-Dioxane	12300	8030	ug/l	42	≤ 22	5,6	No Action
	Acetonitrile	5160	3220	ug/l	46	≤ 18		
	Propionitrile	5960	4870	ug/l	20	≤ 13		
	Acetone	640	479	ug/l	29	≤ 20		
	Tetrachloroethene	505	609	ug/l	19	≤ 15		

ND = Not Detected
MS = Matrix Spike
MSD = Matrix Spike Duplicate
RPD = Relative Percent Difference
SDG = Sample Delivery Group

Table 4-3
Compounds with Relative Percent Difference Values Outside of Quality Control Limits
Parent and Field Duplicate Samples

Parent Sample/ Duplicate Sample	Compound	Parent Sample Result	Duplicate Sample Result	Result Units	RPD	Validator Action
SDG JA1046						
JA1046-7 / JA1046-12	Iron	28100	62800	mg/kg	76	J
	Manganese	398	1150	mg/kg	97	
	Zinc	55.3	82	mg/kg	39	
SDG J51095						
J51095-9 / J51095-6	Aluminum	394	1790	ug/L	1396	R
	Iron	1890	457	ug/L	1433	
SDG J45978						
J45978-1 / J45978-2	Arsenic	24	54.4	mg/kg	77	J
	Chromium	152	227	mg/kg	40	
	Copper	39.9	68.3	mg/kg	52	

RPD Criteria ± 35% for solid matrix (measured in kg), ± 20% for aqueous matrix (measured in L)
RPD = Relative Percent Difference
SDG = Sample Delivery Group

Table 4-4
Compounds with Percent Recoveries Outside of Quality Control Limits
Matrix Spike and Matrix Spike Duplicate Samples

QC Sample ID	Compound	MS %R	MSD %R	%R Criteria	Affected Samples	Validator's Action
SDG JA1046						
JA1114-1 MS/MSD	Acrolein	182	165	9-164	JA1046-3	None, all ND
	Ethyl methacrylate	24	20	27-151		
	Vinyl acetate	12	13	19-157		
JA1046-11 MS/MSD	Acrolein	422	353	9-164	1, 2, 4, 5, 7 thru 12	J in Sample JA1046-11; all samples ND
JA1114-6 MS/MSD	Acrolein	351	289	9-164	JA1046-6	None, all ND
	Vinyl acetate	12	0	19-157		
JA1046-11 MS/MSD	4-Aminobiphenyl	48	48	70-130	1 thru 5, 7 thru 12	J in Sample JA1046-11; all samples ND
	3,3'-dimethylbenzidine	79	40	50-150		
	Famphur	65	72	70-130		
	Hexachlorophene	57	39	70-130		
	Kepone	12	11	70-130		
	1-Naphthylamine	52	51	70-130		
	2-Naphthylamine	57	56	70-130		
	4-Nitroquinoline 1-oxide	57	59	70-130		
	Pyridine	121	60	11-88		
	p-Phenylenediamine	6	5	70-130		
JA1046-11 MS/MSD	Aluminum	123.2	42.2	75-125	1 thru 12	J
	Calcium	75.7	15.6	75-125		
	Copper	89.3	73.1	75-125		
	Iron	133.2	-80.2 [a]	75-125		No Action
	Manganese	126.2	16.3	75-125		J
	Magnesium	91.6	73.5	75-125		
	Vanadium	92.6	153	75-125		
SDG J51095						
J51095-5 MS/MSD	delta-BHC	60	68	66-153	1 thru 9	J/UJ
	4,4'-DDE	720	560	55-148		None, sample ND
	Heptachlor epoxide	172	152	66-141		
	Acrolein	382	368	42-201	2 thru 10	
SDG J52214						
J52214-2 MS/MSD	2,6-Dichlorophenol	68	69	76-93	1 thru 8	J/UJ
SDG J43547						
J43547-1 MS/MSD	Antimony	31.1	26.3	75-125	1 thru 2	J/UJ
	Copper	136.3	127.2	75-125		J
	Vanadium	70.7	67.5	75-125		J/UJ
	2-Methylnaphthalene	50	48	21-102		No Action
SDG J44840						
J44840-1 MS/MSD	Antimony	30.4	31.6	75-125	1 thru 2	J/UJ
SDG J45720						
J45720-1 MS/MSD	Antimony	32.3	33.9	75-125	1 thru 2	J/UJ
	Selenium	74.6	76.3	75-125		
	Vanadium	72.2	75.5	75-125		
	Benzo (b) fluoranthene	65	109	56-187		No Action

Table 4-4
Compounds with Percent Recoveries Outside of Quality Control Limits
Matrix Spike and Matrix Spike Duplicate Samples

QC Sample ID	Compound	MS %R	MSD %R	%R Criteria	Affected Samples	Validator's Action
SDG J45978						
J45978-1 MS/MSD	Antimony	35.6	32.7	75-125	1 thru 3	J/UJ
	Selenium	73.7	70.3	75-125		
	Vanadium	67.1	96.3	75-125		
SDG J46678						
J46678-1 MS/MSD	Antimony	25.4	22.1	75-125	1 thru 2	J/UJ
	Arsenic	71.7	70.1	75-125		
	Cadmium	69.5	67.3	75-125		
	Chromium	51.4	64	75-125		
	Cobalt	67.2	70.2	75-125		
	Lead	73.9	73.1	75-125		
	Selenium	72.6	69.2	75-125		
	Silver	74	71	75-125		
	Thallium	74.5	73	75-125		
	Tin	73.4	69.7	75-125		
	Vanadium	66.6	68.9	75-125		
SDG J48395						
J48395-2 MS/MSD	Antimony	30.5	30.6	75-125	5	J/UJ
	Zinc	69.1	69.2	75-125	1 thru 5	
SDG J48688						
J48688-1 MS/MSD	Antimony	32.4	27.8	75-125	1 thru 3	J/UJ
	Chromium	180.5	114.1	75-125		J
	Vanadium	177.2	93.2	75-125		
SDG J63697						
J63697-5 MS/MSD	Benzo(k) fluoranthene	32	57	39-116	1 thru 9 and 15,16	No Action
	7,12-Dimethylbenz(a)anthracene	88	84	1-71		
	Acrolein	362	370	50-170		
	Trichloroethene	14	18	60-138		
	Mercury	55	50	75-125		J
SDG J63716						
OP28091-MD/MSD	3,3-Dichlorobenzidine	3	8	12-125	10,12,13	No Action
J63930-3 MS/MSD	Acrolein	296	284	50-170	2	
	Ethylbenzene	-22	-38	48-140		
	Toluene	47	37	48-141		
J63709-1 MS/MSD	Acrolein	232	240	50-170	1,3,4,5,6,8	
	Dichlorodifluoromethane	19	20	32-171		
	Trichlorofluoromethane	35	33	42-169		
J63708-14 MS/MSD	Acrolein	264	258	50-170	12 thru 14	
J64414-1 MS/MSD	Acrolein	314	296	50-170	7,8,10,11	
SDG J80982						
J80829-16 MS/MSD	Trichloroethene	28	30	60-138	16 thru 24 and 26	No Action
J80982-25 MS/MSD	Trichloroethene	52	38	60-138	25	J

Table 4-4
Compounds with Percent Recoveries Outside of Quality Control Limits
Matrix Spike and Matrix Spike Duplicate Samples

QC Sample ID	Compound	MS %R	MSD %R	%R Criteria	Affected Samples	Validator's Action
J80982-6 MS/MSD	3,3'-Dimethylbenzidine	30	38	70-130	1 thru 6, 8,14,15,26,27	J
	Hexachloropropene	47	46	46-102		
	Kepone	113	6	46-102		
	Methapyrilene	31.7	36.7	70-130		
	1,4-Naphthoquinone	111	119	59-103		
	N-nitrosomethylethylamine	59	62	62-114		
	2-picoline	69	71	70-130		
	Thionazin	92	99	1-56		No Action
	7,12-Dimethylbenz(a)anthracene	90	94	1-17		No Action
SDG J90784						
J90784-25 MS/MSD	Acrolein	296	NA	43-188	24 thru 29	Accept NDs
J90784-1 MS/MSD	Acrolein	330	334	43-188	1	J
J90784-19 MS/MSD	Acrolein	292	304	43-188	2 thru 15 and 19	Accept NDs
	7,12-Dimethylbenzo(a)anthracene	92	89	1-71		No Action
	Mercury	130	95	75-125		J
J90810-7 MS/MSD	Acrolein	324	314	43-188	2,3,4,11	Accept NDs
J91278-2 MS/MSD	Acrolein	278	281	43-188	16,17,18,20,21,22,23	Accept NDs
SDG JA9388						
JA9388-17 MS/MSD	4-Methyl-2-pentanone	154	152	55-148	1 thru 7 and 17	Accept NDs
	Trichloroethene	53	40	56-145		No Action
	Calcium	100	68	75-125		
	Manganese	84	72	75-125		
OP36417 MS/MSD	MCPA	42 [a]	43 [a]	51-183	17	J
	Dalapon	275	338	5-158		
OP36433- MS/MSD	4,4'-DDT	166 [a]	138	43-150	17	J
	Endosulfan I	116	158 [a]	39-145		
SDG JA13996						
JA13996-4 MS/MSD	Acetonitrile	109	187	45-141	4 thru 14 and 1,2	Accept NDs
	Allyl chloride	144	152	45-136		
	Chloroprene	158	138	47-149		
JA14171-1 MS/MSD	Acetonitrile	87	135	45-141	16,15	No Action
JA14171-3 MS/MSD	Acetonitrile	128	148	45-141	17 thru 25 and 11	No Action
	Isobutyl Alcohol	528	536	49-152		
JA12315-9A MS/MSD	4,4'-DDT	34	22	43-150	11,17	No Action
	Metoxychlor	34	32	45-160		
SDG JA64104						
JA64104-1 MS/MSD	Acetone	234 [a]	246 [a]	44-157	1 thru 4 and 6,7	Accept NDs
	2-Butanone	139	146	58-140		
	2-Hexanone	154	160	53-145		

Table 4-4
Compounds with Percent Recoveries Outside of Quality Control Limits
Matrix Spike and Matrix Spike Duplicate Samples

QC Sample ID	Compound	MS %R	MSD %R	%R Criteria	Affected Samples	Validator's Action
JA54314-11 MS/MSD	Carbon disulfide	158	160	34-136	11	J
JA54314-2 MS/MSD	Carbon disulfide	149	130	34-136	2	J
JA54919-13 MS/MSD	Carbon disulfide	174	196	34-136	5,6	No Action
	Allyl chloride	134	144	45-136		
	Iodomethane	133	145	56-135		
	1,1 Dichloroethene	125	146	41-144		
	trans-1,2-Dichloroethene	121	136	55-131		
	Trichloroethene	-26	30	53-141		

% R = Percent Recovery
MS = Matrix Spike
MSD = Matrix Spike Duplicate
ND = Not Detected
SDG = Sample Delivery Group
a = Spike amount low relative to sample amount.

Table 4-5
Compounds with Percent Recoveries Outside of Quality Control Limits
Lab Control Samples

QC Sample ID	Compound	LCS %R	%R Criteria	Affected Samples	Validator's Action
SDG J5109					
OP26156-BS1	2-Methylphenol	94	40-92	1 thru 9	None, all samples ND
	4-Nitrophenol	68	3-64		
	Anthracene	117	64-110		
	4-Bromophenylphenylether	117	61-115		
	Hexachlorobenzene	127	61-119		
	n-Nitrosodiphenylamine	113	59-112		
	Pyrene	115	58-114		
VA4010-BS	Acrolein	268	30-220	2 thru 10	None, all samples ND
SDG J52214					
OP26159-BS2	delta-BHC	68	72-143	1 thru 8	R
OP26179-BS1	1,2-Dichlorobenzene	54	55-104	1 thru 8	R
	1,4-Dichlorobenzene	51	54-102		
	1,2,4-Trichlorobenzene	49	53-105		
VA4014-BS	Acrolein	340	30-220	1 thru 9	None, all samples ND
	1,1,2-Trichloroethane	122	83-120		
SDG JA1046					
VV3371-BS1	Acrolein	518	30-192	JA1046-3	Accept NDs
VV3374-BS	Acrolein	536	30-192	1, 2, 4, 5, 7 thru 12	Accept NDs
VV3376-BS	Acrolein	490	30-192	JA1046-6	Accept NDs
SDG J43547					
OP25143-BS12	Benzo (k) fluoranthene	298	36-140	1 thru 3	None, all samples ND
OP25156-BS12	Benzo (k) fluoranthene	155	29-145		
OP25090-BS2	Aroclor 1016	150	71-131		
	Aroclor 1260	140	72-134		

Table 4-5
Compounds with Percent Recoveries Outside of Quality Control Limits
Lab Control Samples

QC Sample ID	Compound	LCS %R	%R Criteria	Affected Samples	Validator's Action
SDG J45720					
OP25364-BS2	2,4-D	132	54-123	1 thru 2	None, all samples ND
	2,4,5-TP (Silvex)	146	58-121		
	2,4,5-T	131	66-124		
OP25437-BS12	4-Aminobiphenyl	45	70-130	1 thru 2	J/R
	Aramite	133	70-130		None, all samples ND
	a,a-Dimethylphenethylamine	47	70-130		J/R
	3,3'-Dimethylbenzidine	35	70-130		
	Disulfoton	15	70-130		
	Ethyl methanesulfonate	69	70-130		
	Famphur	64	70-130		
	Hexachlorophene	8	70-130		
	Kepone	48	70-130		
	Methly methanesulfonate	58	70-130		
	1,4-Naphthoquinone	49	70-130		
	1-Naphthylamine	61	70-130		
	2-Naphthylamine	66	70-130		
	n-Nitrosodiphenylamine	68	41-117		
	2-Picoline	59	70-130		
	Phorate	134	70-130		
	p-Phenylenediamine	9	70-130		J
	O-Toluidine	60	70-130		J/R
VG4683-BS	Benzene	120	79-118	1 thru 3	None, all samples ND
	Acrolein	242	14-200		
	Isobutly alcohol	143	48-150		
SDG J45978					
OP25364-BS3	2,4-D	124	54-123	1 thru 3	None, all samples ND

Table 4-5
Compounds with Percent Recoveries Outside of Quality Control Limits
Lab Control Samples

QC Sample ID	Compound	LCS %R	%R Criteria	Affected Samples	Validator's Action
SDG J46678					
OP25502-BS2	2-Chlorophenol	55	65-107	1 thru 2	J/R
	2,4-Dichlorophenol	64	65-112		
	2,6-Dichlorophenol	62	70-130		
	2-Merhylphenol	61	61-105		
	Phenol	57	61-109		
	2,4,6-Trichlorophenol	64	69-111		
	1,2-Dichlorobenzene	54	60-100		
	1,3-Dichlorobenzene	52	59-98		
	1,4-Dichlorobenzene	53	59-99		
	Hexachloroethane	55	56-103		
VD4790-BS	Acrolein	202	17-200	1 thru 3	None, all samples ND
SDG J48395					
VV2480-BS	Bromodichloromethane	126	80-125	1 thru 6	None, all samples ND
	Chloroform	127	78-123		
	Chloroprene	138	66-136		
	1,1-Dichloroethane	125	76-123		
SDG J48688					
VA3975-BS	Acrolein	250	30-220	1 thru 4	None, all samples ND
OP25810-BS-1	Hexachlorobutadiene	46	48-114	3	J/R
	1,2,4-Trichlorobenzene	47	53-105		

Table 4-5
Compounds with Percent Recoveries Outside of Quality Control Limits
Lab Control Samples

QC Sample ID	Compound	LCS %R	%R Criteria	Affected Samples	Validator's Action
SDG J63697					
OP28089-BS11	Diphenylamine	69	82-128	1 thru 16	No Action Taken
	m-Dinitrobenzene	62	90-147		
	Ethyl methanesulfonate	50	66-111		
	Hexachlorophene	128	70-124		
	Isosafrole	42	51-144		
	Methapyrilene	12	68-121		
	Merhylparathion	82	94-145		
	1,4-Naphthoquinone	35	46-117		
	1-Naphthylamine	164	53-97		
	2-Naphthylamine	200	66-103		
	p-Phenylenediamine	79	85-134		
	Safrole	51	74-111		
	Sym-Trinitrobenzene	54	107-164		
	2-Methylnaphthalene	116	17-114		
V3A1617-BS	Acrolein	372	37-179	1 thru 17	R

Table 4-5

Compounds with Percent Recoveries Outside of Quality Control Limits

Lab Control Samples

QC Sample ID	Compound	LCS %R	%R Criteria	Affected Samples	Validator's Action
SDG J63716					
OP28091-BS11	Diphenylamine	72	82-128	10,12,13	No Action Taken
	m-Dinitrobenzene	64	90-147		
	Ethyl methanesulfonate	50	66-111		
	Hexachlorophene	147	70-124		
	Hexachlorocyclopentadiene	101	16-97		
	Isosafrole	50	51-144		
	Methapyrilene	8	68-121		
	Merhylparathion	91	94-145		
	1,4-Naphthoquinone	35	46-117		
	Safrole	55	74-111		
	Sym-Trinitrobenzene	59	107-164		
OP28092-BS12	2-Methylnaphthalene	128	17-114	10,12,13	No Action Taken
VU3539-BS	Acrolein	324	37-179	2	R
VU3543-BS	Acrolein	244	37-179	1,3,4,5,6,8	
VU3544-BS	Acrolein	195	37-179	12,13,14	
VU3545-BS	Acrolein	266	37-179	7,9,10,11	
SDG J80982					
V1C1960-BS	Chloroethane	140	64-139	16 thru 24 and 26	No Action Taken
OP30829-BS1	3,3'-Dimethylbenzidine	129	18-116	1,2,3,4,5,6,8,14,15,26,27	No Action Taken
	5-Nitro-o-toluidine	135	88-123		
	p-Phenylenediamine	51	85-134		R
	O-Toluidine	126	60-101		No Action Taken
	Sym-Trinitrobenzene	99	109-164		R
SDG J90784					
V3C1692-BS2	Acrolein	364	46-188	1	Accept NDs
	Styrene	128	79-126		No Action Taken
V3C1693-BS	Acrolein	412	46-188	2 thru 5	Accept NDs
V3C1693-BS2	Acrolein	310	46-188	2 thru 5	
V3C1694-BS	Acrolein	310	46-188	2 thru 4 and 11	
V3C1695-BS	Acrolein	332	46-188	16,17,18,20,21,22,23	
V3C1696-BS	Acrolein	342	46-188	24 thru 29	

Table 4-5
Compounds with Percent Recoveries Outside of Quality Control Limits
Lab Control Samples

QC Sample ID	Compound	LCS %R	%R Criteria	Affected Samples	Validator's Action
OP32758-BS	Famphur	101	31-79	19 thru 24 and 28, 29	
	Hexachlorophene	154	70-124		
	p-Phenylenediamine	7	20-128	19 thru 20	R
SDG J9A9388					
OP36413A-BS12	Benzo(b)fluoranthene	138	32-136	12 thru 18 and 1,2,3,20	Accept NDs
OP36417-BS1	Dalapon	183	16-156		
OP36433-BS1	4,4'-DDT	152	63-142		
SDG JA13996					
VU4588-BS	Acetonitrile	204	53-136	4 thru 10 and 12 thru 14 and 1,2	Accept NDs
VU4589-BS	Acetonitrile	188	53-136	17 thru 25 and 11	
	Allyl Chloride	138	57-130		
VU4590-BS	Acetonitrile	146	53-136	15,16	
OP37258-BS11	Hexachlorophene	58	70-124	11,17	Reject NDs
	1-Naphthylamine	41	53-97		
OP37258A-BS12	7,12-Dimethylbenzoanthracene	0	40-98	11,17	Reject NDs
	3-Methylchloranthene	0	33-152		
SDG JA54314					
V3A3538	2-Butanone	136	64-141	13,17,18	No Action Taken
	Acetone	152	15-151		
V3A3539	1,1,2,2-Tetrachloroethane	127	66-125	1,7,8,9,10,11,15,16	No Action Taken
	1,1,2-Trichloroethane	124	75-123		
	1,2,3-Trichloropropane	125	64-121		
	1,2-Dichloroethene (total)	125	71-121		
	2-Butanone	133	64-130		
	cis-1,2-Dichloroethene	126	71-119		
	Ethyl methacrylate	127	70-126		
	Methylene chloride	124	69-139		

% R = Percent Recovery
LCS = Lab Control Sample
ND = Not Detected

Table 4-6

Method Detection Limits of Non-Detect Compounds Compared to Screening Levels - Soil

CAS	Compound	Range of MDLs	Units	Industrial RSL
Metals and Cyanide				
7440-36-0	Antimony	0.81 - 16	mg/kg	41 *
7440-38-2	Arsenic	0.64 - 12	mg/kg	**1.6**
7440-39-3	Barium	0.32 - 6.4	mg/kg	19000 *
7440-41-7	Beryllium	0.019 - 0.45	mg/kg	200 *
7440-43-9	Cadmium	0.13 - 3.2	mg/kg	80 *
7440-48-4	Cobalt	0.14 - 2.7	mg/kg	30 *
7440-50-8	Copper	5.5 - 5.5	mg/kg	4100 *
57-12-5	Cyanide	0.013 - 0.018	mg/kg	2000 *
7439-92-1	Lead	0.51 - 9.8	mg/kg	800 *
7439-97-6	Mercury	0.0097 - 0.013	mg/kg	10 *
7440-02-0	Nickel	0.61 - 12	mg/kg	2000 *
7782-49-2	Selenium	0.33 - 17	mg/kg	510 *
7440-22-4	Silver	0.14 - 3.4	mg/kg	510 *
7440-28-0	Thallium	0.17 - 18	mg/kg	**1** *
7440-31-5	Tin	0.62 - 13	mg/kg	61000 *
7440-62-2	Vanadium	3 - 3	mg/kg	520 *
Pesticides				
72-54-8	4,4-DDD	0.3 - 0.49	ug/kg	7200
72-55-9	4,4-DDE	0.38 - 0.51	ug/kg	5100
50-29-3	4,4-DDT	0.42 - 0.63	ug/kg	7000
309-00-2	Aldrin	0.33 - 0.45	ug/kg	100
319-84-6	alpha-BHC	0.28 - 0.38	ug/kg	270
5103-71-9	alpha-Chlordane	0.41 - 0.62	ug/kg	6500
319-85-7	Beta-BHC	0.33 - 0.68	ug/kg	960
319-86-8	delta-BHC	0.32 - 0.76	ug/kg	270
60-57-1	Dieldrin	0.34 - 0.52	ug/kg	110
959-98-8	Endosulfan I	0.35 - 0.55	ug/kg	370000 *
33213-65-9	Endosulfan II	0.4 - 0.67	ug/kg	370000 *
1031-07-8	Endosulfan sulfate	0.37 - 0.56	ug/kg	370000 *
72-20-8	Endrin	0.37 - 0.51	ug/kg	18000 *
7421-93-4	Endrin aldehyde	0.36 - 0.48	ug/kg	18000 *
53494-70-5	Endrin ketone	0.34 - 0.56	ug/kg	18000 *
58-89-9	Gamma-BHC (Lindane)	0.31 - 0.49	ug/kg	2100
5566-34-7	Gamma-chlordane	0.38 - 0.55	ug/kg	6500
76-44-8	Heptachlor	0.39 - 0.53	ug/kg	380
1024-57-3	Heptachlor epoxide	0.34 - 0.57	ug/kg	190
72-43-5	Methoxychlor	0.46 - 0.68	ug/kg	310000 *
8001-35-2	Toxaphene	7.2 - 19	ug/kg	1600
	PCBs			
12674-11-2	Aroclor 1016	7.2 - 9.7	ug/kg	3700 *
11104-28-2	Aroclor 1221	23 - 31	ug/kg	540
11141-16-5	Aroclor 1232	21 - 28	ug/kg	540
53469-21-9	Aroclor 1242	12 - 16	ug/kg	740
12672-29-6	Aroclor 1248	13 - 18	ug/kg	740
11097-69-1	Aroclor 1254	18 - 24	ug/kg	740
11096-82-5	Aroclor 1260	7.6 - 10	ug/kg	740
	Herbicides			
93-76-5	2,4,5-T	0.79 - 2.8	ug/kg	620000 *
93-72-1	2,4,5-TP (silvex)	0.9 - 2.7	ug/kg	490000 *
94-75-7	2,4-D	8.2 - 13	ug/kg	770000 *
	Volatile Organic Compounds			
630-20-6	1,1,1,2-tetrachloroethane	0.31 - 49	ug/kg	9300
71-55-6	1,1,1-trichloroethane	0.39 - 61	ug/kg	3800000 *

Table 4-6

Method Detection Limits of Non-Detect Compounds Compared to Screening Levels - Soil

CAS	**Compound**	**Range of MDLs**	**Units**	**Industrial RSL**
79-34-5	1,1,2,2-tetrachloroethane	0.32 - 60	ug/kg	2800
79-00-5	1,1,2-trichloroethane	0.32 - 56	ug/kg	680 *
75-34-3	1,1-dichloroethane	0.31 - 50	ug/kg	17000
75-35-4	1,1-dichloroethene	0.45 - 71	ug/kg	110000 *
96-18-4	1,2,3-trichloropropane	1.6 - 260	ug/kg	**95**
96-12-8	1,2-Dibromo-3-chloropropane	1.4 - 220	ug/kg	**69**
106-93-4	1,2-dibromoethane	0.37 - 59	ug/kg	170
107-06-2	1,2-dichloroethane	0.36 - 56	ug/kg	2200
78-87-5	1,2-dichloropropane	0.36 - 58	ug/kg	4700
123-91-1	1,4-dioxane	45 - 100	ug/kg	17000
78-93-3	2-butanone	1.8 - 4	ug/kg	20000000 *
591-78-6	2-hexanone	0.89 - 140	ug/kg	140000 *
107-05-1	3-Chloropropene	0.41 - 65	ug/kg	750 *
108-10-1	4-methyl-2-pentanone	1.3 - 210	ug/kg	5300000 *
67-64-1	Acetone	1.9 - 3.2	ug/kg	63000000 *
75-05-8	Acetonitrile	21 - 40	ug/kg	370000 *
107-02-8	Acrolein	3.9 - 18	ug/kg	65 *
107-13-1	Acrylonitrile	1.7 - 360	ug/kg	1200
71-43-2	Benzene	0.31 - 0.7	ug/kg	5400
75-27-4	Bromodichloromethane	0.3 - 47	ug/kg	1400
75-25-2	Bromoform	0.28 - 45	ug/kg	220000
74-83-9	Bromomethane	0.24 - 38	ug/kg	3200 *
75-15-0	Carbon disulfide	0.36 - 57	ug/kg	370000 *
56-23-5	Carbon tetrachloride	0.62 - 99	ug/kg	3000
108-90-7	Chlorobenzene	0.28 - 45	ug/kg	140000 *
75-00-3	Chloroethane	0.86 - 180	ug/kg	6100000 *
67-66-3	Chloroform	0.38 - 60	ug/kg	1500
74-87-3	Chloromethane	0.3 - 48	ug/kg	50000 *
126-99-8	Chloroprene	0.29 - 46	ug/kg	47
156-59-2	Cis-1,2-dichloroethene	0.44 - 0.98	ug/kg	200000 *
10061-01-5	Cis-1,3-dichloropropene	0.27 - 43	ug/kg	8300
124-48-1	Dibromochloromethane	0.34 - 57	ug/kg	3300
74-95-3	Dibromomethane	0.32 - 50	ug/kg	11000 *
75-71-8	Dichlorodifluoromethane	0.52 - 82	ug/kg	40000 *
97-63-2	Ethyl Methacrylate	0.32 - 50	ug/kg	750000 *
100-41-4	Ethylbenzene	0.3 - 0.66	ug/kg	27000
78-83-1	Isobutyl Alcohol	15 - 20	ug/kg	31000000 *
126-98-7	Methacrylonitrile	1.4 - 230	ug/kg	1800 *
80-62-6	Methyl Methacrylate	0.64 - 100	ug/kg	2100000 *
75-09-2	Methylene Chloride	0.37 - 72	ug/kg	53000
76-01-7	Pentachloroethane	0.37 - 99	ug/kg	19000
100-42-5	Styrene	0.21 - 34	ug/kg	3600000 *
127-18-4	Tetrachloroethene	0.54 - 85	ug/kg	2600
108-88-3	Toluene	0.36 - 56	ug/kg	4500000 *
156-60-5	trans-1,2-dichloroethene	0.4 - 71	ug/kg	69000 *
10061-02-6	trans-1,3-dichloropropene	0.26 - 41	ug/kg	8300
110-57-6	trans-1,4-dichloro-2-butene	1.3 - 200	ug/kg	**35**
79-01-6	Trichloroethene	0.34 - 54	ug/kg	10000 *
75-69-4	Trichlorofluoromethane	0.48 - 76	ug/kg	340000 *
108-05-4	Vinyl acetate	1.1 - 180	ug/kg	410000 *
75-01-4	Vinyl chloride	0.42 - 67	ug/kg	1700
1330-20-7	Xylenes, Total	0.32 - 0.72	ug/kg	270000 *
	Semivolatile Organic Compounds			
95-94-3	1,2,4,5-tetrachlorobenzene	4.9 - 37	ug/kg	18000 *

Table 4-6
Method Detection Limits of Non-Detect Compounds Compared to Screening Levels - Soil

CAS	**Compound**	**Range of MDLs**	**Units**	**Industrial RSL**
120-82-1	1,2,4-trichlorobenzene	22 - 32	ug/kg	27000 *
95-50-1	1,2-dichlorobenzene	17 - 27	ug/kg	980000 *
99-35-4	1,3,5-Trinitrobenzene	16 - 41	ug/kg	2700000 *
541-73-1	1,3-dichlorobenzene	18 - 28	ug/kg	12000
99-65-0	1,3-Dinitrobenzene	18 - 29	ug/kg	6200 *
106-46-7	1,4-dichlorobenzene	16 - 22	ug/kg	12000
108-60-1	2,2-oxybis(1-chloropropane)	22 - 39	ug/kg	22000
58-90-2	2,3,4,6-tetrachlorophenol	44 - 61	ug/kg	1800000 *
95-95-4	2,4,5-trichlorophenol	47 - 78	ug/kg	6200000 *
88-06-2	2,4,6-trichlorophenol	32 - 68	ug/kg	62000 *
120-83-2	2,4-dichlorophenol	45 - 87	ug/kg	180000 *
105-67-9	2,4-dimethylphenol	53 - 130	ug/kg	1200000 *
51-28-5	2,4-dinitrophenol	58 - 550	ug/kg	120000 *
121-14-2	2,4-dinitrotoluene	23 - 61	ug/kg	5500
87-65-0	2,6-Dichlorophenol	9.7 - 20	ug/kg	180000 *
606-20-2	2,6-dinitrotoluene	19 - 60	ug/kg	62000 *
53-96-3	2-Acetylaminofluorene	11 - 20	ug/kg	450
91-58-7	2-chloronaphthalene	19 - 73	ug/kg	8200000 *
95-57-8	2-chlorophenol	33 - 45	ug/kg	510000 *
534-52-1	2-Methyl-4,6-dinitrophenol	33 - 54	ug/kg	4900 *
91-57-6	2-methylnaphthalene	1.1 - 1.5	ug/kg	410000 *
95-48-7	2-methylphenol	37 - 55	ug/kg	3100000 *
91-59-8	2-Naphthylamine	12 - 25	ug/kg	960
88-74-4	2-nitroaniline	24 - 38	ug/kg	600000 *
88-75-5	2-nitrophenol	45 - 65	ug/kg	13000
34MP	3&4-methylphenol	55 - 75	ug/kg	310000 *
91-94-1	3,3-dichlorobenzidine	36 - 89	ug/kg	3800
119-93-7	3,3'-Dimethylbenzidine	19 - 54	ug/kg	160
56-49-5	3-Methylcholanthrene	7.6 - 10	ug/kg	78
99-09-2	3-nitroaniline	17 - 40	ug/kg	6200 *
92-67-1	4-Aminobiphenyl	9.3 - 17	ug/kg	82
59-50-7	4-chloro-3-methylphenol	49 - 66	ug/kg	6200000 *
106-47-8	4-chloroaniline	18 - 32	ug/kg	8600
100-01-6	4-nitroaniline	26 - 36	ug/kg	86000
100-02-7	4-nitrophenol	52 - 71	ug/kg	110000
99-55-8	5-Nitro-O-Toluidine	10 - 22	ug/kg	190000
57-97-6	7,12-Dimethylbenz[a]anthracene	7.6 - 10	ug/kg	**6.2**
83-32-9	Acenaphthene	20 - 27	ug/kg	3300000 *
208-96-8	Acenaphthylene	0.39 - 0.53	ug/kg	18000
98-86-2	Acetophenone	21 - 33	ug/kg	10000000 *
62-53-3	Aniline	11 - 21	ug/kg	300000
120-12-7	Anthracene	15 - 23	ug/kg	17000000 *
140-57-8	Aramite	33 - 39	ug/kg	69000
56-55-3	Benzo[a]anthracene	0.24 - 0.32	ug/kg	2100
50-32-8	Benzo[a]pyrene	0.57 - 0.78	ug/kg	210
205-99-2	Benzo[b]fluoranthene	1.4 - 2	ug/kg	2100
191-24-2	Benzo[g,h,i]perylene	0.65 - 0.88	ug/kg	1700000 *
207-08-9	Benzo[k]fluoranthene	0.64 - 0.88	ug/kg	21000
100-51-6	Benzyl alcohol	25 - 43	ug/kg	6200000 *
85-68-7	Benzyl butyl phthalate	21 - 39	ug/kg	910000
111-91-1	Bis(2-chloroethoxy) methane	21 - 34	ug/kg	180000 *
111-44-4	Bis(2-chloroethyl) ether	19 - 26	ug/kg	1000
117-81-7	Bis(2-ethylhexyl) phthalate	23 - 67	ug/kg	120000
510-15-6	Chlorobenzilate	8 - 23	ug/kg	16000

Table 4-6
Method Detection Limits of Non-Detect Compounds Compared to Screening Levels - Soil

CAS	**Compound**	**Range of MDLs**	**Units**	**Industrial RSL**
218-01-9	Chrysene	0.43 - 0.58	ug/kg	210000
2303-16-4	Diallate	19 - 28	ug/kg	28000
53-70-3	Dibenz[a,h]anthracene	0.5 - 0.68	ug/kg	210
132-64-9	Dibenzofuran	18 - 24	ug/kg	100000 *
84-66-2	Diethyl phthalate	16 - 23	ug/kg	49000000 *
60-51-5	Dimethoate	9.8 - 13	ug/kg	12000 *
84-74-2	Di-n-butyl phthalate	24 - 33	ug/kg	6200000 *
117-84-0	Di-n-octyl phthalate	19 - 45	ug/kg	6200000 *
88-85-7	Dinoseb	12 - 19	ug/kg	62000 *
122-39-4	Diphenylamine	20 - 39	ug/kg	1500000 *
298-04-4	Disulfoton	5.4 - 15	ug/kg	2500 *
206-44-0	Fluoranthene	14 - 23	ug/kg	2200000 *
86-73-7	Fluorene	15 - 24	ug/kg	2200000 *
87-68-3	Hexachloro-1,3-butadiene	21 - 34	ug/kg	22000
118-74-1	Hexachlorobenzene	22 - 30	ug/kg	1100
77-47-4	Hexachlorocyclopentadiene	27 - 48	ug/kg	370000 *
67-72-1	Hexachloroethane	19 - 33	ug/kg	62000 *
70-30-4	Hexachlorophene	16 - 19	ug/kg	18000 *
193-39-5	Indeno[1,2,3-c,d]pyrene	0.6 - 0.81	ug/kg	2100
78-59-1	Isophorone	19 - 45	ug/kg	1800000
143-50-0	Kepone	91 - 200	ug/kg	**170**
66-27-3	Methyl Methanesulfonate	12 - 17	ug/kg	17000
298-00-0	Methyl Parathion	14 - 22	ug/kg	15000 *
91-20-3	Naphthalene	0.46 - 0.63	ug/kg	18000
98-95-3	Nitrobenzene	19 - 36	ug/kg	24000
55-18-5	N-Nitrosodiethylamine	10 - 27	ug/kg	**11**
62-75-9	n-Nitrosodimethylamine	22 - 45	ug/kg	**34**
924-16-3	N-Nitrosodi-N-Butylamine	16 - 31	ug/kg	400
621-64-7	N-nitrosodi-n-propylamine	25 - 34	ug/kg	250
86-30-6	N-nitrosodiphenylamine	16 - 35	ug/kg	350000
10595-95-6	N-Nitrosomethylethylamine	26 - 77	ug/kg	78
59-89-2	N-Nitrosomorpholine	8.8 - 17	ug/kg	260
100-75-4	N-Nitrosopiperidine	14 - 53	ug/kg	180
930-55-2	N-Nitrosopyrrolidine	16 - 26	ug/kg	820
60-11-7	P-(Dimethylamine)Azobenzene	11 - 17	ug/kg	370
56-38-2	Parathion	14 - 20	ug/kg	370000 *
608-93-5	Pentachlorobenzene	8 - 35	ug/kg	49000 *
82-68-8	Pentachloronitrobenzene	35 - 41	ug/kg	6600
87-86-5	Pentachlorophenol	43 - 66	ug/kg	2700
62-44-2	Phenacetin	10 - 23	ug/kg	780000
85-01-8	Phenanthrene	0.41 - 0.56	ug/kg	17000000 *
108-95-2	Phenol	33 - 65	ug/kg	18000000 *
298-02-2	Phorate	7.3 - 23	ug/kg	12000 *
106-50-3	P-Phenylenediamine	15 - 260	ug/kg	12000000 *
23950-58-5	Pronamide	2.9 - 24	ug/kg	4600000 *
129-00-0	Pyrene	13 - 23	ug/kg	1700000 *
110-86-1	Pyridine	22 - 30	ug/kg	100000 *
94-59-7	Safrole	9.7 - 30	ug/kg	7800
3689-24-5	Tetraethyl Dithiopyrophosphate	12 - 23	ug/kg	31000 *

Industrial RSL = USEPA Industrial Soil Regional Screening Level, June 2011.

* = A noncarcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1.

Bold font = Maximum MDL > screening level

Table 4-7
Method Detection Limits of Non-Detect Compounds Compared to Screening Levels - Groundwater

CAS	**Compound**	**Range of MDLs (ug/L)**	**RSL Tapwater (ug/L)**	**MCL (ug/L)**	**Groundwater to Air (ug/L)**
Metals and Cyanide					
7429-90-5	Aluminum	23 - 24	3700 *	NSA	NSA
7440-36-0	Antimony	1.8 - 5.7	**1.5** *	6	NSA
7440-38-2	Arsenic	1.7 - 6	**0.045**	10	NSA
7440-39-3	Barium	2.3 - 2.3	730 *	2000	NSA
7440-41-7	Beryllium	0.15 - 0.4	7.3 *	4	NSA
7440-43-9	Cadmium	0.28 - 1.3	1.8 *	5	NSA
7440-47-3	Chromium	0.53 - 9	**0.043**	100	NSA
7440-48-4	Cobalt	0.51 - 3.6	**1.1** *	NSA	NSA
7440-50-8	Copper	1.1 - 2.7	150 *	1300	NSA
57-12-5	Cyanide	4 - 4	73 *	200	NSA
7439-89-6	Iron	25 - 7.4	2600 *	NSA	NSA
7439-92-1	Lead	0.94 - 3	NSA	15	NSA
7439-97-6	Mercury	0.037 - 0.15	3.7 *	2	0.68
7440-02-0	Nickel	1.2 - 4.2	73 *	NSA	NSA
7782-49-2	Selenium	1.6 - 9.3	18 *	50	NSA
7440-22-4	Silver	1 - 2.6	18 *	NSA	NSA
7440-28-0	Thallium	1.3 - 9.8	**0.037** *	**2**	NSA
7440-31-5	Tin	0.62 - 5.2	2200 *	NSA	NSA
7440-62-2	Vanadium	0.43 - 1.8	18 *	NSA	NSA
7440-66-6	Zinc	2.9 - 4	1100 *	NSA	NSA
Organochlorine Pesticides					
72-54-8	4,4-DDD	0.0024 - 0.0046	0.28	NSA	NSA
72-55-9	4,4-DDE	0.0013 - 0.0018	0.2	NSA	29
50-29-3	4,4-DDT	0.0035 - 0.0053	0.2	NSA	NSA
309-00-2	Aldrin	0.0017 - 0.0036	0.004	NSA	0.071
319-84-6	alpha-BHC	0.00099 - 0.0028	0.011	NSA	3.1
5103-71-9	alpha-Chlordane	0.002 - 0.0047	0.19	2	NSA
319-85-7	Beta-BHC	0.0035 - 0.0067	0.037	NSA	NSA
319-86-8	delta-BHC	0.0031 - 0.0035	0.011	NSA	NSA
60-57-1	Dieldrin	0.0014 - 0.0018	0.0042	NSA	0.86
959-98-8	Endosulfan I	0.0018 - 0.0023	22 *	NSA	NSA
33213-65-9	Endosulfan II	0.0032 - 0.0035	22 *	NSA	NSA
1031-07-8	Endosulfan sulfate	0.0026 - 0.005	22 *	NSA	NSA
72-20-8	Endrin	0.003 - 0.0033	1.1 *	2	NSA
7421-93-4	Endrin aldehyde	0.0037 - 0.007	1.1 *	2	NSA
53494-70-5	Endrin ketone	0.0026 - 0.0038	1.1 *	2	NSA
58-89-9	Gamma-BHC (Lindane)	0.0011 - 0.0019	0.061	0.2	11
5566-34-7	Gamma-chlordane	0.0017 - 0.0024	0.19	2	NSA
76-44-8	Heptachlor	0.002 - 0.0028	0.015	0.4	0.4 †
1024-57-3	Heptachlor epoxide	0.0015 - 0.0016	0.0074	0.2	NSA
72-43-5	Methoxychlor	0.0068 - 0.0073	18 *	40	NSA
8001-35-2	Toxaphene	0.094 - 0.21	**0.061**	3	NSA
Organophosphorus Pesticides					
60-51-5	Dimethoate	0.5 - 0.5	0.73 *	NSA	NSA
298-04-4	Disulfoton	0.5 - 0.5	**0.15** *	NSA	NSA
298-00-0	Methyl Parathion	0.5 - 0.5	0.91 *	NSA	NSA
56-38-2	Parathion	0.5 - 0.5	22 *	NSA	NSA
298-02-2	Phorate	0.5 - 0.5	0.73 *	NSA	NSA
3689-24-5	Tetraethyl Dithiopyrophosphate	0.5 - 0.5	1.8 *	NSA	NSA
PCBs					
12674-11-2	Aroclor 1016	0.094 - 0.19	0.26 *	NSA	NSA

Table 4-7
Method Detection Limits of Non-Detect Compounds Compared to Screening Levels - Groundwater

CAS	**Compound**	**Range of MDLs (ug/L)**	**RSL Tapwater (ug/L)**	**MCL (ug/L)**	**Groundwater to Air (ug/L)**
11104-28-2	Aroclor 1221	0.31 - 0.51	**0.0068**	NSA	NSA
11141-16-5	Aroclor 1232	0.21 - 0.42	**0.0068**	NSA	NSA
53469-21-9	Aroclor 1242	0.089 - 0.18	**0.034**	NSA	NSA
12672-29-6	Aroclor 1248	0.15 - 0.25	**0.034**	NSA	NSA
11097-69-1	Aroclor 1254	0.11 - 0.12	**0.034**	NSA	NSA
11096-82-5	Aroclor 1260	0.12 - 0.14	**0.034**	NSA	NSA
Herbicides					
75-99-0	2,2-dichloropropionic acid	0.028 - 0.028	110 *	200	NSA
93-76-5	2,4,5-T	0.033 - 0.039	37 *	NSA	NSA
93-72-1	2,4,5-TP (silvex)	0.034 - 0.036	29 *	50	NSA
94-75-7	2,4-D	0.19 - 0.34	37 *	70	NSA
94-82-6	2,4-DB	0.17 - 0.17	29 *	NSA	NSA
1918-00-9	Dicamba	0.03 - 0.03	110 *	NSA	NSA
88-85-7	Dinoseb	0.095 - 0.095	3.7 *	7	NSA
94-74-6	MCPA	9.6 - 9.6	**1.8** *	NSA	NSA
93-65-2	MCPP	12 - 12	**3.7** *	NSA	NSA
87-86-5	Pentachlorophenol	0.0075 - 0.0075	0.17	1	NSA
Volatile Organic Compounds					
630-20-6	1,1,1,2-tetrachloroethane	0.12 - 2.4	**0.52**	NSA	3.3
71-55-6	1,1,1-trichloroethane	0.24 - 4.8	910 *	200	3100
79-34-5	1,1,2,2-tetrachloroethane	0.13 - 2.7	**0.067**	NSA	3
79-00-5	1,1,2-trichloroethane	0.17 - 0.49	**0.042** *	5	5 †
75-34-3	1,1-dichloroethane	0.16 - 4.8	**2.4**	NSA	2200
75-35-4	1,1-dichloroethene	0.28 - 2.9	34 *	7	190
96-18-4	1,2,3-trichloropropane	0.49 - 6.6	**0.00072**	NSA	290
96-12-8	1,2-Dibromo-3-chloropropane	0.8 - 6.6	**0.00032**	**0.2**	33
106-93-4	1,2-dibromoethane	0.17 - 3.9	**0.0065**	**0.05**	**0.36**
107-06-2	1,2-dichloroethane	0.29 - 7	**0.15**	**5**	**5 †**
540-59-0	1,2-dichloroethene	0.16 - 0.27	33 *	NSA	NSA
78-87-5	1,2-dichloropropane	0.18 - 3.5	**0.39**	5	35
123-91-1	1,4-dioxane	110 - 940	**0.67**	NSA	NSA
78-93-3	2-butanone	1.6 - 8.1	710 *	NSA	440000
591-78-6	2-hexanone	0.94 - 8.6	**4.7** *	NSA	NSA
107-05-1	3-Chloropropene	0.38 - 8.1	**0.21** *	NSA	NSA
108-10-1	4-methyl-2-pentanone	0.86 - 8.6	200 *	NSA	14000
67-64-1	Acetone	11 - 5.4	2200 *	NSA	220000
75-05-8	Acetonitrile	140 - 72	**13** *	NSA	42000
107-02-8	Acrolein	11 - 87	**0.0042** *	NSA	**4**
107-13-1	Acrylonitrile	1 - 6.3	**0.045**	NSA	8.5
71-43-2	Benzene	0.19 - 5.2	**0.41**	**5**	**5 †**
75-27-4	Bromodichloromethane	0.14 - 2.8	**0.12**	80	**2.1**
75-25-2	Bromoform	0.18 - 3.7	8.5	80	**0.0083**
74-83-9	Bromomethane	0.22 - 6.3	**0.87** *	NSA	20
75-15-0	Carbon disulfide	0.14 - 7.4	100 *	NSA	560
56-23-5	Carbon tetrachloride	0.18 - 3.5	**0.44**	5	5 †
108-90-7	Chlorobenzene	0.14 - 3.9	9.1 *	100	390
75-00-3	Chloroethane	0.22 - 4.4	2100 *	NSA	28000
67-66-3	Chloroform	0.16 - 3.2	**0.19**	80	80 †
74-87-3	Chloromethane	0.29 - 5.8	19 *	NSA	6.7
126-99-8	Chloroprene	0.16 - 9.3	**0.016**	NSA	14
156-59-2	Cis-1,2-dichloroethene	0.19 - 0.25	7.3 *	70	210
10061-01-5	Cis-1,3-dichloropropene	0.13 - 3.6	**0.43**	NSA	NSA

Table 4-7

Method Detection Limits of Non-Detect Compounds Compared to Screening Levels - Groundwater

CAS	**Compound**	**Range of MDLs (ug/L)**	**RSL Tapwater (ug/L)**	**MCL (ug/L)**	**Groundwater to Air (ug/L)**
124-48-1	Dibromochloromethane	0.12 - 3.2	**0.15**	80	3.2
74-95-3	Dibromomethane	0.18 - 3.5	**0.82** *	NSA	990
75-71-8	Dichlorodifluoromethane	0.75 - 9.2	20 *	NSA	14
97-63-2	Ethyl Methacrylate	0.38 - 5.3	53 *	NSA	9100
100-41-4	Ethylbenzene	0.2 - 5.3	**1.5**	700	700 †
78-83-1	Isobutyl Alcohol	100 - 59	1100 *	NSA	2200000
126-98-7	Methacrylonitrile	0.97 - 9.7	**0.1** *	NSA	69
80-62-6	Methyl Methacrylate	0.7 - 6.4	140 *	NSA	51000
75-09-2	Methylene Chloride	0.16 - 3	4.8	5	58
76-01-7	Pentachloroethane	0.22 - 4.5	**0.75**	NSA	NSA
100-42-5	Styrene	0.11 - 5.8	160 *	100	8900
127-18-4	Tetrachloroethene	0.27 - 0.29	**0.11**	5	5 †
108-88-3	Toluene	0.15 - 3.1	230 *	1000	NSA
156-60-5	trans-1,2-dichloroethene	0.16 - 1.6	11 *	100	180
10061-02-6	trans-1,3-dichloropropene	0.11 - 3	**0.43**	NSA	NSA
110-57-6	trans-1,4-dichloro-2-butene	0.72 - 7.5	**0.0012**	NSA	NSA
79-01-6	Trichloroethene	0.18 - 0.29	2	5	5 †
75-69-4	Trichlorofluoromethane	0.25 - 5.4	130 *	NSA	180
108-05-4	Vinyl acetate	1.3 - 8.1	41 *	NSA	9600
75-01-4	Vinyl chloride	0.21 - 4.4	**0.016**	**2**	**2** †
1330-20-7	Xylenes, Total	0.2 - 7.7	20 *	10000	NSA
Semivolatile Organic Compounds					
95-94-3	1,2,4,5-tetrachlorobenzene	0.25 - 2	**1.1** *	NSA	NSA
120-82-1	1,2,4-trichlorobenzene	0.12 - 0.37	0.41 *	70	3400
95-50-1	1,2-dichlorobenzene	0.17 - 0.35	37 *	600	2600
99-35-4	1,3,5-Trinitrobenzene	0.26 - 2.5	110 *	NSA	NSA
541-73-1	1,3-dichlorobenzene	0.15 - 0.33	0.43	75	830
99-65-0	1,3-Dinitrobenzene	0.37 - 0.85	**0.37** *	NSA	NSA
106-46-7	1,4-dichlorobenzene	0.14 - 0.35	0.43	75	8200
108-60-1	2,2-oxybis(1-chloropropane)	0.54 - 0.99	**0.32**	NSA	51
58-90-2	2,3,4,6-tetrachlorophenol	1.1 - 1.6	110 *	NSA	NSA
95-95-4	2,4,5-trichlorophenol	1.1 - 2.6	370 *	NSA	NSA
88-06-2	2,4,6-trichlorophenol	1 - 1.7	3.7 *	NSA	NSA
120-83-2	2,4-dichlorophenol	1.4 - 2.1	11 *	NSA	NSA
105-67-9	2,4-dimethylphenol	1.6 - 2.2	73 *	NSA	NSA
51-28-5	2,4-dinitrophenol	0.89 - 4.2	7.3 *	NSA	NSA
121-14-2	2,4-dinitrotoluene	0.45 - 1.1	**0.22**	NSA	NSA
87-65-0	2,6-Dichlorophenol	0.29 - 1.5	11 *	NSA	NSA
606-20-2	2,6-dinitrotoluene	0.5 - 0.75	3.7 *	NSA	NSA
53-96-3	2-Acetylaminofluorene	0.24 - 1.6	**0.018**	NSA	NSA
91-58-7	2-chloronaphthalene	0.2 - 1.3	290 *	NSA	NSA
95-57-8	2-chlorophenol	0.87 - 1.5	18 *	NSA	1100
534-52-1	2-Methyl-4,6-dinitrophenol	0.72 - 2.2	**0.29** *	NSA	NSA
91-57-6	2-methylnaphthalene	0.025 - 0.033	15 *	NSA	3300
95-48-7	2-methylphenol	1 - 1.8	180 *	NSA	NSA
91-59-8	2-Naphthylamine	0.23 - 1.5	**0.037**	NSA	NSA
88-74-4	2-nitroaniline	0.45 - 0.88	37 *	NSA	NSA
88-75-5	2-nitrophenol	1.5 - 2.4	**0.31**	NSA	NSA
34MP	3&4-methylphenol	1.1 - 1.7	18 *	NSA	NSA
91-94-1	3,3-dichlorobenzidine	0.97 - 4.6	**0.15**	NSA	NSA
119-93-7	3,3'-Dimethylbenzidine	1.3 - 2.9	**0.0061**	NSA	NSA
56-49-5	3-Methylcholanthrene	0.2 - 0.27	**0.00098**	NSA	NSA

Table 4-7

Method Detection Limits of Non-Detect Compounds Compared to Screening Levels - Groundwater

CAS	**Compound**	**Range of MDLs (ug/L)**	**RSL Tapwater (ug/L)**	**MCL (ug/L)**	**Groundwater to Air (ug/L)**
99-09-2	3-nitroaniline	0.32 - 1.7	**0.37** *	NSA	NSA
92-67-1	4-Aminobiphenyl	0.35 - 1.1	**0.0032**	NSA	NSA
59-50-7	4-chloro-3-methylphenol	1.2 - 2.3	370 *	NSA	NSA
106-47-8	4-chloroaniline	0.33 - 0.53	**0.34**	NSA	NSA
100-01-6	4-nitroaniline	0.45 - 0.96	3.4	NSA	NSA
100-02-7	4-nitrophenol	0.84 - 2.3	4.2	NSA	NSA
99-55-8	5-Nitro-O-Toluidine	0.22 - 1.6	7.5	NSA	NSA
57-97-6	7,12-Dimethylbenz[a]anthracene	0.2 - 0.27	**8.60E-05**	NSA	NSA
83-32-9	Acenaphthene	0.25 - 0.47	220 *	NSA	NSA
208-96-8	Acenaphthylene	0.007 - 0.013	0.14	NSA	NSA
98-86-2	Acetophenone	0.36 - 0.5	370 *	NSA	800000
62-53-3	Aniline	0.34 - 0.46	12	NSA	NSA
120-12-7	Anthracene	0.33 - 0.53	1100 *	NSA	NSA
140-57-8	Aramite	0.91 - 14	**2.7**	NSA	NSA
56-55-3	Benzo[a]anthracene	0.0068 - 0.034	**0.029**	NSA	NSA
50-32-8	Benzo[a]pyrene	0.017 - 0.036	**0.0029**	0.2	NSA
205-99-2	Benzo[b]fluoranthene	0.017 - 0.048	**0.029**	NSA	NSA
191-24-2	Benzo[g,h,i]perylene	0.012 - 0.024	110 *	NSA	NSA
207-08-9	Benzo[k]fluoranthene	0.016 - 0.021	0.29	NSA	NSA
100-51-6	Benzyl alcohol	0.33 - 0.49	370 *	NSA	NSA
85-68-7	Benzyl butyl phthalate	0.42 - 0.79	35	NSA	NSA
111-91-1	Bis(2-chloroethoxy) methane	0.32 - 0.87	11 *	NSA	NSA
111-44-4	Bis(2-chloroethyl) ether	0.49 - 0.71	**0.012**	NSA	10
117-81-7	Bis(2-ethylhexyl) phthalate	0.66 - 0.88	4.8	6	NSA
510-15-6	Chlorobenzilate	0.26 - 0.73	**0.61**	NSA	NSA
218-01-9	Chrysene	0.017 - 0.022	2.9	NSA	NSA
2303-16-4	Diallate	0.44 - 18	**1.1**	NSA	NSA
53-70-3	Dibenz[a,h]anthracene	0.016 - 0.022	**0.0029**	NSA	NSA
132-64-9	Dibenzofuran	0.23 - 0.49	3.7 *	NSA	NSA
84-66-2	Diethyl phthalate	0.34 - 0.52	2900 *	NSA	NSA
60-51-5	Dimethoate	0.37 - 0.68	0.73 *	NSA	NSA
84-74-2	Di-n-butyl phthalate	0.4 - 0.79	370 *	NSA	NSA
117-84-0	Di-n-octyl phthalate	0.48 - 0.76	370 *	NSA	NSA
88-85-7	Dinoseb	0.36 - 0.93	3.7 *	7	NSA
122-39-4	Diphenylamine	0.46 - 2.9	91 *	NSA	NSA
298-04-4	Disulfoton	0.31 - 0.67	**0.15** *	NSA	NSA
206-44-0	Fluoranthene	0.25 - 0.4	150 *	NSA	NSA
86-73-7	Fluorene	0.36 - 0.6	150 *	NSA	NSA
87-68-3	Hexachloro-1,3-butadiene	0.13 - 0.38	0.86	NSA	**0.33**
118-74-1	Hexachlorobenzene	0.31 - 0.72	**0.042**	1	1 †
77-47-4	Hexachlorocyclopentadiene	0.1 - 4.5	22 *	50	50 †
67-72-1	Hexachloroethane	0.16 - 0.38	3.7 *	NSA	3.8
70-30-4	Hexachlorophene	0.22 - 1.6	**1.1** *	NSA	NSA
193-39-5	Indeno[1,2,3-c,d]pyrene	0.011 - 0.015	0.029	NSA	NSA
78-59-1	Isophorone	0.49 - 0.79	71	NSA	NSA
143-50-0	Kepone	3.1 - 5	**0.0067**	NSA	NSA
66-27-3	Methyl Methanesulfonate	0.29 - 1	**0.68**	NSA	NSA
298-00-0	Methyl Parathion	0.39 - 1.1	**0.91** *	NSA	NSA
91-20-3	Naphthalene	0.014 - 0.034	0.14	NSA	150
98-95-3	Nitrobenzene	0.42 - 0.71	**0.12**	NSA	2000
55-18-5	N-Nitrosodiethylamine	0.22 - 1.2	**0.00014**	NSA	NSA
62-75-9	n-Nitrosodimethylamine	0.36 - 0.73	**0.00042**	NSA	NSA

Table 4-7

Method Detection Limits of Non-Detect Compounds Compared to Screening Levels - Groundwater

CAS	**Compound**	**Range of MDLs (ug/L)**	**RSL Tapwater (ug/L)**	**MCL (ug/L)**	**Groundwater to Air (ug/L)**
924-16-3	N-Nitrosodi-N-Butylamine	0.46 - 3.5	**0.0024**	NSA	**0.12**
621-64-7	N-nitrosodi-n-propylamine	0.38 - 0.62	**0.0096**	NSA	NSA
86-30-6	N-nitrosodiphenylamine	0.41 - 0.69	14	NSA	NSA
10595-95-6	N-Nitrosomethylethylamine	0.74 - 1	**0.0031**	NSA	NSA
59-89-2	N-Nitrosomorpholine	0.27 - 0.99	**0.01**	NSA	NSA
100-75-4	N-Nitrosopiperidine	0.36 - 0.98	**0.0072**	NSA	NSA
930-55-2	N-Nitrosopyrrolidine	0.54 - 1.5	**0.032**	NSA	NSA
60-11-7	P-(Dimethylamine)Azobenzene	0.26 - 2.2	**0.015**	NSA	NSA
56-38-2	Parathion	0.35 - 1.2	22 *	NSA	NSA
608-93-5	Pentachlorobenzene	0.21 - 1.8	2.9 *	NSA	NSA
82-68-8	Pentachloronitrobenzene	0.49 - 3.9	**0.26**	NSA	NSA
87-86-5	Pentachlorophenol	0.93 - 2.5	**0.17**	**1**	NSA
62-44-2	Phenacetin	0.22 - 2.4	31	NSA	NSA
85-01-8	Phenanthrene	0.017 - 0.028	1100 *	NSA	NSA
108-95-2	Phenol	0.5 - 1.4	1100 *	NSA	NSA
298-02-2	Phorate	0.53 - 0.8	**0.73** *	NSA	NSA
106-50-3	P-Phenylenediamine	0.15 - 5	690 *	NSA	NSA
23950-58-5	Pronamide	0.05 - 0.97	270 *	NSA	NSA
129-00-0	Pyrene	0.34 - 0.48	110 *	NSA	NSA
110-86-1	Pyridine	0.21 - 0.85	3.7 *	NSA	NSA
94-59-7	Safrole	0.32 - 1.3	**0.098**	NSA	NSA
3689-24-5	Tetraethyl Dithiopyrophosphate	0.23 - 1.6	1.8 *	NSA	NSA

RSL Tapwater = USEPA Tapwater Regional Screening Level, June 2011.

MCL = USEPA Maximum Contaminant Level, June 2011.

Groundwater to Air = Target groundwater concentration corresponding to target indoor air concentration where the soil gas to indoor air attenuation factor = 0.001 and partitoning across the water tale obeys Henry's Law Cgw (Table 2c of Vapor Intrusion

* = A noncarcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1.

† = value is the same as the MCL

NSA = No screening level available

Bold font = Maximum MDL > screening level

Table 4-8

Method Detection Limits of Non-Detect Compounds Compared to Screening Levels - Pore Water and Surface Water

CAS	Compound	Range of MDLs (ug/L)	Tapwater Modified *10 (ug/L)	MCL
Volatile Organic Compounds				
630-20-6	1,1,1,2-tetrachloroethane	0.22 - 0.22	5.2	NSA
71-55-6	1,1,1-trichloroethane	0.26 - 0.26	9100 *	200
79-34-5	1,1,2,2-tetrachloroethane	0.24 - 0.24	0.67	NSA
79-00-5	1,1,2-trichloroethane	0.23 - 0.23	0.42 *	5
75-34-3	1,1-dichloroethane	0.29 - 0.29	24	NSA
75-35-4	1,1-dichloroethene	0.4 - 0.4	340 *	7
96-18-4	1,2,3-trichloropropane	0.49 - 0.49	**0.0072**	NSA
96-12-8	1,2-Dibromo-3-chloropropane	1.1 - 1.1	**0.0032**	**0.2**
106-93-4	1,2-dibromoethane	0.39 - 0.39	**0.065**	**0.05**
107-06-2	1,2-dichloroethane	0.33 - 0.33	1.5	5
540-59-0	1,2-dichloroethene	0.22 - 0.22	330 *	NSA
78-87-5	1,2-dichloropropane	0.27 - 0.27	3.9	5
123-91-1	1,4-dioxane	94 - 94	**6.7**	NSA
78-93-3	2-butanone	1.6 - 1.6	7100 *	NSA
591-78-6	2-hexanone	1.4 - 1.4	47 *	NSA
107-05-1	3-Chloropropene	1.6 - 1.6	2.1 *	NSA
108-10-1	4-methyl-2-pentanone	0.86 - 0.86	2000 *	NSA
67-64-1	Acetone	2.9 - 2.9	22000 *	NSA
75-05-8	Acetonitrile	31 - 31	130 *	NSA
107-02-8	Acrolein	23 - 23	**0.042** *	NSA
107-13-1	Acrylonitrile	3.6 - 3.6	**0.45**	NSA
71-43-2	Benzene	0.23 - 0.23	4.1	5
75-27-4	Bromodichloromethane	0.22 - 0.22	1.2	80
75-25-2	Bromoform	0.23 - 0.23	85	80
74-83-9	Bromomethane	0.3 - 0.3	8.7 *	NSA
75-15-0	Carbon disulfide	0.74 - 0.74	1000 *	NSA
56-23-5	Carbon tetrachloride	0.26 - 0.26	4.4	5
108-90-7	Chlorobenzene	0.39 - 0.39	91 *	100
75-00-3	Chloroethane	0.37 - 0.37	21000 *	NSA
67-66-3	Chloroform	0.23 - 0.23	1.9	80
74-87-3	Chloromethane	0.29 - 0.29	190 *	NSA
126-99-8	Chloroprene	0.93 - 0.93	**0.16**	NSA
156-59-2	Cis-1,2-dichloroethene	0.22 - 0.22	73 *	70
10061-01-5	Cis-1,3-dichloropropene	0.25 - 0.25	4.3	NSA
124-48-1	Dibromochloromethane	0.22 - 0.22	1.5	80
74-95-3	Dibromomethane	0.24 - 0.24	8.2 *	NSA
75-71-8	Dichlorodifluoromethane	0.92 - 0.92	200 *	NSA
97-63-2	Ethyl Methacrylate	0.48 - 0.48	530 *	NSA
100-41-4	Ethylbenzene	0.27 - 0.27	15	700
78-83-1	Isobutyl Alcohol	20 - 20	11000 *	NSA
126-98-7	Methacrylonitrile	0.97 - 0.97	1 *	NSA
80-62-6	Methyl Methacrylate	1.3 - 1.3	1400 *	NSA
75-09-2	Methylene Chloride	0.3 - 0.3	48	5
76-01-7	Pentachloroethane	0.26 - 0.26	7.5	NSA
100-42-5	Styrene	0.58 - 0.58	1600 *	100
127-18-4	Tetrachloroethene	0.27 - 0.27	1.1	5
108-88-3	Toluene	0.3 - 0.3	2300 *	1000
156-60-5	trans-1,2-dichloroethene	0.25 - 0.25	110 *	100
10061-02-6	trans-1,3-dichloropropene	0.21 - 0.21	4.3	NSA
110-57-6	trans-1,4-dichloro-2-butene	1.5 - 1.5	**0.012**	NSA

Table 4-8
Method Detection Limits of Non-Detect Compounds Compared to Screening Levels - Pore Water and Surface Water

CAS	**Compound**	**Range of MDLs (ug/L)**	**Tapwater Modified *10 (ug/L)**	**MCL**
79-01-6	Trichloroethene	0.24 - 0.24	20	5
75-69-4	Trichlorofluoromethane	0.54 - 0.54	1300 *	NSA
108-05-4	Vinyl acetate	1.3 - 1.3	410 *	NSA
75-01-4	Vinyl chloride	0.44 - 0.44	**0.16**	2
1330-20-7	Xylenes, Total	0.25 - 0.25	200 *	10000

MDL = Method Detection Limit

MCL = Maximum Contaminant Level from National Primary Drinking Water Regulations (June 2011).

Tapwater Modified *10 = USEPA Tapwater Regional Screening Level multipled by 10 to reflect reduced exposure to pore water/surface water compared to groundwater, June 2011.

* = A noncarcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1.

NSA = No screening level available

Bold font = Maximum MDL > screening level

5 NATURE AND EXTENT OF CONTAMINATION

The results of chemical sampling and analyses performed at the site are presented in this section. The data discussed here were generated between October 2006 and August 2010. Tables 5-1 through 5-6 present the compounds that were detected in each media and compare the detected concentrations to screening levels identified in Section 4. This section is organized by media. First, data generated from soil samples are discussed, followed by the groundwater data, and finally the surface water and sediment pore water data.

5.1 SOIL

Soil data were generated with three primary objectives:

1. During the first phase of the RFI, data were generated during well installation to provide general characterization data for the RFI.
2. Data were generated for SWMU 3 to confirm the findings of previous investigations (Section 1.3.3.1) that suggest the SWMU is not a source of contamination to groundwater.
3. Data were generated for a potential source area east of the DPW complex to determine whether or not the area could be a source of groundwater contamination.

Data generated to address the first two objectives are discussed in Section 5.1.1; data generated to address the third objective are discussed in Section 5.1.2.

5.1.1 GENERAL SOIL CHARACTERIZATION AND SWMU 3 DATA

During the Phase I field effort, soil boring samples were collected in conjunction with the installation of monitoring wells in the vicinity of SWMU 3 and along the northwest installation boundary (Figure 3-1 and Section 3.2.1). At each location, the soil samples were collected from the 4 to 6-ft bgs interval and the 2-ft interval immediately above the first encountered groundwater; sample depths are presented on Table 5-1 and Figure 5-1. The primary objectives of the samples from locations MW-1 through MW-4 (in the vicinity of SWMU 3) were to determine whether or not the SWMU is a possible source of contamination to groundwater and to identify the potential existence of a burial trench. The other samples were collected to provide general characterization data for the RFI. During subsequent phases of the RFI, split spoon soil samples were field screened using a PID. Because the PID readings were all below 100 ppm (in fact, all were non-detects), no additional soil samples were submitted for laboratory analysis. The boring at MW-04B is the only boring where the PID registered detections (Appendix B), and sample SB-03-06-04-4-8 was collected where the PID readings were observed..

A total of 16 samples were collected from eight locations. Results are presented in Table 5-1 and exceedances of screening levels are presented in Figure 5-1. Samples were analyzed for VOCs, SVOCs, organochlorine pesticides, organophosphorous pesticides, PCBs, herbicides, TAL metals, and TPH. No organophosphorous pesticides or PCBs were detected in any samples, and of the organic compounds that were detected, none were found at concentrations above industrial soil RSLs.

Arsenic and chromium were detected consistently at concentrations above industrial soil RSLs. Concentrations of arsenic ranged from 3.6 milligrams per kilogram (mg/kg) to 61.8 mg/kg, all of which are greater than the RSL of 1.6 mg/kg. Four of the detected concentrations were also above the background value of 43.9 mg/kg. There does not appear to be a spatial pattern to the horizontal distribution of elevated arsenic concentrations; however, the four samples with concentrations above background were all collected from the shallow subsurface (4 to 8 ft bgs).

Concentrations of chromium ranged from 12.5 mg/kg to 227 mg/kg, all of which are greater than the RSL of 5.6 mg/kg. Six of the detected concentrations (from five locations) were also above the background value of 69.8 mg/kg. As with arsenic, all of the samples with concentrations above background were from the shallow subsurface (4 to 8 ft bgs).

Cobalt was detected in one sample (SB-03-06-03-(4-8), 37.7 mg/kg) at a concentration above the RSL of 30 mg/kg. This concentration is also greater than the background value of 16.6 mg/kg.

These results indicate that the soils of SWMU 3, and the areas where each of the borings was installed, are not contaminated by organic compounds. These results do not support the theory that a pesticides burial trench is located at SWMU 3, at least not in the areas where the borings are located.

There are some elevated concentrations of metals in the shallow subsurface (4 to 8 ft bgs). . As described in Section 2.6, the clay overburden layer, or confining unit, is fairly impervious to infiltration and at its shallowest points extends from the surface to approximately 20 ft bgs. Therefore the elevated concentrations of metals detected in soil samples from 4 to 8 ft bgs would not impact groundwater. Supporting this statement is the fact that groundwater samples from locations with elevated concentrations of arsenic and cobalt in the shallow subsurface soil did not have detections of either of these metals. Some of the groundwater samples from locations with elevated concentrations of chromium in shallow subsurface soil (e.g. locations SB-03-03 and SB-03-05) also had elevated concentrations of total chromium in groundwater, although dissolved chromium was not detected and such an association was not found consistently. Elevated concentrations of metals were not found in soil samples from intervals just above the screened intervals of the wells.

Previous investigations indicate that the primary groundwater contaminant is TCE, and one of the objectives of the soil sampling was to determine whether or not the sampled areas could be a source of the TCE contamination. PCE, which can be a parent compound to TCE, was not detected in any of the soil samples. TCE was detected in one sample (SB-03-06-06-(32-36)) at a concentration of 1.3 ug/kg. Boring 6 is not located within SWMU 3, further suggesting that

SWMU 3 is not the source of the groundwater contamination. The TCE concentration detected in soil is greater than the risk-based protection of groundwater soil screening level (SSL) of 0.72 ug/kg but less than the MCL-based SSL of 1.8 ug/kg (USEPA June 2011). TCE was not detected in groundwater samples from the shallow well at this location (MW-06A, screened from 8 to 18 ft bgs as a water table well not an aquifer well) but was detected in samples from the deep well (MW-06b, screened from 40 to 50 ft bgs). Groundwater data are discussed further in Section 5.2.

5.1.2 AREA EAST OF THE DPW-GEOPHYSICAL SURVEY AND SOIL DATA

During the Phases V and VI, a geophysical investigation was conducted and soil samples were collected from an area east of the DPW complex (Figure 3-4). This area was identified for further evaluation because the highest concentrations of TCE found prior to Phase V were detected there (samples from MW-15) and because aerial photographs from the 1960s and 1970s show the area being open and possibly used for the staging of equipment and parking of vehicles. Ground scars are visible in the photographs, and a railroad line is visible that ran from north to south through the field (Figure 3-2). As described in Section 3.2.6, the geophysical survey identified three anomalies (Anomaly A, Anomaly B, and a linear feature) in the shallow subsurface (Figure 3-3). It should also be noted that as part of Phase VI, additional monitoring wells (MW-25 and MW-26) were installed in this area and elevated concentrations of TCE were found in samples from those wells. Figure 3-4 shows the proximity of the anomalies and soil sampling locations with wells MW-25, MW-26, and MW-15. The groundwater data are discussed in Section 5.2.

To investigate Anomalies A and B, three test pits were dug at Anomaly A (TP-1 through TP-3) and one test pit was dug at Anomaly B (TP-4) on 16 September 2008 (Figure 3-4). Each pit was dug to a depth of approximately 4 to 5 ft bgs. A photographic log of the test pitting is included in Appendix M**.** TP-1 showed evidence of scrap metal starting at approximately 6 inches bgs to 4 ft bgs (Appendix M Photo 1). The majority of the scrap was reinforced steel bars (1-2 ft sections) and steel cable. No potential TCE source materials were uncovered, and there were no PID detections. A single soil sample was collected at the bottom of the pit (TP-1-4) below the scrap metal.

The second pit (TP-2) was excavated approximately 25 ft southeast of TP-1. However, this pit yielded very little scrap other than a piece of reinforced steel bar (Appendix M Photo 2). The pit was dug to 4 ft, but nothing further was uncovered. No soil samples were collected from TP-2.

Another pit (TP-3) was dug in the vicinity of Anomaly A to further investigate the area, since TP-2 yielded very little material. TP-3 was located approximately 15 ft west of TP-2. Under the dark, wet topsoil (approximately 6 inches bgs), the excavator uncovered reinforced steel bars, scrap wood, various sizes of deteriorated metal, and coiled rubber (Appendix M Photos 4 and 5).

No PID detections were reported during the test-pitting. A soil sample was obtained from the bottom of TP-3 (TP-3-4).

The final test pit (TP-4) was excavated in the vicinity of Anomaly B. Since Anomaly B was considerably smaller in area than Anomaly A based on the geophysical data, only one pit was dug to investigate Anomaly B. Beneath the topsoil and a foot of silty clay, the pit revealed several hundred small canisters from 2 to 4 ft bgs. Several of the canisters were collected by DPW personnel to be further identified. The canisters were not identified other than being believed to be vehicle-related. Several canisters were removed from the excavation by Fort Buchanan personnel. No chemical analysis of the contents was performed, but a December 21, 2010 email from Fort Buchanan personnel indicated that the canisters were identified by a mechanic to be part of a drying system in the air conditioners of old trucks. A soil sample was obtained from the base of the pit (TP-4-4).

To investigate the linear feature, which was possibly a storm sewer line, eight soil samples were collected from four locations beside the suspected line location. Sample depths were selected to characterize media adjacent to and below the line. The objective of these soil samples was to determine whether or not the surrounding soil had been contaminated by media that may have been transported through the line (and may have potentially leaked from the line).

All of the test pit and sewer line samples were analyzed for VOCs, SVOCs, organochlorine pesticides, organophosphorous pesticides, PCBs, herbicides, and TAL metals. Results are presented in Table 5-2 and exceedances of screening levels are presented in Figure 5-2. No organophosphorous pesticides or herbicides were detected in any samples, and of the organic compounds that were detected, none were found at concentrations above industrial soil RSLs.

All of the detected concentrations of arsenic and chromium are greater than their industrial soil RSLs. Arsenic concentrations range from 9 mg/kg to 72 mg/kg, which are greater than the RSL of 1.6 mg/kg. Concentrations found in two samples were also greater than the background value of 43.9 mg/kg. The field duplicate collected at location SL-2 had a reported concentration of 53.8 mg/kg while the parent sample from this location had a reported concentration of 9 mg/kg. The maximum concentration of arsenic was found in the sample collected at Test Pit 4.

Detected concentrations of chromium ranged from 32.1 mg/kg to 120 mg/kg, all of which are greater than the industrial soil RSL of 5.6 mg/kg. Only the maximum detected concentration was also greater than the background value of 69.8 mg/kg. The maximum concentration was detected in the sample collected at Test Pit 4.

