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FINAL Focused Feasibility Study

FGGM 13, Former Pesticide Shop Fort George G. Meade, Maryland

July 2012

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FINAL Focused Feasibility Study

FGGM-13, Former Pesticide Shop, Fort George G. Meade, Maryland

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Acronyms and Abbreviations

AR	Army Regulation
ARAR	Applicable or Relevant and Appropriate Requirement
ARCADIS	ARCADIS U.S., Inc.
ATSDR	Agency for Toxic Substances and Disease Registry
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act 1980
CFR	Code of Federal Regulation
CH_4	Methane
Coastal Plain	Coastal Plain physiographic province
CO_2	Carbon Dioxide
COC	Constituents of Concern
COMAR	Code of Maryland Regulation
COPC	Constituents of Potential Concern
CVOC	Chlorinated Volatile Organic Compound
DCE	dichloroethene
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DO	Dissolved Oxygen
DPW	Department of Public Works
DRMO	Defense Reutilization and Marketing Office
EC	Engineering Control
EcoSSLs	Ecological Soil Screening Levels
EPC	Exposure Point Concentration
ERD	Enhanced Reductive Dechlorination
ESLs	Ecological Screening Levels

Acronyms and Abbreviations (cont'd)

EVO	Emulsified Vegetable Oil
°F	degree Fahrenheit
Fe^{2+}	Ferrous Iron
Fe^{3+}	Ferric Iron
FGGM	Fort George G. Meade
FGGM 13	Former Pesticide Shop, Building 6621
FFS	Focused Feasibility Study
GIS	Geographic Information System
H_2S	Sulfide/Hydrogen Sulfide
HHRA	Human Health Risk Assessment
HI	Hazard Index
ID	identification number
IC	Institutional Control
IRZ	In-situ Reactive Zone
LTM	Long-Term Monitoring
LRC	Long Range Component
LUC	Land Use Control
MCL	Maximum Contaminant Level
Mgal/d	Million gallons per day
mg/kg	milligrams per kilogram
Mn^{2+}	Mangenous Manganese
Mn^{4+}	Mangenic Manganese
MRL	Minimal Risk Level
msl	mean sea level
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NO_2^-	Nitrite

Acronyms and Abbreviations (cont'd)

NO_3^-	Nitrate
O&M	Operation and Maintenance
ORNL	Oak Ridge National Laboratory
OSWER	Office of Solid Waste and Emergency Response
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PRG	Preliminary Cleanup Goal
Piedmont	Piedmont physiographic province
PPRTV	Provisional Peer Reviewed Toxicity Value
PVC	polyvinyl chloride
QA/QC	Quality Assurance/Quality Control
RAO	Remedial Action Objective
RA	Remedial Alternative
RfC	Reference Concentration
RfD	Reference Dose
RI	Remedial Investigation
RME	Reasonable Maximum Exposure
ROD	Record of Decision
ROI	Radius of Influence
RSL	Regional Screening Level
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SLERA	Screening-Level Ecological Risk Assessment
SO42-	Sulfate
SVOC	Semi-Volatile Organic Compound
TBC	To Be Considered

Acronyms and Abbreviations (cont'd)

TCE	trichloroethene
URS	URS Group, Inc.
USAEC	United States Army Environmental Command
USEPA	United States Environmental Protection Agency
VC	vinyl chloride
VOC	Volatile Organic Compound
WMP	Waste Management Plan
WWII	World War II

Executive Summary

This report presents the methodology and results of a Focused Feasibility Study (FFS) conducted to address environmental impacts at the Former Pesticide Shop (FGGM-13) at Fort George G. Meade, Maryland. This FFS was performed in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and is based upon a focused list of technologies previously agreed upon between the Army and the United States Environmental Protection Agency (USEPA).

Building upon prior work completed as part of the Remedial Investigation (RI) and Human Health Risk Assessment (HHRA), this FFS evaluates all environmental media at the Former Pesticide Shop. The evaluation of chemicals of potential concern (COPCs), risks to human health, and the need for media specific response actions are discussed below.

The HHRA evaluation of the cancer risk and non-cancer hazard for the soil and groundwater media concluded the following:

- Estimated Reasonable Maximum Exposure (RME) cancer risk for the current and future military office worker (within commercial buildings downgradient of the site) is within the acceptable target risk range (1×10^{-4} to 1×10^{-6}) and the non-cancer hazard estimate is below 1.

- Estimated RME cancer risk for the current and future military maintenance worker and the future military office workers are within the acceptable target risk range (1×10^{-6} to 1×10^{-4}) and the non-cancer hazard estimates are below 1.

- For the future hypothetical resident, the RME cancer risk estimates are above the upper end of the target cancer risk range (1×10^{-4}) and the cumulative non-cancer hazard estimates are above 1. The compounds within surface/subsurface soils identified as risk-drivers for the hypothetical resident receptor are arsenic, aldrin, gamma-chlordane, chlordane, 4,4- dichlorodiphenyldichloroethane (DDD), 4,4-dichlorodiphenyltrichloroethane (DDT), heptachlor epoxide, and dieldrin. The compounds within groundwater identified as risk-drivers for the hypothetical resident receptor are aldrin, 4,4-DDD, 4,4-DDT, 4,4-dichlorodiphenyldichloroethylene (DDE), alpha BHC, alpha-chlordane, gamma-chlordane, dieldrin, heptachlor, heptachlor epoxide, tetrachloroethene (PCE), and arsenic.

- The cumulative non-cancer hazard estimates are greater than 1 for the future construction worker. The liver is the only target organ with a target organ-specific hazard index (HI) greater than 1. Chlordane and heptachlor epoxide in soil are the primary contributors to the cumulative non-cancer hazard estimate.

The results of the HHRA indicate that soil and groundwater media at the Site pose an estimated cancer risk that is greater than the upper end of the target cancer risk range (1×10^{-4}) for the future hypothetical resident and a non-cancer hazard greater than 1 for the future construction worker and hypothetical resident.

RI activities also determined MCL exceedances in groundwater samples for arsenic, alpha-chlordane, gamma-BHC, gamma-chlordane, heptachlor, heptachlor epoxide, trichloroethene (TCE), and PCE. The compounds would also be addressed as part of a remedial action.

Based on the above determinations, response actions were determined necessary to address environmental impacts at the Former Pesticide Shop. Remedial Action Objectives (RAOs) were established for each Constituent of Concern (COC) indentified at the Former Pesticide Shop. The RAOs are:

1. To prevent human exposure to soil that would cause unacceptable risk to human health.

2. To prevent human exposure to groundwater that would cause unacceptable risk over the duration of the response action.

3. To achieve Maximum Contaminant Level (MCL) concentrations for the identified COCs in a reasonable timeframe.

Remedial alternatives (RAs) specific to soil and groundwater were developed to meet the applicable RAOs and to thereby address the quantified risks and hazards posed by the COCs. The alternatives developed and evaluated are listed below.

- Alternative 1 – No Action

- Alternative 2 – Land Use Controls (LUCs)

- Alternative 3 – Soil Excavation with Offsite Disposal, LUCs, and Enhanced Reductive Dechlorination (ERD)

In order to compare the alternatives, each was evaluated on an individual basis against the nine criteria identified in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The nine criteria include the two threshold criteria of overall protection of human health and the environment and compliance with Applicable or Relevant and Appropriate Requirements (ARARs); the five balancing criteria of long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost; and the two modifying criteria of state acceptance and community acceptance.

The comparative analysis evaluated the anticipated performance of each alternative against each other. This analysis is designed to expose the strengths and weaknesses of each alternative and provide a considered basis for identification of the recommended alternatives. Alternative 1 (No Action) was weaker than the other alternatives in almost all of the criteria. Alternative 2 (Land Use Controls) was stronger on implementability and cost, whereas Alternative 3 (Soil Excavation and ERD) was strongest for overall protection of human health and the environment, compliance with ARARs, short and long-term effectiveness, and reduction of toxicity, mobility, and volume.

1. Introduction

This report presents the Focused Feasibility Study (FFS) for the Former Pesticide Shop, Building 6621 (FGGM 13), at Fort George G. Meade (FGGM), Maryland. The Former Pesticide Shop, Building 6621 (FGGM 13) is hereafter referred to as the Site. ARCADIS U.S. Inc. (ARCADIS) is reporting the results of the FFS in accordance with Contract No. W91ZLK-05-D-0015 Task Order 0005 between ARCADIS and the United States Army Environmental Command (USAEC).

FGGM is located between Washington, D.C. and Baltimore in Anne Arundel County, Maryland, as illustrated on the location map, **Figure 1-1**. **Figure 1-2** illustrates the location of the Former Pesticide Shop at FGGM, based on historical aerial photographs. The Site is located at the northwest corner of the intersection of Gordon Street and York Avenue. The building was reportedly labeled "Mess Hall" in the Real Property records and had been used during World War II (WWII) as a mess hall for prisoners of war. This structure was used as a pesticide shop for 20 years between 1958 and 1978. During its operation as a pesticide shop, this building also housed a maintenance facility for lawn mowers, tractors, and other landscaping equipment. It was demolished, and the Site was graded in 1996 (NuTec, 1997). The Site is presently a fenced-in vacant lot.

1.1 Purpose of Report

This report presents the methodology and results of the FFS conducted to address environmental impacts at the Site. The purpose of the FFS is to describe and evaluate remedial alternatives to assist in the selection of an appropriate response action. This FFS addresses remediation of environmental media through the following steps:

- Develop Remedial Action Objectives (RAOs) and determine Preliminary Cleanup Goals (PRGs) for specific constituents, affected media, and exposure pathways.
- Present remedial technologies that can treat, contain, or remove and dispose of site-related constituents.
- Present remedial alternatives based on those technologies that will, to the maximum extent practicable, utilize permanent solutions and alternative technologies to remediate principal threat wastes.

- Conduct a detailed analysis of the remedial alternatives using the nine evaluation criteria listed in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

- Select a remedial alternative that is the best balance of the evaluation criteria.

Sustainability is not one of the nine evaluation criteria listed in the NCP. However, sustainability is considered in the analysis and selection of a recommended response action, in light of Executive Order 13514 for Federal Leadership in Environmental, Energy, and Economic Performance. This executive order, dated October 5, 2009 sets sustainability goals for Federal agencies and focuses on making improvements in environmental, energy, and economic performance.

1.2 Report Organization

The report is organized into the following sections:

- Section 2 – Environmental Setting: This section presents information regarding FGGM and FGGM 13. Climate, geology, topography, hydrogeology, and surface water are discussed.

- Section 3 – Historical Investigations and Results: The rationale and scope of previous environmental investigations is summarized. The site conceptual model and the nature and extent of contamination at the site are discussed.

- Section 4 – Applicable or Relevant and Appropriate Requirements (ARARs) and RAOs: RAOs are identified for the Site and ARARs are identified where applicable. PRGs are presented based on the results of the risk assessment.

- Section 5 – Identification and Screening of Remedial Technologies: Remedial technologies applicable to the Site are identified and then screened based on implementability, effectiveness, and relative cost.

- Section 6 – Development of Remedial Alternatives: Remedial alternatives are developed by combining the remedial technologies which successfully passed an initial screening process.

- Section 7 – Evaluation of Remedial Alternatives: A detailed evaluation of the alternatives retained from the initial screening process is presented using the nine NCP evaluation criteria [40 Code of Federal Regulations [CFR] 300.430(e)].

- Section 8 – References: The references used to develop this report are presented.

2. Environmental Setting

2.1 Climate

The climate at FGGM is variable and influenced by the Chesapeake Bay and the Atlantic Ocean to the east and the Appalachian Mountains to the west. The winter weather in the area is influenced primarily by cold, dry, continental-polar winds from the west and northwest, and less frequent maritime-tropical winds from the south and southwest that bring warm, often humid, air to the region. During the summer, the dominance of these two air masses is reversed, and warm, humid weather dominates.

Local weather data are compiled by the National Oceanic and Atmospheric Administration's Climatic Data center for the Baltimore-Washington Thurgood Marshall International Airport weather station. Annual precipitation averages about 40 inches per year. The distribution of precipitation is essentially even throughout the year, although slightly lower averages are posted for the summer months. Historical average monthly precipitation ranges between 2.8 and 3.5 inches for all months. The annual mean daily temperature for the FGGM area is 61 degrees Fahrenheit (°F), with a daily annual maximum of 72°F and minimum of 45°F. Annual temperature extremes may vary from -6 to 101°F.

2.2 Topography

FGGM is located in the Coastal Plain physiographic province (Coastal Plain), which is characterized by low-rolling uplands and low-gradient streams. The ground elevation at FGGM generally ranges between 150 and 250 feet above mean sea level (msl). Ground elevation at the Site is about 155 to 160 feet above msl and the surface slopes slightly toward the east and southeast (**Figure 2-1**).

2.3 Surface Water

FGGM is almost entirely located within the Patuxent River watershed (**Figure 2-2**), which is one of the primary drainage systems in Anne Arundel County. The extreme northeastern portion of FGGM is within the Severn River drainage basin. The Patuxent River watershed encompasses approximately 932 square miles and comprises eight sub-basins (**Figure 2-3**), from north to south:

- Brighton Dam

- Middle Patuxent River
- Little Patuxent River
- Rocky Gorge Dam
- Patuxent River Upper
- Western Branch
- Patuxent River Middle
- Patuxent River Lower

The portion of FGGM within the Patuxent River watershed lies completely within the Little Patuxent River sub-basin. Several streams drain FGGM within the Little Patuxent River sub-basin. The streams are, from west to east:

- Little Patuxent River
- Midway Branch
- Franklin Branch

The only significant lake/reservoir present on FGGM is Burba Lake (formerly called Kelly Pool).

At the Site, there are no surface water bodies; however, a stormwater retention pond is located immediately beyond the northeast corner of the Site. The local topography indicates that surface water runoff from the Site area does not enter this pond. Instead, surface runoff flows toward the east and southeast and into a drainage ditch that runs north-south, parallel to the west side of York Avenue, which runs along the east side of the Site. This drainage ditch discharges into Midway Branch, located approximately 600 feet east of the Site and York Avenue. Midway Branch continues southward, crossing the southern FGGM boundary at a location about 3,800 feet south-southeast of the Site. Midway Branch then flows into Lake Allen (formerly known as Soldier Lake) located approximately 2,000 feet beyond (south) where

Midway Branch crosses the southern FGGM boundary. Discharge from Lake Allen then flows into the Little Patuxent River, about 1.5 miles south of Lake Allen.

2.4 Geology

FGGM is located just within the western boundary of the Coastal Plain. The Coastal Plain geology is characterized by a wedge of unconsolidated Cretaceous and Quaternary alluvial sediments (unconsolidated sands, silts and clays) that dip and thicken toward the Atlantic Ocean, as illustrated by the stratigraphic cross-section B-B' (**Figure 2-4**). The location of Section B-B' is shown in **Figure 2-5**. It is aligned northwest-southeast and includes several deep wells on FGGM.

West of the Coastal Plain is the Piedmont physiographic province (Piedmont), comprising igneous and metamorphic rocks. The boundary between the Piedmont and Coastal Plain is termed the “Fall Line,” after falls and rapids were found where streams cross this boundary. The Fall Line is located near the western Anne Arundel County line, immediately west of FGGM.

Quaternary- and Cretaceous-aged unconsolidated deposits are exposed at the surface at FGGM. These deposits have a total thickness of about 700 feet at FGGM (URS Group, Inc. [URS], 2003) and are underlain by bedrock consisting of Precambrian crystalline rock composed predominately of gabbro, gneiss and schist. The unconsolidated deposits from youngest to oldest consist of:

- Quaternary alluvium and Patuxent River terraces
- Patapsco Formation
- Arundel Clay
- Patuxent Formation

The Patuxent Formation is exposed at the surface west of FGGM, the Arundel Clay crops out over the western portion of FGGM, and the Patapsco Formation crops out over the central and eastern portions of FGGM. Quaternary alluvium and river terrace deposits locally overlay the Potomac Group near the Patuxent and Little Patuxent Rivers.

Mack and Achmad (1986) further subdivide the Patapsco Formation in Anne Arundel County into an Upper and Lower part, each with a thickness of about 250 feet. Both the Upper and Lower parts are further divided in half, with the upper half consisting of a confining bed and the lower half consisting of a fine to medium sand aquifer. At the Site, the lower portion of the Patapsco Formation crops out at the surface.

All of the unconsolidated deposits are fluvial and lacustrine in origin and consist of interbedded sand, silt and clay layers. Mack and Achmad (1986) state that this fluvial and lacustrine origin results in very complex stratigraphy. They note that sand lenses 25 feet thick at specific points have been found to be much thicker, thinner, or even absent as close as 25 to 100 feet away.

Local geologic information is available from the site investigation report for the Defense Reutilization and Marketing Organization (DRMO) site at FGGM, which is located approximately 0.5 mile southwest of the Site. In this report (URS, 2003), the following descriptions were provided for the Patuxent and Patapsco Formations and the Arundel Clay:

- **Patuxent and Patapsco Formations –** The Patuxent and Patapsco Formations are primarily composed of quartzose sand and gravel grading up to 3 inches in diameter. Sand beds range from clean sands with less than 5 percent fines passing the U.S. No. 200 sieve and classifying generally as poorly graded (SP) per the Unified Soil Classification System, to arkose sands classifying as silty and clayey sand (SM and SC). Individual clay layers within the Patapsco and Patuxent Formations are lenticular and laterally discontinuous. The middle confining clay of the Patapsco Formation is a low to moderately plastic and highly preconsolidated clay, which is brown, tan, maroon and dark gray in color. The middle confining clay unit within the Patapsco is a local confining bed and is not believed to be regionally continuous.

- **Arundel Clay –** The Arundel Clay is of moderate to high plasticity, highly preconsolidated and hard, maroon to dark gray in color, and contains beds and fragments of lignite. The Arundel also contains thin beds of sand and silt. The Arundel Clay forms a major confining unit dividing the Patapsco Formation from the underlying Patuxent Formation.

The above reference to "middle confining clay" is synonymous with Mack and Achmad's (1986) reference to the confining bed at the top of the lower part of the Patapsco Formation. It is estimated that the top of the Arundel Clay at the DRMO

occurs at a depth of approximately 200 to 230 feet below ground surface (bgs) (URS, 2003). Based on the regional dip of the formations, a slightly shallower depth to the top of the Arundel Formation is a reasonable estimate for the Site area.

2.5 Hydrogeology

Coastal Plain groundwater predominantly occurs within the following three major Potomac Group aquifers which underlie FGGM:

- Upper Patapsco
- Lower Patapsco
- Patuxent

The upper and lower portions of the Patapsco Formation are locally separated by a confining clay layer, although this unit may be absent. Similarly, the Arundel Formation acts as a confining layer that separates the Patuxent Formation from the Lower Patapsco Formation. Mack and Achmad (1986) provide the following descriptions for these aquifers in Anne Arundel County, from youngest (shallowest) to oldest (deepest):

- **Upper Patapsco Aquifer –** The upper Patapsco aquifer is one of the best water-bearing formations in Anne Arundel County, but it is much more limited in areal extent than the two deeper aquifers. It crops out in a band-shaped area that extends from the Patuxent Wildlife Refuge in Prince George's County across Fort Meade to an area located a few miles south of Glen Burnie. In areas southeast of the outcrop area, the aquifer is under confined conditions and yields large quantities of water.

- **Confining Layer Overlying Lower Patapsco Aquifer –** A confining layer separates the lower Patapsco aquifer from the upper Patapsco (Middle Patapsco Clay). In some areas, such as Severndale, it consists of massive beds of clay of low vertical hydraulic conductivity, but some layers within the confining bed are relatively more permeable. In Severndale, the layer is over 100 feet thick. In Annapolis it is over 200 feet thick.

- **Lower Patapsco Aquifer –** The lower Patapsco aquifer, which overlies the Arundel Clay, is capable of yielding from 0.5 to 2 million gallons per day (Mgal/d)

from individual wells in most localities where it has been tested. It is the source of water for several of the large wells in the Glen Burnie and Severndale areas.

- **Arundel Clay Confining Layer –** The Arundel Clay, which directly overlies the Patuxent aquifer, functions as a confining layer because of its relatively low vertical hydraulic conductivity. It crops out in band-shaped areas across the northern part of Anne Arundel County.

- **Patuxent Aquifer –** The Patuxent aquifer in the Patuxent Formation, which crops out along the northwestern boundary of Anne Arundel County, is composed of lenticular, interfingering deposits of sand, silt and clay. Wells drilled into this aquifer generally encounter sand layers capable of yielding relatively large quantities of water. The Patuxent Formation directly overlies bedrock. Because the top of the rock is at the land surface near or close to the Fall Line and dips to the southeast at approximately 80 feet per mile, the aquifer lies at relatively shallow depth (less than 100 feet) along the Howard County line and is over 1,500 feet deep in the eastern part of Anne Arundel County. The aquifer is relatively thin and even pinches out in the northwestern part of Anne Arundel County. This explains why quantities of groundwater available from the Maryland City area are quite limited. In down-dip areas, where the aquifer is deeper and thicker, larger quantities of water can be obtained from individual wells. Some of the highest yielding well fields tapping these [Patuxent] aquifers in Anne Arundel and Prince George's Counties are at Crofton Meadows, Bowie, and Glen Burnie. Yields from Sparrows Point and Baltimore City are greater than 1.0 Mgal/d.

2.6 Groundwater and Surface Water Use

FGGM obtains water from the Little Patuxent River and six deep production wells (PW-1 through PW-6) installed within the Patuxent Aquifer. The FGGM Water Treatment Plant surface water intake is located north of Route 198. The six FGGM production wells are screened between 500 and 800 feet bgs (the Patuxent Formation). Production wells PW-1 and PW-2 are located on the FGGM cantonment area north of Route 32. Wells PW-3 through PW-6 are located near Range Road on the extreme eastern side of the Base Realignment and Closure parcel. These deep wells are all screened well below the thick Arundel Clay regional aquitard.

3. Historical Investigations and Results

Previous environmental investigations and sampling have been conducted at the Site. All investigations were conducted after the pesticide shop (Building 6621) was demolished and the Site was re-graded in 1996. The previously collected data is summarized in five reports:

- Comprehensive Site Assessment and Relative Risk Site Evaluation for Building 6621 (NuTec, 1997)
- 2003 Soil Investigation at Former Building 6621 (Versar, 2003)
- 2004 Soil Investigation at Former Building 6621 (Versar, 2004)
- 2007 Remedial Investigation for the Former Pesticide Shop, Building 6621 (URS, 2007)
- 2011 Remedial Investigation Report (ARCADIS, 2011a)

These investigations, including number of samples collected and analyzed, are summarized below and in **Table 3-1**. Sample locations and depths are presented on **Figures 3-1 through 3-14** along with screening results. The comprehensive analytical results presented in detail in the Remedial Investigation (RI) are summarized in Section 3.2. The laboratory analytical reports for the historical investigations are included in the previously submitted documents referenced above.

3.1 Historical Investigations

3.1.1 Comprehensive Site Assessment and Relative Risk Site Evaluation for Building 6621(NuTec 1997)

NuTec (1997) reported that Building 6621 was built before WWII on an 18- by 24-foot concrete slab without footings and had terra cotta walls. The building was reportedly labeled "Mess Hall" in the Real Property records and had been used during WWII as a mess hall for prisoners of war. The Site was reportedly used as a pesticide shop for 20 years between 1958 and 1978. During its operation as a pesticide shop, it was also used as a maintenance facility for lawn mowers, tractors, and other landscaping equipment. Building 6621 was reportedly demolished and the site regraded in 1996.

The pesticide shop and pesticide storage and mixing operations were reportedly limited to the northern portion of the central courtyard area created by the U-shaped building. All pesticide mixing and transfer reportedly occurred in this northern courtyard area. Some of the chemicals reportedly stored at Building 6621 in the past include the pesticides dichlorodiphenyldichloroethane (DDD), dichlorodiphenyltrichloroethane (DDT), malathion, diazinon, baygon, chlordane, and several brands of rodenticides.

Eight soil samples (S-1A/B through S-4A/B) were collected by NuTec from four locations on 26 February 1997 (**Figure 3-1**). Only surface soil samples (sample depths from 0 to 2 feet bgs) were collected during this investigation.

3.1.2 Soil Investigation at Former Building 6621 (Versar 2003)

Versar collected four surface soil samples from three locations (B6621-SB1 through B6621-SB3) in September 2003 (**Figure 3-1**). One sample was collected from each location at a depth interval of 0 to 0.5 foot bgs. The fourth sample was collected at B6621-SB1 at a depth interval of 0.5 to 1 foot bgs.

3.1.3 Soil Investigation at Former Building 6621(Versar 2004)

Versar collected 24 soil samples from ten locations (B6621-SB01 through B6621-SB10) in January 2004. Ten samples were collected from the shallow depth interval 0 to 1 foot bgs, ten samples were collected from a depth interval of 1 to 2.5 feet bgs, and four samples were collected from 2.5 to 4 feet bgs.

3.1.4 Soil and Groundwater Investigation at Former Building 6621 (URS 2007)

URS conducted investigations in 2006 to delineate the horizontal and vertical extent of constituents in soil and to determine if groundwater was impacted by site-related constituents. Because there are no surface water bodies on the Site, surface water and sediment samples were not collected.

3.1.4.1 Surface Soil Investigation (URS 2006)

A total of 25 surface soil samples were collected from 0 to 2 feet bgs to delineate the horizontal extent of constituents in soil, and an additional ten feature-specific surface soil samples were collected from areas exhibiting characteristics suggestive of possible impact (e.g. sparse vegetation). The label ‘S’ was applied to sample identification

numbers (IDs) associated with these surface soil samples to indicate a sample interval of 0 to 2 feet bgs, as presented in **Table 3-1**.

3.1.4.2 Subsurface Soil Investigation (URS 2007)

Subsurface soil samples were collected and analyzed to assess the vertical extent of constituents in soil. The samples were collected using direct push technology to depths up to 20 feet bgs. The subsurface soil sampling program anticipated that constituent concentrations would be greatest near the northern portion of the central courtyard area where pesticides were handled.

At three locations within the northern portion of the central courtyard area (55, 56 and 57), collection of soil samples for chemical analysis were planned at the following depth intervals in feet bgs: 2-4, 4-6, 6-8, 8-10, 14-15, 19-20, and 23-24 (for a total of 21 direct push soil samples). However, the deepest interval (23-24) was not sampled due to refusal during driving of the direct push sampler; therefore, a total of 18 samples were collected from these three locations instead. The following labels were applied to sample IDs associated with the six sample depth intervals (in feet bgs): A: 2-4, B: 4-6, C: 6-8, D: 8-10, E: 14-15, and F: 19-20, as presented on **Table 3-1**.

Beyond the pesticide handling area, shallow- to intermediate-depth soil samples were collected. A total of ten samples were collected from subsurface locations, and five samples were collected from locations where surface features (stressed or absent vegetation) were observed. At each of the 15 locations, the surface samples were collected with intermediate-depth samples from the following intervals (in feet bgs): 2-4, 4-6, and 6-8 (for a total of 45 direct push soil samples). The same labeling (A through C) was applied to sample IDs of samples collected at these depth intervals.