These results indicate that the shallow subsurface soil in this area is not contaminated by organic compounds. Previous investigations indicate that the primary groundwater contaminant for the Northwest Boundary Area is TCE, and the highest concentrations of TCE detected in groundwater during this RFI were found in this area in MW-25 and MW-26. Neither TCE nor

PCE (which can be a parent compound to TCE) were detected in any of the soil samples collected from this area, and a specific source (e.g. buried drums) was not found. Some elevated concentrations of arsenic and chromium were found, although the horizontal distribution appears to be limited.

5.2 GROUNDWATER

Data were generated to characterize both the physical and chemical nature of the aquifer. Physical properties of the aquifer were characterized by measuring groundwater elevations and flow. Chemical properties of the aquifer were characterized by collection of samples for laboratory analysis. This section discusses the results of groundwater level and elevation measurements (collected through gauging and transducers, respectively), slug testing, and the laboratory analyses. As the physical characteristics of the aquifer influence the transport of chemicals in groundwater, they are discussed first in Subsection 5.2.1. Sections 5.2.2 through 5.2.4 present the results of the chemical analytical testing.

Chemical data were generated from seven groundwater sampling events conducted over the course of the investigation (January 2007 through April 2009). A supplemental sampling event was conducted in 2010 as part of the Well Integrity Investigation (Section 3.6). A total of 168 samples, including field duplicates, were collected. The first round of samples collected from each well after installation was analyzed for TAL metals (total and dissolved), VOCs, SVOCs, organochlorine and organophosphorous pesticides, herbicides, and PCBs. All subsequent samples were evaluated for VOCs only. Select samples were analyzed for general chemistry parameters and dissolved gases. Samples collected in 2010 as part of the Well Integrity Investigation were analyzed for VOCs and TPH. No organophosphorous pesticides, herbicides, or PCBs were detected in any samples.

5.2.1 GROUNDWATER FLOW AND SLUG TESTING RESULTS

A groundwater gauging event was conducted prior to each sampling event to determine the water level in each well. Generally speaking, groundwater flows south to north, with a steep gradient from the southern end of the investigation area and flattening out north of the DPW complex and across Route 28. Since groundwater levels are tidally influenced in many of the wells, detailed water elevation data was obtained from transducers.

Transducers were used to monitor changes in water elevations, temperature, and barometric pressure in the monitoring wells. Hydrographs generated from transducer data from June to July 2007 and March 2009 are included in Appendix E. It was found that certain wells responded to tidal forces, and others did not; also, certain wells responded to rainfall events while others did not. These data led to the determination that the most southern wells (e.g., -19A, -21, etc.) were installed in older terrace material. These wells did not respond to changes in tides and had a relatively fast response to rainfall events. Wells in the field east of the DPW complex (e.g. MW-

25) and to the north (downgradient) were installed in younger terrace material. These wells showed definite changes in water elevations corresponding to tidal effects, and did not have immediate responses to rainfall events. It was also determined that MW-25 lies close to the communication zone between the younger terrace and older terrace materials.

The transducer data was used in the development of the groundwater model (see Sections 2.6.1 and 6, and Appendix D) and an overall understanding of the site aquifer. In addition, the water elevation measurements from March 2009 were used in identifying the groundwater flow direction, which is presented in Figure 5-3. The March 2009 data encompass on-post Fort Buchanan wells, CPR wells, and off-post Fort Buchanan wells. The groundwater elevations drop steeply from highs at MW-19A (23.7 ft amsl) and MW-14A (14.14 ft amsl) to below 5 ft amsl immediately to the north of the DPW complex. As seen with slight variations to past gauging events, the flow is to the north-northwest, and then turns slightly toward a true northerly direction.

A vertical groundwater gradient was identified using data from the various cluster wells installed throughout the Northwest Boundary Area. For example, the vertical gradient from the MW-5 wells is upward, at a magnitude of 0.37, based on the depths-to-water from the March 2009 water levels. However, the vertical gradient was slightly downward (magnitude of 0.004) in the vicinity of the MW-10 cluster. Overall, the vertical gradient throughout the investigation area is in an upward direction (e.g., MW-14B is artesian, while MW-14A generally has a depth to water of 8 ft).

5.2.1.1 Slug Tests

As discussed in Section 3.2.6.5, slug tests were conducted to help characterize the aquifer. During the test, change in hydraulic head was monitored through time to determine the near-well hydraulic conductivity of the material surrounding the well. Hydraulic conductivity is represented as K, and is a value that represents how easily water moves through pore spaces or fractures. Hydraulic conductivity is dependent upon the permeability of the material and the degree of saturation. While slug tests only provide data for the conditions at a specific borehole, results can be averaged from across the study area to provide general characterization information for the study area as a whole.

Slug tests were completed at each well except MW-14A and MW-14B, which were inaccessible at the time the tests were being performed. All monitoring wells are screened in the confined aquifer except for MW-6A, which was screened in the water table aquifer and is considered unconfined. The results of the slug tests are summarized in Table 5-3. As noted in the table, water levels returned to pre-test levels very quickly in a number of wells. Such fast recovery can lead to inaccurate collection of water level data, and thus inaccurate results. For this reason, data for MW-12A, MW-13B, and MW-15 were excluded from calculations as were the falling head test results for MW-3A, MW-4A, MW-5A, MW-11B, MW-12B, and MW-16A and the rising head test results for MW-16B and MW-18B.

The data obtained from the falling and rising head slug tests were analyzed with AQTESOLV^{TM}; a printout of each graph and testing parameter is included in Appendix N. The Bouwer and Rice method was used to determine hydraulic conductivity (K) from the data and the site-specific parameters. The tests yielded K values ranging from 0.0432 ft/day in MW-18B to 411.8 ft/day in OP-6 (Table 5-3). Wells OP-6 and OP-7 had K values that were notably higher than all other wells; therefore average K values were calculated with and without the data for these two wells. The average K value in ft/day was 18.2 without OP-6 and OP-7 data; with data for OP-6 and OP-7, the average K in ft/day increased to 35.72. These values are consistent with literature values characteristic of the lithology at the site (Domenico and Schwartz 1990).

5.2.2 CHEMICAL DATA FOR METALS

Total and dissolved metals were analyzed for in the first round of samples collected from the wells. Subsequent rounds of samples were not analyzed for metals because the first set of results did not indicate significant groundwater contamination by metals. It should be noted that unfiltered samples (total concentrations) are likely to contain particulate matter from the surrounding material (soil or sediment particles). Metals may be adsorbed to the particulate matter causing the reported concentrations of these inorganics in unfiltered aqueous samples to be higher than the concentrations reported in associated filtered samples. Because the filtered aqueous samples do not contain particulate matter, the data generated from them are more representative of the actual dissolved concentrations of inorganics that are present in groundwater. For this reason, the following discussions focus on data generated for filtered, or dissolved, metals.

It should also be noted that, as discussed in Section 5.1, many metals occur at naturally elevated concentrations in the soil of Puerto Rico. Therefore naturally occurring concentrations of metals in groundwater can also be expected to be higher than other regions (e.g. the continental United States).

Table 5-4 presents the data for metals detected at least once in groundwater, and Figure 5-4 shows the locations where metals were found at concentrations above the tap water RSLs. Fourteen metals were detected at least once at a concentration above the tap water RSL. However, only seven metals were found at dissolved concentrations above tap water RSLs: antimony, arsenic, barium, chromium, cobalt, iron, and manganese.

Dissolved antimony was detected in two samples and both concentrations were greater than the tap water RSL of 1.5 ug/L. One of the concentrations was greater than the MCL of 6 ug/L. Dissolved antimony was detected at 1.8 ug/L in the sample from MW-24 and at 6.1 ug/L in the field duplicate collected from MW-17A. Dissolved antimony was not detected in the parent sample from MW-17A. These two detections appear to be isolated, and downgradient wells did not have detections of antimony. MW-17A and MW-24 are not located in the vicinity of any SWMUs identified for evaluation, including the SWMUs being investigated as part of the Site Wide RFI (Figure 1-1).

Dissolved arsenic was detected in eleven samples at concentrations ranging from 1.7 ug/L to 30.8 ug/L. All of the detected concentrations are greater than the tap water RSL of 0.045 ug/L, and two of the detected concentrations were greater than the MCL of 10 ug/L. The two highest concentrations of arsenic were found in wells OP-06 and MW-08. As presented in Figure 5-5, the highest concentrations of arsenic are isolated from each other, and there is not an apparent trend to the distribution of concentrations. Only one of the detected concentrations was found in a well near one of the sites being addressed in the Site Wide RFI. A concentration of 9.4 ug/L was detected in MW-19B, which is just downgradient of SWMU 7, Building 541 (Figure 1-1). Building 541 was a hazardous materials storage building; surface soil and subsurface soil from this site were analyzed for metals, and arsenic was detected in both media at concentrations below background values (EA 2010a). Therefore SWMU 7 is not considered a source of arsenic contamination in groundwater.

Dissolved barium and iron were detected in one groundwater sample at concentrations above the tap water RSL of 730 ug/L (barium) and 2,600 ug/L (iron). The detected concentrations did not exceed MCLs. The sample, collected from OP-6, had a concentration of 1,140 ug/L barium and 21,300 ug/L iron. These elevated concentrations are isolated and were found in a well located off of Fort Buchanan. Therefore the elevated concentrations are not the result of an onsite source.

Dissolved chromium was detected in eighteen samples at concentrations ranging from 0.6 ug/L to 75.4 ug/L. All of the detected concentrations are greater than the tap water RSL of 0.043 ug/L and none are greater than the MCL of 100 ug/L. The highest concentrations of chromium were detected in the off-post wells (Figure 5-5). Two of the wells with detections of dissolved chromium are located just downgradient of sites being addressed in the Site Wide RFI. A concentration of 2 ug/L was detected in MW-10A and a concentration of 5.1 ug/L was detected in MW-10B, which are located near Site 4/SWMU 5, a PCB transformer storage area. Soils from this site were not analyzed for metals, as PCBs were the only constituents of potential concern (COPCs) (EA 2010a). Based on site history, SWMU 5 is not expected to be a source of chromium contamination in groundwater. A concentration of 1.1 ug/L dissolved chromium was detected in MW-23, which is immediately downgradient of Site 8, Building S-563. Building S-563 was used as an automobile body shop. Chromium was detected in subsurface soil from this site, but at concentrations below background (EA 2010a). Therefore Site 8 is not considered a source of chromium contamination in groundwater.

Dissolved cobalt was detected in 15 samples at concentrations above the tap water RSL of 1.1 ug/L; a MCL is not available for cobalt. Elevated concentrations are scattered among the Northwest Boundary Area wells, with no apparent pattern (Figure 5-5) suggesting the lack of a contaminant source area. Concentrations detected in off-post wells were similar, and just as high, as concentrations detected in on-post wells. Two of the wells with elevated concentrations (although not the most elevated) are in the vicinity of sites being addressed in the Site Wide RFI. A concentration of 2.8 ug/L was detected in MW-23, which is downgradient of Site 8 (discussed in the previous paragraph). One of the subsurface soil samples from Site 8 had a detected concentration of cobalt that was greater than the background value; 56.6 mg/kg was detected in sample S08-08-01-4-6. All of the other detected concentrations of cobalt in soil at this site were notably lower (EA 2010a), suggesting that the site as a whole is not characterized by elevated concentrations of cobalt in soil, and is unlikely to be a source of groundwater contamination. Concentrations of 2.3 ug/L and 2.1 ug/L were detected in MW-19A and MW-19B respectively, which are downgradient of Site 7/Building 541 (discussed above for arsenic). Concentrations of cobalt detected in soil at Site 7 were below the background value (EA 2010a).

Dissolved manganese was detected in 14 samples at concentrations above the tap water RSL of 88 ug/L. It should be noted that dissolved manganese was not measured in wells installed during Phases I, II, and III. Therefore data are only available for the off-post wells and wells east of the DPW complex (discussed in Section 5.1.2, see also Figure 3-1). As presented in Figure 5-5, concentrations on- and off-post were similar. The highest concentrations were found in wells MW-25 (1,950 ug/L) and MW-26 (2,700 ug/L and 2,730 ug/L), and a similarly high concentration was found in well OP-6 (1,230 ug/L). Only one of the samples with an elevated concentration was collected from a well in the vicinity of a site being addressed in the Site Wide RFI. A concentration of 321 ug/L was found at well MW-23, which is downgradient of Site 8. One of the subsurface soil samples from Site 8 had a detected concentration of manganese that was greater than the background value; 2,050 mg/kg was detected in sample S08-08-01-4-6. All of the other detected concentrations of manganese in soil at this site were notably lower (EA 2010a), suggesting that the site as a whole is not characterized by elevated concentrations of manganese in soil, and is unlikely to be a source of groundwater contamination.

5.2.2.1 Summary of Findings for Metals

The metals that were detected at elevated, dissolved, concentrations were typically found in isolated wells, at concentrations similar to MCLs, and in off-post wells at similar concentrations. The data do not indicate the presence of a plume or source of metals contamination.

5.2.3 CHEMICAL DATA FOR SVOCS AND PESTICIDES

SVOCs and pesticides were analyzed for in the first sampling event at each well. Subsequent rounds of samples were not analyzed for these chemical groups because the first set of results did not indicate significant groundwater contamination from them. Table 5-4 presents the data for

SVOCs and pesticides that were detected at least once in groundwater, and Figure 5-4 shows the locations where compounds were found at concentrations above the tap water RSLs.

Five SVOCs were detected at least once in the groundwater samples; two were found at concentrations above the tap water RSL (Table 5-4). 1,4-Dichlorobenzene was detected in the field duplicate collected from MW-05B at a concentration of 1.5 ug/L. This concentration is greater than the tap water RSL of 0.43 ug/L but is below the MCL (75 ug/L) and below the groundwater to air screening level (8,200 ug/L). In addition, 1,4-dichlorobenzene was not detected in the parent sample collected from this well. Naphthalene was detected in three samples, and all detected concentrations were above the tap water RSL of 0.14 ug/L but below the groundwater to air screening level of 150 ug/L. Detected concentrations of naphthalene ranged from 0.796 ug/L to 1.51 ug/L. As with 1,4-dichlorobenzene, naphthalene was detected in the field duplicate collected from MW-05B but was not detected in the parent sample. The available data suggest that these SVOCs are present in the groundwater, but there is no evidence of a plume or significant, wide-spread contamination.

The pesticide heptachlor was the only pesticide detected in groundwater, and it was only detected in one sample (G-03-09-OP-03, Table 5-4). The detected concentration was 0.96 ug/L, which is above the tap water RSL of 0.015 ug/L and above the MCL and groundwater to air screening level of 0.4 ug/L. This is an isolated detection that was found off-post, and therefore is not indicative of overall groundwater contamination or of the presence of an onsite source.

5.2.3.1 Summary of Findings for SVOCs and Pesticides

Two SVOCs and one pesticide were detected in groundwater samples at concentrations above screening levels. However, the detections were isolated, not repeated in parent samples (when found in field duplicates), and are not indicative of overall groundwater contamination or of the presence of an onsite source.

5.2.4 CHEMICAL DATA FOR VOCS

VOCs were analyzed for in each sampling event. Sampling results for January 2007, June 2007, January 2008, May 2008, January 2009, March 2009, April 2009, and August 2010 are presented in Table 5-5. Concentrations of detected compounds that are greater than tap water RSLs are presented on Figure 5-6. Eighteen VOCs were detected at least once in groundwater samples, and 14 of them were found at concentrations above screening levels. No dense non-aqueous phase liquid (DNAPL) was detected in any of the wells.

The VOCs that were detected with the greatest frequency and highest concentrations (relative to screening levels) are related to the breakdown of PCE (Figure 5-7). This discussion is organized to present the data for these related compounds together, and then discuss the other VOCs that were detected at elevated concentrations.

5.2.4.1 VOCs Related to the Breakdown of PCE

As presented in Figure 5-7, the breakdown products of PCE are: TCE, cis- and trans-1,2-DCE, vinyl chloride, and finally ethene. Each of these compounds was detected in groundwater samples. Figure 5-8 presents the relative concentrations of PCE, TCE, 1,2-DCE, and vinyl chloride.

The highest concentrations of PCE were found in wells MW-15 and MW-25, which are located in the vicinity of the geophysical investigation discussed in Section 5.1.2. Concentrations detected in these wells ranged from 34.1 ug/L to 20.9 ug/L. MW-11A & B and MW-26 also showed elevated concentrations, ranging from 11.5 ug/L to 5.4 ug/L. Of these wells, some were sampled during multiple phases of the RFI, and the results showed decreasing concentrations of PCE over time (Table 5-5). Despite this trend, all concentrations detected in these wells were greater than the tap water RSL (0.11 ug/L), the MCL (5 ug/L), and the groundwater to air screening level (5 ug/L). The horizontal distribution of PCE is presented in Figure 5-8. Additional wells were not necessary, as the positive detections for PCE were bounded in all directions by non-detect samples.

The highest concentrations of TCE were also found in wells MW-25 and MW-26 with concentrations ranging from 1,150 ug/L to 4,040 mg/L in those two wells. MW-15, just east of these wells, had the next highest concentrations, which ranged from 331 ug/L to 378 ug/L. Concentrations then decrease in wells to the northwest (Figure 5-8). Concentrations remain elevated, with respect to the tap water RSL of 2 ug/L and the MCL of 5 ug/L, at and beyond the Installation boundary. Additional downgradient wells were not installed off-post because the area is inaccessible to a drill rig. Downgradient of the northernmost off-post wells is a low-lying, swampy area with surface water. Because wells could not be installed in this area, surface water samples were collected to determine whether VOCs in groundwater were discharging to the surface. This was not found to be occurring, and is discussed further in Section 5.3. Further characterization to the west was not warranted because groundwater in that area is monitored by the refinery and concentrations appeared to be decreasing as exhibited by the concentrations reported in OP-01 and CPR-84B2. Similarly, it was agreed that further characterization would not be conducted to the east of MW-13 and OP-05 because of accessibility issues off-post (due to the toll plaza on PR No. 22 and swampy nature of the land in this area) and decreasing concentrations as exhibited by the results for wells OP-05, MW-17A, and MW-18A/B.

Figure 5-9 presents isoconcentrations of TCE estimated from the March 2009 data. The plume appears to originate at MW-25 and MW-26 and spread almost due north with the exception of a western leg caused by concentrations found in wells MW-06B, CPR-83B1, and CPR-83B2. The potential for another source area in the vicinity of MW-06B was considered through an evaluation of data generated as part of the Fort Buchanan Site Wide RFI. As shown in Figure 1-1, there are five sites upgradient of MW-06B (Sites 4, 3, 11, 6, and 9) and there are two monitoring well clusters located between these sites and MW-06B (MW-10A/B and MW-5A/B). The soil data generated for these sites do not indicate the presence of contamination from either PCE or TCE, and TCE was not detected in either MW-10A or 10B, nor was it detected MW-05B. TCE was detected in MW-05A at 5.5 ug/L, but if a source was located in that area, concentrations would have been detected in the other downgradient wells. Furthermore, there is a flat groundwater gradient in the area and when the samples were collected there was a large pump and treat system on the CPR property to the west. These two factors combined could have drawn TCE-impacted groundwater westward and resulted in the detections observed in MW-06B, CPR-83B1, and CPR-83B2.

Consistent with the findings for PCE and TCE, the highest concentrations of 1,2-DCE were also found in MW-15 and MW-25 (Figure 5-8). Concentrations detected in MW-25 ranged from 259 ug/L to 288 ug/L (for purposes of discussion, concentrations of cis- and trans-1,2-DCE were summed to provide a single value for 1,2-DCE if the laboratory did not report such a value). Concentrations detected at MW-26 ranged from 44.1 ug/L to 68.7 ug/L, and concentrations in MW-15 ranged from 53.1 ug/L to 66.9 ug/L. All of these concentrations are well above the tap water RSL of 33 ug/L. Highly elevated concentrations were also detected in MW-7B, where concentrations ranged from 184 ug/L to 232 ug/L; 1,2-DCE was not detected in the shallow well at this location (MW-7A). Other than the concentrations of 1,2-DCE detected at these few locations, the wide majority of detections at other wells were below the tap water RSL, indicating that elevated concentrations of this VOC have a limited horizontal extent.

Vinyl chloride is one of the final degradation projects of PCE and TCE (Figure 5-7). It was detected in groundwater samples from six locations (Figure 5-8). The highest concentrations were found in samples from MW-7B, with concentrations ranging from 7.8 ug/L to 25.6 ug/L. These concentrations are above the tap water RSL of 0.016 ug/L, the MCL of 2 ug/L, and the groundwater to air screening level of 2 ug/L. Elevated concentrations were also found east of the DPW complex. The first time MW-25 was sampled (January 2009), a concentration of 7 ug/L was detected; however, this well was sampled two more times, in March 2009 and August 2010, and vinyl chloride was not detected. This VOC was also detected in each of the four samples collected from MW-15 at concentrations close to the MCL; concentrations ranged from 2.3 ug/L to 3 ug/L. As presented in Figure 5-8 the horizontal extent of vinyl chloride is limited and bounded by wells whose samples were non-detect for this VOC.

In summary, the data indicate that groundwater in the Northwest Boundary Area is contaminated with PCE and TCE, and to a lesser extent 1,2-DCE and vinyl chloride. The horizontal extent of elevated concentrations of PCE, 1,2-DCE, and vinyl chloride is generally limited to Fort Buchanan; notable concentrations were not found in off-post wells. The horizontal extent of TCE is more widespread and extends north from the Installation boundary. The northern extent of the TCE plume remains uncertain due to the impossibility of sampling groundwater north of the existing off-post wells. Wells MW-25, MW-26, and MW-15 consistently had the highest concentrations of these VOCs. This led to the speculation that a source might be present in the field and to the geophysical investigation completed as Phase V of the RFI. The geophysical investigation and the evaluation of soil samples from the area (Section 5.1) did not identify a clear soil source for the groundwater contamination.

There is a potential for impacts to air from concentrations in groundwater, based on comparisons to the groundwater to air screening levels. These screening levels were equal to the MCLs for PCE, TCE, and vinyl chloride, and as such the areas with the greatest exceedances are found in the field east of the DPW complex (e.g. wells MW-25 and MW-15). A groundwater to air screening level is not available for 1,2-DCE, but screening levels are available for the individual cis- and trans- isomers. Detected concentrations of trans-1,2-DCE were less than the groundwater to air screening level (180 ug/L) while concentrations of cis-1,2-DCE were greater than the screening level at MW-25 (screening level of 210 ug/L). The potential for risks to human health from vapor intrusion is assessed in the HHRA (Section 7). It is important to note however, that there is only one building located within the definitive plume area. Building 539, also known as SWMU 1, is not consistently occupied, but rather is used periodically as an armory and temporary staging area.

5.2.4.2 Other VOCs

Twelve other VOCs were also detected in groundwater samples and are discussed in the following paragraphs. Notable contamination from these VOCs was not found. All detected concentrations of acetone, carbon disulfide, chloromethane, and total xylenes were below tap water RSLs, MCLs, and groundwater to air screening levels.

Samples collected from eight wells had detected concentrations of 1,1,2-trichloroethane (1,1,2-TCA), which ranged from 0.29 ug/L to 25.7 ug/L (Table 5-5). All of these concentrations were above the tap water RSL of 0.042 ug/L, but only concentrations found in MW-25 and MW-26 were greater than the MCL and groundwater to air screening level of 5 ug/L. As shown in Figure 5-10, the highest concentrations were found in wells MW-25 and MW-26, and concentrations quickly decreased in wells to the northwest.

Detected concentrations of 1,1-DCE were all below the tap water RSL of 34 ug/L and only the maximum concentration was greater than the MCL of 7 ug/L. The maximum concentration, 7.8 ug/L, was found in MW-25.

Five wells reported detections of 1,2-dichloroethane (1,2-DCA), with concentrations ranging from 0.31 to 0.59 ug/L. All of these concentrations were above the tap water RSL of 0.15 ug/L but are below the MCL and groundwater to air screening level of 5 ug/L. Unlike the other VOCs discussed thus far, the highest concentrations of 1,2-DCA were not found east of the DPW complex, but rather in MW-12A, which is to the northwest (Figure 5-6). It is important to note that 1,2-DCA was only detected in four of the six samples collected from this well, and was not detected in the most recent sampling effort (Table 5-5).

Chloroform was detected in 37 samples with concentrations ranging from 0.2 ug/L to 7.4 ug/L. All of these concentrations are above the tap water RSL of 0.19 ug/L but are below the MCL and groundwater to air screening level of 80 ug/L. The highest concentrations of chloroform were detected in wells located off-post (Figure 5-10): OP-5 (3.2 ug/L to 7.4 ug/L) and OP-4 (2.6 ug/L to 5.2 ug/L), although MW-13B reported concentrations up to 3.8 ug/L. The concentrations of chloroform detected in each of these wells decreased over time (Table 5-5).

Methylene chloride was detected in only one sample, collected from MW-25 in January 2009 (11.9 ug/L). The detected concentration was above the tap water RSL of 4.8 ug/L and the MCL of 5 ug/L, but below the groundwater to air screening level of 58 ug/L. This well was sampled again during two subsequent efforts (March 2009 and August 2010), and methylene chloride was not detected in either of the more recent samples. Bromodichloromethane was detected in one sample from OP-5 collected in January 2009 at a concentration of 0.5 ug/L. This concentration is above the tap water RSL of 0.12 ug/L but below the MCL of 80 ug/L and the groundwater to air screening level of 2.1 ug/L. In addition, subsequent samples from OP-5 were non-detect for bromodichloromethane.

Benzene was detected in three samples at concentrations ranging from 0.49 ug/L to 0.93 ug/L. These concentrations are above the tap water RSL of 0.41 ug/L but below the MCL and groundwater to air screening levels of 5 ug/L. Benzene was detected in two samples from MW-04A and one sample from MW-04B and the most recent samples from each of these wells were non-detect for benzene.

Ethylbenzene was detected in three samples at concentrations ranging from 0.4 ug/L to 3.9 ug/L. The maximum concentration was greater than the tap water RSL of 1.5 ug/L, but all concentrations were below the MCL and groundwater to air screening levels of 700 ug/L. Ethylbenzene was detected in one sample from MW-04A and two samples from MW-04B, and the most recent samples from each of these wells were non-detect for ethylbenzene.

5.2.4.3 Summary of Findings for VOCs

The data indicate that groundwater in the Northwest Boundary Area is contaminated with PCE and TCE, and to a lesser extent 1,2-DCE and vinyl chloride. The horizontal extent of elevated concentrations of PCE, 1,2-DCE, and vinyl chloride is generally limited to Fort Buchanan; notable contamination was not found in off-post wells. The horizontal extent of TCE is more widespread and extends north from the Installation boundary. The northern extent of the TCE plume remains uncertain due to the impossibility of sampling groundwater north of the existing off-post wells. Wells MW-25, MW-26, and MW-15 consistently had the highest concentrations of PCE, TCE, and 1,2-DCE. This led to the speculation that a source might be present in the field and to the geophysical investigation completed as Phase V of the RFI. The geophysical investigation and the evaluation of soil samples from the area (Section 5.1) did not identify a clear source for the groundwater contamination.

While other VOCs are present in the groundwater of the Northwest Boundary Area, the horizontal extent of detections is limited, the concentrations are low in comparison to screening levels, the compounds were detected infrequently onsite, and the data do not indicate the presence of a plume or significant contamination.

5.3 SURFACE WATER AND SEDIMENT PORE WATER

The analytical data from Phases I through VI of the RFI indicated that TCE was present at elevated concentrations in groundwater as far north as OP-6 and OP-7. However, further characterization of the groundwater downgradient of these wells was not completed because the terrain became inaccessible for groundwater sampling equipment. Downgradient of the northernmost off-post wells is a low-lying wetland area. Because wells could not be installed in this area, surface water and sediment pore water samples were collected to further evaluate the horizontal extent of TCE contamination and to determine whether VOCs were entering surface water from the underlying groundwater.

Six sediment pore water samples and one surface water sample were collected and analyzed for VOCs. Sample locations are presented in Figure 3-5 and results are presented in Table 5-6. Acetone (a common laboratory contaminant) was the only VOC detected, and it was only detected in two pore water samples (Pore-05 and Pore-06). The detected concentrations, 4.9 ug/L and 4.7 ug/L, were below screening levels. These data indicate that contaminated groundwater is not impacting the sediment pore water or surface water of this downgradient area.

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Table 5-1
Concentrations of Compounds Detected in Subsurface Soil Samples from Well Borings

Location:				SB-03-01	SB-03-01	SB-03-02	SB-03-02	SB-03-03	SB-03-03
Sample:				SB-03-06-01-(4-8)	SB-03-06-01-(20-24)	SB-03-06-02-(4-8)	SB-03-06-02-(26-28)	SB-03-06-03-(4-8)	SB-03-06-03-(20-22)
Parent Sample:									
Sample Date:				12/1/2006	12/1/2006	12/6/2006	12/6/2006	10/20/2006	10/20/2006
Depth:				4 - 8 ft	20 - 24 ft	4 - 8 ft	26 - 28 ft	4 - 8 ft	20 - 22 ft
Compound	**Industrial RSL**	**Background**	**Units**						
Metals									
Antimony	41 *	2.2	mg/kg	ND	ND	ND	ND	ND	ND
Arsenic	1.6	43.9	mg/kg	37.2	ND	**45.4**	ND	**61.8**	ND
Barium	19000	102	mg/kg	ND	ND	ND	ND	ND	ND
Beryllium	200 *	0.647	mg/kg	ND	ND	ND	ND	ND	ND
Cadmium	80 *	0.858	mg/kg	**1.8**	ND	ND	ND	**1.3**	ND
Chromium	5.6	69.8	mg/kg	**72.4 J**	12.5 J	**89.3 J**	14.9 J	**109**	24.5
Cobalt	30 *	16.6	mg/kg	ND	ND	ND	ND	**37.7**	ND
Copper	4100 *	83.7	mg/kg	29.4	20.4	46.9 J	11 J	54.4	ND
Lead	800 *	27.5	mg/kg	5.9 J	ND	ND	ND	9.3	ND
Mercury	10.0 *	0.32	mg/kg	**0.38 J**	ND	0.22	ND	0.1	0.064
Nickel	2000 *	23.0	mg/kg	5.7 J	5.3 J	ND	ND	**39.8**	ND
Selenium	510 *	1	mg/kg	**4.4**	ND	ND	ND	ND	ND
Vanadium	520 *	145	mg/kg	**186 J**	30.8 J	**202 J**	23.4 J	**168**	ND
Zinc	31000 *	81.0	mg/kg	24.1 J	22 J	35	16.4	70.6	**88.7**
Pesticides									
4,4-DDE	5100	NSA	ug/kg	ND	ND	ND	ND	ND	ND
alpha-Chlordane	6500	NSA	ug/kg	ND	ND	ND	ND	ND	ND
Gamma-chlordane	6500	NSA	ug/kg	ND	ND	ND	ND	ND	ND
Volatile Organic Compounds									
1,1-dichloroethene	110000 *	NSA	ug/kg	ND	ND	ND	ND	ND	ND
2-butanone	20000000	NSA	ug/kg	ND	ND	ND	ND	ND	ND
Acetone	63000000	NSA	ug/kg	b	b	12.5	ND	ND	ND
Benzene	5400	NSA	ug/kg	ND	ND	ND	ND	ND	ND
Carbon disulfide	370000	NSA	ug/kg	ND	ND	ND	ND	ND	ND
Cis-1,2-dichloroethene	200000 *	NSA	ug/kg	ND	ND	a	a	ND	ND
Ethylbenzene	27000	NSA	ug/kg	ND	ND	ND	ND	ND	ND
Isobutyl Alcohol	31000000	NSA	ug/kg	b	b	b	b	b	b
Trichloroethene	14000	NSA	ug/kg	ND	ND	ND	ND	ND	ND
Xylenes, Total	270000	NSA	ug/kg	ND	ND	ND	ND	ND	ND
Semivolatile Organic Compounds									
2-methylnaphthalene	410000	NSA	ug/kg	ND	ND	ND	ND	ND	ND
Acenaphthene	3300000 *	NSA	ug/kg	ND	ND	ND	ND	ND	ND

Table 5-1
Concentrations of Compounds Detected in Subsurface Soil Samples from Well Borings

			Location:	SB-03-01	SB-03-01	SB-03-02	SB-03-02	SB-03-03	SB-03-03
			Sample:	SB-03-06-01-(4-8)	SB-03-06-01-(20-24)	SB-03-06-02-(4-8)	SB-03-06-02-(26-28)	SB-03-06-03-(4-8)	SB-03-06-03-(20-22)
			Parent Sample:						
			Sample Date:	12/1/2006	12/1/2006	12/6/2006	12/6/2006	10/20/2006	10/20/2006
			Depth:	4 - 8 ft	20 - 24 ft	4 - 8 ft	26 - 28 ft	4 - 8 ft	20 - 22 ft
Compound	**Industrial RSL**	**Background**	**Units**						
Anthracene	17000000	NSA	ug/kg	ND	ND	ND	ND	ND	ND
Benzo[a]anthracene	2100	NSA	ug/kg	ND	ND	ND	ND	ND	ND
Benzo[a]pyrene	210	NSA	ug/kg	ND	ND	ND	ND	ND	ND
Bis(2-ethylhexyl) phthalate	120000	NSA	ug/kg	ND	ND	ND	ND	72.3 J	71.9 J
Chrysene	210000	NSA	ug/kg	ND	ND	ND	ND	ND	ND
Dibenzofuran	100000	NSA	ug/kg	ND	ND	ND	ND	ND	ND
Fluoranthene	2200000 *	NSA	ug/kg	ND	ND	ND	ND	ND	ND
Fluorene	2200000 *	NSA	ug/kg	ND	ND	ND	ND	ND	ND
Naphthalene	18000	NSA	ug/kg	ND	ND	ND	ND	ND	ND
Phenanthrene	17000000	NSA	ug/kg	ND	ND	ND	ND	ND	ND
Pyrene	1700000 *	NSA	ug/kg	ND	ND	ND	ND	ND	ND
Total Petroleum Hydrocarbons									
TPH-DRO (C10-C28)	100 +	NSA	mg/kg	ND	ND	ND	16.5	ND	ND
TPH-GRO (C6-C10)	100 +	NSA	mg/kg	ND	ND	ND	ND	ND	ND
General Chemistry[c]									
Cyanide	2000 *	NSA	mg/kg	ND	ND	ND	ND	0.066 B	ND
Sulfide	NSA	NSA	mg/kg	ND	2.4 B	5.1	ND	3.8 B	2.3 B
Percent Solids	NSA	NSA	%	85.3	81.9	77.2	82.1	78	85.4

Samples were analyzed for metals, pesticides, PCBs, herbicides, VOCs, SVOCs, TPH, and general chemistry. Compounds not listed were not detected in any samples.

Industrial RSL = USEPA Industrial Soil Regional Screening Level, June 2011.

* = A noncarcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1.

+ = PREQB Recommended value

Background = Site specific background value

NSA = No screening level available

Gray shading = detected concentration is > the industrial screening level

Bold font = detected concentration is > background

B = Not substantially different than levels reported in associated laboratory blanks.

J = Estimated

ND = Non-detect

a = Compound was not analyzed for.

b = Data were R qualified

c = Data for cyanide and sulfide were not validated.

Table 5-1
Concentrations of Compounds Detected in Subsurface Soil Samples from Well Borings

			Location:	SB-03-04	SB-03-04	SB-03-05	SB-03-05	SB-03-05	SB-03-06
			Sample:	SB-03-06-04-(4-8)	SB-03-06-04-(37-36)	SB-03-06-05-(4-8)	06-NO-08-DP	SB-03-06-05-(28-32)	SB-03-06-06-(4-8)
			Parent Sample:				SB-03-06-05-(4-8)		
			Sample Date:	11/13/2006	11/13/2006	11/8/2006	11/8/2006	11/8/2006	11/2/2006
			Depth:	4 - 8 ft	37 - 36 ft	4 - 8 ft	4 - 8 ft	28 - 32 ft	4 - 8 ft
Compound	**Industrial RSL**	**Background**	**Units**						
Metals									
Antimony	41 *	2.2	mg/kg	ND	ND	**4 J**	ND	ND	ND
Arsenic	1.6	43.9	mg/kg	34.1 J	4.7 J	24 J	**54.5 J**	4.2	**54.6 J**
Barium	19000	102	mg/kg	83.4 J	ND	ND	ND	ND	ND
Beryllium	200 *	0.647	mg/kg	**0.82**	ND	ND	ND	ND	ND
Cadmium	80 *	0.858	mg/kg	ND	ND	ND	**1.7**	ND	ND
Chromium	5.6	69.8	mg/kg	49.7 J	13.2 J	**152 J**	**227 J**	13.9	**95.1 J**
Cobalt	30 *	16.6	mg/kg	**21.1 J**	9 J	ND	ND	ND	10.3 J
Copper	4100 *	83.7	mg/kg	44.4	53.1	39.9 J	68.3 J	15.2	50.9
Lead	800 *	27.5	mg/kg	9.1 J	4.5 J	5	2.9	ND	6.9
Mercury	10.0 *	0.32	mg/kg	0.16	0.046	ND	0.049	0.036	0.12
Nickel	2000 *	23.0	mg/kg	12	6.7	10.5	12.5	6.2	13.9
Selenium	510 *	1	mg/kg	ND	ND	**2.5 J**	ND	ND	ND
Vanadium	520 *	145	mg/kg	96.9 J	40.3 J	**155 J**	**322 J**	30.8 J	**189 J**
Zinc	31000 *	81.0	mg/kg	41.5 J	51.3 J	29.9 J	39.6 J	15.4 J	49.7 J
Pesticides									
4,4-DDE	5100	NSA	ug/kg	2.8	ND	ND	ND	ND	ND
alpha-Chlordane	6500	NSA	ug/kg	ND	ND	ND	ND	ND	ND
Gamma-chlordane	6500	NSA	ug/kg	ND	ND	ND	ND	ND	ND
Volatile Organic Compounds									
1,1-dichloroethene	110000 *	NSA	ug/kg	ND	ND	2.3 J	0.9 J	ND	ND
2-butanone	20000000	NSA	ug/kg	b	ND	ND	ND	ND	28.5
Acetone	63000000	NSA	ug/kg	b	ND	ND	ND	ND	103 J
Benzene	5400	NSA	ug/kg	1040	ND	ND	ND	ND	ND
Carbon disulfide	370000	NSA	ug/kg	ND	ND	ND	ND	ND	1.2 J
Cis-1,2-dichloroethene	200000 *	NSA	ug/kg	a	a	ND	ND	ND	ND
Ethylbenzene	27000	NSA	ug/kg	18600	ND	ND	ND	ND	ND
Isobutyl Alcohol	31000000	NSA	ug/kg	65100	b	b	b	b	b
Trichloroethene	14000	NSA	ug/kg	ND	ND	ND	ND	ND	ND
Xylenes, Total	270000	NSA	ug/kg	1380	ND	ND	ND	ND	ND
Semivolatile Organic Compounds									
2-methylnaphthalene	410000	NSA	ug/kg	1630	ND	ND	ND	ND	ND
Acenaphthene	3300000 *	NSA	ug/kg	53.4 J	ND	ND	ND	ND	ND

Table 5-1

Concentrations of Compounds Detected in Subsurface Soil Samples from Well Borings

Location:				SB-03-04	SB-03-04	SB-03-05	SB-03-05	SB-03-05	SB-03-06
Sample:				SB-03-06-04-(4-8)	SB-03-06-04-(37-36)	SB-03-06-05-(4-8)	06-NO-08-DP	SB-03-06-05-(28-32)	SB-03-06-06-(4-8)
Parent Sample:							SB-03-06-05-(4-8)		
Sample Date:				11/13/2006	11/13/2006	11/8/2006	11/8/2006	11/8/2006	11/2/2006
Depth:				4 - 8 ft	37 - 36 ft	4 - 8 ft	4 - 8 ft	28 - 32 ft	4 - 8 ft
Compound	**Industrial RSL**	**Background**	**Units**						
Anthracene	17000000	NSA	ug/kg	39.2 J	ND	ND	ND	ND	ND
Benzo[a]anthracene	2100	NSA	ug/kg	29.1	ND	ND	ND	ND	ND
Benzo[a]pyrene	210	NSA	ug/kg	ND	ND	ND	ND	ND	ND
Bis(2-ethylhexyl) phthalate	120000	NSA	ug/kg	70.9 J	ND	ND	ND	ND	ND
Chrysene	210000	NSA	ug/kg	19.1 J	ND	ND	ND	ND	ND
Dibenzofuran	100000	NSA	ug/kg	30.4 J	ND	ND	ND	ND	ND
Fluoranthene	2200000 *	NSA	ug/kg	90.9	ND	ND	ND	ND	ND
Fluorene	2200000 *	NSA	ug/kg	145	ND	ND	ND	ND	ND
Naphthalene	18000	NSA	ug/kg	1510	ND	ND	ND	ND	ND
Phenanthrene	17000000	NSA	ug/kg	83.3 J	ND	ND	ND	ND	ND
Pyrene	1700000 *	NSA	ug/kg	73.6 J	ND	ND	ND	ND	ND
Total Petroleum Hydrocarbons									
TPH-DRO (C10-C28)	100 +	NSA	mg/kg	136	ND	ND	ND	ND	ND
TPH-GRO (C6-C10)	100 +	NSA	mg/kg	515	ND	ND	ND	ND	ND
General Chemistry[c]									
Cyanide	2000 *	NSA	mg/kg	ND	ND	ND	ND	ND	ND
Sulfide	NSA	NSA	mg/kg	8	5	2.5 B	ND	1.1 B	10.5
Percent Solids	NSA	NSA	%	74.7	77.5	78.5	76.4	86.9	75.5

Samples were analyzed for metals, pesticides, PCBs, herbicides, VOCs, SVOCs, TPH, and general chemistry. Compounds not listed were not detected in any samples.

Industrial RSL = USEPA Industrial Soil Regional Screening Level, June 2011.

* = A noncarcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1.

+ = PREQB Recommended value

Background = Site specific background value

NSA = No screening level available

Gray shading = detected concentration is > the industrial screening level

Bold font = detected concentration is > background

B = Not substantially different than levels reported in associated laboratory blanks.

J = Estimated

ND = Non-detect

a = Compound was not analyzed for.

b = Data were R qualified

c = Data for cyanide and sulfide were not validated.

Table 5-1
Concentrations of Compounds Detected in Subsurface Soil Samples from Well Borings

			Location:	SB-03-06	SB-03-07	SB-03-07	SB-03-08	SB-03-08	SB-03-08
			Sample:	SB-03-06-06-(32-36)	SB-03-06-07-(5-6)	SB-03-06-07-(16-17)	SB-03-06-08-(12-16)	06-DE-04-DP	SB-03-06-08-(16-20)
			Parent Sample:					SB-03-06-08-(12-16)	
			Sample Date:	11/3/2006	10/10/2006	10/10/2006	12/4/2006	12/4/2006	12/4/2006
			Depth:	32 - 36 ft	5 - 6 ft	16 - 17 ft	12 - 16 ft	12 - 16 ft	16 - 20 ft
Compound	**Industrial RSL**	**Background**	**Units**						
Metals									
Antimony	41 *	2.2	mg/kg	ND	ND	ND	ND	ND	ND
Arsenic	1.6	43.9	mg/kg	ND	6.5	27.6	ND	3.6	35.4
Barium	19000	102	mg/kg	ND	90.2	ND	ND	86.7 J	29.2 J
Beryllium	200 *	0.647	mg/kg	ND	ND	ND	ND	ND	ND
Cadmium	80 *	0.858	mg/kg	ND	ND	ND	ND	**0.95**	**1.8**
Chromium	5.6	69.8	mg/kg	23.1	22.2 J	50.9 J	51 J	41.8 J	37.6 J
Cobalt	30 *	16.6	mg/kg	ND	8	ND	ND	ND	7.4 J
Copper	4100 *	83.7	mg/kg	19.4	45.9 J	81.5 J	63.4	78	24.6
Lead	800 *	27.5	mg/kg	ND	11.2	ND	ND	7.4 J	5.3 J
Mercury	10.0 *	0.32	mg/kg	0.039	0.15	ND	0.21 J	0.26 J	0.097 J
Nickel	2000 *	23.0	mg/kg	ND	6.1	ND	ND	9.1 J	6.6 J
Selenium	510 *	1	mg/kg	ND	ND	ND	ND	ND	**4.7**
Vanadium	520 *	145	mg/kg	56.5 J	89.5 J	**169 J**	104 J	70.5 J	112 J
Zinc	31000 *	81.0	mg/kg	43.8 J	42.3	57.6	57.6 J	69.7 J	26.2 J
Pesticides									
4,4-DDE	5100	NSA	ug/kg	ND	ND	ND	ND	ND	ND
alpha-Chlordane	6500	NSA	ug/kg	6.8 J	ND	ND	ND	ND	ND
Gamma-chlordane	6500	NSA	ug/kg	6.3	ND	ND	ND	ND	ND
Volatile Organic Compounds									
1,1-dichloroethene	110000 *	NSA	ug/kg	ND	ND	ND	ND	ND	ND
2-butanone	20000000	NSA	ug/kg	ND	ND	ND	ND	5.6 J	ND
Acetone	63000000	NSA	ug/kg	ND	38.7 J	b	37.7 J	35.9	22.1 J
Benzene	5400	NSA	ug/kg	ND	ND	ND	ND	ND	ND
Carbon disulfide	370000	NSA	ug/kg	ND	ND	ND	ND	ND	ND
Cis-1,2-dichloroethene	200000 *	NSA	ug/kg	ND	ND	ND	ND	ND	0.6 J
Ethylbenzene	27000	NSA	ug/kg	ND	ND	ND	ND	ND	ND
Isobutyl Alcohol	31000000	NSA	ug/kg	b	b	b	b	b	b
Trichloroethene	14000	NSA	ug/kg	1.3 J	ND	ND	ND	ND	ND
Xylenes, Total	270000	NSA	ug/kg	ND	ND	ND	ND	ND	ND
Semivolatile Organic Compounds									
2-methylnaphthalene	410000	NSA	ug/kg	ND	ND	ND	ND	ND	ND
Acenaphthene	3300000 *	NSA	ug/kg	ND	ND	ND	ND	ND	ND

Table 5-1
Concentrations of Compounds Detected in Subsurface Soil Samples from Well Borings

Location:				SB-03-06	SB-03-07	SB-03-07	SB-03-08	SB-03-08	SB-03-08
Sample:				SB-03-06-06-(32-36)	SB-03-06-07-(5-6)	SB-03-06-07-(16-17)	SB-03-06-08-(12-16)	06-DE-04-DP	SB-03-06-08-(16-20)
Parent Sample:								SB-03-06-08-(12-16)	
Sample Date:				11/3/2006	10/10/2006	10/10/2006	12/4/2006	12/4/2006	12/4/2006
Depth:				32 - 36 ft	5 - 6 ft	16 - 17 ft	12 - 16 ft	12 - 16 ft	16 - 20 ft
Compound	**Industrial RSL**	**Background**	**Units**						
Anthracene	17000000	NSA	ug/kg	ND	ND	ND	ND	ND	ND
Benzo[a]anthracene	2100	NSA	ug/kg	ND	ND	ND	ND	ND	24.8
Benzo[a]pyrene	210	NSA	ug/kg	ND	ND	ND	ND	ND	16.2
Bis(2-ethylhexyl) phthalate	120000	NSA	ug/kg	ND	ND	ND	ND	ND	ND
Chrysene	210000	NSA	ug/kg	ND	ND	ND	ND	ND	22.9
Dibenzofuran	100000	NSA	ug/kg	ND	ND	ND	ND	ND	ND
Fluoranthene	2200000 *	NSA	ug/kg	ND	ND	ND	ND	ND	36.7 J
Fluorene	2200000 *	NSA	ug/kg	ND	ND	ND	ND	ND	ND
Naphthalene	18000	NSA	ug/kg	ND	ND	ND	ND	ND	ND
Phenanthrene	17000000	NSA	ug/kg	ND	ND	ND	ND	ND	42.5
Pyrene	1700000 *	NSA	ug/kg	ND	ND	ND	ND	ND	29.2 J
Total Petroleum Hydrocarbons									
TPH-DRO (C10-C28)	100 +	NSA	mg/kg	ND	ND	ND	ND	ND	ND
TPH-GRO (C6-C10)	100 +	NSA	mg/kg	ND	ND	ND	ND	ND	ND
General Chemistry[c]									
Cyanide	2000 *	NSA	mg/kg	ND	ND	ND	ND	ND	ND
Sulfide	NSA	NSA	mg/kg	2.5 B	1.3 B	ND	1.6 B	4.6 B	3.9 B
Percent Solids	NSA	NSA	%	78.4	76	72.1	63.4	64.6	75.3

Samples were analyzed for metals, pesticides, PCBs, herbicides, VOCs, SVOCs, TPH, and general chemistry. Compounds not listed were not detected in any samples.

Industrial RSL = USEPA Industrial Soil Regional Screening Level, June 2011.

* = A noncarcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1.

\+ = PREQB Recommended value

Background = Site specific background value

NSA = No screening level available

Gray shading = detected concentration is > the industrial screening level

Bold font = detected concentration is > background

B = Not substantially different than levels reported in associated laboratory blanks.

J = Estimated

ND = Non-detect

a = Compound was not analyzed for.

b = Data were R qualified

c = Data for cyanide and sulfide were not validated.

Table 5-2
Concentrations of Compounds Detected in Sewer Line and Test Pit Soil Samples

Location:				SL-1	SL-1	SL-2	SL-2	SL-2	SL-3	SL-3	SL-4	SL-4	TP-1	TP-3	TP-4
Sample:				SL-1-3	SL-1-5	SL-2-3	SL-2-5	08-SE-17-DP	SL-3-3	SL-3-5	SL-4-3	SL-4-5	TP-1-4	TP-3-4	TP-4-4
Parent Sample:								SL-2-5							
Sample Date:				9/17/2008	9/17/2008	9/17/2008	9/17/2008	9/17/2008	9/17/2008	9/17/2008	9/17/2008	9/17/2008	9/16/2008	9/16/2008	9/16/2008
Sample Depth (ft):				3	5	3	5	5	3	5	3	5	4	4	4
Compound	**Industrial RSL**	**Background**	**Units**												
Metals															
Aluminum	99000	30027	mg/kg	27200 J	25700 J	21500 J	**30500 J**	24800 J	24800 J	28600 J	22000 J	**30100 J**	22600 J	22000 J	29200 J
Antimony	41 *	2.2	mg/kg	0.82 J	0.52 J	1.2 J	0.43 J	1.8 J	1.2 J	0.81 J	0.55 J	0.97 J	1.2 J	1.1 J	**4.1**
Arsenic	1.6	43.9	mg/kg	11.5	9	21.2	9	**53.8**	25.9	16	18.5	14.5	25.7	12.7	**72**
Barium	19000	102	mg/kg	91	65.1	45.8	95.9	75.9	44.5	53.7	40.5	36	54.9	55	17.4 J
Beryllium	200 *	0.647	mg/kg	0.32 J	0.29 J	0.18 J	0.25 J	0.23 J	0.17 J	0.17 J	0.12 J	0.17 J	ND	0.21 J	ND
Cadmium	80 *	0.858	mg/kg	0.84	0.71 J	0.7	0.74 J	**1.5**	**0.9**	0.74 J	0.68 J	0.84	**1**	0.82	**2.1**
Calcium	NSA	105848	mg/kg	22200 J	29600 J	95300 J	8330 J	6160 J	79400 J	7100 J	15600 J	5340 J	12400 J	11400 J	37700 J
Chromium	5.6	69.8	mg/kg	42.4	34.9	49.6	38	45.6	56.7	39.8	36.1	36	37.2	32.1	**120**
Cobalt	30 *	16.6	mg/kg	10.6 J	7.6 J	7.6 J	7.4 J	**19.5 J**	11.3 J	10.5 J	10.7 J	8.6 J	9.5 J	7.1 J	5.7 J
Copper	4100 *	83.7	mg/kg	49.1 J	48 J	29.6 J	49.3 J	58 J	35.5 J	39.9 J	32.4 J	35.9 J	29.5 J	30.8 J	**178 J**
Iron	72000 *	47064	mg/kg	26600	26500	26500	28100 J	**62800 J**	31100	33600	32500	35300	41700	29100	**71400**
Lead	800 *	27.5	mg/kg	13.6	10.2	8.4	7.4	18.4	12.7	8.3	7.2	7.3	8.4	20.5	**32.4**
Magnesium	NSA	5131	mg/kg	1990 J	1900 J	1640 J	2130 J	1540 J	1620 J	1890 J	1370 J	1850 J	1320 J	1670 J	1220 J
Manganese	2300 *	1184	mg/kg	782 J	303 J	418 J	398 J	1150 J	782 J	431 J	506 J	348 J	315 J	192 J	497 J
Mercury	10.0 *	0.32	mg/kg	0.18	0.17	0.079	0.21	0.19	0.16	0.17	0.16	0.21	0.19	0.21	0.14
Nickel	2000 *	23.0	mg/kg	9.1 J	7.5 J	9.8 J	8 J	11.3 J	11.6 J	9.5 J	8.3 J	6.9 J	7.4 J	8 J	12.9 J
Potassium	NSA	1459	mg/kg	632 J	596 J	598 J	717 J	544 J	540 J	690 J	451 J	607 J	419 J	528 J	311 J
Selenium	510 *	1	mg/kg	ND	ND	0.67	0.94	**1.4**	**1.1**	0.81	0.4 J	0.52 J	0.42 J	ND	ND
Sodium	NSA	238	mg/kg	137 J	170 J	123 J	144 J	106 J	118 J	118 J	117 J	193 J	117 J	110 J	81.6 J
Vanadium	520.0 *	145	mg/kg	88.1 J	87.6 J	81 J	105 J	125 J	98.4 J	110 J	94.8 J	111 J	**153 J**	81.9 J	**189 J**
Zinc	31000 *	81.0	mg/kg	70.2 J	55.5 J	41.9 J	55.3 J	**82 J**	52.4 J	56.6 J	42 J	42.8 J	45 J	69.9 J	77.5 J
Pesticides															
4,4-DDD	7200	NSA	ug/kg	ND	ND	2.2	ND	ND	1.8	ND	ND	ND	ND	45.8	3.3
4,4-DDE	5100	NSA	ug/kg	ND	ND	30.6	ND	ND	7.7	ND	ND	ND	ND	74.2	9.1
4,4-DDT	7000	NSA	ug/kg	2.7	ND	3.3	ND	ND	9.8	ND	ND	ND	ND	ND	4
alpha-Chlordane	6500	NSA	ug/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.8	ND
Gamma-chlordane	6500	NSA	ug/kg	ND	ND	2	ND	ND	ND	ND	ND	ND	ND	ND	ND
Polychlorinated Biphenyls															
Aroclor 1254	740	NSA	ug/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	167	ND
Volatile Organic Compounds															
Acetone	63000000	NSA	ug/kg	ND	31.9	42.5	126	82	7.9 J	55.1	58.2	23.6	43.8	13.8 J	ND
Carbon disulfide	370000	NSA	ug/kg	ND	0.87 J	ND	ND	ND	ND	2.2 J	ND	ND	ND	ND	ND

Table 5-2
Concentrations of Compounds Detected in Sewer Line and Test Pit Soil Samples

			Location:	SL-1	SL-1	SL-2	SL-2	SL-2	SL-3	SL-3	SL-4	SL-4	TP-1	TP-3	TP-4
			Sample:	SL-1-3	SL-1-5	SL-2-3	SL-2-5	08-SE-17-DP	SL-3-3	SL-3-5	SL-4-3	SL-4-5	TP-1-4	TP-3-4	TP-4-4
			Parent Sample:					SL-2-5							
			Sample Date:	9/17/2008	9/17/2008	9/17/2008	9/17/2008	9/17/2008	9/17/2008	9/17/2008	9/17/2008	9/17/2008	9/16/2008	9/16/2008	9/16/2008
			Sample Depth (ft):	3	5	3	5	5	3	5	3	5	4	4	4
Compound	**Industrial RSL**	**Background**	**Units**												
Semivolatile Organic Compounds															
2-methylnaphthalene	410000	NSA	ug/kg	ND	ND	ND	ND	ND	44.8	ND	ND	ND	ND	23.1	ND
Benzo[a]anthracene	2100	NSA	ug/kg	ND	ND	21.1	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo[a]pyrene	210	NSA	ug/kg	ND	ND	12.8	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo[b]fluoranthene	2100	NSA	ug/kg	ND	ND	16.2	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo[g,h,i]perylene	1700000 *	NSA	ug/kg	ND	ND	9.05	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo[k]fluoranthene	21000	NSA	ug/kg	ND	ND	9.84	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bis(2-ethylhexyl) phthalate	120000	NSA	ug/kg	ND	ND	ND	ND	94.2 J	44.7 J	ND	ND	ND	ND	ND	ND
Chrysene	210000	NSA	ug/kg	ND	ND	17.4	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	2200000 *	NSA	ug/kg	ND	ND	64.2	ND	ND	ND	ND	ND	ND	ND	ND	ND
Indeno[1,2,3-c,d]pyrene	2100	NSA	ug/kg	ND	ND	8.43 J	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	18000	NSA	ug/kg	ND	ND	ND	ND	ND	34.3	ND	ND	ND	ND	10.8	ND
Phenanthrene	17000000	NSA	ug/kg	ND	ND	31.7	ND	ND	15.6	ND	ND	ND	ND	15.2	ND
Pyrene	1700000 *	NSA	ug/kg	ND	ND	49.3	ND	ND	ND	ND	ND	ND	ND	ND	ND
General Chemistry															
Percent Solids	NSA	NSA	%	73.1	70.2	74.4	65.3	65.1	76.3	66.5	72.9	67.9	69.6	70.6	76.9

Samples were analyzed for metals, pesticides, PCBs, herbicides, VOCs, and SVOCs. Compounds not listed were not detected in any samples.

Industrial RSL = USEPA Industrial Soil Regional Screening Level, June 2011.

* = A noncarcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1.

Background = Site specific background value

NSA = No screening level available

Gray shading = detected concentration is > the industrial screening level

Bold font = detected concentration is > the background value

J = Estimated

ND = Non-detect

Table 5-3 Hydraulic Conductivity Assessment Results - Fort Buchanan, Puerto Rico

Well	Aquifer Type	Date Tested	Slug Test Type	Hydraulic Conductivity (K) ft/min	Average K ft/min	Average K ft/day
MW-01	Confined	Jan. 07	▲	0.0044	0.0082	11.8
			▼	0.0121		
MW-02	Confined	Jan. 07	▲	0.0053	0.0048	6.90
			▼	0.0043		
MW-03A	Confined	Jan. 07	▲	0.0189	0.0189	27.2
			▼	*		
MW-03B	Confined	Jan. 07	▲	0.0014	0.0015	2.20
			▼	0.0016		
MW-04A	Confined	Jan. 07	▲	0.0044	0.0044	6.37
			▼	*		
MW-04B	Confined	Jan. 07	▲	0.0020	0.0030	4.33
			▼	0.0040		
MW-05A	Confined	Jan. 07	▲	0.0155	0.0155	22.2
			▼	*		
MW-05B	Confined	Jan. 07	▲	0.0117	0.0116	16.8
			▼	0.0116		
MW-06A	Unconfined	Jan. 07	▲	0.0126	0.0136	19.5
			▼	0.0146		
MW-06B	Confined	Jan. 07	▲	0.0000	0.0006	0.881
			▼	0.0012		
MW-07A	Confined	Jan. 07	▲	0.0012	0.0013	1.89
			▼	0.0014		
MW-07B	Confined	Jan. 07	▲	0.0345	0.0386	55.6
			▼	0.0427		
MW-08A	Confined	Jan. 07	▲	0.0001	0.0001	0.149
			▼	0.0001		
MW-08B	Confined	Jan. 07	▲	0.0571	0.0585	84.3
			▼	0.0600		
MW-09A	Confined	Sep. 08	▲	0.0026	0.0031	4.46
			▼	0.0036		
MW-09B	Confined	Sep. 08	▲	0.0022	0.0026	3.76
			▼	0.0030		
MW-10A	Confined	Sep. 08	▲	0.0172	0.0163	23.4
			▼	0.0153		
MW-10B	Confined	Sep. 08	▲	0.0016	0.0014	2.02
			▼	0.0012		
MW-11A	Confined	Sep. 08	▲	0.0177	0.0169	24.3
			▼	0.0160		
MW-11B	Confined	Sep. 08	▲	0.0596	0.0596	85.8
			▼	*		
MW-12A	Confined	Sep. 08	▲	*	*	*
			▼	*		
MW-12B	Confined	Sep. 08	▲	0.0345	0.0345	49.7
			▼	*		
MW-13A	Confined	Sep. 08	▲	0.0107	0.0119	17.1
			▼	0.0131		
MW-13B	Confined	Sep. 08	▲	*	*	*
			▼	*		

Table 5-3 Hydraulic Conductivity Assessment Results -
Fort Buchanan, Puerto Rico

MW-15	Confined	Sep. 08	▲	*	*	*
			▼	*		
MW-16A	Confined	Sep. 08	▲	0.0060	0.0060	8.64
			▼	*		
MW-16B	Confined	Sep. 08	▲	*	0.0087	12.5
			▼	0.0087		
MW-17	Confined	Sep. 08	▲	0.0021	0.0021	3.02
			▼	0.0021		
MW-18A	Confined	Sep. 08	▲	0.0086	0.0075	10.7
			▼	0.0063		
MW-18B	Confined	Sep. 08	▲	*	0.0000	0.043
			▼	0.00003		
MW-19A	Confined	Sep. 08	▲	0.0104	0.0112	16.1
			▼	0.0120		
MW-19B	Confined	Sep. 08	▲	0.0109	0.0119	17.1
			▼	0.0128		
MW-20	Confined	Sep. 08	▲	0.0017	0.0018	2.59
			▼	0.0019		
MW-21	Confined	Sep. 08	▲	0.0008	0.0011	1.51
			▼	0.0013		
MW-22	Confined	Sep. 08	▲	0.0003	0.0004	0.504
			▼	0.0004		
MW-23	Confined	Sep. 08	▲	0.0050	0.0055	7.85
			▼	0.0059		
MW-24	Confined	Sep. 08	▲	0.0015	0.0016	2.23
			▼	0.0016		
MW-25	Confined	Sep. 08	▲	0.0122	0.0110	15.8
			▼	0.0098		
MW-26	Confined	Sep. 08	▲	0.0256	0.0303	43.6
			▼	0.0349		
OP-1	Confined	Jan. 09	▲	0.01578	0.01799	25.9
			▼	0.02019		
OP-2	Confined	Jan. 09	▲	0.01997	0.01997	28.8
			▼	*		
OP-3	Confined	Jan. 09	▲	0.01828	0.02936	42.3
			▼	0.04044		
OP-4	Confined	Jan. 09	▲	0.01641	0.01485	21.4
			▼	0.01328		
OP-5	Confined	Jan. 09	▲	0.01101	0.01081	15.6
			▼	0.01060		
OP-6	Confined	Feb. 09	▲	0.22646	0.28598	412
			▼	0.34549		
OP-7	Confined	Feb. 09	▲	0.26528	0.26216	378
			▼	0.25903		

Average K (ft/day) = 18.2161

Notes:
* = Did not utilize test results due to rapid recovery of wells yielding unreliable results
Could not access MW-14A, B due to wet conditions.
▲ = Rising Head Test
▼ = Falling Head Test

Table 5-4
Concentrations of Metals, Pesticides, PCBs, Herbicides, and SVOCs Detected in Groundwater Samples

				Location:	G-03-MW-01	G-03-MW-02	G-03-MW-03A	G-03-MW-03B	G-03-MW-04A	G-03-MW-04B	G-03-MW-05A	G-03-MW-05B	G-03-MW-05B	G-03-MW-06A	G-03-MW-06B
				Sample:	G-03-07-MW-01	G-03-07-MW-02	G-03-07-MW-03A	G-03-07-MW-03B	G-03-07-MW-04A	G-03-07-MW-04B	G-03-07-MW-05A	G-03-07-MW-05B	07-JA-09-DP	G-03-07-MW-06A	G-03-07-MW-06B
				Parent Sample:									G-03-07-MW-05B		
				Sample Date:	1/10/2007	1/10/2007	1/9/2007	1/9/2007	1/9/2007	1/9/2007	1/9/2007	1/9/2007	1/9/2007	1/9/2007	1/9/2007
Compound	**RSL Tapwater**	**MCL**	**Groundwater to Air**	**Units**											
Metals															
Aluminum,(total)	3700 *	NSA	NSA	ug/l	a	a	235	ND	3400	ND	ND	b	b	225	ND
Aluminum,(dissolved)	3700 *	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Antimony,(total)	1.5 *	6	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Antimony,(dissolved)	1.5 *	6	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic,(total)	0.045	10	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic,(dissolved)	0.045	10	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Barium,(total)	730 *	2000	NSA	ug/l	ND	ND	ND	313	ND	442	ND	ND	ND	ND	ND
Barium,(dissolved)	730 *	2000	NSA	ug/l	ND	ND	ND	324	ND	450	ND	ND	ND	ND	ND
Beryllium,(total)	7.3 *	4	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Beryllium,(dissolved)	7.3 *	4	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium,(total)	1.8 *	5	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium,(dissolved)	1.8 *	5	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Calcium,(total)	NSA	NSA	NSA	ug/l	a	a	171000	105000	136000	104000	135000	119000	117000	97900	114000
Calcium,(dissolved)	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Chromium,(total)	0.043	100	NSA	ug/l	ND	ND	19.8	ND	ND	ND	ND	ND	10.5	ND	ND
Chromium,(dissolved)	0.043	100	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cobalt,(total)	1.1 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cobalt,(dissolved)	1.1 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Copper,(total)	150 *	1300	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Copper,(dissolved)	150 *	1300	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron,(total)	2600 *	NSA	NSA	ug/l	a	a	326	681	3450	1080	224	b	b	516	ND
Iron,(dissolved)	2600 *	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Lead,(total)	NSA	15	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lead,(dissolved)	NSA	15	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Magnesium,(total)	NSA	NSA	NSA	ug/l	a	a	12100	24100	10000	25200	5890	28200	28100	7340	15300
Magnesium,(dissolved)	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Manganese,(total)	88 *	NSA	NSA	ug/l	a	a	28.6	53.9	92.2	135	19.2	78.1	81.6	2100	229
Manganese,(dissolved)	88 *	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Mercury,(total)	3.7 *	2	0.68	ug/l	1.4	ND	0.75	ND	0.33	ND	ND	ND	ND	ND	ND
Mercury,(dissolved)	3.7 *	2	0.68	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel,(total)	73 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel,(dissolved)	73 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Potassium,(total)	NSA	NSA	NSA	ug/l	a	a	ND	ND	ND	ND	ND	ND	ND	ND	ND
Potassium,(dissolved)	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Selenium,(total)	18 *	50	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Selenium,(dissolved)	18 *	50	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver,(total)	18 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver,(dissolved)	18 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sodium,(total)	NSA	NSA	NSA	ug/l	a	a	25400	27900	26400	27900	17200	39100	38800	15900	32200
Sodium,(dissolved)	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Thallium,(total)	0.037 *	2	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tin,(total)	2200 *	NSA	NSA	ug/l	ND	ND	a	a	a	a	a	a	a	a	a
Vanadium,(total)	18 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vanadium,(dissolved)	18 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc,(total)	1100 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc,(dissolved)	1100 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Organochlorine Pesticides															
Heptachlor	0.015	0.4	0.4 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Semivolatile Organic Compounds															
1,2-dichlorobenzene	37 *	600	2600	ug/l	b	b	ND	ND	0.81 J	ND	ND	ND	4.4	4.8	1.10 J
1,4-dichlorobenzene	0.43	75	8200	ug/l	b	b	ND	ND	ND	ND	ND	ND	1.50 J	ND	ND

Table 5-4
Concentrations of Metals, Pesticides, PCBs, Herbicides, and SVOCs Detected in Groundwater Samples

				Location:	G-03-MW-01	G-03-MW-02	G-03-MW-03A	G-03-MW-03B	G-03-MW-04A	G-03-MW-04B	G-03-MW-05A	G-03-MW-05B	G-03-MW-05B	G-03-MW-06A	G-03-MW-06B
				Sample:	G-03-07-MW-01	G-03-07-MW-02	G-03-07-MW-03A	G-03-07-MW-03B	G-03-07-MW-04A	G-03-07-MW-04B	G-03-07-MW-05A	G-03-07-MW-05B	07-JA-09-DP	G-03-07-MW-06A	G-03-07-MW-06B
				Parent Sample:									G-03-07-MW-05B		
				Sample Date:	1/10/2007	1/10/2007	1/9/2007	1/9/2007	1/9/2007	1/9/2007	1/9/2007	1/9/2007	1/9/2007	1/9/2007	1/9/2007
Bis(2-ethylhexyl) phthalate	4.8	6	NSA	ug/l	ND	2.9	ND	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-octyl phthalate	370 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	0.14	NSA	150	ug/l	ND	ND	ND	ND	ND	1.51	ND	ND	0.796	ND	0.885

Samples were analyzed for metals, OC and OP pesticides, PCBs, herbicides, VOCs, SVOCs, TPH, general chemistry, and dissolved gasses unless otherwise noted. Results for VOCs, general chemistry, and dissolved gasses are presented in Table 5-5. Compounds not listed were not detected in any samples.

RSL Tapwater = USEPA Tapwater Regional Screening Level, June 2011.

MCL = USEPA Maximum Contaminant Level, June 2011.

Groundwater to Air = Target groundwater concentration corresponding to target indoor air concentration where the soil gas to indoor air attenuation factor = 0.001 and partitoning across the water tale obeys Henry's Law Cgw (Table 2c of Vapor Intrusion Guidance, 2002)

* = A noncarcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1.

† = value is the same as the MCL

NSA = No screening level available

a = Compound was not analyzed for.

b = Result was rejected for use by the data validator.

Gray shading = detected concentration is > the Tapwater RSL

Bold font = detected concentration is > MCL

Underline = detected concentration is > Groundwater to Air value

B = Not substantially different than levels reported in associated laboratory blanks.

J = Estimated

ND = Non-detect

Table 5-4
Concentrations of Metals, Pesticides, PCBs, Herbicides, and SVOCs Detected in Groundwater Samples

				Location:	G-03-MW-07A	G-03-MW-07A	G-03-MW-07B	G-03-MW-08A	G-03-MW-08B	G-03-MW-09A	G-03-MW-09B	G-03-MW-10A	G-03-MW-10B	G-03-MW-11A	G-03-MW-11B
				Sample:	G-03-07-MW-07A	G-07-JA-10-DP	G-03-07-MW-07B	G-03-07-MW-08A	G-03-07-MW-08B	G-03-07-MW-09A	G-03-07-MW-09B	G-03-07-MW-10A	G-03-07-MW-10B	G-03-07-MW-11A	G-03-07-MW-11B
				Parent Sample:		G-03-07-MW-07A									
				Sample Date:	1/10/2007	1/10/2007	1/10/2007	1/10/2007	1/10/2007	6/12/2007	6/12/2007	6/13/2007	6/12/2007	6/12/2007	6/12/2007
Compound	**RSL Tapwater**	**MCL**	**Groundwater to Air**	**Units**											
Metals															
Aluminum,(total)	3700 *	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Aluminum,(dissolved)	3700 *	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Antimony,(total)	1.5 *	6	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Antimony,(dissolved)	1.5 *	6	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic,(total)	0.045	10	NSA	ug/l	ND	ND	ND	**274**	ND	ND	ND	ND	ND	ND	ND
Arsenic,(dissolved)	0.045	10	NSA	ug/l	ND	ND	ND	**15.6**	ND	ND	ND	ND	ND	ND	6 J
Barium,(total)	730 *	2000	NSA	ug/l	ND	ND	ND	956 J	243 J	11.1 J	231	9.4 J	76.7 J	33.6 J	36.4 J
Barium,(dissolved)	730 *	2000	NSA	ug/l	ND	ND	ND	247 J	234	11.9 J	212	8.9 J	79.4 J	32.9 J	38.2 J
Beryllium,(total)	7.3 *	4	NSA	ug/l	ND	ND	ND	**5.9**	ND	ND	ND	ND	ND	ND	ND
Beryllium,(dissolved)	7.3 *	4	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium,(total)	1.8 *	5	NSA	ug/l	ND	ND	ND	**22.3**	ND	ND	ND	ND	ND	ND	ND
Cadmium,(dissolved)	1.8 *	5	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Calcium,(total)	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Calcium,(dissolved)	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Chromium,(total)	0.043	100	NSA	ug/l	ND	ND	ND	**490**	ND	ND	1 J	4.7 J	1.5 J	ND	0.8 J
Chromium,(dissolved)	0.043	100	NSA	ug/l	ND	ND	ND	ND	ND	1.4 J	ND	2.0 J	5.1 J	1.3 J	ND
Cobalt,(total)	1.1 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cobalt,(dissolved)	1.1 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.5 J	ND
Copper,(total)	150 *	1300	NSA	ug/l	ND	ND	ND	504	ND	ND	18.8 J	ND	ND	ND	ND
Copper,(dissolved)	150 *	1300	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron,(total)	2600 *	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Iron,(dissolved)	2600 *	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Lead,(total)	NSA	15	NSA	ug/l	ND	ND	ND	**349**	ND	ND	ND	ND	ND	ND	ND
Lead,(dissolved)	NSA	15	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Magnesium,(total)	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Magnesium,(dissolved)	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Manganese,(total)	88 *	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Manganese,(dissolved)	88 *	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Mercury,(total)	3.7 *	2	0.68	ug/l	ND	ND	ND	**2**	ND	0.16 J	0.11 J	0.36	0.15 J	0.16 J	0.051 J
Mercury,(dissolved)	3.7 *	2	0.68	ug/l	ND	ND	ND	ND	ND	0.042 J	0.086 J	ND	0.38	0.093 J	0.08 J
Nickel,(total)	73 *	NSA	NSA	ug/l	ND	ND	ND	94	ND	ND	37.7 J	ND	42.3	8 J	ND
Nickel,(dissolved)	73 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	3.4 J	7.4 J	ND
Potassium,(total)	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Potassium,(dissolved)	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Selenium,(total)	18 *	50	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Selenium,(dissolved)	18 *	50	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver,(total)	18 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	1.4 J	1.5 J	ND	ND	ND	ND
Silver,(dissolved)	18 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	3.1 J	ND	ND	ND	2.8 J	ND
Sodium,(total)	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Sodium,(dissolved)	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Thallium,(total)	0.037 *	2	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tin,(total)	2200 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vanadium,(total)	18 *	NSA	NSA	ug/l	ND	ND	ND	1200	ND	ND	ND	4.6 J	1.9 J	ND	ND
Vanadium,(dissolved)	18 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	3.1 J	ND	2.8 J	3.2 J	2.6 J	ND
Zinc,(total)	1100 *	NSA	NSA	ug/l	ND	ND	ND	452	ND	ND	10.3 J	4.8 J	5.6 J	13.7 J	ND
Zinc,(dissolved)	1100 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	3.9 J	ND	5.2 J	6.5 J	7.9 J	9.8 J
Organochlorine Pesticides															
Heptachlor	0.015	0.4	0.4 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Semivolatile Organic Compounds															
1,2-dichlorobenzene	37 *	600	2600	ug/l	b	b	b	b	b	ND	ND	ND	ND	ND	ND
1,4-dichlorobenzene	0.43	75	8200	ug/l	b	b	b	b	b	ND	ND	ND	ND	ND	ND

Table 5-4
Concentrations of Metals, Pesticides, PCBs, Herbicides, and SVOCs Detected in Groundwater Samples

				Location:	G-03-MW-07A	G-03-MW-07A	G-03-MW-07B	G-03-MW-08A	G-03-MW-08B	G-03-MW-09A	G-03-MW-09B	G-03-MW-10A	G-03-MW-10B	G-03-MW-11A	G-03-MW-11B
				Sample:	G-03-07-MW-07A	G-07-JA-10-DP	G-03-07-MW-07B	G-03-07-MW-08A	G-03-07-MW-08B	G-03-07-MW-09A	G-03-07-MW-09B	G-03-07-MW-10A	G-03-07-MW-10B	G-03-07-MW-11A	G-03-07-MW-11B
				Parent Sample:		G-03-07-MW-07A									
				Sample Date:	1/10/2007	1/10/2007	1/10/2007	1/10/2007	1/10/2007	6/12/2007	6/12/2007	6/13/2007	6/12/2007	6/12/2007	6/12/2007
Bis(2-ethylhexyl) phthalate	4.8	6	NSA	ug/l	ND	3.5	ND	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-octyl phthalate	370 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	0.14	NSA	150	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Samples were analyzed for metals, OC and OP pesticides, PCBs, herbicides, VOCs, SVOCs, TPH, general chemistry, and dissolved gasses unless otherwise noted. Results for VOCs, general chemistry, and dissolved gasses are presented in Table 5-5. Compounds not listed were not detected in any samples.