3.1.4.3 Groundwater Investigation (URS 2007)

In 2006, URS conducted a groundwater investigation by installing four direct push, temporary on-site shallow groundwater table monitoring wells (MW-1 through MW-4). In 2007, URS also installed four permanent off-site shallow groundwater table monitoring wells (MW-5 through MW-8). Each well was constructed using 2-inch-diameter polyvinyl chloride (PVC) with a 10-foot-long screen that straddled the water table. Prior to well installation, the groundwater flow direction was determined to be southeastward, based on local topography and the location of Midway Branch east of the Site. Therefore, temporary well MW-1 was installed to serve as the upgradient well; temporary well MW-2 was installed in the middle of the suspected pesticide

handling area; and temporary wells MW-3 and MW-4 were installed to serve as on-site wells downgradient of the central courtyard. Permanent wells MW-5 through MW-8 were installed to serve as off-site downgradient monitoring wells. The temporary monitoring wells MW-1 through MW-4 were abandoned at the completion of the 2006 investigation activities.

Sample results from temporary monitoring wells MW-1 to MW-4 were not included in the RI. After review of the Draft Final RI prepared by URS in 2007, United States Environmental Protection Agency (USEPA) concluded that the groundwater investigation, specifically the use of temporary groundwater monitoring wells, did not provide data of sufficient quality for use in the Human Health Risk Assessment (HHRA) evaluation. However, sample results from those wells were used during the Supplemental Groundwater Investigation (ARCADIS, 2011a) to determine the locations of permanent wells installed during that investigation. Therefore, results from the temporary monitoring wells obtained were not used for purposes other than determining the locations of permanent wells MW-1R through MW-4R.

3.1.5 Supplemental Groundwater Investigation (ARCADIS 2011a)

In response to USEPA comments regarding the collection of groundwater samples from temporary wells as noted in Section 3.4.3, a supplemental groundwater investigation at the Site was performed by ARCADIS in 2010 to fully characterize site groundwater conditions. Investigation activities consisted of installing four permanent monitoring wells (MW-1R through MW-4R) and gauging and sampling all eight monitoring wells (MW-1R through MW-4R and MW-5 through MW-8); well locations are shown on **Figure 3-15**. Temporary monitoring wells MW-1, MW-2 and MW-3 were replaced with permanent wells (MW-1R through MW-3R) in approximately the same locations in order to collect co-located samples for data comparison purposes. Temporary monitoring well MW-4 was replaced by a permanent well (MW-4R) that was installed further downgradient of the original well to enable better delineation and groundwater flow direction evaluation (triangulation).

A series of two sampling events were conducted in April and June 2010. Those samples collected during the supplemental groundwater investigation are summarized in **Table 3-1**.

3.2 Site Conceptual Model

The site conceptual model is based on available regional information and investigations conducted to date at the Site.

Four main unconsolidated deposits representative of the Coastal Plain geology that are exposed at the surface of FGGM are the quaternary alluvium and Patuxent River terraces, Patapsco Formation, Arundel Clay, and Patuxent Formation (youngest to oldest), as presented on **Figure 2-4**.

At the Site, soil boring logs indicate fine to medium grained sands to depths of at least 30 feet bgs (**Figures 3-16 and 3-17**), with sandy silt and silty sand observed near the surface in borings MW-6 and MW-7. A clay layer was encountered at approximately 24 feet bgs and 29 feet bgs in borings MW-1R and MW-2R, respectively, but not in other borings. The shallow subsurface is interpreted to be sands of the Lower Patapsco underlain by a clay layer that are typical within the Lower Patapsco sands.

Groundwater at the Site is located in a surficial aquifer composed of Lower Patapsco sands (primarily fine to medium grained sands as described above). The groundwater table is located approximately 18 to 20 feet bgs on-site (wells MW-2R and MW-3R). Groundwater flow is to the east-southeast (**Figure 3-18**) toward Middle Branch which is a gaining stream at this location (based on surface water gauges installed as part of this study), and shallow groundwater discharges to this feature. There are no surface water bodies directly on the Site.

3.3 Nature and Extent of Contamination

The following summarizes the nature and extent of surface soil, subsurface soil, and groundwater constituents present at the Site. Analytical sampling data are presented in detail in the RI Report (ARCADIS, 2011a).

3.3.1 Surface Soil

Chemicals detected within surface soils at the Site during the 1997, 2003, 2004 and 2006 soil investigations include various metals and pesticides. Although polychlorinated biphenyls (PCBs) analysis was performed, no PCBs were detected. Two herbicides were detected (2,4,5-T and 2,4-D) in samples collected in 1997, and only one semi-volatile organic compound (SVOC) (pentachlorophenol) was detected in samples collected in 2004. The chemicals were detected at concentrations below

their respective residential soil regional screening level (RSL), indicating that herbicides and SVOCs are not constituents of potential concern (COPCs). Volatile organic compounds (VOCs) were not analyzed during these sampling events.

Metals Results

Twelve metal constituents were detected in surface soil samples at concentrations exceeding the upper-limit of the Fort Meade background concentration range; these include arsenic, barium, cadmium, calcium, chromium, copper, lead, magnesium, manganese, mercury, nickel, and zinc. However, of these constituents, only arsenic also exceeded its residential or industrial RSL.

Because the upper-limit of the arsenic surface soil background concentration range (4.84 milligrams per kilogram [mg/kg]) is greater than the residential and industrial RSLs of 0.39 mg/kg and 1.6 mg/kg, respectively, surface soil samples with arsenic concentrations within the range of background concentrations may exceed residential or industrial RSLs. Therefore, arsenic concentrations detected in surface soil samples at the Site were delineated to 4.84 mg/kg, rather than the RSLs. Exceedances of the arsenic maximum background concentration are presented on **Figure 3-1**.

Arsenic concentrations detected above the background concentration range are mainly clustered near the central portion of the Site area. These arsenic surface soil background exceedances are suggestive of arsenic associated with historic pesticide shop activities.

Pesticides Results

The concentrations of nine pesticides exceed industrial soil RSLs: 4,4-DDD, 4,4-dichlorodiphenyldichloroethylene (DDE), 4,4-DDT, alpha-chlordane, chlordane, dieldrin, gamma-chlordane, heptachlor, and heptachlor epoxide. Surface soil pesticide sample locations and results are presented on **Figure 3-8**. **Figure 3-8** shows that the majority of the industrial RSL exceedances; and therefore, residential RSL exceedances, in surface soil are located in ten sample locations near the central portion of the Site. This geographical distribution is consistent with the findings previously described for arsenic background exceedances. In four locations south of and beyond the immediate vicinity of the reported pesticide management area, sample concentrations exceeded industrial RSLs. These samples are:

- 49-S (chlordane, dieldrin, and heptachlor epoxide exceed the industrial RSL)

- 50-S (chlordane exceeds the industrial RSL)
- 51-S (4,4-DDT, chlordane, dieldrin and heptachlor exceed the industrial RSL)
- 52-S (chlordane exceeds the industrial RSL)

Exceedances at these locations are shallow and interpreted as constituents that were spread during site grading activities associated with Building 6621 demolition in 1996.

3.3.2 Subsurface Soil

Chemicals detected within subsurface soil samples at the Site during the 2004 soil investigations completed by Versar and the 2006 soil investigation completed by URS include arsenic, chromium, mercury, and various pesticides. One herbicide (parathion) and one SVOC (methoxychlor) were detected in 2006 during the URS investigation. The chemicals were detected at concentrations well below their respective residential RSL, indicating that herbicides and SVOCs are not COPCs in subsurface soil.

<u>Metals Results</u>

Three constituents were detected in subsurface soil samples at concentrations exceeding the upper-limit of their respective Fort Meade subsurface soil background concentration range. However, as stated above, the only maximum background concentration for subsurface soils that is greater than the industrial RSL is arsenic. As discussed earlier in this section, because the upper-limit of the arsenic subsurface soil background concentration (1.67 mg/kg) is greater than the residential and industrial RSLs of 0.39 mg/kg and 1.6 mg/kg, respectively, soil samples with arsenic concentrations within the range of the background concentrations may exceed residential or industrial RSLs. Therefore, arsenic concentrations detected in subsurface soils at the Site were delineated to 1.67 mg/kg, rather than the RSLs.

No metals other than arsenic exceeded their respective residential or industrial RSLs. Because the maximum background concentrations for chromium and mercury are lower than their respective residential and industrial RSLs, and no RSL exceedances were identified, chromium and mercury background exceedances are not presented on soil metals figures. The subsurface soil sample locations and background concentration results for arsenic are presented for sampling intervals 2 to 4, 4 to 6, 6 to 8, 8 to 10, 14 to 15, and 19 to 20 (in feet bgs) on **Figures 3-2 through 3-7**, respectively.

The vertical extent of arsenic detected above the background concentration range was identified in three locations (55, 56, and 57) centrally located within the Site area. Arsenic concentrations above background were delineated by samples with concentrations below background at sample location 55 at a depth of 15 feet bgs, at location 56 at a depth of 8 feet bgs, and from location 57 at a depth of 10 feet bgs, as presented on **Figures 3-5 through 3-7**. These exceedances of the arsenic subsurface soil background concentration suggest that arsenic is associated with historic pesticide shop activities.

Pesticides Results

The concentrations of seven pesticides in subsurface soil samples exceeded industrial soil RSLs: 4,4-DDD, 4,4-DDT, alpha-chlordane, chlordane, dieldrin, gamma-chlordane, and heptachlor. These subsurface soil results for pesticides are graphically illustrated in **Figures 3-9 through 3-14**. These figures show that the industrial RSL exceedances, and therefore residential RSL exceedances, are located near the central portion of the Site area. This is consistent with the findings previously described for pesticides in surface soil and arsenic concentrations in surface soil samples that exceed the Fort Meade surface soil background concentration range. Additionally, these figures illustrate that the horizontal area with exceedances becomes smaller with increasing depth. Therefore, vertical delineation is considered complete for the Site area. No pesticide concentrations exceeded the industrial RSLs in samples collected deeper than 8 feet bgs.

3.3.3 Groundwater Results

In April 2010 and June 2010, groundwater samples were collected from monitoring wells MW-1R through MW-8 as described in Section 3.1.5. Analytical results were compared to MCLs and Tapwater RSLs for constituents with no MCL. This comparison does not supersede the COPC screening process performed as part of the HHRA in the RI report.

MCL Exceedances

Only one VOC constituent, tetrachloroethene (PCE) was detected at concentrations exceeding its maximum contaminant level (MCL) in April 2010 samples. Two VOC constituents (PCE and trichloroethene [TCE]) were detected at concentrations exceeding their MCLs in June 2010 samples. Four pesticide constituents (alpha-chlordane, gamma-BHC, gamma-chlordane, and heptachlor epoxide) were detected at

concentrations exceeding their respective MCLs in samples collected during the April 2010 event. Three pesticide constituents (alpha-chlordane, gamma-chlordane, and heptachlor) were detected at concentrations exceeding their respective MCLs in samples collected during the June 2010 event). There were no metals MCL exceedances in groundwater samples collected during the April 2010 and June 2010 sampling events from on-site or downgradient wells.

Tapwater RSL Exceedances

Constituent concentrations for analytes with no MCL were compared to Tapwater RSLs. There were no exceedances of Tapwater RSLs for VOC constituents without MCLs in groundwater samples collected in April 2010. One VOC constituent (1,1,2,2-tetrachloroethane) that does not have an MCL exceeded its Tapwater RSL in groundwater samples collected in June 2010. Four pesticide constituents (4,4-DDD, 4,4-DDT, alpha-BHC, and dieldrin) without MCLs exceeded their respective Tapwater RSLs in groundwater samples collected in April 2010. Seven pesticide constituents (4,4-DDD, 4,4-DDE, 4,4-DDT, aldrin, alpha-BHC, beta-BHC, and dieldrin) without MCLs exceeded their respective Tapwater RSLs in groundwater samples collected in June 2010.

Overall Groundwater Results

Groundwater results are graphically presented in **Figure 3-19 through Figure 3-21** for metals, pesticides, and VOCs, respectively. MCL exceedances in groundwater appear to be limited to the Site (wells MW-2R and MW-3R). Samples collected from well MW-2R, which is centrally located in the northern portion of the central courtyard area, had five constituents (three pesticides and two VOCs) with concentrations exceeding MCLs. Samples collected from downgradient monitoring well MW-3R only had three constituent concentrations (two pesticides and one VOC) that exceed their respective MCLs. No MCL exceedances were detected downgradient of MW-3R, indicating that constituents are not present above the MCLs in groundwater downgradient of the Site.

Based on groundwater analytical results obtained during the 2010 sampling events, horizontal delineation of groundwater impacts at the Site has been completed. Vertical delineation is also complete because vertical migration of groundwater and any constituents therein is controlled by the clay layer identified beneath the site (**Figure 3-17**); however, based on USEPA comments on the RI, an additional well will be included in the eventual remedial design to corroborate evidence of the presence of the clay layer.

3.4 Overall Site Investigation Conclusions

The historical site investigations have met the overall site characterization objective, which was to delineate the extent of site-related constituents in soil and groundwater in sufficient detail to conduct a HHRA and Screening-Level Ecological Risk Assessment (SLERA).

The historic and recent site investigations are consistent with regard to the following major findings:

- The soil has concentrations of pesticides and arsenic that exceed screening levels.
- Arsenic was the only metal frequently detected above the maximum background concentration.
- The horizontal and vertical extent of soil exceedances is well-defined and centrally located at the former pesticide handling area of the Site.
- Groundwater arsenic and pesticide exceedances are located near the former pesticide handling area of the Site, consistent with the soil exceedances.
- Groundwater VOC exceedances are also present in the immediate vicinity of the former pesticide handling area and are limited in horizontal and vertical extent.
- The delineation of groundwater exceedances is horizontally and vertically complete. Samples from wells downgradient of the Site did not have constituent concentrations exceeding MCLs, and the thick clay layer identified at the same site prevents vertical migration of constituents.

3.5 Human Health Risk Assessment Summary

As presented in the Remedial Investigation Report (ARCADIS, 2011a), a HHRA was completed to identify COPCs at or from the Site to be quantitatively evaluated as part of a hazard evaluation. The HHRA was completed in accordance with USEPA guidance (USEPA, 1991). Surface soils (0 to 2 feet bgs) and indoor air exposure were evaluated to assess current potential exposures associated with accessible soils at the Site. Surface/subsurface soils (0 to 10 feet bgs), groundwater, and indoor air exposure were evaluated to assess potential future exposures associated with direct contact by humans. The relationship between the magnitude of potential exposure to the COPCs

via a particular exposure pathway, and the likelihood of an adverse health effect, was quantified during the toxicity assessment. The results of the toxicity assessment are then combined with results from the exposure assessment to provide a quantitative estimate of the potential for carcinogenic and non-carcinogenic human health effects due to chronic exposure.

The HHRA evaluation of the cancer risk and non-cancer hazard for the soil and groundwater media concluded the following:

- Estimated reasonable maximum exposure (RME) cancer risk for the current and future military office worker (within commercial buildings downgradient of the Site) is within the acceptable target risk range (1×10^{-4} to 1×10^{-6}) and the non-cancer hazard estimate is below 1.

- Estimated RME cancer risk for the current and future military maintenance worker and the future military office workers are within the acceptable target risk range (1×10^{-6} to 1×10^{-4}) and the non-cancer hazard estimates are below 1.

- For the future hypothetical resident, the RME cancer risk estimates are above the upper end of the target cancer risk range (1×10^{-4}) and the cumulative non-cancer hazard estimates are above 1. The compounds within surface/subsurface soils identified as risk-drivers for the hypothetical resident receptor are aldrin, gamma-chlordane, chlordane, 4,4-DDD, 4,4-DDT, heptachlor epoxide, arsenic, and dieldrin concentrations. The compounds within groundwater identified as risk-drivers for the hypothetical resident receptor are aldrin, 4,4-DDD, 4,4-DDT, 4,4-DDE, alpha BHC, alpha-chlordane, gamma-chlordane, dieldrin, heptachlor, heptachlor epoxide, PCE, and arsenic.

- The cumulative non-cancer hazard estimates are greater than 1 for the future construction worker. The liver is the only target organ with a target organ-specific hazard index (HI) greater than 1. Chlordane and heptachlor epoxide in soil are the primary contributors to the cumulative non-cancer hazard estimate.

The results of the HHRA indicate that soil and groundwater media at the Site poses an estimated cancer risk that is greater than the upper end of the target cancer risk range (1×10^{-4}) for the future hypothetical resident and a non-cancer hazard greater than 1 for the future construction worker and hypothetical resident. As such, under unrestricted land use conditions, if a residence is located at the Site, concentrations of pesticides and arsenic pose a cancer risk to a resident that is greater than the risk

management range and a target organ-specific hazard estimate that is above hazard criteria. No exceedances concern current land use. The future receptors at risk are:

- Future residents who might live in housing constructed at the Site.
- Future construction workers who might construct buildings at the Site.

The HHRA assumed that future commercial/military workers or residents could theoretically use shallow groundwater for drinking purposes. The theoretical drinking water pathway is a major contributor to the elevated cumulative cancer risks and non-cancer hazards calculated for the hypothetical resident. The groundwater at the Former Pesticide Shop is not currently used as a source of drinking water. However, exceedances of groundwater MCLs for PCE, TCE, arsenic, alpha-chlordane, gamma-BHC, gamma-chlordane, heptachlor, and heptachlor epoxide will be addressed as part of remedial action.

Evaluation of indoor air indicates that vapor intrusion is not the main contributor to overall risk for the current and future worker scenarios or the future hypothetical resident scenario. In addition, removal of surface soils that contain the risk drivers (elevated concentrations of pesticides) would reduce the non-cancer risks for the future construction worker below the 1 threshold. This is based on a comparison of surface soil exposure point concentrations (EPCs) to surface/subsurface soil EPCs, which indicates that cumulative non-cancer risks for the future construction worker would likely drop below the USEPA threshold of 1 if the surface soils were removed.

3.6 Screening Level Ecological Risk Assessment Summary

As presented in the Remedial Investigation Report (ARCADIS, 2011a), a SLERA was completed evaluate potential risks to ecological receptors at the Site. The SLERA was completed in accordance with USEPA Methodology (USEPA 1997 and USEPA 1998). To identify the site-specific COPCs, the maximum detected concentrations in surface soil were compared to conservative ecological screening levels (ESLs) for soil, based on USEPA's Ecological Soil Screening Levels (EcoSSLs), Region 5 Ecological Screening Levels, or values obtained from Oak Ridge National Laboratory (ORNL). For the purpose of this SLERA, the following terrestrial indicator species were assessed:

- Terrestrial plants
- Terrestrial invertebrates – earthworms and soil invertebrates

- Small omnivorous mammals – deer mouse (*Peromyscus maniculatus*)
- Small vermivorous mammals – short-tailed shrew (*Blarina brevicauda*)
- Large carnivorous mammals – red fox (*Vulpes fulva*)
- Insectivorous/vermivorous birds – American robin (*Turdus migratorius*)
- Carnivorous birds – red-tailed hawk (*Buteo jamaicensis*)

Based on the physical characteristics of the Former Pesticide Shop and the COPCs present at the site, it is assumed that ecological receptors present at the site are exposed to COPCs by direct exposure to soil and ingestion of food items.

The SLERA evaluation of risk to ecological receptors concluded that risks associated with a number of chlorinated pesticides (mainly 4,4-DDT and chlordane components, as well as endrin) are elevated for several species. However, no further evaluation was recommended for ecological risks at the site due to several factors. Primarily, the proposed soil removal will eliminate the potential risk due to constituent concentrations in surface soil. Additionally, the site is small (0.5 acres) and is an altered environment with a high level of surrounding human activity.

Removal of the surface soil at the site would reduce the risk to ecological receptors. Therefore, due to the small size of the site supported by the other factors, no further evaluation of ecological risk is warranted.

4. Applicable or Relevant and Appropriate Requirements and Remedial Action Objectives

RAOs for the Site have been developed to implement the decision to address the constituents of concern (COCs) in both soil and groundwater. The objectives are developed based on the criteria outlined in Section 300.430(e)(2) of the NCP and Section 12 of the Superfund Amendments and Reauthorization Act (SARA).

4.1 Scope of the Remedial Action

COCs that pose an unacceptable cancer risk or non-cancer hazard have been identified in multiple media, including soil and groundwater. The following sub-sections are organized by media type and present the COCs and specific exposure pathways that must be mitigated and controlled by the recommended remedial action.

4.1.1 Soil COCs

No COCs were identified for soils for the current site use and exposure to surface soils do not result in unacceptable risk to human health for current use receptors. The future construction worker receptor had cumulative non-cancer hazards greater than 1 from chlordane and heptachlor epoxide in soil. For the future hypothetical resident receptor, identified COCs for soil as the main risk drivers were arsenic, aldrin, gamma-chlordane, chlordane, 4,4-DDD, 4,4-DDT, heptachlor epoxide, and dieldrin.

4.1.2 Groundwater COCs

No COCs were identified for groundwater for current use scenarios as there is no current groundwater use at the Site. For the future hypothetical resident receptor, risks above the upper end of target risk range were identified. COCs in groundwater for the future hypothetical resident receptor were aldrin, 4,4-DDD, 4,4-DDT, 4,4-DDE, alpha BHC, alpha-chlordane, gamma-chlordane, dieldrin, heptachlor, heptachlor epoxide, PCE, and arsenic.

4.2 Applicable or Relevant and Appropriate Requirements

Based on the decision to address soil and groundwater, an ARAR analysis was conducted. Identification of ARARs is an integral part of the remediation process mandated under Section 121 (d) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by SARA. ARARs

are used to develop remedial action cleanup levels, determine the appropriate extent of site cleanup, and govern implementation and operation of the selected remedial alternative. The preamble of CERCLA states the purpose of the law is "to provide for liability, compensation, cleanup, and emergency response for hazardous substances released into the environment and the cleanup of inactive hazardous waste disposal sites." Remedial actions that address hazardous substances at CERLCA sites must comply with state and federal standards and criteria that are legally applicable to the substance, pollutant, or contaminant, or that are relevant and appropriate under the circumstances [42 U.S.C. 9621(d)(2)(A)]. Furthermore, the more stringent ARAR identified must be complied with [40 CFR 300.5]. "More stringent" also includes those state laws or programs that have no federal counterpart. State requirements, however, must be adopted by formal means (i.e. promulgated) and applied universally throughout the state (i.e. not just to Superfund sites but to all circumstances addressed in the requirement) [42 U.S.C. 9621(d)(2)(C)(iii)(I)].

4.2.1 ARAR Classification Requirements

In order to be classified as an ARAR, the NCP states that federal and/or state laws must meet one of the following two requirements: (1) applicability or (2) relevance and appropriateness. “Applicable” requirements are "those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental, state environmental, or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site" [40 CFR ' 300.5]. “Relevant and appropriate” requirements are "those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental, state environmental, or facility siting laws that, while not 'applicable' to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site" [40 CFR 300.5].

After a federal or state law has been classified as applicable or relevant and appropriate, its requirements must be distinguished between substantive and administrative. “Substantive” requirements are “those requirements that pertain directly to actions or conditions in the environment.” “Administrative” requirements are “those mechanisms that facilitate the implementation of the substantive requirements of a statute or regulation.” Compliance with administrative requirements is not mandated for on-site actions (USEPA, 1988). For example, CERCLA specifically

exempts on-site actions from federal, state, and local permitting requirements [42 U.S.C. 9621(e)(1)].

In addition, the NCP identifies a third category, termed information to be considered (TBC). TBCs are guidelines or advisories that are issued by the federal or state government, but which are neither legally binding nor promulgated (USEPA, 1988). However, these guidelines may be used when they are necessary to ensure protection of public health and the environment (USEPA, 1988). If ARARs do not address a particular circumstance at a CERCLA site, then TBCs can be used to establish remedial guidelines or targets. Even when TBCs are used, the requirements imposed on the response action, including cost-effectiveness, still apply (55 Fed. Reg. 8745, March 8, 1990).

4.2.2 Types of ARARs

Selection of ARARs is dependent on the hazardous substances present at the site, site characteristics, the site location, and the actions selected to remediate the site. Consequently, requirements may be chemical, location, or action-specific. These categories are not always mutually exclusive.

Chemical-specific ARARs are generally health- or risk-based concentration values set for specific hazardous substances or other contaminants potentially found in environmental media. Chemical-specific ARARs provide protective cleanup levels or a basis for calculating cleanup levels for chemicals of concern in the designated media. Chemical-specific ARARs are also used to determine treatment and disposal requirements for a particular remedial activity and to assess the effectiveness of an remedial alternative. In the event that a chemical has more than one ARAR, the most stringent is applied.

Location-specific ARARs are made up of restrictions or requirements for substances or activities based primarily on their specific physical location (USEPA, 1988). A remedial action may be restricted or precluded based on federal, state, or facility siting laws that address things such as proximity to wetlands, flood plains, or man-made features (such as existing landfills, disposal areas, and local historic buildings). Location-specific ARARs provide a basis for assessing restrictions during the formulation and evaluation of potential site-specific response actions.

Action-specific ARARs are generally technology or activity-based requirements on actions taken with respect to cleanup of hazardous substances at a site. These

requirements are triggered by the particular activities that are selected to accomplish a response action. Action-specific requirements do not in themselves determine the Remedial Alternative (RA); rather, they indicate how a selected alternative must be achieved.

4.2.3 Chemical-Specific ARARs and TBC Guidance

Table 4-1 presents chemical-specific ARARs and TBC guidance identified for the Site. For groundwater, USEPA MCLs and non-zero MCLGs are utilized as potential ARARs. For soils, USEPA RSLs for industrial soils and the FGGM soil background concentrations presented in the *Soil Background Concentration Report of Fort George G. Meade Maryland* (Malcolm Pirnie, 2001) are considered TBC guidance.

4.2.4 Location-Specific ARARs and TBC Guidance

Table 4-2 presents location-specific ARARs and TBC guidance identified for the Site. Potential location-specific ARARs include the Endangered Species Act 50 CFR 402 16 USC 35, Threatened and Endangered Species Code of Maryland Regulation (COMAR) 08.03.08, and Erosion and Sediment Control *COMAR 26.17.01*.

4.2.5 Action-Specific ARARs and TBC Guidance

Table 4-3 presents action-specific ARARS and TBC guidance identified for the Site. Potential action-specific ARARs include Erosion and Sediment Control *COMAR 26.17.01*, Disposal of Controlled Hazardous Substances *COMAR 26.13*, and Control of Noise Pollution *COMAR 26.02.03*. For potential removal actions including excavation, best management practices will be implemented to control storm water, erosion and sediment transport in order to comply with applicable ARARs.

4.3 Remedial Action Objectives

The RAOs for the Site have been developed to be protective of human health and to meet identified ARARs. The RAOs for each COC for the Former Pesticide Shop are:

- To prevent human exposure to soil that would cause unacceptable risk to human health.

- To prevent human exposure to groundwater that would cause unacceptable risk over the duration of the response action.

- To achieve MCLs for the identified COCs in groundwater in a reasonable timeframe, thereby restoring groundwater to its beneficial use.

4.4 Determination of Site Cleanup Levels

Site Cleanup Levels (SCLs) for groundwater will be MCLs in accordance with the requirements of CERCLA. This section presents a discussion of the derivation for risk-based SCLs for soil.

The conclusions of the HHRA were that soil concentrations of chlordane and heptachlor epoxide posed unacceptable risk to future construction workers. The HHRA also determined that arsenic, aldrin, chlordane, gamma-chlordane, 4,4-DDD, 4,4'-DDT, heptachlor epoxide and dieldrin posed an unacceptable risk to future residents.