RSL Tapwater = USEPA Tapwater Regional Screening Level, June 2011.

MCL = USEPA Maximum Contaminant Level, June 2011.

Groundwater to Air = Target groundwater concentration corresponding to target indoor air concentration where the soil gas to indoor air attenuation factor = 0.001 and partitoning across the water tale obeys Henry's Law Cgw (Table 2c of Vapor Intrusion Guidance, 2002)

* = A noncarcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1.

† = value is the same as the MCL

NSA = No screening level available

a = Compound was not analyzed for.

b = Result was rejected for use by the data validator.

Gray shading = detected concentration is > the Tapwater RSL

Bold font = detected concentration is > MCL

Underline = detected concentration is > Groundwater to Air value

B = Not substantially different than levels reported in associated laboratory blanks.

J = Estimated

ND = Non-detect

Table 5-4
Concentrations of Metals, Pesticides, PCBs, Herbicides, and SVOCs Detected in Groundwater Samples

				Location:	G-03-MW-12A	G-03-MW-12A	G-03-MW-12B	G-03-MW-13A	G-03-MW-13B	G-03-MW-13B	G-03-MW-14A	G-03-MW-14B	G-03-MW-15	G-03-MW-16A	G-03-MW-16B
				Sample:	G-03-07-MW-12A	07-JN-12-DP2	G-03-07-MW-12B	G-03-07-MW-13A	G-03-07-MW-13B	07-JN-12-DP1	G-03-08-MW-14A	G-03-08-MW-14B	G-03-08-MW-15A	G-03-08-MW-16A	G-03-08-MW-16B
				Parent Sample:		G-03-07-MW-12A				G-03-07-MW-13B					
				Sample Date:	6/12/2007	6/12/2007	6/12/2007	6/12/2007	6/12/2007	6/12/2007	1/9/2008	1/9/2008	1/8/2008	1/8/2008	1/8/2008
Compound	**RSL Tapwater**	**MCL**	**Groundwater to Air**	**Units**											
Metals															
Aluminum,(total)	3700 *	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Aluminum,(dissolved)	3700 *	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Antimony,(total)	1.5 *	6	NSA	ug/l	ND	ND	ND	ND	ND	ND	**29.8**	ND	ND	ND	ND
Antimony,(dissolved)	1.5 *	6	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic,(total)	0.045	10	NSA	ug/l	ND	6.5 J	ND	ND	ND	ND	10	9.5	9.1	ND	ND
Arsenic,(dissolved)	0.045	10	NSA	ug/l	6.7 J	ND	5.4 J	5.8 J	ND	ND	ND	ND	9.4	ND	ND
Barium,(total)	730 *	2000	NSA	ug/l	91.7 J	87.8 J	75.2 J	250	35.1 J	35.1 J	135 J	220	210	60 J	150 J
Barium,(dissolved)	730 *	2000	NSA	ug/l	92.7 J	91.6 J	72.5 J	246	37.1 J	29.6 J	132 J	221	206	59.7 J	148 J
Beryllium,(total)	7.3 *	4	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Beryllium,(dissolved)	7.3 *	4	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium,(total)	1.8 *	5	NSA	ug/l	ND	ND	ND	ND	ND	ND	1.2 J	ND	ND	ND	ND
Cadmium,(dissolved)	1.8 *	5	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Calcium,(total)	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Calcium,(dissolved)	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Chromium,(total)	0.043	100	NSA	ug/l	ND	ND	0.92 J	3.5 J	2 J	1.4 J	ND	ND	ND	ND	ND
Chromium,(dissolved)	0.043	100	NSA	ug/l	ND	ND	ND	0.91 J	ND	1.7 J	ND	ND	ND	ND	ND
Cobalt,(total)	1.1 *	NSA	NSA	ug/l	ND	2.2 J	ND	ND	ND	ND	1 J	3.9 J	2.1 J	0.95 J	1.3 J
Cobalt,(dissolved)	1.1 *	NSA	NSA	ug/l	ND	2.4 J	ND	ND	ND	ND	ND	ND	1.8 J	3.7 J	0.99 J
Copper,(total)	150 *	1300	NSA	ug/l	ND	95.2	ND	ND	ND	ND	ND	32.9	ND	ND	ND
Copper,(dissolved)	150 *	1300	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.1 J	ND
Iron,(total)	2600 *	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Iron,(dissolved)	2600 *	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Lead,(total)	NSA	15	NSA	ug/l	ND	ND	ND	ND	ND	ND	7.7	ND	ND	ND	ND
Lead,(dissolved)	NSA	15	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Magnesium,(total)	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Magnesium,(dissolved)	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Manganese,(total)	88 *	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Manganese,(dissolved)	88 *	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Mercury,(total)	3.7 *	2	0.68	ug/l	0.17 J	0.11 J	ND	0.074 J	0.49	0.089 J	ND	ND	ND	ND	ND
Mercury,(dissolved)	3.7 *	2	0.68	ug/l	0.096 J	0.11 J	0.14 J	0.081 J	0.19 J	0.081 J	ND	ND	ND	ND	ND
Nickel,(total)	73 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	ND	4.5 J	ND	ND	ND	ND
Nickel,(dissolved)	73 *	NSA	NSA	ug/l	2.9 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Potassium,(total)	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Potassium,(dissolved)	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Selenium,(total)	18 *	50	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Selenium,(dissolved)	18 *	50	NSA	ug/l	ND	6.8 J	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver,(total)	18 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	ND	6.9 J	ND	ND	ND	ND
Silver,(dissolved)	18 *	NSA	NSA	ug/l	ND	ND	1.6 J	2.4 J	ND	1.4 J	ND	ND	ND	4.1 J	ND
Sodium,(total)	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Sodium,(dissolved)	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Thallium,(total)	0.037 *	2	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tin,(total)	2200 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	ND	9.5 J	ND	ND	ND	ND
Vanadium,(total)	18 *	NSA	NSA	ug/l	ND	ND	1.8 J	3.6 J	1.9 J	ND	ND	16.5 J	ND	ND	ND
Vanadium,(dissolved)	18 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	2 J	ND	ND	ND	2.3 J	ND
Zinc,(total)	1100 *	NSA	NSA	ug/l	ND	50.7	3.9 J	8.9 J	5.3 J	5 J	4.7 J	24.6	9.9 J	5.1 J	ND
Zinc,(dissolved)	1100 *	NSA	NSA	ug/l	ND	4.4 J	6.8 J	7.2 J	5.9 J	4.4 J	5.9 J	ND	9.3 J	5.3 J	ND
Organochlorine Pesticides															
Heptachlor	0.015	0.4	0.4 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Semivolatile Organic Compounds															
1,2-dichlorobenzene	37 *	600	2600	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-dichlorobenzene	0.43	75	8200	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 5-4
Concentrations of Metals, Pesticides, PCBs, Herbicides, and SVOCs Detected in Groundwater Samples

Location:					G-03-MW-12A	G-03-MW-12A	G-03-MW-12B	G-03-MW-13A	G-03-MW-13B	G-03-MW-13B	G-03-MW-14A	G-03-MW-14B	G-03-MW-15	G-03-MW-16A	G-03-MW-16B
Sample:					G-03-07-MW-12A	07-JN-12-DP2	G-03-07-MW-12B	G-03-07-MW-13A	G-03-07-MW-13B	07-JN-12-DP1	G-03-08-MW-14A	G-03-08-MW-14B	G-03-08-MW-15A	G-03-08-MW-16A	G-03-08-MW-16B
Parent Sample:						G-03-07-MW-12A				G-03-07-MW-13B					
Sample Date:					6/12/2007	6/12/2007	6/12/2007	6/12/2007	6/12/2007	6/12/2007	1/9/2008	1/9/2008	1/8/2008	1/8/2008	1/8/2008
Bis(2-ethylhexyl) phthalate	4.8	6	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-octyl phthalate	370 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	0.14	NSA	150	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Samples were analyzed for metals, OC and OP pesticides, PCBs, herbicides, VOCs, SVOCs, TPH, general chemistry, and dissolved gasses unless otherwise noted. Results for VOCs, general chemistry, and dissolved gasses are presented in Table 5-5. Compounds not listed were not detected in any samples.

RSL Tapwater = USEPA Tapwater Regional Screening Level, June 2011.

MCL = USEPA Maximum Contaminant Level, June 2011.

Groundwater to Air = Target groundwater concentration corresponding to target indoor air concentration where the soil gas to indoor air attenuation factor = 0.001 and partitoning across the water tale obeys Henry's Law Cgw (Table 2c of Vapor Intrusion Guidance, 2002)

* = A noncarcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1.

† = value is the same as the MCL

NSA = No screening level available

a = Compound was not analyzed for.

b = Result was rejected for use by the data validator.

Gray shading = detected concentration is > the Tapwater RSL

Bold font = detected concentration is > MCL

Underline = detected concentration is > Groundwater to Air value

B = Not substantially different than levels reported in associated laboratory blanks.

J = Estimated

ND = Non-detect

Table 5-4

Concentrations of Metals, Pesticides, PCBs, Herbicides, and SVOCs Detected in Groundwater Samples

				Location:	G-03-MW-17A	G-03-MW-17A	G-03-MW-18A	G-03-MW-18B	G-03-MW-19A	G-03-MW-19B	G-03-MW-20	G-03-MW-21	G-03-MW-22	G-03-MW-22	G-03-MW-23
				Sample:	G-03-08-MW-17A	08-JA-08-DP	G-03-08-MW-18A	G-03-08-MW-18B	G-03-08-MW-19A	G-03-08-MW-19B	G-03-08-MW-20	G-03-08-MW-21	G-03-08-MW-22	08-MA-13-DP1	G-03-08-MW-23
				Parent Sample:		G-03-08-MW-17A								G-03-08-MW-22	
				Sample Date:	1/8/2008	1/8/2008	1/9/2008	1/9/2008	1/8/2008	1/8/2008	5/13/2008	5/13/2008	5/13/2008	5/13/2008	5/13/2008
Compound	**RSL Tapwater**	**MCL**	**Groundwater to Air**	**Units**											
Metals															
Aluminum,(total)	3700 *	NSA	NSA	ug/l	a	a	a	a	a	a	569	665	ND	44.1 J	77.3 J
Aluminum,(dissolved)	3700 *	NSA	NSA	ug/l	a	a	a	a	a	a	ND	ND	ND	ND	ND
Antimony,(total)	1.5 *	6	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Antimony,(dissolved)	1.5 *	6	NSA	ug/l	ND	**6.1**	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic,(total)	0.045	10	NSA	ug/l	ND	ND	ND	ND	ND	9	2.2 J	ND	ND	ND	ND
Arsenic,(dissolved)	0.045	10	NSA	ug/l	ND	ND	ND	ND	ND	9.4	2 J	ND	ND	ND	ND
Barium,(total)	730 *	2000	NSA	ug/l	24.6 J	27.5 J	86 J	104 J	145 J	90.5 J	86.1 J	347	168 J	167 J	121 J
Barium,(dissolved)	730 *	2000	NSA	ug/l	24.5 J	21.6 J	82.6 J	85.5 J	120 J	87.4 J	83.1 J	350	168 J	168 J	120 J
Beryllium,(total)	7.3 *	4	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Beryllium,(dissolved)	7.3 *	4	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium,(total)	1.8 *	5	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium,(dissolved)	1.8 *	5	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Calcium,(total)	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	99400	131000	66800	66600	131000
Calcium,(dissolved)	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	95300	129000	66700	65800	132000
Chromium,(total)	0.043	100	NSA	ug/l	ND	ND	ND	18.9	ND	ND	2.1 J	5.2 J	1.5 J	0.7 J	0.9 J
Chromium,(dissolved)	0.043	100	NSA	ug/l	ND	ND	ND	ND	ND	ND	0.6 J	1.2 J	2.8 J	1.3 J	1.1 J
Cobalt,(total)	1.1 *	NSA	NSA	ug/l	ND	ND	ND	3 J	5.4 J	3 J	0.6 J	0.8 J	1.4 J	1.2 J	3 J
Cobalt,(dissolved)	1.1 *	NSA	NSA	ug/l	ND	ND	1 J	ND	2.3 J	2.1 J	ND	ND	1.2 J	1.4 J	2.8 J
Copper,(total)	150 *	1300	NSA	ug/l	ND	ND	2.5 J	21.1 J	4.5 J	ND	3.2 J	ND	ND	ND	ND
Copper,(dissolved)	150 *	1300	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron,(total)	2600 *	NSA	NSA	ug/l	a	a	a	a	a	a	791	878	40.2 J	53.7 J	102
Iron,(dissolved)	2600 *	NSA	NSA	ug/l	a	a	a	a	a	a	43.3 J	71.6 J	16.6 J	13 J	18.4 J
Lead,(total)	NSA	15	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lead,(dissolved)	NSA	15	NSA	ug/l	ND	3.5	ND	ND	ND	ND	ND	ND	ND	ND	ND
Magnesium,(total)	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	26800	16300	12800	12800	16700
Magnesium,(dissolved)	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	26400	16500	12800	12600	16800
Manganese,(total)	88 *	NSA	NSA	ug/l	a	a	a	a	a	a	219	98.3	665	669	347
Manganese,(dissolved)	88 *	NSA	NSA	ug/l	a	a	a	a	a	a	208	67.4	651	655	321
Mercury,(total)	3.7 *	2	0.68	ug/l	0.17 J	0.28	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mercury,(dissolved)	3.7 *	2	0.68	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel,(total)	73 *	NSA	NSA	ug/l	ND	ND	ND	13.1 J	ND	ND	1.8 J	5.8 J	1.7 J	1.6 J	4.8 J
Nickel,(dissolved)	73 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	3.6 J	3 J	1.6 J	4 J
Potassium,(total)	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	2800 J	2530 J	2900 J	2900 J	1990 J
Potassium,(dissolved)	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	2760 J	2570 J	2930 J	2880 J	2020 J
Selenium,(total)	18 *	50	NSA	ug/l	ND	ND	ND	ND	ND	ND	4.1 J	ND	ND	1.7 J	ND
Selenium,(dissolved)	18 *	50	NSA	ug/l	ND	ND	ND	ND	ND	ND	2.1 J	3 J	1.7 J	ND	ND
Silver,(total)	18 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver,(dissolved)	18 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sodium,(total)	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	56900	30200	31200	30900	35200
Sodium,(dissolved)	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	56500	31200	31000	30600	35300
Thallium,(total)	0.037 *	2	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tin,(total)	2200 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	ND	a	a	a	a	a
Vanadium,(total)	18 *	NSA	NSA	ug/l	ND	ND	ND	11.4 J	9.8 J	ND	3 J	5.1 J	0.8 J	1 J	2 J
Vanadium,(dissolved)	18 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	ND	0.8 J	2.3 J	1 J	0.8 J	1.6 J
Zinc,(total)	1100 *	NSA	NSA	ug/l	ND	3.3 J	ND	13.6 J	5.7 J	3.4 J	4.2 J	4.3 J	ND	ND	ND
Zinc,(dissolved)	1100 *	NSA	NSA	ug/l	3 J	ND	ND	4.3 J	ND	ND	ND	5.9 J	ND	ND	9.9 J
Organochlorine Pesticides															
Heptachlor	0.015	0.4	0.4 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Semivolatile Organic Compounds															
1,2-dichlorobenzene	37 *	600	2600	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-dichlorobenzene	0.43	75	8200	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 5-4
Concentrations of Metals, Pesticides, PCBs, Herbicides, and SVOCs Detected in Groundwater Samples

				Location:	G-03-MW-17A	G-03-MW-17A	G-03-MW-18A	G-03-MW-18B	G-03-MW-19A	G-03-MW-19B	G-03-MW-20	G-03-MW-21	G-03-MW-22	G-03-MW-22	G-03-MW-23
				Sample:	G-03-08-MW-17A	08-JA-08-DP	G-03-08-MW-18A	G-03-08-MW-18B	G-03-08-MW-19A	G-03-08-MW-19B	G-03-08-MW-20	G-03-08-MW-21	G-03-08-MW-22	08-MA-13-DP1	G-03-08-MW-23
				Parent Sample:		G-03-08-MW-17A								G-03-08-MW-22	
				Sample Date:	1/8/2008	1/8/2008	1/9/2008	1/9/2008	1/8/2008	1/8/2008	5/13/2008	5/13/2008	5/13/2008	5/13/2008	5/13/2008
Bis(2-ethylhexyl) phthalate	4.8	6	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-octyl phthalate	370 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	0.14	NSA	150	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Samples were analyzed for metals, OC and OP pesticides, PCBs, herbicides, VOCs, SVOCs, TPH, general chemistry, and dissolved gasses unless otherwise noted. Results for VOCs, general chemistry, and dissolved gasses are presented in Table 5-5. Compounds not listed were not detected in any samples.

RSL Tapwater = USEPA Tapwater Regional Screening Level, June 2011.

MCL = USEPA Maximum Contaminant Level, June 2011.

Groundwater to Air = Target groundwater concentration corresponding to target indoor air concentration where the soil gas to indoor air attenuation factor = 0.001 and partitoning across the water tale obeys Henry's Law Cgw (Table 2c of Vapor Intrusion Guidance, 2002)

* = A noncarcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1.

† = value is the same as the MCL

NSA = No screening level available

a = Compound was not analyzed for.

b = Result was rejected for use by the data validator.

Gray shading = detected concentration is > the Tapwater RSL

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Underline = detected concentration is > Groundwater to Air value

B = Not substantially different than levels reported in associated laboratory blanks.

J = Estimated

ND = Non-detect

Table 5-4

Concentrations of Metals, Pesticides, PCBs, Herbicides, and SVOCs Detected in Groundwater Samples

				Location:	G-03-MW-24	G-03-MW-25	G-03-MW-26	G-03-MW-26	G-03-OP-01	G-03-OP-02	G-03-OP-03	G-03-OP-04	G-03-OP-05	G-03-OP-06	G-03-OP-07
				Sample:	G-03-08-MW-24	G-03-09-MW-25	G-03-09-MW-26	09-JA-07-DP1	G-03-09-OP-01	G-03-09-OP-02	G-03-09-OP-03	G-03-09-OP-04	G-03-09-OP-05	G-03-09-OP-6	G-03-09-OP-7
				Parent Sample:				G-03-09-MW-26							
				Sample Date:	5/13/2008	1/7/2009	1/7/2009	1/7/2009	1/6/2009 & 1/7/2009	1/6/2009 & 1/7/2009	1/6/2009	1/6/2009	1/6/2009 & 1/7/2009	3/10/2009	3/10/2009
Compound	**RSL Tapwater**	**MCL**	**Groundwater to Air**	**Units**											
Metals															
Aluminum,(total)	3700 *	NSA	NSA	ug/l	25.1 J	34.1 J	49.2 J	53.7 J	684	47.3 J	98.4 J	1280	15100	514	175 J
Aluminum,(dissolved)	3700 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	561	123 J
Antimony,(total)	1.5 *	6	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	1.9 J	ND	ND
Antimony,(dissolved)	1.5 *	6	NSA	ug/l	1.8 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic,(total)	0.045	10	NSA	ug/l	3.2	ND	ND	ND	1.9 J	1.7 J	ND	2.7 J	**34.2**	**30.9**	ND
Arsenic,(dissolved)	0.045	10	NSA	ug/l	ND	ND	ND	ND	ND	ND	1.8 J	ND	1.7 J	**30.8**	ND
Barium,(total)	730 *	2000	NSA	ug/l	306	116 J	230	234	88 J	152 J	46.3 J	45.8 J	161 J	1920	185 J
Barium,(dissolved)	730 *	2000	NSA	ug/l	313	99.1 J	219	221	88.8 J	152 J	45.2 J	39.7 J	85.4 J	1140	177 J
Beryllium,(total)	7.3 *	4	NSA	ug/l	ND	0.4 J	0.4 J	0.2 J	0.5 J	0.3 J	0.3 J	0.3 J	0.8 J	ND	ND
Beryllium,(dissolved)	7.3 *	4	NSA	ug/l	ND	0.3 J	0.2 J	0.2 J	0.3 J	0.3 J	0.3 J	0.3 J	ND	ND	ND
Cadmium,(total)	1.8 *	5	NSA	ug/l	ND	0.8 J	0.5 J	0.5 J	ND	ND	ND	ND	1.5 J	0.5 J	0.5 J
Cadmium,(dissolved)	1.8 *	5	NSA	ug/l	ND	0.5 J	0.4 J	0.3 J	ND	ND	ND	ND	ND	0.6 J	0.5 J
Calcium,(total)	NSA	NSA	NSA	ug/l	67000	152000	146000	148000	98100	108000	119000	105000	278000	484000	114000
Calcium,(dissolved)	NSA	NSA	NSA	ug/l	68600	137000	138000	140000	97600	108000	119000	99300	111000	492000	110000
Chromium,(total)	0.043	100	NSA	ug/l	36.5	ND	ND	ND	9.8 J	47.5	74.1	8.3 J	70.1	ND	32.2
Chromium,(dissolved)	0.043	100	NSA	ug/l	0.9 J	ND	ND	ND	8.9 J	49.5	75.4	5.9 J	0.7 J	ND	33.2
Cobalt,(total)	1.1 *	NSA	NSA	ug/l	2 J	0.6 J	1.6 J	1.7 J	0.7 J	1.1 J	ND	ND	17.7 J	3.8 J	2.1 J
Cobalt,(dissolved)	1.1 *	NSA	NSA	ug/l	1.2 J	ND	1.6 J	1.4 J	ND	0.9 J	ND	ND	1.6 J	3.7 J	2.3 J
Copper,(total)	150 *	1300	NSA	ug/l	ND	ND	ND	ND	2.3 J	1.7 J	ND	1.5 J	53.2	ND	1.7 J
Copper,(dissolved)	150 *	1300	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron,(total)	2600 *	NSA	NSA	ug/l	530	70.7 J	103	93.4 J	671	84.4 J	114	933	33300	21600	80.2 J
Iron,(dissolved)	2600 *	NSA	NSA	ug/l	17.6 J	ND	ND	ND	ND	ND	ND	ND	16.8 J	21300	25.9 J
Lead,(total)	NSA	15	NSA	ug/l	ND	2.4 J	1.8 J	2.2 J	2.4 J	ND	2.2 J	ND	9.7	ND	ND
Lead,(dissolved)	NSA	15	NSA	ug/l	ND	1.4 J	ND	1.5 J	2.1 J	ND	2.1 J	1.7 J	1.4 J	ND	ND
Magnesium,(total)	NSA	NSA	NSA	ug/l	17900	17700	15100	15300	17700	13200	17400	15300	20500	93400	22500
Magnesium,(dissolved)	NSA	NSA	NSA	ug/l	18300	16100	14400	14600	18500	13300	17900	15400	15800	93000	22100
Manganese,(total)	88 *	NSA	NSA	ug/l	955	2250	2810	2840	227	547	74.6	178	1800	1230	685
Manganese,(dissolved)	88 *	NSA	NSA	ug/l	868	1950	2700	2730	185	540	52	120	631	1230	634
Mercury,(total)	3.7 *	2	0.68	ug/l	ND	ND	ND	ND	ND	0.16 J	**3.7**	0.078 J	0.19 J	ND	ND
Mercury,(dissolved)	3.7 *	2	0.68	ug/l	ND	ND	ND	ND	ND	ND	ND	0.062 J	0.053 J	ND	ND
Nickel,(total)	73 *	NSA	NSA	ug/l	22.2 J	1.8 J	1.8 J	1.6 J	1.8 J	1.3 J	ND	ND	26.2	0.8 J	1.2 J
Nickel,(dissolved)	73 *	NSA	NSA	ug/l	1.4 J	1.9 J	1.5 J	1.5 J	1.3 J	ND	ND	ND	4.4 J	1.8 J	1 J
Potassium,(total)	NSA	NSA	NSA	ug/l	7830 J	2610 J	2020 J	2070 J	2870 J	2850 J	2690 J	2860 J	6780 J	7060 J	6270 J
Potassium,(dissolved)	NSA	NSA	NSA	ug/l	7990 J	2390 J	1990 J	1990 J	2890 J	2880 J	2720 J	2760 J	4810 J	7000 J	6100 J
Selenium,(total)	18 *	50	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	3 J	ND	ND
Selenium,(dissolved)	18 *	50	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver,(total)	18 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver,(dissolved)	18 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sodium,(total)	NSA	NSA	NSA	ug/l	37600	50900	42400	43300	87200	187000	105000	141000	58800	397000	364000
Sodium,(dissolved)	NSA	NSA	NSA	ug/l	38900	45800	40500	41400	91300	190000	109000	144000	58000	399000	356000
Thallium,(total)	0.037 *	2	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.8 J	1.7 J
Tin,(total)	2200 *	NSA	NSA	ug/l	a	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vanadium,(total)	18 *	NSA	NSA	ug/l	2 J	0.7 J	0.7 J	0.8 J	3.5 J	1.4 J	1.6 J	4.3 J	97.2	ND	2.1 J
Vanadium,(dissolved)	18 *	NSA	NSA	ug/l	1.5 J	1.1 J	ND	ND	1.7 J	1.4 J	0.9 J	1.1 J	1.4 J	ND	1.5 J
Zinc,(total)	1100 *	NSA	NSA	ug/l	ND	ND	5.4 J	ND	ND	ND	ND	ND	67.7	4 J	3.2 J
Zinc,(dissolved)	1100 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	ND	8.8 J	ND	ND	ND	197
Organochlorine Pesticides															
Heptachlor	0.015	0.4	0.4 †	ug/l	ND	ND	ND	ND	ND	ND	**0.96 J**	ND	ND	ND	ND
Semivolatile Organic Compounds															
1,2-dichlorobenzene	37 *	600	2600	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-dichlorobenzene	0.43	75	8200	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 5-4
Concentrations of Metals, Pesticides, PCBs, Herbicides, and SVOCs Detected in Groundwater Samples

				Location:	G-03-MW-24	G-03-MW-25	G-03-MW-26	G-03-MW-26	G-03-OP-01	G-03-OP-02	G-03-OP-03	G-03-OP-04	G-03-OP-05	G-03-OP-06	G-03-OP-07
				Sample:	G-03-08-MW-24	G-03-09-MW-25	G-03-09-MW-26	09-JA-07-DP1	G-03-09-OP-01	G-03-09-OP-02	G-03-09-OP-03	G-03-09-OP-04	G-03-09-OP-05	G-03-09-OP-6	G-03-09-OP-7
				Parent Sample:				G-03-09-MW-26							
				Sample Date:	5/13/2008	1/7/2009	1/7/2009	1/7/2009	1/6/2009 & 1/7/2009	1/6/2009 & 1/7/2009	1/6/2009	1/6/2009	1/6/2009 & 1/7/2009	3/10/2009	3/10/2009
Bis(2-ethylhexyl) phthalate	4.8	6	NSA	ug/l	2.4	ND	ND	ND	ND	ND	ND	ND	2.5	ND	ND
Di-n-octyl phthalate	370 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	4	ND	ND
Naphthalene	0.14	NSA	150	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Samples were analyzed for metals, OC and OP pesticides, PCBs, herbicides, VOCs, SVOCs, TPH, general chemistry, and dissolved gasses unless otherwise noted. Results for VOCs, general chemistry, and dissolved gasses are presented in Table 5-5. Compounds not listed were not detected in any samples.

RSL Tapwater = USEPA Tapwater Regional Screening Level, June 2011.

MCL = USEPA Maximum Contaminant Level, June 2011.

Groundwater to Air = Target groundwater concentration corresponding to target indoor air concentration where the soil gas to indoor air attenuation factor = 0.001 and partitoning across the water tale obeys Henry's Law Cgw (Table 2c of Vapor Intrusion Guidance, 2002)

* = A noncarcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1.

† = value is the same as the MCL

NSA = No screening level available

a = Compound was not analyzed for.

b = Result was rejected for use by the data validator.

Gray shading = detected concentration is **>** the Tapwater RSL

Bold font = detected concentration is > MCL

Underline = detected concentration is > Groundwater to Air value

B = Not substantially different than levels reported in associated laboratory blanks.

J = Estimated

ND = Non-detect

Table 5-5

Concentrations of VOCs, Dissolved Gasses, and General Chemistry Parameters Detected in Groundwater Samples

				Location:	G-03-CPR-75B	G-03-CPR-83B1	G-03-CPR-83B2	G-03-CPR-84B2	G-03-MW-01	G-03-MW-01	G-03-MW-01	G-03-MW-02	G-03-MW-02	G-03-MW-02	G-03-MW-03A
				Sample:	G-03-09-CPR-75B	G-03-09-CPR-83B1	G-03-09-CPR-83B2	G-03-09-CPR-84B2	G-03-07-MW-01	G-03-07-MW-01	G-03-10-MW-01	G-03-07-MW-02	G-03-07-MW-02	07-JN-13-DP-3	G-03-07-MW-03A
				Parent Sample:										G-03-07-MW-02	
				Sample Date:	3/11/2009	3/11/2009	3/11/2009	3/11/2009	1/10/2007	6/12/2007	8/17/2010	1/10/2007	6/13/2007	6/13/2007	1/9/2007
Compound	**RSL Tapwater**	**MCL**	**Groundwater to Air**	**Units**											
Volatile Organic Compounds															
1,1,2-trichloroethane	0.042 *	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-dichloroethene	34 *	7	190	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-dichloroethane	0.15	5	5 †	ug/l	0.45 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-dichloroethene	33 *	NSA	NSA	ug/l	9.7	9.5	16.1	10	ND	ND	ND	ND	ND	ND	ND
Cis-1,2-dichloroethene	7.3 *	70	210	ug/l	8.1	8	13.7	9	a	a	ND	a	a	a	a
trans-1,2-dichloroethene	11 *	100	180	ug/l	1.6	1.5	2.4	1	ND	ND	ND	ND	ND	ND	ND
Acetone	2200 *	NSA	220000	ug/l	ND	ND	ND	ND	b	ND	ND	b	ND	ND	b
Benzene	0.41	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	0.12	80	2.1	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon disulfide	100 *	NSA	560	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	0.19	80	80 †	ug/l	ND	0.41 J	0.27 J	ND	ND	ND	ND	ND	ND	ND	ND
Chloromethane	19 *	NSA	6.7	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	1.5	700	700 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene Chloride	4.8	5	58	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	0.11	5	5 †	ug/l	ND	0.63 J	1.4	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	2	5	5 †	ug/l	**45.8**	**85.5**	**115**	**20.8**	ND	ND	ND	ND	ND	ND	ND
Vinyl chloride	0.016	2	2 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes, Total	20 *	10000	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Petroleum Hydrocarbons															
TPH-GRO (C6-C10)	NSA	NSA		mg/l	a	a	a	a	a	a	ND	a	a	a	a
General Chemistry															
Sulfate	NSA	NSA	NSA	mg/l	a	a	a	a	a	a	a	a	a	a	a
Nitrogen as nitrate + nitrite	NSA	NSA	NSA	mg/l	a	a	a	a	a	a	a	a	a	a	a
Dissolved Gasses															
Ethane	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Ethene	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Methane	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Total organic carbon	NSA	NSA	NSA	mg/l	a	a	a	a	a	a	a	a	a	a	a

Samples were analyzed for metals, OC and OP pesticides, PCBs, herbicides, VOCs, SVOCs, TPH, general chemistry, and dissolved gasses unless otherwise noted. Results for metals, pesticides, PCBs, herbicides, and SVOCs are presented in Table 5-4. Compounds not listed were not detected in any samples.

RSL Tapwater = USEPA Tapwater Regional Screening Level, June 2011.

MCL = USEPA Maximum Contaminant Level, June 2011.

Groundwater to Air = Target groundwater concentration corresponding to target indoor air concentration where the soil gas to indoor air attenuation factor = 0.001 and partitoning across the water table obeys Henry's Law Cgw (Table 2c of Vapor Intrusion Guidance, 2002)

* = A noncarcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1.

† = value is the same as the MCL

NSA = No screening level available

a = Compound was not analyzed for.

b = Result was rejected for use by the data validator.

Gray shading = detected concentration is > the Tapwater RSL

Bold font = detected concentration is > MCL

Underline = detected concentration is > Groundwater to Air value

B = Not substantially different than levels reported in associated laboratory blanks.

J = Estimated

ND = Non-detect

Table 5-5

Concentrations of VOCs, Dissolved Gasses, and General Chemistry Parameters Detected in Groundwater Samples

				Location:	G-03-MW-03A	G-03-MW-03A	G-03-MW-03B	G-03-MW-03B	G-03-MW-04A	G-03-MW-04A	G-03-MW-04A	G-03-MW-04B	G-03-MW-04B	G-03-MW-04B	G-03-MW-05A
				Sample:	G-03-07-MW-03A	G-03-10-MW-03A	G-03-07-MW-03B	G-03-07-MW-03B	G-03-07-MW-04A	G-03-07-MW-04A	G-03-10-MW-04A	G-03-07-MW-04B	G-03-07-MW-04B	G-03-10-MW-04B	G-03-07-MW-05A
				Parent Sample:											
				Sample Date:	6/12/2007	8/17/2010	1/9/2007	6/12/2007	1/9/2007	6/12/2007	8/18/2010	1/9/2007	6/12/2007	8/18/2010	1/9/2007
Compound	**RSL Tapwater**	**MCL**	**Groundwater to Air**	**Units**											
Volatile Organic Compounds															
1,1,2-trichloroethane	0.042 *	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-dichloroethene	34 *	7	190	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-dichloroethane	0.15	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-dichloroethene	33 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cis-1,2-dichloroethene	7.3 *	70	210	ug/l	a	ND	a	a	a	a	ND	a	a	ND	a
trans-1,2-dichloroethene	11 *	100	180	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acetone	2200 *	NSA	220000	ug/l	ND	ND	ND	ND	b	ND	ND	b	ND	ND	b
Benzene	0.41	5	5 †	ug/l	ND	ND	ND	ND	0.53 J	0.93 J	ND	0.49 J	ND	ND	ND
Bromodichloromethane	0.12	80	2.1	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon disulfide	100 *	NSA	560	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	0.19	80	80 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloromethane	19 *	NSA	6.7	ug/l	ND	ND	b	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	1.5	700	700 †	ug/l	ND	ND	ND	ND	ND	0.44 J	ND	3.9	0.4 J	ND	ND
Methylene Chloride	4.8	5	58	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	0.11	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	2	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	4.6
Vinyl chloride	0.016	2	2 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes, Total	20 *	10000	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	0.58 J	ND	ND	ND
Total Petroleum Hydrocarbons															
TPH-GRO (C6-C10)	NSA	NSA		mg/l	a	ND	a	a	a	a	ND	a	a	ND	a
General Chemistry															
Sulfate	NSA	NSA	NSA	mg/l	a	a	a	a	a	a	a	a	a	a	a
Nitrogen as nitrate + nitrite	NSA	NSA	NSA	mg/l	a	a	a	a	a	a	a	a	a	a	a
Dissolved Gasses															
Ethane	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Ethene	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Methane	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Total organic carbon	NSA	NSA	NSA	mg/l	a	a	a	a	a	a	a	a	a	a	a

Samples were analyzed for metals, OC and OP pesticides, PCBs, herbicides, VOCs, SVOCs, TPH, general chemistry, and dissolved gasses unless otherwise noted. Results for metals, pesticides, PCBs, herbicides, and SVOCs are presented in Table 5-4. Compounds not listed were not detected in any samples.

RSL Tapwater = USEPA Tapwater Regional Screening Level, June 2011.

MCL = USEPA Maximum Contaminant Level, June 2011.

Groundwater to Air = Target groundwater concentration corresponding to target indoor air concentration where the soil gas to indoor air attenuation factor = 0.001 and partitoning across the water table obeys Henry's Law Cgw (Table 2c of Vapor Intrusion Guidance, 2002)

* = A noncarcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1.

† = value is the same as the MCL

NSA = No screening level available

a = Compound was not analyzed for.

b = Result was rejected for use by the data validator.

Gray shading = detected concentration is > the Tapwater RSL

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Underline = detected concentration is > Groundwater to Air value

B = Not substantially different than levels reported in associated laboratory blanks.

J = Estimated

ND = Non-detect

Table 5-5

Concentrations of VOCs, Dissolved Gasses, and General Chemistry Parameters Detected in Groundwater Samples

				Location:	G-03-MW-05A	G-03-MW-05A	G-03-MW-05A	G-03-MW-05B	G-03-MW-05B	G-03-MW-05B	G-03-MW-06A	G-03-MW-06A	G-03-MW-06A	G-03-MW-06B	G-03-MW-06B
				Sample:	G-03-07-MW-05A	G-03-09-MW-5A	G-03-10-MW-05A	G-03-07-MW-05B	07-JA-09-DP	G-03-07-MW-05B	G-03-07-MW-06A	G-03-07-MW-06A	G-03-10-MW-06A	G-03-07-MW-06B	G-03-07-MW-06B
				Parent Sample:					G-03-07-MW-05B						
				Sample Date:	6/13/2007	3/11/2009	8/17/2010	1/9/2007	1/9/2007	6/13/2007	1/9/2007	6/13/2007	8/17/2010	1/9/2007	6/13/2007
Compound	**RSL Tapwater**	**MCL**	**Groundwater to Air**	**Units**											
Volatile Organic Compounds															
1,1,2-trichloroethane	0.042 *	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-dichloroethene	34 *	7	190	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-dichloroethane	0.15	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.49 J
1,2-dichloroethene	33 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.8	3.7
Cis-1,2-dichloroethene	7.3 *	70	210	ug/l	a	ND	ND	a	a	a	a	a	ND	a	a
trans-1,2-dichloroethene	11 *	100	180	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.39 J
Acetone	2200 *	NSA	220000	ug/l	ND	ND	ND	b	b	ND	b	ND	ND	b	ND
Benzene	0.41	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	0.12	80	2.1	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon disulfide	100 *	NSA	560	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	0.19	80	80 †	ug/l	ND	0.31 J	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloromethane	19 *	NSA	6.7	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	1.5	700	700 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene Chloride	4.8	5	58	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	0.11	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	2	5	5 †	ug/l	3	**5.5**	3.7	ND	ND	ND	ND	ND	ND	**68.2**	**70.1**
Vinyl chloride	0.016	2	2 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes, Total	20 *	10000	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Petroleum Hydrocarbons															
TPH-GRO (C6-C10)	NSA	NSA		mg/l	a	a	ND	a	a	a	a	a	ND	a	a
General Chemistry															
Sulfate	NSA	NSA	NSA	mg/l	a	a	a	a	a	a	a	a	a	a	a
Nitrogen as nitrate + nitrite	NSA	NSA	NSA	mg/l	a	a	a	a	a	a	a	a	a	a	a
Dissolved Gasses															
Ethane	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Ethene	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Methane	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Total organic carbon	NSA	NSA	NSA	mg/l	a	a	a	a	a	a	a	a	a	a	a

Samples were analyzed for metals, OC and OP pesticides, PCBs, herbicides, VOCs, SVOCs, TPH, general chemistry, and dissolved gasses unless otherwise noted. Results for metals, pesticides, PCBs, herbicides, and SVOCs are presented in Table 5-4. Compounds not listed were not detected in any samples.

RSL Tapwater = USEPA Tapwater Regional Screening Level, June 2011.

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Groundwater to Air = Target groundwater concentration corresponding to target indoor air concentration where the soil gas to indoor air attenuation factor = 0.001 and partitoning across the water table obeys Henry's Law Cgw (Table 2c of Vapor Intrusion Guidance, 2002)

* = A noncarcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1.

† = value is the same as the MCL

NSA = No screening level available

a = Compound was not analyzed for.

b = Result was rejected for use by the data validator.

Gray shading = detected concentration is > the Tapwater RSL

Bold font = detected concentration is > MCL

Underline = detected concentration is > Groundwater to Air value

B = Not substantially different than levels reported in associated laboratory blanks.

J = Estimated

ND = Non-detect

Table 5-5

Concentrations of VOCs, Dissolved Gasses, and General Chemistry Parameters Detected in Groundwater Samples

				Location:	G-03-MW-06B	G-03-MW-06B	G-03-MW-06B	G-03-MW-06B	G-03-MW-06B	G-03-MW-06B	G-03-MW-07A	G-03-MW-07A	G-03-MW-07A	G-03-MW-07A	G-03-MW-07A
				Sample:	G-03-08-MW-06B	08-JA-09-DP2	G-03-08-MW-6B	G-03-09-MW-06B	09-JA-06-DP1	G-03-09-MW-6B	G-03-07-MW-07A	G-07-JA-10-DP	G-03-07-MW-07A	G-03-08-MW-07A	G-03-10-MW-07A
				Parent Sample:		G-03-08-MW-06B			G-03-09-MW-06B			G-03-07-MW-07A			
				Sample Date:	1/9/2008	1/9/2008	5/14/2008	1/6/2009	1/6/2009	3/10/2009	1/10/2007	1/10/2007	6/13/2007	1/8/2008	8/17/2010
Compound	**RSL Tapwater**	**MCL**	**Groundwater to Air**	**Units**											
Volatile Organic Compounds															
1,1,2-trichloroethane	0.042 *	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-dichloroethene	34 *	7	190	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-dichloroethane	0.15	5	5 †	ug/l	ND	ND	ND	0.48 J	0.51 J	0.5 J	ND	ND	ND	ND	ND
1,2-dichloroethene	33 *	NSA	NSA	ug/l	3.6	3.2	2.3	a	a	2.1	ND	ND	ND	ND	ND
Cis-1,2-dichloroethene	7.3 *	70	210	ug/l	a	a	2.3	3.1	3.2	2.1	a	a	a	a	ND
trans-1,2-dichloroethene	11 *	100	180	ug/l	ND	ND	ND	0.31 J	0.28 J	ND	ND	ND	ND	ND	ND
Acetone	2200 *	NSA	220000	ug/l	ND	ND	ND	ND	ND	ND	b	b	ND	ND	ND
Benzene	0.41	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	0.12	80	2.1	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon disulfide	100 *	NSA	560	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	0.19	80	80 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloromethane	19 *	NSA	6.7	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	1.5	700	700 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene Chloride	4.8	5	58	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	0.11	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	2	5	5 †	ug/l	**95**	**87.8 J**	**52.1**	**73.8**	**76**	**66.4**	0.95 J	0.92 J	0.69 J	0.82 J	0.61 J
Vinyl chloride	0.016	2	2 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes, Total	20 *	10000	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Petroleum Hydrocarbons															
TPH-GRO (C6-C10)	NSA	NSA		mg/l	a	a	a	a	a	a	a	a	a	a	ND
General Chemistry															
Sulfate	NSA	NSA	NSA	mg/l	a	a	a	a	a	a	a	a	a	a	a
Nitrogen as nitrate + nitrite	NSA	NSA	NSA	mg/l	a	a	a	a	a	a	a	a	a	a	a
Dissolved Gasses															
Ethane	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Ethene	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Methane	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Total organic carbon	NSA	NSA	NSA	mg/l	a	a	a	a	a	a	a	a	a	a	a

Samples were analyzed for metals, OC and OP pesticides, PCBs, herbicides, VOCs, SVOCs, TPH, general chemistry, and dissolved gasses unless otherwise noted. Results for metals, pesticides, PCBs, herbicides, and SVOCs are presented in Table 5-4. Compounds not listed were not detected in any samples.

RSL Tapwater = USEPA Tapwater Regional Screening Level, June 2011.

MCL = USEPA Maximum Contaminant Level, June 2011.

Groundwater to Air = Target groundwater concentration corresponding to target indoor air concentration where the soil gas to indoor air attenuation factor = 0.001 and partitoning across the water table obeys Henry's Law Cgw (Table 2c of Vapor Intrusion Guidance, 2002)

* = A noncarcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1.

† = value is the same as the MCL

NSA = No screening level available

a = Compound was not analyzed for.

b = Result was rejected for use by the data validator.

Gray shading = detected concentration is > the Tapwater RSL

Bold font = detected concentration is > MCL

Underline = detected concentration is > Groundwater to Air value

B = Not substantially different than levels reported in associated laboratory blanks.

J = Estimated

ND = Non-detect

Table 5-5

Concentrations of VOCs, Dissolved Gasses, and General Chemistry Parameters Detected in Groundwater Samples

				Location:	G-03-MW-07B	G-03-MW-07B	G-03-MW-07B	G-03-MW-07B	G-03-MW-07B	G-03-MW-08A	G-03-MW-08A	G-03-MW-08B	G-03-MW-08B	G-03-MW-08B	G-03-MW-08B
				Sample:	G-03-07-MW-07B	G-03-07-MW-07B	G-03-08-MW-07B	G-03-08-MW-7B	G-03-09-MW-07B	G-03-07-MW-08A	G-03-07-MW-08A	G-03-07-MW-08B	G-03-07-MW-08B	G-03-08-MW-08B	08-JA-09-DP1
				Parent Sample:											G-03-08-MW-08B
				Sample Date:	1/10/2007	6/13/2007	1/8/2008	5/14/2008	1/6/2009 &1/7/2009	1/10/2007	6/13/2007	1/10/2007	6/13/2007	1/9/2008	1/9/2008
Compound	**RSL Tapwater**	**MCL**	**Groundwater to Air**	**Units**											
Volatile Organic Compounds															
1,1,2-trichloroethane	0.042 *	5	5 †	ug/l	ND	0.57 J	ND	ND	0.29 J	ND	ND	ND	ND	ND	ND
1,1-dichloroethene	34 *	7	190	ug/l	0.86 J	ND	0.59 J	1.1	0.86 J	ND	ND	ND	ND	ND	ND
1,2-dichloroethane	0.15	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-dichloroethene	33 *	NSA	NSA	ug/l	229	184	204	215	a	17	21	ND	ND	ND	ND
Cis-1,2-dichloroethene	7.3 *	70	210	ug/l	a	a	a	**183**	**197**	a	a	a	a	a	a
trans-1,2-dichloroethene	11 *	100	180	ug/l	33.1	21.5	24.3	31.8	35.4	ND	0.35 J	ND	ND	ND	ND
Acetone	2200 *	NSA	220000	ug/l	b	ND	ND	ND	ND	b	ND	b	ND	ND	ND
Benzene	0.41	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	0.12	80	2.1	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon disulfide	100 *	NSA	560	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	0.19	80	80 †	ug/l	1.4	0.70 J	ND	ND	0.43 J	ND	ND	ND	ND	ND	ND
Chloromethane	19 *	NSA	6.7	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.8
Ethylbenzene	1.5	700	700 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene Chloride	4.8	5	58	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	0.11	5	5 †	ug/l	2.1	0.92 J	0.68 J	0.81 J	0.95 J	ND	ND	ND	ND	ND	ND
Trichloroethene	2	5	5 †	ug/l	**162**	**108**	**73.5**	**95.5**	**122**	ND	ND	ND	ND	ND	ND
Vinyl chloride	0.016	2	2 †	ug/l	**15.5**	**7.8**	**13.7**	**18.3**	**25.6**	ND	ND	ND	ND	ND	ND
Xylenes, Total	20 *	10000	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Petroleum Hydrocarbons															
TPH-GRO (C6-C10)	NSA	NSA		mg/l	a	a	a	a	a	a	a	a	a	a	a
General Chemistry															
Sulfate	NSA	NSA	NSA	mg/l	a	a	a	a	69.6	a	a	a	a	a	a
Nitrogen as nitrate + nitrite	NSA	NSA	NSA	mg/l	a	a	a	a	ND	a	a	a	a	a	a
Dissolved Gasses															
Ethane	NSA	NSA	NSA	ug/l	a	a	a	a	0.16	a	a	a	a	a	a
Ethene	NSA	NSA	NSA	ug/l	a	a	a	a	0.23	a	a	a	a	a	a
Methane	NSA	NSA	NSA	ug/l	a	a	a	a	17.4	a	a	a	a	a	a
Total organic carbon	NSA	NSA	NSA	mg/l	a	a	a	a	1.4	a	a	a	a	a	a

Samples were analyzed for metals, OC and OP pesticides, PCBs, herbicides, VOCs, SVOCs, TPH, general chemistry, and dissolved gasses unless otherwise noted. Results for metals, pesticides, PCBs, herbicides, and SVOCs are presented in Table 5-4. Compounds not listed were not detected in any samples.

RSL Tapwater = USEPA Tapwater Regional Screening Level, June 2011.

MCL = USEPA Maximum Contaminant Level, June 2011.

Groundwater to Air = Target groundwater concentration corresponding to target indoor air concentration where the soil gas to indoor air attenuation factor = 0.001 and partitoning across the water table obeys Henry's Law Cgw (Table 2c of Vapor Intrusion Guidance, 2002)

* = A noncarcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1.

† = value is the same as the MCL

NSA = No screening level available

a = Compound was not analyzed for.

b = Result was rejected for use by the data validator.

Gray shading = detected concentration is > the Tapwater RSL

Bold font = detected concentration is > MCL

Underline = detected concentration is > Groundwater to Air value

B = Not substantially different than levels reported in associated laboratory blanks.

J = Estimated

ND = Non-detect

Table 5-5

Concentrations of VOCs, Dissolved Gasses, and General Chemistry Parameters Detected in Groundwater Samples

				Location:	G-03-MW-08B	G-03-MW-09A	G-03-MW-09A	G-03-MW-09B	G-03-MW-09B	G-03-MW-10A	G-03-MW-10A	G-03-MW-10A	G-03-MW-10B	G-03-MW-10B	G-03-MW-10B
				Sample:	G-03-09-MW-8B	G-03-07-MW-09A	G-03-08-MW-09A	G-03-07-MW-09B	G-03-08-MW-09B	G-03-07-MW-10A	G-03-08-MW-10A	G-03-09-MW-10A	G-03-07-MW-10B	G-03-08-MW-10B	G-03-09-MW-10B
				Parent Sample:											
				Sample Date:	3/10/2009	6/12/2007	1/9/2008	6/12/2007	1/9/2008	6/13/2007	1/8/2008	3/10/2009	6/12/2007	1/8/2008	3/10/2009
Compound	**RSL Tapwater**	**MCL**	**Groundwater to Air**	**Units**											
Volatile Organic Compounds															
1,1,2-trichloroethane	0.042 *	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-dichloroethene	34 *	7	190	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-dichloroethane	0.15	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-dichloroethene	33 *	NSA	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cis-1,2-dichloroethene	7.3 *	70	210	ug/l	ND	a	a	a	a	a	a	ND	a	a	ND
trans-1,2-dichloroethene	11 *	100	180	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acetone	2200 *	NSA	220000	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	0.41	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	0.12	80	2.1	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon disulfide	100 *	NSA	560	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	0.19	80	80 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloromethane	19 *	NSA	6.7	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	1.5	700	700 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene Chloride	4.8	5	58	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	0.11	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	2	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl chloride	0.016	2	2 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes, Total	20 *	10000	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Petroleum Hydrocarbons															
TPH-GRO (C6-C10)	NSA	NSA		mg/l	a	a	a	a	a	a	a	a	a	a	a
General Chemistry															
Sulfate	NSA	NSA	NSA	mg/l	a	a	a	a	a	a	a	a	a	a	a
Nitrogen as nitrate + nitrite	NSA	NSA	NSA	mg/l	a	a	a	a	a	a	a	a	a	a	a
Dissolved Gasses															
Ethane	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Ethene	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Methane	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Total organic carbon	NSA	NSA	NSA	mg/l	a	a	a	a	a	a	a	a	a	a	a

Samples were analyzed for metals, OC and OP pesticides, PCBs, herbicides, VOCs, SVOCs, TPH, general chemistry, and dissolved gasses unless otherwise noted. Results for metals, pesticides, PCBs, herbicides, and SVOCs are presented in Table 5-4. Compounds not listed were not detected in any samples.

RSL Tapwater = USEPA Tapwater Regional Screening Level, June 2011.

MCL = USEPA Maximum Contaminant Level, June 2011.

Groundwater to Air = Target groundwater concentration corresponding to target indoor air concentration where the soil gas to indoor air attenuation factor = 0.001 and partitoning across the water table obeys Henry's Law Cgw (Table 2c of Vapor Intrusion Guidance, 2002)

* = A noncarcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1.

† = value is the same as the MCL

NSA = No screening level available

a = Compound was not analyzed for.

b = Result was rejected for use by the data validator.

Gray shading = detected concentration is > the Tapwater RSL

Bold font = detected concentration is > MCL

Underline = detected concentration is > Groundwater to Air value

B = Not substantially different than levels reported in associated laboratory blanks.

J = Estimated

ND = Non-detect

Table 5-5

Concentrations of VOCs, Dissolved Gasses, and General Chemistry Parameters Detected in Groundwater Samples

				Location:	G-03-MW-11A	G-03-MW-11A	G-03-MW-11A	G-03-MW-11A	G-03-MW-11A	G-03-MW-11A	G-03-MW-11B	G-03-MW-11B	G-03-MW-11B	G-03-MW-11B
				Sample:	G-03-07-MW-11A	G-03-08-MW-11A	G-03-08-MW-11A	G-03-09-MW-11A	G-03-10-MW-11A	10-AUG-18-DP2	G-03-07-MW-11B	G-03-08-MW-11B	G-03-08-MW-11B	G-03-09-MW-11B
				Parent Sample:						G-03-10-MW-11A				
				Sample Date:	6/12/2007	1/9/2008	5/14/2008	1/6/2009 & 1/7/2009	8/18/2010	8/18/2010	6/12/2007	1/9/2008	5/14/2008	1/6/2009
Compound	**RSL Tapwater**	**MCL**	**Groundwater to Air**	**Units**										
Volatile Organic Compounds														
1,1,2-trichloroethane	0.042 *	5	5 †	ug/l	0.73 J	0.69 J	ND	0.81 J	0.51 J	0.52 J	1.3	1.2	1.3	1 J
1,1-dichloroethene	34 *	7	190	ug/l	0.41 J	ND	ND	0.38 J	ND	ND	0.72 J	0.63 J	ND	ND
1,2-dichloroethane	0.15	5	5 †	ug/l	0.31 J	ND	ND	0.36 J	ND	ND	ND	ND	ND	ND
1,2-dichloroethene	33 *	NSA	NSA	ug/l	18.1	20.7	17.7	a	21.7	20.7	17.4	16.7	17.8	a
Cis-1,2-dichloroethene	7.3 *	70	210	ug/l	a	a	16.8	21	21	20	a	a	16.6	14
trans-1,2-dichloroethene	11 *	100	180	ug/l	0.76 J	0.79 J	0.87 J	0.87 J	0.69 J	0.67 J	1.1	0.93 J	1.1	0.77 J
Acetone	2200 *	NSA	220000	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	0.41	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	0.12	80	2.1	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon disulfide	100 *	NSA	560	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	0.19	80	80 †	ug/l	0.56 J	0.62 J	0.62 J	0.75 J	0.4 J	0.38 J	ND	ND	ND	ND
Chloromethane	19 *	NSA	6.7	ug/l	ND	ND	ND	0.5 J	ND	ND	ND	ND	ND	ND
Ethylbenzene	1.5	700	700 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene Chloride	4.8	5	58	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	0.11	5	5 †	ug/l	**11.1**	**10.5**	**10.2**	**9.8**	**7**	**7.5**	**11.5**	**8.3**	**9.8**	**6.7**
Trichloroethene	2	5	5 †	ug/l	**175**	**187**	**171**	**163**	**174**	**179**	**186**	**207**	**229**	**240**
Vinyl chloride	0.016	2	2 †	ug/l	ND	ND	ND	0.45 J	ND	ND	0.83 J	0.62 J	0.71 J	ND
Xylenes, Total	20 *	10000	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Petroleum Hydrocarbons														
TPH-GRO (C6-C10)	NSA	NSA		mg/l	a	a	a	a	ND	ND	a	a	a	a
General Chemistry														
Sulfate	NSA	NSA	NSA	mg/l	a	a	a	37.6	a	a	a	a	a	a
Nitrogen as nitrate + nitrite	NSA	NSA	NSA	mg/l	a	a	a	0.19	a	a	a	a	a	a
Dissolved Gasses														
Ethane	NSA	NSA	NSA	ug/l	a	a	a	ND	a	a	a	a	a	a
Ethene	NSA	NSA	NSA	ug/l	a	a	a	ND	a	a	a	a	a	a
Methane	NSA	NSA	NSA	ug/l	a	a	a	13.8	a	a	a	a	a	a
Total organic carbon	NSA	NSA	NSA	mg/l	a	a	a	ND	a	a	a	a	a	a

Samples were analyzed for metals, OC and OP pesticides, PCBs, herbicides, VOCs, SVOCs, TPH, general chemistry, and dissolved gasses unless otherwise noted. Results for metals, pesticides, PCBs, herbicides, and SVOCs are presented in Table 5-4. Compounds not listed were not detected in any samples.

RSL Tapwater = USEPA Tapwater Regional Screening Level, June 2011.

MCL = USEPA Maximum Contaminant Level, June 2011.

Groundwater to Air = Target groundwater concentration corresponding to target indoor air concentration where the soil gas to indoor air attenuation factor = 0.001 and partitioning across the water table obeys Henry's Law Cgw (Table 2c of Vapor Intrusion Guidance, 2002)

* = A noncarcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1.

† = value is the same as the MCL

NSA = No screening level available

a = Compound was not analyzed for.

b = Result was rejected for use by the data validator.

Gray shading = detected concentration is > the Tapwater RSL

Bold font = detected concentration is > MCL

Underline = detected concentration is > Groundwater to Air value

B = Not substantially different than levels reported in associated laboratory blanks.

J = Estimated

ND = Non-detect

Table 5-5

Concentrations of VOCs, Dissolved Gasses, and General Chemistry Parameters Detected in Groundwater Samples

				Location:	G-03-MW-12A	G-03-MW-12A	G-03-MW-12A	G-03-MW-12A	G-03-MW-12A	G-03-MW-12A	G-03-MW-12B	G-03-MW-12B	G-03-MW-12B	G-03-MW-12B	G-03-MW-12B
				Sample:	G-03-07-MW-12A	07-JN-12-DP2	G-03-08-MW-12A	G-03-08-MW-12A	G-03-09-MW-12A	G-03-10-MW-12A	G-03-07-MW-12B	G-03-08-MW-12B	G-03-08-MW-12B	G-03-09-MW-12B	G-03-10-MW-12B
				Parent Sample:		G-03-07-MW-12A									
				Sample Date:	6/12/2007	6/12/2007	1/9/2008	5/14/2008	1/7/2009	8/18/2010	6/12/2007	1/9/2008	5/14/2008	1/7/2009	8/18/2010
Compound	**RSL Tapwater**	**MCL**	**Groundwater to Air**	**Units**											
Volatile Organic Compounds															
1,1,2-trichloroethane	0.042 *	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-dichloroethene	34 *	7	190	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-dichloroethane	0.15	5	5 †	ug/l	0.59 J	0.56 J	ND	0.4 J	0.51 J	ND	ND	ND	ND	ND	ND
1,2-dichloroethene	33 *	NSA	NSA	ug/l	20.3	20.3	25.2	20.4	a	17.3	4.2	5.6	7.2	a	12.7
Cis-1,2-dichloroethene	7.3 *	70	210	ug/l	a	a	a	19.4	28.1	16.7	a	a	7.2	13.1	12.7
trans-1,2-dichloroethene	11 *	100	180	ug/l	1.1	1.2	1.1	0.97 J	1.1	0.59 J	ND	ND	ND	0.37 J	ND
Acetone	2200 *	NSA	220000	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	0.41	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	0.12	80	2.1	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon disulfide	100 *	NSA	560	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	0.19	80	80 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloromethane	19 *	NSA	6.7	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	1.5	700	700 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene Chloride	4.8	5	58	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	0.11	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	2	5	5 †	ug/l	**41.2**	**43**	**38.3**	**31.8**	**26.6**	**45.8**	**36.1**	**39.7**	**39.1**	**25.2**	**35.5**
Vinyl chloride	0.016	2	2 †	ug/l	0.52 J	0.66 J	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes, Total	20 *	10000	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Petroleum Hydrocarbons															
TPH-GRO (C6-C10)	NSA	NSA		mg/l	a	a	a	a	a	ND	a	a	a	a	ND
General Chemistry															
Sulfate	NSA	NSA	NSA	mg/l	a	a	a	a	a	a	a	a	a	a	a
Nitrogen as nitrate + nitrite	NSA	NSA	NSA	mg/l	a	a	a	a	a	a	a	a	a	a	a
Dissolved Gasses															
Ethane	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Ethene	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Methane	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Total organic carbon	NSA	NSA	NSA	mg/l	a	a	a	a	a	a	a	a	a	a	a

Samples were analyzed for metals, OC and OP pesticides, PCBs, herbicides, VOCs, SVOCs, TPH, general chemistry, and dissolved gasses unless otherwise noted. Results for metals, pesticides, PCBs, herbicides, and SVOCs are presented in Table 5-4. Compounds not listed were not detected in any samples.

RSL Tapwater = USEPA Tapwater Regional Screening Level, June 2011.

MCL = USEPA Maximum Contaminant Level, June 2011.

Groundwater to Air = Target groundwater concentration corresponding to target indoor air concentration where the soil gas to indoor air attenuation factor = 0.001 and partitoning across the water table obeys Henry's Law Cgw (Table 2c of Vapor Intrusion Guidance, 2002)

* = A noncarcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1.

† = value is the same as the MCL

NSA = No screening level available

a = Compound was not analyzed for.

b = Result was rejected for use by the data validator.

Gray shading = detected concentration is > the Tapwater RSL

Bold font = detected concentration is > MCL

Underline = detected concentration is > Groundwater to Air value

B = Not substantially different than levels reported in associated laboratory blanks.

J = Estimated

ND = Non-detect

Table 5-5

Concentrations of VOCs, Dissolved Gasses, and General Chemistry Parameters Detected in Groundwater Samples

				Location:	G-03-MW-13A	G-03-MW-13A	G-03-MW-13A	G-03-MW-13A	G-03-MW-13A	G-03-MW-13A	G-03-MW-13B	G-03-MW-13B	G-03-MW-13B	G-03-MW-13B	G-03-MW-13B
				Sample:	G-03-07-MW-13A	G-03-08-MW-13A	G-03-08-MW-13A	08-MA-14-DP3	G-03-09-MW-13A	G-03-10-MW-13A	G-03-07-MW-13B	07-JN-12-DP1	G-03-08-MW-13B	G-03-08-MW-13B	G-03-09-MW-13B
				Parent Sample:				G-03-08-MW-13A				G-03-07-MW-13B			
				Sample Date:	6/12/2007	1/8/2008	5/14/2008	5/13/2008	1/7/2009	8/18/2010	6/12/2007	6/12/2007	1/8/2008	5/14/2008	1/7/2009
Compound	**RSL Tapwater**	**MCL**	**Groundwater to Air**	**Units**											
Volatile Organic Compounds															
1,1,2-trichloroethane	0.042 *	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.44 J
1,1-dichloroethene	34 *	7	190	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-dichloroethane	0.15	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-dichloroethene	33 *	NSA	NSA	ug/l	ND	ND	ND	ND	a	ND	9.3	9	21.2	19.3	a
Cis-1,2-dichloroethene	7.3 *	70	210	ug/l	a	a	ND	ND	ND	ND	a	a	a	15.5	16.8
trans-1,2-dichloroethene	11 *	100	180	ug/l	ND	ND	ND	ND	ND	ND	1.2	1.2	3.7	3.8	3.4
Acetone	2200 *	NSA	220000	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	0.41	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	0.12	80	2.1	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon disulfide	100 *	NSA	560	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	0.19	80	80 †	ug/l	ND	ND	ND	ND	ND	ND	3.4	3.8	2.6	2.1	2
Chloromethane	19 *	NSA	6.7	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	1.5	700	700 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene Chloride	4.8	5	58	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	0.11	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	4.4	4	4.4	4.2	4.3
Trichloroethene	2	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	**81.7**	**85.2**	**122**	**115**	**121**
Vinyl chloride	0.016	2	2 †	ug/l	ND	ND	ND	ND	ND	ND	0.76 J	0.76 J	**2.4**	**2.5**	**2.4**
Xylenes, Total	20 *	10000	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Petroleum Hydrocarbons															
TPH-GRO (C6-C10)	NSA	NSA		mg/l	a	a	a	a	a	ND	a	a	a	a	a
General Chemistry															
Sulfate	NSA	NSA	NSA	mg/l	a	a	a	a	a	a	a	a	a	a	a
Nitrogen as nitrate + nitrite	NSA	NSA	NSA	mg/l	a	a	a	a	a	a	a	a	a	a	a
Dissolved Gasses															
Ethane	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Ethene	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Methane	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Total organic carbon	NSA	NSA	NSA	mg/l	a	a	a	a	a	a	a	a	a	a	a

Samples were analyzed for metals, OC and OP pesticides, PCBs, herbicides, VOCs, SVOCs, TPH, general chemistry, and dissolved gasses unless otherwise noted. Results for metals, pesticides, PCBs, herbicides, and SVOCs are presented in Table 5-4. Compounds not listed were not detected in any samples.

RSL Tapwater = USEPA Tapwater Regional Screening Level, June 2011.

MCL = USEPA Maximum Contaminant Level, June 2011.

Groundwater to Air = Target groundwater concentration corresponding to target indoor air concentration where the soil gas to indoor air attenuation factor = 0.001 and partitoning across the water table obeys Henry's Law Cgw (Table 2c of Vapor Intrusion Guidance, 2002)

* = A noncarcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1.

† = value is the same as the MCL

NSA = No screening level available

a = Compound was not analyzed for.

b = Result was rejected for use by the data validator.

Gray shading = detected concentration is > the Tapwater RSL

Bold font = detected concentration is > MCL

Underline = detected concentration is > Groundwater to Air value

B = Not substantially different than levels reported in associated laboratory blanks.

J = Estimated

ND = Non-detect

Table 5-5
Concentrations of VOCs, Dissolved Gasses, and General Chemistry Parameters Detected in Groundwater Samples

				Location:	G-03-MW-13B	G-03-MW-14A	G-03-MW-14A	G-03-MW-14A	G-03-MW-14B	G-03-MW-14B	G-03-MW-15	G-03-MW-15	G-03-MW-15	G-03-MW-15
				Sample:	G-03-10-MW-13B	G-03-08-MW-14A	G-03-08-MW-14A	G-03-09-MW-14A	G-03-08-MW-14B	G-03-08-MW-14B	G-03-09-MW-15	09-JA-07-DP2	G-03-08-MW-15A	G-03-08-MW-15A
				Parent Sample:								G-03-09-MW-15		
				Sample Date:	8/18/2010	1/9/2008	5/13/2008	3/10/2009	1/9/2008	5/13/2008	1/7/2009 & 1/8/2009	1/7/2009 & 1/8/2009	1/8/2008	5/14/2008
Compound	**RSL Tapwater**	**MCL**	**Groundwater to Air**	**Units**										
Volatile Organic Compounds														
1,1,2-trichloroethane	0.042 *	5	5 †	ug/l	0.44 J	ND	ND	ND	ND	ND	1.2 J	1.4	1.7	1.6
1,1-dichloroethene	34 *	7	190	ug/l	ND	ND	ND	ND	ND	ND	ND	0.68 J	0.67 J	1.1
1,2-dichloroethane	0.15	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-dichloroethene	33 *	NSA	NSA	ug/l	51.1	ND	ND	ND	ND	ND	a	a	57.6	58.4
Cis-1,2-dichloroethene	7.3 *	70	210	ug/l	41.4	a	ND	ND	a	ND	52.2	65.6	a	56.8
trans-1,2-dichloroethene	11 *	100	180	ug/l	9.7	ND	ND	ND	ND	ND	0.88 J	1.3	1.4	1.6
Acetone	2200 *	NSA	220000	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	0.41	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	0.12	80	2.1	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon disulfide	100 *	NSA	560	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	0.19	80	80 †	ug/l	1.4	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloromethane	19 *	NSA	6.7	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	1.5	700	700 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene Chloride	4.8	5	58	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	0.11	5	5 †	ug/l	3.4	ND	ND	ND	ND	ND	**25**	**24.7**	**32.5**	**34.1**
Trichloroethene	2	5	5 †	ug/l	**154**	ND	ND	ND	ND	ND	**356**	**331**	**378**	**374**
Vinyl chloride	0.016	2	2 †	ug/l	ND	ND	ND	ND	ND	ND	**2.3 J**	**2.6**	**2.7**	**3**
Xylenes, Total	20 *	10000	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Petroleum Hydrocarbons														
TPH-GRO (C6-C10)	NSA	NSA		mg/l	ND	a	a	a	a	a	a	a	a	a
General Chemistry														
Sulfate	NSA	NSA	NSA	mg/l	a	a	a	a	a	a	37.1	37.1	a	a
Nitrogen as nitrate + nitrite	NSA	NSA	NSA	mg/l	a	a	a	a	a	a	ND	ND	a	a
Dissolved Gasses														
Ethane	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	0.23	a	a	a
Ethene	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	ND	a	a	a
Methane	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	12	a	a	a
Total organic carbon	NSA	NSA	NSA	mg/l	a	a	a	a	a	a	0.38 a	ND	a	a

Samples were analyzed for metals, OC and OP pesticides, PCBs, herbicides, VOCs, SVOCs, TPH, general chemistry, and dissolved gasses unless otherwise noted. Results for metals, pesticides, PCBs, herbicides, and SVOCs are presented in Table 5-4. Compounds not listed were not detected in any samples.

RSL Tapwater = USEPA Tapwater Regional Screening Level, June 2011.

MCL = USEPA Maximum Contaminant Level, June 2011.

Groundwater to Air = Target groundwater concentration corresponding to target indoor air concentration where the soil gas to indoor air attenuation factor = 0.001 and partitoning across the water table obeys Henry's Law Cgw (Table 2c of Vapor Intrusion Guidance, 2002)

* = A noncarcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1.

† = value is the same as the MCL

NSA = No screening level available

a = Compound was not analyzed for.

b = Result was rejected for use by the data validator.

Gray shading = detected concentration is > the Tapwater RSL

Bold font = detected concentration is > MCL

Underline = detected concentration is > Groundwater to Air value

B = Not substantially different than levels reported in associated laboratory blanks.

J = Estimated

ND = Non-detect

Table 5-5
Concentrations of VOCs, Dissolved Gasses, and General Chemistry Parameters Detected in Groundwater Samples

				Location:	G-03-MW-16A	G-03-MW-16A	G-03-MW-16A	G-03-MW-16B	G-03-MW-16B	G-03-MW-16B	G-03-MW-17A	G-03-MW-17A	G-03-MW-17A	G-03-MW-17A	G-03-MW-18A
				Sample:	G-03-08-MW-16A	G-03-08-MW-16A	G-03-09-MW-16A	G-03-08-MW-16B	G-03-08-MW-16B	G-03-09-MW-16B	G-03-08-MW-17A	08-JA-08-DP	G-03-08-MW-17A	08-MA-13-DP2	G-03-08-MW-18A
				Parent Sample:								G-03-08-MW-17A		G-03-08-MW-17A	
				Sample Date:	1/8/2008	5/13/2008	1/7/2009	1/8/2008	5/13/2008	1/7/2009	1/8/2008	1/8/2008	5/13/2008	5/13/2008	1/9/2008
Compound	**RSL Tapwater**	**MCL**	**Groundwater to Air**	**Units**											
Volatile Organic Compounds															
1,1,2-trichloroethane	0.042 *	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-dichloroethene	34 *	7	190	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-dichloroethane	0.15	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-dichloroethene	33 *	NSA	NSA	ug/l	2.3	2.3	a	2.4	4.1	a	ND	ND	ND	ND	0.53 J
Cis-1,2-dichloroethene	7.3 *	70	210	ug/l	a	2.3	2	a	4.1	3	a	a	ND	ND	a
trans-1,2-dichloroethene	11 *	100	180	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acetone	2200 *	NSA	220000	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	0.41	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	0.12	80	2.1	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon disulfide	100 *	NSA	560	ug/l	1.1 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	0.19	80	80 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloromethane	19 *	NSA	6.7	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	1.5	700	700 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene Chloride	4.8	5	58	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	0.11	5	5 †	ug/l	1.6	1.7	1.6	4.2	3.2	3.5	ND	ND	ND	ND	ND
Trichloroethene	2	5	5 †	ug/l	**7.9**	**7.7**	**7.5**	**18.8**	**15.3**	**16**	ND	ND	ND	ND	**7.8**
Vinyl chloride	0.016	2	2 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes, Total	20 *	10000	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Petroleum Hydrocarbons															
TPH-GRO (C6-C10)	NSA	NSA		mg/l	a	a	a	a	a	a	a	a	a	a	a
General Chemistry															
Sulfate	NSA	NSA	NSA	mg/l	a	a	a	a	a	a	a	a	a	a	a
Nitrogen as nitrate + nitrite	NSA	NSA	NSA	mg/l	a	a	a	a	a	a	a	a	a	a	a
Dissolved Gasses															
Ethane	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Ethene	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Methane	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Total organic carbon	NSA	NSA	NSA	mg/l	a	a	a	a	a	a	a	a	a	a	a

Samples were analyzed for metals, OC and OP pesticides, PCBs, herbicides, VOCs, SVOCs, TPH, general chemistry, and dissolved gasses unless otherwise noted. Results for metals, pesticides, PCBs, herbicides, and SVOCs are presented in Table 5-4. Compounds not listed were not detected in any samples.

RSL Tapwater = USEPA Tapwater Regional Screening Level, June 2011.

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Groundwater to Air = Target groundwater concentration corresponding to target indoor air concentration where the soil gas to indoor air attenuation factor = 0.001 and partitoning across the water table obeys Henry's Law Cgw (Table 2c of Vapor Intrusion Guidance, 2002)

* = A noncarcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1.

† = value is the same as the MCL

NSA = No screening level available

a = Compound was not analyzed for.

b = Result was rejected for use by the data validator.

Gray shading = detected concentration is > the Tapwater RSL

Bold font = detected concentration is > MCL

Underline = detected concentration is > Groundwater to Air value

B = Not substantially different than levels reported in associated laboratory blanks.

J = Estimated

ND = Non-detect

Table 5-5
Concentrations of VOCs, Dissolved Gasses, and General Chemistry Parameters Detected in Groundwater Samples

				Location:	G-03-MW-18A	G-03-MW-18A	G-03-MW-18B	G-03-MW-18B	G-03-MW-19A	G-03-MW-19A	G-03-MW-19B	G-03-MW-19B	G-03-MW-20	G-03-MW-20	G-03-MW-21
				Sample:	G-03-08-MW-18A	G-03-09-MW-18A	G-03-08-MW-18B	G-03-08-MW-18B	G-03-08-MW-19A	G-03-08-MW-19A	G-03-08-MW-19B	G-03-08-MW-19B	G-03-08-MW-20	G-03-09-MW-20	G-03-08-MW-21
				Parent Sample:											
				Sample Date:	5/13/2008	1/7/2009	1/9/2008	5/13/2008	1/8/2008	5/13/2008	1/8/2008	5/13/2008	5/13/2008	1/7/2009	5/13/2008
Compound	**RSL Tapwater**	**MCL**	**Groundwater to Air**	**Units**											
Volatile Organic Compounds															
1,1,2-trichloroethane	0.042 *	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-dichloroethene	34 *	7	190	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-dichloroethane	0.15	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-dichloroethene	33 *	NSA	NSA	ug/l	ND	a	ND	ND	ND	ND	ND	ND	ND	a	ND
Cis-1,2-dichloroethene	7.3 *	70	210	ug/l	ND	0.71 J	a	ND	a	ND	a	ND	ND	ND	ND
trans-1,2-dichloroethene	11 *	100	180	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acetone	2200 *	NSA	220000	ug/l	ND	ND	ND	7.6 J	ND	ND	ND	ND	ND	ND	ND
Benzene	0.41	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	0.12	80	2.1	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon disulfide	100 *	NSA	560	ug/l	ND	ND	2.5	0.89 J	ND	ND	ND	ND	ND	ND	ND
Chloroform	0.19	80	80 †	ug/l	ND	ND	0.94 J	0.68 J	ND	ND	ND	ND	ND	ND	0.38 J
Chloromethane	19 *	NSA	6.7	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	1.5	700	700 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene Chloride	4.8	5	58	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	0.11	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	2	5	5 †	ug/l	**6.6**	**7.5**	0.86 J	0.45 J	ND	ND	ND	ND	1.2	0.62 J	ND
Vinyl chloride	0.016	2	2 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes, Total	20 *	10000	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Petroleum Hydrocarbons															
TPH-GRO (C6-C10)	NSA	NSA		mg/l	a	a	a	a	a	a	a	a	a	a	a
General Chemistry															
Sulfate	NSA	NSA	NSA	mg/l	a	a	a	a	a	a	a	a	a	a	a
Nitrogen as nitrate + nitrite	NSA	NSA	NSA	mg/l	a	a	a	a	a	a	a	a	a	a	a
Dissolved Gasses															
Ethane	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Ethene	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Methane	NSA	NSA	NSA	ug/l	a	a	a	a	a	a	a	a	a	a	a
Total organic carbon	NSA	NSA	NSA	mg/l	a	a	a	a	a	a	a	a	a	a	a

Samples were analyzed for metals, OC and OP pesticides, PCBs, herbicides, VOCs, SVOCs, TPH, general chemistry, and dissolved gasses unless otherwise noted. Results for metals, pesticides, PCBs, herbicides, and SVOCs are presented in Table 5-4. Compounds not listed were not detected in any samples.