Institutional controls to restrict the Site to industrial use will be incorporated into all remedial alternatives for the FFS. Therefore, draft PRGs were calculated based on the COCs (chlordane and heptachlor epoxide) for only the future construction worker scenario. PRGs for these COCs were also derived for future military worker scenarios where potential exposure is limited by means of an institutional control (e.g., deed or use restriction) to commercial and military office workers, or workers involved with minimal landscape activity (e.g., lawn mowing) to ensure that PRGs are also protective under those scenarios. These draft PRGs are presented on Table 1 of **Appendix A**.

Because land use controls will be used to restrict the site to industrial use only, soil PRGs protective of only future use scenarios were retained as SCLs. The SCLs based on the lowest PRGs are summarized and presented in **Table 4-4**. The SCLs are compared to surface and subsurface soil samples on **Tables 4-5 and 4-6**.

The following summarizes the process for deriving PRGs for soil. A detailed description is included in **Appendix A**.

4.4.1 Preliminary Remediation Goals in Soil

To identify the PRGs for each COC in soil, risk-based concentrations were derived based on non-carcinogenic health effects and on carcinogenic effects where they exist.

For all compounds considered to potentially elicit carcinogenic effects, risk-based concentrations were calculated to correspond with three incremental target risk levels

for an individual developing cancer over a lifetime--one in one million ($1x10^{-6}$), one in one hundred thousand ($1x10^{-5}$), and one in ten thousand ($1x10^{-4}$), representing the target risk range that USEPA uses to make remedial action decisions under CERCLA (USEPA, 1990).

The risk-based concentrations for compounds with health effects other than cancer are generally derived using a target HI of one (1). The target HI is the level of exposure to a chemical from all significant exposure pathways in the media of interest (soil), below which, it is unlikely for even sensitive populations to experience adverse health effects. The liver is a common target organ for the toxicity values for chronic health effects (e.g., the RfD and the RfC) for pesticide compounds of potential concern (COPCs) evaluated in the HHRA, including chlordane and heptachlor epoxide, the two COCs considered in this FFS; and the COPC pesticides also evaluated in the HHRA, including gamma-chlordane, aldrin, 4,4'-DDT and dieldrin (ARCADIS, 2011). As a result, risk-based soil concentrations based on chronic exposures (e.g., Commercial/Military Office Worker and Military Maintenance Worker) to COCs with non-carcinogenic effects are based on an adjusted target hazard index of 0.17 (or 1/6)

Subchronic toxicity values have been derived to evaluate subchronic exposures, which are defined by USEPA are less than 10% of an average human lifespan (USEPA, 2011), and generally range from two weeks to seven years in duration (USEPA, 2010).The exposure scenario for the construction worker (an exposure duration of less than one year) represents a subchronic exposure. Therefore, subchronic toxicity values were identified where they exist from USEPA's Provisional Peer Reviewed Toxicity Values for Superfund (PPRTV) Assessments Electronic Library and Minimal Risk Levels (MRLs) developed for intermediate exposure durations (defined as greater than 14 days, up to 365 days) by Agency for Toxic Substances and Disease Registry (ATSDR). No subchronic toxicity values were identified for either chlordane or heptachlor epoxide. Chronic toxicity values were used as subchronic values for these COCs. Subchronic toxicity values exist for the other pesticide COPCs evaluated in the HHRA (ARCADIS, 2011a), with a total of four pesticides sharing the liver as a target endpoint (the COCs chlordane and heptachlor epoxide; and COPCs gamma chlordane and 4,4'-DDT). As a result, risk-based soil concentrations based non-carcinogenic health effects associated with subchronic exposures by the Construction Worker to pesticide COCs are based on an adjusted target HI of 0.25 (or 1/4 based on liver effects).

For those compounds that elicit both carcinogenic effects and non-carcinogenic effects, the recommended soil PRG for that receptor is based on the lower of the risk-

based concentration based on a target cancer risk limit of $1x10^{-6}$ and the compound-specific target HI. The derived soil PRGs are summarized and presented on Table 1 of **Appendix A**. For each compound, the risk-based value representing the lowest receptor-specific PRG is the recommended draft soil PRG for this Site, based on future restricted use of the Site. Those PRGs (16.21 mg/kg for chlordane and 0.77 mg/kg for heptachlor epoxide) were retained as SCLs as described in Section 4.4 and as presented on **Table 4-4**.

5. Identification and Screening of Remedial Technologies

Remedial technologies have been identified for the Site based on the media of concern, COCs, RAOs and the ARARs previously identified. The intent of the Site FFS is to identify remedial alternatives based on the identified technologies and recommend an alternative that will achieve the RAOs and serve as the final corrective action for the Site and also meet completion requirements under CERCLA. In the following sections, the technologies are analyzed for their effectiveness, implementability, and cost in achieving these objectives. In later sections, alternatives based on the technologies are presented and further screened against both set criteria and against one another before ultimately selecting the best alternative to address the Site.

5.1 Screening Criteria

This evaluation is focused on effectiveness factors and institutional implementability with less emphasis on cost evaluation. This initial screening analysis evaluates the feasibility of each technology as it relates to site characteristics, specific contaminant types and concentrations as a measure of effectiveness, implementability, past performance, and relative cost. Of these criteria, implementability and effectiveness of the technology are the most critical.

5.1.1 Implementability

The evaluation of implementability focuses on technical feasibility, availability, and administrative feasibility. Technical feasibility refers to the capability to build and reliably operate/maintain a technology, whereas administrative feasibility refers to the likelihood of receiving approval from regulators and other agencies and obtaining the necessary materials and skilled labor.

The NCP instructs that alternatives “that are technically or administratively infeasible or that would require equipment, specialists, or facilities that are not available within a reasonable period of time may be eliminated from further consideration” [40CFR300.430(e)(7)(ii)].

5.1.2 Effectiveness

The effectiveness criterion focuses on the ability of a technology to:

- Reduce toxicity, mobility, or volume through treatment

- Minimize residual risks
- Afford long-term protection
- Comply with ARARs
- Minimize short-term impacts
- Achieve protection within a reasonable timeframe

The NCP instructs that "alternatives providing significantly less effectiveness than other, more promising alternatives may be eliminated. Alternatives that do not provide adequate protection of human health and the environment shall be eliminated from further consideration." [40CFR300.430(e)(7)(i)].

5.1.3 Cost

The evaluation of cost addresses direct and indirect capital costs and annual operation and maintenance (O&M) costs. When the information is available, the cost range is presented quantitatively. Otherwise, qualitative descriptions of low, moderate, and high are used. The cost ranges are based on a review of the literature and data prepared for other studies.

The NCP instructs that "costs that are grossly excessive compared to the overall effectiveness of alternatives may be considered as one of several factors used to eliminate alternatives. Alternatives providing effectiveness and implementability similar to that of another alternative by employing a similar method of treatment or engineering control, but at greater cost, may be eliminated." [40CFR300.430(e)(7)(iii)].

5.2 Identification and Screening of Remedial Technologies for Soil

The preamble to the NCP identifies a preference for alternatives that involve on-site treatment; however, on-site treatment options would be much more expensive than the off-site options due to the small volume of impacted material. Therefore, the treatment alternative presented in this FFS focuses on off-site disposal of the impacted material.

Table 5-1 outlines the comparative analysis of implementability, effectiveness, and relative costs of the technologies identified as response actions for soil.

5.2.1 Description of Technology 1 – Land Use Controls

Land Use Controls (LUCs) are both administrative and physical means to control activities at the Site. Examples of soil LUCs include prohibition of excavation on the site, signage to indicating that excavation is not permitted at the site, as well as an excavation permitting process that would trigger a review of possible excavation prohibitions. Operations and maintenance for LUCs could include maintenance of vegetation on the surface to prevent soil from being carried away as dust. The implementation of LUCs does not reduce the volume, toxicity, or mobility of constituents. However, if impacted media remains at the Site, LUCs can limit unauthorized access to the Site, minimizing the exposure to potential receptors without treating or removing the contaminated media.

Implementability: Readily implemented.

Effectiveness: If properly enforced, land-use restrictions are an effective means of preventing exposure to contaminated media. Because the Site is a controlled military base, access is already restricted to authorized personnel only.

Cost: This has a low capital cost and low O&M cost.

5.2.2 Description of Technology 2 – Excavation of Impacted Soil

Excavation of impacted soil can be achieved by employing standard excavation and construction equipment to remove a portion of the contaminated soils or remove the entire area of contamination. Excavation activities also include but are not limited to clearing underground utilities, establishing staging for equipment, and establishing storage areas for soil roll-off containers. Any removal action requires that the excavation area is backfilled with soil and re-graded to promote positive drainage and also that the excavation area is revegetated.

Implementability: Low complexity for implementation to engineer and complete the excavation**.**

Effectiveness: Provides protection to human health by permanently removing constituents in soil. Depending on site conditions, excavation may also contribute to reducing groundwater concentrations through potential source removal. There is no unacceptable risk to ecological receptors under this alternative.

Cost: This technology has a moderate capital cost and low O&M cost.

5.3 Identification and Screening of Remedial Technologies for Groundwater

Two remedial technologies were identified to address the impacted groundwater at the Site, thereby protecting human health and complying with ARARs. **Table 5-2** outlines the comparative analysis of implementability, effectiveness, and relative costs of the technologies identified as response actions for groundwater.

5.3.1 Description of Technology 1 – Land Use Controls

LUCs are both administrative and physical means to control activities at the Site. Examples of soil LUCs include prohibition of drilling wells for potable use on the site, signage to indicating that drilling of potable wells is not permitted at the site, as well as an permitting process that would trigger a review of possible drilling prohibitions. Operations and maintenance for groundwater LUCs is typically administrative, although physical inspection of the site may also be performed to insure that groundwater is not being used. The implementation of LUCs does not reduce the volume, toxicity, or mobility of constituents. However, if impacted media remains at the Site can limit unauthorized access to the Site, minimizing the exposure to potential receptors without treating or removing the contaminated media.

Implementability: Readily implemented.

Effectiveness: If properly enforced, land-use restrictions are an effective means of preventing exposure to contaminated media. Because the Site is a controlled military base, access is already restricted to authorized personnel only.

Cost: This technology has a low capital cost and low O&M cost.

5.3.2 Description of Technology 2 – Enhanced Reductive Dechlorination

Enhanced Reductive Dechlorination (ERD) is an engineered bioremediation technique in which chlorinated compounds are degraded under anaerobic conditions through a series of transformations. ERD involves the injection into the groundwater of an easily degradable carbohydrate solution (e.g., food-grade molasses or emulsified vegetable oil [EVO]), which is metabolized by the naturally occurring bacteria in the subsurface.

The carbon source is injected to promote the consumption of natural electron acceptors (e.g., oxygen, nitrate, ferric iron, manganese, sulfate, and carbon dioxide) by native bacteria within the aquifer matrix. Following depletion of dissolved oxygen (DO), the bacteria begin the successive utilization of alternative electron acceptors to support respiration. The general sequence of alternate electron acceptor utilization and respiration byproduct formation is as follows (from most thermodynamically favorable to least):

Nitrate (NO_3^-)	$\rightarrow$	Nitrite (NO_2^-)
Ferric Iron (Fe^{3+})	$\rightarrow$	Ferrous Iron (Fe^{2+})
Mangenic Manganese (Mn^{4+})	$\rightarrow$	Mangenous Manganese (Mn^{2+})
Sulfate (SO_4^{2-})	$\rightarrow$	Sulfide/Hydrogen Sulfide (H_2S)
Carbon Dioxide (CO_2)	$\rightarrow$	Methane (CH_4)

Microbial utilization of such alternate electron acceptors creates electrochemically reducing conditions. Consequently, by maintaining excess organic carbon in the groundwater environment, ERD technology drives the groundwater environment to anaerobic and strongly reducing conditions. The zone in which this environment is established becomes an in-situ reactive zone (IRZ). The primary goal of the IRZ, in this case, is to stimulate complete dechlorination of the target contaminants (PCE and TCE). In the case of chlorinated alkenes, this follows the path from:

PCE $\rightarrow$ TCE $\rightarrow$ dichloroethene (DCE) $\rightarrow$ vinyl chloride (VC) $\rightarrow$ ethene $\rightarrow$ ethane.

ERD technology relies on an active delivery method, whereby the organic carbon source is periodically injected. This process ensures immediate and continued delivery of excess organic carbon to the formation. This allows microbial populations to flourish in a relatively short time frame, resulting in a highly reducing groundwater environment and supporting contaminant degradation at rates sufficient to meet remedial goals. Additional injections, natural dispersion, and advective groundwater transport also help maintain and propagate the IRZ.

During application of ERD, the increase in microbial populations also typically result in a natural surfactant effect caused by the generation of biosurfactants and bioemulsifiers that can promote desorption of residual and adsorbed phase

contaminant mass, making it available for degradation (Suthersan, 2002). This effect is an important advantage of the ERD technology as it can aggressively access the adsorbed phase – and free-phase – mass that represents the bulk of chlorinated volatile organic compounds (CVOCs) that will need to be treated for successful remediation at the Site. This will provide an advantage in a shortening of expected treatment duration as compared to other physical and chemical treatment techniques which rely on the extremely slow process of diffusion to access the adsorbed phase mass (Nyer et al., 2001).

Assuming a sufficient population of naturally occurring bacteria and availability of sufficient nutrients and alternate electron acceptors, the primary technical challenges associated with the use of ERD for groundwater remediation include delivering the carbohydrate solution to the subsurface and controlling the groundwater biogeochemical environment.

Implementability: Moderate complexity for implementation to engineer and complete the direct injection of the carbon substrate.

Effectiveness: Provides protection to human health by treating constituents in groundwater. There is no unacceptable risk to ecological receptors under this alternative.

Cost: This technology has moderate capital cost and O&M costs.

5.4 Retained Technologies

In summary, the following conclusions are drawn regarding retention of the screened soil technologies:

- LUCs are retained for further consideration as potentially applicable.
- Excavation of soils is retained.

In summary, the following conclusions are drawn regarding retention of the screened groundwater technologies:

- LUCs are retained for further consideration as potentially applicable.
- Enhanced reductive dechlorination is retained.

6. Development of Remedial Alternatives

Three RAs have been developed from the technologies retained from the screening processes. This section describes the alternatives developed and their conceptualized implementation at the Site.

Three RAs, including No Action as required by the NCP, were developed to address the impacted soil and groundwater at the Site, thereby protecting human health and complying with ARARs. The three alternatives are:

- Alternative 1 – No Action
- Alternative 2 – Land Use Controls
- Alternative 3 – Soil Excavation with Off-site Disposal, Land Use Controls, and Enhanced Reductive Dechlorination

Each of these alternatives is further described in the following sections.

6.1 Alternative 1 – No Action

Alternative 1 assumes that no corrective action of any kind would be employed at the Site to address soil and groundwater contamination. This alternative would not prevent exposure to impacted soil at the Site. The no action alternative must be evaluated to establish a baseline of comparison regarding future performance and risk for the other alternatives presented in accordance with the NCP.

6.2 Alternative 2 – Land Use Controls

Under Alternative 2, existing LUCs already in place at FGGM, specifically institutional controls (ICs), will be maintained and enhanced and engineering controls (ECs) will be added. These LUCs will restrict the Site to industrial use only. Residential uses, including but not limited to single-family and multi-family dwellings, day care facilities, and nursing homes, would be prohibited.

ICs are administrative measures put in place to affect human activity in order to control current and future land use. The four general categories of ICs evaluated or already in use at FGGM, and which provide layers of protection, are as follows: governmental controls, proprietary controls, enforcement and permitting, and informational devices,

which assist with the management and implementation of LUCs. Most of these measures are already in place as elements of required procedures at FGGM. These elements include requirements to obtain dig permits from the Department of Public Works (DPW) office for any intrusive activity at FGGM; Master Plan Regulations; FGGM Geographic Information System (GIS) Database; FGGM Access Restrictions; and Army Military Construction Program. These existing requirements are detailed below. These controls have been developed with a consideration of all reasonably anticipated land uses at FGGM; these include administrative and industrial military operations, and outdoor recreation. These ICs would be formalized into CERCLA required procedures at the Site

The following IC is already in place at FGGM:

- **Master Plan Regulations, Army Regulation (AR) 210-20**: The Army issued a new regulation, Master Planning for Army Installations, AR 210-20, on 13 July 1987 updating an earlier regulation dated 27 January 1976. In accordance with AR 210-20, all Army installations are required to develop and maintain a Real Property Master Plan (RPMP). This regulation provides for comprehensive planning at Army installations and not only allows, but requires incorporation of existing land-use and conditions into the RPMP. The RPMP regulations provide a framework for comprehensive planning through the use of component plans. The five main components of the FGGM RPMP include the Short Range Component, Long Range Component (LRC), RPMP Digest, Capital Investment Strategy, and the Installation Design Guide.

  As part of the LRC, the Site is identified as having both contaminated soil and groundwater. Because of this, the LRC requires that improvements on the site require preapproval by the Environmental Division Chief.

The overall objective is to provide each installation with a master plan through the integration of each component plan into the installation master plan. The component plans form a series of narrative, tabular and graphic plans. Their integration into an installation master plan provides many benefits as outlined in AR 210-20, including “the mechanism for ensuring that installation projects are sited to meet operational, safety, physical security, and environmental requirements.”

Engineering controls, including signage (warning signs) describing restrictions of Site use at key locations of the Site will be installed. An existing perimeter fence surrounds

the Site and a second perimeter fence surrounds the entire FGGM installation. Annual Inspections of the Site will be performed to establish that all on-site LUCs (for example, signage) are in good condition, to confirm that the land use of the Site has not changed, and that through visual inspection that no unauthorized excavations were performed.

The 5-year review process and the annual land use certifications/inspections will be used to document continuing land use is industrial and the remedy remains protective. Additionally, the remedial design will specify notification requirements to the USEPA should land use change occur, or be planned. The Army owns and controls the property and there are no plans to close FGGM in the future. LUCs will be implemented using the Department of Navy Guidance as agreed programmatically between the Army and the USEPA. This alternative anticipates up to six 5-year reviews to be performed follow remedial implementation.

Alternative 2 includes Long-Term Monitoring (LTM) of groundwater. The LTM activities would monitor the expected decline in COC concentrations due to attenuation. LTM would include annual groundwater monitoring for pesticides, metals and VOCs for five years in order to establish declining concentration trends, and once every five years thereafter from select wells at the Site for a total of 30 years of LTM. Annual groundwater monitoring would be performed to address the RAO to achieve MCLs for identified COCs within approximately 10 years. The estimated duration of five years of annual monitoring is used in order to determine a cost estimate for Alternative 2. Actual LTM frequency will depend on the rate of decline in concentrations as well as approval from EPA and MDE.

6.3 Alternative 3 – Soil Excavation with Offsite Disposal, Land Use Controls, and Enhanced Reductive Dechlorination

Alternative 3 consists of soil excavation and off-site disposal along with enhanced reductive dechlorination to treat CVOCs in groundwater. The combination of the two technologies would address pesticide constituents in soil and CVOCs in groundwater through active remediation, and address pesticides in groundwater through potential groundwater source removal and continued monitoring. The application of these technologies through this alternative is described below.

6.3.1 Soil Excavation with Off-Site Disposal and Land Use Controls

The excavation footprint would focus on the central portion of the Site where the highest concentrations of arsenic and pesticides were detected, but would be defined by areas of the Site where samples exceed PRGs for pesticides in soil. Arsenic detections observed above industrial RSLs were sporadic and close to the upper limit of the FGGM background concentration range (4.84 mg/kg) (Malcolm Pirnie, 2001) and are therefore not the driver for the excavation area. Removal of soil that exceeds PRGs would have the additional effect of removing potential source material, which would facilitate attenuation of minimal pesticide concentrations in groundwater. Monitoring well MW-2R is located within the excavation area, but will be protected during excavation activities in order to maintain the well in its current location. Additionally, surface soil sample locations 49-S and 50-S as identified by EPA will also be included in the excavation plan. The approximate area and depth of excavation are displayed on **Figure 6-1**.

Pre-excavation soil confirmation samples will be collected using direct-push drilling methods from the perimeter and base of the proposed excavated area in order to delineate the excavation prior to commencing removal activities. Confirmation samples will be submitted for laboratory analysis of arsenic, pesticides, and VOCs via USEPA methods 6010, 8081, and 8260, respectively, to confirm and document the required excavation area and volume. All of the confirmation samples and quality assurance/quality control (QA/QC) samples will be collected in accordance with procedures established in the FGGM Sampling and Analysis Plan (SAP) (ARCADIS, 2011b).

Excavated material would be placed directly into roll-off containers or dump trucks and transported to an approved waste disposal facility. All waste from the excavation will be profiled, managed and disposed of in accordance with procedures established in the FGGM Waste Management Plan (WMP) (ARCADIS, 2010).

After the excavation is complete, the excavated areas will be backfilled with clean soil imported from off-site, unless an approved on-site source is identified. Samples of the backfill material will be submitted for laboratory analysis to ensure that contaminants are not imported to the Site. Upon completion of the backfill activities, the area will be seeded with grass to minimize the potential for erosion. If required, erosion and sediment controls will be established and maintained throughout the duration of the removal action in accordance with the ARARs specified in Section 5.6.

Following excavation, existing LUCs already in place at FGGM, specifically ICs, will be maintained and enhanced and ECs will be added. LUCs used following excavation would be similar to those described under Alternative 2, including restricting the Site to industrial use only. Annual Inspections of the Site will be performed to establish that all on-site LUCs (for example, signage prohibiting intrusive activities) are in good condition, to confirm that the land use of the Site has not changed, and that through visual inspection that no unauthorized excavations were performed.

The 5-year review process and the annual land use certifications/inspections will be used to document continuing land use is industrial and the remedy remains protective. Additionally, the remedial design will specify notification requirements to the USEPA should land use change occur, or be planned. The Army owns and controls the property and there are no plans to close FGGM in the future. LUCs will be implemented using the Department of Navy Guidance as agreed programmatically between the Army and the USEPA. This alternative anticipates up to six 5-year reviews to be performed follow remedial implementation.

6.3.2 Enhanced Reductive Dechlorination

Following excavation activities, ERD technology as described in Section 5.3.2 will be implemented to address CVOC constituents in groundwater. EVO has been selected as the carbon source for ERD implementation because it is a slower release/longer term carbon source than soluble substrates like molasses, lactate, and ethanol. The primary benefit of using EVO is that less frequent injections will be necessary due to its longer residence time and slow release of organic carbon (typically a year or more).

Because EVO distribution is primarily achieved at the time of injection, it serves as an on-going slow-release carbon source across the achieved injection radius. As a result, it is important to determine the achieved radius of influence from a given volume of injected material. For the purposes of the FFS alternative costing, it is assumed that injections will be completed in two stages to gather sufficient data to determine the achieved radius of influence leading to optimum injection spacing. The first stage will serve to determine whether the second stage of injections can be completed through direct-push locations or whether permanent injection wells would be necessary.

The data collected during the first stage will be utilized to determine whether additional application of EVO is appropriate throughout the defined impacted area (as defined during RI activities). It is expected that if the first stage proves favorable then the

second stage application of the 3 percent EVO/water solution throughout the defined area would be completed.

For the purpose of this FFS it is assumed that EVO solution will be injected one time into the subsurface via proposed direct-push borings along two transects perpendicular to groundwater flow (**Appendix B, Figure B-1**). Transect 1, upgradient of MW-2R, would be approximately 40 feet long. Transect 2, upgradient of MW-3R, would be approximately 60 feet long. These transects are spaced approximately 125 feet apart, which represents approximately 6 months travel time based on the Site geology. The target radius of influence (ROI) for the EVO solution is 2.5 feet. The target injection depth is 15 to 30 feet bgs, which is based on the typical depth to water and the total depth of monitor wells MW-2R and MW-3R. The estimated volume of solution is 220 gallons for each of 20 injection points, or a total of 4,400 gallons; however, the number of injection points and estimated injection volumes would be refined during field implementation. Based on field observations (e.g., subsurface lithology, soil classification, etc.), volumes and injection point spacing may be adjusted to ensure delivery across the target area. Additional detail regarding this conceptual feasibility level design is provided in an internal ARCADIS memorandum dated July 2011 included in **Appendix B**. This additional detail was used to determine probable cost of this alternative and does not supersede the parameters for the eventual remedial design for the Site.

ERD performance monitoring will be conducted following completion of the injection using monitoring wells MW-2R and MW-3R. Data collected from monitoring wells located within the injection ROI will be used to evaluate the adequate concentration and distribution of reagent. Performance and operational data will be collected to satisfy the following criteria:

- Confirm that the presence of excess organic carbon does not result in pH levels that inhibit microbial activity within the IRZ.
- Observe IRZ propagation at monitoring wells MW-2R and MW-3R.
- Collect additional data to evaluate progress of the ERD process and to monitor the level of methanogenesis (dissolved methane concentrations) occurring within the IRZ.
- Trends in molar concentrations of parent compounds (PCE and TCE) and dechlorination products (cis-DCE, VC, ethene, and ethane) will be assessed over

time within and downgradient of each IRZ system to evaluate IRZ system performance.

Alternative 3 includes LTM for groundwater. The LTM activities would monitor the performance of the ERD and the expected decline in pesticide concentrations as a result of the removal of potential source material during excavation activities. An additional monitoring well will be installed near the intersection of York and Gordon Streets. Boring logs during well installation would be used to confirm the depth and thickness of the clay layer in the vicinity of the Site.

The LTM frequency will be based on an estimated time frame to achieve MCLs following remedial activities. A preliminary pore-flushing model calculation (Zhang and Bennett, 2002) was performed using conservative assumptions (**Table B-1 in Appendix B**), such as initial PCE concentrations across the entire plume equal to the current maximum concentration (270 μg/L in MW-2). This is a conservative assumption because concentrations are expected to be lower in peripheral areas of the plume. Based on this preliminary estimate with conservative assumptions, MCLs would be achieved within approximately 10 years. LTM would include annual groundwater monitoring for pesticides, metals and VOCs for five years in order to establish declining trends in concentrations, and then once every five years thereafter from select wells at the Site for a total of 30 years of LTM. Actual LTM frequency would depend on the rate of decline in concentrations as well as approval from EPA and MDE. Annual groundwater monitoring would be performed to address the RAO to achieve MCLs for identified COCs in a reasonable time frame.

7. Evaluation of Remedial Alternatives

Section 300.430(e) of the NCP lists nine criteria against which each RA must be assessed. The acceptability or performance of each alternative against the criteria is evaluated individually so that relative strengths and weaknesses may be identified. The detailed criteria are as follows:

1. Protection of human health and the environment
2. Compliance with ARARs
3. Long-term effectiveness and permanence
4. Reduction of toxicity, mobility, or volume through treatment
5. Short-term effectiveness
6. Implementability
7. Cost
8. State acceptance
9. Community acceptance

The NCP [Section 300.430(f)] states that the first two criteria, protection of human health and the environment and compliance with ARARs, are "threshold criteria" which must be met by the selected remedial action unless a waiver can be granted under Section 121(d)(4) of CERCLA. Criteria three through seven are "primary balancing criteria," and the trade-offs within this group must be balanced. The preferred alternative will be the alternative which is protective of human health and the environment, is ARAR-compliant, and provides the best combination of primary balancing attributes. The final two criteria, state and community acceptance, are "modifying criteria" which are evaluated following the comment period on the FS report and the proposed plan. The nine NCP criteria are described in further detail in the following sections and the results are presented on **Table 7-1**. Only the first seven criteria are evaluated in this report. State and community acceptance will be evaluated in the Record of Decision (ROD) following the public comment period.