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* = A noncarcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1.

† = value is the same as the MCL

NSA = No screening level available

a = Compound was not analyzed for.

b = Result was rejected for use by the data validator.

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Underline = detected concentration is > Groundwater to Air value

B = Not substantially different than levels reported in associated laboratory blanks.

J = Estimated

ND = Non-detect

Table 5-5
Concentrations of VOCs, Dissolved Gasses, and General Chemistry Parameters Detected in Groundwater Samples

				Location:	G-03-MW-21	G-03-MW-22	G-03-MW-22	G-03-MW-22	G-03-MW-23	G-03-MW-23	G-03-MW-24	G-03-MW-24	G-03-MW-25	G-03-MW-25	G-03-MW-25	G-03-MW-26
				Sample:	G-03-09-MW-21	G-03-08-MW-22	08-MA-13-DP1	G-03-09-MW-22	G-03-08-MW-23	G-03-09-MW-23	G-03-08-MW-24	G-03-09-MW-24	G-03-09-MW-25	G-03-09-MW-25	G-03-10-MW-25	G-03-09-MW-26
				Parent Sample:			G-03-08-MW-22									
				Sample Date:	1/7/2009	5/13/2008	5/13/2008	1/6/2009 & 1/7/2009	5/13/2008	1/7/2009	5/13/2008	1/6/2009	1/7/2009	3/11/2009	8/18/2010	1/7/2009
Compound	**RSL Tapwater**	**MCL**	**Groundwater to Air**	**Units**												
Volatile Organic Compounds																
1,1,2-trichloroethane	0.042 *	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	**25.4**	**25.7**	**23.8**	**7.4 J**
1,1-dichloroethene	34 *	7	190	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	6.6 J	4.3 J	**7.8 J**	ND
1,2-dichloroethane	0.15	5	5 †	ug/l	0.52 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-dichloroethene	33 *	NSA	NSA	ug/l	a	ND	ND	a	ND	a	ND	a	a	259	270	a
Cis-1,2-dichloroethene	7.3 *	70	210	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	**275**	**247**	**257**	44.1
trans-1,2-dichloroethene	11 *	100	180	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	13.3 J	11.7	13.5	ND
Acetone	2200 *	NSA	220000	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	0.41	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	0.12	80	2.1	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon disulfide	100 *	NSA	560	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	0.19	80	80 †	ug/l	ND	ND	ND	ND	ND	ND	0.58 J	ND	ND	ND	ND	ND
Chloromethane	19 *	NSA	6.7	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	1.5	700	700 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene Chloride	4.8	5	58	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	**11.9 J**	ND	ND	ND
Tetrachloroethene	0.11	5	5 †	ug/l	ND	ND	0.37 J	ND	ND	ND	0.6 J	ND	**27.8**	**20.9**	**21.9**	**6.3 J**
Trichloroethene	2	5	5 †	ug/l	ND	1.1	0.8 J	0.91 J	ND	ND	1.6	0.25 J	**4040**	**3360**	**3430**	**1250**
Vinyl chloride	0.016	2	2 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	**7 J**	ND	ND	ND
Xylenes, Total	20 *	10000	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Petroleum Hydrocarbons																
TPH-GRO (C6-C10)	NSA	NSA		mg/l	a	a	a	a	a	a	a	a	a	a	2.22	a
General Chemistry																
Sulfate	NSA	NSA	NSA	mg/l	a	a	a	25.1	a	a	a	a	a	a	a	a
Nitrogen as nitrate + nitrite	NSA	NSA	NSA	mg/l	a	a	a	ND	a	a	a	a	a	a	a	a
Dissolved Gasses																
Ethane	NSA	NSA	NSA	ug/l	a	a	a	ND	a	a	a	a	a	a	a	a
Ethene	NSA	NSA	NSA	ug/l	a	a	a	ND	a	a	a	a	a	a	a	a
Methane	NSA	NSA	NSA	ug/l	a	a	a	0.52	a	a	a	a	a	a	a	a
Total organic carbon	NSA	NSA	NSA	mg/l	a	a	a	ND	a	a	a	a	a	a	a	a

Samples were analyzed for metals, OC and OP pesticides, PCBs, herbicides, VOCs, SVOCs, TPH, general chemistry, and dissolved gasses unless otherwise noted. Results for metals, pesticides, PCBs, herbicides, and SVOCs are presented in Table 5-4. Compounds not listed were not detected in any samples.

RSL Tapwater = USEPA Tapwater Regional Screening Level, June 2011.

MCL = USEPA Maximum Contaminant Level, June 2011.

Groundwater to Air = Target groundwater concentration corresponding to target indoor air concentration where the soil gas to indoor air attenuation factor = 0.001 and partitoning across the water table obeys Henry's Law Cgw (Table 2c of Vapor Intrusion Guidance, 2002)

* = A noncarcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1.

† = value is the same as the MCL

NSA = No screening level available

a = Compound was not analyzed for.

b = Result was rejected for use by the data validator.

Gray shading = detected concentration is > the Tapwater RSL

Bold font = detected concentration is > MCL

Underline = detected concentration is > Groundwater to Air value

B = Not substantially different than levels reported in associated laboratory blanks.

J = Estimated

ND = Non-detect

Table 5-5
Concentrations of VOCs, Dissolved Gasses, and General Chemistry Parameters Detected in Groundwater Samples

				Location:	G-03-MW-26	G-03-MW-26	G-03-MW-26	G-03-OP-01	G-03-OP-01	G-03-OP-01	G-03-OP-01	G-03-OP-02	G-03-OP-02	G-03-OP-02	G-03-OP-02	G-03-OP-03
				Sample:	09-JA-07-DP1	G-03-09-MW-26	G-03-10-MW-26	G-03-09-OP-01	G-03-09-OP-1	9-MR-10-DP1	G-03-10-OP-1	G-03-09-OP-02	G-03-09-OP-2	9-MR-11-DP1	G-03-10-OP-2	G-03-09-OP-03
				Parent Sample:	G-03-09-MW-26					G-03-09-OP-1				G-03-09-OP-2		
				Sample Date:	1/7/2009	3/11/2009	8/18/2010	1/6/2009 & 1/7/2009	3/10/2009	3/10/2009	8/17/2010	1/6/2009 & 1/7/2009	3/11/2009	3/11/2009	8/17/2010	1/6/2009
Compound	**RSL Tapwater**	**MCL**	**Groundwater to Air**	**Units**												
Volatile Organic Compounds																
1,1,2-trichloroethane	0.042 *	5	5 †	ug/l	**7.9 J**	**8.4**	**7.7**	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-dichloroethene	34 *	7	190	ug/l	ND	1.8 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-dichloroethane	0.15	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-dichloroethene	33 *	NSA	NSA	ug/l	a	46.3	68.7	a	0.32 J	0.31 J	ND	a	1.5	1.5	1.4	a
Cis-1,2-dichloroethene	7.3 *	70	210	ug/l	44.5	43.6	65.7	0.31 J	0.32 J	0.31 J	ND	1.5	1.5	1.5	1.4	5.6
trans-1,2-dichloroethene	11 *	100	180	ug/l	ND	2.7	3 J	ND	ND	ND	ND	ND	ND	ND	ND	0.41 J
Acetone	2200 *	NSA	220000	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	0.41	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	0.12	80	2.1	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon disulfide	100 *	NSA	560	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	0.19	80	80 †	ug/l	ND	ND	ND	0.2 J	ND	ND	ND	1.2	0.35 J	0.41 J	ND	1.4
Chloromethane	19 *	NSA	6.7	ug/l	ND	ND	ND	ND	ND	ND	ND	1.3	ND	ND	ND	ND
Ethylbenzene	1.5	700	700 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene Chloride	4.8	5	58	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	0.11	5	5 †	ug/l	**6 J**	**5.7**	**5.4**	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	2	5	5 †	ug/l	**1290**	**1150**	**1380**	1.5	1.2	1.2	0.75 J	**5.2**	**5.3**	**5.2**	3.7	**22.6**
Vinyl chloride	0.016	2	2 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes, Total	20 *	10000	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Petroleum Hydrocarbons																
TPH-GRO (C6-C10)	NSA	NSA		mg/l	a	a	0.78	a	a	a	ND	a	a	a	ND	a
General Chemistry																
Sulfate	NSA	NSA	NSA	mg/l	a	a	a	23.2	a	a	a	58.6	a	a	a	a
Nitrogen as nitrate + nitrite	NSA	NSA	NSA	mg/l	a	a	a	ND	a	a	a	ND	a	a	a	a
Dissolved Gasses																
Ethane	NSA	NSA	NSA	ug/l	a	a	a	ND	a	a	a	0.88	a	a	a	a
Ethene	NSA	NSA	NSA	ug/l	a	a	a	ND	a	a	a	ND	a	a	a	a
Methane	NSA	NSA	NSA	ug/l	a	a	a	25.3	a	a	a	3.2	a	a	a	a
Total organic carbon	NSA	NSA	NSA	mg/l	a	a	a	0.32	a	a	a	0.43	a	a	a	a

Samples were analyzed for metals, OC and OP pesticides, PCBs, herbicides, VOCs, SVOCs, TPH, general chemistry, and dissolved gasses unless otherwise noted. Results for metals, pesticides, PCBs, herbicides, and SVOCs are presented in Table 5-4. Compounds not listed were not detected in any samples.

RSL Tapwater = USEPA Tapwater Regional Screening Level, June 2011.

MCL = USEPA Maximum Contaminant Level, June 2011.

Groundwater to Air = Target groundwater concentration corresponding to target indoor air concentration where the soil gas to indoor air attenuation factor = 0.001 and partitioning across the water table obeys Henry's Law Cgw (Table 2c of Vapor Intrusion Guidance, 2002)

* = A noncarcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1.

† = value is the same as the MCL

NSA = No screening level available

a = Compound was not analyzed for.

b = Result was rejected for use by the data validator.

Gray shading = detected concentration is > the Tapwater RSL

Bold font = detected concentration is > MCL

Underline = detected concentration is > Groundwater to Air value

B = Not substantially different than levels reported in associated laboratory blanks.

J = Estimated

ND = Non-detect

Table 5-5

Concentrations of VOCs, Dissolved Gasses, and General Chemistry Parameters Detected in Groundwater Samples

				Location:	G-03-OP-03	G-03-OP-03	G-03-OP-04	G-03-OP-04	G-03-OP-04	G-03-OP-05	G-03-OP-05	G-03-OP-05	G-03-OP-05	G-03-OP-06	G-03-OP-06	G-03-OP-06	G-03-OP-07
				Sample:	G-03-09-OP-3	G-03-10-OP-3	G-03-09-OP-04	G-03-09-OP-4	G-03-10-OP-4	G-03-09-OP-05	G-03-09-OP-5	G-03-10-OP-5	10-AUG-17-DP1	G-03-09-OP-6	G-03-09-OP-6	G-03-10-OP-6	G-03-09-OP-7
				Parent Sample:									G-03-10-OP-5				
				Sample Date:	3/10/2009	8/17/2010	1/6/2009	3/10/2009	8/17/2010	1/6/2009 & 1/7/2009	3/10/2009	8/17/2010	8/17/2010	3/10/2009	4/14/2009	8/18/2010	3/10/2009
Compound	**RSL Tapwater**	**MCL**	**Groundwater to Air**	**Units**													
Volatile Organic Compounds																	
1,1,2-trichloroethane	0.042 *	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.64 J	ND	ND	ND
1,1-dichloroethene	34 *	7	190	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.33 J	ND	ND	ND
1,2-dichloroethane	0.15	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-dichloroethene	33 *	NSA	NSA	ug/l	6	4.9	a	30.6	41.6	a	0.52 J	0.63 J	0.7 J	6.3	5	4	ND
Cis-1,2-dichloroethene	7.3 *	70	210	ug/l	5.5	4.9	23.9	26.4	35.6	0.46 J	0.52 J	0.63 J	0.7 J	5.3	4.4	4	ND
trans-1,2-dichloroethene	11 *	100	180	ug/l	0.53 J	ND	3.7	4.3	6	ND	ND	ND	ND	1	0.54 J	ND	ND
Acetone	2200 *	NSA	220000	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	0.41	5	5 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	0.12	80	2.1	ug/l	ND	ND	ND	ND	ND	0.5 J	ND	ND	ND	ND	ND	ND	ND
Carbon disulfide	100 *	NSA	560	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	0.19	80	80 †	ug/l	0.66 J	ND	5.2	4.9	2.6	7.4	5.3	3.2	3.6	2.2	1.2	ND	ND
Chloromethane	19 *	NSA	6.7	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	1.5	700	700 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene Chloride	4.8	5	58	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	0.11	5	5 †	ug/l	0.31 J	ND	1.1	1.4	1.4	ND	ND	ND	ND	1.5	1.1	ND	ND
Trichloroethene	2	5	5 †	ug/l	**20**	**17.3**	**68.2**	**75.5**	**89.6**	**6.4**	**6.8**	**6.6**	**7.2**	**141**	**99.3**	**37**	ND
Vinyl chloride	0.016	2	2 †	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes, Total	20 *	10000	NSA	ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Petroleum Hydrocarbons																	
TPH-GRO (C6-C10)	NSA	NSA		mg/l	a	ND	a	a	ND	a	a	ND	ND	a	a	ND	a
General Chemistry																	
Sulfate	NSA	NSA	NSA	mg/l	a	a	a	a	a	51.4	a	a	a	a	a	a	a
Nitrogen as nitrate + nitrite	NSA	NSA	NSA	mg/l	a	a	a	a	a	0.73	a	a	a	a	a	a	a
Dissolved Gasses																	
Ethane	NSA	NSA	NSA	ug/l	a	a	a	a	a	ND	a	a	a	a	a	a	a
Ethene	NSA	NSA	NSA	ug/l	a	a	a	a	a	ND	a	a	a	a	a	a	a
Methane	NSA	NSA	NSA	ug/l	a	a	a	a	a	18.4	a	a	a	a	a	a	a
Total organic carbon	NSA	NSA	NSA	mg/l	a	a	a	a	a	0.37	a	a	a	a	a	a	a

Samples were analyzed for metals, OC and OP pesticides, PCBs, herbicides, VOCs, SVOCs, TPH, general chemistry, and dissolved gasses unless otherwise noted. Results for metals, pesticides, PCBs, herbicides, and SVOCs are presented in Table 5-4. Compounds not listed were not detected in any samples.

RSL Tapwater = USEPA Tapwater Regional Screening Level, June 2011.

MCL = USEPA Maximum Contaminant Level, June 2011.

Groundwater to Air = Target groundwater concentration corresponding to target indoor air concentration where the soil gas to indoor air attenuation factor = 0.001 and partitoning across the water table obeys Henry's Law Cgw (Table 2c of Vapor Intrusion Guidance, 2002)

* = A noncarcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1.

† = value is the same as the MCL

NSA = No screening level available

a = Compound was not analyzed for.

b = Result was rejected for use by the data validator.

Gray shading = detected concentration is > the Tapwater RSL

Bold font = detected concentration is > MCL

Underline = detected concentration is > Groundwater to Air value

B = Not substantially different than levels reported in associated laboratory blanks.

J = Estimated

ND = Non-detect

Table 5-5
Concentrations of VOCs, Dissolved Gasses, and General Chemistry Parameters Detected in Groundwater Samples

				Location:	G-03-OP-07
				Sample:	G-03-09-OP-7
				Parent Sample:	
				Sample Date:	4/14/2009
Compound	**RSL Tapwater**	**MCL**	**Groundwater to Air**	**Units**	
Volatile Organic Compounds					
1,1,2-trichloroethane	0.042 *	5	5 †	ug/l	ND
1,1-dichloroethene	34 *	7	190	ug/l	ND
1,2-dichloroethane	0.15	5	5 †	ug/l	ND
1,2-dichloroethene	33 *	NSA	NSA	ug/l	9.9
Cis-1,2-dichloroethene	7.3 *	70	210	ug/l	9
trans-1,2-dichloroethene	11 *	100	180	ug/l	0.89 J
Acetone	2200 *	NSA	220000	ug/l	ND
Benzene	0.41	5	5 †	ug/l	ND
Bromodichloromethane	0.12	80	2.1	ug/l	ND
Carbon disulfide	100 *	NSA	560	ug/l	ND
Chloroform	0.19	80	80 †	ug/l	ND
Chloromethane	19 *	NSA	6.7	ug/l	ND
Ethylbenzene	1.5	700	700 †	ug/l	ND
Methylene Chloride	4.8	5	58	ug/l	ND
Tetrachloroethene	0.11	5	5 †	ug/l	ND
Trichloroethene	2	5	5 †	ug/l	**20.3**
Vinyl chloride	0.016	2	2 †	ug/l	ND
Xylenes, Total	20 *	10000	NSA	ug/l	ND
Total Petroleum Hydrocarbons					
TPH-GRO (C6-C10)	NSA	NSA		mg/l	a
General Chemistry					
Sulfate	NSA	NSA	NSA	mg/l	a
Nitrogen as nitrate + nitrite	NSA	NSA	NSA	mg/l	a
Dissolved Gasses					
Ethane	NSA	NSA	NSA	ug/l	a
Ethene	NSA	NSA	NSA	ug/l	a
Methane	NSA	NSA	NSA	ug/l	a
Total organic carbon	NSA	NSA	NSA	mg/l	a

Samples were analyzed for metals, OC and OP pesticides, PCBs, herbicides, VOCs, SVOCs, TPH, general chemistry, and dissolved gasses unless otherwise noted. Results for metals, pesticides, PCBs, herbicides, and SVOCs are presented in Table 5-4. Compounds not listed were not detected in any samples.

RSL Tapwater = USEPA Tapwater Regional Screening Level, June 2011.

MCL = USEPA Maximum Contaminant Level, June 2011.

Groundwater to Air = Target groundwater concentration corresponding to target indoor air concentration where the soil gas to indoor air attenuation factor = 0.001 and partitoning across the water table obeys Henry's Law Cgw (Table 2c of Vapor Intrusion Guidance, 2002)

* = A noncarcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1.

† = value is the same as the MCL

NSA = No screening level available

a = Compound was not analyzed for.

b = Result was rejected for use by the data validator.

Gray shading = detected concentration is > the Tapwater RSL

Bold font = detected concentration is > MCL

Underline = detected concentration is > Groundwater to Air value

B = Not substantially different than levels reported in associated laboratory blanks.

J = Estimated

ND = Non-detect

Table 5-6

Concentrations of Compounds Detected in Sediment Pore Water and Surface Water Samples

			Sample Name:	PORE-01	DUP-1	PORE-02	PORE-03	PORE-04	PORE-05	PORE-06	SW-01
			Parent Name:		PORE-01						
			Sample Date:	12/9/2010	12/9/2010	12/9/2010	12/9/2010	12/9/2010	12/10/2010	12/10/2010	12/9/2010
Compound	**MCL**	**Tapwater Modified *10**	**Unit**								
Volatile Organic Compounds											
Acetone	NSA	22000 *	ug/l	ND	ND	ND	ND	ND	4.9 J	4.7 J	ND

Samples were analyzed for VOCs. Compounds not shown were not detected in any samples.

MCL = Maximum Contaminant Level from National Primary Drinking Water Regulations (June 2011).

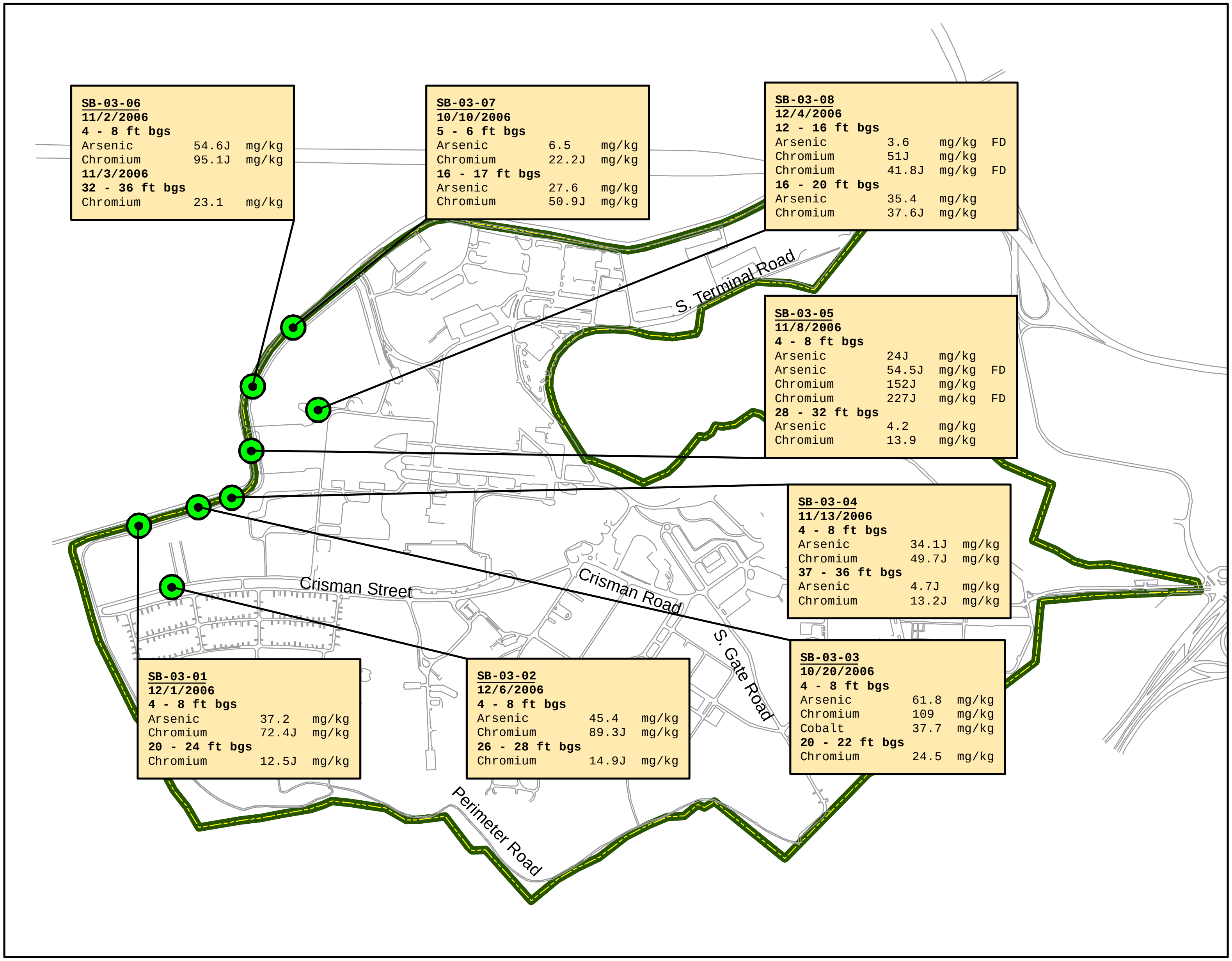
Tapwater Modified *10 = USEPA Tapwater Regional Screening Level multipled by 10 to reflect reduced exposure to pore water/surface water compared to groundwater, June 2011.

* = A noncarcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1.

NSA = No screening level available

J = Estimated

ND = Non-detect



SB-03-06

11/2/2006			
4 - 8 ft bgs			
Arsenic	54.6J	mg/kg	
Chromium	95.1J	mg/kg	
11/3/2006			
32 - 36 ft bgs			
Chromium	23.1	mg/kg	

SB-03-07

10/10/2006			
5 - 6 ft bgs			
Arsenic	6.5	mg/kg	
Chromium	22.2J	mg/kg	
16 - 17 ft bgs			
Arsenic	27.6	mg/kg	
Chromium	50.9J	mg/kg	

SB-03-08

12/4/2006			
12 - 16 ft bgs			
Arsenic	3.6	mg/kg	FD
Chromium	51J	mg/kg	
Chromium	41.8J	mg/kg	FD
16 - 20 ft bgs			
Arsenic	35.4	mg/kg	
Chromium	37.6J	mg/kg	

SB-03-05

11/8/2006			
4 - 8 ft bgs			
Arsenic	24J	mg/kg	
Arsenic	54.5J	mg/kg	FD
Chromium	152J	mg/kg	
Chromium	227J	mg/kg	FD
28 - 32 ft bgs			
Arsenic	4.2	mg/kg	
Chromium	13.9	mg/kg	

SB-03-04

11/13/2006			
4 - 8 ft bgs			
Arsenic	34.1J	mg/kg	
Chromium	49.7J	mg/kg	
37 - 36 ft bgs			
Arsenic	4.7J	mg/kg	
Chromium	13.2J	mg/kg	

SB-03-01

12/1/2006			
4 - 8 ft bgs			
Arsenic	37.2	mg/kg	
Chromium	72.4J	mg/kg	
20 - 24 ft bgs			
Chromium	12.5J	mg/kg	

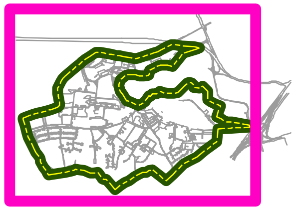
SB-03-02

12/6/2006			
4 - 8 ft bgs			
Arsenic	45.4	mg/kg	
Chromium	89.3J	mg/kg	
26 - 28 ft bgs			
Chromium	14.9J	mg/kg	

SB-03-03

10/20/2006			
4 - 8 ft bgs			
Arsenic	61.8	mg/kg	
Chromium	109	mg/kg	
Cobalt	37.7	mg/kg	
20 - 22 ft bgs			
Chromium	24.5	mg/kg	

Area Shown in Main Map



Legend

● Soil Sample Locations

▭ Installation Boundary

— Roads

FD = Field Duplicate
J = Estimated value
mg/kg = milligrams per kilogram
ft bgs = feet below ground surface
The criteria are USEPA Industrial Soil Regional Screening Level, June 2011
Note: Only results exceeding criteria are shown.
Exceedance results for sewer line and test pit soil samples are shown in Figure 5-2.

Source of base layers is Fort Buchanan.

Label Key

Locations With Exceedance of Criteria

Location Name
Sample Date
Analyte Result Qualifier Unit

N
W E
S

0 400
Meters

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Soil Sample Results Exceeding Criteria

Figure 5 -1

Fort Buchanan, Puerto Rico

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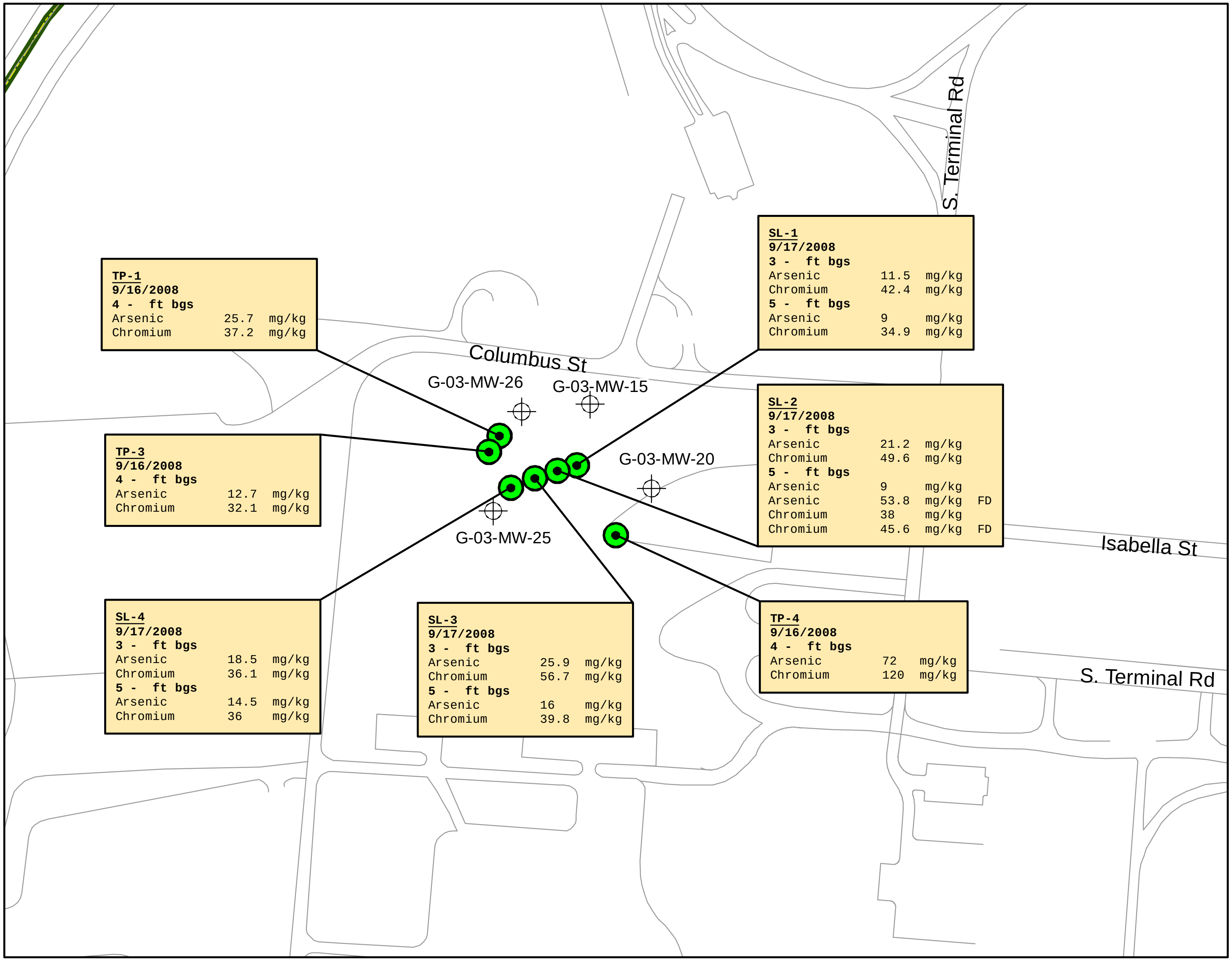


TP-1
9/16/2008
4 - ft bgs

Arsenic	25.7		mg/kg
Chromium	37.2		mg/kg

TP-3
9/16/2008
4 - ft bgs

Arsenic	12.7		mg/kg
Chromium	32.1		mg/kg

SL-4
9/17/2008
3 - ft bgs

Arsenic	18.5		mg/kg
Chromium	36.1		mg/kg

5 - ft bgs

Arsenic	14.5		mg/kg
Chromium	36		mg/kg

SL-3
9/17/2008
3 - ft bgs

Arsenic	25.9		mg/kg
Chromium	56.7		mg/kg

5 - ft bgs

Arsenic	16		mg/kg
Chromium	39.8		mg/kg

SL-1
9/17/2008
3 - ft bgs

Arsenic	11.5		mg/kg
Chromium	42.4		mg/kg

5 - ft bgs

Arsenic	9		mg/kg
Chromium	34.9		mg/kg

SL-2
9/17/2008
3 - ft bgs

Arsenic	21.2		mg/kg
Chromium	49.6		mg/kg

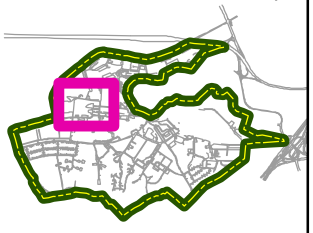
5 - ft bgs

Arsenic	9		mg/kg
Arsenic	53.8		mg/kg FD
Chromium	38		mg/kg
Chromium	45.6		mg/kg FD

TP-4
9/16/2008
4 - ft bgs

Arsenic	72		mg/kg
Chromium	120		mg/kg

Area Shown in Main Map



Legend

- ● Soil Sample Locations
- ⌖ Monitoring Wells
- ▭ Installation Boundary
- — Roads

FD = Field Duplicate
J = Estimated value
mg/kg = milligrams per kilogram
ft bgs = feet below ground surface

The criteria are USEPA Industrial Soil Regional Screening Level, June 2011
<u>Note: Only results exceeding criteria are shown.</u> **Exceedance results for other soil samples are shown in Figure 5-1.**

Source of base layers is Fort Buchanan.

Label Key

Locations With Exceedance of Criteria

Location Name
Sample Date
Analyte Result Qualifier Unit

N W E S

0 75

Meters

EA Engineering, Science, and Technology

Test Pit and Sewer Line Soil Sample Results Exceeding Criteria

Figure 5 - 2

Fort Buchanan, Puerto Rico

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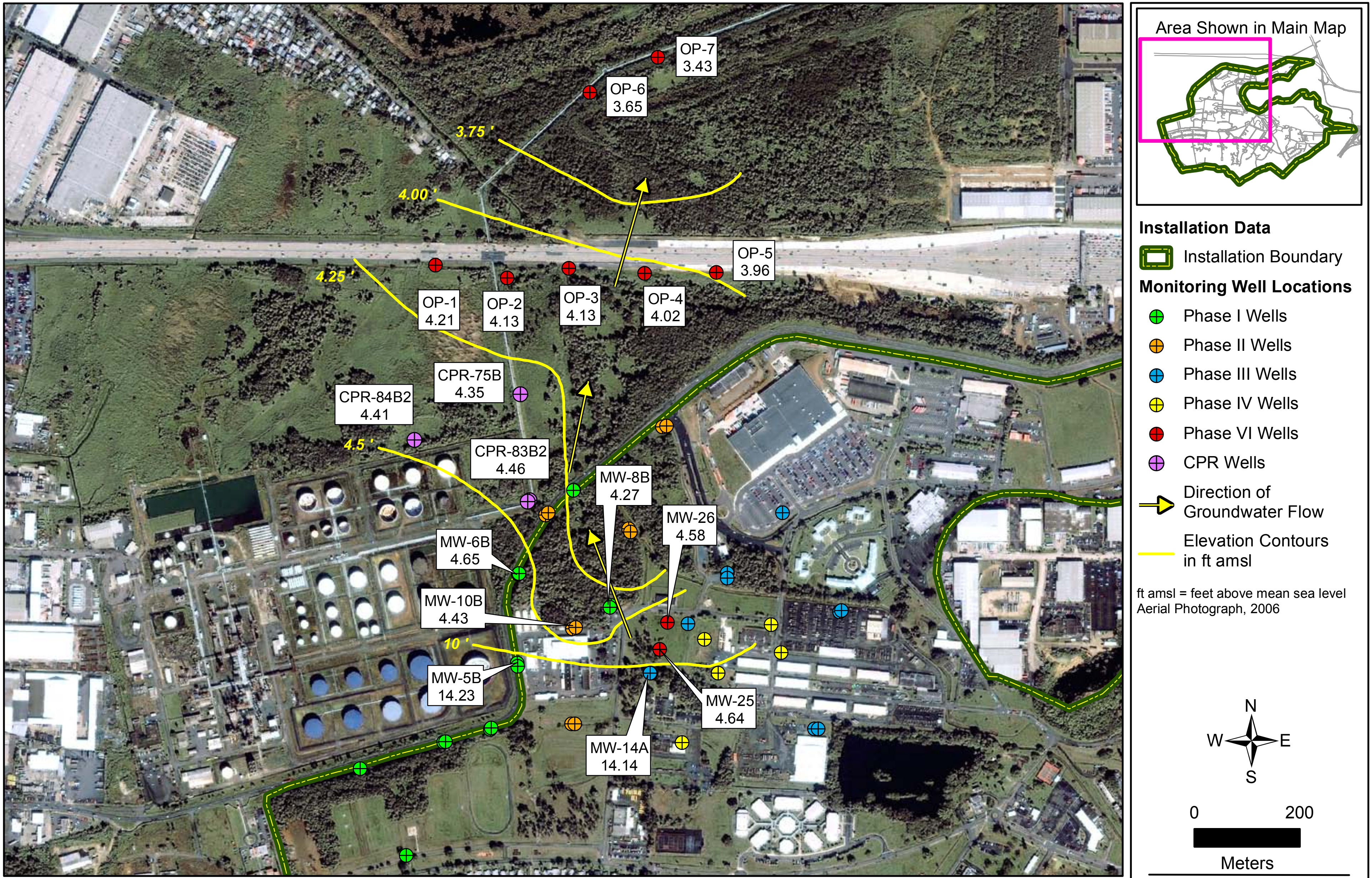

ft amsl = feet above mean sea level
Aerial Photograph, 2006

March 2009 Groundwater Elevations and Flow Direction

Figure 5-3

Fort Buchanan, Puerto Rico

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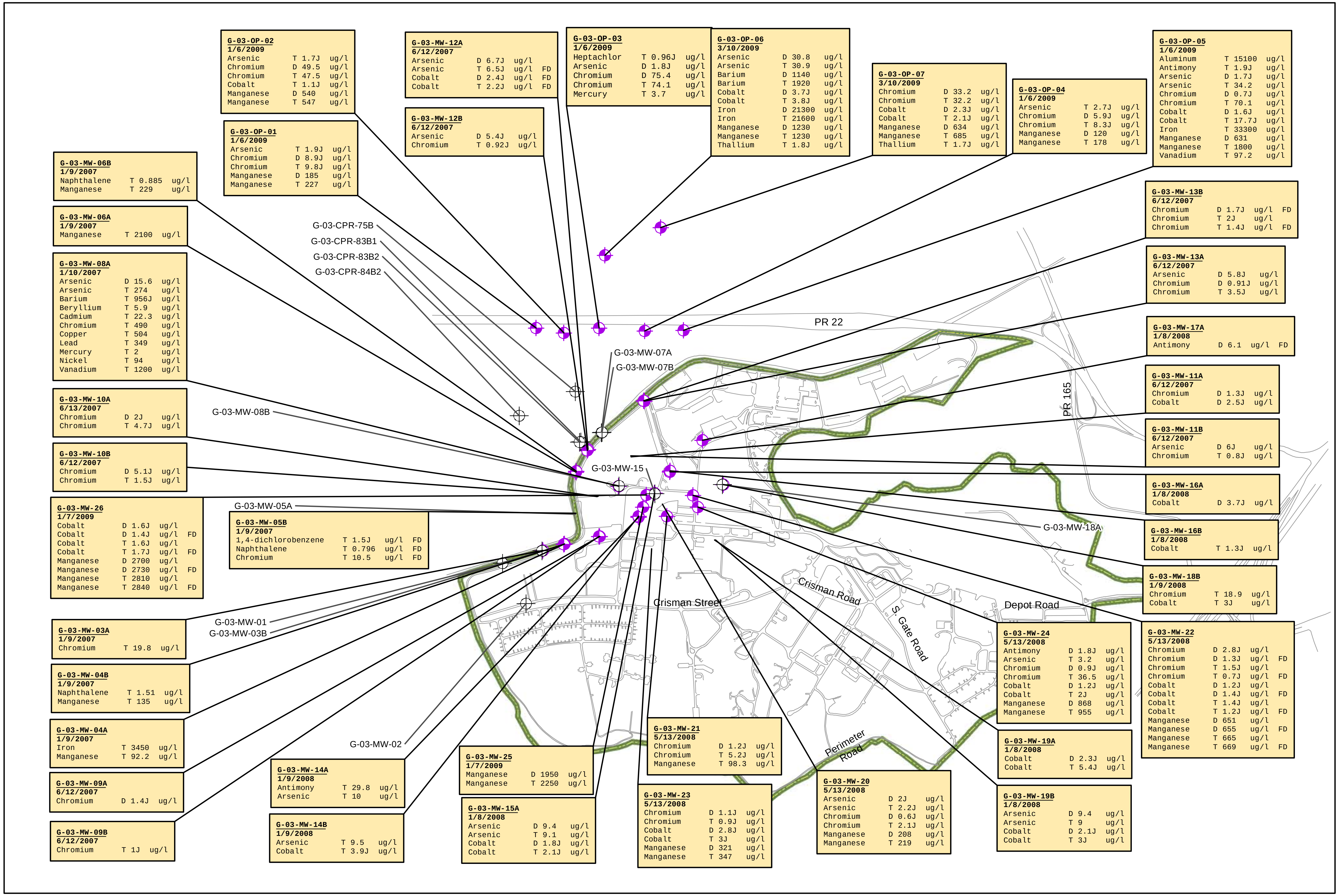
\\Edgewoodfp\Projects\Universal GIS\Buchanan\MXDs\Figure 5-10 March 2009 GW Elevations.mxd



G-03-OP-02
1/6/2009

Arsenic	T	1.7J	ug/l	
Chromium	D	49.5	ug/l	
Chromium	T	47.5	ug/l	
Cobalt	T	1.1J	ug/l	
Manganese	D	540	ug/l	
Manganese	T	547	ug/l	

G-03-OP-01
1/6/2009

Arsenic	T	1.9J	ug/l	
Chromium	D	8.9J	ug/l	
Chromium	T	9.8J	ug/l	
Manganese	D	185	ug/l	
Manganese	T	227	ug/l	

G-03-MW-12A
6/12/2007

Arsenic	D	6.7J	ug/l	
Arsenic	T	6.5J	ug/l	FD
Cobalt	D	2.4J	ug/l	FD
Cobalt	T	2.2J	ug/l	FD

G-03-MW-12B
6/12/2007

Arsenic	D	5.4J	ug/l	
Chromium	T	0.92J	ug/l	

G-03-OP-03
1/6/2009

Heptachlor	T	0.96J	ug/l	
Arsenic	D	1.8J	ug/l	
Chromium	D	75.4	ug/l	
Chromium	T	74.1	ug/l	
Mercury	T	3.7	ug/l	

G-03-OP-06
3/10/2009

Arsenic	D	30.8	ug/l	
Arsenic	T	30.9	ug/l	
Barium	D	1140	ug/l	
Barium	T	1920	ug/l	
Cobalt	D	3.7J	ug/l	
Cobalt	T	3.8J	ug/l	
Iron	D	21300	ug/l	
Iron	T	21600	ug/l	
Manganese	D	1230	ug/l	
Manganese	T	1230	ug/l	
Thallium	T	1.8J	ug/l	

G-03-OP-07
3/10/2009

Chromium	D	33.2	ug/l	
Chromium	T	32.2	ug/l	
Cobalt	D	2.3J	ug/l	
Cobalt	T	2.1J	ug/l	
Manganese	D	634	ug/l	
Manganese	T	685	ug/l	
Thallium	T	1.7J	ug/l	

G-03-OP-04
1/6/2009

Arsenic	T	2.7J	ug/l	
Chromium	D	5.9J	ug/l	
Chromium	T	8.3J	ug/l	
Manganese	D	120	ug/l	
Manganese	T	178	ug/l	

G-03-OP-05
1/6/2009

Aluminum	T	15100	ug/l	
Antimony	T	1.9J	ug/l	
Arsenic	D	1.7J	ug/l	
Arsenic	T	34.2	ug/l	
Chromium	D	0.7J	ug/l	
Chromium	T	70.1	ug/l	
Cobalt	D	1.6J	ug/l	
Cobalt	T	17.7J	ug/l	
Iron	T	33300	ug/l	
Manganese	D	631	ug/l	
Manganese	T	1800	ug/l	
Vanadium	T	97.2	ug/l	

G-03-MW-06B
1/9/2007

Naphthalene	T	0.885	ug/l	
Manganese	T	229	ug/l	

G-03-MW-06A
1/9/2007

Manganese	T	2100	ug/l	

G-03-MW-08A
1/10/2007

Arsenic	D	15.6	ug/l	
Arsenic	T	274	ug/l	
Barium	T	956J	ug/l	
Beryllium	T	5.9	ug/l	
Cadmium	T	22.3	ug/l	
Chromium	T	490	ug/l	
Copper	T	504	ug/l	
Lead	T	349	ug/l	
Mercury	T	2	ug/l	
Nickel	T	94	ug/l	
Vanadium	T	1200	ug/l	

G-03-MW-10A
6/13/2007

Chromium	D	2J	ug/l	
Chromium	T	4.7J	ug/l	

G-03-MW-10B
6/12/2007

Chromium	D	5.1J	ug/l	
Chromium	T	1.5J	ug/l	

G-03-MW-26
1/7/2009

Cobalt	D	1.6J	ug/l	
Cobalt	D	1.4J	ug/l	FD
Cobalt	T	1.6J	ug/l	
Cobalt	T	1.7J	ug/l	FD
Manganese	D	2700	ug/l	
Manganese	D	2730	ug/l	FD
Manganese	T	2810	ug/l	
Manganese	T	2840	ug/l	FD

G-03-MW-05B
1/9/2007

1,4-dichlorobenzene	T	1.5J	ug/l	FD
Naphthalene	T	0.796	ug/l	FD
Chromium	T	10.5	ug/l	FD

G-03-MW-03A
1/9/2007

Chromium	T	19.8	ug/l	

G-03-MW-04B
1/9/2007

Naphthalene	T	1.51	ug/l	
Manganese	T	135	ug/l	

G-03-MW-04A
1/9/2007

Iron	T	3450	ug/l	
Manganese	T	92.2	ug/l	

G-03-MW-09A
6/12/2007

Chromium	D	1.4J	ug/l	

G-03-MW-09B
6/12/2007

Chromium	T	1J	ug/l	

G-03-MW-14A
1/9/2008

Antimony	T	29.8	ug/l	
Arsenic	T	10	ug/l	

G-03-MW-14B
1/9/2008

Arsenic	T	9.5	ug/l	
Cobalt	T	3.9J	ug/l	

G-03-MW-25
1/7/2009

Manganese	D	1950	ug/l	
Manganese	T	2250	ug/l	

G-03-MW-15A
1/8/2008

Arsenic	D	9.4	ug/l	
Arsenic	T	9.1	ug/l	
Cobalt	D	1.8J	ug/l	
Cobalt	T	2.1J	ug/l	

G-03-MW-21
5/13/2008

Chromium	D	1.2J	ug/l	
Chromium	T	5.2J	ug/l	
Manganese	T	98.3	ug/l	

G-03-MW-23
5/13/2008

Chromium	D	1.1J	ug/l	
Chromium	T	0.9J	ug/l	
Cobalt	D	2.8J	ug/l	
Cobalt	T	3J	ug/l	
Manganese	D	321	ug/l	
Manganese	T	347	ug/l	

G-03-MW-20
5/13/2008

Arsenic	D	2J	ug/l	
Arsenic	T	2.2J	ug/l	
Chromium	D	0.6J	ug/l	
Chromium	T	2.1J	ug/l	
Manganese	D	208	ug/l	
Manganese	T	219	ug/l	

G-03-MW-24
5/13/2008

Antimony	D	1.8J	ug/l	
Arsenic	T	3.2	ug/l	
Chromium	D	0.9J	ug/l	
Chromium	T	36.5	ug/l	
Cobalt	D	1.2J	ug/l	
Cobalt	T	2J	ug/l	
Manganese	D	868	ug/l	
Manganese	T	955	ug/l	

G-03-MW-19A
1/8/2008

Cobalt	D	2.3J	ug/l	
Cobalt	T	5.4J	ug/l	

G-03-MW-19B
1/8/2008

Arsenic	D	9.4	ug/l	
Arsenic	T	9	ug/l	
Cobalt	D	2.1J	ug/l	
Cobalt	T	3J	ug/l	

G-03-MW-13B
6/12/2007

Chromium	D	1.7J	ug/l	FD
Chromium	T	2J	ug/l	
Chromium	T	1.4J	ug/l	FD

G-03-MW-13A
6/12/2007

Arsenic	D	5.8J	ug/l	
Chromium	D	0.91J	ug/l	
Chromium	T	3.5J	ug/l	

G-03-MW-17A
1/8/2008

Antimony	D	6.1	ug/l	FD

G-03-MW-11A
6/12/2007

Chromium	D	1.3J	ug/l	
Cobalt	D	2.5J	ug/l	

G-03-MW-11B
6/12/2007

Arsenic	D	6J	ug/l	
Chromium	T	0.8J	ug/l	

G-03-MW-16A
1/8/2008

Cobalt	D	3.7J	ug/l	

G-03-MW-16B
1/8/2008

Cobalt	T	1.3J	ug/l	

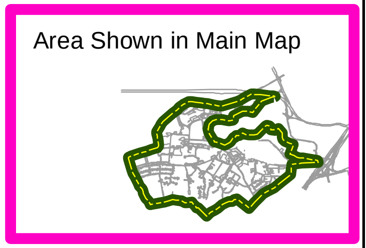
G-03-MW-18B
1/9/2008

Chromium	T	18.9	ug/l	
Cobalt	T	3J	ug/l	

G-03-MW-22
5/13/2008

Chromium	D	2.8J	ug/l	
Chromium	D	1.3J	ug/l	FD
Chromium	T	1.5J	ug/l	
Chromium	T	0.7J	ug/l	FD
Cobalt	D	1.2J	ug/l	
Cobalt	D	1.4J	ug/l	FD
Cobalt	T	1.4J	ug/l	
Cobalt	T	1.2J	ug/l	FD
Manganese	D	651	ug/l	
Manganese	D	655	ug/l	FD
Manganese	T	665	ug/l	
Manganese	T	669	ug/l	FD

Area Shown in Main Map



Legend

- ⌖ Monitoring Wells With Excedance of Criteria
- ⌖ Monitoring Wells With No Exccedance of Criteria
- ─ Roads
- 🟩 Installation Boundary

FD = Field Duplicate
J = Estimated value
ug/l = micrograms per liter
T = Total Fraction
D = Disolved Fraction
The criteria used were the lesser of the USEPA Tapwater Regional Screening Level, June 2011 and the MCL.
Note: Only results exceeding criteria are shown.
Exceedance results for Volatile Organic Compounds are shown in Figure 5 - 3.

Source of base layers is Fort Buchanan.

Label Key

Locations With Exceedance of Criteria

Location Name
Sample Date
Analyte Fraction Result Qualifier Unit

Locations With No Exceedance of Criteria

Location Name

N
W E
S
0 400
Meters

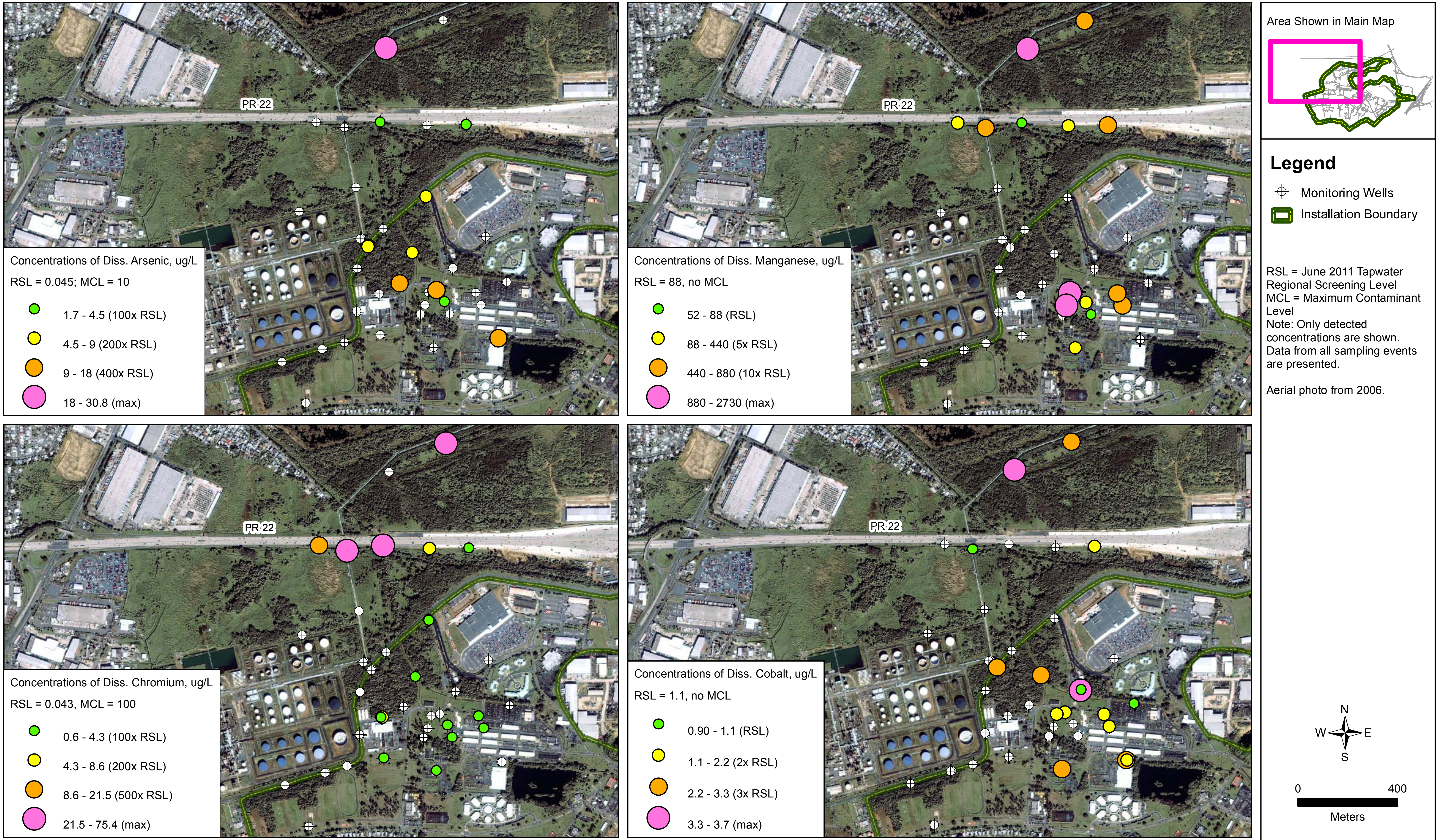
Monitoring Well Semivolatile Organic Compound, Metals, and Pesticide Results Exceeding Criteria

Figure 5 - 4

Fort Buchanan, Puerto Rico

EA Engineering, Science, and Technology, Inc.

\\LOVETONFEDERAL\GISData\PuertoRico\FtBuchanan\MXD\GWResultsOther.mxd



RSL = June 2011 Tapwater Regional Screening Level

MCL = Maximum Contaminant Level

Note: Only detected concentrations are shown. Data from all sampling events are presented.

Aerial photo from 2006.

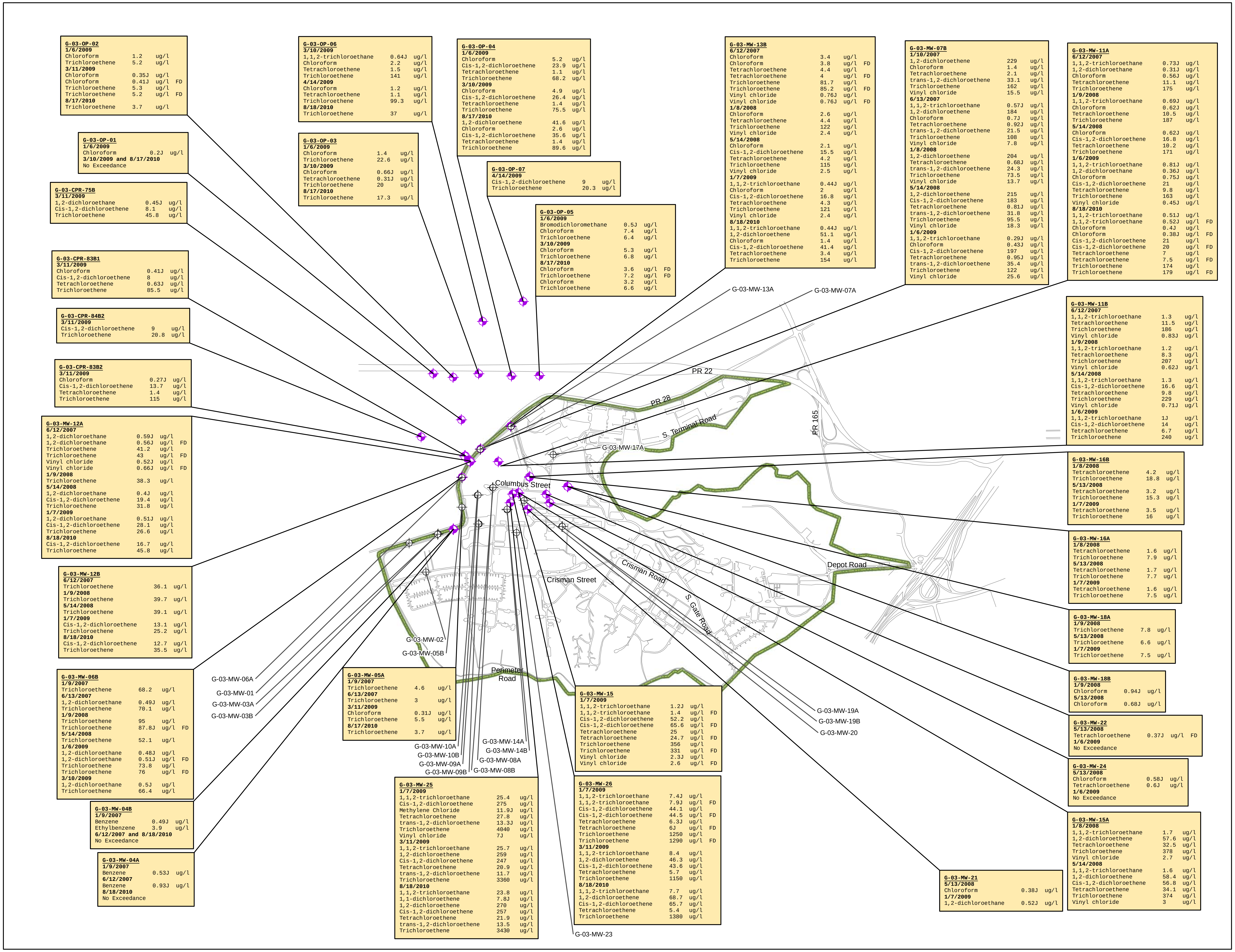
Relative Concentrations of Arsenic, Chromium, Cobalt, and Manganese in Groundwater Samples

Figure 5 - 5

Fort Buchanan, Puerto Rico

EA Engineering, Science, and Technology, Inc.

\\Edgewood\Projects\Universal GIS\Buchanan\MXDs\NWB_Metals_WG.mxd



G-03-OP-02

1/6/2009			
Chloroform	1.2	ug/l	
Trichloroethene	5.2	ug/l	
3/11/2009			
Chloroform	0.35J	ug/l	
Chloroform	0.41J	ug/l	FD
Trichloroethene	5.3	ug/l	
Trichloroethene	5.2	ug/l	FD
8/17/2010			
Trichloroethene	3.7	ug/l	

G-03-OP-01

1/6/2009		
Chloroform	0.2J	ug/l
3/10/2009 and 8/17/2010		
No Exceedance		

G-03-CPR-75B

3/11/2009		
1,2-dichloroethane	0.45J	ug/l
Cis-1,2-dichloroethene	8.1	ug/l
Trichloroethene	45.8	ug/l

G-03-CPR-83B1

3/11/2009		
Chloroform	0.41J	ug/l
Cis-1,2-dichloroethene	8	ug/l
Tetrachloroethene	0.63J	ug/l
Trichloroethene	85.5	ug/l

G-03-CPR-84B2

3/11/2009		
Cis-1,2-dichloroethene	9	ug/l
Trichloroethene	20.8	ug/l

G-03-CPR-83B2

3/11/2009		
Chloroform	0.27J	ug/l
Cis-1,2-dichloroethene	13.7	ug/l
Tetrachloroethene	1.4	ug/l
Trichloroethene	115	ug/l

G-03-MW-12A

6/12/2007			
1,2-dichloroethane	0.59J	ug/l	
1,2-dichloroethane	0.56J	ug/l	FD
Trichloroethene	41.2	ug/l	
Trichloroethene	43	ug/l	FD
Vinyl chloride	0.52J	ug/l	
Vinyl chloride	0.66J	ug/l	FD
1/9/2008			
Trichloroethene	38.3	ug/l	
5/14/2008			
1,2-dichloroethane	0.4J	ug/l	
Cis-1,2-dichloroethene	19.4	ug/l	
Trichloroethene	31.8	ug/l	
1/7/2009			
1,2-dichloroethane	0.51J	ug/l	
Cis-1,2-dichloroethene	28.1	ug/l	
Trichloroethene	26.6	ug/l	
8/18/2010			
Cis-1,2-dichloroethene	16.7	ug/l	
Trichloroethene	45.8	ug/l	

G-03-MW-12B

6/12/2007		
Trichloroethene	36.1	ug/l
1/9/2008		
Trichloroethene	39.7	ug/l
5/14/2008		
Trichloroethene	39.1	ug/l
1/7/2009		
Cis-1,2-dichloroethene	13.1	ug/l
Trichloroethene	25.2	ug/l
8/18/2010		
Cis-1,2-dichloroethene	12.7	ug/l
Trichloroethene	35.5	ug/l

G-03-MW-06B

1/9/2007			
Trichloroethene	68.2	ug/l	
6/13/2007			
1,2-dichloroethane	0.49J	ug/l	
Trichloroethene	70.1	ug/l	
1/9/2008			
Trichloroethene	95	ug/l	
Trichloroethene	87.8J	ug/l	FD
5/14/2008			
Trichloroethene	52.1	ug/l	
1/6/2009			
1,2-dichloroethane	0.48J	ug/l	
1,2-dichloroethane	0.51J	ug/l	FD
Trichloroethene	73.8	ug/l	
Trichloroethene	76	ug/l	FD
3/10/2009			
1,2-dichloroethane	0.5J	ug/l	
Trichloroethene	66.4	ug/l	

G-03-MW-04B

1/9/2007		
Benzene	0.49J	ug/l
Ethylbenzene	3.9	ug/l
6/12/2007 and 8/18/2010		
No Exceedance		

G-03-MW-04A

1/9/2007		
Benzene	0.53J	ug/l
6/12/2007		
Benzene	0.93J	ug/l
8/18/2010		
No Exceedance		

G-03-OP-06

3/10/2009		
1,1,2-trichloroethane	0.64J	ug/l
Chloroform	2.2	ug/l
Tetrachloroethene	1.5	ug/l
Trichloroethene	141	ug/l
4/14/2009		
Chloroform	1.2	ug/l
Tetrachloroethene	1.1	ug/l
Trichloroethene	99.3	ug/l
8/18/2010		
Trichloroethene	37	ug/l

G-03-OP-03

1/6/2009		
Chloroform	1.4	ug/l
Trichloroethene	22.6	ug/l
3/10/2009		
Chloroform	0.66J	ug/l
Tetrachloroethene	0.31J	ug/l
Trichloroethene	20	ug/l
8/17/2010		
Trichloroethene	17.3	ug/l

G-03-OP-04

1/6/2009		
Chloroform	5.2	ug/l
Cis-1,2-dichloroethene	23.9	ug/l
Tetrachloroethene	1.1	ug/l
Trichloroethene	68.2	ug/l
3/10/2009		
Chloroform	4.9	ug/l
Cis-1,2-dichloroethene	26.4	ug/l
Tetrachloroethene	1.4	ug/l
Trichloroethene	75.5	ug/l
8/17/2010		
1,2-dichloroethene	41.6	ug/l
Chloroform	2.6	ug/l
Cis-1,2-dichloroethene	35.6	ug/l
Tetrachloroethene	1.4	ug/l
Trichloroethene	89.6	ug/l

G-03-OP-07

4/14/2009		
Cis-1,2-dichloroethene	9	ug/l
Trichloroethene	20.3	ug/l

G-03-OP-05

1/6/2009			
Bromodichloromethane	0.5J	ug/l	
Chloroform	7.4	ug/l	
Trichloroethene	6.4	ug/l	
3/10/2009			
Chloroform	5.3	ug/l	
Trichloroethene	6.8	ug/l	
8/17/2010			
Chloroform	3.6	ug/l	FD
Trichloroethene	7.2	ug/l	FD
Chloroform	3.2	ug/l	
Trichloroethene	6.6	ug/l	

G-03-MW-13B

6/12/2007			
Chloroform	3.4	ug/l	
Chloroform	3.8	ug/l	FD
Tetrachloroethene	4.4	ug/l	
Tetrachloroethene	4	ug/l	FD
Trichloroethene	81.7	ug/l	
Trichloroethene	85.2	ug/l	FD
Vinyl chloride	0.76J	ug/l	
Vinyl chloride	0.76J	ug/l	FD
1/8/2008			
Chloroform	2.6	ug/l	
Tetrachloroethene	4.4	ug/l	
Trichloroethene	122	ug/l	
Vinyl chloride	2.4	ug/l	
5/14/2008			
Chloroform	2.1	ug/l	
Cis-1,2-dichloroethene	15.5	ug/l	
Tetrachloroethene	4.2	ug/l	
Trichloroethene	115	ug/l	
Vinyl chloride	2.5	ug/l	
1/7/2009			
1,1,2-trichloroethane	0.44J	ug/l	
Chloroform	2	ug/l	
Cis-1,2-dichloroethene	16.8	ug/l	
Tetrachloroethene	4.3	ug/l	
Trichloroethene	121	ug/l	
Vinyl chloride	2.4	ug/l	
8/18/2010			
1,1,2-trichloroethane	0.44J	ug/l	
1,2-dichloroethene	51.1	ug/l	
Chloroform	1.4	ug/l	
Cis-1,2-dichloroethene	41.4	ug/l	
Tetrachloroethene	3.4	ug/l	
Trichloroethene	154	ug/l	

G-03-MW-07B

1/10/2007		
1,2-dichloroethene	229	ug/l
Chloroform	1.4	ug/l
Tetrachloroethene	2.1	ug/l
trans-1,2-dichloroethene	33.1	ug/l
Trichloroethene	162	ug/l
Vinyl chloride	15.5	ug/l
6/13/2007		
1,1,2-trichloroethane	0.57J	ug/l
1,2-dichloroethene	184	ug/l
Chloroform	0.7J	ug/l
Tetrachloroethene	0.92J	ug/l
trans-1,2-dichloroethene	21.5	ug/l
Trichloroethene	108	ug/l
Vinyl chloride	7.8	ug/l
1/8/2008		
1,2-dichloroethene	204	ug/l
Tetrachloroethene	0.68J	ug/l
trans-1,2-dichloroethene	24.3	ug/l
Trichloroethene	73.5	ug/l
Vinyl chloride	13.7	ug/l
5/14/2008		
1,2-dichloroethene	215	ug/l
Cis-1,2-dichloroethene	183	ug/l
Tetrachloroethene	0.81J	ug/l
trans-1,2-dichloroethene	31.8	ug/l
Trichloroethene	95.5	ug/l
Vinyl chloride	18.3	ug/l
1/6/2009		
1,1,2-trichloroethane	0.29J	ug/l
Chloroform	0.43J	ug/l
Cis-1,2-dichloroethene	197	ug/l
Tetrachloroethene	0.95J	ug/l
trans-1,2-dichloroethene	35.4	ug/l
Trichloroethene	122	ug/l
Vinyl chloride	25.6	ug/l

G-03-MW-11A

6/12/2007			
1,1,2-trichloroethane	0.73J	ug/l	
1,2-dichloroethane	0.31J	ug/l	
Chloroform	0.56J	ug/l	
Tetrachloroethene	11.1	ug/l	
Trichloroethene	175	ug/l	
1/9/2008			
1,1,2-trichloroethane	0.69J	ug/l	
Chloroform	0.62J	ug/l	
Tetrachloroethene	10.5	ug/l	
Trichloroethene	187	ug/l	
5/14/2008			
Chloroform	0.62J	ug/l	
Cis-1,2-dichloroethene	16.8	ug/l	
Tetrachloroethene	10.2	ug/l	
Trichloroethene	171	ug/l	
1/6/2009			
1,1,2-trichloroethane	0.81J	ug/l	
1,2-dichloroethane	0.36J	ug/l	
Chloroform	0.75J	ug/l	
Cis-1,2-dichloroethene	21	ug/l	
Tetrachloroethene	9.8	ug/l	
Trichloroethene	163	ug/l	
Vinyl chloride	0.45J	ug/l	
8/18/2010			
1,1,2-trichloroethane	0.51J	ug/l	
1,1,2-trichloroethane	0.52J	ug/l	FD
Chloroform	0.4J	ug/l	
Chloroform	0.38J	ug/l	FD
Cis-1,2-dichloroethene	21	ug/l	
Cis-1,2-dichloroethene	20	ug/l	FD
Tetrachloroethene	7	ug/l	
Tetrachloroethene	7.5	ug/l	FD
Trichloroethene	174	ug/l	
Trichloroethene	179	ug/l	FD

G-03-MW-11B

6/12/2007		
1,1,2-trichloroethane	1.3	ug/l
Tetrachloroethene	11.5	ug/l
Trichloroethene	186	ug/l
Vinyl chloride	0.83J	ug/l
1/9/2008		
1,1,2-trichloroethane	1.2	ug/l
Tetrachloroethene	8.3	ug/l
Trichloroethene	207	ug/l
Vinyl chloride	0.62J	ug/l
5/14/2008		
1,1,2-trichloroethane	1.3	ug/l
Cis-1,2-dichloroethene	16.6	ug/l
Tetrachloroethene	9.8	ug/l
Trichloroethene	229	ug/l
Vinyl chloride	0.71J	ug/l
1/6/2009		
1,1,2-trichloroethane	1J	ug/l
Cis-1,2-dichloroethene	14	ug/l
Tetrachloroethene	6.7	ug/l
Trichloroethene	240	ug/l

G-03-MW-16B

1/8/2008		
Tetrachloroethene	4.2	ug/l
Trichloroethene	18.8	ug/l
5/13/2008		
Tetrachloroethene	3.2	ug/l
Trichloroethene	15.3	ug/l
1/7/2009		
Tetrachloroethene	3.5	ug/l
Trichloroethene	16	ug/l

G-03-MW-16A

1/8/2008		
Tetrachloroethene	1.6	ug/l
Trichloroethene	7.9	ug/l
5/13/2008		
Tetrachloroethene	1.7	ug/l
Trichloroethene	7.7	ug/l
1/7/2009		
Tetrachloroethene	1.6	ug/l
Trichloroethene	7.5	ug/l

G-03-MW-18A

1/9/2008		
Trichloroethene	7.8	ug/l
5/13/2008		
Trichloroethene	6.6	ug/l
1/7/2009		
Trichloroethene	7.5	ug/l

G-03-MW-18B

1/9/2008		
Chloroform	0.94J	ug/l
5/13/2008		
Chloroform	0.68J	ug/l

G-03-MW-22

5/13/2008			
Tetrachloroethene	0.37J	ug/l	FD
1/6/2009			
No Exceedance			

G-03-MW-24

5/13/2008		
Chloroform	0.58J	ug/l
Tetrachloroethene	0.6J	ug/l
1/6/2009		
No Exceedance		

G-03-MW-15A

1/8/2008		
1,1,2-trichloroethane	1.7	ug/l
1,2-dichloroethene	57.6	ug/l
Tetrachloroethene	32.5	ug/l
Trichloroethene	378	ug/l
Vinyl chloride	2.7	ug/l
5/14/2008		
1,1,2-trichloroethane	1.6	ug/l
1,2-dichloroethene	58.4	ug/l
Cis-1,2-dichloroethene	56.8	ug/l
Tetrachloroethene	34.1	ug/l
Trichloroethene	374	ug/l
Vinyl chloride	3	ug/l

G-03-MW-21

5/13/2008		
Chloroform	0.38J	ug/l
1/7/2009		
1,2-dichloroethane	0.52J	ug/l

G-03-MW-05A

1/9/2007		
Trichloroethene	4.6	ug/l
6/13/2007		
Trichloroethene	3	ug/l
3/11/2009		
Chloroform	0.31J	ug/l
Trichloroethene	5.5	ug/l
8/17/2010		
Trichloroethene	3.7	ug/l

G-03-MW-15

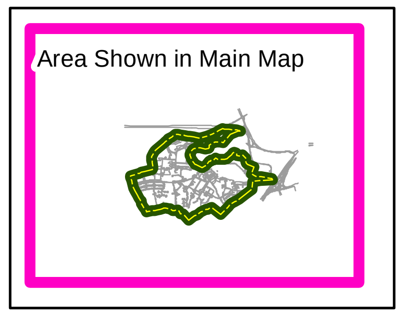
1/7/2009			
1,1,2-trichloroethane	1.2J	ug/l	
1,1,2-trichloroethane	1.4	ug/l	FD
Cis-1,2-dichloroethene	52.2	ug/l	
Cis-1,2-dichloroethene	65.6	ug/l	FD
Tetrachloroethene	25	ug/l	
Tetrachloroethene	24.7	ug/l	FD
Trichloroethene	356	ug/l	
Trichloroethene	331	ug/l	FD
Vinyl chloride	2.3J	ug/l	
Vinyl chloride	2.6	ug/l	FD

G-03-MW-25

1/7/2009		
1,1,2-trichloroethane	25.4	ug/l
Cis-1,2-dichloroethene	275	ug/l
Methylene Chloride	11.9J	ug/l
Tetrachloroethene	27.8	ug/l
trans-1,2-dichloroethene	13.3J	ug/l
Trichloroethene	4040	ug/l
Vinyl chloride	7J	ug/l
3/11/2009		
1,1,2-trichloroethane	25.7	ug/l
1,2-dichloroethene	259	ug/l
Cis-1,2-dichloroethene	247	ug/l
Tetrachloroethene	20.9	ug/l
trans-1,2-dichloroethene	11.7	ug/l
Trichloroethene	3360	ug/l
8/18/2010		
1,1,2-trichloroethane	23.8	ug/l
1,1-dichloroethene	7.8J	ug/l
1,2-dichloroethene	270	ug/l
Cis-1,2-dichloroethene	257	ug/l
Tetrachloroethene	21.9	ug/l
trans-1,2-dichloroethene	13.5	ug/l
Trichloroethene	3430	ug/l

G-03-MW-26

1/7/2009			
1,1,2-trichloroethane	7.4J	ug/l	
1,1,2-trichloroethane	7.9J	ug/l	FD
Cis-1,2-dichloroethene	44.1	ug/l	
Cis-1,2-dichloroethene	44.5	ug/l	FD
Tetrachloroethene	6.3J	ug/l	
Tetrachloroethene	6J	ug/l	FD
Trichloroethene	1250	ug/l	
Trichloroethene	1290	ug/l	FD
3/11/2009			
1,1,2-trichloroethane	8.4	ug/l	
1,2-dichloroethene	46.3	ug/l	
Cis-1,2-dichloroethene	43.6	ug/l	
Tetrachloroethene	5.7	ug/l	
Trichloroethene	1150	ug/l	
8/18/2010			
1,1,2-trichloroethane	7.7	ug/l	
1,2-dichloroethene	68.7	ug/l	
Cis-1,2-dichloroethene	65.7	ug/l	
Tetrachloroethene	5.4	ug/l	
Trichloroethene	1380	ug/l	



Legend

- Monitoring Wells With Exccedance of VOC Criteria
- Monitoring Wells With No Exceedance of VOC Criteria
- Roads
- 🟩 Installation Boundary

VOC = Volatile Organic Compound
FD = Field Duplicate
J = Estimated value
ug/l = micrograms per liter
The criteria used were the lesser of the USEPA Tapwater Regional Screening Level, June 2011 and the MCL.
<u>Note: Only results exceeding criteria are shown</u>. Exceedance results for other analyte groups are shown in Figure 5 - 4.

Source of base layers is Fort Buchanan.