7.1 Evaluation Criteria

7.1.1 Overall Protection of Human Health and the Environment

This criterion involves an assessment based on a composite of factors addressed under other evaluation criteria, including long-term effectiveness, short-term effectiveness, and compliance with ARARs.

This criterion provides an evaluation of how the remedial alternative, as a whole, achieves RAOs and maintains protection of human health and the environment. A determination and declaration that this criterion will be met by the proposed remedial action must be made in the ROD; therefore, this is a threshold criterion, which must be met by the selected response action. This criterion will be met if the risks associated with exposure of ecological receptors to contaminated media are eliminated, reduced, or controlled through treatment, engineering, or ICs, and if the remedial action is protective of the environment.

7.1.2 Compliance with ARARs

This criterion assesses the compliance of an alternative with all contaminant-specific, action-specific, and location-specific ARARs. In the absence of ARARs, TBCs may also be taken into consideration as well as any other appropriate state or federal criteria, advisories, and guidance as they apply.

7.1.3 Long-Term Effectiveness and Permanence

This criterion examines the protection of human health and the environment after construction and implementation of the RA. This criterion addresses the long-term adequacy, reliability, and permanence of the RA.

7.1.4 Reduction of Toxicity, Mobility, and Volume through Treatment

This criterion examines the effectiveness of the RA in reducing the toxicity, mobility, and volume of contaminants through treatment. The statutory preference for remedial technologies that significantly and permanently reduce the toxicity, mobility, or volume of the waste is addressed by this criterion. The following factors will be considered:

- The amount of hazardous materials that will be destroyed or treated

- The degree of expected reduction in toxicity, mobility, or volume
- The degree to which the treatment will be irreversible
- The type and quantity of treatment residuals that will remain following treatment

7.1.5 Short-Term Effectiveness

The effects of the remedial alternative from construction and implementation to completion are addressed under this criterion. The following factors will be addressed:

- Protection of the community during the remedial action, including the effects of dust from excavation, transportation of contaminated materials, and air-quality impacts from on-site treatment
- Protection of workers during the remedial action
- Environmental impacts of the remedial action
- Time required to achieve RAOs

7.1.6 Implementability

This criterion considers the technical and administrative feasibility of each alternative, as well as availability of required resources. Factors considered in assessing this criterion include construction, operation, and maintenance of the RA; required approvals and permits from regulatory agencies; availability of required off-site treatment or disposal services; and availability of necessary equipment, materials, and personnel for implementation.

7.1.7 Cost

This criterion involves development and evaluation of the capital cost of construction, equipment, land, buildings, engineering services, and project administration, and O&M costs for labor, spare parts, materials, and administration. In addition, the present worth of each alternative is calculated using a discount rate of seven percent. Costs are then compared on a common, present-worth basis in terms of year 2011 dollars. The level of detail employed in developing these estimates is considered appropriate

for making choices between alternatives, but the estimates are not intended for use in detailed budgetary planning.

7.1.8 State Acceptance

This criterion identifies the State's preferences or concerns about alternatives.

7.1.9 Community Acceptance

This criterion identifies the community's preferences or concerns about alternatives.

7.2 Analysis of Alternatives

This section includes individual and comparative analyses of the alternatives proposed for the Site with respect to the seven evaluation criteria described in Section 7.1. The comparative analysis of remedial alternatives for the Site is summarized in **Table 7-1**.

7.2.1 Individual Analysis of Alternatives

Individual analysis of alternatives consists of an evaluation and assessment of the proposed alternatives with respect to the seven evaluation criteria described in Section 7.1.

7.2.1.1 Alternative 1 – No Action

According to the NCP, the level of protectiveness achieved must be compared to the required expenditure of time and materials as an integral portion of the response action selection process. The no action alternative is intended to serve as a baseline by which to compare the risk reduction effectiveness of other potential alternatives. Under this alternative, no remedial actions would be performed and no efforts would be made to contain, remove, or monitor impacted soil and groundwater at the Site.

- Overall Protection of Human Health and the Environment: The no-action alternative provides no control of exposure to impacted soil and groundwater at the Site and no reduction in risk to human health or the environment. Currently there is no unacceptable risk to human health under the current land use; however, future land use scenarios suggest unacceptable risks may occur. Therefore, Alternative 1 does not meet this criterion for overall protection of human health and the environment.

- Compliance with ARARs: ARARs are not identified for the No Action alternative (ARARs Question and Answers USEPA Office of Solid Waste and Emergency Response [OSWER] Directive 9234.2-01/FS-4, June 2004).

- Long-Term Effectiveness and Permanence: The no-action alternative does not provide controls for monitoring reduction of concentrations over time, reduction of exposure, or long-term management measures. Potential future risks would remain under this alternative.

- Reduction of Toxicity, Mobility, and Volume through Treatment: This alternative does not employ treatment that would reduce the toxicity, mobility, or volume of impacted soil and groundwater; therefore, it does not meet this criterion.

- Short-Term Effectiveness: Implementation of this alternative does not mitigate any potential future risks from site-related constituents. However, the no-action alternative does not pose any additional risks to the community, the workers, or the environment because there are no remedial activities associated with it.

- Implementability: There are no implementability concerns posed by this option.

- Cost: There are no present overhead costs and capital costs for the no-action alternative because there would be no action taken.

7.2.1.2 Alternative 2 – Land Use Controls

Alternative 2 includes installation of new and maintenance of existing LUCs to restrict future land use at the Site.

- Overall Protection of Human Health and the Environment: Installation and maintenance of LUCs to restrict future land use and preclude residential use would limit uncontrolled exposure to soil and groundwater, thereby controlling unacceptable risks to human health. Compliance with ARARs: Under this alternative the Site would not be compliant with chemical-specific ARARs as COCs above screening levels in soil and groundwater would remain. However, this alternative would comply with both action-specific and location-specific ARARs.

- Long-Term Effectiveness and Permanence: Installation of LUCs would be effective in the long-term preventing risks to human health posed by soil and groundwater. The permanence would require maintenance of the LUCs which is readily

achievable through existing controls that would remain in place for the foreseeable future as ownership of FGGM is not planned to change and will remain with the Army.

- Reduction of Toxicity, Mobility, and Volume through Treatment: This alternative would not reduce toxicity, mobility, and volume through treatment at the Site.

- Short-Term Effectiveness: This alternative is effective in the short-term given there is currently no risk under current land use.

- Implementability: There are no implementability concerns posed by this option as this alternative requires minimal time and coordination of labor, materials, and resources for completion.

- Cost: The projected present worth cost to implement LUCs to restrict future land use at the Site is $113,900. The costs and detailed assumptions associated with the implementation of Alternative 2 are presented in **Tables B-1 and B-2** of **Appendix B.**

7.2.1.3 Alternative 3 – Soil Excavation with Offsite Disposal, Land Use Controls, and Enhanced Reductive Dechlorination

Alternative 3 incorporates soil excavation with off-site disposal and LUCs, and ERD for treatment of CVOCs in groundwater.

- Overall Protection of Human Health and the Environment: Alternative 3 is protective of human health and the environment. Excavation would permanently remove soils containing COCs above screening levels, thereby addressing unacceptable risks for future land use at the Site. Excavation also addresses potential unacceptable risks to ecological receptors. Alternative 3 also provides groundwater treatment and monitoring to achieve MCLs of Site COCs.

- Compliance with ARARs: This alternative would comply with chemical-specific ARARs and would be implemented in compliance with location-specific and action-specific ARARS.

- Long-Term Effectiveness and Permanence: A removal action for soil and groundwater treatment would provide a long-term and permanent solution to impacted soil and groundwater at the Site.

- Reduction of Toxicity, Mobility, and Volume through Treatment: This alternative would reduce the on-site toxicity, mobility, and volume of impacted soil and groundwater through excavation and groundwater treatment.

- Short-Term Effectiveness: This alternative is successful in the short-term because there will be no unacceptable risks upon completion of the excavation and groundwater treatment. Marginal short-term risks to the community and construction workers are present when soils are excavated and transported to an off-site facility for disposal. However, the potential for exposure during excavation would be reduced through the use of suitable protective clothing and equipment, good construction practices, and standard dust suppression techniques.

- Implementability: There are no implementability concerns posed by this option. However this alternative will require logistical coordination with FGGM Environmental Office to ensure impacted soil is trucked through, and off, the installation in a safe manner.

- Cost: The estimated present worth cost for the excavation with off-site disposal and ERD is $303,000. The costs and detailed assumptions associated with the implementation of Alternative 3 are presented in **Tables B-3** and **B-4** of **Appendix B.**

7.2.2 Comparative Analysis of Alternatives

The comparative analysis of alternatives includes an evaluation of the expected performance of each alternative relative to the other alternatives with respect to the seven criteria described in Section 7.1. The objective of this analysis is to identify the respective advantages and disadvantages of the alternatives.

7.2.2.1 Overall Protection of Human Health and the Environment

Under current land use, all alternatives provide protection to human health and the environment. However, future land use scenarios at the Site present unacceptable risks. Alternatives 2 and 3 either remove or control possible future exposure to COCs in impacted soil and groundwater. .

7.2.2.2 Compliance with ARARs

Under Alternatives 1 and 2, chemical-specific ARARs are not in compliance because COCs exceeding PRGs are left in place. Alternative 3 complies with chemical-specific ARARs. Alternatives 2 and 3 either control exposure to site COCs or actively remove and treat the site. Location-specific and action-specific ARARs would be met by Alternatives 2 and 3, and they do not apply to Alternative 1.

7.2.2.3 Long-Term Effectiveness and Permanence

Under Alternative 1, residual risk would remain unchanged and the adequacy and reliability of this alternative would be poor. Alternatives 2 and Alternative 3 are effective in the long-term because they would reduce risk to human health by controlling or removing pathways of exposure to COCs in soil and groundwater. For Alternative 2, LUCs are required to restrict land use and remove pathways of exposure. Alternative 3 also includes LUCs in conjunction with soil cleanup levels based on PRGs for non-residential future use scenarios. Of these three alternatives, Alternative 3 would be most effective in the long-term since it removes impacted soils and treats impacted groundwater at the Site. .

7.2.2.4 Reduction of Toxicity, Mobility, and Volume through Treatment

Alternatives 1 and 2 would not reduce the toxicity, mobility, and volume through treatment of impacted soil and groundwater at the Site. Alternative 3 would reduce the toxicity, mobility, and volume through treatment by excavating contaminated soil and treating groundwater.

7.2.2.5 Short-Term Effectiveness

Alternative 1 is considered effective in the short-term as there are no risks to human health under the current land use. However, Alternative 1 is ineffective overall because there is no action taken to address risk to human health under future land use scenarios. Alternative 2 is also considered effective in the short-term as there are no risks under current land use scenarios and it addresses risks to human health under future land use scenarios. Alternative 3 is effective in the short-term because there are no risks under current land use and there will be no unacceptable risks associated with future land use scenarios upon completion of the excavation.

7.2.2.6 Implementability

The most readily implementable alternatives are Alternatives 1 and 2. Alternative 3 presents the most complex alternative to implement. However the complex implementation can be handled using industry-standard engineering and planning.

7.2.2.7 Cost

Based on the present worth estimates of probable costs for the alternatives, Alternative 3 is the most costly; however, it eliminates future risk and would therefore be considered cost-effective. Although there is no cost associated with Alternative 1, there is also no risk reduction or effectiveness provided by this alternative. Therefore, Alternative 1 would not be considered to be cost effective. Alternatives 2 controls but does not eliminate the hazard posed by Site COCs to receptors under future land use scenarios. Therefore, when considering risk reduction applicable to future land use scenarios in relation to cost for these three alternatives, Alternative 3 is the most cost effective option.