Label Key

Locations With Exceedance of VOC Criteria

Location Name
Sample Date
Analyte Result Qualifier Unit

Locations With No Exceedance of VOC Criteria

Location Name

N
W E
S

0 400
Meters

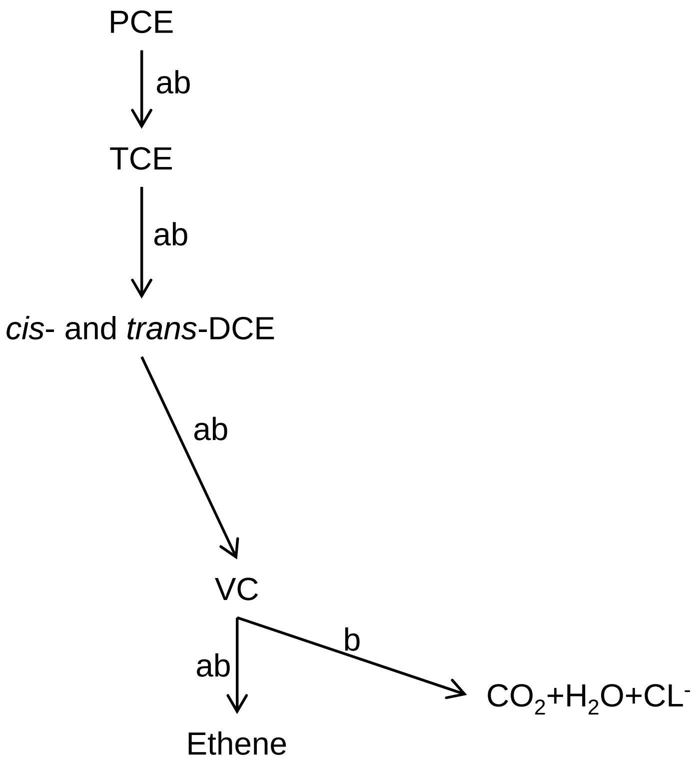
\\LOVETONFEDERAL\GIS\Data\PuertoRico\FtBuchanan\MXD\GWResultsVOC.mxd

Monitoring Well Volatile Organic Compound Results Exceeding Criteria

Figure 5 - 6

Fort Buchanan, Puerto Rico

EA Engineering, Science, and Technology, Inc.



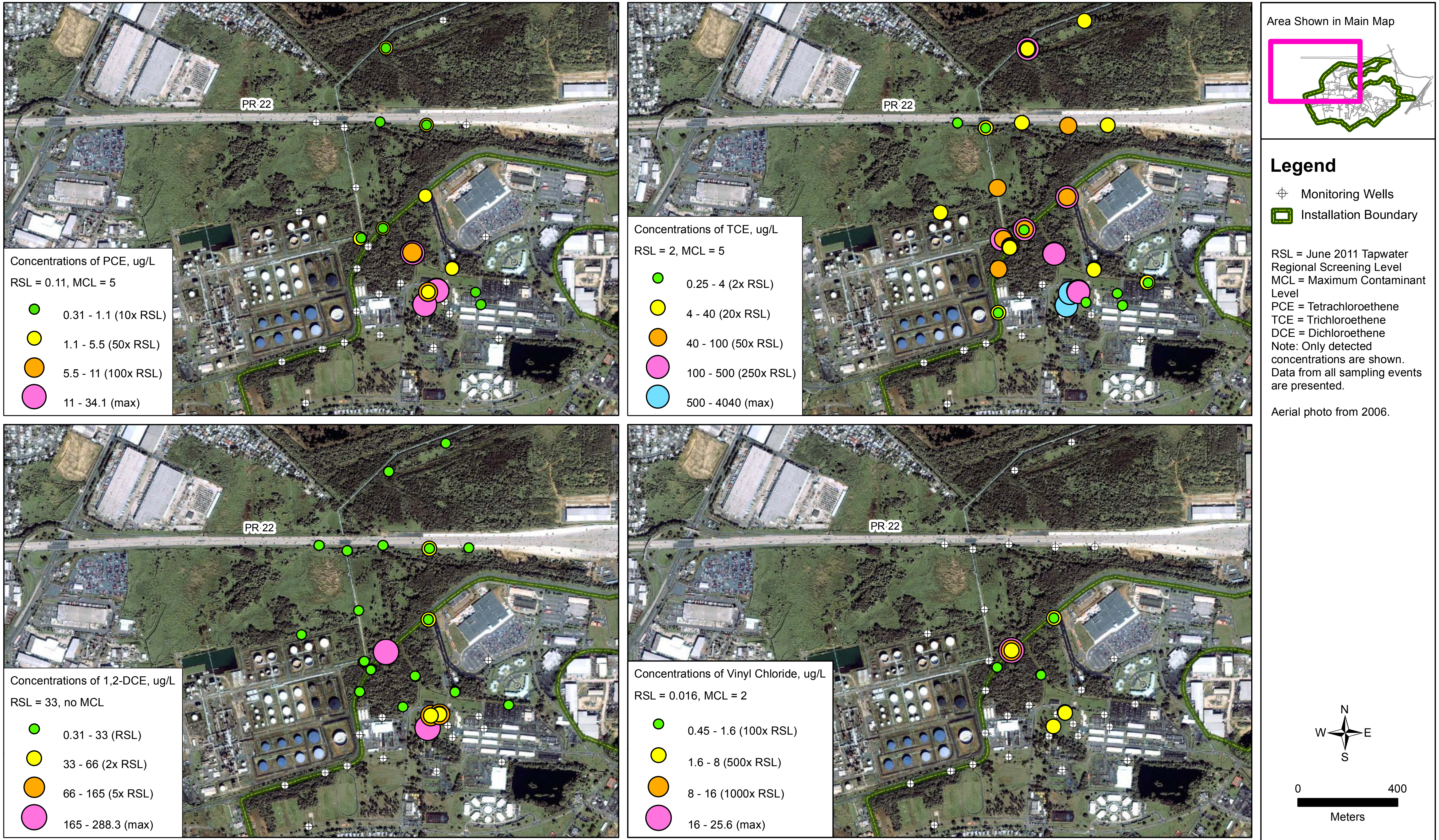
DCE = Dichloroethene
TCE = Trichloroethene
VC = Vinyl Chloride
a = abiotic transformation
ab = abiotic & biological transformation
b = biological transformation

Breakdown Pathway for Tetrachloroethene

Figure 5-7

Fort Buchanan, Puerto Rico

EA Engineering, Science, and Technology



RSL = June 2011 Tapwater Regional Screening Level
MCL = Maximum Contaminant Level
PCE = Tetrachloroethene
TCE = Trichloroethene
DCE = Dichloroethene
Note: Only detected concentrations are shown. Data from all sampling events are presented.

Aerial photo from 2006.

Relative Concentrations of Tetrachloroethene and Its Degradation Products

Figure 5 - 8

Fort Buchanan, Puerto Rico

EA Engineering, Science, and Technology, Inc.

\Edgewood\Projects\Universal GIS\Buchanan\NWB_PCE-TCE_WG.mxd

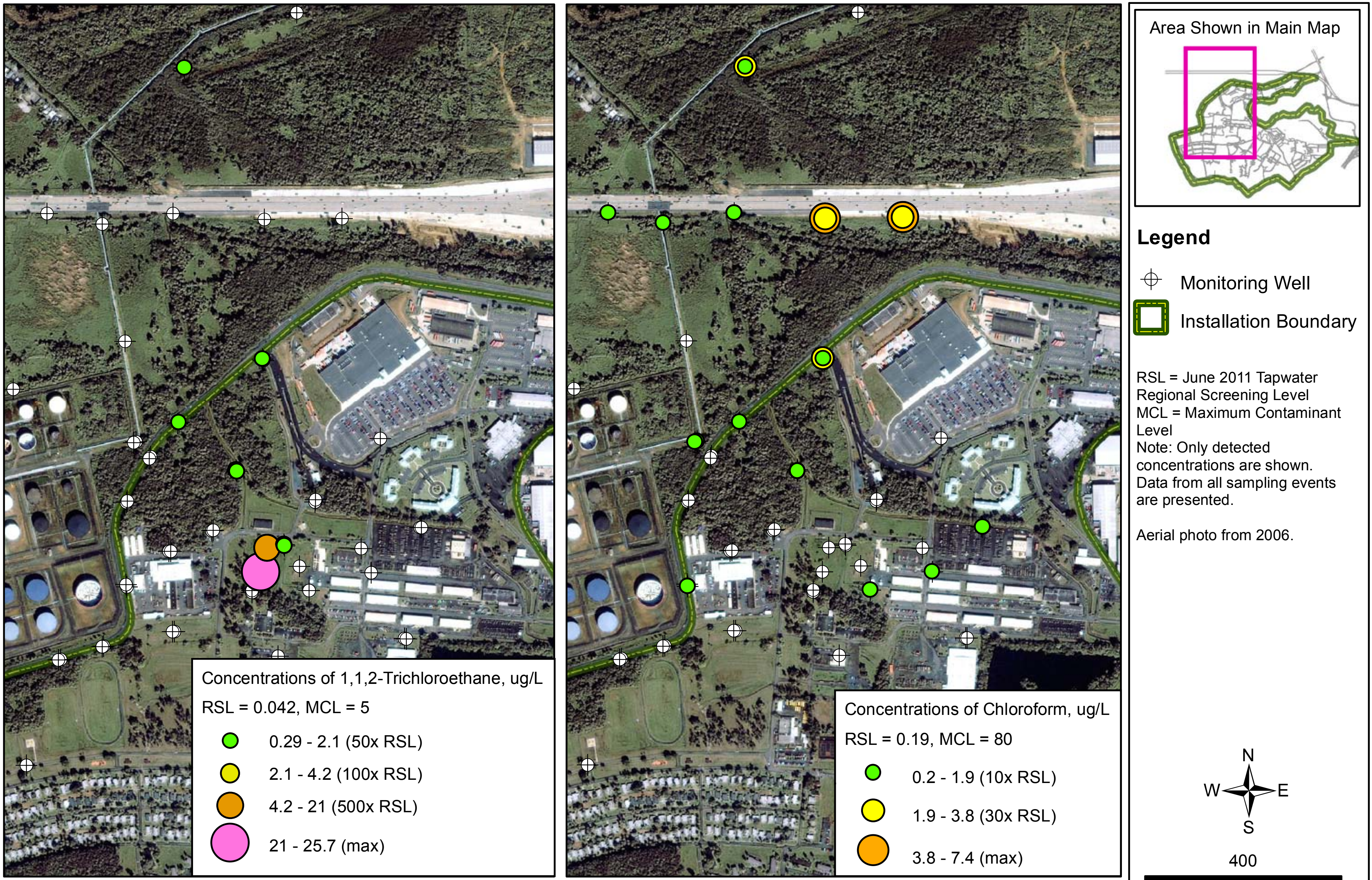
March 2009 TCE Isoconcentrations

Figure 5-9

Fort Buchanan, Puerto Rico

EA Engineering, Science, and Technology

\\Edgewoodfp\Projects\Universal GIS\Buchanan\MXDs\Figure 4-8 March 2009 TCE Isoconcentrations.mxd



RSL = June 2011 Tapwater Regional Screening Level

MCL = Maximum Contaminant Level

Note: Only detected concentrations are shown. Data from all sampling events are presented.

Aerial photo from 2006.

EA Engineering, Science, and Technology

Relative Concentrations of
1,1,2-Trichloroethene and Chloroform

Figure 5-10

Fort Buchanan, Puerto Rico

\\Edgewood\Projects\Universal GIS\Buchanan\MXDs\NWB_TeCA_Chloroform_WG.mxd

6 CONTAMINANT TRANSPORT AND FATE

The data indicate that some elevated concentrations of metals and organics are present in the groundwater. However, the data indicate that the primary constituents of concern (COCs) are PCE and TCE, and to a lesser extent 1,2-DCE and vinyl chloride. Therefore the following discussion focuses on the transport and fate of these chlorinated VOCs.

6.1 PHYSICAL AND CHEMICAL PROPERTIES

The physical and chemical properties of organic and inorganic compounds determine how they interact with various environmental media and ultimately influence their transport and fate. Some of the more important properties influencing contaminant-media interactions include: specific gravity, vapor pressure, water solubility, Henry's Law Constant, and the distribution coefficient.

Specific gravity is the ratio of a compound's density to the density of water. Therefore, compounds that are less dense than water have specific gravities less than one, and compounds that are denser than water have specific gravities greater than one. Vapor pressure is defined as the pressure of the vapor of a compound at equilibrium with its pure condensed phase, and is a measure of a compound's tendency to volatilize (i.e., compounds with higher vapor pressures will volatilize more readily than those with relatively lower vapor pressures). Water solubility is a measure of a compound's tendency to dissolve into water and is generally defined as the mass of compound present in a unit volume of water in equilibrium with the pure phase. Henry's Law Constant is often defined as the ratio of a compound's vapor pressure to its aqueous solubility and is a measure of how the chemical will be distributed between air and water when the two phases are in contact. The distribution coefficient (K_d) is a measure of how a compound originally in solution becomes distributed between the aqueous and solid phase through sorption. K_d is usually reported as the concentration of dissolved compound under equilibrium conditions.

The following subsections present a discussion of the physical and chemical properties of organic and inorganic contaminants present at the site and how these properties will affect compound-media interactions at the site subsurface.

6.1.1 ORGANIC COMPOUNDS

Organic compounds present at the site are primarily chlorinated VOCs. TCE is the primary COC, although PCE, 1,2-DCE, and vinyl chloride were also detected at elevated concentrations and in a pattern resembling a plume. Table 6-1 presents a summary of values for chemical and physical properties of chlorinated VOCs as reported in literature. VOCs generally have lower molecular weights than other organic compounds and are therefore more volatile (i.e. have a higher vapor pressure) and more soluble in water. In contrast, compounds with higher molecular weights, such as SVOCs, pesticides, and PCBs, have lower vapor pressures and lower aqueous solubilities. A compound's Henry's Law Constant is dependent upon several factors including polarity, and is not easily predicted by molecular weight. Organic contaminants sorb primarily to the organic portion of soils; therefore, their water-solid partitioning behavior is often described by the organic carbon coefficient (K_{oc}). This coefficient is used to calculate a distribution coefficient using the equation $K_d = K_{oc} * f_{oc}$, where f_{oc} is equal to the fraction of organic carbon in the uncontaminated soil. In general, the higher molecular weight SVOCs have greater K_{oc} than the lighter VOCs and will, therefore, sorb more strongly to an organic rich soil.

A compound's physical and chemical properties correlate directly with how mobile it will be once released to an aquifer. The more soluble, less sorptive compounds will readily dissolve in the groundwater and will migrate at a rate similar to the average groundwater velocity. In contrast, compounds with lower solubilities and higher sorptive properties will tend to remain in the pure phase and sorb to aquifer solids, thus retarding their movement relative to the rate of groundwater flow. Based on this understanding and the values reported in Table 6-1, it can be inferred that of the organic compounds present at the site, the chlorinated VOCs will be the most mobile in the site subsurface.

6.1.2 INORGANIC COMPOUNDS

In general, the solubility of inorganic compounds is dependent upon the constituent species present (i.e. valence state). The more reduced species of metals are generally the most soluble; therefore, metals will dissolve more readily under reducing conditions in an aquifer. Among the common inorganic compounds, the chloride, nitrate, and nitrite species are the most soluble, and sulfate, carbonate, and hydroxide species have low to moderate solubility. However, it is difficult to determine constituent species of inorganic compounds using standard laboratory methods, and chemical modeling is usually required to develop a complete understanding of which species are present in a geochemical system. Therefore, the solubilities of the inorganic compounds at the site are not known. The mobility of inorganics is also influenced by their reactions with soils or other solid surfaces via ion exchange and adsorption, measured by the distribution coefficient. K_d values for inorganic compounds can vary several orders of magnitude and depend upon several factors including pH, oxidation-reduction conditions, solubility, and the type and amount of organic matter, clay, and hydrous oxides present. In general, vapor pressure and Henry's Law Constants are not important chemical parameters for inorganic compounds since they do not volatilize under typical environmental conditions.

6.2 CHEMICAL AND BIOLOGICAL TRANSFORMATION

The environmental transport and fate of contaminants are also influenced by reactions that actually alter the structure of the compound and transform it into one or more products. These structural transformation processes can be either chemical or biological. The most common chemical (abiotic) transformation processes include: hydrolysis, oxidation-reduction, and photolysis. Hydrolysis is a reaction occurring in the presence of water in which an atom or group of atoms in the compound is replaced with a hydroxyl ion (OH^-). Oxidation-reduction is a chemical substitution involving the transfer of electrons. Photolysis is the decomposition of a compound caused by absorption of energy provided either directly or indirectly by light.

In biological transformation, microorganisms native to the environment degrade organic compounds to obtain energy and carbon. In this process, the organics are converted to simpler compounds and, ultimately, to carbon dioxide or methane and water. The microorganisms generally derive the energy by oxidizing the energy source (i.e., the contaminant) and transferring the electrons to an acceptor. This reaction can occur under aerobic conditions in which oxygen is the electron acceptor, or under anaerobic conditions in which another compound acts as the electron acceptor (i.e., nitrate, iron, sulfate, or carbonate). In some cases, the contaminant is used as the electron acceptor, and some other organic material such as natural organic matter or fuel hydrocarbons act as the carbon source and electron donor. Another mechanism by which a contaminant can be biodegraded is co-metabolism. During this process, degradation of the contaminant is catalyzed by an enzyme or co-factor that is fortuitously produced by microorganisms as they use some other compound as a carbon and energy source.

Biological degradation is the dominant transformation process affecting the ultimate fate of organic compounds. The rate at which an organic chemical is degraded in the environment due to various transformation processes can be represented by its half-life, which is defined as the amount of time required to reduce a contaminant concentration to one-half its original concentration. The half-life of an organic compound is highly site specific and can vary several orders of magnitudes. Half-life values reported in the literature for some of the compounds present at the Northwest Boundary are listed in Table 6-1. A discussion specific to the degradation of chlorinated VOCs is presented in Section 6.4.

6.3 TRANSPORT OF CONTAMINANTS

The migration of contaminants is influenced by not only the factors discussed in Section 6.1 and 6.2, but also by the hydrogeology of the site, soil type and chemistry, contaminant concentrations, and the biological and chemical characteristics of the aquifer. The following sections contain an assessment of transport pathways at the site based on the available site characterization data. This discussion is presented with respect to chlorinated compounds because these are the most mobile and toxic contaminants at the site and they are encountered at the highest concentrations.

6.3.1 VADOSE ZONE AND SURFACE SOILS TO ATMOSPHERE

Upon release to the ground, a contaminant will travel downward through the vadose zone under the force of gravity. As it travels downward, a portion of the non-aqueous phase liquid (NAPL) will volatilize to the gaseous phase. Once in the gaseous phase, the contaminant can migrate upward through the soil pores to the atmosphere because of barometric pressure gradients. In addition, contaminants present in the sorbed phase on soil particles or in the dissolved phase in pore water may volatilize and enter the atmosphere.

Significant adsorbed contamination was not detected in soil samples collected during the initial phases of the investigation. Therefore, this does not appear to be a pathway for further contaminant migration in the downgradient area of the plume. Soils were not evaluated during the installation of wells in the area where the highest TCE concentrations were found (MW-25 and -26); however, no detections were recorded on the PID. Also, soil samples were collected from the test pits and around the suspected sewer line (Section 5.1.2), and the results indicated that the soil was not contaminated with organic compounds. Since the highest concentrations of chlorinated VOCs were detected in this area, however, the potential exists for chlorinated VOCs in soil vapor in these areas.

6.3.2 VADOSE ZONE AND SURFACE SOILS TO GROUNDWATER

Sorbed, gaseous, and free phase contaminants in the surface and vadose zone soils can dissolve into infiltrating water and leach into the groundwater. These phases of the contaminants can also dissolve into the groundwater through direct contact within the capillary zone.

Results from soil sample analyses from the monitoring well installations, test pits, and sewer line sampling indicate that significant contamination is not present in the vadose zone soils. The vadose zone to groundwater pathway was probably important at the site only for a short time after releases occurred. Due to their high solubilities and low K_d values, chlorinated compounds in the vadose zone readily leach into groundwater and, therefore, no longer remain as a source of contamination.

6.3.3 FREE PHASE TO GROUNDWATER AND SURFACE WATER

Free phase chlorinated VOCs have specific gravities greater than 1.0 (Table 6-1) and as a result, migrate downward in an aquifer. If the DNAPL encounters a confining unit (permeability $<10^{-6}$ darcys), it will collect on top of it and act as a secondary source of groundwater contamination. In addition, the DNAPL may travel along the confining layer until it reaches a discharge point or breach in the layer.

Boring logs from the monitoring well installations in the area of the plume indicate high silt and clay content in the overburden at thicknesses ranging from 20-40 ft. It can be assumed that the permeability of this layer is low enough to impede downward flow of DNAPL. However, DNAPL accumulations were not detected in the monitoring wells. Therefore, it is assumed that DNAPL to groundwater and surface water are not significant pathways at the site. It is possible that isolated pockets of residual free phase are present acting as a minor source of dissolved contamination.

6.3.4 GROUNDWATER TO SURFACE WATER

Some of the dissolved contaminants in an aquifer will be transported with groundwater through the process of advection (i.e., they will travel at the same rate as the average linear velocity of the groundwater). The rate of movement of some of the contaminants will be retarded through the process of dispersion and through sorption onto aquifer particles. In addition, contaminant concentrations will decrease via chemical and biological transformations.

Groundwater at the site flows north. The average linear velocity of groundwater (V) is defined by the equation: $V = KI/n$, where K = hydraulic conductivity, I = hydraulic gradient, and n =

porosity. Using an average hydraulic conductivity of 18.21 ft/day and an *n* of 30 percent, and a gradient of 0.0023 ft/ft, the average linear groundwater velocities were calculated to be 0.14 ft/day. The average linear groundwater velocity was calculated using hydraulic conductivity data from the downgradient portion of the dissolved phase chlorinated solvent plume (Section 5.2.1). Groundwater velocities within the dissolved phase plume would also be anticipated to vary due to mounds and depressions resulting from the intermittent clay layers and possible water line leaks.

After reaching the downgradient area near OP-6 and OP-7, groundwater flows beneath the low-lying area with surface water (Section 2.5), and surfaces in San Juan Bay. This is deduced based on the knowledge that the carbonate aquifer is penetrated at a depth of around 40 to 50 ft bgs at OP-6 and OP-7, and likely continues to dip slightly towards the north.

6.3.5 PREFERENTIAL PATHWAYS DISCHARGING TO SURFACE WATER

Groundwater flow patterns are determined by paths of least resistance and driving head. Often underground utility lines act as preferential pathways for groundwater because of the low resistance of open conduits and coarse material used to backfill trenches. In addition, the driving head created by graded storm or sanitary lines can increase the rate of groundwater flow. Because sewers often discharge to streams and lakes, these preferential pathways can accelerate contaminant transport to surface waters.

The storm sewer running east-to-west across the field east of the DPW complex that was identified during the geophysical investigation empties into El Toro Creek. No chlorinated VOC concentrations were detected in the soil samples collected adjacent to or below the sewer line.

6.3.6 SURFACE WATER TO ATMOSPHERE

Once dissolved contaminants have been introduced to a surface water body through groundwater or storm sewer discharge, they can be transferred directly to the atmosphere by volatilization. The factors governing this migration pathway include dissolved contaminant concentration, vapor pressure of the chemical, and characteristics of the water body and air. Volatilization increases with increasing chemical concentration, increasing vapor pressure, increasing surface area to volume ratio, and increasing turbulence at the air-water interface (EA 1998).

The aquifer of concern in this investigation is confined, and is generally located 30 ft bgs in the area with the highest TCE concentrations, and deeper (40 ft bgs) downgradient. Therefore El Toro Creek does not receive contaminated groundwater. Volatilization of chlorinated VOCs from surface water on the installation or in downgradient waters (i.e., the San Juan Bay) is not a significant pathway, as evidenced by the results of the pore water and surface water sampling. These samples were collected from the low-lying area downgradient of OP-6 and OP-7, and no chlorinated VOCs were detected in the samples.

6.4 USAERDC GROUNDWATER MODEL

The groundwater flow and transport model created and interpreted by USAERDC (see Section 2.6.1) was developed based on a detailed geologic conceptual model that was developed over time using the geologic data collected at the site during the RFI process, geologic data made available from neighboring sites like CPR, and the geologic history of the region in which Fort Buchanan is located. From this geologic conceptual model, a 3-dimensional (3D) computational grid was created to simulate the flow and transport behavior of the aquifer system at the site. Parameters for a 3D groundwater flow model were estimated from available data sources including numerous slug tests performed at the site monitoring wells to determine hydraulic conductivity values for the various subsurface stratigraphic units included in the flow model. These estimates were later refined through a calibration process that was carried out using observed water level data obtained using transducers placed in several of the monitoring wells over various time periods at the site. The water level data was also used to set model head boundary conditions at the southern and northern edges of the model in order to simulate the proper volume of flow moving through the system. Because of the relative impermeability of the overburden material that exists at the surface throughout the area of the site groundwater model, no direct recharge from rainfall through the overburden material was simulated in the model. Due to the detailed nature of the geologic conceptual model on which the flow model was constructed and the healthy amount of observed monitoring well data, the 3D flow model was able to be calibrated to a high degree of confidence.

Using the flow velocities computed by the flow model, a transport model was used to simulate the advection and dispersion of the dissolved contaminants in the aquifer downstream of OP-6. The simulations were carried out in the area from OP-6 northward to the northern boundary of the groundwater model which coincides with low-lying area located approximately 600 ft to the north of OP-6. While it is unlikely that this lagoon fully penetrates the thick overburden material and comes into direct contact with the uppermost units of the carbonate sand aquifer, for conservative purposes it was assumed that this northern boundary represented the potential contact point between any dissolved contaminants in the groundwater and a surface water body. Simulations were conducted using the transport model to determine what the concentrations of contaminants 600 ft downstream from OP-6 might be given various scenarios. Using the maximum observed value at OP-6 of about 140 ug/L and conservative estimates of dispersion parameters, the transport simulations indicated a maximum concentration of less than 80 ug/L at the southern boundary of the low-lying area, even when using a groundwater flow velocity that is 10 times greater than those computed by the flow model. The transport model was also used to determine the minimum concentration needed at OP-6 to achieve a concentration of 350 ug/L at the southern end of the water body. 350 ug/L represents the ECOTOX threshold value established for surface water screening (USEPA 1996). According to the transport model results, a concentration of approximately 660 ug/L would be required at OP-6 in order to exceed the 350 ug/L ECOTOX limit at the southern end of the surface water body.

The construction and application of the geologic conceptual model and the groundwater flow and transport models used in the simulations described here are described and documented in detail in Appendix D.

6.5 FATE OF THE CONTAMINANTS

Many of the factors discussed in Sections 6.1 and 6.2 influence not only how a contaminant migrates along various environmental pathways, but also whether and how long it will persist in various environmental media. The following sections present a discussion of the eventual fate of the chlorinated compounds at the northwest boundary of Fort Buchanan.

6.5.1 SOIL AND VADOSE ZONE

Due to their higher vapor pressures and solubilities and low sorption characteristics, chlorinated compounds are not likely to persist in the vadose zone. Rather they will volatilize into soil gas and eventually be released to the atmosphere, or leach into the groundwater. As discussed in Section 6.3.2, this appears to be the case at the northwest boundary, as no significant contamination was detected in vadose zone soil samples.

6.5.2 GROUNDWATER

The persistence of chlorinated VOCs in groundwater is largely determined by biological factors. Since the compounds are highly soluble, not likely to sorb onto aquifer solids at high concentrations, and degrade abiotically at very slow rates with maximum half-lives on the order of 37 years (Cookson 1995), they will tend to persist in groundwater unless their concentrations are reduced through biodegradation.

Biodegradation of chlorinated aliphatics by three different mechanisms (oxidation, reduction, and co-metabolism) has been documented in literature. However, because of the electronegative character of the chlorine in these compounds, they tend to act as the electron acceptor (i.e., are reduced by the microbes) in most cases, particularly for the more chlorinated compounds. The use of chlorinated organic compounds as electron acceptors becomes more favorable as conditions in the aquifer become more reduced. Favorable reduction conditions typically occur in anaerobic environments. The process involves the sequential removal of chlorine atoms from the molecular structure and is called reductive dehalogenation (Cookson 1995).

Groundwater was sampled at seven locations within the site for biogeochemical parameters that are indicative of conditions beneficial to biotic and abiotic transformations of chlorinated VOCs. The geochemical data for groundwater samples is presented in Table 6-2.

6.6 NATURAL ATTENUATION

Natural attenuation processes (biodegradation, dispersion, dilution, sorption, volatilization, and abiotic degradation mechanisms) affect the fate and transport of chlorinated solvents in all hydrologic systems. Groundwater chemical data can show that geochemical conditions are suitable for biodegradation. When microorganisms degrade organic contaminants in the subsurface they can cause measurable changes in groundwater chemistry (Wiedemeier 1998).

In general, dissolved chlorinated hydrocarbons (such as TCE and DCE) compose the majority of contaminants affecting the groundwater quality. As chlorinated hydrocarbons degrade (by either reductive dechlorination or co-metabolic oxidation) generally in anoxic environments, a reduction in the dissolved oxygen concentrations would be needed to create an anoxic from a naturally aerobic environment.

6.6.1 Natural Attenuation Parameter Results Analysis

Analysis of DO, ORP, conductivity, pH, nitrogen, methane, ethane, ethene, sulfate, and TOC were performed at select wells to assess whether the subsurface is capable of attenuating the dissolved contaminant concentrations. Other indicators of the natural attenuation of chlorinated solvents including the absence of “parent” compounds, such as TCE or PCE, and the presence of “daughter products” (such as vinyl chloride) were also evaluated.

Figure 6-1 presents DO concentrations from the March 2009 sampling event. DO concentrations were detected below 0.5 mg/L (indicating an anoxic environment) in most of the plume area. Low DO concentrations make for suitable conditions for the dechlorination of chlorinated hydrocarbons, as observed in the groundwater at site monitoring wells. In general, the lower DO concentrations were located in the area of the plume with the highest concentrations, allowing for better biodegradation conditions. Downgradient, DO increases slightly, but the concentrations generally remained below 0.5 mg/L (with the exception of OP-5, which had a DO concentration of 0.94 mg/L in the March 2009 event).

The ORP of groundwater reflects the relative oxidation or reducing nature of the groundwater system. Negative values indicate a strongly reducing environment while positive ORP values generally indicate an oxidized environment. Dechlorination of PCE or TCE to DCE occurs under either mildly or strongly reducing conditions (Wiedemeier 1998). In general, the observed March 2009 ORP values concur with the DO concentrations in identifying anoxic environments (Figure 6-2).

Nitrate is used as a substrate for microbial respiration once oxygen has been depleted during the reduction of organic carbon. A denitrified environment is more suitable for reductive dechlorination of chlorinated hydrocarbons than just an anoxic environment. Nitrate was generally depleted in the groundwater with maximum detections of 0.19 (MW-11A) and 0.73 mg/L (OP-5). Reductive dechlorination is more likely to occur when nitrate concentrations in the contaminated portion of the aquifer are less than 1.0 mg/L.

The presence of sulfate also creates an effective environment for the dechlorination of chlorinated hydrocarbons. Figure 6-3 shows the concentrations of sulfate found in seven wells in January 2009. The reported concentrations of ranged from 23.20 mg/L (OP-1) to 69.60 mg/L (MW-7B).

The presence of methane, another metabolic byproduct, in the groundwater samples may also indicate biodegradation via methanogenesis. The degradation of chlorinated hydrocarbons is the most efficient under methanogenic conditions, as more molecular hydrogen is available for reductive dechlorination. Concentrations of methane reported in groundwater samples are presented on Figure 6-4. The figure indicates that methane was more available in the wells nearer to the area of elevated TCE concentrations than the farther downgradient (OP-2 had a concentration of 3.20 ug/L). However, the presence of methane in the wells indicates that molecular hydrogen is available and could help facilitate reductive dechlorination.

A good indicator of the salinity of groundwater can be through the measure of conductivity. Figure 6-5 represents the conductivities of wells sampled during the March 2009 sampling event. The figure clearly shows that the conductivity increases down the plume, resulting in high values for conductivity in OP-6 (2.367 millisiemens per centimeter [mS/cm]) and OP-7 (4.928 mS/cm). These higher conductivities in the extreme downgradient wells may account for the more elevated TCE concentrations detected during the March and April 2009 sampling events. The downgradient wells are within a mile of San Juan Bay, and this accounts for the higher salinity in these locations. Higher salinity may affect the rate at which chlorinated hydrocarbons biodegrade (Lee and Liu 2006).

Ethane and ethene are the benign degradation products of the reduction dechlorination of chlorinated solvents such as PCE or TCE. The highest concentrations of these compounds are expected in areas where reduction dechlorination is occurring. Of the seven well locations analyzed for ethane and ethene, three locations (MW-7B, MW-15, and OP-2) had measurable detections (Table 6-2). A summary of geochemical parameters from the January 2009 sampling event is shown in Figure 6-6.

As shown in Figure 6-6, pH values for the seven wells selected for natural attenuation parameter analysis are just above or slightly below 7, exhibiting a neutral range. These pH conditions in the aquifer provide adequate conditions for natural attenuation, as microbes that can attenuate the chlorinated solvents tend to be active with pH ranges between 6.5 and 8.5.

It appears that the presence of electron acceptors, such as sulfate, are being reduced, thereby creating an anoxic and methanogenic environment beneath the site. This environment is the most suitable for the degradation of chlorinated hydrocarbons such as PCE and TCE. Reductive dechlorination of chlorinated hydrocarbons appears to be occurring due to the observed concentrations of “daughter” products (such as vinyl chloride and ethane/ethene). Concentrations of TCE at many wells have generally decreased at many, although not all, wells over time.

6.6.2 NATURAL ATTENUATION SUMMARY AND PLUME ANALYSIS

It appears that the best reducing environment for biodegradation of TCE is in the area with the highest concentrations. This conclusion is supported by the low DO concentrations and negative ORP values. Higher conductivity in the downgradient area of the plume (OP-6 and -7) has possibly inhibited biodegradation processes. Methane, ethane, and ethene detections indicate that some level of biodegradation is occurring. Daughter products have been observed in many of the site wells (Figure 5-8). Throughout the course of the sampling events, the evidence suggests that the plume is relatively stable. TCE concentrations have not changed by orders of magnitude in any of the wells within the plume area.

Table 6-1
Physical and Chemical Parameters for Chlorinated VOCs

Parameter	Molecular Weight (g/mole)	Specific Gravity	log K_{oc} or K_d (L/kg)	Henry's Law Constant (atm-m^3/mole)	Vapor Pressure (mm Hg)	Solubility (mg/L)	Half-Life (days)
Chloromethane	51[C]	NA	7.02[E]	6.38E+04[F]	3.80E+03[C]	4.00E-03[C]	NA
Dichloroethane, 1,1-	99[B]	1.74[H]	1.76[B]	1.54E-02[B]	5.91E+02[B]	5.50E+03[C]	360[A]
Dichloroethane, 1, 2-	99[B]	1.25[H]	1.76[B]	1.20E-03[B]	8.00E+01[B]	8.69E+03[C]	360[A]
Dichloroethene, 1,1-	96.936[B]	1.218[H]	NA	1.70E-01[H]	5.91E+02[H]	4.00E+02[H]	NA
Dichloroethene, cis-1,2-	96.936[B]	NA	1.38[D]	3.19E-02[B]	2.00E+02[C]	8.00E+02[C]	NA
Dichloroethene, trans-1,2-	96.936[B]	1.25[H]	1.46[B]	5.32E-03[B]	3.31E+02[B]	6.00E+02[C]	NA
Tetrachloroethane, 1,1,2,2-	168[B]	1.6[H]	0.00[B]	2.00E-03[B]	6.50E+00[B]	7.18E+02[B]	45[A]
Tetrachloroethene	165.83[B]	1.6[H]	5.12[B]	2.90E-02[B]	1.90E+01[B]	1.43E+02[B]	720[A]
Trichloroethane, 1,1,1-	133.4[B]	1.35[H]	2.45[B]	1.72E-02[B]	1.23E+02[B]	1.26E+03[B]	546[A]
Trichloroethane, 1,1, 2-	133.4[B]	1.44[H]	0.00[B]	7.40E-04[B]	2.50E+01[B]	5.93E+03[B]	730[A]
Trichloroethene	131.4[G]	1.456[H]	1.26[E]	1.00E-02[F]	5.80E+01[G]	1.00E+03[G]	1653[A]
Vinyl Chloride	62.5[B]	0.9121[H]	0.06[B]	8.60E-02[B]	2.66E+03[B]	2.54E+03[B]	2875[A]

Notes:

A - Howard, 1989.

B - USEPA, 1989.

C - Verschueren, Karel, 1983.

D - Lyman, 1982.

E - Back calculated from solubility.

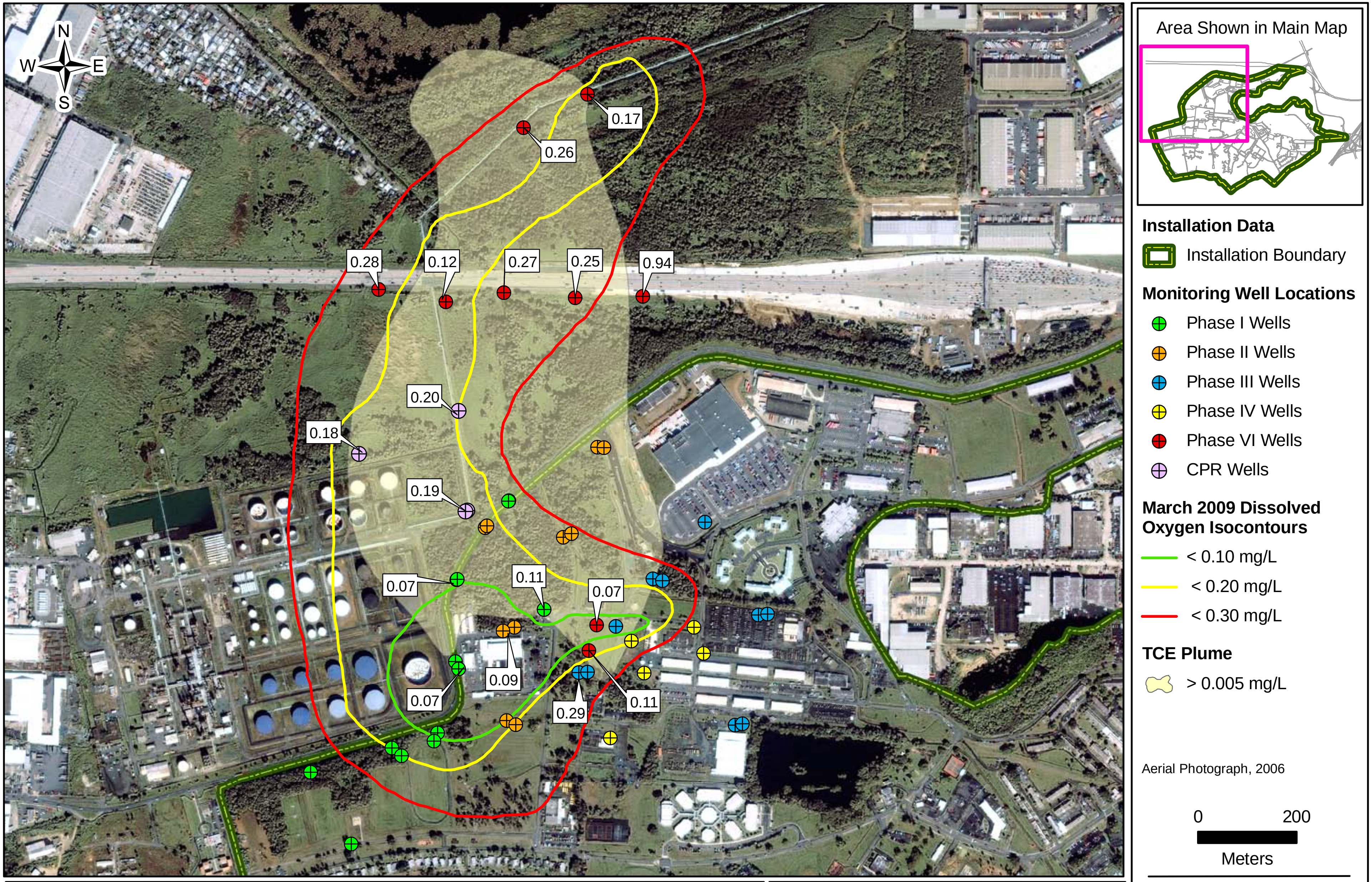
F - Calculated from (Pv/Patm)/(solubility/mol. wt.).

G - NIOSH, 1990.

H - Spitz and Moreno, 1996.

Table 6-2
Geochemical Parameters of Monitoring Wells
Northwest Boundary Investigation, Fort Buchanan, Puerto Rico

Well Number	Sample Date	Oxidation-Reduction Potential (mV)	Conductivity (ms/cm)	Dissolved Oxygen (mg/L)	pH	Nitrogen mg/L	Ethane µg/L	Ethene µg/L	Methane µg/L	Sulfate mg/L	TOC mg/L
MW-7B	01/06/09	-10.4	1.648	0.01	6.87	ND	0.16	0.23	17.40	69.60	1.40
MW-11A	01/06/09	30	0.854	0.20	6.79	0.19	ND	ND	13.80	37.60	0.31
MW-15	01/08/09	-50	0.907	0.10	6.73	ND	0.23	ND	12.00	37.10	0.38
MW-22	01/06/09	134.8	0.500	0.17	6.75	ND	ND	ND	0.52	25.10	0.31
OP-1	01/06/09	61.9	1.220	0.01	7.04	ND	ND	ND	25.30	23.20	0.32
OP-2	01/06/09	-48	1.528	0.16	7.05	ND	0.88	ND	3.20	58.60	0.43
OP-5	01/06/09	189.6	1.050	0.08	6.96	0.73	ND	ND	18.40	51.40	0.37



March 2009 Dissolved Oxygen Concentrations

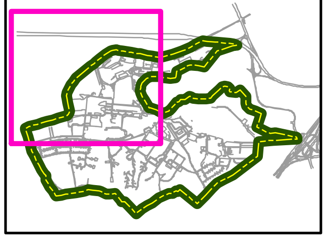
Figure 6 - 1

Fort Buchanan, Puerto Rico

EA Engineering, Science, and Technology

\\Edgewoodfp\Projects\Universal GIS\Buchanan\MXDs\Figure 5-1 March 2009 DO Concentrations.mxd

Area Shown in Main Map



Installation Data

Installation Boundary

Monitoring Well Locations

- Phase I Wells
- Phase II Wells
- Phase III Wells
- Phase IV Wells
- Phase VI Wells
- CPR Wells

TCE Plume

> 5 ug/L

Note:
ORP is measured in mV.

Aerial Photograph, 2006

0 200
Meters

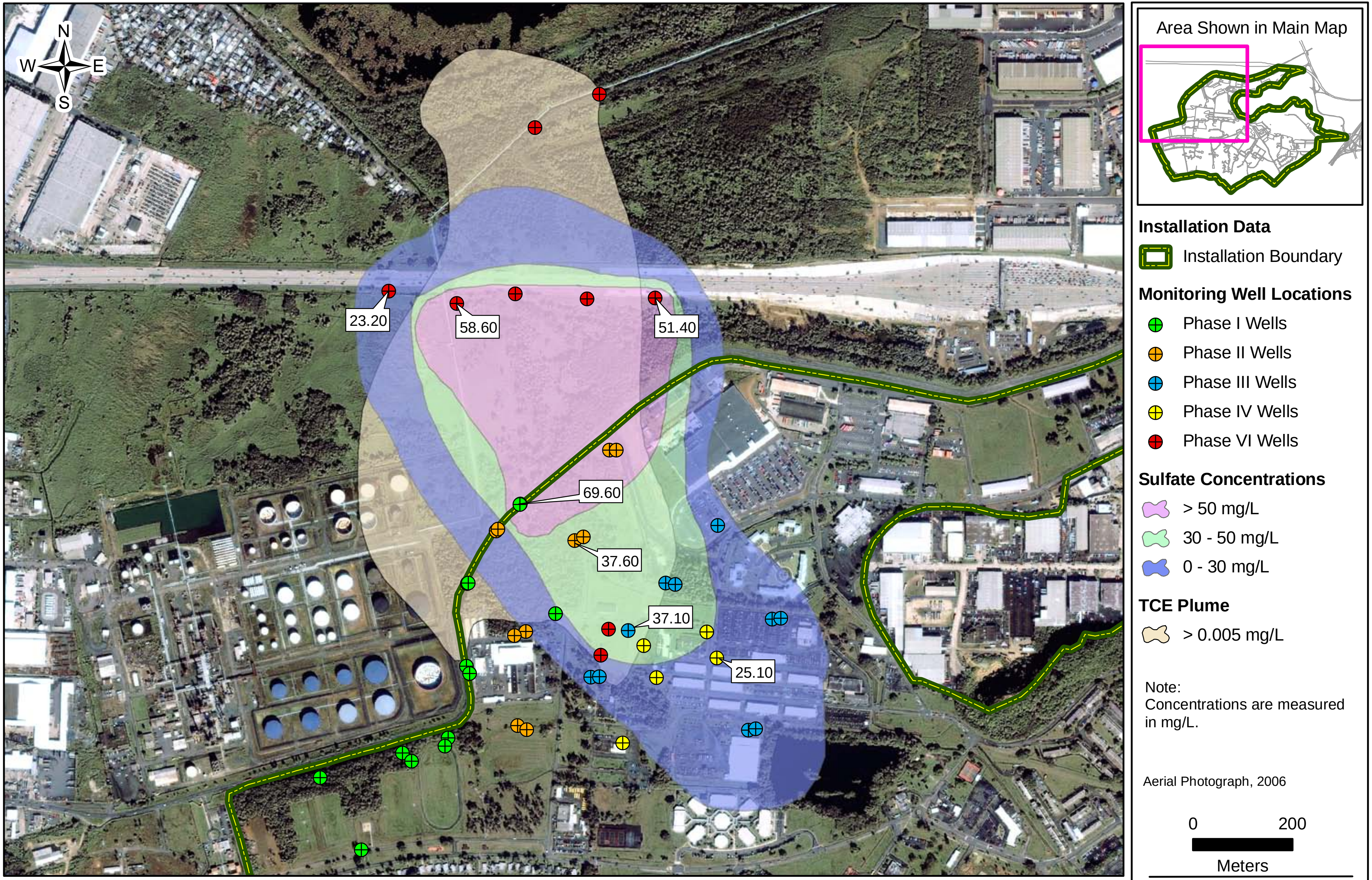
EA Engineering,
Science, and
Technology

March 2009 ORP Concentrations

Figure 6-2

Fort Buchanan, Puerto Rico

\\Edgewoodfp\Projects\Universal GIS\Buchanan\Figure 5-2 March 2009 ORP Concentrations.mxd



Note:
Concentrations are measured in mg/L.

Aerial Photograph, 2006

January 2009 Sulfate Concentrations

Figure 6-3

Fort Buchanan, Puerto Rico

EA Engineering, Science, and Technology

\\Edgewoodfp\Projects\Universal GIS\Buchanan\MXDs\Figure 5-3 January 2009 Sulfate Concentrations.mxd

January 2009 Methane Concentrations

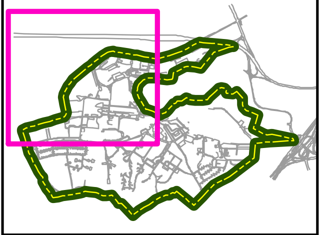
Figure 6 - 4

Fort Buchanan, Puerto Rico

EA Engineering, Science, and Technology

\\Edgewoodfp\Projects\Universal GIS\Buchanan\MXDs\Figure 5-4 January 2009 Methane Concentrations.mxd

Area Shown in Main Map



Installation Data

▭ Installation Boundary

Monitoring Well Locations

⊕ Phase I Wells

⊕ Phase II Wells

⊕ Phase III Wells

⊕ Phase IV Wells

⊕ Phase VI Wells

⊕ CPR Wells

March 2009 Conductivity

▨ <1.0 mS/cm

▨ 1.0 - 2.0 mS/cm

▨ >2.0 mS/cm

TCE Plume

▨ > 5 ug/L

Note:
Conductivity values in the figure are measured in mS/cm.

Aerial Photograph, 2006

0 200
Meters

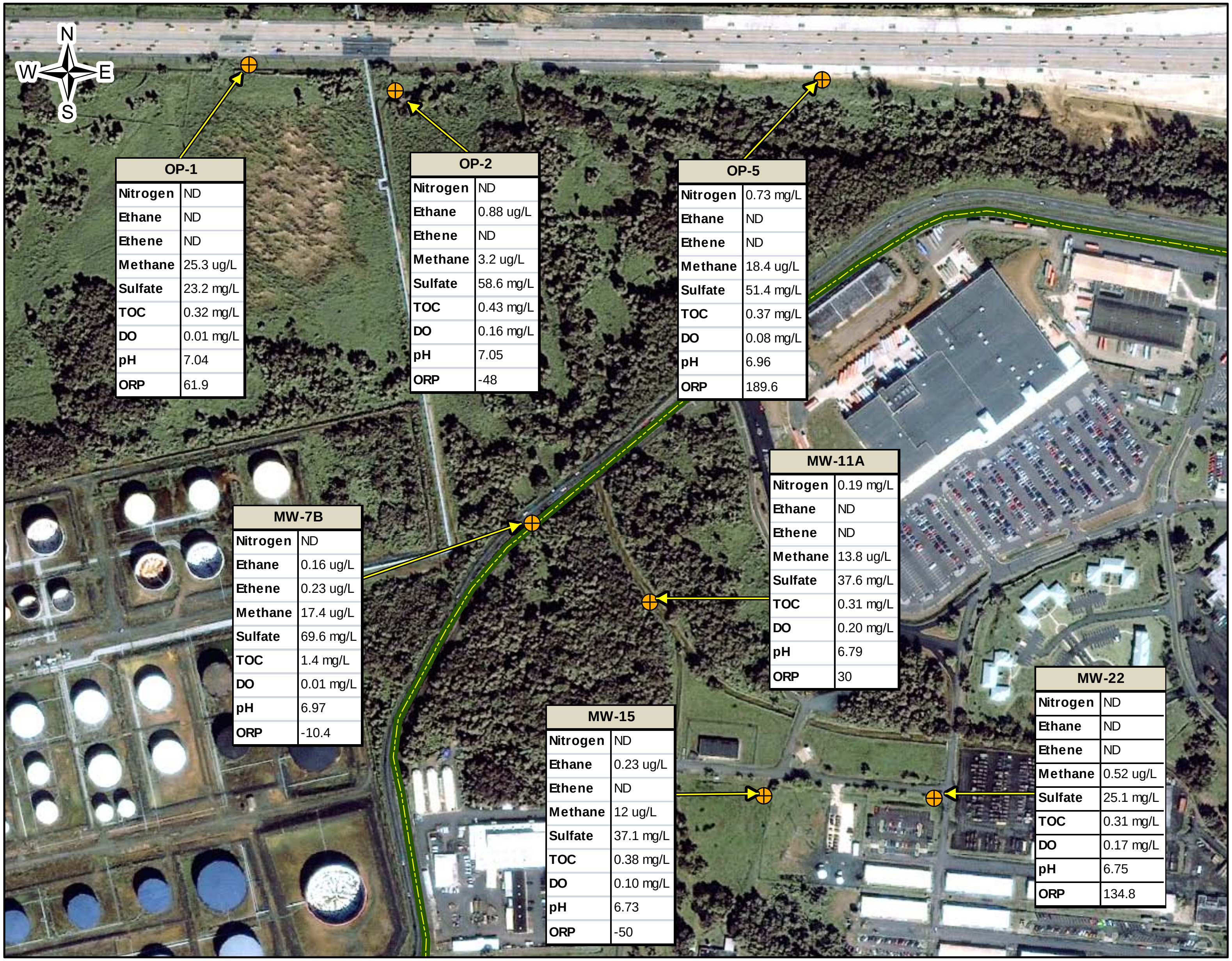
EA Engineering, Science, and Technology

March 2009
Conductivity of Sampled Wells

Figure 6-5

Fort Buchanan, Puerto Rico

\\Edgewoodfp\Projects\Universal GIS\Buchanan\MXDs\Figure 5-5 March 2009 Conductivity.mxd



OP-1	
Nitrogen	ND
Ethane	ND
Ethene	ND
Methane	25.3 ug/L
Sulfate	23.2 mg/L
TOC	0.32 mg/L
DO	0.01 mg/L
pH	7.04
ORP	61.9

OP-2	
Nitrogen	ND
Ethane	0.88 ug/L
Ethene	ND
Methane	3.2 ug/L
Sulfate	58.6 mg/L
TOC	0.43 mg/L
DO	0.16 mg/L
pH	7.05
ORP	-48

OP-5	
Nitrogen	0.73 mg/L
Ethane	ND
Ethene	ND
Methane	18.4 ug/L
Sulfate	51.4 mg/L
TOC	0.37 mg/L
DO	0.08 mg/L
pH	6.96
ORP	189.6

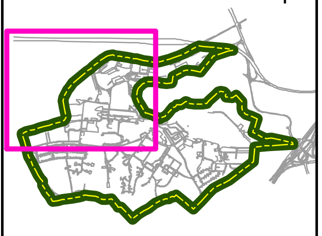
MW-11A	
Nitrogen	0.19 mg/L
Ethane	ND
Ethene	ND
Methane	13.8 ug/L
Sulfate	37.6 mg/L
TOC	0.31 mg/L
DO	0.20 mg/L
pH	6.79
ORP	30

MW-7B	
Nitrogen	ND
Ethane	0.16 ug/L
Ethene	0.23 ug/L
Methane	17.4 ug/L
Sulfate	69.6 mg/L
TOC	1.4 mg/L
DO	0.01 mg/L
pH	6.97
ORP	-10.4

MW-15	
Nitrogen	ND
Ethane	0.23 ug/L
Ethene	ND
Methane	12 ug/L
Sulfate	37.1 mg/L
TOC	0.38 mg/L
DO	0.10 mg/L
pH	6.73
ORP	-50

MW-22	
Nitrogen	ND
Ethane	ND
Ethene	ND
Methane	0.52 ug/L
Sulfate	25.1 mg/L
TOC	0.31 mg/L
DO	0.17 mg/L
pH	6.75
ORP	134.8

Area Shown in Main Map



Installation Data

🟩 Installation Boundary

⊕ January 2009 Groundwater Geochemistry Sample Locations

Aerial Photograph, 2006

January 2009 Geochemical Parameters of Select Wells

Figure 6-6

Fort Buchanan, Puerto Rico

EA Engineering, Science, and Technology

\\Edgewoodfp\Projects\Universal GIS\Buchanan\MXDs\Figure 5-6 January 2009 Geochem Parameteres of Select Wells.mxd

7 HUMAN HEALTH RISK ASSESSMENT

A HHRA is conducted to assess potential risks from human exposure to chemicals in groundwater within the Northwest Boundary Area of Fort Buchanan. As discussed in Section 1.0, the objectives of this RFI include characterization of the groundwater within the Northwest Boundary Area and preparation of a baseline risk assessment that evaluates the potential for impact to human health from a potential TCE source and the groundwater plume. This investigation is designed to address groundwater and associated impacted media only. The *Site Wide RCRA Facility Investigation Report, Fort Buchanan, Puerto Rico* (EA 2010a) was issued in Draft Final form in June 2010. The objectives of the Site Wide RFI are to characterize potential contaminants of concern in surface/subsurface soil, surface water, sediment, and groundwater at sites not associated with the TCE groundwater plume. Many of the sites involved in the Site Wide RFI are located adjacent to the old DPW complex and are within the area being investigated as part of the Northwest Boundary Area RFI (this document). It is important to note that the Northwest Boundary Area RFI and associated risk assessment are focused on the groundwater TCE plume. The Site Wide RFI is the document that characterizes potential contamination in other media. The Site Wide RFI includes data generated as part of the Northwest Boundary Area RFI.

7.1 GENERAL HHRA APPROACH

The HHRA evaluates the potential source of contamination and routes of migration based on current and potential future site uses to determine complete exposure pathways. The HHRA evaluates potential exposure pathways that can occur or are reasonably likely to occur under these uses at the site. The HHRA is performed in accordance with the USEPA guidance as referenced in this report and is based upon agreements between U.S. Army Environmental Command (USAEC), USEPA, and PREQB. The HHRA evaluates the reasonable maximum exposure that has the potential to occur in accordance with USEPA guidance (USEPA 1989). The HHRA methodology involves a four-step process: data evaluation, exposure assessment, toxicity assessment, and risk characterization. The HHRA for the Northwest Boundary Area is conducted in accordance with the following USEPA Guidance:

- *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A) (Interim Final).* Report No. EPA/540/1-89/002. Office of Emergency and Remedial Response, Washington, DC. USEPA, December 1989.
- *Risk Assessment Guidance for Superfund Volume I-Human Health Evaluation Manual: (Part B - Development of Risk-Based Preliminary Remediation Goals) (Interim Final).* Publication 9285.7-01B. Interim. USEPA, 1991a.
- *Memorandum: Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors".* Office of Solid Waste and Emergency Response. OSWER Directive: 9285.6-03. March 25. USEPA, 1991b.

- *Exposure Factors Handbook: 2011 Version*. EPA/600/R-90/052F. USEPA, September, 2011a.
- *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part D)*. Office of Emergency and Remedial Response, Washington, DC. USEPA, December 2002a.
- *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)*. Final. Office of Superfund Remedial and Technology Innovation. USEPA, July 2004a.
- *Risk Assessment Guidance for Superfund, Volume I*: *Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment*). Final. Office of Superfund Remediation and Technology Innovation. USEPA, January 2009.
- *Regional Screening Level (RSL) Tables.* USEPA, June 2011b.
- *ProUCL Version 4.1*. Software developed by USEPA. Obtained on the Internet at http://www.epa.gov/osp/hstl/tsc/software.htm. Site Characterization and Monitoring Technical Support Center. USEPA, 2011c.

7.2 DATA EVALUATION

Data evaluation is the first step of the HHRA process. In the data evaluation, site-specific data are compiled and analyzed for data quality. The second step of data evaluation is the determination of COPCs that will be evaluated either quantitatively or qualitatively in the HHRA.

7.2.1 DATA QUALITY EVALUATION

The HHRA evaluates data collected for the Northwest Boundary Area as discussed in Section 4 and presented in Table 4-1. All data used in the HHRA are validated per protocols identified in USEPA guidance for data usability (USEPA 1992). Inclusion or exclusion of data on the basis of analytical qualifiers is performed in accordance with USEPA guidance (USEPA 1989, 1992). The first step in the HHRA is the evaluation of analytical data on the basis of qualifiers in each medium of concern using the rationale below. Analytical qualifiers are applied during the data validation process.

- Analytical results bearing the R qualifier (indicating that the data was rejected during the validation process) are not used in the HHRA.

- Analytical results bearing the U or UJ qualifier (indicating that the analyte is not detected at the given RL) are retained in the data set and considered non-detects. Where warranted for statistical purposes, each analytical result bearing the U or UJ qualifier is assigned a numerical value equal to its RL.

- Analytical results bearing the J qualifier (the reported value is estimated), D qualifier (the compounds in an analysis are at a secondary dilution factor), K qualifier (reported value may be biased high), L qualifier (reported value may be biased low), N qualifier (the spiked recovery is not within control limits), E qualifier (reported value is estimated because of the presence of interference), P qualifier (there is greater than 25% difference for detected concentrations between the two gas chromatograph columns), and "*" qualifier (the duplicate analysis is not within control limits) are retained at the measured concentration.
- Analytical results bearing the B or BJ qualifier are retained for further analysis. Analytical results for inorganic compounds are evaluated according to USEPA guidance (USEPA 1989) for inorganic COPCs bearing the B or BJ qualifiers (which indicate that the reported value is less than the contract-required detection limit, but greater than the instrument detection limit). Inorganic COPCs bearing the B or BJ qualifiers are retained in the data set at the measured concentration. Analytical results for organic compounds bearing the B qualifier (blank-related data) are evaluated as non-detects.

If duplicate samples are collected or duplicate analyses are conducted on a single sample, the following guidelines are employed to select the appropriate sample measurement:

- If both samples/analyses show that the analyte is present, the average of the two detected concentrations is retained for analysis, based on conservative professional judgment;
- If both samples/analyses are not detected, the average of the two RL concentrations is retained for analysis; and
- If only one sample/analysis indicated that the analyte is present, it is retained for analysis and the non-detect value is discarded.

7.2.2 SELECTION OF CHEMICALS OF POTENTIAL CONCERN

COPCs are selected in a screening process to limit the number of chemicals and exposure routes quantitatively evaluated in the HHRA to chemicals that contribute to overall potential risks. The screening process involves risk-based concentrations that take into account chemical toxicity and potential exposure routes. A chemical is selected as a COPC and retained for further evaluation in the HHRA if the maximum detected concentration in a sample medium exceeds the risk-based screening concentration. Chemicals not considered COPCs are assumed to be present at levels that present minimal risks to potential human receptors.

The USEPA RSLs (USEPA 20011b) are used for risk-based screening purposes in the HHRA. The USEPA RSLs combine human health toxicity values with standard exposure scenarios to estimate analyte concentrations in environmental media that are considered by the USEPA to be protective of human exposures (including sensitive populations), over a lifetime. The screening values are based on specific, conservative, fixed levels of risk. For carcinogens, this is 10^{-6}, which is the lower bound for potential acceptable carcinogenic risk as defined by the National Oil and Hazardous Substances Pollution Contingency Plan (USEPA 1990). For non-carcinogens, the screening values are based on a hazard quotient of 1.0. To account for potential additive or cumulative effects of multiple contaminants, one-tenth of the acceptable non-carcinogenic threshold is used for screening. The USEPA RSL table identifies some carcinogenic contaminants where the carcinogenic RSL is greater than 1/10th the non-carcinogenic RSL (identified in the USEPA RSL tables as "c^{**}"). In these instances, the more conservative 1/10th the non-carcinogenic RSL is used.

For soil, the residential and trespasser scenarios are compared to the residential soil RSLs. When an industrial scenario is evaluated (i.e., commercial worker, construction worker), soil concentrations are compared to the industrial soil RSLs. The maximum detected concentrations in groundwater are compared to the tap water RSLs. For surface water, the tap water RSLs are increased by a factor of ten. The one order-of-magnitude increase is appropriate based upon expected reduced exposure to surface water in comparison to tap water. Surface water is not a domestic drinking water source, and exposure is expected to be mostly incidental.

The maximum concentration of SVOCs and VOCs detected in groundwater will also be compared to target groundwater concentrations presented in Table 2C of USEPA's *Evaluating Vapor-Intrusion into Indoor Air* (USEPA 2002b). The target groundwater concentrations correspond to a target carcinogenic risk of 10^{-6} or hazard index of 1 for non-carcinogens. These values are derived to identify chemical concentrations in groundwater that may affect the indoor air quality of a building overlying VOC contamination.

Essential nutrients are not selected as COPCs based upon USEPA guidance (1989). Essential nutrients include calcium, magnesium, potassium, and sodium. Site history for the Northwest Boundary Area does not indicate any unusual use or disposal of these chemicals at the site. In addition, chemicals with a frequency of detection less than 5% are also not considered COPCs (USEPA 1989). Chemicals that have a maximum detected concentration greater than the RSL, but are not considered COPCs, are evaluated in the Uncertainty Section.

Surrogate compounds are determined for detected chemicals that lack specific RSL values. For example, the non-carcinogenic polycyclic aromatic hydrocarbon (PAH) pyrene is commonly used as a surrogate for the non-carcinogenic PAH benzo(g,h,i)perylene, which lacks a listed RSL. Another example surrogate is the use of the chlordane RSL for alpha-chlordane. Surrogate compounds are identified on the basis of similarity in chemical structure and toxic properties. The examples listed above demonstrate this process; a surrogate non-carcinogenic PAH is chosen to represent other non-carcinogenic PAHs that lack RSL values. Each risk-based screening table notes which surrogates are used.

7.2.3 COPCS SELECTED FOR THE HHRA

The occurrence, distribution, and selection of analytes in each medium are represented in medium-specific tables following the USEPA's Risk Assessment Guidance for Superfund

(RAGS) D format (USEPA 2002a). The tables are scenario-specific and present the minimum and maximum detected concentrations, the location of the maximum detected concentrations, as well as the frequency of detection (FOD) for each chemical detected. Analytes that exceed screening criteria are presented in bold type. Section 5 presents a discussion of the nature and extent of chemicals detected at the site. Risk-based screening tables are presented in Tables 7-2.1 through 7-2.5. COPCs for all media evaluated in the HHRA are presented in the following sections.

7.2.3.1 Subsurface Soil (Greater than 2 ft bgs)

The following COPCs are identified in subsurface soil (Table 7-2.1) based on the USEPA residential soil RSL screen: aluminum, antimony, arsenic, cobalt, iron, manganese, vanadium, and benzo(a)pyrene.

The following COPCs are identified in subsurface soil (Table 7-2.1) based on the USEPA industrial soil RSL screen: arsenic and cobalt.

7.2.3.2 Groundwater

Based on a comparison to the USEPA tap water RSLs, the following groundwater COPCs (Table 7-2.3) are identified: total aluminum, total and dissolved arsenic, total and dissolved barium, total cadmium, total and dissolved cobalt, total copper, total and dissolved iron, total and dissolved manganese, total and dissolved mercury, total nickel, naphthalene, chloroform, 1,2-DCA, cis-1,2-DCE, trans-1,2-DCE, PCE, 1,1,2-TCA, TCE, and vinyl chloride.

7.2.3.3 Surface Water

To account for surface water exposures, the tap water RSLs are increased by a factor of ten. No surface water COPCs (Table 7-2.4) are identified based on the comparison to tap water RSLs.

7.2.3.4 Groundwater to Indoor Air

Based on a comparison to the Office of Solid Waste and Emergency Response (OSWER) generic screening levels, the following COPCs are identified for the vapor intrusion pathway (Table 7-2.5): cis-1,2-DCE, PCE, 1,1,2-TCA, TCE, and vinyl chloride.

7.3 EXPOSURE ASSESSMENT

The second step of the HHRA process is the exposure assessment. In the exposure assessment, the human population, or groups of individuals potentially exposed to site media (i.e., potential human receptors) are identified. Pathways applicable to potential receptors at the site are identified from the many potential pathways of exposure. The COPCs in site media are converted into systemic doses, taking into account rates of contact (e.g., ingestion rates) and absorption rates of different COPCs. The magnitude, frequency, and duration of these exposures are then integrated to obtain estimates of daily doses over a specified period of time (e.g., lifetime, activity-specific duration).

Actual pathways and receptors that are assessed for quantitative evaluation are medium-specific. An exposure pathway describes a mechanism by which a population or individual may be exposed to chemicals present at a site. A completed exposure pathway requires the following four components:

- A source and mechanism of chemical release to the environment
- An environmental transport medium for the released chemical
- A point of potential human contact with the contaminated medium
- A human exposure route at the point of exposure

All four components must exist for an exposure pathway to be complete and for exposure to occur. Incomplete exposure pathways do not result in actual human exposure and are not included in the exposure assessment and resulting risk characterization.

7.3.1 CONCEPTUAL SITE MODEL

A conceptual site model has been developed to show potential sources of contamination, routes of migration, and receptors evaluated in this HHRA. Pathways begin from potential sources and progress through the environment through various fate and transport processes to potential human receptors. Figure 7-1 presents the conceptual model. The rationale for the selection of receptors and exposure pathways of concern in the conceptual site models is discussed below.

7.3.1.1 Contamination Source Areas and Migration Pathways

Section 6 discusses contaminant transport and fate. Once chemicals have been released to an environmental medium (e.g., soil), they may migrate within that medium or migrate to another environmental medium (e.g., air). This section discusses the potential source areas and potential contaminant-release mechanisms. In 2004, chlorinated solvents, primarily TCE, were detected at concentrations up to 154 ug/L in groundwater monitoring well samples within the lower aquifer collected within the CPR property, adjacent to Fort Buchanan. The area of detected TCE concentrations included the eastern portion of the CPR facility, extended beyond the CPR facility boundary, and extend beyond the northwestern boundary of Fort Buchanan.

The primary source at the site is groundwater. The contaminated groundwater plume contains concentrations of TCE and other VOCs. Some of the dissolved contaminants in an aquifer will be transported with groundwater through the process of advection (i.e., they will travel at the same rate as the average linear velocity of the groundwater). The rate of movement of some of the contaminants will be retarded through the process of dispersion and through sorption onto aquifer particles. In addition, contaminant concentrations will decrease via chemical and biological transformations. After reaching the downgradient area near OP-6 and OP-7, groundwater flows beneath the wetland area and El Toro Creek, and surfaces in San Juan Bay. This is deduced based on the knowledge that the carbonate aquifer is penetrated at a depth of around 40 to 50 ft bgs at OP-6 and OP-7, and likely continues to dip slightly toward the north.

Groundwater flow patterns are determined by paths of least resistance and driving head. Often underground utility lines act as preferential pathways for groundwater because of the low resistance of open conduits and coarse material used to backfill trenches. In addition, the driving head created by graded storm or sanitary lines can increase the rate of groundwater flow. Because sewers often discharge to streams and lakes, these preferential pathways can accelerate contaminant transport to surface waters. The storm sewer running east-to-west across the open field east of the DPW complex empties into El Toro Creek.

Additionally, subsurface soil is a potential secondary source at the site within the area east of the DPW complex. Surface soils are not expected to be a secondary source at the site because dumping typically occurs in the subsurface. Subsurface soil in the area east of the DPW complex is the main secondary source with three release mechanisms (wind suspension, volatilization, and infiltration and percolation). Any excavation activities conducted within this area may cause suspension of contaminated particulates. In the area east of the DPW complex, high VOC concentrations in groundwater indicate that volatilization (vapor transport) may also be a significant source of chemical contribution. As contaminants partition into the vapor phase, migration occurs primarily via diffusion, advection, and negative buoyancy. Depending on the contaminant's vapor pressure, it may migrate downward towards the water table or volatilize into ambient air.

The following are primary migration pathways for the site:

- Infiltration/leaching to groundwater;
- Groundwater migration;
- Soil and groundwater to soil gas;
- Vapor intrusion.

Media evaluated for the Northwest Boundary Area include: subsurface soil, surface water, and groundwater. Subsurface soil samples were collected during Phase I and Phase VI of the RFI investigation (see Section 3). Samples were collected from approximately 3 ft bgs to 36 ft bgs. For the HHRA, only subsurface soil samples to a depth of 20 ft bgs are evaluated for direct contact with receptors. Surface water samples were collected outside of Fort Buchanan in a downgradient water body (lagoon-like basin). The lagoon is bounded on the south by a dike, and surface water was also observed south of the dike in the direction of monitoring wells OP-6 and OP-7. As a result, sample locations included samples north of the dike and two to the south. Groundwater samples were collected from monitoring wells installed for all phases of the RFI effort. Monitoring well installation and sampling is further detailed in the *Northwest Boundary Investigation Work Plan and Quality Assurance Project Plan* (EA 2006) and associated addendums (EA 2007a, 2007b, 2008a, 2008b, 2008c, and 2010).

Surface soil is not evaluated in this HHRA for the Northwest Boundary Area. This HHRA evaluates potential risks from groundwater and associated impacted media only. The *Site Wide*

RCRA Facility Investigation Report, Fort Buchanan, Puerto Rico (EA 2010a) was issued in Draft Final form in June 2010. The objectives of the Site Wide RFI are to characterize potential contaminants of concern in surface/subsurface soil, surface water, sediment, and groundwater at sites not associated with the TCE groundwater plume. Many of the sites involved in the Site Wide RFI are located adjacent to the old DPW complex and are within the area being investigated as part of the Northwest Boundary RFI (this document). It is important to note that the Northwest Boundary RFI and associated risk assessment are focused on the groundwater TCE plume. The Site Wide RFI is the document that characterizes potential contamination in other media, including surface soil. The Site Wide RFI includes data generated as part of the Northwest Boundary RFI.

7.3.1.2 Receptors of Concern

When conducting an exposure assessment, USEPA (1989, 1991a,b) guidance requires that plausible exposure under both current and future land-use be evaluated in the HHRA. Accordingly, potential receptors are identified for both current and future use scenarios. The HHRA evaluates the risk to a range of onsite human receptor populations that are either currently or are reasonably anticipated to visit the site.

The Northwest Boundary Area is generally open and there is an unoccupied warehouse building (Building 539) within the groundwater plume. The Fort Buchanan Master Plan does not include any residential development for the portion of the installation included in the Northwest Boundary Area. However, there are no restrictions against building other structures at the site. The groundwater plume extends beyond the Fort Buchanan boundary. No production wells exist within 1 mile of Fort Buchanan. However, there are currently no groundwater restrictions for Fort Buchanan or off-post areas. As a result, potential receptors considered include adolescent trespasser, commercial worker, construction worker, off-post resident adult and child, and off-post recreational users.

7.3.1.2.1 Adolescent Trespasser –

An adolescent trespasser is evaluated in the HHRA because this receptor represents a more conservative exposure scenario than an adult trespasser. The adolescent age group of 7 to 16 years old is used to span 10 years after the 0-6 years of childhood. Typically, trespassers are only exposed to surface soil since they are not expected to dig while onsite. The trespasser exposure to subsurface soil is not expected unless future construction disturbs the subsurface. Therefore, the adolescent trespasser is evaluated for exposure to subsurface soil to aid in risk management decisions for the site. Trespassers are not expected to have direct contact with groundwater, thus they are not evaluated for this exposure pathway. Specific exposure pathways for an adolescent trespasser include:

- inhalation of fugitive dust from soil;
- dermal contact with soil; and
- incidental ingestion of soil.

7.3.1.2.2 Commercial Worker –

There are no restrictions against building or the development of the Northwest Boundary Area for industrial use. The commercial worker may result from the future construction of office space, warehouses, miscellaneous buildings, or research areas that would be occupied by full-time employees. Commercial workers are assumed to mainly work within enclosed building areas and occasionally visit other areas of the site. Typically, commercial workers are only exposed to surface soil; however, the presence of commercial workers within office spaces or other buildings would require construction to occur within the site. As a result, subsurface soil may be disturbed or mixed during construction activities. This would result in potential contact with subsurface soil media. Fort Buchanan is supplied potable water by PRASA. Therefore, commercial workers are not expected to have contact with groundwater. Groundwater within the Northwest Boundary Area does contain VOCs at levels that may cause a concern for indoor air through vapor intrusion. This exposure pathway is a potential concern if any buildings are built within the Northwest Boundary Area. Modeling this exposure pathway requires use of USEPA's Johnson and Ettinger model (USEPA 2004b). Specific exposure pathways for a commercial worker include:

- incidental ingestion of soil;
- dermal contact with soil;
- inhalation of fugitive dust from soil; and
- inhalation of VOCs in indoor air from vapor intrusion.

7.3.1.2.3 Construction Worker –

Future land use scenarios could include the development of the area. As a result, the construction worker would be present during development. Additionally, the construction worker is also expected during construction of underground utilities or sewer lines. As a result of construction activities, the construction worker would be exposed to media both on the surface and at depths. Due to the depth of groundwater (greater than 25 ft bgs) within the Northwest Boundary Area, the construction worker is not expected to contact groundwater within excavations or trenches. However, irrigation activities do occur within Fort Buchanan. Construction workers may have contact with irrigation water during construction or maintenance activities. Specific exposure pathways for a construction worker include:

- inhalation of fugitive dust from soil;
- dermal contact with soil and groundwater; and
- incidental ingestion of soil and groundwater.

7.3.1.2.4 Resident –

The Fort Buchanan Master Plan does not include any residential developments for the Northwest Boundary Area. Therefore, onsite residents are not a possibility for this area. The groundwater plume extends beyond the Fort Buchanan boundary where there are no restrictions on residential development. An off-post resident is considered in this HHRA as a conservative measure to evaluate the potential migration of the groundwater plume. It is assumed that the residences would use groundwater as a tap water source, even though a public water supply is available. Groundwater within the Northwest Boundary Area does contain VOCs at levels that may cause a concern for indoor air through vapor intrusion. This exposure pathway is a potential concern if any new buildings are built within the Northwest Boundary Area. Modeling this exposure pathway requires use of USEPA's Johnson and Ettinger model (USEPA 2004b). Off-post residents could also be exposed to surface water that has been potentially impacted by groundwater discharges. However, as noted in Section 7.2.3.3, there are no COPCs for surface water, so this exposure pathway will not be evaluated further. Specific exposure pathways for an off-post resident include:

- ingestion of groundwater when used as tap water;
- dermal contact with groundwater when used as tap water;
- inhalation of VOCs from groundwater while showering (adult only); and
- inhalation of VOCs through vapor intrusion.

Two age groups are considered for the residential scenario, including an adult and a child. The age group for the child is assumed at 0 to 6 years. The adult age group is considered an individual greater than 6 years of age.

7.3.1.2.5 Recreational User

Surface water in the lagoon-like basin located north of Fort Buchanan, outside of the Installation's boundary, could be impacted by groundwater discharges. This water body could be used for recreational purposes, potentially exposing users to impacted surface water. However, as noted in Section 7.2.3.3, there are no COPCs for surface water, so this exposure pathway will not be evaluated further. Recreational users are not expected to have direct contact with groundwater, thus they are not evaluated for this exposure pathway. Recreational users are also not expected within Fort Buchanan and are not evaluated for exposure to impacted media within the post.

7.3.2 SELECTION OF EXPOSURE POINT CONCENTRATIONS

Exposure point concentrations (EPCs) are derived to quantify concentrations of analytes. For the HHRA, the EPC represents the concentration of COPCs in media of concern that a selected receptor is expected to contact over a designated exposure period. In this HHRA, EPCs are derived as representative of a reasonable maximum exposure scenario. Table 7-3.1 through 7-3.5 present the EPCs for each media of concern.

Reported concentrations, as discussed in Section 7.2.1, are used to calculate the 95th percentile upper confidence limit on the mean (95UCLM) for COPCs in each medium (USEPA 1989). The 95UCLM is used because assuming long-term contact with the maximum concentration is not reasonable (USEPA 1989). The 95UCLM is determined based on the USEPA ProUCL program

(USEPA 2011c). The first step in estimation of an EPC is to determine how medium-specific environmental data for a COPC is distributed (i.e., normal, log-normal, non-parametric, etc.). The second step is to calculate the 95UCLM using a methodology appropriate for the distribution, sample size, and variance of each COPC data set. The ProUCL program calculates both the data distribution and the 95UCLM. Outputs from this program are provided for each COPC in each medium in Appendix O. In cases where the 95UCLM values exceed the maximum detected concentration, the maximum detected concentration is used as the EPC (USEPA 2011c).

For the vapor intrusion pathway, the EPC is calculated based upon a smaller dataset than identified for other media or exposure pathways. To determine the EPC for the vapor intrusion pathway, it is assumed that a building would be located over the area of highest groundwater concentrations. This area is approximately south of Columbus Street and includes an area encompassed by monitoring wells: MW14A, MW-14B, MW-15, MW-20, MW-21, MW-25, and MW-26 (Figure 3-1). The ProUCL outputs for this EPC are presented in Table 7-3.5 and Appendix P. For residents, it is assumed that any construction would occur outside the Fort Buchanan boundary in an area near PR-22. Due to the large spatial distribution between wells in this area, the well with the highest TCE detection is used to determine COPC EPCs. Historically, monitoring well OP-06 has had the highest detections of TCE. The maximum concentration of groundwater to indoor air COPCs will be selected from the sample results of this monitoring well. The EPCs for this exposure pathway are presented on Table 7-3.6.

7.3.3 EXPOSURE INTAKE EQUATIONS

The next step in the exposure assessment is to estimate COPC intakes for each pathway considered in the assessment. Intakes for each potential receptor are calculated using current USEPA risk assessment guidance and are presented in applicable risk assessment spreadsheets. Most exposure assumptions used to estimate intakes are based on default assumptions described in USEPA guidance documents (USEPA 1989, 1991a, 1991b, 2004a, 2009, and 2011a).

Two different measures of intake are evaluated, depending on the nature of the effect being evaluated. When evaluating longer-term (i.e., chronic) exposures to chemicals that produce adverse non-carcinogenic effects, intakes are averaged over the period of exposure (i.e., the averaging time [AT]) (USEPA 1989). This measure of intake is referred to as the average daily intake (ADI) and is a less than lifetime exposure. For chemicals that produce carcinogenic effects, intakes are averaged over an entire lifetime and are referred to as the lifetime average daily intake (LADI) (USEPA 1989).

7.3.3.1 Incidental Ingestion of Soil

Intake for the incidental ingestion of soil is estimated using the following equation:

$$(L)ADI = \frac{EPC \ x \ IR \ x \ EF \ x \ ED \ x \ CF}{BW \ x \ AT} \qquad \text{(Equation 1)}$$

where:

$(L)ADI$ = (Lifetime) Average daily intake (mg/kg-day)
EPC = Concentration in soil (mg/kg)
IR = Ingestion Rate (mg/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
CF = Conversion Factor (10^{-6} kg/mg)
BW = Body weight (kg)
AT = Averaging time (days)
For non-carcinogens, AT = ED x 365 days/yr
For carcinogens, AT = 70 years x 365 days/yr

7.3.3.2 Dermal Contact with Soil

Exposure associated with dermal contact with soil is estimated based upon the following equation:

$$(L)ADI = \frac{EPC \; x \; SA \; x \; AF \; x \; ABS \; x \; EF \; x \; ED \; x \; CF}{BW \; x \; AT} \qquad \text{(Equation 2)}$$

where:

$(L)ADI$ = (Lifetime) Average daily intake (mg/kg-day)
EPC = Concentration of a COPC in a soil (mg/kg)
SA = Surface Area for Contact (cm^2)
AF = Skin adherence factor (mg/cm^2-event)
ABS = Absorption factor (dimensionless)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
CF = Conversion Factor (10^{-6} kg/mg)
BW = Body weight (kg)
AT = Averaging time (days)
For non-carcinogens, AT = ED x 365 days/yr
For carcinogens, AT = 70 years x 365 days/yr

Most exposure assumptions used to estimate intake from dermal contact with soil are based upon USEPA default assumptions (USEPA 2004a). However, dermal absorption factors (ABS) are only available for a short list of chemicals in Exhibit 3-4 of USEPA RAGS E (USEPA 2004a).

The uncertainty associated with the lack of ABS factors is discussed in the uncertainty analysis section of the HHRA.

7.3.3.3 Inhalation of Air Containing Fugitive Dust/Volatiles Emitted from Soil

The intake of both particulates and vapors/gases are calculated using the same equation (USEPA 2009):

$$EC = \frac{C_{air}\ x\ ET\ x\ EF\ x\ ED}{AT} \qquad \text{(Equation 3)}$$

Where,

EC = Exposure concentration (mg/m^3)

C_{air} = Concentration of chemical in air (mg/m^3)

ET = Exposure time (hours)

EF = Exposure frequency (days/year)

ED = Exposure duration (years)

AT = Averaging time (days)

For non-carcinogens, AT = ED x 365 days/yr x 24 hours/day

For carcinogens, AT = 70 years x 365 days/yr x 24 hours/day

The concentration of chemicals in air resulting from emissions from soil is developed following procedures presented in the USEPA Soil Screening guidance (USEPA 2002c). The chemical concentration in air is calculated from:

$$C_{air} = C_{soil}\ x \left[\frac{1}{PEF} + \frac{1}{VF} \right] \qquad \text{(Equation 4)}$$

Where,

C_{air} = Concentration of chemical in air (mg/m^3)

C_{soil} = Chemical concentration in soil (mg/kg)

PEF = Particulate emission factor (m^3/kg)

VF = Volatilization factor (m^3/kg)

The PEF relates the concentration of a chemical in soil with the concentration of dust particles in air. A PEF value of 3.23×10^9 is used from the USEPA's Soil Screening Guidance (USEPA 2002c). Ambient air concentrations resulting from the volatilization of COPCs from soil are chemical dependent and are calculated using the USEPA's Soil Screening Guidance (USEPA 2002c).

7.3.3.4 Ingestion of Groundwater and Surface Water

Ingestion of groundwater is possible under a potential future residential scenario. Incidental ingestion of groundwater by construction workers may occur during construction or excavations. In addition, off-post residents and recreational users may incidentally ingest surface water from the wetland area. Intakes for groundwater and surface water ingestion are calculated based upon the following equation:

$$(L)ADI = \frac{EPC \ x \ IR \ x \ EF \ x \ ED}{BW \ x \ AT} \qquad \text{(Equation 5)}$$

Where,

$(L)ADI$ = (Lifetime) Average daily intake (mg/kg-day)
EPC = Concentration in groundwater or surface water (mg/L)
IR = Ingestion Rate (L/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (days)
For non-carcinogens, AT = ED x 365 days/yr
For carcinogens, AT = 70 years x 365 days/yr

7.3.3.5 Dermal Contact with Groundwater and Surface Water

Dermal contact with groundwater can occur during residential and construction activities. Residential dermal contact is assumed to occur during showering or bathing activities. For the construction worker, contact with groundwater is primarily assumed during construction at depth. In addition, the off-post resident and recreational user are assumed have dermal contact with surface water. The following equation is used to assess dermal contact exposures:

$$DAD = \frac{DA_{event} \ x \ SA \ x \ EV \ x \ EF \ x \ ED \ x \ CF}{BW \ x \ AT} \qquad \text{(Equation 6)}$$

Where,

DAD = Dermal absorbed dose (mg/kg-day)
DA_{event} = Dermal absorbed dose per event (mg/cm^2-event)
SA = Skin-surface area available for contact (cm^2)
EV = Event frequency (events/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)

AT = Averaging time (days)
For non-carcinogens, AT = ED x 365 days/yr
For carcinogens, AT = 70 years x 365 days/yr

The absorbed dose per event (DA_{event}) is estimated using a non-steady state approach for organic compounds and a steady-state approach for inorganics, except for surface water. Limited COPCs are detected in surface water. As a result, a steady-state approach is used. For organics, the following equations apply:

$$If\ t_{event} < t^{*}\ then: DA_{event} = (2)(K_p)(FA)(C_w)(CF)\left(\sqrt{\frac{6\tau\, t_{event}}{\pi}}\right) \quad \text{(Equation 7)}$$

$$If\ t_{event} > t^{*}\ then: DA_{event} = (K_p)(FA)(C_w)(CF)\left(\frac{t_{event}}{1+B} + 2\tau\left[\frac{1+3B+3B^2}{(1+B)^2}\right]\right)$$

Where,

t_{event} = Event duration (hour/event)
t^* = Time to reach steady-state conditions (hour)
K_p = Permeability coefficient of water through skin (cm/hr)
FA = Chemical-specific fraction absorbed (dimensionless)
C_w = Chemical concentration in water (mg/L)
τ = Lag time (hour)
π = Pi (dimensionless; equal to 3.14)
CF = Conversion factor (0.011 L/cm^3)
B = Dimensionless ratio of the permeability of the stratum corneum relative to permeability across the viable epidermis

For inorganics, the following steady-state equation to estimate DA_{event}:

$$DA_{event} = (K_p) \times (C_w) \times (t_{event}) \quad \text{(Equation 8)}$$

A majority of the exposure assumptions for dermal contact with water are based on default assumptions presented in USEPA RAGS E guidance (USEPA 2004a). For groundwater, dermal contact for residents assumes a total-body exposure. For the construction worker, the exposed surface area of the body available for contact is based on assumed activities, and is similar to the assumptions outlined for industrial dermal contact with soil and sediment.

For surface water, the water body adjacent to the site might be sufficient for swimming. Therefore, the off-post resident and recreational user exposure to surface water also assumes a total-body exposure. For the maintenance worker, they are not assumed to swim but contact surface water on a limited basis, similar to the assumptions outlined for industrial dermal contact with soil.

7.3.3.6 Inhalation of Volatiles in Groundwater

For VOCs in groundwater, there is potential exposure for residents to chemicals through inhalation while showering, bathing, washing dishes, etc. For residential receptors, chemical intakes from inhalation of VOCs while showering are estimated for the adult only. The following equation is used to estimate inhalation exposures:

$$EC = \frac{C_{air}\ x\ ET\ x\ EF\ x\ ED}{AT} \qquad \text{(Equation 9)}$$

Where,

EC = Exposure concentration (mg/m^3)

C_{air} = Concentration of chemical in air (mg/m^3)

C_{air} = Chemical concentration in water (mg/L) x K

K = Andelman volatilization factor (L/m^3)

= 0.5 L/m^3 (USEPA 2011b)

ET = Exposure time (hours)

EF = Exposure frequency (days/year)

ED = Exposure duration (years)

AT = Averaging time (days)

For non-carcinogens, AT = ED x 365 days/yr x 24 hours/day

For carcinogens, AT = 70 years x 365 days/yr x 24 hours/day

7.3.3.7 Inhalation of Volatiles in Indoor Air

There is an unoccupied warehouse building (Building 539) within the groundwater plume. However, there are no restrictions on future construction in the area or if the changes in the extent of the groundwater plume occur. As a result, VOCs in groundwater also have the potential to migrate into indoor air through vapor intrusion. Modeling this exposure pathway requires use of USEPA's Johnson and Ettinger model (USEPA 2004b). The Johnson and Ettinger model incorporates both convective and diffusive mechanisms for estimating the transport of contaminant vapors emanating from groundwater into indoor air spaces located directly above the source of contamination. The Johnson and Ettinger model is a one-dimensional analytical solution to convective and diffusive vapor transport into indoor spaces. Inputs to the model include chemical properties of the COPCs, saturated and unsaturated zone soil properties, and structural properties of the building. Structural properties of buildings at the Northwest Boundary Area are not known at this time. As a result, default values are used for structural properties of the buildings. Site-specific soil types are entered into the model;

however, default model values are used for soil parameters (i.e., soil vapor permeability, dry bulk density, etc.). Calculations for the Johnson and Ettinger model are included in Appendix P. Calculations are provided for both the commercial worker and the resident adult.

7.4 TOXICITY ASSESSMENT

Toxicity assessment is the third step of the HHRA process. The toxicity assessment considers the types of potential adverse health effects associated with exposures to COPCs; the relationship between the magnitude of exposure and potential adverse effects; and related uncertainties, such as the weight of evidence of a particular COPC's carcinogenicity in humans. USEPA guidance (USEPA 1989) specifies that the assessment be accomplished in two steps: hazard identification and dose-response assessment. Hazard identification is the process of determining whether studies claim that exposure to a COPC may cause the incidence of an adverse effect. USEPA specifies the dose-response assessment, which involves: (1) USEPA's quantitative evaluation of the existing toxicity information, and (2) USEPA's characterization of the relationship between the dose of the COPC administered or received, and the incidence of potentially adverse health effects in the exposed population. From this quantitative dose-response relationship, specific toxicity values are derived by USEPA that can be used to estimate the incidence of potentially adverse effects occurring in humans at different exposure levels (USEPA 1989). These USEPA-derived toxicity values are called reference doses (RfDs) for non-carcinogens and reference concentrations (RfCs) for potential carcinogens. Compounds lacking values, for which surrogates cannot be substituted, are not assessed quantitatively. Qualitative analysis of these compounds is provided in the Uncertainties Section.

Toxicity values are selected in keeping with appropriate exposure duration and USEPA guidance (USEPA 1989 and 2003). Tier 1 values are found using the Integrated Risk Information System (IRIS) for established, current values (USEPA 2011d). When toxicity values are not available from IRIS, Tier 2 values are then examined.

Tier 2 values are USEPA's Provisional Peer Reviewed Toxicity Values (PPRTVs), which are developed by the Office of Research and Development, the National Center for Environmental Assessment (NCEA), and the Superfund Health Risk Technical Support Center on a chemical-specific basis when requested by the Superfund program.

Tier 3, other toxicity values, are considered when Tier 1 or Tier 2 toxicity values are not available. These toxicity values are taken from additional USEPA and non-USEPA sources and are chosen based on the most current and best peer-reviewed source available. Health Effects Assessment Summary Tables (HEAST) (USEPA 1997), the California Environmental Protection Agency Office of Environmental Health Hazard Assessment (OEHHA) Toxicity Criteria Database (CalEPA 2011), and the Agency for Toxic Substances and Disease Registry (ATSDR) Minimal Risk Levels (MRLs) (ATSDR 2008) are the Tier 3 sources utilized for this HHRA.

7.4.1 TOXICITY ASSESSMENT FOR NON-CARCINOGENS

The methodology used by USEPA for deriving non-cancer reference values for non-carcinogens and site-specific considerations for modifying or using these concentrations are discussed in detail in USEPA guidance (USEPA 2011d). Non-carcinogens are typically judged to have a threshold daily dose below which deleterious or harmful effects are unlikely to occur. This concentration is called the no-observed-adverse-effect-level (NOAEL), and may be derived from either animal laboratory experiments or human epidemiology investigations (usually workplace studies). In developing a toxicity value or human NOAEL for non-carcinogens (i.e., an RfD), the regulatory approach is to (1) identify the critical toxic effect associated with chemical exposure (i.e., the most sensitive adverse effect); (2) identify the threshold dose in either an animal or human study; and (3) modify this dose to account for interspecies variability (where appropriate), differences in individual sensitivity (within-species variability), and other uncertainty and modifying factors.

Uncertainty factors (UFs) are intended to account for specific types of uncertainty inherent in extrapolation from the available data. The modifying factor (MF) accounts for the confidence in the scientific studies from which toxicity values are derived, according to such parameters as study quality and study reproducibility. The UFs are generally 10-fold, default factors used in operationally deriving the RfD and RfC from experimental data. UFs less than 10 can be used. A UF of 3 can be used in place of one-half power ($10^{0.5}$) when appropriate. The UFs are intended to account for (1) variation in susceptibility among the members of the human population (i.e., inter-individual or intraspecies variability); (2) uncertainty in extrapolating animal data to humans (i.e., interspecies uncertainty); (3) uncertainty in extrapolating from data obtained in a study with less-than-lifetime exposure (i.e., extrapolating from subchronic to chronic exposure); (4) uncertainty in extrapolating from a lowest-observed-adverse-effect-level (LOAEL) rather than from a NOAEL; and (5) uncertainty associated with extrapolation when the database is incomplete. The maximum UF for the derivation of the RfC is 3,000. The theoretical maximum UF for the derivation of the RfD is 10,000. However, the USEPA has recently begun limiting the total uncertainty factors applied to 3,000.

A MF ranging from 0 to 10 is included to reflect a qualitative professional assessment of additional uncertainties in the critical study and in the entire database not addressed by the uncertainty factors. The default value for the MF is 1. The USEPA discontinued the use of the modifying factor in 2004. However, toxicity values for some chemicals, derived before 2004, still contain a modifying factor. The use of these factors is a conservative approach for protection of human health and is likely to overestimate the toxic potency associated with chemical exposure. The RfDs and RfCs provided in this HHRA take into account the associated uncertainty/modifying factors identified by the USEPA. To calculate the RfD/RfC, the appropriate NOAEL is divided by the product of all the applicable UFs and the MF.

This is expressed as:

$$\text{RfD/RfC} = \text{NOAEL} / (\text{UF}_1 \text{ x } \text{UF}_2 \ldots \text{ x MF}) \qquad \text{(Equation 10)}$$

The resulting RfD is expressed in units of milligrams of chemical per kilogram of body weight per day (mg/kg-bw/day). The RfC is expressed in units of mg/m^3.

7.4.2 TOXICITY ASSESSMENT FOR CARCINOGENICITY

Unlike non-carcinogens, carcinogens are generally assumed to have no threshold. There is presumed to be no level of exposure below which carcinogenic effects will not manifest themselves. This "non-threshold" concept supports the idea that there are small, finite probabilities of inducing a carcinogenic response associated with every level of exposure to a potential carcinogen. USEPA uses a two-part evaluation for carcinogenic effects. This evaluation includes the assignment of a weight-of-evidence classification and the quantification of a cancer toxic potency concentration. Quantification is expressed as a slope factor (SF) or an inhalation unit risk (IUR), which reflects the dose-response data for the carcinogenic endpoint(s) (USEPA 2011d).

The weight-of-evidence classification system assigns a letter or alphanumeric (A through E) to each potential carcinogen that reflects an assessment of its potential to be a human carcinogen.[1] The weight-of-evidence classification is based on a thorough scientific examination of the body of available data. USEPA has recently established five recommended standard hazard descriptors: "*Carcinogenic to Humans*," "*Likely to Be Carcinogenic to Humans*," "*Suggestive Evidence of Carcinogenic Potential*," "*Inadequate Information to Assess Carcinogenic Potential*," and "*Not Likely to Be Carcinogenic to Humans*" (USEPA 2005a). The weight-of-evidence classification is based on a thorough scientific examination of the body of available data. Only compounds that have a weight-of-evidence classification of C or above are considered to have carcinogenic potential in this HHRA.

The SF and the IUR is the upper 95th percentile confidence limit of the probability of response per unit daily intake of a chemical over a lifetime. Typically, the SF and IUR is used to estimate the upper-bound lifetime probability of a person developing cancer from exposure to a given concentration of a carcinogen. SFs and IURs are generally based on experimental animal data, unless suitable epidemiological studies are available. Because of the difficulty in detecting and measuring carcinogenic endpoints at low exposure concentrations, SFs and IURs are typically developed by using a model to fit the available high-dose, experimental animal data, and then

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[1] A = a known human carcinogen; B1 = a probable human carcinogen, based on sufficient animal data and limited human data; B2 = a probable human carcinogen based on sufficient animal data and inadequate or no human data; C = a possible human carcinogen; D = not classifiable as to human carcinogenicity; and E = evidence of non-carcinogenicity for humans.

extrapolating downward to the low-dose range to which humans are typically exposed. USEPA recommends the linear multistage model to derive an SF and IUR. The model is conservative and provides an upper bound estimate of excess lifetime cancer risk.

COPCs that are determined to have sufficient weight of evidence for carcinogenic endpoints are also assessed for mutagenic modes of action. The mutagenic mode of action is assessed with a linear approach (USEPA 2005a). COPCs identified as mutagenic have sensitivity pertaining to cancer risks associated with early-life exposures. To account for the early-life exposure and the mutagenic mode of action, the cancer potency estimates are adjusted. USEPA recommends, for mutagenic chemicals, when no chemical-specific data exist, a default approach using estimates from chronic studies (i.e., cancer slope factors) with appropriate modifications to address the potential for differential risk of early-life stage exposure (USEPA 2005a,b). A modification for early-life stage exposure to mutagenic COPCs is required because available studies indicate higher cancer risks resulting from a given exposure occurring early in life when compared with the same amount of exposure during adulthood (USEPA 2005a). For this HHRA, the SFs for COPCs identified with a mutagenic mode of action are modified for the following (USEPA 2005b):

- For exposures between infant and <3 years of age, a 10-fold adjustment is made.
- For exposures between 3 and <16 years of age, a 3-fold adjustment is made.
- For exposures after turning 16 years of age, no adjustment is made.

7.4.3 MODIFICATIONS FOR DERMAL CONTACT

Toxicity values specific to dermal exposures are not available and require adjustment of the oral toxicity values (oral RfDs or SFs). This adjustment accounts for the difference between the daily intake doses through dermal contact as opposed to ingestion. Most toxicity values are based on the actual administered dose and must be corrected for the percent of chemical-specific absorption that occurs across the gastrointestinal tract prior to use in dermal contact risk assessment (USEPA 1989 and 2004a). USEPA recommends utilizing oral absorption efficiency factors in converting oral toxicity values to dermal toxicity values (USEPA 2004a). This adjustment accounts for the absorption efficiency in the "critical study," which is utilized in determining the RfD and SF. Where oral absorption in the critical study is essentially complete (i.e., 100 percent), the absorbed dose is equivalent to the administered dose, and no adjustment of oral toxicity values is necessary when evaluating dermal exposures. When gastrointestinal absorption of a chemical in the critical study is poor (e.g., 1 percent), the absorbed dose is smaller than the administered dose, and toxicity values for dermal exposure are adjusted to account for the difference in the absorbed dose relative to the administered dose. To account for the differences between the administered (oral) and the absorbed (dermal) dose, RfDs and SFs are modified by the gastrointestinal dermal absorption factor (GIABS).

7.5 RISK CHARACTERIZATION

Risk characterization is the fourth step of the HHRA process. In this step, the toxicity values are combined with the estimated chemical intakes for the receptor populations to quantitatively estimate both carcinogenic risks and non-carcinogenic hazards. Effects are estimated for each receptor of concern.

7.5.1 HAZARD INDEX FOR NON-CARCINOGENIC EFFECTS

The potential human health risks associated with exposures to non-carcinogenic COPCs are estimated by comparing the ADI with the chemical-specific RfD, as per USEPA Guidance (USEPA 1989).

A hazard quotient (HQ) is derived for each COPC, as shown in the equation below:

$$HQ = \frac{ADI}{RfD} \quad \text{or} \quad EC = \frac{ADI}{RfC} \qquad \text{(Equation 11)}$$

where:

HQ = Hazard Quotient; ratio of average daily intake level to acceptable daily intake level (unitless)

ADI = Estimated non-carcinogenic average daily intake (mg/kg-day)

EC = Exposure concentration (mg/m^3)

RfD = Reference dose (mg/kg-day)

RfC = Reference concentration (mg/m^3)

If the average daily dose exceeds the RfD, the HQ will exceed a ratio of one (1.0) and there may be concern that potential adverse systemic health effects will be observed in the exposed populations. If the ADI does not exceed the RfD, the HQ will not exceed 1.0 and there will be no concern that potential adverse systemic health effects will be observed in the exposed populations. However, if the sum of several HQs exceeds 1.0, and the COPCs affect the same target organ, there may be concern that potential adverse systemic health effects will be observed in the exposed populations. In general, the greater the value of the HQ above 1.0, the greater the level of concern. However, the HQ does not represent a statistical probability that an adverse health effect will occur.

For consideration of exposures to more than one chemical causing systemic toxicity via several different pathways, the individual HQs are summed to provide an overall hazard index (HI). If the HI is less than 1.0, then no adverse health effects are likely to be associated with exposures at the site. However, if the total HI is greater than 1.0, separate endpoint-specific HIs may be calculated based on toxic endpoint of concern or target organ (e.g., HQs for neurotoxins are summed separately from HQs for renal toxins). Only if an endpoint-specific HI is greater than 1.0 is there reason for concern about potential health effects for that endpoint.

7.5.2 CARCINOGENIC RISKS

Carcinogenic risk is estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen. The numerical estimate of excess lifetime cancer risk is calculated by multiplying the LADI by the risk per unit dose (SF).

This is shown in the following equation:

$$Risk = LADI \times SF \quad or \quad EC \, x \, IUR \qquad \text{(Equation 12)}$$

where:

Risk	=	Unitless probability of an exposed individual developing cancer
LADI	=	Lifetime cancer average daily intake (mg/kg-day)
EC	=	Exposure concentration (ug/m^3)
SF	=	Cancer slope factor (mg/kg-day)$^{-1}$
IUR	=	Inhalation Unit Risk (ug/m^3)$^{-1}$

Because the SF is the statistical 95th percent upper-bound confidence limit on the dose-response slope, this method provides a conservative, upper-bound estimate of risk.

It should be noted that the interpretation of the significance of the cancer risk estimate is based on the appropriate public policy. USEPA in the National Oil and Hazardous Substances Pollution Contingency Plan (40 CFR Part 300) (USEPA 1990) states that:

> *"...For known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an excess upper bound lifetime cancer risk to an individual of between 10^{-4} and 10^{-6}."*

7.6 RISK CHARACTERIZATION RESULTS – NORTHWEST BOUNDARY AREA

Calculations are presented by receptor in Tables 7-7.1 through 7-7.5. Table 7-7.6 presents the estimation of COPC air concentrations of particulate from soil. Tables 7-7.7 and 7-7.8 present the calculations for the dermal absorbed dose for the resident and the construction worker, respectively.

Estimates of cumulative risks across all pathways for non-carcinogenic and carcinogenic effects for all receptors are presented in Tables 7-9.1 through 7-9.4. A risk assessment summary is presented in Tables 7-10.1 through 7-10.4. COPCs are only identified on Tables 7-10.1 through 7-10.4 if cumulative carcinogenic risks are greater than the lower bound of the USEPA's "acceptable risk range" (i.e., 10^{-6}) or cumulative non-carcinogenic risks are greater than 1.0. Only COPCs with carcinogenic risks greater than 10^{-6} or non-carcinogenic risks greater than 0.1 are shown on these tables.

7.6.1 ADOLESCENT TRESPASSER RESULTS

The current adolescent trespasser receptor is evaluated for COPC exposure in soil. The exposure scenario calculations are presented in Table 7-7.1. The carcinogenic and non-carcinogenic risk assessment results for the adolescent trespasser are summarized in Table 7-9.1.

7.6.1.1 Non-Carcinogenic Results

The total non-carcinogenic HI for the adolescent trespasser is 0.06, which is below the acceptable threshold of 1.0 (Table 7-9.1). Therefore, there are no non-carcinogenic concerns for the adolescent trespasser at the Northwest Boundary Area.

7.6.1.2 Carcinogenic Results

The cumulative carcinogenic risk for the adolescent trespasser is 1.3×10^{-6}, which is within the USEPA's "acceptable risk range" of 10^{-4} to 10^{-6} (Table 7-9.1). Therefore, there are no carcinogenic risk concerns for the adolescent trespasser at the Northwest Boundary Area.

7.6.2 COMMERCIAL WORKER RESULTS

The commercial worker receptor is evaluated for exposure to COPCs in soil and COPCs in indoor air from groundwater VOC vapor intrusion. The exposure scenario calculations are presented in Table 7-7.2. The carcinogenic and non-carcinogenic risk assessment results for the commercial worker are summarized in Table 7-9.2.

7.6.2.1 Non-Carcinogenic Results

The total non-carcinogenic HI for the commercial worker is 2.8, which is above the acceptable threshold of 1.0 (Table 7-9.2). The HI for exposure to soil is 0.1 and for exposure to indoor air is 2.7. TCE is the primary contributor to non-carcinogenic hazards in indoor air. TCE is the only COPC with a HQ greater than 1. No other COPCs have a HQ greater than 0.01. Therefore, there are potential non-carcinogenic concerns for the commercial worker in future buildings within the Northwest Boundary Area.

7.6.2.2 Carcinogenic Results

The cumulative carcinogenic risk for the commercial worker is 2.2×10^{-5}, which is within USEPA's "acceptable risk range" of 10^{-4} to 10^{-6} (Table 7-9.2). The carcinogenic risk for exposure to soil is $1.3x10^{-5}$ and for exposure to indoor air is $8.4x10^{-6}$. Therefore, there are no carcinogenic risk concerns for the commercial worker exposure to the Northwest Boundary Area.

7.6.3 CONSTRUCTION WORKER RESULTS

The future construction worker receptor is evaluated for exposure to COPCs in soil and groundwater. The exposure scenario calculations are presented in Table 7-7.3. The carcinogenic and non-carcinogenic risk assessment results for the construction worker are summarized in Table 7-9.3.

7.6.3.1 Non-Carcinogenic Results

The total non-carcinogenic HI for the construction worker is 0.6, which is below the acceptable threshold of 1.0 (Table 7-9.3). The HI for exposure to soil is 0.2 and for exposure to groundwater is 0.4. Therefore, there are no non-carcinogenic concerns for the construction worker at the Northwest Boundary Area.

7.6.3.2 Carcinogenic Results

The cumulative carcinogenic risk for the construction worker is 1.1×10^{-6}, which is within USEPA's "acceptable risk range" of 10^{-4} to 10^{-6} (Table 7-9.3). The carcinogenic risk for exposure to soil is $9.7\text{x}10^{-7}$ and for exposure to groundwater is $1.6\text{x}10^{-6}$. Therefore, there are no carcinogenic risk concerns for the construction worker at the Northwest Boundary Area.

7.6.4 OFF-POST RESIDENT ADULT AND CHILD RESULTS

The off-post resident adult and child receptors are evaluated for exposure to COPCs in groundwater. The exposure scenario calculations are presented in Table 7-7.4 for the resident adult and Table 7-7.5 for the resident child. The carcinogenic and non-carcinogenic risk assessment results for resident adult and child are summarized in Table 7-9.4. For the resident adult, inhalation of VOCs from groundwater are evaluated in two separate exposure pathways. Table 7-7.4 presents the calculations for inhalation of VOCs while showering. The resident adult is also evaluated for inhalation of VOCs in indoor air from vapor intrusion. Calculations for this exposure pathway are presented in Appendix P. Table 7-9.4 presents a summation of both inhalation exposure pathways for the resident adult.

7.6.4.1 Non-Carcinogenic Results

The total non-carcinogenic HI for the off-post resident child is 67, which exceeds the acceptable threshold of 1.0 (Table 7-9.4). TCE is the primary contributor to the non-carcinogenic hazard with a HQ of 60. In addition, iron, manganese, and cis-1,2-DCE also have HQs greater than 1. Table 7-10.4 presents the COPCs that contribute to the non-carcinogenic hazard and a breakdown by target organ. Therefore, there are potential non-carcinogenic concerns for the resident child exposure to groundwater as a tap water source near the Northwest Boundary Area.

The total non-carcinogenic HI for the off-post resident adult is 37, which is above the acceptable threshold of 1.0 (Table 7-9.4). TCE is the primary contributor to the non-carcinogenic hazard with a HQ of 34. No other chemicals have a HQ greater than 1. Table 7-10.4 presents the COPCs that contribute to the non-carcinogenic hazard and a breakdown by target organ. The evaluation of indoor air through vapor intrusion reveals that this exposure pathway is not a primary concern. Therefore, there are potential non-carcinogenic concerns for the resident adult exposure to groundwater as a tap water source near the Northwest Boundary Area.

7.6.4.2 Carcinogenic Results

The total lifetime carcinogenic risk for the off-post resident (adult and child combined) exposure to groundwater is $5.2\text{x}10^{-4}$ (Table 7-9.4). This carcinogenic risk is above the USEPA's "acceptable risk range" of 10^{-6} to 10^{-4}. Arsenic and TCE have carcinogenic risks greater than 10^{-4}. In addition, PCE has carcinogenic risks greater than 10^{-5}. Therefore, there are potential carcinogenic risk concerns for the resident exposure to groundwater as a tap water source near the Northwest Boundary Area.

7.7 UNCERTAINTIES IN THE HHRA

There are numerous uncertainties involved in the HHRA process. These are discussed briefly in the following sections.

7.7.1 CHEMICALS NOT ASSESSED IN THE HHRA

7.7.1.1 Soil

The maximum detected concentration of Aroclor 1254 and ethylbenzene are greater than the screening levels presented in Table 7-2.1. However, they are not assessed in the HHRA due to a low frequency of detection. Both chemicals are only detected in 1 out of 21 samples. Therefore, the maximum detected concentration of these chemicals is compared to the residential soil RSLs (not modified) to assess potential risk contributions. The maximum detected concentration of Aroclor 1254 is 0.167 mg/kg. This concentration is higher than the selected screening value of 0.11 mg/kg, which is 1/10th the non-carcinogenic HQ. However, the unmodified RSL is 0.22 mg/kg, which equals a carcinogenic risk level of 10^{-6}. The maximum detected concentration of Aroclor 1254 is not higher than the carcinogenic RSL and is only 2 times the modified non-carcinogenic RSL. This reveals that Aroclor 1254 does not contribute significantly to risk results. The maximum detected concentration of ethylbenzene is 18.6 mg/kg, which exceeds the carcinogenic RSL of 5.4 mg/kg. To determine an approximate carcinogenic risk, the maximum detected concentration is divided by the RSL and multiplied by 10^{-6}. Therefore, the resulting carcinogenic risk for ethylbenzene is 3×10^{-6}, which reveals ethylbenzene is not a concern in soil.

7.7.1.2 Groundwater

Total and dissolved antimony, total thallium, heptachlor, 1,4-dichlorobenzene, benzene, bromodichloromethane, ethylbenzene, and methylene chloride are not assessed in the groundwater risk calculations because these chemicals have low frequency of detections. Therefore, the maximum detected concentration of these chemicals is compared to the tap water RSLs (not modified) to assess potential risk contributions. The tap water RSLs for heptachlor, 1,4-dichlorobenzene, benzene, bromodichloromethane, ethylbenzene, and methylene chloride are based upon a carcinogenic endpoint, so these chemicals will be assessed by dividing the maximum detected concentration by the tap water RSL. The resulting ratio will be multiplied by 10^{-6} to represent an approximate carcinogenic risk. The tap water RSLs for antimony and thallium are based upon a non-carcinogenic endpoint, so the approximate hazard will be based upon a ratio of the maximum detected concentration to the RSL. The results for groundwater are presented in the following table:

Chemical	Maximum Detected Concentration (ug/L)	Tap Water RSL (ug/L)	Carcinogenic Risk or Non-carcinogenic Hazard
Carcinogenic Endpoints			
Heptachlor	0.96	0.015	$6x10^{-5}$
1,4-Dichlorobenzene	1.5	0.43	$3x10^{-6}$
Benzene	0.93	0.41	$2x10^{-6}$
Bromodichloromethane	0.5	0.12	$4x10^{-6}$
Ethylbenzene	3.9	1.5	$3x10^{-6}$
Methylene Chloride	11.9	4.8	$2x10^{-6}$
Non-carcinogenic Endpoints			
Total Antimony	29.8	15.0	2
Dissolved Antimony	6.1	15.0	0.4
Total Thallium	1.8	0.78	2

The cumulative carcinogenic risk for residential exposure to groundwater is $5.2x10^{-4}$, with arsenic and TCE contributing approximately 94% of the carcinogenic risks. Therefore, these chemicals would not contribute significantly to the overall risk results and do not result in an underestimate of chemicals of concern in groundwater.

Total antimony and total thallium do have HQs greater than 1. However, only the maximum detected concentration of total antimony exceeds the tap water RSL. The maximum concentration of total antimony also exceeds the MCL. This monitoring well (MW-14A) is located within the area of the highest detected VOC concentrations. The maximum concentration of total thallium is higher than the RSL but lower than the MCL. Thallium was only detected in the total fraction in 2 out of 48 samples. However, it is noted that the detection limit for thallium is higher than the RSL and MCL, which presents some uncertainty in the actual contribution of thallium to overall risk results. The uncertainty associated with thallium is increased because the toxicity values presented by the USEPA for thallium are provisional values. The studies utilized in determining an RfD are of low quality and result in high uncertainty factors that the USEPA considers unreliable. Therefore, the RfD presented for thallium is only to be used for screening purposes (USEPA 2010). As a result of the uncertainty for antimony and thallium, non-carcinogenic hazards may be slightly underestimated for groundwater.

Additionally, the oral RfD for 1,2-dichloroethane and the inhalation RfC for 1,1,2-trichloroethane are not used to determine non-carcinogenic hazards in groundwater. These non-carcinogenic toxicity values have been identified in their associated PPRTV support documentation as having too high uncertainty to adequately derive chronic values. The non-carcinogenic toxicity values are only to be used in screening and not for derivation of risks. These chemicals are assessed for the carcinogenic end point in groundwater. Because both chemicals are quantitatively assessed for carcinogenic risks, the uncertainties associated with the non-carcinogenic hazards are not expected to change the overall risk results for groundwater.

7.7.2 SAMPLING AND ANALYSIS UNCERTAINTIES

The sampling plan can have a significant impact on the results obtained in calculating human health risks at a site. To the extent that samples are taken in areas that are expected to be contaminated (biased sampling), the EPC used in calculating risk exposures and risks is likely to overestimate the actual concentration encountered from random exposure across the site. This sampling bias will generally result in an overestimate of exposures and risks at a site. As the majority of the samples collected are biased toward potentially contaminated areas, the measured concentrations and calculated health risks would tend to be overestimated.

7.7.3 UNCERTAINTIES ANALYSIS OF EXPOSURE ASSESSMENT

An analysis of uncertainties is an important aspect of the exposure assessment. It provides the risk assessor and reviewer with information relevant to the individual uncertainties associated with exposure factor assumptions and their potential impact on the final assessment. The exposure assessment assumes potential receptors that may reside, work, or trespass onto certain areas of the Northwest Boundary Area. Furthermore, assumptions are made about potential receptors' exposure to site media, especially groundwater. Currently, there are no potable water supply wells within a 1-mile area of the Northwest Boundary Area. However, groundwater is assessed as a potable water source to provide risk management decisions for the area. This may overestimate risks for groundwater to receptors.

7.7.4 UNCERTAINTIES OF TOXICITY ASSESSMENT

There are numerous uncertainties associated with the toxicity assessment. These are generally due to the unavailability of data to thoroughly calculate the toxicity of COPCs. These uncertainties are described in more detail in the following sections.

7.7.4.1 Uncertainties Associated With Non-Carcinogenic Effects

7.7.4.1.1 Interspecies Extrapolation –

The majority of toxicological information comes from experiments with laboratory animals. Experimental animal data have been relied on by regulatory agencies to assess the hazards of chemical exposures to humans. Interspecies differences in chemical absorption, metabolism, excretion, and toxic response are not well understood; therefore, conservative assumptions are applied to animal data when extrapolating to humans. These probably result in an overestimation of toxicity.

7.7.4.1.2 Intraspecies Extrapolation –

Differences in individual human susceptibilities to the effects of chemical exposures may be caused by such variables as genetic factors (e.g., glucose-6-phosphate dehydrogenase deficiency), lifestyle (e.g., cigarette smoking and alcohol consumption), age, hormonal status (e.g., pregnancy), and disease. To take into account the diversity of human populations and their differing susceptibilities to chemically induced injury or disease, a safety factor is used. USEPA uses a factor between 1 and 10. This uncertainty may lead to overestimation of human health effects at given doses.

7.7.4.2 Uncertainties Associated With Carcinogenic Effects

7.7.4.2.1 Interspecies Extrapolation –

The majority of toxicological information for carcinogenic assessments comes from experiments with laboratory animals. There is uncertainty about whether animal carcinogens are also carcinogenic in humans. While many chemical substances are carcinogenic in one or more animal species, only a very small number of chemical substances are known to be human carcinogens. The fact that some chemicals are carcinogenic in some animal species but not in others raises the possibility that not all animal carcinogens are human carcinogens. Regulatory agencies assume that humans are as sensitive to carcinogens as the most sensitive animal species. This policy decision, designed to prevent underestimation of risk, introduces the potential to overestimate carcinogenic risk.

7.7.4.2.2 High-Dose to Low-Dose Extrapolation –

Typical cancer bioassays provide limited low-dose data on responses in experimental animals for chemicals being assessed for carcinogenic or chronic effects. The usual dose regime involves three dose groups per assay. The first dose group is given the highest dose that can be tolerated, the second is exposed to one-half that dose, and the third group is unexposed (control group) (National Research Council [NRC] 1983). Because this dosing method does not reflect how animals would react to much lower doses of a chemical, a dose-response assessment normally requires extrapolation from high to low doses using mathematical modeling that incorporates to varying degrees information about physiologic processes in the body (NRC 1983).

A central problem with the low-dose extrapolation models is that they all too often fit the data from animal bioassays equally well, and it is not possible to determine their validity based on goodness of fit. Several models may fit experimental data equally well, but all may not be equally plausible biologically. The dose-response curves derived from different models diverge substantially in the dose range of interest (NRC 1983). Therefore, low-dose extrapolation is more than a curve-fitting process, and considerations of biological plausibility of the models must be taken into account before choosing the best model for a particular set of data.

7.7.5 UNCERTAINTIES IN RISK CHARACTERIZATION

Uncertainties in the risk characterization can stem from the inherent uncertainties in the data evaluation, the exposure assessment process, including any modeling of exposure point concentrations in secondary media from primary media, and the toxicity assessment process. The individual uncertainties in these respective processes are addressed in previous sections.

7.8 CONCLUSIONS

Groundwater, soil, and surface water are evaluated as potential media of concern for potential human receptors at the Northwest Boundary Area of Fort Buchanan. The HHRA determined there are no potential concerns for human contact with soil and surface water potentially affected by activities within the Northwest Boundary Area. There are potential concerns for exposure to groundwater within the Northwest Boundary Area. The HHRA found potential concerns for the commercial worker and off-post resident exposure to groundwater. For the commercial worker, there are potential concerns for inhalation of indoor air from vapor intrusion. Any buildings constructed or used in the future that are within the Northwest Boundary Area should take into account potential vapor intrusion of VOCs from groundwater to the indoor spaces. Furthermore, there are potential risk concerns for off-post resident exposure to groundwater as a tap water source. The primary contributor to groundwater concerns is TCE. TCE contributes approximately 71% of carcinogenic risks and approximately 90% of non-carcinogenic hazards.

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TABLE 7-2.1
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
FORT BUCHANAN HUMAN HEALTH RISK ASSESSMENT
SUBSURFACE SOIL - RESIDENTIAL

Scenario Timeframe: Current/Future-Residential
Medium: Subsurface soil
Exposure Medium: Subsurface soil
Exposure Point: Fort Buchanan Northwest Boundary

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration (2) Used for Screening	Background (3) Value	Screening (4) Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for (5) Contaminant Deletion or Selection
INORGANICS																
7429-90-5	**ALUMINUM**	**2.15E+04**	**J**	**3.01E+04**	**J**	**mg/kg**	**SL-4-5**	**11/11**	**2.60E+01 - 3.00E+01**	**3.01E+04**	**3.00E+04**	**7.70E+03 N**	**NA**	**NA**	**Yes**	**ASL**
7440-36-0	**ANTIMONY**	**5.20E-01**	**J**	**4.10E+00**		**mg/kg**	**TP-4-4**	**12/21**	**2.30E+00 - 1.40E+01**	**4.10E+00**	**2.20E+00**	**3.10E+00 N**	**NA**	**NA**	**Yes**	**ASL**
7440-38-2	**ARSENIC**	**3.60E+00**		**7.20E+01**		**mg/kg**	**TP-4-4**	**21/21**	**4.00E-01 - 1.40E+01**	**7.20E+01**	**4.39E+01**	**3.90E-01 C**	**NA**	**NA**	**Yes**	**ASL**
7440-39-3	BARIUM	1.74E+01	J	9.10E+01		mg/kg	SL-1-3	15/21	2.30E+01 - 1.40E+02	9.10E+01	1.02E+02	1.50E+03 N	NA	NA	No	BSL
7440-41-7	BERYLLIUM	1.20E-01	J	8.20E-01		mg/kg	SB-03-06-04-(4-8)	10/21	5.60E-01 - 3.50E+00	8.20E-01	6.47E-01	1.60E+01 N	NA	NA	No	BSL
7440-43-9	CADMIUM	6.80E-01	J	2.10E+00		mg/kg	TP-4-4	16/21	5.60E-01 - 3.50E+00	2.10E+00	8.58E-01	7.00E+00 N	NA	NA	No	BSL
7440-47-3	CHROMIUM	2.22E+01	J	1.90E+02	J	mg/kg	SB-03-06-05-(4-8)	21/21	1.10E+00 - 7.00E+00	1.90E+02	6.98E+01	1.20E+04 N	NA	NA	No	BSL
7440-48-4	**COBALT**	**5.70E+00**	**J**	**3.77E+01**		**mg/kg**	**SB-03-06-03-(4-8)**	**16/21**	**5.60E+00 - 3.50E+01**	**3.77E+01**	**1.66E+01**	**2.30E+00 N**	**NA**	**NA**	**Yes**	**ASL**
7440-50-8	COPPER	2.46E+01		1.78E+02	J	mg/kg	TP-4-4	21/21	2.80E+00 - 1.80E+01	1.78E+02	8.37E+01	3.10E+02 N	NA	NA	No	BSL
7439-89-6	**IRON**	**2.65E+04**		**7.14E+04**		**mg/kg**	**TP-4-4**	**11/11**	**1.30E+01 - 2.60E+01**	**7.14E+04**	**4.71E+04**	**5.50E+03 N**	**NA**	**NA**	**Yes**	**ASL**
7439-92-1	LEAD	3.95E+00		3.24E+01		mg/kg	TP-4-4	19/21	2.30E+00 - 1.40E+01	3.24E+01	2.75E+01	4.00E+01 N	NA	NA	No	BSL
7439-96-5	**MANGANESE**	**1.92E+02**	**J**	**7.82E+02**	**J**	**mg/kg**	**SL-3-3 / SL-1-3**	**11/11**	**1.90E+00 - 2.30E+00**	**7.82E+02**	**1.18E+03**	**1.80E+02 N**	**NA**	**NA**	**Yes**	**ASL**
7439-97-6	MERCURY	4.90E-02		3.80E-01	J	mg/kg	SB-03-06-01-(4-8)	20/21	3.80E-02 - 5.00E-02	3.80E-01	3.20E-01	1.00E+00 N	NA	NA	No	BSL
7440-02-0	NICKEL	5.70E+00	J	3.98E+01		mg/kg	SB-03-06-03-(4-8)	19/21	4.50E+00 - 2.80E+01	3.98E+01	2.30E+01	1.50E+02 N	NA	NA	No	BSL
7782-49-2	SELENIUM	4.00E-01	J	4.70E+00		mg/kg	SB-03-06-08-(16-20)	10/21	6.40E-01 - 1.40E+01	4.70E+00	1.00E+00	3.90E+01 N	NA	NA	No	BSL
7440-62-2	**VANADIUM**	**8.10E+01**	**J**	**2.39E+02**	**J**	**mg/kg**	**SB-03-06-05-(4-8)**	**21/21**	**1.30E+00 - 3.50E+01**	**2.39E+02**	**1.45E+02**	**3.90E+01 N**	**NA**	**NA**	**Yes**	**ASL**
7440-66-6	ZINC	2.41E+01	J	7.75E+01	J	mg/kg	TP-4-4	21/21	2.30E+00 - 1.40E+01	7.75E+01	8.10E+01	2.30E+03 N	NA	NA	No	BSL
PESTICIDES/PCBS																
72-54-8	4,4-DDD	1.80E-03		4.58E-02		mg/kg	TP-3-4	4/21	1.50E-03 - 2.00E-03	4.58E-02	NA	2.00E+00 C	NA	NA	No	BSL
72-55-9	4,4-DDE	2.80E-03		7.42E-02		mg/kg	TP-3-4	5/21	1.50E-03 - 2.00E-03	7.42E-02	NA	1.40E+00 C	NA	NA	No	BSL
50-29-3	4,4-DDT	2.70E-03		9.80E-03		mg/kg	SL-3-3	4/21	1.50E-03 - 2.00E-03	9.80E-03	NA	1.70E+00 C	NA	NA	No	BSL
5103-71-9	ALPHA-CHLORDANE	2.80E-03		2.80E-03		mg/kg	TP-3-4	1/21	1.50E-03 - 2.00E-03	2.80E-03	NA	1.60E+00 C	NA	NA	No	BSL
11097-69-1	AROCLOR 1254	1.67E-01		1.67E-01		mg/kg	TP-3-4	1/21	3.80E-02 - 5.05E-02	1.67E-01	NA	1.10E-01 N	NA	NA	No	LOW
5566-34-7	GAMMA-CHLORDANE	2.00E-03		2.00E-03		mg/kg	SL-2-3	1/21	1.50E-03 - 2.00E-03	2.00E-03	NA	1.60E+00 C	NA	NA	No	BSL
POLYCYCLIC AROMATIC HYDROCARBONS																
91-57-6	2-METHYLNAPHTHALENE	2.31E-02		1.63E+00		mg/kg	SB-03-06-04-(4-8)	3/21	7.70E-03 - 8.90E-02	1.63E+00	NA	3.10E+01 N	NA	NA	No	BSL
83-32-9	ACENAPHTHENE	5.34E-02	J	5.34E-02	J	mg/kg	SB-03-06-04-(4-8)	1/21	4.30E-02 - 1.00E-01	5.34E-02	NA	3.40E+02 N	NA	NA	No	BSL
120-12-7	ANTHRACENE	3.92E-02	J	3.92E-02	J	mg/kg	SB-03-06-04-(4-8)	1/21	4.30E-02 - 1.00E-01	3.92E-02	NA	1.70E+03 N	NA	NA	No	BSL
56-55-3	BENZO[A]ANTHRACENE	2.11E-02		2.91E-02		mg/kg	SB-03-06-04-(4-8)	3/21	7.70E-03 - 1.00E-02	2.91E-02	NA	1.50E-01 C	NA	NA	No	BSL
50-32-8	**BENZO[A]PYRENE**	**1.28E-02**		**1.62E-02**		**mg/kg**	**SB-03-06-08-(16-20)**	**2/21**	**7.70E-03 - 1.00E-02**	**1.62E-02**	**NA**	**1.50E-02 C**	**NA**	**NA**	**Yes**	**ASL**
205-99-2	BENZO[B]FLUORANTHENE	1.62E-02		1.62E-02		mg/kg	SL-2-3	1/21	7.70E-03 - 1.00E-02	1.62E-02	NA	1.50E-01 C	NA	NA	No	BSL
191-24-2	BENZO[G,H,I]PERYLENE	9.05E-03		9.05E-03		mg/kg	SL-2-3	1/21	7.70E-03 - 1.00E-02	9.05E-03	NA	1.70E+02 N	NA	NA	No	BSL
207-08-9	BENZO[K]FLUORANTHENE	9.84E-03		9.84E-03		mg/kg	SL-2-3	1/21	7.70E-03 - 1.00E-02	9.84E-03	NA	1.50E+00 C	NA	NA	No	BSL
218-01-9	CHRYSENE	1.74E-02		2.29E-02		mg/kg	SB-03-06-08-(16-20)	3/21	7.70E-03 - 1.00E-02	2.29E-02	NA	1.50E+01 C	NA	NA	No	BSL
206-44-0	FLUORANTHENE	3.67E-02	J	9.09E-02		mg/kg	SB-03-06-04-(4-8)	3/21	4.30E-02 - 1.00E-01	9.09E-02	NA	2.30E+02 N	NA	NA	No	BSL
86-73-7	FLUORENE	1.45E-01		1.45E-01		mg/kg	SB-03-06-04-(4-8)	1/21	4.30E-02 - 1.00E-01	1.45E-01	NA	2.30E+02 N	NA	NA	No	BSL
193-39-5	INDENO[1,2,3-C,D]PYRENE	8.43E-03	J	8.43E-03	J	mg/kg	SL-2-3	1/21	7.70E-03 - 1.00E-02	8.43E-03	NA	1.50E-01 C	NA	NA	No	BSL
91-20-3	NAPHTHALENE	1.08E-02		1.51E+00		mg/kg	SB-03-06-04-(4-8)	3/21	7.70E-03 - 8.90E-02	1.51E+00	NA	3.60E+00 C	NA	NA	No	BSL
85-01-8	PHENANTHRENE	1.52E-02		8.33E-02	J	mg/kg	SB-03-06-04-(4-8)	5/21	7.70E-03 - 1.00E-02	8.33E-02	NA	1.70E+03 N	NA	NA	No	BSL
129-00-0	PYRENE	2.92E-02	J	7.36E-02	J	mg/kg	SB-03-06-04-(4-8)	3/21	4.30E-02 - 1.00E-01	7.36E-02	NA	1.70E+02 N	NA	NA	No	BSL
SEMI-VOLATILE ORGANIC COMPOUNDS																
117-81-7	BIS(2-ETHYLHEXYL) PHTHALATE	4.47E-02	J	9.42E-02	J	mg/kg	SL-2-5	4/21	7.70E-02 - 1.00E-01	9.42E-02	NA	3.50E+01 C	NA	NA	No	BSL
132-64-9	DIBENZOFURAN	3.04E-02	J	3.04E-02	J	mg/kg	SB-03-06-04-(4-8)	1/21	7.70E-02 - 1.00E-01	3.04E-02	NA	7.80E+00 N	NA	NA	No	BSL

TABLE 7-2.1
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
FORT BUCHANAN HUMAN HEALTH RISK ASSESSMENT
SUBSURFACE SOIL - RESIDENTIAL

Scenario Timeframe: Current/Future-Residential
Medium: Subsurface soil
Exposure Medium: Subsurface soil
Exposure Point: Fort Buchanan Northwest Boundary

CAS Number	Chemical	Minimum [(1)] Concentration	Minimum Qualifier	Maximum [(1)] Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [(2)] Used for Screening	Background [(3)] Value	Screening [(4)] Toxicity Value		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [(5)] Contaminant Deletion or Selection
VOLATILE ORGANIC COMPOUNDS																	
75-35-4	1,1-DICHLOROETHENE	1.60E-03	J	1.60E-03	J	mg/kg	SB-03-06-05-(4-8)	1/21	3.90E-03 - 5.20E-01	1.60E-03	NA	2.40E+01	N	NA	NA	No	BSL
78-93-3	2-BUTANONE	5.60E-03	J	2.85E-02		mg/kg	SB-03-06-06-(4-8)	2/20	7.70E-03 - 1.60E-02	2.85E-02	NA	2.80E+03	N	NA	NA	No	BSL
67-64-1	ACETONE	7.90E-03	J	1.04E-01		mg/kg	SL-2-5	14/18	7.90E-03 - 1.60E-02	1.04E-01	NA	6.10E+03	N	NA	NA	No	BSL
71-43-2	BENZENE	1.04E+00		1.04E+00		mg/kg	SB-03-06-04-(4-8)	1/21	7.70E-04 - 1.00E-01	1.04E+00	NA	1.10E+00	C	NA	NA	No	BSL
75-15-0	CARBON DISULFIDE	8.70E-04	J	2.20E-03	J	mg/kg	SL-3-5	3/21	3.90E-03 - 5.20E-01	2.20E-03	NA	8.20E+01	N	NA	NA	No	BSL
156-59-2	CIS-1,2-DICHLOROETHENE	6.00E-04	J	6.00E-04	J	mg/kg	SB-03-06-08-(16-20)	1/19	3.90E-03 - 8.20E-03	6.00E-04	NA	1.60E+01	N	NA	NA	No	BSL
100-41-4	ETHYLBENZENE	1.86E+01		1.86E+01		mg/kg	SB-03-06-04-(4-8)	1/21	7.70E-04 - 1.00E-01	1.86E+01	NA	5.40E+00	C	NA	NA	No	LOW
78-83-1	ISOBUTYL ALCOHOL	6.51E+01		6.51E+01		mg/kg	SB-03-06-04-(4-8)	1/12	6.30E-02 - 5.20E+00	6.51E+01	NA	2.30E+03	N	NA	NA	No	BSL
1330-20-7	XYLENES, TOTAL	1.38E+00		1.38E+00		mg/kg	SB-03-06-04-(4-8)	1/21	1.50E-03 - 2.10E-01	1.38E+00	NA	6.30E+01	N	NA	NA	No	BSL

(1) Minimum/maximum detected concentration.

(2) Maximum concentration used as screening value.

(3) Background values are taken from Table 1 of *Technical Memorandum of Background Concentrations of Metals and Organochlorine Pesticides for use in the Fort Buchanan RCRA Facility Investigations* (EA 2011).

(4) USEPA Regional Screening Levels, USEPA, June 2011. For non-carcinogens, value shown is equal to 1/10 the residential soil value. For carcinogens the value shown is equal to the residential soil value.

(5) Rationale Codes

Selection Reason: ASL = Above Screening Toxicity Level
Deletion Reason: BSL = Below Screening Toxicity Level
NSL = No Screening Level
NUT = Essential Nutrient
LOW = Low Freqency of Detection

Surrogates used: Chlordane for Alpha-Chlordane and Gamma-Chlordane, Anthracene for Phenanthrene, and Pyrene for Benzo[g,h,i]perylene.

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
C = Carcinogenic

COPC = Chemical of Potential Concern
N = Non-Carcinogenic
NA = Not Applicable
PCBS = Polychlorinated Bipheyls
mg/kg = milligrams per kilogram

Data Qualifiers: J = Value is estimated.

TABLE 7-2.2
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
FORT BUCHANAN HUMAN HEALTH RISK ASSESSMENT
SUBSURFACE SOIL - INDUSTRIAL

Scenario Timeframe: Current/Future-Industrial
Medium: Subsurface soil
Exposure Medium: Subsurface soil
Exposure Point: Fort Buchanan Northwest Boundary

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration (2) Used for Screening	Background (3) Value	Screening (4) Toxicity Value		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for (5) Contaminant Deletion or Selection
INORGANICS																	
7429-90-5	ALUMINUM	2.15E+04	J	3.01E+04	J	mg/kg	SL-4-5	11/11	2.60E+01 - 3.00E+01	3.01E+04	3.00E+04	9.90E+04	N	NA	NA	No	BSL
7440-36-0	ANTIMONY	5.20E-01	J	4.10E+00		mg/kg	TP-4-4	12/21	2.30E+00 - 1.40E+01	4.10E+00	2.20E+00	4.10E+01	N	NA	NA	No	BSL
7440-38-2	**ARSENIC**	**3.60E+00**		**7.20E+01**		**mg/kg**	**TP-4-4**	**21/21**	**4.00E-01 - 1.40E+01**	**7.20E+01**	**4.39E+01**	**1.60E+00**	**C**	**NA**	**NA**	**Yes**	**ASL**
7440-39-3	BARIUM	1.74E+01	J	9.10E+01		mg/kg	SL-1-3	15/21	2.30E+01 - 1.40E+02	9.10E+01	1.02E+02	1.90E+04	N	NA	NA	No	BSL
7440-41-7	BERYLLIUM	1.20E-01	J	8.20E-01		mg/kg	SB-03-06-04-(4-8)	10/21	5.60E-01 - 3.50E+00	8.20E-01	6.47E-01	2.00E+02	N	NA	NA	No	BSL
7440-43-9	CADMIUM	6.80E-01	J	2.10E+00		mg/kg	TP-4-4	16/21	5.60E-01 - 3.50E+00	2.10E+00	8.58E-01	8.00E+01	N	NA	NA	No	BSL
7440-47-3	CHROMIUM	2.22E+01	J	1.90E+02	J	mg/kg	SB-03-06-05-(4-8)	21/21	1.10E+00 - 7.00E+00	1.90E+02	6.98E+01	1.50E+05	N	NA	NA	No	BSL
7440-48-4	**COBALT**	**5.70E+00**	**J**	**3.77E+01**		**mg/kg**	**SB-03-06-03-(4-8)**	**16/21**	**5.60E+00 - 3.50E+01**	**3.77E+01**	**1.66E+01**	**3.00E+01**	**N**	**NA**	**NA**	**Yes**	**ASL**
7440-50-8	COPPER	2.46E+01		1.78E+02	J	mg/kg	TP-4-4	21/21	2.80E+00 - 1.80E+01	1.78E+02	8.37E+01	4.10E+03	N	NA	NA	No	BSL
7439-89-6	IRON	2.65E+04		7.14E+04		mg/kg	TP-4-4	11/11	1.30E+01 - 2.60E+01	7.14E+04	4.71E+04	7.20E+04	N	NA	NA	No	BSL
7439-92-1	LEAD	3.95E+00		3.24E+01		mg/kg	TP-4-4	19/21	2.30E+00 - 1.40E+01	3.24E+01	2.75E+01	8.00E+01	N	NA	NA	No	BSL
7439-96-5	MANGANESE	1.92E+02	J	7.82E+02	J	mg/kg	SL-3-3 / SL-1-3	11/11	1.90E+00 - 2.30E+00	7.82E+02	1.18E+03	2.30E+03	N	NA	NA	No	BSL
7439-97-6	MERCURY	4.90E-02		3.80E-01	J	mg/kg	SB-03-06-01-(4-8)	20/21	3.80E-02 - 5.00E-02	3.80E-01	3.20E-01	4.30E+00	N	NA	NA	No	BSL
7440-02-0	NICKEL	5.70E+00	J	3.98E+01		mg/kg	SB-03-06-03-(4-8)	19/21	4.50E+00 - 2.80E+01	3.98E+01	2.30E+01	2.00E+03	N	NA	NA	No	BSL
7782-49-2	SELENIUM	4.00E-01	J	4.70E+00		mg/kg	SB-03-06-08-(16-20)	10/21	6.40E-01 - 1.40E+01	4.70E+00	1.00E+00	5.10E+02	N	NA	NA	No	BSL
7440-62-2	VANADIUM	8.10E+01	J	2.39E+02	J	mg/kg	SB-03-06-05-(4-8)	21/21	1.30E+00 - 3.50E+01	2.39E+02	1.45E+02	5.20E+02	N	NA	NA	No	BSL
7440-66-6	ZINC	2.41E+01	J	7.75E+01	J	mg/kg	TP-4-4	21/21	2.30E+00 - 1.40E+01	7.75E+01	8.10E+01	3.10E+04	N	NA	NA	No	BSL
PESTICIDES/PCBS																	
72-54-8	4,4-DDD	1.80E-03		4.58E-02		mg/kg	TP-3-4	4/21	1.50E-03 - 2.00E-03	4.58E-02	NA	7.20E+00	C	NA	NA	No	BSL
72-55-9	4,4-DDE	2.80E-03		7.42E-02		mg/kg	TP-3-4	5/21	1.50E-03 - 2.00E-03	7.42E-02	NA	5.10E+00	C	NA	NA	No	BSL
50-29-3	4,4-DDT	2.70E-03		9.80E-03		mg/kg	SL-3-3	4/21	1.50E-03 - 2.00E-03	9.80E-03	NA	7.00E+00	C	NA	NA	No	BSL
5103-71-9	ALPHA-CHLORDANE	2.80E-03		2.80E-03		mg/kg	TP-3-4	1/21	1.50E-03 - 2.00E-03	2.80E-03	NA	6.50E+00	C	NA	NA	No	BSL
11097-69-1	AROCLOR 1254	1.67E-01		1.67E-01		mg/kg	TP-3-4	1/21	3.80E-02 - 5.05E-02	1.67E-01	NA	7.40E-01	C	NA	NA	No	BSL
5566-34-7	GAMMA-CHLORDANE	2.00E-03		2.00E-03		mg/kg	SL-2-3	1/21	1.50E-03 - 2.00E-03	2.00E-03	NA	6.50E+00	C	NA	NA	No	BSL
POLYCYCLIC AROMATIC HYDROCARBONS																	
91-57-6	2-METHYLNAPHTHALENE	2.31E-02		1.63E+00		mg/kg	SB-03-06-04-(4-8)	3/21	7.70E-03 - 8.90E-02	1.63E+00	NA	4.10E+02	N	NA	NA	No	BSL
83-32-9	ACENAPHTHENE	5.34E-02	J	5.34E-02	J	mg/kg	SB-03-06-04-(4-8)	1/21	4.30E-02 - 1.00E-01	5.34E-02	NA	3.30E+03	N	NA	NA	No	BSL
120-12-7	ANTHRACENE	3.92E-02	J	3.92E-02	J	mg/kg	SB-03-06-04-(4-8)	1/21	4.30E-02 - 1.00E-01	3.92E-02	NA	1.70E+04	N	NA	NA	No	BSL
56-55-3	BENZO[A]ANTHRACENE	2.11E-02		2.91E-02		mg/kg	SB-03-06-04-(4-8)	3/21	7.70E-03 - 1.00E-02	2.91E-02	NA	2.10E+00	C	NA	NA	No	BSL
50-32-8	BENZO[A]PYRENE	1.28E-02		1.62E-02		mg/kg	SB-03-06-08-(16-20)	2/21	7.70E-03 - 1.00E-02	1.62E-02	NA	2.10E-01	C	NA	NA	No	BSL
205-99-2	BENZO[B]FLUORANTHENE	1.62E-02		1.62E-02		mg/kg	SL-2-3	1/21	7.70E-03 - 1.00E-02	1.62E-02	NA	2.10E+00	C	NA	NA	No	BSL
191-24-2	BENZO[G,H,I]PERYLENE	9.05E-03		9.05E-03		mg/kg	SL-2-3	1/21	7.70E-03 - 1.00E-02	9.05E-03	NA	1.70E+03	N	NA	NA	No	BSL
207-08-9	BENZO[K]FLUORANTHENE	9.84E-03		9.84E-03		mg/kg	SL-2-3	1/21	7.70E-03 - 1.00E-02	9.84E-03	NA	2.10E+01	C	NA	NA	No	BSL
218-01-9	CHRYSENE	1.74E-02		2.29E-02		mg/kg	SB-03-06-08-(16-20)	3/21	7.70E-03 - 1.00E-02	2.29E-02	NA	2.10E+02	C	NA	NA	No	BSL
206-44-0	FLUORANTHENE	3.67E-02	J	9.09E-02		mg/kg	SB-03-06-04-(4-8)	3/21	4.30E-02 - 1.00E-01	9.09E-02	NA	2.20E+03	N	NA	NA	No	BSL
86-73-7	FLUORENE	1.45E-01		1.45E-01		mg/kg	SB-03-06-04-(4-8)	1/21	4.30E-02 - 1.00E-01	1.45E-01	NA	2.20E+03	N	NA	NA	No	BSL
193-39-5	INDENO[1,2,3-C,D]PYRENE	8.43E-03	J	8.43E-03	J	mg/kg	SL-2-3	1/21	7.70E-03 - 1.00E-02	8.43E-03	NA	2.10E+00	C	NA	NA	No	BSL
91-20-3	NAPHTHALENE	1.08E-02		1.51E+00		mg/kg	SB-03-06-04-(4-8)	3/21	7.70E-03 - 8.90E-02	1.51E+00	NA	1.80E+01	C	NA	NA	No	BSL
85-01-8	PHENANTHRENE	1.52E-02		8.33E-02	J	mg/kg	SB-03-06-04-(4-8)	5/21	7.70E-03 - 1.00E-02	8.33E-02	NA	1.70E+04	N	NA	NA	No	BSL
129-00-0	PYRENE	2.92E-02	J	7.36E-02	J	mg/kg	SB-03-06-04-(4-8)	3/21	4.30E-02 - 1.00E-01	7.36E-02	NA	1.70E+03	N	NA	NA	No	BSL
SEMI-VOLATILE ORGANIC COMPOUNDS																	
117-81-7	BIS(2-ETHYLHEXYL) PHTHALATE	4.47E-02	J	9.42E-02	J	mg/kg	SL-2-5	4/21	7.70E-02 - 1.00E-01	9.42E-02	NA	1.20E+02	C	NA	NA	No	BSL
132-64-9	DIBENZOFURAN	3.04E-02	J	3.04E-02	J	mg/kg	SB-03-06-04-(4-8)	1/21	7.70E-02 - 1.00E-01	3.04E-02	NA	1.00E+02	N	NA	NA	No	BSL

TABLE 7-2.2
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
FORT BUCHANAN HUMAN HEALTH RISK ASSESSMENT
SUBSURFACE SOIL - INDUSTRIAL

Scenario Timeframe: Current/Future-Industrial
Medium: Subsurface soil
Exposure Medium: Subsurface soil
Exposure Point: Fort Buchanan Northwest Boundary

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration (2) Used for Screening	Background (3) Value	Screening (4) Toxicity Value		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for (5) Contaminant Deletion or Selectio
VOLATILE ORGANIC COMPOUNDS																	
75-35-4	1,1-DICHLOROETHENE	1.60E-03	J	1.60E-03	J	mg/kg	SB-03-06-05-(4-8)	1/21	3.90E-03 - 5.20E-01	1.60E-03	NA	1.10E+02	N	NA	NA	No	BSL
78-93-3	2-BUTANONE	5.60E-03	J	2.85E-02		mg/kg	SB-03-06-06-(4-8)	2/20	7.70E-03 - 1.60E-02	2.85E-02	NA	2.00E+04	N	NA	NA	No	BSL
67-64-1	ACETONE	7.90E-03	J	1.04E-01		mg/kg	SL-2-5	14/18	7.90E-03 - 1.60E-02	1.04E-01	NA	6.30E+04	N	NA	NA	No	BSL
71-43-2	BENZENE	1.04E+00		1.04E+00		mg/kg	SB-03-06-04-(4-8)	1/21	7.70E-04 - 1.00E-01	1.04E+00	NA	5.40E+00	C	NA	NA	No	BSL
75-15-0	CARBON DISULFIDE	8.70E-04	J	2.20E-03	J	mg/kg	SL-3-5	3/21	3.90E-03 - 5.20E-01	2.20E-03	NA	3.70E+02	N	NA	NA	No	BSL
156-59-2	CIS-1,2-DICHLOROETHENE	6.00E-04	J	6.00E-04	J	mg/kg	SB-03-06-08-(16-20)	1/19	3.90E-03 - 8.20E-03	6.00E-04	NA	2.00E+02	N	NA	NA	No	BSL
100-41-4	ETHYLBENZENE	1.86E+01		1.86E+01		mg/kg	SB-03-06-04-(4-8)	1/21	7.70E-04 - 1.00E-01	1.86E+01	NA	2.70E+01	C	NA	NA	No	BSL
78-83-1	ISOBUTYL ALCOHOL	6.51E+01		6.51E+01		mg/kg	SB-03-06-04-(4-8)	1/12	6.30E-02 - 5.20E+00	6.51E+01	NA	3.10E+04	N	NA	NA	No	BSL
1330-20-7	XYLENES, TOTAL	1.38E+00		1.38E+00		mg/kg	SB-03-06-04-(4-8)	1/21	1.50E-03 - 2.10E-01	1.38E+00	NA	2.70E+02	N	NA	NA	No	BSL

(1) Minimum/maximum detected concentration.

(2) Maximum concentration used as screening value.

(3) Background values are taken from Table 1 of*Technical Memorandum of Background Concentrations of Metals and Organochlorine Pesticides for use in the Fort Buchanan RCRA Facility Investigations* (EA 2011).

(4) USEPA Regional Screening Levels, USEPA, June 2011. For non-carcinogens, value shown is equal to 1/10 the industrial soil value. For carcinogens the value shown is equal to the industrial soil value.

(5) Rationale Codes
Selection Reason: ASL = Above Screening Toxicity Level
Deletion Reason: BSL = Below Screening Toxicity Level
NSL = No Screening Level
NUT = Essential Nutrient

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
C = Carcinogenic

COPC = Chemical of Potential Concern
N = Non-Carcinogenic
NA = Not Applicable
PCBS = Polychlorinated Bipheyls
mg/kg = milligrams per kilogram

Data Qualifiers: J = Value is estimated.

Surrogates used: Chlordane for Alpha-Chlordane and Gamma-Chlordane, Anthracene for Phenanthrene, and Pyrene for Benzo[g,h,i]perylene.

TABLE 7-2.3

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

FORT BUCHANAN HUMAN HEALTH RISK ASSESSMENT

GROUNDWATER

Scenario Timeframe: Current/Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Fort Buchanan Northwest Boundary

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration (2) Used for Screening	Background (3) Value	Screening (4) Toxicity Value		Potential (5) ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for (6) Contaminant Deletion or Selection
INORGANICS-DISSOLVED																	
7429-90-5	ALUMINUM	1.23E+02	J	5.61E+02		ug/L	G-03-09-OP-6	2/14	2.00E+02 - 2.00E+02	5.61E+02	NA	3.70E+03	N	NA	NA	No	BSL
7440-36-0	ANTIMONY	1.80E+00	J	6.10E+00		ug/L	G-03-08-MW-17A	2/48	6.00E+00 - 6.00E+00	6.10E+00	NA	1.50E+00	N	6.0E+00	MCL	No	LOW
7440-38-2	**ARSENIC**	**1.70E+00**	**J**	**3.08E+01**		**ug/L**	**G-03-09-OP-6**	**11/48**	**3.00E+00 - 8.00E+00**	**3.08E+01**	**NA**	**4.50E-02**	**C**	**1.0E+01**	**MCL**	**Yes**	**ASL**
7440-39-3	**BARIUM**	**8.90E+00**	**J**	**1.14E+03**		**ug/L**	**G-03-09-OP-6**	**38/48**	**2.00E+02 - 2.00E+02**	**1.14E+03**	**NA**	**7.30E+02**	**N**	**2.0E+03**	**MCL**	**Yes**	**ASL**
7440-41-7	BERYLLIUM	2.00E-01	J	3.00E-01	J	ug/L	G-03-09-OP-04 / G-03-09-	6/48	1.00E+00 - 1.00E+00	3.00E-01	NA	7.30E+00	N	4.0E+00	MCL	No	BSL
7440-43-9	CADMIUM	3.50E-01	J	6.00E-01	J	ug/L	G-03-09-OP-6	4/48	3.00E+00 - 4.00E+00	6.00E-01	NA	1.80E+00	N	5.0E+00	MCL	No	BSL
7440-70-2	CALCIUM	6.63E+04		4.92E+05		ug/L	G-03-09-OP-6	14/14	5.00E+03 - 1.00E+04	4.92E+05	NA	NUT		NA	NA	No	NUT
7440-47-3	CHROMIUM	6.00E-01	J	7.54E+01		ug/L	G-03-09-OP-03	17/48	1.00E+01 - 1.00E+01	7.54E+01	NA	4.30E-02	C	1.0E+02	MCL	No	BSL
7440-48-4	**COBALT**	**9.00E-01**	**J**	**3.70E+00**	**J**	**ug/L**	**G-03-08-MW-16A / G-03-**	**16/48**	**5.00E+01 - 5.00E+01**	**3.70E+00**	**NA**	**1.10E+00**	**N**	**NA**	**NA**	**Yes**	**ASL**
7440-50-8	COPPER	3.10E+00	J	3.10E+00	J	ug/L	G-03-08-MW-16A	1/48	1.00E+01 - 2.50E+01	3.10E+00	NA	1.50E+02	N	1.3E+03	MCL	No	BSL
7439-89-6	**IRON**	**1.48E+01**	**J**	**2.13E+04**		**ug/L**	**G-03-09-OP-6**	**8/14**	**1.00E+02 - 1.00E+02**	**2.13E+04**	**NA**	**2.60E+03**	**N**	**NA**	**NA**	**Yes**	**ASL**
7439-92-1	LEAD	1.40E+00	J	3.50E+00		ug/L	G-03-08-MW-17A	7/48	3.00E+00 - 3.00E+00	3.50E+00	NA	1.50E+01		1.5E+01	MCL	No	BSL
7439-95-4	MAGNESIUM	1.27E+04		9.30E+04		ug/L	G-03-09-OP-6	14/14	5.00E+03 - 5.00E+03	9.30E+04	NA	NUT		NA	NA	No	NUT
7439-96-5	**MANGANESE**	**5.20E+01**		**2.72E+03**		**ug/L**	**G-03-09-MW-26**	**14/14**	**1.50E+01 - 1.50E+01**	**2.72E+03**	**NA**	**8.80E+01**	**N**	**NA**	**NA**	**Yes**	**ASL**
7439-97-6	**MERCURY**	**4.20E-02**	**J**	**3.80E-01**		**ug/L**	**G-03-07-MW-10B**	**11/48**	**2.00E-01 - 2.00E-01**	**3.80E-01**	**NA**	**6.30E-02**	**N**	**2.0E+00**	**MCL**	**Yes**	**ASL**
7440-02-0	NICKEL	1.00E+00	J	7.40E+00	J	ug/L	G-03-07-MW-11A	13/48	1.00E+01 - 4.00E+01	7.40E+00	NA	7.30E+01	N	NA	NA	No	BSL
7440-09-7	POTASSIUM	1.99E+03	J	7.99E+03	J	ug/L	G-03-08-MW-24	14/14	1.00E+04 - 1.00E+04	7.99E+03	NA	NUT		NA	NA	No	NUT
7782-49-2	SELENIUM	1.70E+00	J	6.80E+00	J	ug/L	G-03-07-MW-12A	4/48	1.00E+01 - 1.00E+01	6.80E+00	NA	1.80E+01	N	5.0E+01	MCL	No	BSL
7440-22-4	SILVER	1.40E+00	J	4.10E+00	J	ug/L	G-03-08-MW-16A	6/48	1.00E+01 - 1.00E+01	4.10E+00	NA	1.80E+01	N	NA	NA	No	BSL
7440-23-5	SODIUM	3.08E+04		3.99E+05		ug/L	G-03-09-OP-6	14/14	1.00E+04 - 1.00E+04	3.99E+05	NA	NUT		NA	NA	No	NUT
7440-62-2	VANADIUM	8.00E-01	J	3.20E+00	J	ug/L	G-03-07-MW-10B	18/48	5.00E+01 - 5.00E+01	3.20E+00	NA	1.80E+01	N	NA	NA	No	BSL
7440-66-6	ZINC	3.00E+00	J	1.97E+02		ug/L	G-03-09-OP-7	18/48	2.00E+01 - 2.00E+01	1.97E+02	NA	1.10E+03	N	NA	NA	No	BSL
INORGANICS-TOTAL																	
7429-90-5	**ALUMINUM**	**2.51E+01**	**J**	**1.51E+04**		**ug/L**	**G-03-09-OP-05**	**17/21**	**2.00E+02 - 2.00E+02**	**1.51E+04**	**NA**	**3.70E+03**	**N**	**NA**	**NA**	**Yes**	**ASL**
7440-36-0	ANTIMONY	1.90E+00	J	2.98E+01		ug/L	G-03-08-MW-14A	2/48	6.00E+00 - 1.20E+01	2.98E+01	NA	1.50E+00	N	6.0E+00	MCL	No	LOW
7440-38-2	**ARSENIC**	**1.70E+00**	**J**	**2.74E+02**		**ug/L**	**G-03-07-MW-08A**	**13/48**	**3.00E+00 - 1.60E+01**	**2.74E+02**	**NA**	**4.50E-02**	**C**	**1.0E+01**	**MCL**	**Yes**	**ASL**
7440-39-3	**BARIUM**	**9.40E+00**	**J**	**1.92E+03**		**ug/L**	**G-03-09-OP-6**	**38/48**	**2.00E+02 - 4.00E+02**	**1.92E+03**	**NA**	**7.30E+02**	**N**	**2.0E+03**	**MCL**	**Yes**	**ASL**
7440-41-7	BERYLLIUM	3.00E-01	J	5.90E+00		ug/L	G-03-07-MW-08A	8/48	1.00E+00 - 2.00E+00	5.90E+00	NA	7.30E+00	N	4.0E+00	MCL	No	BSL
7440-43-9	**CADMIUM**	**5.00E-01**	**J**	**2.23E+01**		**ug/L**	**G-03-07-MW-08A**	**7/48**	**3.00E+00 - 8.00E+00**	**2.23E+01**	**NA**	**1.80E+00**	**N**	**5.0E+00**	**MCL**	**Yes**	**ASL**
7440-70-2	CALCIUM	6.67E+04		4.84E+05		ug/L	G-03-09-OP-6	22/22	5.00E+03 - 1.00E+04	4.84E+05	NA	NUT		NA	NA	No	NUT
7440-47-3	CHROMIUM	8.00E-01	J	4.90E+02		ug/L	G-03-07-MW-08A	22/48	1.00E+01 - 2.00E+01	4.90E+02	NA	4.30E-02	C	1.0E+02	MCL	No	BSL
7440-48-4	**COBALT**	**6.00E-01**	**J**	**1.77E+01**	**J**	**ug/L**	**G-03-09-OP-05**	**21/48**	**5.00E+01 - 1.00E+02**	**1.77E+01**	**NA**	**1.10E+00**	**N**	**NA**	**NA**	**Yes**	**ASL**
7440-50-8	**COPPER**	**1.50E+00**	**J**	**5.04E+02**		**ug/L**	**G-03-07-MW-08A**	**13/48**	**1.00E+01 - 5.00E+01**	**5.04E+02**	**NA**	**1.50E+02**	**N**	**1.3E+03**	**MCL**	**Yes**	**ASL**
7439-89-6	**IRON**	**4.70E+01**	**J**	**3.33E+04**		**ug/L**	**G-03-09-OP-05**	**20/21**	**1.00E+02 - 1.00E+02**	**3.33E+04**	**NA**	**2.60E+03**	**N**	**NA**	**NA**	**Yes**	**ASL**
7439-92-1	LEAD	2.00E+00	J	3.49E+02		ug/L	G-03-07-MW-08A	7/48	3.00E+00 - 6.00E+00	3.49E+02	NA	1.50E+01		1.5E+01	MCL	No	BSL
7439-95-4	MAGNESIUM	5.89E+03		9.34E+04		ug/L	G-03-09-OP-6	22/22	5.00E+03 - 5.00E+03	9.34E+04	NA	NUT		NA	NA	No	NUT
7439-96-5	**MANGANESE**	**1.92E+01**		**2.83E+03**		**ug/L**	**G-03-09-MW-26**	**22/22**	**1.50E+01 - 1.50E+01**	**2.83E+03**	**NA**	**8.80E+01**	**N**	**NA**	**NA**	**Yes**	**ASL**
7439-97-6	**MERCURY**	**5.10E-02**	**J**	**3.70E+00**		**ug/L**	**G-03-09-OP-03**	**18/48**	**2.00E-01 - 8.00E-01**	**3.70E+00**	**NA**	**6.30E-02**	**N**	**2.0E+00**	**MCL**	**Yes**	**ASL**
7440-02-0	**NICKEL**	**8.00E-01**	**J**	**9.40E+01**		**ug/L**	**G-03-07-MW-08A**	**18/48**	**1.00E+01 - 8.00E+01**	**9.40E+01**	**NA**	**7.30E+01**	**N**	**NA**	**NA**	**Yes**	**ASL**
7440-09-7	POTASSIUM	1.99E+03	J	7.83E+03	J	ug/L	G-03-08-MW-24	14/22	5.00E+03 - 1.00E+04	7.83E+03	NA	NUT		NA	NA	No	NUT
7782-49-2	SELENIUM	1.70E+00	J	4.10E+00	J	ug/L	G-03-08-MW-20	3/48	1.00E+01 - 2.00E+01	4.10E+00	NA	1.80E+01	N	5.0E+01	MCL	No	BSL
7440-22-4	SILVER	1.40E+00	J	6.90E+00	J	ug/L	G-03-08-MW-14A	3/48	1.00E+01 - 2.00E+01	6.90E+00	NA	1.80E+01	N	NA	NA	No	BSL
7440-23-5	SODIUM	1.59E+04		3.97E+05		ug/L	G-03-09-OP-6	22/22	1.00E+04 - 1.00E+04	3.97E+05	NA	NUT		NA	NA	No	NUT
7440-28-0	THALLIUM	1.70E+00	J	1.80E+00	J	ug/L	G-03-09-OP-6	2/48	2.00E+00 - 2.00E+01	1.80E+00	NA	3.70E-02	N	2.0E+00	MCL	No	LOW
7440-31-5	TIN	9.50E+00	J	9.50E+00	J	ug/L	G-03-08-MW-14A	1/35	1.00E+01 - 2.00E+01	9.50E+00	NA	2.20E+03	N	NA	NA	No	BSL
7440-62-2	VANADIUM	7.00E-01	J	1.20E+03		ug/L	G-03-07-MW-08A	22/48	5.00E+01 - 1.00E+02	1.20E+03	NA	1.80E+01	N	NA	NA	No	BSL
7440-66-6	ZINC	3.20E+00	J	4.52E+02		ug/L	G-03-07-MW-08A	23/48	2.00E+01 - 4.00E+01	4.52E+02	NA	1.10E+03	N	NA	NA	No	BSL
PESTICIDES/PCBS																	
76-44-8	HEPTACHLOR	9.60E-01	J	9.60E-01	J	ug/L	G-03-09-OP-03	1/48	2.00E-02 - 2.20E-02	9.60E-01	NA	1.50E-02	C	4.0E-01	MCL	No	LOW
POLYCYCLIC AROMATIC HYDROCARBONS																	
91-20-3	**NAPHTHALENE**	**7.96E-01**		**1.51E+00**		**ug/L**	**G-03-07-MW-04B**	**3/48**	**2.00E-01 - 2.70E-01**	**1.51E+00**	**NA**	**1.40E-01**	**C**	**NA**	**NA**	**Yes**	**ASL**

TABLE 7-2.3
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
FORT BUCHANAN HUMAN HEALTH RISK ASSESSMENT
GROUNDWATER

Scenario Timeframe: Current/Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Fort Buchanan Northwest Boundary

CAS Number	Chemical	Minimum [(1)] Concentration	Minimum Qualifier	Maximum [(1)] Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [(2)] Used for Screening	Background [(3)] Value	Screening [(4)] Toxicity Value		Potential [(5)] ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [(6)] Contaminant Deletion or Selection
SEMI-VOLATILE ORGANIC COMPOUNDS																	
95-50-1	1,2-DICHLOROBENZENE	8.10E-01	J	4.80E+00		ug/L	G-03-07-MW-06A	4/42	2.00E+00 - 2.10E+00	4.80E+00	NA	3.70E+01	N	6.0E+02	MCL	No	BSL
106-46-7	1,4-DICHLOROBENZENE	1.50E+00	J	1.50E+00	J	ug/L	G-03-07-MW-05B	1/42	2.00E+00 - 2.10E+00	1.50E+00	NA	4.30E-01	C	7.5E+01	MCL	Yes	LOW
117-81-7	BIS(2-ETHYLHEXYL) PHTHALATE	2.40E+00		3.50E+00		ug/L	G-03-07-MW-07A	4/48	2.00E+00 - 2.70E+00	3.50E+00	NA	4.80E+00	C	6.0E+00	MCL	No	BSL
117-84-0	DI-N-OCTYL PHTHALATE	4.00E+00		4.00E+00		ug/L	G-03-09-OP-05	1/48	2.00E+00 - 2.70E+00	4.00E+00	NA	NA		NA	NA	No	NSL
VOLATILE ORGANIC COMPOUNDS																	
79-00-5	**1,1,2-TRICHLOROETHANE**	**2.90E-01**	**J**	**2.57E+01**		**ug/L**	**G-03-09-MW-25**	**23/153**	**1.00E+00 - 2.00E+01**	**2.57E+01**	**NA**	**4.20E-02**	**N**	**5.0E+00**	**MCL**	**Yes**	**ASL**
75-35-4	1,1-DICHLOROETHENE	3.30E-01	J	7.80E+00	J	ug/L	G-03-10-MW-25	16/153	1.00E+00 - 2.00E+01	7.80E+00	NA	3.40E+01	N	7.0E+00	MCL	No	BSL
107-06-2	**1,2-DICHLOROETHANE**	**3.10E-01**	**J**	**5.75E-01**	**J / J**	**ug/L**	**G-03-07-MW-12A**	**10/153**	**1.00E+00 - 2.00E+01**	**5.75E-01**	**NA**	**1.50E-01**	**C**	**5.0E+00**	**MCL**	**Yes**	**ASL**
67-64-1	ACETONE	7.60E+00	J	7.60E+00	J	ug/L	G-03-08-MW-18B	1/140	1.00E+01 - 2.00E+02	7.60E+00	NA	2.20E+03	N	NA	NA	No	BSL
71-43-2	BENZENE	4.90E-01	J	9.30E-01	J	ug/L	G-03-07-MW-04A	3/153	1.00E+00 - 2.00E+01	9.30E-01	NA	4.10E-01	C	5.0E+00	MCL	No	LOW
75-27-4	BROMODICHLOROMETHANE	5.00E-01	J	5.00E-01	J	ug/L	G-03-09-OP-05	1/153	1.00E+00 - 2.00E+01	5.00E-01	NA	1.20E-01	C	8.00E+01	MCL	No	LOW
75-15-0	CARBON DISULFIDE	8.90E-01	J	2.50E+00		ug/L	G-03-08-MW-18B	3/153	2.00E+00 - 4.00E+01	2.50E+00	NA	1.00E+02	N	NA	NA	No	BSL
67-66-3	**CHLOROFORM**	**2.00E-01**	**J**	**7.40E+00**		**ug/L**	**G-03-09-OP-05**	**35/153**	**1.00E+00 - 2.00E+01**	**7.40E+00**	**NA**	**1.90E-01**	**C**	**8.00E+01**	**MCL**	**Yes**	**ASL**
74-87-3	CHLOROMETHANE	5.00E-01	J	1.80E+00		ug/L	G-03-08-MW-08B	3/152	1.00E+00 - 2.00E+01	1.80E+00	NA	1.90E+01	N	NA	NA	No	BSL
156-59-2	**CIS-1,2-DICHLOROETHENE**	**3.10E-01**	**J**	**2.75E+02**		**ug/L**	**G-03-09-MW-25**	**56/91**	**1.00E+00 - 2.00E+01**	**2.75E+02**	**NA**	**7.30E+00**	**N**	**7.0E+01**	**MCL**	**Yes**	**ASL**
100-41-4	ETHYLBENZENE	4.00E-01	J	3.90E+00		ug/L	G-03-07-MW-04B	3/153	1.00E+00 - 2.00E+01	3.90E+00	NA	1.50E+00	C	7.0E+02	MCL	No	LOW
75-09-2	METHYLENE CHLORIDE	1.19E+01	J	1.19E+01	J	ug/L	G-03-09-MW-25	1/153	2.00E+00 - 4.00E+01	1.19E+01	NA	4.80E+00	C	5.0E+00	MCL	No	LOW
127-18-4	**TETRACHLOROETHENE**	**3.10E-01**	**J**	**3.41E+01**		**ug/L**	**G-03-08-MW-15A**	**45/153**	**1.00E+00 - 2.00E+01**	**3.41E+01**	**NA**	**1.10E-01**	**C**	**5.0E+00**	**MCL**	**Yes**	**ASL**
156-60-5	**TRANS-1,2-DICHLOROETHENE**	**2.95E-01**	**J / J**	**3.54E+01**		**ug/L**	**G-03-09-MW-07B**	**49/153**	**1.00E+00 - 2.00E+01**	**3.54E+01**	**NA**	**1.10E+01**	**N**	**1.0E+02**	**MCL**	**Yes**	**ASL**
79-01-6	**TRICHLOROETHENE**	**2.50E-01**	**J**	**4.04E+03**		**ug/L**	**G-03-09-MW-25**	**94/153**	**1.00E+00 - 5.00E+01**	**4.04E+03**	**NA**	**2.00E+00**	**C**	**5.0E+00**	**MCL**	**Yes**	**ASL**
75-01-4	**VINYL CHLORIDE**	**4.50E-01**	**J**	**2.56E+01**		**ug/L**	**G-03-09-MW-07B**	**18/153**	**1.00E+00 - 2.00E+01**	**2.56E+01**	**NA**	**1.60E-02**	**C**	**2.0E+00**	**MCL**	**Yes**	**ASL**
1330-20-7	XYLENES, TOTAL	5.80E-01	J	5.80E-01	J	ug/L	G-03-07-MW-04B	1/153	1.00E+00 - 2.00E+01	5.80E-01	NA	2.00E+01	N	1.0E+04	MCL	No	BSL

(1) Minimum/maximum detected concentration.
(2) Maximum concentration used as screening value.
(3) Background values are not included as part of the COPC selection process.

(4) USEPA Regional Screening Levels, USEPA, June 2011. For non-carcinogens, value shown is equal to 1/10 the tap water value. For carcinogens the value shown is equal to the tap water value.
(5) ARAR value is the Maximum Contaminant Level (MCL) from USEPA, 2009, *National Primary Drinking Water Regulations* , EPA 816-F-09-004, May.
(6) Rationale Codes

Selection Reason:	ASL = Above Screening Toxicity Level	
Deletion Reason:	BSL = Below Screening Toxicity Level	
	NSL = No Screening Level	
	NUT = Essential Nutrient	
	LOW = Low Frequency of Detection	

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
C = Carcinogenic
COPC = Chemical of Potential Concern
N = Non-Carcinogenic
NA = Not Applicable
PCBS = Polychlorinated Bipheyls
ug/L = micrograms per liter

Data Qualifiers:
J = Value is estimated.

TABLE 7-2.4
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
FORT BUCHANAN HUMAN HEALTH RISK ASSESSMENT
SURFACE WATER

Scenario Timeframe: Current/Future
Medium: Surface water
Exposure Medium: Surface water
Exposure Point: Fort Buchanan Northwest Boundary

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration (2) Used for Screening	Background (3) Value	Screening (4) Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for (5) Contaminant Deletion or Selectio
VOLATILE ORGANIC COMPOUNDS-TOTAL																
67-64-1	ACETONE	4.70E+00	J	4.90E+00	J	ug/L	PORE-5	2/7	1.00E+01 - 1.00E+01	4.90E+00	NA	2.20E+04 N	NA	NA	No	BSL

(1) Minimum/maximum detected concentration.
(2) Maximum concentration used as screening value.
(3) Background values are not included as part of the COPC selection process.
(4) USEPA Regional Screening Levels, USEPA, June 2011. For non-carcinogens, value shown is equal to 1/10 the tap water value. For carcinogens the value shown is equal to the tap water value. To account for surface water exposures, the resulting values have been increased by a factor of ten.
(5) Rationale Codes

Selection Reason: ASL = Above Screening Toxicity Level
Deletion Reason: BSL = Below Screening Toxicity Level
NSL = No Screening Level
NUT = Essential Nutrient

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
C = Carcinogenic
COPC = Chemical of Potential Concern
N = Non-Carcinogenic
NA = Not Applicable
PCBS = Polychlorinated Bipheyls
ug/L = micrograms per liter

Data Qualifiers: J = Value is estimated.

TABLE 7-2.5
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
FORT BUCHANAN HUMAN HEALTH RISK ASSESSMENT
GROUNDWATER - INDOOR AIR

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air
Exposure Point: Fort Buchanan Northwest Boundary

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration (2) Used for Screening	Background (3) Value	Screening (4) Toxicity Value		Potential (5) ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for (6) Contaminant Deletion or Selection
PESTICIDES/PCBS																	
76-44-8	HEPTACHLOR	9.60E-01	J	9.60E-01	J	ug/L	G-03-09-OP-03	1/48	2.00E-02 - 2.20E-02	9.60E-01	NA	4.00E-01	C	4.0E-01	MCL	No	LOW
POLYCYCLIC AROMATIC HYDROCARBONS																	
91-20-3	NAPHTHALENE	7.96E-01		1.51E+00		ug/L	G-03-07-MW-04B	3/48	2.00E-01 - 2.70E-01	1.51E+00	NA	1.50E+02	N	NA	NA	No	BSL
SEMI-VOLATILE ORGANIC COMPOUNDS																	
95-50-1	1,2-DICHLOROBENZENE	8.10E-01	J	4.80E+00		ug/L	G-03-07-MW-06A	4/42	2.00E+00 - 2.10E+00	4.80E+00	NA	2.60E+03	N	6.0E+02	MCL	No	BSL
106-46-7	1,4-DICHLOROBENZENE	1.50E+00	J	1.50E+00	J	ug/L	G-03-07-MW-05B	1/42	2.00E+00 - 2.10E+00	1.50E+00	NA	8.20E+03	N	7.5E+01	MCL	No	LOW
117-81-7	BIS(2-ETHYLHEXYL) PHTHALATE	2.40E+00		3.50E+00		ug/L	G-03-07-MW-07A	4/48	2.00E+00 - 2.70E+00	3.50E+00	NA	NA		6.0E+00	MCL	No	NSL
117-84-0	DI-N-OCTYL PHTHALATE	4.00E+00		4.00E+00		ug/L	G-03-09-OP-05	1/48	2.00E+00 - 2.70E+00	4.00E+00	NA	NA		NA	NA	No	LOW
VOLATILE ORGANIC COMPOUNDS																	
79-00-5	**1,1,2-TRICHLOROETHANE**	**2.90E-01**	**J**	**2.57E+01**		**ug/L**	**G-03-09-MW-25**	**23/153**	**1.00E+00 - 2.00E+01**	**2.57E+01**	**NA**	**5.00E+00**		**5.0E+00**	**MCL**	**Yes**	**ASL**
75-35-4	1,1-DICHLOROETHENE	3.30E-01	J	7.80E+00	J	ug/L	G-03-10-MW-25	16/153	1.00E+00 - 2.00E+01	7.80E+00	NA	2.20E+03	N	7.0E+00	MCL	No	BSL
107-06-2	1,2-DICHLOROETHANE	3.10E-01	J	5.75E-01	J / J	ug/L	G-03-07-MW-12A	10/153	1.00E+00 - 2.00E+01	5.75E-01	NA	5.00E+00	C	5.0E+00	MCL	No	BSL
67-64-1	ACETONE	7.60E+00	J	7.60E+00	J	ug/L	G-03-08-MW-18B	1/140	1.00E+01 - 2.00E+02	7.60E+00	NA	2.20E+05	N	NA	NA	No	BSL
71-43-2	BENZENE	4.90E-01	J	9.30E-01	J	ug/L	G-03-07-MW-04A	3/153	1.00E+00 - 2.00E+01	9.30E-01	NA	5.00E+00	C	5.0E+00	MCL	No	LOW
75-27-4	BROMODICHLOROMETHANE	5.00E-01	J	5.00E-01	J	ug/L	G-03-09-OP-05	1/153	1.00E+00 - 2.00E+01	5.00E-01	NA	2.10E+00	C	NA	NA	No	LOW
75-15-0	CARBON DISULFIDE	8.90E-01	J	2.50E+00		ug/L	G-03-08-MW-18B	3/153	2.00E+00 - 4.00E+01	2.50E+00	NA	5.60E+02	N	NA	NA	No	LOW
67-66-3	CHLOROFORM	2.00E-01	J	7.40E+00		ug/L	G-03-09-OP-05	35/153	1.00E+00 - 2.00E+01	7.40E+00	NA	8.00E+01	C	NA	NA	No	BSL
74-87-3	CHLOROMETHANE	5.00E-01	J	1.80E+00		ug/L	G-03-08-MW-08B	3/152	1.00E+00 - 2.00E+01	1.80E+00	NA	6.70E+00	C	NA	NA	No	LOW
156-59-2	**CIS-1,2-DICHLOROETHENE**	**3.10E-01**	**J**	**2.75E+02**		**ug/L**	**G-03-09-MW-25**	**56/91**	**1.00E+00 - 2.00E+01**	**2.75E+02**	**NA**	**2.10E+02**	**C**	**7.0E+01**	**MCL**	**Yes**	**ASL**
100-41-4	ETHYLBENZENE	4.00E-01	J	3.90E+00		ug/L	G-03-07-MW-04B	3/153	1.00E+00 - 2.00E+01	3.90E+00	NA	7.00E+02	C	7.0E+02	MCL	No	LOW
75-09-2	METHYLENE CHLORIDE	1.19E+01	J	1.19E+01	J	ug/L	G-03-09-MW-25	1/153	2.00E+00 - 4.00E+01	1.19E+01	NA	6.70E+00	C	5.0E+00	MCL	No	LOW
127-18-4	**TETRACHLOROETHENE**	**3.10E-01**	**J**	**3.41E+01**		**ug/L**	**G-03-08-MW-15A**	**45/153**	**1.00E+00 - 2.00E+01**	**3.41E+01**	**NA**	**5.00E+00**	**C**	**5.0E+00**	**MCL**	**Yes**	**ASL**
156-60-5	TRANS-1,2-DICHLOROETHENE	2.95E-01	J / J	3.54E+01		ug/L	G-03-09-MW-07B	49/153	1.00E+00 - 2.00E+01	3.54E+01	NA	1.80E+02	N	1.0E+02	MCL	No	BSL
79-01-6	**TRICHLOROETHENE**	**2.50E-01**	**J**	**4.04E+03**		**ug/L**	**G-03-09-MW-25**	**94/153**	**1.00E+00 - 5.00E+01**	**4.04E+03**	**NA**	**5.00E+00**	**C**	**5.0E+00**	**MCL**	**Yes**	**ASL**
75-01-4	**VINYL CHLORIDE**	**4.50E-01**	**J**	**2.56E+01**		**ug/L**	**G-03-09-MW-07B**	**18/153**	**1.00E+00 - 2.00E+01**	**2.56E+01**	**NA**	**2.00E+00**	**C**	**2.0E+00**	**MCL**	**Yes**	**ASL**
1330-20-7	XYLENES, TOTAL	5.80E-01	J	5.80E-01	J	ug/L	G-03-07-MW-04B	1/153	1.00E+00 - 2.00E+01	5.80E-01	NA	2.20E+04	N	1.0E+04	MCL	No	LOW

(1) Minimum/maximum detected concentration.

(2) Maximum concentration used as screening value.

(3) Background values are not included as part of the COPC selection process.

(4) USEPA Generic Screening Levels for Risk = 1x10E-6. USEPA, 2002, *OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance).* EPA 530-D-02-004. November.

(5) ARAR value is the Maximum Contaminant Level (MCL) from USEPA 2009.

(6) Rationale Codes
Selection Reason: ASL = Above Screening Toxicity Level
Deletion Reason: BSL = Below Screening Toxicity Level
NSL = No Screening Level
NUT = Essential Nutrient
LOW = Low Frequency of Detection

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
C = Carcinogenic
COPC = Chemical of Potential Concern
N = Non-Carcinogenic
NA = Not Applicable
PCBS = Polychlorinated Bipheyls
ug/L = micrograms per liter

Data Qualifiers:
J = Value is estimated.

TABLE 7-3.1
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
FORT BUCHANAN HUMAN HEALTH RISK ASSESSMENT
SUBSURFACE SOIL - RESIDENTIAL

Scenario Timeframe: Current/Future-Residential
Medium: Subsurface soil
Exposure Medium: Subsurface soil
Exposure Point: Fort Buchanan Northwest Boundary

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
INORGANICS									
ALUMINUM	mg/kg	2.56E+04	2.73E+04	3.01E+04	J	mg/kg	2.73E+04	95%UCLM-N	ProUCL 4.1
ANTIMONY	mg/kg	1.47E+00	1.62E+00	4.10E+00		mg/kg	1.62E+00	95%UCLM-KMt	ProUCL 4.1
ARSENIC	mg/kg	2.88E+01	3.57E+01	7.20E+01		mg/kg	3.57E+01	95%UCLM-N	ProUCL 4.1
COBALT	mg/kg	1.17E+01	1.37E+01	3.77E+01		mg/kg	1.37E+01	95%UCLM-BCA	ProUCL 4.1
IRON	mg/kg	3.63E+04	4.37E+04	7.14E+04		mg/kg	4.37E+04	95%UCLM-G	ProUCL 4.1
MANGANESE	mg/kg	4.86E+02	6.00E+02	7.82E+02	J	mg/kg	6.00E+02	95%UCLM-N	ProUCL 4.1
VANADIUM	mg/kg	1.31E+02	1.49E+02	2.39E+02	J	mg/kg	1.49E+02	95%UCLM-M	ProUCL 4.1
POLYCYCLIC AROMATIC HYDROCARBONS									
BENZO[A]PYRENE	mg/kg	1.45E-02	NA	1.62E-02		mg/kg	1.62E-02	Maximum	ProUCL 4.1

Note: Statistics calculated by the EPA program ProUCL. ProUCL outputs are presented in Appendix M.

95%UCLM-BCA indicates that the 95 percent upper confidence limit on the mean is based on the Kaplan-Meier (KM) Bias-Corrected Accelerated (BCA) percentile bootstrap test.

95%UCLM-G indicates that the 95 percent upper confidence limit on the mean is based on the approximate or adjusted gamma distribution.

95%UCLM-KMt indicates that the 95 percent upper confidence limit on the mean is based on the non-parametric Kaplan-Meier (KM) student's t-test.

95%UCLM-L indicates that the 95 percent upper confidence limit on the mean is based on the Land (H) statistic for lognormal distributions.

95%UCLM-M indicates that the 95 percent upper confidence limit on the mean is based on the non-parametric modified t-test.

95%UCLM-N indicates that the 95 percent upper confidence limit on the mean is based on the student's t-test for normal distributions.

NA = not applicable.

TABLE 7-3.2
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
FORT BUCHANAN HUMAN HEALTH RISK ASSESSMENT
SUBSURFACE SOIL - INDUSTRIAL

Scenario Timeframe: Current/Future-Industrial
Medium: Subsurface soil
Exposure Medium: Subsurface soil
Exposure Point: Fort Buchanan Northwest Boundary

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
INORGANICS									
ARSENIC	mg/kg	2.88E+01	3.57E+01	7.20E+01		mg/kg	3.57E+01	95%UCLM-N	ProUCL 4.1
COBALT	mg/kg	1.17E+01	1.37E+01	3.77E+01		mg/kg	1.37E+01	95%UCLM-BCA	ProUCL 4.1

Note: Statistics calculated by the EPA program ProUCL. ProUCL outputs are presented in Appendix M.

95%UCLM-BCA indicates that the 95 percent upper confidence limit on the mean is based on the Kaplan-Meier (KM) Bias-Corrected Accelerated (BCA) percentile bootstrap test.

95%UCLM-N indicates that the 95 percent upper confidence limit on the mean is based on the student's t-test for normal distributions.

TABLE 7-3.3
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
FORT BUCHANAN HUMAN HEALTH RISK ASSESSMENT
GROUNDWATER

Scenario Timeframe: Current/Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Fort Buchanan Northwest Boundary

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
INORGANICS-DISSOLVED									
ARSENIC	ug/L	8.60E+00	4.57E+00	3.08E+01		ug/L	4.57E+00	95%UCLM-KMt	ProUCL 4.1
BARIUM	ug/L	1.67E+02	1.88E+02	1.14E+03		ug/L	1.88E+02	95%UCLM-BCA	ProUCL 4.1
COBALT	ug/L	2.01E+00	1.56E+00	3.70E+00	J	ug/L	1.56E+00	95%UCLM-KMp	ProUCL 4.1
IRON	ug/L	2.69E+03	1.71E+04	2.13E+04		ug/L	1.71E+04	95%UCLM-KMC	ProUCL 4.1
MANGANESE	ug/L	7.27E+02	1.26E+03	2.72E+03		ug/L	1.26E+03	95%UCLM-G	ProUCL 4.1
MERCURY	ug/L	1.14E-01	7.86E-02	3.80E-01		ug/L	7.86E-02	95%UCLM-KMt	ProUCL 4.1
INORGANICS-TOTAL									
ALUMINUM	ug/L	1.37E+03	8.31E+03	1.51E+04		ug/L	8.31E+03	95%UCLM-KMC	ProUCL 4.1
ARSENIC	ug/L	3.04E+01	2.14E+01	2.74E+02		ug/L	2.14E+01	95%UCLM-BCA	ProUCL 4.1
BARIUM	ug/L	2.11E+02	3.65E+02	1.92E+03		ug/L	3.65E+02	95%UCLM-KMC	ProUCL 4.1
CADMIUM	ug/L	3.90E+00	2.01E+00	2.23E+01		ug/L	2.01E+00	95%UCLM-KMC	ProUCL 4.1
COBALT	ug/L	2.77E+00	2.37E+00	1.77E+01	J	ug/L	2.37E+00	95%UCLM-KMC	ProUCL 4.1
COPPER	ug/L	5.71E+01	3.50E+01	5.04E+02		ug/L	3.50E+01	95%UCLM-KMC	ProUCL 4.1
IRON	ug/L	3.28E+03	2.12E+04	3.33E+04		ug/L	2.12E+04	95%UCLM-KMC	ProUCL 4.1
MANGANESE	ug/L	6.75E+02	1.12E+03	2.83E+03		ug/L	1.12E+03	95%UCLM-G	ProUCL 4.1
MERCURY	ug/L	5.74E-01	4.49E-01	3.70E+00		ug/L	4.49E-01	95%UCLM-BCA	ProUCL 4.1
NICKEL	ug/L	1.50E+01	1.09E+01	9.40E+01		ug/L	1.09E+01	95%UCLM-BCA	ProUCL 4.1

TABLE 7-3.3
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
FORT BUCHANAN HUMAN HEALTH RISK ASSESSMENT
GROUNDWATER

Scenario Timeframe: Current/Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Fort Buchanan Northwest Boundary

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
POLYCYCLIC AROMATIC HYDROCARBONS									
NAPHTHALENE	ug/L	NA	NA	1.51E+00		ug/L	1.51E+00	Maximum	ProUCL 4.1
VOLATILE ORGANIC COMPOUNDS									
1,1,2-TRICHLOROETHANE	ug/L	4.94E+00	1.69E+00	2.56E+01		ug/L	1.69E+00	95%UCLM-BCA	ProUCL 4.1
1,2-DICHLOROETHANE	ug/L	4.61E-01	4.09E-01	5.75E-01	J	ug/L	4.09E-01	95%UCLM-KMp	ProUCL 4.1
CHLOROFORM	ug/L	1.73E+00	7.44E-01	7.40E+00		ug/L	7.44E-01	95%UCLM-KMt	ProUCL 4.1
CIS-1,2-DICHLOROETHENE	ug/L	3.39E+01	5.62E+01	2.61E+02		ug/L	5.62E+01	95%UCLM-KMC	ProUCL 4.1
TETRACHLOROETHENE	ug/L	7.18E+00	3.09E+00	3.33E+01		ug/L	3.09E+00	95%UCLM-KMt	ProUCL 4.1
TRANS-1,2-DICHLOROETHENE	ug/L	5.20E+00	2.72E+00	3.54E+01		ug/L	2.72E+00	95%UCLM-BCA	ProUCL 4.1
TRICHLOROETHENE	ug/L	2.19E+02	4.02E+02	3.70E+03		ug/L	4.02E+02	95%UCLM-KMC	ProUCL 4.1
VINYL CHLORIDE	ug/L	5.96E+00	1.75E+00	2.56E+01		ug/L	1.75E+00	95%UCLM-BCA	ProUCL 4.1

Note: Statistics calculated by the EPA program ProUCL. ProUCL outputs are presented in Appendix M.

95%UCLM-BCA indicates that the 95 percent upper confidence limit on the mean is based on the Kaplan-Meier (KM) Bias-Corrected Accelerated (BCA) percentile bootstrap test.

95%UCLM-G indicates that the 95 percent upper confidence limit on the mean is based on the approximate or adjusted gamma distribution.

95%UCLM-KMC indicates that the 95 percent upper confidence limit on the mean is based on the non-parametric Kaplan-Meier (KM) Chebyshev test.

95%UCLM-KMNP indicates that the 95 percent upper confidence limit on the mean is based on the non-parametric Kaplan-Meier (KM) standard bootstrap test.

95%UCLM-KMp indicates that the 95 percent upper confidence limit on the mean is based on the non-parametric Kaplan-Meier (KM) percentile boostrap test.

95%UCLM-KMt indicates that the 95 percent upper confidence limit on the mean is based on the non-parametric Kaplan-Meier (KM) student's t-test.

NA = not applicable.

TABLE 7-3.4
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
FORT BUCHANAN HUMAN HEALTH RISK ASSESSMENT
SURFACE WATER

Scenario Timeframe: Current/Future
Medium: Surface water
Exposure Medium: Surface water
Exposure Point: Fort Buchanan Northwest Boundary

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
NO COPCS									

TABLE 7-3.5
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
FORT BUCHANAN HUMAN HEALTH RISK ASSESSMENT
GROUNDWATER TO INDOOR AIR

Scenario Timeframe: Current/Future
Medium: Groundwater
Exposure Medium: Air
Exposure Point: Fort Buchanan Northwest Boundary

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
VOLATILE ORGANIC COMPOUNDS									
1,1,2-TRICHLOROETHANE	ug/L	1.02E+01	9.80E+00	2.57E+01		ug/L	9.80E+00	95%UCLM-BCA	ProUCL 4.1
CIS-1,2-DICHLOROETHENE	ug/L	1.15E+02	1.22E+02	2.75E+02		ug/L	1.22E+02	95%UCLM-BCA	ProUCL 4.1
TETRACHLOROETHENE	ug/L	1.91E+01	1.73E+01	3.41E+01		ug/L	1.73E+01	95%UCLM-BCA	ProUCL 4.1
TRICHLOROETHENE	ug/L	1.33E+03	1.43E+03	4.04E+03		ug/L	1.43E+03	95%UCLM-BCA	ProUCL 4.1
VINYL CHLORIDE	ug/L	3.52E+00	3.28E+00	7.00E+00		ug/L	3.28E+00	95%UCLM-BCA	ProUCL 4.1

Note: Statistics calculated by the EPA program ProUCL. ProUCL outputs are presented in Appendix N.

95%UCLM-BCA indicates that the 95 percent upper confidence limit on the mean is based on the Kaplan-Meier (KM) Bias-Corrected Accelerated (BCA) percentile bootstrap test.

95%UCLM-KMC indicates that the 95 percent upper confidence limit on the mean is based on the non-parametric Kaplan-Meier (KM) Chebyshev test.

95%UCLM-KMt indicates that the 95 percent upper confidence limit on the mean is based on the non-parametric Kaplan-Meier (KM) student's t-test.

TABLE 7-4.1
VALUES USED FOR ADOLESCENT TRESPASSER DAILY SURFACE SOIL INTAKE EQUATIONS
NORTHWEST BOUNDARY AREA
FORT BUCHANAN

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Surface Soil, Air
Exposure Point: Northwest Boundary Area
Receptor Population: Trespasser
Receptor Age: Adolescent

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Intake Equation / Model Name
Ingestion	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	CR	Ingestion Rate	mg/day	50	BPJ (1)	CS x CR x EF x ED x CF / (BW x AT)
	EF	Exposure Frequency	day/yr	52	BPJ (3)	
	ED	Exposure Duration	yr	8	BPJ (3)	
	BW	Body Weight	kg	45	U.S. EPA 2011a	
	AT-NC	Averaging time - Noncancer	days	2,920	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	U.S. EPA 1989	
Dermal	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	SA	Surface Area for Contact	cm^2/event	2,900	U.S. EPA 2004a (2)	CS x SA x AF x ABS x EF x ED x CF / (BW x AT)
	AF	Adherence Factor	mg/cm^2	0.20	U.S. EPA 2004a (2)	
	ABS	Dermal Absorption Fraction	unitless	Chemical-Specific	U.S. EPA 2004a (2)	
	EF	Exposure Frequency	event/yr	52	BPJ (3)	
	ED	Exposure Duration	yr	8	BPJ (3)	
	BW	Body Weight	kg	45	U.S. EPA 2011a	
	AT-NC	Averaging time - Noncancer	days	2,920	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	U.S. EPA 1989	
Inhalation	CA	Chemical Concentration in Air	mg/m^3	Chemical-Specific	Chemical-Specific	Exposure Concentration (ug/m^3) =
	ET	Exposure Time	hours	4	BPJ (3)	CA x CF_1 x ET x EF x ED / AT x CF_2
	CF_1	Conversion Factor	ug/mg	1,000	U.S. EPA 2009	
	EF	Exposure Frequency	day/yr	52	BPJ (3)	
	ED	Exposure Duration	yr	8	BPJ (3)	Note: CF_1 is only used in determining carcinogenic
	CF_2	Conversion Factor	hr/day	24	U.S. EPA 2009	exposure concentrations
	AT-NC	Averaging time - Noncancer	days	2,920	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	

Note : BPJ = Best Professional Judgment
(1) The incidental soil ingestion rate is assumed to be half that of a resident.
(2) Assumes exposure similar to that of resident child.
(3) The exposure frequency is based on best professional judgment, assuming that the trespasser would visit the site approximately 1 days/week for 12 months of the year for 4 hours per day. The exposure duration is based on the age range evaluated (8 - 16 years of age).

TABLE 7-4.2
VALUES USED FOR CONSTRUCTION WORKER DAILY SOIL INTAKE EQUATIONS
NORTHWEST BOUNDARY AREA
FORT BUCHANAN

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Soil, Air
Exposure Point: Northwest Boundary Area
Receptor Population: Construction Worker
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Intake Equation / Model Name
Ingestion	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) = CS x CR x EF x ED x CF / (BW x AT)
	CR	Ingestion Rate	mg/day	100	U.S. EPA 2011a	
	EF	Exposure Frequency	day/yr	250	U.S. EPA 1991a,b	
	ED	Exposure Duration	yr	1	BPJ (1)	
	BW	Body Weight	kg	70	U.S. EPA 1989	
	AT-NC	Averaging time - Noncancer	days	365	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	U.S. EPA 1989	
Dermal	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) = CS x SA x AF x ABS x EF x ED x CF / (BW x AT)
	SA	Surface Area for Contact	cm^2/event	3,300	U.S. EPA 2004a	
	AF	Adherence Factor	mg/cm^2	0.3	U.S. EPA 2004a	
	ABS	Dermal Absorption Fraction	unitless	Chemical-Specific	U.S. EPA 2004a	
	EF	Exposure Frequency	event/yr	250	U.S. EPA 1991 a,b	
	ED	Exposure Duration	yr	1	BPJ (1)	
	BW	Body Weight	kg	70	U.S. EPA 1989	
	AT-NC	Averaging time - Noncancer	days	365	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	U.S. EPA 1989	
Inhalation	CA	Chemical Concentration in Air	mg/m^3	Chemical-Specific	Chemical-Specific	Exposure Concentration (ug/m^3) = Note: CF_1 is only used in determining carcinogenic exposure concentrations
	ET	Exposure Time	hours	8	U.S. EPA 1991a,b	
	CF_1	Conversion Factor	ug/mg	1,000	U.S. EPA 2009	
	EF	Exposure Frequency	day/yr	250	U.S. EPA 1991a,b	
	ED	Exposure Duration	yr	1	BPJ (1)	
	CF_2	Conversion Factor	hr/day	24	U.S. EPA 2009	
	AT-NC	Averaging time - Noncancer	days	365	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	

Note : BPJ = Best Professional Judgment
(1) Construction events are assumed to extend for up to one year total in duration.

TABLE 7-4.3
VALUES USED FOR COMMERCIAL WORKER DAILY SOIL INTAKE EQUATIONS
NORTHWEST BOUNDARY AREA
FORT BUCHANAN

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Soil, Air
Exposure Point: Northwest Boundary Area
Receptor Population: Commercial Worker
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Intake Equation / Model Name
Ingestion	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	CR	Ingestion Rate	mg/day	50	U.S. EPA 2011a	CS x CR x EF x ED x CF / (BW x AT)
	EF	Exposure Frequency	day/yr	250	U.S. EPA 1991a,b	
	ED	Exposure Duration	yr	25	U.S. EPA 1991a,b	
	BW	Body Weight	kg	70	U.S. EPA 1989	
	AT-NC	Averaging time - Noncancer	days	9,125	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	U.S. EPA 1989	
Dermal	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	SA	Surface Area for Contact	cm^2/event	3,300	U.S. EPA 2004a	CS x SA x AF x ABS x EF x ED x CF / (BW x AT)
	AF	Adherence Factor	mg/cm^2	0.2	U.S. EPA 2004a	
	ABS	Dermal Absorption Fraction	unitless	Chemical-Specific	U.S. EPA 2004a	
	EF	Exposure Frequency	event/yr	250	U.S. EPA 1991a,b	
	ED	Exposure Duration	yr	25	U.S. EPA 1991a,b	
	BW	Body Weight	kg	70	U.S. EPA 1989	
	AT-NC	Averaging time - Noncancer	days	9,125	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	U.S. EPA 1989	
Inhalation	CA	Chemical Concentration in Air	mg/m^3	Chemical-Specific	Chemical-Specific	Exposure Concentration (ug/m^3) =
	ET	Exposure Time	hours	8	BPJ	CA x CF_1 x ET x EF x ED / AT x CF_2
	CF_1	Conversion Factor	ug/mg	1,000	U.S. EPA 2009	
	EF	Exposure Frequency	day/yr	250	U.S. EPA 1991a,b	
	ED	Exposure Duration	yr	25	U.S. EPA 1991a,b	Note: CF_1 is only used in determining carcinogenic exposure concentrations
	CF_2	Conversion Factor	hr/day	24	U.S. EPA 2009	
	AT-NC	Averaging time - Noncancer	days	9,125	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	

Note : BPJ = Best Professional Judgement

TABLE 7-4.4
VALUES USED FOR RESIDENT ADULT DAILY TOTAL GROUNDWATER INTAKE EQUATIONS
NORTHWEST BOUNDARY AREA
FORT BUCHANAN

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Tap Water
Exposure Point: Northwest Boundary Area
Receptor Population: Off-site Resident
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Intake Equation / Model Name
Ingestion	CW	Chemical Concentration in Water	mg/L	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	CR	Ingestion Rate	L/day	2.45	U.S. EPA 2011a	CW x CR x EF x ED / (BW x AT)
	EF	Exposure Frequency	day/yr	350	U.S. EPA 1991a,b	
	ED-NC	Exposure Duration - Noncancer	yr	30	U.S. EPA 1991a,b	
	ED-C	Exposure Duration - Cancer	yr	24	U.S. EPA 1991a,b	
	BW	Body Weight	kg	70	U.S. EPA 1989	
	AT-NC	Averaging time - Noncancer	days	10,950	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
Dermal	CW	Chemical Concentration in Water	mg/L	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	SA	Surface Area for Contact	cm^2	18,000	U.S. EPA 2004a	CW x SA x PC x ET x EF x ED x CF / (BW x AT)
	PC	Permeability Coefficient	cm/hr	Chemical-Specific	Chemical-Specific	
	ET	Event Time	hr/day	0.58	U.S. EPA 2004a	
	EF	Exposure Frequency	day/yr	350	U.S. EPA 1991a,b	For organic compounds
	ED-NC	Exposure Duration - Noncancer	days	30	U.S. EPA 1991a,b	CDI (mg/kg/day) =
	ED-C	Exposure Duration - Cancer	yr	24	U.S. EPA 1991a,b	DA_{event} x SA x EF x ED / (BW x AT)
	BW	Body Weight	kg	70	U.S. EPA 1989	
	AT-NC	Averaging time - Noncancer	days	10,950	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
	CF	Conversion Factor	L/cm^3	0.001	U.S. EPA 1989	
Inhalation	CA	Chemical Concentration in Air	mg/m^3	Chemical-Specific	Chemical-Specific	Exposure Concentration (ug/m^3) =
	ET	Event Time	hr/day	0.58	U.S. EPA 2004a	CA x CF_1 x ET x EF x ED / AT x CF_2
	EF	Exposure Frequency	day/yr	350	U.S. EPA 1991a,b	
	VF	Volatilization Factor	L/m^3	0.5	U.S. EPA 2011b	where, CA = VF x CW
	CF_1	Conversion Factor	ug/mg	1,000	U.S. EPA 2009	
	CF_2	Conversion Factor	hr/day	24	U.S. EPA 2009	
	ED-NC	Exposure Duration - Noncancer	yr	30	U.S. EPA 1991a,b	
	ED-C	Exposure Duration - Cancer	yr	24	U.S. EPA 1991a,b	
	AT-NC	Averaging Time - Noncancer	days	10,950	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	

(1) Refer to Table 7-7.6 for details on calculation of DA_{event}.

TABLE 7-4.5
VALUES USED FOR RESIDENT CHILD DAILY TOTAL GROUNDWATER INTAKE EQUATIONS
NORTHWEST BOUNDARY AREA
FORT BUCHANAN

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Tap Water
Exposure Point: Northwest Boundary Area
Receptor Population: Off-site Resident
Receptor Age: Child

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Intake Equation / Model Name
Ingestion	CW	Chemical Concentration in Water	mg/L	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	CR	Ingestion Rate	L/day	1	U.S. EPA 2011a	CW x CR x EF x ED / (BW x AT)
	EF	Exposure Frequency	day/yr	350	U.S. EPA 1991a,b	
	ED	Exposure Duration	yr	6	U.S. EPA 1991a,b	
	BW	Body Weight	kg	15	U.S. EPA 1989	
	AT-NC	Averaging time - Noncancer	days	2,190	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
Dermal	CW	Chemical Concentration in Water	mg/L	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	SA	Surface Area for Contact	cm^2	6,600	U.S. EPA 2004a	CW x SA x PC x ET x EF x ED x CF / (BW x AT)
	PC	Permeability Coefficient	cm/hr	Chemical-Specific	Chemical-Specific	
	ET	Event Time	hr/day	1	U.S. EPA 2004a	
	EF	Exposure Frequency	day/yr	350	U.S. EPA 1991a,b	For organic compounds
	ED	Exposure Duration	yr	6	U.S. EPA 1991a,b	CDI (mg/kg/day) =
	BW	Body Weight	kg	15	U.S. EPA 1989	DA_{event} x SA x EF x ED / (BW x AT)
	AT-NC	Averaging time - Noncancer	days	2,190	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
	CF	Conversion Factor	L/cm^3	0.001	U.S. EPA 1989	

(1) Refer to Table 7-7.6 for details on calculation of DA_{event}.

TABLE 7-4.6
VALUES USED FOR CONSTRUCTION WORKER DAILY GROUNDWATER INTAKE EQUATIONS
NORTHWEST BOUNDARY AREA
FORT BUCHANAN

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Northwest Boundary Area
Receptor Population: Construction Worker
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Intake Equation / Model Name
Ingestion	CW	Chemical Concentration in Water	mg/L	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	CR	Ingestion Rate	L/day	0.02	U.S. EPA 2011a (1)	CW x CR x EF x ED / (BW x AT)
	EF	Exposure Frequency	day/yr	50	BPJ (2)	
	ED-C	Exposure Duration	yr	1	BPJ (3)	
	BW	Body Weight	kg	70	U.S. EPA 1989	
	AT-NC	Averaging time - Noncancer	days	365	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
Dermal	CW	Chemical Concentration in Water	mg/L	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	SA	Surface Area for Contact	cm^2	3,300	U.S. EPA 2004a	CW x SA x PC x ET x EF x ED x CF / (BW x AT)
	PC	Permeability Coefficient	cm/hr	Chemical-Specific	Chemical-Specific	
	ET	Event Time	hr/day	4	BPJ (4)	
	EF	Exposure Frequency	day/yr	50	BPJ (2)	For organic compounds
	ED-C	Exposure Duration	yr	1	BPJ (3)	CDI (mg/kg/day) =
	BW	Body Weight	kg	70	U.S. EPA 1989	DA_{event} x SA x EF x ED / (BW x AT)
	AT-NC	Averaging time - Noncancer	days	365	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
	CF	Conversion Factor	L/cm^3	0.001	U.S. EPA 1989	

Note : BPJ = Best Professional Judgment
(1) Incidental ingestion of groundwater is assumed equal 1/100th of ingestion rate of resident adult tap water.
(2) Construction workers are assumed to contact groundwater only 50 days out of the year.
(3) Construction events are assumed to extend for up to one year total in duration.
(4) Construction events are assumed to contact groundwater for half of their time on the site per day.

TABLE 7-5.1
NON-CANCER TOXICITY DATA - ORAL/DERMAL
NORTHWEST BOUNDARY AREA
FORT BUCHANAN

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD Value (mg/kg-day)	Oral to Dermal Adjustment Factor (GI ABS) (1)	Adjusted Dermal RfD (2) (mg/kg bw-day)	Primary Target Organ	Combined Uncertainty/ Modifying Factors	Sources of RfD: Target Organ	Dates of RfD: Target Organ (3) (mm/dd/yy)
Inorganics								
ALUMINUM	Chronic	1.00E+00	1	1.00E+00	Central Nervous System	100/1	PPRTV	10/23/2006
ANTIMONY	Chronic	4.00E-04	0.15	6.00E-05	Blood glucose and cholesterol	1000/1	IRIS	9/26/2011
ARSENIC	Chronic	3.00E-04	1	3.00E-04	Skin	3/1	IRIS	9/26/2011
BARIUM	Chronic	2.00E-01	0.07	1.40E-02	Kidneys	300/1	IRIS	9/26/2011
CADMIUM	Chronic	5.00E-04	0.05	2.50E-05	Kidneys	10/1	IRIS	9/26/2011
COBALT	Chronic	3.00E-04	1	3.00E-04	Thyroid	3000/1	PPRTV	8/25/2008
COPPER	Chronic	4.00E-02	1	4.00E-02	Gastrointestinal System	1000/1	HEAST	1997
IRON	Chronic	7.00E-01	1	7.00E-01	Digestive System	1.5/1	PPRTV	9/11/2006
MANGANESE	Chronic	4.60E-02	0.04	1.84E-03	Central Nervous System	1/3	IRIS	9/26/2011
NICKEL	Chronic	2.00E-02	0.04	8.00E-04	None	300/1	IRIS	9/26/2011
VANADIUM	Chronic	5.00E-03	1	5.00E-03	Hair	100/1	IRIS	9/26/2011
PAHs								
BENZO(A)PYRENE	NA	NA	1	NA	NA	NA/NA	IRIS	9/26/2011
NAPHTHALENE	Chronic	2.00E-02	1	2.00E-02	None	3000/1	IRIS	9/26/2011
Volatiles								
CHLOROFORM	Chronic	1.00E-02	1	1.00E-02	Liver	100/1	IRIS	9/26/2011
1,2-DICHLOROETHANE	NA	NA	1	NA	NA	NA/NA	PPRTV	10/1/2010
CIS-1,2-DICHLOROETHENE	Chronic	2.00E-03	1	2.00E-03	Kidneys	3000/1	IRIS	9/26/2011
TRANS-1,2-DICHLOROETHENE	Chronic	2.00E-02	1	2.00E-02	Blood	3000/1	IRIS	9/26/2011
TETRACHLOROETHENE	Chronic	1.00E-02	1	1.00E-02	Liver	1000/1	IRIS	9/26/2011
1,1,2-TRICHLOROETHANE	Chronic	4.00E-03	1	4.00E-03	Liver	1000/1	IRIS	9/26/2011
TRICHLOROETHENE	Chronic	5.00E-04	1	5.00E-04	Immune System	100/1	IRIS	9/28/2011
VINYL CHLORIDE	Chronic	3.00E-03	1	3.00E-03	Liver	30/1	IRIS	9/26/2011

NA = Not Applicable

(1) Taken from USEPA 2004a Guidance.

(2) Dermal toxicological values adjusted from oral values using USEPA 2004a recommended chemical-specific gastrointestinal absorption factors (GI ABS). RfDs are multiplied by the GI ABS.

(3) IRIS - Integrated Risk Information System. For IRIS values, the date IRIS was searched is provided.
HEAST - Health Effects Assessment Summary Tables. For HEAST values, the date of HEAST is provided.
PPRTV - Provisional Peer Reviewed Toxicity Value
CAL EPA - California Environmental Protection Agency

TABLE 7-5.2
NON-CANCER TOXICITY DATA - INHALATION
NORTHWEST BOUNDARY AREA
FORT BUCHANAN

Chemical of Potential Concern	Chronic/ Subchronic	Value Inhalation (RfC) (mg/m^3)	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfC:RfD: Target Organ	Dates (1) (mm/dd/yy)
Inorganics						
ALUMINUM	Chronic	5.00E-03	Central Nervous System	300/1	PPRTV	10/23/2006
ANTIMONY	NA	NA	None	NA/NA	IRIS	9/26/2011
ARSENIC	Chronic	1.50E-05	Cardiovascular System	30/1	CalEPA	9/26/2011
BARIUM	Chronic	5.00E-04	Cardiovascular System	1000/1	HEAST	1997
CADMIUM	Chronic	2.00E-05	Kidneys	9/1	CalEPA	9/26/2011
COBALT	Chronic	6.00E-06	Cardiovascular System	300/1	PPRTV	8/25/2008
COPPER	NA	NA	NA	NA/NA	IRIS	9/26/2011
IRON	NA	NA	NA	NA/NA	PPRTV	9/11/2006
MANGANESE	Chronic	5.00E-05	Central Nervous System	1000/1	IRIS	9/26/2011
NICKEL	Chronic	9.00E-05	Respiratory System	30/1	ATSDR	09/2005
VANADIUM	NA	NA	NA	NA/NA	IRIS	9/26/2011
PAHs						
BENZO(A)PYRENE	NA	NA	NA	NA/NA	IRIS	9/26/2011
NAPHTHALENE	Chronic	3.00E-03	Respiratory System	3000/1	IRIS	9/26/2011
Volatiles						
CHLOROFORM	Chronic	9.80E-02	Liver	30/1	ATSDR	09/1997
1,2-DICHLOROETHANE	Chronic	7.00E-03	Liver	3000/1	PPRTV	10/1/2011
CIS-1,2-DICHLOROETHENE	NA	NA	NA	NA/NA	IRIS	9/26/2011
TRANS-1,2-DICHLOROETHENE	Chronic	6.00E-02	Lungs	3000/1	PPRTV	9/26/2011
TETRACHLOROETHENE	Chronic	2.70E-01	Central Nervous System	100/1	ATSDR	09/1997
1,1,2-TRICHLOROETHANE	NA	NA	NA	NA/NA	PPRTV	4/1/2011
TRICHLOROETHENE	Chronic	2.00E-03	Immune System	100/1	IRIS	9/28/2011
VINYL CHLORIDE	Chronic	1.00E-01	Liver	30/1	IRIS	9/26/2011

NA = Not Applicable

(1) IRIS - Integrated Risk Information System. For IRIS values, the date IRIS was searched is provided.
HEAST - Health Effects Assessment Summary Tables. For HEAST values, the date of HEAST is provided.
PPRTV - Provisional Peer Reviewed Toxicity Value
CAL EPA - California Environmental Protection Agency

TABLE 7-5.3
CHEMICAL-SPECIFIC PARAMETERS
NORTHWEST BOUNDARY AREA
FORT BUCHANAN

Chemical of Potential Concern	Absorption Factor	Reference	GI ABS	Reference	Permeability Constant (cm/hr)	Reference
Inorganics						
ALUMINUM	NA	U.S. EPA, 2004a	1	U.S. EPA, 2004a	1.00E-03	U.S. EPA, 2004a
ANTIMONY	NA	U.S. EPA, 2004a	0.15	U.S. EPA, 2004a	1.00E-03	U.S. EPA, 2004a
ARSENIC	0.03	U.S. EPA, 2004a	1	U.S. EPA, 2004a	1.00E-03	U.S. EPA, 2004a
BARIUM	NA	U.S. EPA, 2004a	0.07	U.S. EPA, 2004a	1.00E-03	U.S. EPA, 2004a
CADMIUM	0.001	U.S. EPA, 2004a	0.05	U.S. EPA, 2004a	1.00E-03	U.S. EPA, 2004a
COBALT	NA	U.S. EPA, 2004a	1	U.S. EPA, 2004a	4.00E-04	U.S. EPA, 2004a
COPPER	NA	U.S. EPA, 2004a	1	U.S. EPA, 2004a	1.00E-03	U.S. EPA, 2004a
IRON	NA	U.S. EPA, 2004a	1	U.S. EPA, 2004a	1.00E-03	U.S. EPA, 2004a
MANGANESE	NA	U.S. EPA, 2004a	0.04	U.S. EPA, 2004a	1.00E-03	U.S. EPA, 2004a
NICKEL	NA	U.S. EPA, 2004a	0.04	U.S. EPA, 2004a	2.00E-04	U.S. EPA, 2004a
VANADIUM	NA	U.S. EPA, 2004a	1	U.S. EPA, 2004a	1.00E-03	U.S. EPA, 2004a
PAHs						
BENZO(A)PYRENE	0.13	U.S. EPA, 2004a	1	U.S. EPA, 2004a	7.00E-01	U.S. EPA, 2004a
NAPHTHALENE	0.13	U.S. EPA, 2004a	1	U.S. EPA, 2004a	4.70E-02	U.S. EPA, 2004a
Volatiles						
CHLOROFORM	NA	U.S. EPA, 2004a	1	U.S. EPA, 2004a	6.80E-03	U.S. EPA, 2004a
1,2-DICHLOROETHANE	NA	U.S. EPA, 2004a	1	U.S. EPA, 2004a	4.20E-03	U.S. EPA, 2004a
CIS-1,2-DICHLOROETHENE	NA	U.S. EPA, 2004a	1	U.S. EPA, 2004a	7.70E-03	U.S. EPA, 2004a
TRANS-1,2-DICHLOROETHENE	NA	U.S. EPA, 2004a	1	U.S. EPA, 2004a	7.70E-03	U.S. EPA, 2004a
TETRACHLOROETHENE	NA	U.S. EPA, 2004a	1	U.S. EPA, 2004a	3.30E-02	U.S. EPA, 2004a
1,1,2-TRICHLOROETHANE	NA	U.S. EPA, 2004a	1	U.S. EPA, 2004a	6.40E-03	U.S. EPA, 2004a
TRICHLOROETHENE	NA	U.S. EPA, 2004a	1	U.S. EPA, 2004a	1.20E-02	U.S. EPA, 2004a
VINYL CHLORIDE	NA	U.S. EPA, 2004a	1	U.S. EPA, 2004a	5.60E-03	U.S. EPA, 2004a

NA = Data not available.
GI ABS = Gastrointestional Absorption factors
U.S. EPA, 2004a = U.S. Environmental Protection Agency, 2004. *Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment).* Final Guidance.

TABLE 7-6.1
CANCER TOXICITY DATA - ORAL/DERMAL
NORTHWEST BOUNDARY AREA
FORT BUCHANAN

Chemical of Potential Concern	Oral Cancer Slope Factor	Oral Absorption Efficiency for Dermal (GI ABS)(1)	Absorbed Cancer Slope Factor for Dermal (2)	Units	Mutagenic Compound	Weight of Evidence/Cancer Guideline Description	Source	Date (3) (mm/dd/yy)
Inorganics								
ALUMINUM	NA	1	NA	per (mg/kg-day)		D	PPRTV	10/23/2006
ANTIMONY	NA	0.15	NA	per (mg/kg-day)		NA	IRIS	9/26/2011
ARSENIC	1.50E+00	1	1.50E+00	per (mg/kg-day)		A	IRIS	9/26/2011
BARIUM	NA	0.07	NA	per (mg/kg-day)		D	IRIS	9/26/2011
CADMIUM	NA	0.05	NA	per (mg/kg-day)		B1	IRIS	9/26/2011
COBALT	NA	1	NA	per (mg/kg-day)		NA	PPRTV	8/25/2008
COPPER	NA	1	NA	per (mg/kg-day)		D	IRIS	9/26/2011
IRON	NA	1	NA	per (mg/kg-day)		NA	PPRTV	9/11/2006
MANGANESE	NA	0.04	NA	per (mg/kg-day)		D	IRIS	9/26/2011
NICKEL	NA	0.04	NA	per (mg/kg-day)		NA	IRIS	9/26/2011
VANADIUM	NA	1	NA	per (mg/kg-day)		NA	IRIS	9/26/2011
PAHs								
BENZO(A)PYRENE	7.30E+00	1	7.30E+00	per (mg/kg-day)		B2	IRIS	9/26/2011
NAPHTHALENE	NA	1	NA	per (mg/kg-day)		C	IRIS	9/26/2011
Volatiles								
CHLOROFORM	3.10E-02	1	3.10E-02	per (mg/kg-day)		B2	IRIS	9/26/2011
1,2-DICHLOROETHANE	9.10E-02	1	9.10E-02	per (mg/kg-day)		B2	IRIS	9/26/2011
CIS-1,2-DICHLOROETHENE	NA	1	NA	per (mg/kg-day)		NA	IRIS	9/26/2011
TRANS-1,2-DICHLOROETHENE	NA	1	NA	per (mg/kg-day)		NA	IRIS	9/26/2011
TETRACHLOROETHENE	5.40E-01	1	5.40E-01	per (mg/kg-day)		B2	CalEPA	2002
1,1,2-TRICHLOROETHANE	5.70E-02	1	5.70E-02	per (mg/kg-day)		C	IRIS	9/26/2011
TRICHLOROETHENE	4.60E-02	1	4.60E-02	per (mg/kg-day)		A	IRIS	9/28/2011
VINYL CHLORIDE	7.20E-01	1	7.20E-01	per (mg/kg-day)	M	A	IRIS	9/26/2011

M = Chemical has been identified as having a mutagenic mode of action

NA = Not Applicable

(1) Taken from USEPA 2004a Guidance.

(2) Dermal Toxicological values adjusted from oral values using USEPA 2004a recommended chemical-specific gastrointestinal absorption factors (GI ABS). CSFs are divided by the GI ABS.

(3) IRIS - Integrated Risk Information System. For IRIS values, the date IRIS was searched is provided.

PPRTV - Provisional Peer Reviewed Toxicity Value

CAL EPA - California Environmental Protection Agency

Weight of Evidence:
A - Human carcinogen
B1 - Probable human carcinogen - limited human data
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

TABLE 7-6.2
CANCER TOXICITY DATA - INHALATION
NORTHWEST BOUNDARY AREA
FORT BUCHANAN

Chemical of Potential Concern	Unit Risk		Weight of Evidence/Cancer Guideline Description	Mutagenic Compound	Unit Risk - Inhalation CSF	
	Value	Units			Source	Date (1)
Inorganics						
ALUMINUM	NA	per (ug/m^3)	D		PPRTV	10/23/2006
ANTIMONY	NA	per (ug/m^3)	NA		IRIS	9/26/2011
ARSENIC	1.50E+00	per (ug/m^3)	A		IRIS	9/26/2011
BARIUM	NA	per (ug/m^3)	D		IRIS	9/26/2011
CADMIUM	1.80E-03	per (ug/m^3)	B1		IRIS	9/26/2011
COBALT	9.00E-03	per (ug/m^3)	B2		PPRTV	8/25/2008
COPPER	NA	per (ug/m^3)	D		IRIS	9/26/2011
IRON	NA	per (ug/m^3)	NA		PPRTV	9/11/2006
MANGANESE	NA	per (ug/m^3)	D		IRIS	9/26/2011
NICKEL	2.60E-04	per (ug/m^3)	NA		IRIS	9/26/2011
VANADIUM	NA	per (ug/m^3)	NA		IRIS	9/26/2011
PAHs						
BENZO(A)PYRENE	3.10E+00	per (ug/m^3)	B2		IRIS	9/26/2011
NAPHTHALENE	3.40E-05	per (ug/m^3)	C		CalEPA	2004
Volatiles						
CHLOROFORM	2.30E-05	per (ug/m^3)	B2		IRIS	9/26/2011
1,2-DICHLOROETHANE	2.60E-05	per (ug/m^3)	B2		IRIS	9/26/2011
CIS-1,2-DICHLOROETHENE	NA	per (ug/m^3)	NA		IRIS	9/26/2011
TRANS-1,2-DICHLOROETHENE	NA	per (ug/m^3)	NA		IRIS	9/26/2011
TETRACHLOROETHENE	5.90E-06	per (ug/m^3)	B2		CalEPA	5/1/2009
1,1,2-TRICHLOROETHANE	1.60E-05	per (ug/m^3)	C		IRIS	9/26/2011
TRICHLOROETHENE	4.10E-06	per (ug/m^3)	A		IRIS	9/28/2011
VINYL CHLORIDE	4.40E-06	per (ug/m^3)	A	M	IRIS	9/26/2011

M = Chemical has been identified as having a mutagenic mode of action
NA = Not Applicable
(1) IRIS - Integrated Risk Information System. For IRIS values, the date IRIS was searched is provided.
HEAST - Health Effects Assessment Summary Tables. For HEAST values, the date of HEAST is provided.
PPRTV - Provisional Peer Reviewed Toxicity Value
CAL EPA - California Environmental Protection Agency

Weight of Evidence: A - Human carcinogen
B1 - Probable human carcinogen - indicate that limited human data are available
B2 - Probable human carcinogen - indicates inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

TABLE 7-7.1
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
NORTHWEST BOUNDARY AREA
FORT BUCHANAN

Scenario Timeframe: Current/Future
Receptor Population: Trespasser
Receptor Age: Adolescent

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Soil	Subsurface Soil	Northwest Boundary Area	Ingestion	**Inorganics**												
				ALUMINUM	2.73E+04	(mg/kg)	4.94E-04	(mg/kg-day)	NA	per (mg/kg-day)	--	4.32E-03	(mg/kg-day)	1.00E+00	(mg/kg-day)	4.32E-03
				ANTIMONY	1.62E+00	(mg/kg)	2.93E-08	(mg/kg-day)	NA	per (mg/kg-day)	--	2.56E-07	(mg/kg-day)	4.00E-04	(mg/kg-day)	6.41E-04
				ARSENIC	3.57E+01	(mg/kg)	6.46E-07	(mg/kg-day)	1.50E+00	per (mg/kg-day)	9.69E-07	5.65E-06	(mg/kg-day)	3.00E-04	(mg/kg-day)	1.88E-02
				COBALT	1.37E+01	(mg/kg)	2.48E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	2.17E-06	(mg/kg-day)	3.00E-04	(mg/kg-day)	7.23E-03
				IRON	4.37E+04	(mg/kg)	7.91E-04	(mg/kg-day)	NA	per (mg/kg-day)	--	6.92E-03	(mg/kg-day)	7.00E-01	(mg/kg-day)	9.88E-03
				MANGANESE	6.00E+02	(mg/kg)	1.09E-05	(mg/kg-day)	NA	per (mg/kg-day)	--	9.50E-05	(mg/kg-day)	4.60E-02	(mg/kg-day)	2.06E-03
				VANADIUM	1.49E+02	(mg/kg)	2.70E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	2.36E-05	(mg/kg-day)	5.00E-03	(mg/kg-day)	4.72E-03
				PAHs												
				BENZO(A)PYRENE	1.62E-02	(mg/kg)	2.93E-10	(mg/kg-day)	7.30E+00	per (mg/kg-day)	2.14E-09	2.56E-09	(mg/kg-day)	NA	(mg/kg-day)	--
			Exp. Route Total								**9.71E-07**					**4.77E-02**
			Dermal[1]	**Inorganics**												
				ALUMINUM	2.73E+04	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	1.00E+00	(mg/kg-day)	--
				ANTIMONY	1.62E+00	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	6.00E-05	(mg/kg-day)	--
				ARSENIC	3.57E+01	(mg/kg)	2.25E-07	(mg/kg-day)	1.50E+00	per (mg/kg-day)	3.37E-07	1.97E-06	(mg/kg-day)	3.00E-04	(mg/kg-day)	6.56E-03
				COBALT	1.37E+01	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	3.00E-04	(mg/kg-day)	--
				IRON	4.37E+04	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	7.00E-01	(mg/kg-day)	--
				MANGANESE	6.00E+02	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	1.84E-03	(mg/kg-day)	--
				VANADIUM	1.49E+02	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	5.00E-03	(mg/kg-day)	--
				PAHs												
				BENZO(A)PYRENE	1.62E-02	(mg/kg)	4.42E-10	(mg/kg-day)	7.30E+00	per (mg/kg-day)	3.23E-09	3.87E-09	(mg/kg-day)	NA	(mg/kg-day)	--
			Exp. Route Total								**3.40E-07**					**6.56E-03**
		Exposure Point Total									**1.31E-06**					**5.42E-02**
	Exposure Medium Total										**1.31E-06**					**5.42E-02**
	Air	Northwest Boundary Area	Inhalation	**Inorganics**												
				ALUMINUM	2.07E-05	(mg/m^3)	2.53E-06	(ug/m^3)	NA	per (ug/m^3)	--	4.91E-07	(mg/m^3)	5.00E-03	(mg/m^3)	9.82E-05
				ANTIMONY	1.23E-09	(mg/m^3)	1.50E-10	(ug/m^3)	NA	per (ug/m^3)	--	2.91E-11	(mg/m^3)	NA	(mg/m^3)	--
				ARSENIC	2.70E-08	(mg/m^3)	3.30E-09	(ug/m^3)	1.50E+00	per (ug/m^3)	4.95E-09	6.42E-10	(mg/m^3)	1.50E-05	(mg/m^3)	4.28E-05
				COBALT	1.04E-08	(mg/m^3)	1.27E-09	(ug/m^3)	9.00E-03	per (ug/m^3)	1.14E-11	2.46E-10	(mg/m^3)	6.00E-06	(mg/m^3)	4.11E-05
				IRON	3.31E-05	(mg/m^3)	4.04E-06	(ug/m^3)	NA	per (ug/m^3)	--	7.86E-07	(mg/m^3)	NA	(mg/m^3)	--
				MANGANESE	4.55E-07	(mg/m^3)	5.55E-08	(ug/m^3)	NA	per (ug/m^3)	--	1.08E-08	(mg/m^3)	5.00E-05	(mg/m^3)	2.16E-04
				VANADIUM	1.13E-07	(mg/m^3)	1.38E-08	(ug/m^3)	NA	per (ug/m^3)	--	2.68E-09	(mg/m^3)	NA	(mg/m^3)	--
				PAHs		(mg/m^3)										
				BENZO(A)PYRENE	1.23E-11	(mg/m^3)	1.50E-12	(ug/m^3)	3.10E+00	per (ug/m^3)	4.65E-12	2.91E-13	(mg/m^3)	NA	(mg/m^3)	--
			Exp. Route Total								**4.97E-09**					**3.98E-04**
		Exposure Point Total									**4.97E-09**					**3.98E-04**
	Exposure Medium Total										**4.97E-09**					**3.98E-04**
Soil Total											**1.32E-06**					**5.46E-02**
										Total of Receptor Risks Across All Media	**1.32E-06**				Total of Receptor Hazards Across All Media	**5.46E-02**

1) Dermal intake value is "NA" due to no published dermal absorption fraction for COPC. Please see USEPA 2004 guidance and Table 7-5.
EPC = Exposure Point Concentration
CSF = Cancer Slope Factor
RfD = Reference Dose
RfC = Reference Concentration

TABLE 7-7.2

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

NORTHWEST BOUNDARY AREA
FORT BUCHANAN

Scenario Timeframe: Future
Receptor Population: Commercial Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Soil	Subsurface Soil	Northwest Boundary Area	Ingestion	**Inorganics**												
				ARSENIC	3.57E+01	(mg/kg)	6.24E-06	(mg/kg-day)	1.50E+00	per (mg/kg-day)	9.36E-06	1.75E-05	(mg/kg-day)	3.00E-04	(mg/kg-day)	5.82E-02
				COBALT	1.37E+01	(mg/kg)	2.39E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	6.70E-06	(mg/kg-day)	3.00E-04	(mg/kg-day)	2.23E-02
			Exp. Route Total								**9.36E-06**					**8.06E-02**
			Dermal[1]	**Inorganics**												
				ARSENIC	3.57E+01	(mg/kg)	2.47E-06	(mg/kg-day)	1.50E+00	per (mg/kg-day)	3.71E-06	6.92E-06	(mg/kg-day)	3.00E-04	(mg/kg-day)	2.31E-02
				COBALT	1.37E+01	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	3.00E-04	(mg/kg-day)	--
			Exp. Route Total								**3.71E-06**					**2.31E-02**
		Exposure Point Total									**1.31E-05**					**1.04E-01**
	Exposure Medium Total										**1.31E-05**					**1.04E-01**
	Air	Northwest Boundary Area	Inhalation	**Inorganics**												
				ARSENIC	2.70E-08	(mg/m^3)	1.54E-07	(ug/m^3)	1.50E+00	per (ug/m^3)	2.32E-07	6.17E-09	(mg/m^3)	1.50E-05	(mg/m^3)	4.12E-04
				COBALT	1.04E-08	(mg/m^3)	5.92E-08	(ug/m^3)	9.00E-03	per (ug/m^3)	5.33E-10	2.37E-09	(mg/m^3)	6.00E-06	(mg/m^3)	3.95E-04
			Exp. Route Total								**2.32E-07**					**8.07E-04**
		Exposure Point Total									**2.32E-07**					**8.07E-04**
	Exposure Medium Total										**2.32E-07**					**8.07E-04**
Soil Total											**1.33E-05**					**1.04E-01**
										Total of Receptor Risks Across All Medi	**1.33E-05**				Total of Receptor Hazards Across All Medi	**1.04E-01**

1) Dermal intake value is "NA" due to no published dermal absorption fraction for COPC. Please see USEPA 2004 guidance and Table 7-5.3.
EPC = Exposure Point Concentration
CSF = Cancer Slope Factor
RfD = Reference Dose
RfC = Reference Concentration

TABLE 7-7.3
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
NORTHWEST BOUNDARY AREA
FORT BUCHANAN

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater/Irrigation	Northwest Boundary Area	Ingestion	**Inorganics**												
				ALUMINUM	8.31E+00	(mg/L)	5.69E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	3.98E-04	(mg/kg-day)	1.00E+00	(mg/kg-day)	3.98E-04
				ARSENIC	2.14E-02	(mg/L)	1.47E-08	(mg/kg-day)	1.50E+00	per (mg/kg-day)	2.20E-08	1.03E-06	(mg/kg-day)	3.00E-04	(mg/kg-day)	3.42E-03
				BARIUM	3.65E-01	(mg/L)	2.50E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	1.75E-05	(mg/kg-day)	2.00E-01	(mg/kg-day)	8.75E-05
				CADMIUM	2.01E-03	(mg/L)	1.38E-09	(mg/kg-day)	NA	per (mg/kg-day)	--	9.64E-08	(mg/kg-day)	5.00E-04	(mg/kg-day)	1.93E-04
				COBALT	2.37E-03	(mg/L)	1.62E-09	(mg/kg-day)	NA	per (mg/kg-day)	--	1.14E-07	(mg/kg-day)	3.00E-04	(mg/kg-day)	3.79E-04
				COPPER	3.50E-02	(mg/L)	2.40E-08	(mg/kg-day)	NA	per (mg/kg-day)	--	1.68E-06	(mg/kg-day)	4.00E-02	(mg/kg-day)	4.20E-05
				IRON	2.12E+01	(mg/L)	1.45E-05	(mg/kg-day)	NA	per (mg/kg-day)	--	1.02E-03	(mg/kg-day)	7.00E-01	(mg/kg-day)	1.45E-03
				MANGANESE	1.12E+00	(mg/L)	7.67E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	5.37E-05	(mg/kg-day)	4.60E-02	(mg/kg-day)	1.17E-03
				MERCURY	4.49E-04	(mg/L)	3.08E-10	(mg/kg-day)	NA	per (mg/kg-day)	--	2.15E-08	(mg/kg-day)	1.00E-04	(mg/kg-day)	2.15E-04
				NICKEL	1.09E-02	(mg/L)	7.47E-09	(mg/kg-day)	NA	per (mg/kg-day)	--	5.23E-07	(mg/kg-day)	2.00E-02	(mg/kg-day)	2.61E-05
				PAHs												
				NAPHTHALENE	1.51E-03	(mg/L)	1.03E-09	(mg/kg-day)	NA	per (mg/kg-day)	--	7.24E-08	(mg/kg-day)	2.00E-02	(mg/kg-day)	3.62E-06
				Volatiles												
				CHLOROFORM	7.44E-04	(mg/L)	5.10E-10	(mg/kg-day)	3.10E-02	per (mg/kg-day)	1.58E-11	3.57E-08	(mg/kg-day)	1.00E-02	(mg/kg-day)	3.57E-06
				1,2-DICHLOROETHANE	4.09E-04	(mg/L)	2.80E-10	(mg/kg-day)	9.10E-02	per (mg/kg-day)	2.55E-11	1.96E-08	(mg/kg-day)	NA	(mg/kg-day)	--
				CIS-1,2-DICHLOROETHENE	5.62E-02	(mg/L)	3.85E-08	(mg/kg-day)	NA	per (mg/kg-day)	--	2.69E-06	(mg/kg-day)	2.00E-03	(mg/kg-day)	1.35E-03
				TRANS-1,2-DICHLOROETHENE	2.72E-03	(mg/L)	1.86E-09	(mg/kg-day)	NA	per (mg/kg-day)	--	1.30E-07	(mg/kg-day)	2.00E-02	(mg/kg-day)	6.52E-06
				TETRACHLOROETHENE	3.09E-03	(mg/L)	2.12E-09	(mg/kg-day)	5.40E-01	per (mg/kg-day)	1.14E-09	1.48E-07	(mg/kg-day)	1.00E-02	(mg/kg-day)	1.48E-05
				1,1,2-TRICHLOROETHANE	1.69E-03	(mg/L)	1.16E-09	(mg/kg-day)	5.70E-02	per (mg/kg-day)	6.60E-11	8.10E-08	(mg/kg-day)	4.00E-03	(mg/kg-day)	2.03E-05
				TRICHLOROETHENE	4.02E-01	(mg/L)	2.75E-07	(mg/kg-day)	4.60E-02	per (mg/kg-day)	1.27E-08	1.93E-05	(mg/kg-day)	5.00E-04	(mg/kg-day)	3.85E-02
				VINYL CHLORIDE	1.75E-03	(mg/L)	1.20E-09	(mg/kg-day)	7.20E-01	per (mg/kg-day)	8.63E-10	8.39E-08	(mg/kg-day)	3.00E-03	(mg/kg-day)	2.80E-05
			Exp. Route Total								**3.68E-08**					**4.74E-02**
			Dermal	**Inorganics**												
				ALUMINUM	8.31E+00	(mg/L)	3.07E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	2.15E-04	(mg/kg-day)	1.00E+00	(mg/kg-day)	2.15E-04
				ARSENIC	2.14E-02	(mg/L)	7.90E-09	(mg/kg-day)	1.50E+00	per (mg/kg-day)	1.18E-08	5.53E-07	(mg/kg-day)	3.00E-04	(mg/kg-day)	1.84E-03
				BARIUM	3.65E-01	(mg/L)	1.35E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	9.43E-06	(mg/kg-day)	1.40E-02	(mg/kg-day)	6.73E-04
				CADMIUM	2.01E-03	(mg/L)	7.42E-10	(mg/kg-day)	NA	per (mg/kg-day)	--	5.19E-08	(mg/kg-day)	2.50E-05	(mg/kg-day)	2.08E-03
				COBALT	2.37E-03	(mg/L)	3.50E-10	(mg/kg-day)	NA	per (mg/kg-day)	--	2.45E-08	(mg/kg-day)	3.00E-04	(mg/kg-day)	8.16E-05
				COPPER	3.50E-02	(mg/L)	1.29E-08	(mg/kg-day)	NA	per (mg/kg-day)	--	9.04E-07	(mg/kg-day)	4.00E-02	(mg/kg-day)	2.26E-05
				IRON	2.12E+01	(mg/L)	7.82E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	5.48E-04	(mg/kg-day)	7.00E-01	(mg/kg-day)	7.82E-04
				MANGANESE	1.12E+00	(mg/L)	4.13E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	2.89E-05	(mg/kg-day)	1.84E-03	(mg/kg-day)	1.57E-02
				MERCURY	4.49E-04	(mg/L)	1.66E-10	(mg/kg-day)	NA	per (mg/kg-day)	--	1.16E-08	(mg/kg-day)	1.00E-04	(mg/kg-day)	1.16E-04
				NICKEL	1.09E-02	(mg/L)	8.04E-10	(mg/kg-day)	NA	per (mg/kg-day)	--	5.63E-08	(mg/kg-day)	8.00E-04	(mg/kg-day)	7.04E-05
				PAHs												
				NAPHTHALENE	1.51E-03	(mg/L)	3.04E-08	(mg/kg-day)	NA	per (mg/kg-day)	--	2.13E-06	(mg/kg-day)	2.00E-02	(mg/kg-day)	1.06E-04
				Volatiles												
				CHLOROFORM	7.44E-04	(mg/L)	2.29E-09	(mg/kg-day)	3.10E-02	per (mg/kg-day)	7.09E-11	1.60E-07	(mg/kg-day)	1.00E-02	(mg/kg-day)	1.60E-05
				1,2-DICHLOROETHANE	4.09E-04	(mg/L)	7.45E-10	(mg/kg-day)	9.10E-02	per (mg/kg-day)	6.78E-11	5.22E-08	(mg/kg-day)	NA	(mg/kg-day)	--
				CIS-1,2-DICHLOROETHENE	5.62E-02	(mg/L)	1.85E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	1.30E-05	(mg/kg-day)	2.00E-03	(mg/kg-day)	6.49E-03
				TRANS-1,2-DICHLOROETHENE	2.72E-03	(mg/L)	8.77E-09	(mg/kg-day)	NA	per (mg/kg-day)	--	6.14E-07	(mg/kg-day)	2.00E-02	(mg/kg-day)	3.07E-05
				TETRACHLOROETHENE	3.09E-03	(mg/L)	5.41E-09	(mg/kg-day)	5.40E-01	per (mg/kg-day)	2.92E-09	3.79E-07	(mg/kg-day)	1.00E-02	(mg/kg-day)	3.79E-05
				1,1,2-TRICHLOROETHANE	1.69E-03	(mg/L)	5.09E-09	(mg/kg-day)	5.70E-02	per (mg/kg-day)	2.90E-10	3.56E-07	(mg/kg-day)	4.00E-03	(mg/kg-day)	8.90E-05
				TRICHLOROETHENE	4.02E-01	(mg/L)	2.23E-06	(mg/kg-day)	4.60E-02	per (mg/kg-day)	1.02E-07	1.56E-04	(mg/kg-day)	5.00E-04	(mg/kg-day)	3.12E-01
				VINYL CHLORIDE	1.75E-03	(mg/L)	3.99E-09	(mg/kg-day)	7.20E-01	per (mg/kg-day)	2.87E-09	2.79E-07	(mg/kg-day)	3.00E-03	(mg/kg-day)	9.31E-05
			Exp. Route Total								**1.21E-07**					**3.40E-01**
		Exposure Point Total									**1.57E-07**					**3.88E-01**
	Exposure Medium Total										**1.57E-07**					**3.88E-01**
Sediment Total											**1.57E-07**					**3.88E-01**
Soil	Total Soil	Northwest Boundary Area	Ingestion	**Inorganics**												
				ARSENIC	3.57E+01	(mg/kg)	4.99E-07	(mg/kg-day)	1.50E+00	per (mg/kg-day)	7.49E-07	3.49E-05	(mg/kg-day)	3.00E-04	(mg/kg-day)	1.16E-01
				COBALT	1.37E+01	(mg/kg)	1.92E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	1.34E-05	(mg/kg-day)	3.00E-04	(mg/kg-day)	4.47E-02
			Exp. Route Total								**7.49E-07**					**1.61E-01**
			Dermal[1]	**Inorganics**												
				ARSENIC	3.57E+01	(mg/kg)	1.48E-07	(mg/kg-day)	1.50E+00	per (mg/kg-day)	2.22E-07	1.04E-05	(mg/kg-day)	3.00E-04	(mg/kg-day)	3.46E-02
				COBALT	1.37E+01	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	3.00E-04	(mg/kg-day)	--
			Exp. Route Total								**2.22E-07**					**3.46E-02**
		Exposure Point Total									**9.71E-07**					**1.96E-01**
	Exposure Medium Total										**9.71E-07**					**1.96E-01**
	Air	Northwest Boundary Area	Inhalation	**Inorganics**												
				ARSENIC	2.70E-08	(mg/m^3)	2.12E-09	(ug/m^3)	1.50E+00	per (ug/m^3)	3.18E-09	6.17E-09	(mg/m^3)	1.50E-05	(mg/m^3)	4.12E-04
				COBALT	1.04E-08	(mg/m^3)	8.12E-10	(ug/m^3)	9.00E-03	per (ug/m^3)	7.31E-12	2.37E-09	(mg/m^3)	6.00E-06	(mg/m^3)	3.95E-04
			Exp. Route Total								**3.18E-09**					**4.12E-04**
		Exposure Point Total									**3.18E-09**					**4.12E-04**
	Exposure Medium Total										**3.18E-09**					**4.12E-04**
Soil Total											**9.74E-07**					**1.96E-01**
										Total of Receptor Risks Across All Media	**1.13E-06**				Total of Receptor Hazards Across All Media	**5.84E-01**

1) Dermal intake value is "NA" due to no published dermal absorption fraction for COPC. Please see USEPA 2004 guidance and Table 7-5.3.
EPC = Exposure Point Concentration
CSF = Cancer Slope Factor
RfD = Reference Dose
RfC = Reference Concentration

TABLE 7-7.4
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
NORTHWEST BOUNDARY AREA
FORT BUCHANAN

Scenario Timeframe: Future
Receptor Population: Off-Site Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Tap Water	Tap Water Off-site	Ingestion	**Inorganics**												
				ARSENIC	4.57E-03	(mg/L)	5.26E-05	(mg/kg-day)	1.50E+00	per (mg/kg-day)	7.89E-05	1.53E-04	(mg/kg-day)	3.00E-04	(mg/kg-day)	5.11E-01
				BARIUM	1.88E-01	(mg/L)	2.16E-03	(mg/kg-day)	NA	per (mg/kg-day)	--	6.31E-03	(mg/kg-day)	2.00E-01	(mg/kg-day)	3.15E-02
				COBALT	1.56E-03	(mg/L)	1.80E-05	(mg/kg-day)	NA	per (mg/kg-day)	--	5.24E-05	(mg/kg-day)	3.00E-04	(mg/kg-day)	1.75E-01
				IRON	1.71E+01	(mg/L)	1.97E-01	(mg/kg-day)	NA	per (mg/kg-day)	--	5.74E-01	(mg/kg-day)	7.00E-01	(mg/kg-day)	8.20E-01
				MANGANESE	1.26E+00	(mg/L)	1.45E-02	(mg/kg-day)	NA	per (mg/kg-day)	--	4.23E-02	(mg/kg-day)	4.60E-02	(mg/kg-day)	9.19E-01
				MERCURY	7.86E-05	(mg/L)	9.04E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	2.64E-06	(mg/kg-day)	1.00E-04	(mg/kg-day)	2.64E-02
				PAHs												
				NAPHTHALENE	1.51E-03	(mg/L)	1.74E-05	(mg/kg-day)	NA	per (mg/kg-day)	--	5.07E-05	(mg/kg-day)	2.00E-02	(mg/kg-day)	2.53E-03
				Volatiles												
				CHLOROFORM	7.44E-04	(mg/L)	8.56E-06	(mg/kg-day)	3.10E-02	per (mg/kg-day)	2.65E-07	2.50E-05	(mg/kg-day)	1.00E-02	(mg/kg-day)	2.50E-03
				1,2-DICHLOROETHANE	4.09E-04	(mg/L)	4.71E-06	(mg/kg-day)	9.10E-02	per (mg/kg-day)	4.28E-07	1.37E-05	(mg/kg-day)	NA	(mg/kg-day)	--
				CIS-1,2-DICHLOROETHENE	5.62E-02	(mg/L)	6.47E-04	(mg/kg-day)	NA	per (mg/kg-day)	--	1.89E-03	(mg/kg-day)	2.00E-03	(mg/kg-day)	9.43E-01
				TRANS-1,2-DICHLOROETHENE	2.72E-03	(mg/L)	3.13E-05	(mg/kg-day)	NA	per (mg/kg-day)	--	9.13E-05	(mg/kg-day)	2.00E-02	(mg/kg-day)	4.56E-03
				TETRACHLOROETHENE	3.09E-03	(mg/L)	3.56E-05	(mg/kg-day)	5.40E-01	per (mg/kg-day)	1.92E-05	1.04E-04	(mg/kg-day)	1.00E-02	(mg/kg-day)	1.04E-02
				1,1,2-TRICHLOROETHANE	1.69E-03	(mg/L)	1.94E-05	(mg/kg-day)	5.70E-02	per (mg/kg-day)	1.11E-06	5.67E-05	(mg/kg-day)	4.00E-03	(mg/kg-day)	1.42E-02
				TRICHLOROETHENE	4.02E-01	(mg/L)	4.63E-03	(mg/kg-day)	4.60E-02	per (mg/kg-day)	2.13E-04	1.35E-02	(mg/kg-day)	5.00E-04	(mg/kg-day)	2.70E+01
				VINYL CHLORIDE	1.75E-06	(mg/L)	2.01E-08	(mg/kg-day)	7.20E-01	per (mg/kg-day)	1.45E-08	5.87E-08	(mg/kg-day)	3.00E-03	(mg/kg-day)	1.96E-05
			Exp. Route Total								**3.13E-04**					**3.04E+01**
			Dermal	**Inorganics**												
				ARSENIC	4.57E-03	(mg/L)	2.24E-07	(mg/kg-day)	1.50E+00	per (mg/kg-day)	3.36E-07	6.54E-07	(mg/kg-day)	3.00E-04	(mg/kg-day)	2.18E-03
				BARIUM	1.88E-01	(mg/L)	9.22E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	2.69E-05	(mg/kg-day)	1.40E-02	(mg/kg-day)	1.92E-03
				COBALT	1.56E-03	(mg/L)	3.06E-08	(mg/kg-day)	NA	per (mg/kg-day)	--	8.92E-08	(mg/kg-day)	3.00E-04	(mg/kg-day)	2.97E-04
				IRON	1.71E+01	(mg/L)	8.38E-04	(mg/kg-day)	NA	per (mg/kg-day)	--	2.45E-03	(mg/kg-day)	7.00E-01	(mg/kg-day)	3.49E-03
				MANGANESE	1.26E+00	(mg/L)	6.18E-05	(mg/kg-day)	NA	per (mg/kg-day)	--	1.80E-04	(mg/kg-day)	1.84E-03	(mg/kg-day)	9.79E-02
				MERCURY	7.86E-05	(mg/L)	3.85E-09	(mg/kg-day)	NA	per (mg/kg-day)	--	1.12E-08	(mg/kg-day)	1.00E-04	(mg/kg-day)	1.12E-04
				PAHs												
				NAPHTHALENE	1.51E-03	(mg/L)	9.36E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	2.73E-05	(mg/kg-day)	2.00E-02	(mg/kg-day)	1.36E-03
				Volatiles												
				CHLOROFORM	7.44E-04	(mg/L)	2.48E-07	(mg/kg-day)	3.10E-02	per (mg/kg-day)	7.69E-09	7.24E-07	(mg/kg-day)	1.00E-02	(mg/kg-day)	7.24E-05
				1,2-DICHLOROETHANE	4.09E-04	(mg/L)	1.88E-07	(mg/kg-day)	9.10E-02	per (mg/kg-day)	1.71E-08	5.47E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				CIS-1,2-DICHLOROETHENE	5.62E-02	(mg/L)	4.67E-05	(mg/kg-day)	NA	per (mg/kg-day)	--	1.36E-04	(mg/kg-day)	2.00E-03	(mg/kg-day)	6.80E-02
				TRANS-1,2-DICHLOROETHENE	2.72E-03	(mg/L)	2.09E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	6.09E-06	(mg/kg-day)	2.00E-02	(mg/kg-day)	3.05E-04
				TETRACHLOROETHENE	3.09E-03	(mg/L)	1.71E-06	(mg/kg-day)	5.40E-01	per (mg/kg-day)	9.26E-07	5.00E-06	(mg/kg-day)	1.00E-02	(mg/kg-day)	5.00E-04
				1,1,2-TRICHLOROETHANE	1.69E-03	(mg/L)	1.48E-06	(mg/kg-day)	5.70E-02	per (mg/kg-day)	8.41E-08	4.30E-06	(mg/kg-day)	4.00E-03	(mg/kg-day)	1.08E-03
				TRICHLOROETHENE	4.02E-01	(mg/L)	6.49E-04	(mg/kg-day)	4.60E-02	per (mg/kg-day)	2.99E-05	1.89E-03	(mg/kg-day)	5.00E-04	(mg/kg-day)	3.79E+00
				VINYL CHLORIDE	1.75E-06	(mg/L)	8.69E-07	(mg/kg-day)	7.20E-01	per (mg/kg-day)	6.26E-07	2.54E-06	(mg/kg-day)	3.00E-03	(mg/kg-day)	8.45E-04
			Exp. Route Total								**3.19E-05**					**3.97E+00**
		Exposure Point Total									**3.45E-04**					**3.44E+01**
	Exposure Medium Total										**3.45E-04**					**3.44E+01**
	Air	Shower Head	Inhalation	**PAHs**												
				NAPHTHALENE	7.55E-04	(mg/m^3)	6.00E-03	(ug/m^3)	3.40E-05	per (ug/m^3)	2.04E-07	1.75E-05	(mg/m^3)	3.00E-03	(mg/m^3)	5.83E-03
				Volatiles												
				CHLOROFORM	3.72E-04	(mg/m^3)	2.96E-03	(ug/m^3)	2.30E-05	per (ug/m^3)	6.80E-08	8.62E-06	(mg/m^3)	9.80E-02	(mg/m^3)	8.80E-05
				1,2-DICHLOROETHANE	2.05E-04	(mg/m^3)	1.62E-03	(ug/m^3)	2.60E-05	per (ug/m^3)	4.22E-08	4.74E-06	(mg/m^3)	7.00E-03	(mg/m^3)	6.77E-04
				CIS-1,2-DICHLOROETHENE	2.81E-02	(mg/m^3)	2.23E-01	(ug/m^3)	NA	per (ug/m^3)	--	6.51E-04	(mg/m^3)	NA	(mg/m^3)	--
				TRANS-1,2-DICHLOROETHENE	1.36E-03	(mg/m^3)	1.08E-02	(ug/m^3)	NA	per (ug/m^3)	--	3.15E-05	(mg/m^3)	6.00E-02	(mg/m^3)	5.25E-04
				TETRACHLOROETHENE	1.55E-03	(mg/m^3)	1.23E-02	(ug/m^3)	5.90E-06	per (ug/m^3)	7.24E-08	3.58E-05	(mg/m^3)	2.70E-01	(mg/m^3)	1.33E-04
				1,1,2-TRICHLOROETHANE	8.45E-04	(mg/m^3)	6.71E-03	(ug/m^3)	1.60E-05	per (ug/m^3)	1.07E-07	1.96E-05	(mg/m^3)	NA	(mg/m^3)	--
				TRICHLOROETHENE	2.01E-01	(mg/m^3)	1.60E+00	(ug/m^3)	4.10E-06	per (ug/m^3)	6.55E-06	4.66E-03	(mg/m^3)	2.00E-03	(mg/m^3)	2.33E+00
				VINYL CHLORIDE	8.75E-04	(mg/m^3)	6.95E-03	(ug/m^3)	4.40E-06	per (ug/m^3)	3.06E-08	2.03E-05	(mg/m^3)	1.00E-01	(mg/m^3)	2.03E-04
			Exp. Route Total								**6.87E-06**					**2.33E+00**
		Exposure Point Total									**6.87E-06**					**2.33E+00**
	Exposure Medium Total										**6.87E-06**					**2.33E+00**
Groundwater Total											**3.51E-04**					**3.67E+01**
										Total of Receptor Risks Across All Media	**3.51E-04**				Total of Receptor Hazards Across All Media	**3.67E+01**

EPC = Exposure Point Concentration
CSF = Cancer Slope Factor
RfD = Reference Dose
RfC = Reference Concentration

TABLE 7-7.5
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
NORTHWEST BOUNDARY AREA
FORT BUCHANAN

Scenario Timeframe: Future
Receptor Population: Off-Site Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Tap Water	Off-site	Ingestion	**Inorganics**												
				ARSENIC	4.57E-03	(mg/L)	2.50E-05	(mg/kg-day)	1.50E+00	per (mg/kg-day)	3.76E-05	2.92E-04	(mg/kg-day)	3.00E-04	(mg/kg-day)	9.74E-01
				BARIUM	1.88E-01	(mg/L)	1.03E-03	(mg/kg-day)	NA	per (mg/kg-day)	--	1.20E-02	(mg/kg-day)	2.00E-01	(mg/kg-day)	6.01E-02
				COBALT	1.56E-03	(mg/L)	8.55E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	9.97E-05	(mg/kg-day)	3.00E-04	(mg/kg-day)	3.32E-01
				IRON	1.71E+01	(mg/L)	9.37E-02	(mg/kg-day)	NA	per (mg/kg-day)	--	1.09E+00	(mg/kg-day)	7.00E-01	(mg/kg-day)	1.56E+00
				MANGANESE	1.26E+00	(mg/L)	6.90E-03	(mg/kg-day)	NA	per (mg/kg-day)	--	8.05E-02	(mg/kg-day)	4.60E-02	(mg/kg-day)	1.75E+00
				MERCURY	7.86E-05	(mg/L)	4.31E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	5.02E-06	(mg/kg-day)	1.00E-04	(mg/kg-day)	5.02E-02
				PAHs												
				NAPHTHALENE	1.51E-03	(mg/L)	8.27E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	9.65E-05	(mg/kg-day)	2.00E-02	(mg/kg-day)	4.83E-03
				Volatiles												
				CHLOROFORM	7.44E-04	(mg/L)	4.08E-06	(mg/kg-day)	3.10E-02	per (mg/kg-day)	1.26E-07	4.76E-05	(mg/kg-day)	1.00E-02	(mg/kg-day)	4.76E-03
				1,2-DICHLOROETHANE	4.09E-04	(mg/L)	2.24E-06	(mg/kg-day)	9.10E-02	per (mg/kg-day)	2.04E-07	2.61E-05	(mg/kg-day)	NA	(mg/kg-day)	--
				CIS-1,2-DICHLOROETHENE	5.62E-02	(mg/L)	3.08E-04	(mg/kg-day)	NA	per (mg/kg-day)	--	3.59E-03	(mg/kg-day)	2.00E-03	(mg/kg-day)	1.80E+00
				TRANS-1,2-DICHLOROETHENE	2.72E-03	(mg/L)	1.49E-05	(mg/kg-day)	NA	per (mg/kg-day)	--	1.74E-04	(mg/kg-day)	2.00E-02	(mg/kg-day)	8.69E-03
				TETRACHLOROETHENE	3.09E-03	(mg/L)	1.69E-05	(mg/kg-day)	5.40E-01	per (mg/kg-day)	9.14E-06	1.98E-04	(mg/kg-day)	1.00E-02	(mg/kg-day)	1.98E-02
				1,1,2-TRICHLOROETHANE	1.69E-03	(mg/L)	9.26E-06	(mg/kg-day)	5.70E-02	per (mg/kg-day)	5.28E-07	1.08E-04	(mg/kg-day)	4.00E-03	(mg/kg-day)	2.70E-02
				TRICHLOROETHENE	4.02E-01	(mg/L)	2.20E-03	(mg/kg-day)	4.60E-02	per (mg/kg-day)	1.01E-04	2.57E-02	(mg/kg-day)	5.00E-04	(mg/kg-day)	5.14E+01
				VINYL CHLORIDE	1.75E-06	(mg/L)	9.59E-09	(mg/kg-day)	7.20E-01	per (mg/kg-day)	6.90E-09	1.12E-07	(mg/kg-day)	3.00E-03	(mg/kg-day)	3.73E-05
			Exp. Route Total								**1.49E-04**					**5.80E+01**
			Dermal	**Inorganics**												
				ARSENIC	4.57E-03	(mg/L)	1.65E-07	(mg/kg-day)	1.50E+00	per (mg/kg-day)	2.48E-07	1.93E-06	(mg/kg-day)	3.00E-04	(mg/kg-day)	6.43E-03
				BARIUM	1.88E-01	(mg/L)	6.80E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	7.93E-05	(mg/kg-day)	1.40E-02	(mg/kg-day)	5.67E-03
				COBALT	1.56E-03	(mg/L)	2.26E-08	(mg/kg-day)	NA	per (mg/kg-day)	--	2.63E-07	(mg/kg-day)	3.00E-04	(mg/kg-day)	8.78E-04
				IRON	1.71E+01	(mg/L)	6.18E-04	(mg/kg-day)	NA	per (mg/kg-day)	--	7.21E-03	(mg/kg-day)	7.00E-01	(mg/kg-day)	1.03E-02
				MANGANESE	1.26E+00	(mg/L)	4.56E-05	(mg/kg-day)	NA	per (mg/kg-day)	--	5.32E-04	(mg/kg-day)	1.84E-03	(mg/kg-day)	2.89E-01
				MERCURY	7.86E-05	(mg/L)	2.84E-09	(mg/kg-day)	NA	per (mg/kg-day)	--	3.32E-08	(mg/kg-day)	1.00E-04	(mg/kg-day)	3.32E-04
				PAHs												
				NAPHTHALENE	1.51E-03	(mg/L)	5.26E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	6.13E-05	(mg/kg-day)	2.00E-02	(mg/kg-day)	3.07E-03
				Volatiles												
				CHLOROFORM	7.44E-04	(mg/L)	1.83E-07	(mg/kg-day)	3.10E-02	per (mg/kg-day)	5.67E-09	2.13E-06	(mg/kg-day)	1.00E-02	(mg/kg-day)	2.13E-04
				1,2-DICHLOROETHANE	4.09E-04	(mg/L)	1.09E-07	(mg/kg-day)	9.10E-02	per (mg/kg-day)	9.89E-09	1.27E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				CIS-1,2-DICHLOROETHENE	5.62E-02	(mg/L)	2.70E-05	(mg/kg-day)	NA	per (mg/kg-day)	--	3.15E-04	(mg/kg-day)	2.00E-03	(mg/kg-day)	1.58E-01
				TRANS-1,2-DICHLOROETHENE	2.72E-03	(mg/L)	1.23E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	1.43E-05	(mg/kg-day)	2.00E-02	(mg/kg-day)	7.15E-04
				TETRACHLOROETHENE	3.09E-03	(mg/L)	9.63E-07	(mg/kg-day)	5.40E-01	per (mg/kg-day)	5.20E-07	1.12E-05	(mg/kg-day)	1.00E-02	(mg/kg-day)	1.12E-03
				1,1,2-TRICHLOROETHANE	1.69E-03	(mg/L)	8.29E-07	(mg/kg-day)	5.70E-02	per (mg/kg-day)	4.72E-08	9.67E-06	(mg/kg-day)	4.00E-03	(mg/kg-day)	2.42E-03
				TRICHLOROETHENE	4.02E-01	(mg/L)	3.65E-04	(mg/kg-day)	4.60E-02	per (mg/kg-day)	1.68E-05	4.26E-03	(mg/kg-day)	5.00E-04	(mg/kg-day)	8.51E+00
				VINYL CHLORIDE	1.75E-06	(mg/L)	5.18E-07	(mg/kg-day)	7.20E-01	per (mg/kg-day)	3.73E-07	6.05E-06	(mg/kg-day)	3.00E-03	(mg/kg-day)	2.02E-03
			Exp. Route Total								**1.80E-05**					**8.99E+00**
		Exposure Point Total									**1.67E-04**					**6.70E+01**
	Exposure Medium Total										**1.67E-04**					**6.70E+01**
Groundwater Total											**1.67E-04**					**6.70E+01**
										Total of Receptor Risks Across All Media	**1.67E-04**				Total of Receptor Hazards Across All Media	**6.70E+01**

EPC = Exposure Point Concentration
CSF = Cancer Slope Factor
RfD = Reference Dose
RfC = Reference Concentration

TABLE 7-7.6

CALCULATIONS OF AIR CONCENTRATIONS DUE TO DUST ENTRAINMENT FROM SUBSURFACE SOIL

NORTHWEST BOUNDARY AREA

FORT BUCHANAN

Model Equations:

Particulate Emmision Factor	PEF = Q/C x [(3,600 s/h)/(.36 x (1- V) x (Um/Ut)^3 x F(x))] =	1.32E+09
Air Concentration	Cair = Csoil/PEF	m^3/kg

Model Constants:				
Q/C	9.08E+01	g/m^2-s per kg/m^3	Inverse Mean Concentration at Center of 0.05 square, U.S. EPA 1996
V	5.00E-01	unitless	Default, U.S. EPA 1996
Um	4.69E+00	m/s	Mean annual wind speed, EPA, 1996
Ut	1.13E+01	m/s	Equivalent threshold value of windspeed at 7 m, EPA, 1996
F(x)	1.94E-01	unitless	Default, U.S. EPA 1996

Reference for the model: USEPA Soil Screening Guidance: Technical Background Document. Office of Emergency and Remedial Response. U.S. EPA, 1996.

Chemical	**Csoil, Subsurface Soil** RME EPC mg/kg	**Cair, Subsurface Soil Particulate** RME EPC mg/m^3
Inorganics		
ALUMINUM	2.73E+04	2.07E-05
ANTIMONY	1.62E+00	1.23E-09
ARSENIC	3.57E+01	2.70E-08
COBALT	1.37E+01	1.04E-08
IRON	4.37E+04	3.31E-05
MANGANESE	6.00E+02	4.55E-07
VANADIUM	1.49E+02	1.13E-07
PAHs		
BENZO(A)PYRENE	1.62E-02	1.23E-11

TABLE 7-7.7
CALCULATION OF DERMAL ABSORBED DOSE FROM GROUNDWATER
RESIDENT (ADULT AND CHILD) - REASONABLE MAXIMUM EXPOSURE
NORTHWEST BOUNDARY AREA

Contaminant of Potential Concern	**EPC (ug/L)**	**K_p (cm/hr)**	**Log K_p**	**MW (g/mole)**	**Log K_{ow}**	**B (unitless)**	**D_{sc} (cm^2/hr)**	**τ_{event} (hr)**	**b**	**c**	**t* (hr)**	**DA_{adult} (mg/cm^2-event)**	**DA_{child} (mg/cm^2-event)**
NAPHTHALENE	1.51E+00	4.70E-02	-1.34E+00	128.18	3.30	2.05E-01	3.04E-07	5.49E-01	4.43E-01	4.81E-01	1.32E+00	1.1E-07	1.5E-07
CHLOROFORM	7.44E-01	6.80E-03	-2.17E+00	119.38	1.97	2.86E-02	3.40E-07	4.90E-01	3.21E-01	3.53E-01	1.18E+00	2.9E-09	5.1E-09
1,2-DICHLOROETHANE	4.09E-01	4.20E-03	-2.38E+00	98.96	1.48	1.61E-02	4.42E-07	3.77E-01	3.13E-01	3.44E-01	9.04E-01	2.2E-09	3.0E-09
CIS-1,2-DICHLOROETHENE	5.62E+01	7.70E-03	-1.96E+00	96.94	2.09	2.92E-02	4.54E-07	3.67E-01	3.21E-01	3.53E-01	8.81E-01	5.5E-07	7.5E-07
TRANS-1,2-DICHLOROETHENE	2.72E+00	7.70E-03	-2.45E+00	84.90	1.25	2.73E-02	5.30E-07	3.14E-01	3.20E-01	3.52E-01	7.54E-01	2.5E-08	3.4E-08
TETRACHLOROETHENE	3.09E+00	3.30E-03	-1.48E+00	165.83	3.40	1.63E-02	1.87E-07	8.92E-01	3.13E-01	3.44E-01	2.14E+00	2.0E-08	2.7E-08
1,1,2-TRICHLOROETHANE	1.69E+00	6.40E-03	-2.30E+00	133.41	1.89	2.84E-02	2.84E-07	5.87E-01	3.21E-01	3.53E-01	1.41E+00	1.7E-08	2.3E-08
TRICHLOROETHENE	4.02E+02	1.20E-02	-1.94E+00	131.39	2.42	5.29E-02	2.91E-07	5.72E-01	3.36E-01	3.69E-01	1.37E+00	7.7E-06	1.0E-05
VINYL CHLORIDE	1.75E+00	5.60E-03	-2.08E+00	62.50	1.62	1.70E-02	7.08E-07	2.35E-01	3.14E-01	3.45E-01	5.65E-01	1.0E-08	1.4E-08

Notes:

-- = Not applicable
B = Ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis
cm/hr = Centimeter per hour
cm^2/hr = Square centimeter per hour
DA = Dose absorbed per event per area of skin exposed for the adult and child resident scenario
D_{sc} = Effective diffusivity for chemical transfer through the skin
USEPA = U.S. Environmental Protection Agency
EPC = Exposure point concentration (see Table 7-3.3)
g/mol = Gram per mole
hr = Hour
K_p = Dermal permeability coefficient of compound in water; calculated per USEPA 2004 for organics
Log K_{ow} = Log octanol/water partition coefficient (Primary source: USEPA 2004)
Log K_p = Log of the dermal permeability coefficient

ug/L = Microgram per liter
mg/cm^2-event = Milligram per square centimeter per event
MW = Molecular weight
τ_{event} = Lag time per event
t* = Time it takes to reach steady-state

TABLE 7-7.8
CALCULATION OF DERMAL ABSORBED DOSE FROM GROUNDWATER
CONSTRUCTION WORKER - REASONABLE MAXIMUM EXPOSURE
NORTHWEST BOUNDARY AREA

Contaminant of Potential Concern	**EPC (ug/L)**	**K_p (cm/hr)**	**Log K_p**	**MW (g/mole)**	**Log K_{ow}**	**B (unitless)**	**D_{sc} (cm^2/hr)**	**τ_{event} (hr)**	**b**	**c**	**t* (hr)**	**DA_{CW} (mg/cm^2-event)**
NAPHTHALENE	1.51E+00	4.70E-02	-1.34E+00	128.18	3.30	2.05E-01	3.04E-07	5.49E-01	4.43E-01	4.81E-01	1.32E+00	3.3E-07
CHLOROFORM	7.44E-01	6.80E-03	-2.17E+00	119.38	1.97	2.86E-02	3.40E-07	4.90E-01	3.21E-01	3.53E-01	1.18E+00	2.5E-08
1,2-DICHLOROETHANE	4.09E-01	4.20E-03	-2.38E+00	98.96	1.48	1.61E-02	4.42E-07	3.77E-01	3.13E-01	3.44E-01	9.04E-01	8.1E-09
CIS-1,2-DICHLOROETHENE	5.62E+01	7.70E-03	-1.96E+00	96.94	2.09	2.92E-02	4.54E-07	3.67E-01	3.21E-01	3.53E-01	8.81E-01	2.0E-06
TRANS-1,2-DICHLOROETHENE	2.72E+00	7.70E-03	-2.45E+00	84.90	1.25	2.73E-02	5.30E-07	3.14E-01	3.20E-01	3.52E-01	7.54E-01	9.5E-08
TETRACHLOROETHENE	3.09E+00	3.30E-03	-1.48E+00	165.83	3.40	1.63E-02	1.87E-07	8.92E-01	3.13E-01	3.44E-01	2.14E+00	5.9E-08
1,1,2-TRICHLOROETHANE	1.69E+00	6.40E-03	-2.30E+00	133.41	1.89	2.84E-02	2.84E-07	5.87E-01	3.21E-01	3.53E-01	1.41E+00	5.5E-08
TRICHLOROETHENE	4.02E+02	1.20E-02	-1.94E+00	131.39	2.42	5.29E-02	2.91E-07	5.72E-01	3.36E-01	3.69E-01	1.37E+00	2.4E-05
VINYL CHLORIDE	1.75E+00	5.60E-03	-2.08E+00	62.50	1.62	1.70E-02	7.08E-07	2.35E-01	3.14E-01	3.45E-01	5.65E-01	4.3E-08

Notes:
-- = Not applicable
B = Ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis
cm/hr = Centimeter per hour
cm^2/hr = Square centimeter per hour
DA_{CW} = Dose absorbed per event per area of skin exposed for the construction worker scenario
D_{sc} = Effective diffusivity for chemical transfer through the skin
USEPA = U.S. Environmental Protection Agency
EPC = Exposure point concentration (see Table 7-3.3)
g/mol = Gram per mole
hr = Hour
IW = Industrial worker
K_p = Dermal permeability coefficient of compound in water; calculated per USEPA 2004 for organics
Log K_{ow} = Log octanol/water partition coefficient (Primary source: USEPA 2004)
Log K_p = Log of the dermal permeability coefficient
ug/L = Microgram per liter
mg/cm^2-event = Milligram per square centimeter per event
MW = Molecular weight
τ_{event} = Lag time per event
t* = Time it takes to reach steady-state
Log K_p = Log of the dermal permeability coefficient

TABLE 7-9.1

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

NORTHWEST BOUNDARY AREA

FORT BUCHANAN

Location: Fort Buchanan

Scenario Timeframe: Current/Future

Receptor Population: Trespasser

Receptor Age: Adolescen

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Dermal	Inhalation	Exposure Routes Total		Primary Target Organ	Ingestion	Dermal	Inhalation	Exposure Routes Total
Soil	Subsurface Soil	Northwest Boundary Area	**Inorganics**					**Inorganics**					
			ALUMINUM	--	--	--	NA	ALUMINUM	Central Nervous System	4.3E-03	--	9.8E-05	4.4E-03
			ANTIMONY	--	--	--	NA	ANTIMONY	Blood glucose and cholesterol	6.4E-04	--	--	6.4E-04
			ARSENIC	9.7E-07	3.4E-07	5.0E-09	1.3E-06	ARSENIC	Skin	1.9E-02	6.6E-03	4.3E-05	2.5E-02
			COBALT	--	--	1.1E-11	1.1E-11	COBALT	Thyroid	7.2E-03	--	4.1E-05	7.3E-03
			IRON	--	--	--	NA	IRON	Digestive System	9.9E-03	--	--	9.9E-03
			MANGANESE	--	--	--	NA	MANGANESE	Central Nervous System	2.1E-03	--	2.2E-04	2.3E-03
			VANADIUM	--	--	--	NA	VANADIUM	Hair	4.7E-03	--	--	4.7E-03
			PAHs					**PAHs**					
			BENZO(A)PYRENE	2.1E-09	3.2E-09	4.6E-12	5.4E-09	BENZO(A)PYRENE	NA	--	--	--	NA
			(Total)	9.7E-07	3.4E-07	5.0E-09	1.3E-06		(Total)	4.8E-02	6.6E-03	4.0E-04	5.5E-02
					Total Risk Across Subsurface Soil		**1.3E-06**			**Total Hazard Index Across Subsurface Soil**			**5.5E-02**
				Total Risk Across All Media and All Exposure Routes			**1.3E-06**			**Total Hazard Index Across All Media and All Exposure Routes**			**5.5E-02**

TABLE 7-9.2

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

NORTHWEST BOUNDARY AREA

FORT BUCHANAN

Location: Fort Buchanan

Scenario Timeframe: Future
Receptor Population: Commercial Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Dermal	Inhalation	Exposure Routes Total		Primary Target Organ	Ingestion	Dermal	Inhalation	Exposure Routes Total
Soil	Subsurface Soil	Northwest Boundary Area	**Inorganics**					**Inorganics**					
			ARSENIC	9.4E-06	3.7E-06	2.3E-07	1.3E-05	ARSENIC	Skin	5.8E-02	2.3E-02	4.1E-04	8.2E-02
			COBALT	--	--	5.3E-10	5.3E-10	COBALT	Thyroid	2.2E-02	--	3.9E-04	2.3E-02
			(Total)	9.4E-06	3.7E-06	2.3E-07	1.3E-05		(Total)	8.1E-02	2.3E-02	8.1E-04	1.0E-01
				Total Risk Across Subsurface Soil			**1.3E-05**		**Total Hazard Index Across Subsurface Soil**				**1.0E-01**
Groundwater	Indoor Air	Northwest Boundary Area	**Volatiles**					**Volatiles**					
			CIS-1,2-DICHLOROETHENE	--	--	--	NA	CIS-1,2-DICHLOROETHENE	NA	--	--	6.3E-04	6.3E-04
			TETRACHLOROETHENE	--	--	2.0E-07	2.0E-07	TETRACHLOROETHENE	Central Nervous System	--	--	5.7E-04	5.7E-04
			1,1,2-TRICHLOROETHANE	--	--	3.3E-08	3.3E-08	1,1,2-TRICHLOROETHANE	NA	--	--	--	NA
			TRICHLOROETHENE	--	--	8.1E-06	8.1E-06	TRICHLOROETHENE	Immune System	--	--	2.7E+00	2.7E+00
			VINYL CHLORIDE	--	--	9.0E-08	9.0E-08	VINYL CHLORIDE	Liver	--	--	5.7E-04	5.7E-04
			(Total)	---	---	8.4E-06	8.4E-06		(Total)	---	---	2.7E+00	2.7E+00
				Total Risk Across Groundwater			**8.4E-06**		**Total Hazard Index Across Groundwater**				**2.7E+00**
			Total Risk Across All Media and All Exposure Routes				**2.2E-05**	**Total Hazard Index Across All Media and All Exposure Routes**					**2.8E+00**

TABLE 7-9.3
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
NORTHWEST BOUNDARY AREA
FORT BUCHANAN

Location: Fort Buchanan
Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Dermal	Inhalation	Exposure Routes Total		Primary Target Organ	Ingestion	Dermal	Inhalation	Exposure Routes Total
Soil	Subsurface Soil	Northwest Boundary Area	**Inorganics**					**Inorganics**					
			ARSENIC	7.5E-07	2.2E-07	3.2E-09	9.7E-07	ARSENIC	Skin	1.2E-01	3.5E-02	4.1E-04	1.5E-01
			COBALT	--	--	7.3E-12	7.3E-12	COBALT	Thyroid	4.5E-02	--	3.9E-04	4.5E-02
			(Total)	7.5E-07	2.2E-07	3.2E-09	9.7E-07		(Total)	1.6E-01	3.5E-02	8.1E-04	2.0E-01
						Total Risk Across Subsurface Soil	**9.7E-07**					**Total Hazard Index Across Subsurface Soil**	**2.0E-01**
Groundwater	Groundwater	Irrigation Water Northwest Boundary Area	**Inorganics**					**Inorganics**					
			ALUMINUM	--	--	--	NA	ALUMINUM	Central Nervous System	4.0E-04	2.1E-04	--	6.1E-04
			ARSENIC	2.2E-08	1.2E-08	--	3.4E-08	ARSENIC	Skin	3.4E-03	1.8E-03	--	5.3E-03
			BARIUM	--	--	--	NA	BARIUM	Kidneys	8.8E-05	6.7E-04	--	7.6E-04
			CADMIUM	--	--	--	NA	CADMIUM	Kidneys	1.9E-04	2.1E-03	--	2.3E-03
			COBALT	--	--	--	NA	COBALT	Thyroid	3.8E-04	8.2E-05	--	4.6E-04
			COPPER	--	--	--	NA	COPPER	Gastrointestinal System	4.2E-05	2.3E-05	--	6.5E-05
			IRON	--	--	--	NA	IRON	Digestive System	1.5E-03	7.8E-04	--	2.2E-03
			MANGANESE	--	--	--	NA	MANGANESE	Central Nervous System	1.2E-03	1.6E-02	--	1.7E-02
			MERCURY	--	--	--	NA	MERCURY	Central Nervous System	2.2E-04	1.2E-04	--	3.3E-04
			NICKEL	--	--	--	NA	NICKEL	None	2.6E-05	7.0E-05	--	9.7E-05
			PAHs					**PAHs**					
			NAPHTHALENE	--	--	--	NA	NAPHTHALENE	None	3.6E-06	1.1E-04	--	1.1E-04
			Volatiles					**Volatiles**					
			CHLOROFORM	1.6E-11	7.1E-11	--	8.7E-11	CHLOROFORM	Liver	3.6E-06	1.6E-05	--	2.0E-05
			1,2-DICHLOROETHANE	2.5E-11	6.8E-11	--	9.3E-11	1,2-DICHLOROETHANE	NA	--	--	--	NA
			CIS-1,2-DICHLOROETHENE	--	--	--	NA	CIS-1,2-DICHLOROETHENE	Kidneys	1.3E-03	6.5E-03	--	7.8E-03
			TRANS-1,2-DICHLOROETHENE	--	--	--	NA	TRANS-1,2-DICHLOROETHENE	Blood	6.5E-06	3.1E-05	--	3.7E-05
			TETRACHLOROETHENE	1.1E-09	2.9E-09	--	4.1E-09	TETRACHLOROETHENE	Liver	1.5E-05	3.8E-05	--	5.3E-05
			1,1,2-TRICHLOROETHANE	6.6E-11	2.9E-10	--	3.6E-10	1,1,2-TRICHLOROETHANE	Liver	2.0E-05	8.9E-05	--	1.1E-04
			TRICHLOROETHENE	1.3E-08	1.0E-07	--	1.2E-07	TRICHLOROETHENE	Immune System	3.9E-02	3.1E-01	--	3.5E-01
			VINYL CHLORIDE	8.6E-10	2.9E-09	--	3.7E-09	VINYL CHLORIDE	Liver	2.8E-05	9.3E-05	--	1.2E-04
			(Total)	3.7E-08	1.2E-07	---	1.6E-07		(Total)	4.7E-02	3.4E-01	---	3.9E-01
						Total Risk Across Groundwater	**1.6E-07**					**Total Hazard Index Across Groundwater**	**3.9E-01**
						Total Risk Across All Media and All Exposure Routes	**1.1E-06**					**Total Hazard Index Across All Media and All Exposure Routes**	**5.8E-01**

TABLE 7-9.4

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

NORTHWEST BOUNDARY AREA

FORT BUCHANAN

Location: Fort Buchanan
Scenario Timeframe: Future
Receptor Population: Off-site Resident
Receptor Age: Child and Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Dermal	Inhalation	Exposure Routes Total		Primary Target Organ	Ingestion	Dermal	Inhalation	Exposure Routes Total
Groundwater	Groundwater Child	Tap Water Off-Site	**Inorganics**					**Inorganics**					
			ARSENIC	3.8E-05	2.5E-07	--	3.8E-05	ARSENIC	Skin	9.7E-01	6.4E-03	--	9.8E-01
			BARIUM	--	--	--	NA	BARIUM	Kidneys	6.0E-02	5.7E-03	--	6.6E-02
			COBALT	--	--	--	NA	COBALT	Thyroid	3.3E-01	8.8E-04	--	3.3E-01
			IRON	--	--	--	NA	IRON	Digestive System	1.6E+00	1.0E-02	--	1.6E+00
			MANGANESE	--	--	--	NA	MANGANESE	Central Nervous System	1.8E+00	2.9E-01	--	2.0E+00
			MERCURY	--	--	--	NA	MERCURY	Central Nervous System	5.0E-02	3.3E-04	--	5.1E-02
			PAHs					**PAHs**					
			NAPHTHALENE	--	--	--	NA	NAPHTHALENE	None	4.8E-03	3.1E-03	--	7.9E-03
			Volatiles			--		**Volatiles**					
			CHLOROFORM	1.3E-07	5.7E-09	--	1.3E-07	CHLOROFORM	Liver	4.8E-03	2.1E-04	--	5.0E-03
			1,2-DICHLOROETHANE	2.0E-07	9.9E-09	--	2.1E-07	1,2-DICHLOROETHANE	NA	--	--	--	NA
			CIS-1,2-DICHLOROETHENE	--	--	--	NA	CIS-1,2-DICHLOROETHENE	Kidneys	1.8E+00	1.6E-01	--	2.0E+00
			TRANS-1,2-DICHLOROETHENE	--	--	--	NA	TRANS-1,2-DICHLOROETHENE	Blood	8.7E-03	7.2E-04	--	9.4E-03
			TETRACHLOROETHENE	9.1E-06	5.2E-07	--	9.7E-06	TETRACHLOROETHENE	Liver	2.0E-02	1.1E-03	--	2.1E-02
			1,1,2-TRICHLOROETHANE	5.3E-07	4.7E-08	--	5.8E-07	1,1,2-TRICHLOROETHANE	Liver	2.7E-02	2.4E-03	--	2.9E-02
			TRICHLOROETHENE	1.0E-04	1.7E-05	--	1.2E-04	TRICHLOROETHENE	Immune System	5.1E+01	8.5E+00	--	6.0E+01
			VINYL CHLORIDE	6.9E-09	3.7E-07	--	3.8E-07	VINYL CHLORIDE	Liver	3.7E-05	2.0E-03	--	2.1E-03
			(Total for Child)	1.5E-04	1.8E-05	---	1.7E-04		(Total for Child)	5.8E+01	9.0E+00	---	6.7E+01
	Groundwater Adult	Tap Water Off-Site	**Inorganics**					**Inorganics**					
			ARSENIC	7.9E-05	3.36E-07	--	7.9E-05	ARSENIC	Skin	5.1E-01	2.18E-03	--	5.1E-01
			BARIUM	--	--	--	NA	BARIUM	Kidneys	3.2E-02	1.92E-03	--	3.3E-02
			COBALT	--	--	--	NA	COBALT	Thyroid	1.7E-01	2.97E-04	--	1.7E-01
			IRON	--	--	--	NA	IRON	Digestive System	8.2E-01	3.49E-03	--	8.2E-01
			MANGANESE	--	--	--	NA	MANGANESE	Central Nervous System	9.2E-01	9.79E-02	--	1.0E+00
			MERCURY	--	--	--	NA	MERCURY	Central Nervous System	2.6E-02	1.12E-04	--	2.6E-02
			PAHs					**PAHs**					
			NAPHTHALENE	--	--	--	NA	NAPHTHALENE	None	2.5E-03	1.36E-03	--	3.9E-03
			Volatiles					**Volatiles**					
			CHLOROFORM	2.7E-07	7.69E-09	6.8E-08	3.4E-07	CHLOROFORM	Liver	2.5E-03	7.24E-05	8.8E-05	2.7E-03
			1,2-DICHLOROETHANE	4.3E-07	1.71E-08	4.2E-08	4.9E-07	1,2-DICHLOROETHANE	NA	--	--	6.8E-04	6.8E-04
			CIS-1,2-DICHLOROETHENE	--	--	--	NA	CIS-1,2-DICHLOROETHENE	Kidneys	9.4E-01	6.80E-02	6.5E-04	1.0E+00
			TRANS-1,2-DICHLOROETHENE	--	--	--	NA	TRANS-1,2-DICHLOROETHENE	Blood	4.6E-03	3.05E-04	5.3E-04	5.4E-03
			TETRACHLOROETHENE	1.9E-05	9.26E-07	1.2E-07	2.0E-05	TETRACHLOROETHENE	Liver	1.0E-02	5.00E-04	2.1E-04	1.1E-02
			1,1,2-TRICHLOROETHANE	1.1E-06	8.41E-08	1.6E-07	1.4E-06	1,1,2-TRICHLOROETHANE	Liver	1.4E-02	1.08E-03	--	1.5E-02
			TRICHLOROETHENE	2.1E-04	2.99E-05	8.8E-06	2.5E-04	TRICHLOROETHENE	Immune System	2.7E+01	3.79E+00	3.0E+00	3.4E+01
			VINYL CHLORIDE	1.4E-08	6.26E-07	3.1E-08	6.7E-07	VINYL CHLORIDE	Liver	2.0E-05	8.45E-04	2.0E-04	1.1E-03
			(Total for Adult)	3.1E-04	3.2E-05	9.3E-06	3.5E-04		(Total for Adult)	3.0E+01	4.0E+00	3.0E+00	3.7E+01

TABLE 7-9.4

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

NORTHWEST BOUNDARY AREA

FORT BUCHANAN

Location: Fort Buchanan
Scenario Timeframe: Future
Receptor Population: Off-site Resident
Receptor Age: Child and Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Dermal	Inhalation	Exposure Routes Total		Primary Target Organ	Ingestion	Dermal	Inhalation	Exposure Routes Total
Groundwater	Groundwater Child + Adult	Tap Water Off-Site	**Inorganics**										
			ARSENIC	1.2E-04	5.8E-07	NA	1.2E-04						
			BARIUM	NA	NA	NA	NA						
			COBALT	NA	NA	NA	NA						
			IRON	NA	NA	NA	NA						
			MANGANESE	NA	NA	NA	NA						
			MERCURY	NA	NA	NA	NA						
			PAHs										
			NAPHTHALENE	NA	NA	NA	NA						
			Volatiles										
			CHLOROFORM	3.9E-07	1.3E-08	6.8E-08	4.7E-07						
			1,2-DICHLOROETHANE	6.3E-07	2.7E-08	4.2E-08	7.0E-07						
			CIS-1,2-DICHLOROETHENE	NA	NA	NA	NA						
			TRANS-1,2-DICHLOROETHENE	NA	NA	NA	NA						
			TETRACHLOROETHENE	2.8E-05	1.4E-06	1.2E-07	3.0E-05						
			1,1,2-TRICHLOROETHANE	1.6E-06	1.3E-07	1.6E-07	1.9E-06						
			TRICHLOROETHENE	3.1E-04	4.7E-05	8.8E-06	3.7E-04						
			VINYL CHLORIDE	2.1E-08	1.0E-06	3.1E-08	1.1E-06						
			(Total for Child + Adult)	4.6E-04	5.0E-05	9.3E-06	5.2E-04		**Total Hazard Index Across Groundwater (Child)**				**6.7E+01**
	Total Risk Across Groundwater (Adult + Child)						**5.2E-04**		**Total Hazard Index Across Groundwater (Adult)**				**3.7E+01**
	Total Risk Across All Media and All Exposure Routes						**5.2E-04**		**Total Hazard Index Across All Media and All Exposure Routes (Child)**				**6.7E+01**
									Total Hazard Index Across All Media and All Exposure Routes (Adult)				**3.7E+01**

TABLE 7-10.1

RISK ASSESSMENT SUMMARY

REASONABLE MAXIMUM EXPOSURE

NORTHWEST BOUNDARY AREA

FORT BUCHANAN

Location: Fort Buchanan

Scenario Timeframe: Current/Future
Receptor Population: Trespasser
Receptor Age: Adolescen

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Dermal	Inhalation	Exposure Routes Total		Primary Target Organ	Ingestion	Dermal	Inhalation	Exposure Routes Total
Soil	Subsurface Soil	Northwest Boundary Area	**Inorganics**					**Inorganics**					
			ARSENIC	9.7E-07	3.4E-07	5.0E-09	1.3E-06	ARSENIC	Skin	--	--	--	NA
			(Total)	9.7E-07	3.4E-07	5.0E-09	1.3E-06		(Total)	---	---	---	---
					Total Risk Across Subsurface Soil		**1.3E-06**				**Total Hazard Index Across Subsurface Soil**		**---**
					Total Risk Across All Media and All Exposure Routes		**1.3E-06**				**Total Hazard Index Across All Media and All Exposure Routes**		**0.0E+00**

TABLE 7-10.2

RISK ASSESSMENT SUMMARY

REASONABLE MAXIMUM EXPOSURE

NORTHWEST BOUNDARY AREA

FORT BUCHANAN

Location: Fort Buchanan

Scenario Timeframe: Future
Receptor Population: Commercial Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Dermal	Inhalation	Exposure Routes Total		Primary Target Organ	Ingestion	Dermal	Inhalation	Exposure Routes Total
Soil	Subsurface Soil	Northwest Boundary Area	**Inorganics**					**Inorganics**					
			ARSENIC	9.4E-06	3.7E-06	2.3E-07	1.3E-05	ARSENIC	Skin	--	--	--	NA
			(Total)	9.4E-06	3.7E-06	2.3E-07	1.3E-05		(Total)	---	---	---	---
				Total Risk Across Subsurface Soil			**1.3E-05**			**Total Hazard Index Across Subsurface Soil**			**---**
Groundwater	Indoor Air	Northwest Boundary Area	**Volatiles**					**Volatiles**					
			TRICHLOROETHENE	--	--	8.1E-06	8.1E-06	TRICHLOROETHENE	Immune System	--	--	2.7E+00	2.7E+00
			(Total)	---	---	8.1E-06	8.1E-06		(Total)	---	---	2.7E+00	2.7E+00
				Total Risk Across Groundwater			**8.1E-06**			**Total Hazard Index Across Groundwater**			**2.7E+00**
			Total Risk Across All Media and All Exposure Routes				**2.1E-05**		**Total Hazard Index Across All Media and All Exposure Routes**				**2.7E+00**

TABLE 7-10.3

RISK ASSESSMENT SUMMARY

REASONABLE MAXIMUM EXPOSURE

NORTHWEST BOUNDARY AREA

FORT BUCHANAN

Location: Fort Buchanan

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adul

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Dermal	Inhalation	Exposure Routes Total		Primary Target Organ	Ingestion	Dermal	Inhalation	Exposure Routes Total
						Total Risk Across Subsurface Soil	**NA**					**Total Hazard Index Across Subsurface Soil**	**NA**
						Total Risk Across Groundwater	**NA**					**Total Hazard Index Across Groundwater**	**NA**
						Total Risk Across All Media and All Exposure Routes	**0.0E+00**					**Total Hazard Index Across All Media and All Exposure Routes**	**0.0E+00**

TABLE 7-10.4

RISK ASSESSMENT SUMMARY

REASONABLE MAXIMUM EXPOSURE

NORTHWEST BOUNDARY AREA

FORT BUCHANAN

Location: Fort Buchanan
Scenario Timeframe: Future
Receptor Population: Off-site Resident
Receptor Age: Child and Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Dermal	Inhalation	Exposure Routes Total		Primary Target Organ	Ingestion	Dermal	Inhalation	Exposure Routes Total
Groundwater	Groundwater Child	Tap Water	**Inorganics**					**Inorganics**					
			ARSENIC	3.8E-05	2.5E-07	--	3.8E-05	ARSENIC	Skin	9.7E-01	6.4E-03	--	9.8E-01
			COBALT	--	--	--	NA	COBALT	Thyroid	3.3E-01	8.8E-04	--	3.3E-01
			IRON	--	--	--	NA	IRON	Digestive System	1.6E+00	1.0E-02	--	1.6E+00
			MANGANESE	--	--	--	NA	MANGANESE	Central Nervous System	1.8E+00	2.9E-01	--	2.0E+00
			Volatiles			--		**Volatiles**					
			CIS-1,2-DICHLOROETHENE	--	--	--	NA	CIS-1,2-DICHLOROETHENE	Kidneys	1.8E+00	1.6E-01	--	2.0E+00
			TETRACHLOROETHENE	9.1E-06	5.2E-07	--	9.7E-06	TETRACHLOROETHENE	Liver	--	--	--	NA
			1,1,2-TRICHLOROETHANE	5.3E-07	4.7E-08	--	5.8E-07	1,1,2-TRICHLOROETHANE	Liver	--	--	--	NA
			TRICHLOROETHENE	1.0E-04	1.7E-05	--	1.2E-04	TRICHLOROETHENE	Immune System	5.1E+01	8.5E+00	--	6.0E+01
			VINYL CHLORIDE	6.9E-09	3.7E-07	--	3.8E-07	VINYL CHLORIDE	Liver	--	--	--	NA
			(Total for Child)	1.5E-04	1.8E-05	---	1.7E-04		(Total for Child)	5.8E+01	9.0E+00	---	6.7E+01
	Groundwater Adult	Tap Water	**Inorganics**					**Inorganics**					
			ARSENIC	7.9E-05	3.36E-07	--	7.9E-05	ARSENIC	Skin	5.1E-01	2.18E-03	--	5.1E-01
			COBALT	--	--	--	NA	COBALT	Thyroid	1.7E-01	2.97E-04	--	1.7E-01
			IRON	--	--	--	NA	IRON	Digestive System	8.2E-01	3.49E-03	--	8.2E-01
			MANGANESE	--	--	--	NA	MANGANESE	Central Nervous System	9.2E-01	9.79E-02	--	1.0E+00
			Volatiles					**Volatiles**					
			CIS-1,2-DICHLOROETHENE	--	--	--	NA	CIS-1,2-DICHLOROETHENE	Kidneys	9.4E-01	6.80E-02	6.5E-04	1.0E+00
			TETRACHLOROETHENE	1.9E-05	9.26E-07	1.2E-07	2.0E-05	TETRACHLOROETHENE	Liver	--	--	--	NA
			1,1,2-TRICHLOROETHANE	1.1E-06	8.41E-08	1.6E-07	1.4E-06	1,1,2-TRICHLOROETHANE	Liver	--	--	--	NA
			TRICHLOROETHENE	2.1E-04	2.99E-05	8.8E-06	2.5E-04	TRICHLOROETHENE	Immune System	2.7E+01	3.79E+00	3.0E+00	3.4E+01
			VINYL CHLORIDE	1.4E-08	6.26E-07	3.1E-08	6.7E-07	VINYL CHLORIDE	Liver	--	--	--	NA
			(Total for Adult)	3.1E-04	3.2E-05	9.2E-06	3.5E-04		(Total for Adult)	3.0E+01	4.0E+00	3.0E+00	3.7E+01

TABLE 7-10.4

RISK ASSESSMENT SUMMARY

REASONABLE MAXIMUM EXPOSURE

NORTHWEST BOUNDARY AREA

FORT BUCHANAN

Location: Fort Buchanan
Scenario Timeframe: Future
Receptor Population: Off-site Resident
Receptor Age: Child and Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Dermal	Inhalation	Exposure Routes Total		Primary Target Organ	Ingestion	Dermal	Inhalation	Exposure Routes Total
Groundwater	Groundwater Child + Adult	Tap Water	**Inorganics**										
			ARSENIC	1.2E-04	5.8E-07	NA	1.2E-04						
			Volatiles										
			TETRACHLOROETHENE	2.8E-05	1.4E-06	1.2E-07	3.0E-05						
			1,1,2-TRICHLOROETHANE	1.6E-06	1.3E-07	1.6E-07	1.9E-06						
			TRICHLOROETHENE	3.1E-04	4.7E-05	8.8E-06	3.7E-04						
			VINYL CHLORIDE	2.1E-08	1.0E-06	3.1E-08	1.1E-06						
			(Total for Child + Adult)	4.6E-04	5.0E-05	9.2E-06	5.2E-04		**Total Hazard Index Across Groundwater (Child)**				**6.7E+01**
	Total Risk Across Groundwater (Adult + Child)						**5.2E-04**		**Total Hazard Index Across Groundwater (Adult)**				**3.7E+01**
	Total Risk Across All Media and All Exposure Routes						**5.2E-04**		**Total Hazard Index Across All Media and All Exposure Routes (Child)**				**6.7E+01**
									Total Hazard Index Across All Media and All Exposure Routes (Adult)				**3.7E+01**

Total Hazard Index Skin (Child)	**9.8E-01**
Total Hazard Index Thyroid (Child)	**3.3E-01**
Total Hazard Index Digestive System (Child)	**1.6E+00**
Total Hazard Index Central Nervous System (Child)	**2.0E+00**
Total Hazard Index Kidneys (Child)	**2.0E+00**
Total Hazard Index Immune System (Child)	**6.0E+01**

Total Hazard Index Skin (Adult)	**5.1E-01**
Total Hazard Index Thyroid (Adult)	**1.7E-01**
Total Hazard Index Digestive System (Adult)	**8.2E-01**
Total Hazard Index Kidneys (Adult)	**1.0E+00**
Total Hazard Index Central Nervous System (Adult)	**1.0E+00**
Total Hazard Index Immune System (Adult)	**3.4E+01**

Media	Exposure Pathway	On-Post Residential	On-Post Industrial	On-Post Trespassers	Biota
Soil	Ingestion	○	●	●	○
	Inhalation	○	●	●	○
	Dermal Contact	○	●	●	○

Media	Exposure Pathway	Off-Post Residential	On-Post Residential	On-Post Industrial
Groundwater	Ingestion	🔵	🔵	🔵
	Vapor Intrusion	🔵	🔵	🔵
	Dermal Contact	🔵	🔵	🔵

Media	Exposure Pathway	Off-Post Residential	Off-Post Recreational	On-Post Residential	On-Post Industrial	On-Post Trespassers	Biota
Surface Water Discharge	Ingestion	🔵	🔵	○	○	○	○
	Dermal Contact	🔵	🔵	○	○	○	○

● Complete Pathway
○ Incomplete Pathway
🔵 Potentially Complete Pathway

Figure 7-1: Conceptual Site Model

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8 SUMMARY AND CONCLUSIONS

The investigation of the groundwater in the Northwest Boundary Area was initiated in response to concerns expressed by the USEPA over TCE detected in groundwater samples collected as part of a RFI completed for the adjacent CPR property. In addition to characterizing potential chemical contamination in the groundwater, this RFI included an investigation of potential source areas for the TCE contamination. There were five main objectives of the RFI:

1. Characterize the nature and extent of groundwater contamination within the Northwest Boundary Area, and determine whether the contamination was originating from Fort Buchanan or from an area outside the installation.
2. Determine whether or not contaminated groundwater is impacting other media (e.g. surface water or air) and if so, characterize the nature and extent of those impacts.
3. Prepare a baseline risk assessment that evaluates the potential for impacts to human health from a potential contaminant source and from the contaminated groundwater.
4. Collect and evaluate natural attenuation data to assess geochemical conditions and to support remedial alternative selection and screening in a CMS Work Plan and Report.

Each of these objectives was achieved, as discussed below.

8.1 NATURE AND EXTENT OF GROUNDWATER CONTAMINATION

Chemical data were generated from seven groundwater sampling events conducted in support of the RFI (January 2007 through April 2009) and a supplemental sampling event that was conducted in 2010 as part of the Well Integrity Investigation. The potential for contamination from metals, pesticides, herbicides, PCBs, SVOCs, and VOCs was evaluated. Contamination from organophosphorus pesticides, herbicides, and PCBs was not found.

Seven metals were found at dissolved concentrations above tap water RSLs: antimony, arsenic, barium, chromium, cobalt, iron, and manganese. Elevated concentrations of these metals were typically found in isolated wells, at concentrations similar to MCLs, and in off-post wells at similar concentrations. The data do not indicate the presence of a plume or source of metals contamination (Section 5.2.2).

Two SVOCs and one organochlorine pesticide were detected in groundwater samples at concentrations above screening levels. However, the detections were isolated, not repeated in parent samples (when found in field duplicates), and are not indicative of overall groundwater contamination or of the presence of an onsite source (Section 5.2.3).

The data indicate that groundwater in the Northwest Boundary Area is contaminated with PCE and TCE, and to a lesser extent 1,2-DCE and vinyl chloride (Section 5.2.4). The area with the highest concentrations of these VOCs is located on-post, east of the DPW complex. The horizontal extent of elevated concentrations of PCE, 1,2-DCE, and vinyl chloride is generally limited to Fort Buchanan; notable contamination was not found in off-post wells. The horizontal extent of TCE is more widespread and extends north from the Installation boundary. The northern extent of the TCE plume remains uncertain due to the impossibility of sampling groundwater north of the existing off-post wells. Wells MW-25, MW-26, and MW-15, located in the field east of the DPW complex, consistently had the highest concentrations of these PCE, TCE, and 1,2-DCE. This led to the speculation that a source might be present in the field and to the geophysical investigation completed as Phase V of the RFI. The geophysical investigation and the evaluation of soil samples from the area did not identify a clear source for the groundwater contamination.

While other VOCs are present in the groundwater of the Northwest Boundary Area, the horizontal extent of detections is limited, the concentrations are low in comparison to screening levels, the compounds were detected infrequently onsite, and the data do not indicate the presence of a plume or significant contamination. Notable contamination from these VOCs was not found (Section 5.2.4).

8.2 GROUNDWATER IMPACTS TO OTHER MEDIA

Groundwater contaminated with chlorinated VOCs can lead to contamination of other media such as surface water (via communication between the aquifer and surface water features) or air (via volatilization into the air between soil particles and movement up into the atmosphere). The potential for contamination in the groundwater to impact sediment pore water and surface water was evaluated through the collection of samples in the low-lying area immediately downgradient of OP-6 and OP-7 (Section 5.3). Acetone was the only VOC detected, indicating that the chlorinated VOC contamination in groundwater is not impacting the sediment pore water or surface water of this downgradient area.

The potential for contamination in the groundwater to impact the atmosphere was evaluated through the comparison of groundwater concentrations to groundwater to air screening levels, and through the evaluation of the vapor intrusion pathway in the HHRA. Based on comparisons to the groundwater to air screening levels, there is a potential for impacts to air from concentrations of PCE, TCE, and vinyl chloride in groundwater, particularly in the vicinity of wells MW-25, MW-26, and MW-15. Furthermore, the HHRA identified potential concerns for commercial workers who inhale indoor air due to vapor intrusion. TCE is the primary contributor to hazards in indoor air. Currently, there are no occupied buildings within the groundwater plume that are occupied. However, any new buildings constructed or used in the future that are within the area should take into account potential vapor intrusion of VOCs from groundwater to the indoor spaces.

8.3 HUMAN HEALTH RISK ASSESSMENT

The HHRA determined there are no potential concerns for human contact to soil and surface water potentially affected by activities within the Northwest Boundary Area. There are potential concerns for the commercial worker and off-post resident exposure to groundwater. For the commercial worker, there are potential concerns for inhalation of indoor air from vapor intrusion. As noted above, there are currently no buildings within the Northwest Boundary Area that are occupied on a regular basis. However, any buildings constructed within the Northwest Boundary Area should take into account potential vapor intrusion of VOCs from groundwater to the indoor spaces. There are potential risk concerns for off-post resident exposure to groundwater as a tap water source. The primary contributor to groundwater concerns is TCE. TCE contributes approximately 71% of carcinogenic risks and approximately 90% of non-carcinogenic hazards.

8.4 POTENTIAL FOR NATURAL ATTENUATION

Geochemical data were generated from seven wells to provide information on whether or not current conditions would support natural attenuation of the groundwater contamination (Section 6.6). Conditions are favorable for a healthy microorganism population at the site. The data indicate that a reducing environment (low DO concentrations and negative ORP values) supportive of biodegradation of TCE is present in the area with the highest concentrations (based on data from MW-15). Higher conductivity in the downgradient portion of the plume (OP-6 and -7) could inhibit biodegradation processes in that area. Methane, ethane, and ethene detections indicate that some level of biodegradation is occurring, and this is evidenced by the presence of daughter products in many of the wells in the plume area. It should be noted that natural attenuation is just one of many remedial alternatives that will be considered in the CMS.

8.5 CONCLUSIONS

Groundwater in the Northwest Boundary Area is contaminated with PCE and TCE, and to a lesser extent 1,2-DCE and vinyl chloride. The horizontal extent of elevated concentrations of PCE, 1,2-DCE, and vinyl chloride is generally limited to Fort Buchanan; notable contamination was not found in off-post wells. The horizontal extent of TCE is more widespread and extends north from the Installation boundary. The northern extent of the TCE plume remains uncertain due to the impossibility of sampling groundwater north of the existing off-post wells. Wells MW-25, MW-26, and MW-15, consistently had the highest concentrations of these PCE, TCE, and 1,2-DCE. The area where these wells are located was investigated for a source, but one was not found.

There is no evidence of groundwater contamination impacting downgradient surface water, and the HHRA did not identify a potential for risks from human exposure to soil or surface water. There are potential concerns, however, for exposure of future commercial workers and off-post residents to groundwater. Concerns for future commercial workers are due to exposure via inhalation of indoor air, and concerns for off-post residents are due to exposure to groundwater if used as a tap water source. The primary contributor to groundwater concerns is TCE.

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