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Tables

Table 3-1
Sample Collection and Analysis Summary
Former Pesticide Shop, Building 6621
Fort George G. Meade, Maryland

Sample Location	Sample ID	Sampling Interval (ft)	Sample Date	Analytical Parameters					
				Metals	PCBs	VOC	SVOC	Herb.	Pest.
Groundwater									
MW-1	FM13-MW001R (041510)	--	04/15/2010	yes	no	yes	no	no	yes
	FM13-MW01R	--	06/02/2010	yes	no	yes	no	no	yes
MW-2	FM13-MW002R (041510)	--	04/15/2010	yes	no	yes	no	no	yes
	FM13-MW02R	--	06/02/2010	yes	no	yes	no	no	yes
	FM13-MW02R (DUP)	--	06/02/2010	yes	no	yes	no	no	yes
MW-3	FM13-MW003R (041510)	--	04/15/2010	yes	no	yes	no	no	yes
	FM13-MW03D	--	06/02/2010	yes	no	yes	no	no	yes
MW-4	FM13-MW004R (041510)	--	04/15/2010	yes	no	yes	no	no	yes
	FM13-DUP001 (041610)	--	04/16/2010	yes	no	yes	no	no	yes
	FM13-MW04R	--	06/01/2010	yes	no	yes	no	no	yes
MW-5	MW-05-102809	--	10/28/2009	yes	no	no	no	no	yes
	FM13-MW005 (041510)	--	04/15/2010	yes	no	yes	no	no	yes
	FM13-MW05	--	06/02/2010	yes	no	yes	no	no	yes
MW-6	MW-06-102809	--	10/28/2009	yes	no	no	no	no	yes
	DUP-1-102809	--	10/28/2009	yes	no	no	no	no	yes
	FM13-MW006 (041510)	--	04/15/2010	yes	no	yes	no	no	yes
	FM13-MW06	--	06/01/2010	yes	no	yes	no	no	yes
MW-7	MW-7 (111709)	--	11/17/2009	yes	no	no	no	no	yes
	FM13-MW007 (041410)	--	04/14/2010	yes	no	yes	no	no	yes
	FM13-MW07	--	06/01/2010	yes	no	yes	no	no	yes
MW-8	MW-8 (111909)	--	11/19/2009	yes	no	no	no	no	yes
	FM13-MW008 (041410)	--	04/14/2010	yes	no	yes	no	no	yes
	FM13-MW08	--	06/01/2010	yes	no	yes	no	no	yes
Soil									
S-1	S-1A(6"-12")	0.5 - 1	02/26/1997	yes	yes	no	no	no	yes
	S-1B(12"-18")	1 - 1.5	02/26/1997	yes	yes	no	no	no	yes
S-2	S-2A(6"-12")	0.5 - 1	02/26/1997	yes	yes	no	no	no	yes
	S-2B(12"-18")	1 - 1.5	02/26/1997	yes	yes	no	no	no	yes
S-3	S-3A(6"-12")	0.5 - 1	02/26/1997	yes	yes	no	no	no	yes
	S-3B(12"-18")	1 - 1.5	02/26/1997	yes	yes	no	no	no	yes
S-4	S-4A(6"-12")	0.5 - 1	02/26/1997	yes	yes	no	no	no	yes
	S-4B(12"-18")	1 - 1.5	02/26/1997	yes	yes	no	no	no	yes
SB-1	B6621-SB01_0-1(012704)	0 - 1	01/27/2004	no	no	no	yes	yes	no
	B6621-SB1_0-5(090303)	0 - 0.5	09/03/2003	yes	yes	no	no	no	yes
	B6621-SB1_0.5-1(090303)	0.5 - 1	09/03/2003	no	yes	no	no	no	yes
	B6621-SB01_1-2.5(012704)	1 - 2.5	01/27/2004	yes	no	no	yes	no	yes
	B6621-SB01_2.5-4(012704)	2.5 -4	01/27/2004	yes	no	no	yes	no	yes
SB-2	B6621-SB02_0-1(012704)	0 - 1	01/27/2004	yes	no	no	yes	no	yes
	B6621-SB2_0-0.5(090303)	0 - 0.5	09/03/2003	yes	yes	no	no	no	yes
	B6621-SB02_1-2.5(012704)	1 - 2.5	01/27/2004	yes	no	no	yes	no	yes
SB-3	B6621-SB03_0-1(012704)	0 - 1	01/27/2004	yes	no	no	yes	no	yes
	B6621-SB3_0-0.5(090303)	0 - 0.5	09/03/2003	yes	yes	no	no	no	yes
	B6621-SB03_1-2.5(012704)	1 - 2.5	01/27/2004	yes	no	no	yes	no	yes
SB-4	B6621-SB04_0-1(012704)	0 - 1	01/27/2004	yes	no	no	yes	no	yes
	B6621-SB04_1-2.5(012704)	1 - 2.5	01/27/2004	yes	no	no	yes	no	yes
SB-5	B6621-SB05_0-1(012704)	0 - 1	01/27/2004	yes	no	no	yes	yes	yes
	B6621-SB05_1-2.5(012704)	1 - 2.5	01/27/2004	yes	no	no	yes	no	yes
	B6621-SB05_2.5-4(012704)	2.5 -4	01/27/2004	yes	no	no	yes	no	yes
SB-6	B6621-SB06_0-1(012704)	0 - 1	01/27/2004	yes	no	no	yes	yes	yes
	B6621-SB06_1-2.5(012704)	1 - 2.5	01/27/2004	yes	no	no	yes	no	yes
	B6621-SB06_2.5-4(012704)	2.5 - 4	01/27/2004	yes	no	no	yes	no	yes

Notes:
1. ft - feet
2. Herb. - Herbicide
3. PCB - Polychlorinated byphenyl
4. Pest. - Pesticide
5. SVOC - Semi-Volatile Organic Compound
6. VOC - Volatile Organic Compound
7. -- - Not Applicable

Table 3-1
Sample Collection and Analysis Summary
Former Pesticide Shop, Building 6621
Fort George G. Meade, Maryland

Sample Location	Sample ID	Sampling Interval (ft)	Sample Date	Analytical Parameters					
				Metals	PCBs	VOC	SVOC	Herb.	Pest.
SB-7	B6621-SB07_0-1(012704)	0 - 1	01/27/2004	yes	no	no	yes	yes	yes
	B6621-SB07_1-2.5(012704)	1 - 2.5	01/27/2004	yes	no	no	yes	no	yes
	B6621-SB07_2.5-4(012704)	2.5 - 4	01/27/2004	yes	no	no	yes	no	yes
SB-8	B6621-SB08_0-1(012704)	0 - 1	01/27/2004	yes	no	no	yes	no	yes
	B6621-SB08_1-2.5(012704)	1 - 2.5	01/27/2004	yes	no	no	yes	no	yes
SB-9	B6621-SB09_0-1(012704)	0 - 1	01/27/2004	yes	no	no	yes	no	yes
	B6621-SB09_1-2.5(012704)	1 - 2.5	01/27/2004	yes	no	no	yes	no	yes
SB-10	B6621-SB10_0-1(012704)	0 - 1	01/27/2004	yes	no	no	yes	no	yes
	B6621-SB10_1-2.5(012704)	1 - 2.5	01/27/2004	yes	no	no	yes	no	yes
37	37-S-20030320	0 - 2	03/20/2006	yes	no	no	no	no	yes
38	38-S-20030320	0 - 2	03/20/2006	yes	no	no	no	no	yes
39	39-S-20030320	0 - 2	03/20/2006	yes	no	no	no	no	yes
40	40-S-20060322	0 - 2	03/22/2006	yes	no	no	no	no	yes
41	41-S-20060322	0 - 2	03/22/2006	yes	no	no	no	no	yes
42	42-S-20060322	0 - 2	03/22/2006	yes	no	no	no	no	yes
43	43-S-20060322	0 - 2	03/22/2006	yes	no	no	no	no	yes
44	44-S-20060322	0 - 2	03/22/2006	yes	no	no	no	no	yes
45	45-S-20060322	0 - 2	03/22/2006	yes	no	no	no	no	yes
46	46-S-20060322	0 - 2	03/22/2006	yes	no	no	no	no	yes
47	47-S-20030320	0 - 2	03/20/2006	yes	no	no	no	no	yes
48	48-S-20030320	0 - 2	03/20/2006	yes	no	no	no	no	yes
	48-A-20060316	2 - 4	03/16/2006	yes	no	no	no	no	yes
	48-B-20060316	4 - 6	03/16/2006	yes	no	no	no	no	yes
	48-C-20060316	6 - 8	03/16/2006	yes	no	no	no	no	yes
49	49-S-20030320	0 - 2	03/20/2006	yes	no	no	no	no	yes
50	50-S-20030320	0 - 2	03/20/2006	yes	no	no	no	no	yes
51	51-S-20030320	0 - 2	03/20/2006	yes	no	no	no	no	yes
	51-A-20060316	2 - 4	03/16/2006	yes	no	no	no	no	yes
	51-B-20060316	4 - 6	03/16/2006	yes	no	no	no	no	yes
	51-C-20060316	6 - 8	03/16/2006	yes	no	no	no	no	yes
52	52-S-20030320	0 - 2	03/20/2006	yes	no	no	no	no	yes
	52-A-20060316	2 - 4	03/16/2006	yes	no	no	no	no	yes
	52-B-20060316	4 - 6	03/16/2006	yes	no	no	no	no	yes
	52-C-20060316	6 - 8	03/16/2006	yes	no	no	no	no	yes
53	53-S-20030320	0 - 2	03/20/2006	yes	no	no	no	no	yes
	53-A-20060316	2 - 4	03/16/2006	yes	no	no	no	no	yes
	53-B-20060316	4 - 6	03/16/2006	yes	no	no	no	no	yes
	53-C-20060316	6 - 8	03/16/2006	yes	no	no	no	no	yes
55	55-S-20030320	0 - 2	03/20/2006	yes	no	no	no	no	yes
	55-A-20060315	2 - 4	03/15/2006	yes	no	no	no	no	yes
	55-B-20060315	4 - 6	03/15/2006	yes	no	no	no	no	yes
	55-C-20060315	6 - 8	03/15/2006	yes	no	no	no	no	yes
	55-D-20060315	8 - 10	03/15/2006	yes	no	no	no	no	yes
	55-E-20060315	14 - 15	03/15/2006	yes	no	no	no	no	yes
	55-F-20060315	19 - 20	03/15/2006	yes	no	no	no	no	yes
56	56-S-20030320	0 - 2	03/20/2006	yes	no	no	no	no	yes
	56-A-20060315	2 - 4	03/15/2006	yes	no	no	no	no	yes
	56-B-20060315	4 - 6	03/15/2006	yes	no	no	no	no	yes
	56-C-20060315	6 - 8	03/15/2006	yes	no	no	no	no	yes
	56-D-20060315	8 - 10	03/15/2006	yes	no	no	no	no	yes
	56-E-20060315	14 - 15	03/15/2006	yes	no	no	no	no	yes
	56-F-20060315	19 - 20	03/15/2006	yes	no	no	no	no	yes
57	57-S-20030320	0 - 2	03/20/2006	yes	no	no	no	no	yes
	57-A-20060315	2 - 4	03/15/2006	yes	no	no	no	no	yes
	57-B-20060315	4 - 6	03/15/2006	yes	no	no	no	no	yes
	57-C-20060315	6 - 8	03/15/2006	yes	no	no	no	no	yes
	57-D-20060315	8 - 10	03/15/2006	yes	no	no	no	no	yes
	57-E-20060315	14 - 15	03/15/2006	yes	no	no	no	no	yes
	57-F-20060315	19 - 20	03/15/2006	yes	no	no	no	no	yes

Notes:
1. ft - feet
2. Herb. - Herbicide
3. PCB - Polychlorinated byphenyl
4. Pest. - Pesticide
5. SVOC - Semi-volatile Organic Compounds
6. VOC - Volatile Organic Compounds
7. -- - Not Applicable

Table 3-1
Sample Collection and Analysis Summary
Former Pesticide Shop, Building 6621
Fort George G. Meade, Maryland

Sample Location	Sample ID	Sampling Interval (ft)	Sample Date	Analytical Parameters					
				Metals	PCBs	VOC	SVOC	Herb.	Pest.
58	58-S-20060322	0 - 2	03/22/2006	yes	no	no	no	yes	yes
	58-A-20060316	2 - 4	03/16/2006	yes	no	no	no	yes	yes
	58-B-20060316	4 - 6	03/16/2006	yes	no	no	no	yes	yes
	58-C-20060316	6 - 8	03/16/2006	yes	no	no	no	yes	yes
59	59-S-20060322	0 - 2	03/22/2006	yes	no	no	no	yes	yes
60	60-S-20060322	0 - 2	03/22/2006	yes	no	no	no	yes	yes
61	61-S-20060322	0 - 2	03/22/2006	yes	no	no	no	yes	yes
	61-A-20060316	2 - 4	03/16/2006	yes	no	no	no	yes	yes
	61-B-20060316	4 - 6	03/16/2006	yes	no	no	no	yes	yes
	61-C-20060316	6 - 8	03/16/2006	yes	no	no	no	yes	yes
62	62-S-20030320	0 - 2	03/20/2006	yes	no	no	no	yes	yes
	62-A-20060316	2 - 4	03/16/2006	yes	no	no	no	yes	yes
	62-B-20060316	4 - 6	03/16/2006	yes	no	no	no	yes	yes
	62-C-20060316	6 - 8	03/16/2006	yes	no	no	no	yes	yes
63	63-S-20030320	0 - 2	03/20/2006	yes	no	no	no	yes	yes
	63-A-20060316	2 - 4	03/16/2006	yes	no	no	no	yes	yes
	63-B-20060316	4 - 6	03/16/2006	yes	no	no	no	yes	yes
	63-C-20060316	6 - 8	03/16/2006	yes	no	no	no	yes	yes
64	64-S-20030320	0 - 2	03/20/2006	yes	no	no	no	yes	yes
	64-A-20060316	2 - 4	03/16/2006	yes	no	no	no	yes	yes
	64-B-20060316	4 - 6	03/16/2006	yes	no	no	no	yes	yes
	64-C-20060316	6 - 8	03/16/2006	yes	no	no	no	yes	yes
65	65-S-20030320	0 - 2	03/20/2006	yes	no	no	no	yes	yes
66	66-S-20030320	0 - 2	03/20/2006	yes	no	no	no	yes	yes
67	67-S-20030320	0 - 2	03/20/2006	yes	no	no	no	yes	yes
68	68-S-20030320	0 - 2	03/20/2006	yes	no	no	no	yes	yes
	68-A-20060316	2 - 4	03/16/2006	yes	no	no	no	yes	yes
	68-B-20060316	4 - 6	03/16/2006	yes	no	no	no	yes	yes
	68-C-20060316	6 - 8	03/16/2006	yes	no	no	no	yes	yes
70	70-S-20060320	0 - 2	03/20/2006	yes	no	no	no	yes	yes
71	71-S-20060322	0 - 2	03/22/2006	yes	no	no	no	yes	yes
72	72-S-20060322	0 - 2	03/22/2006	yes	no	no	no	yes	yes
83	83-S-20060322	0 - 2	03/22/2006	yes	no	no	no	yes	yes
	83-A-20060316	2 - 4	03/16/2006	yes	no	no	no	yes	yes
	83-B-20060316	4 - 6	03/16/2006	yes	no	no	no	yes	yes
	83-C-20060316	6 - 8	03/16/2006	yes	no	no	no	yes	yes

Notes:
1. ft - feet
2. Herb. - Herbicide
3. PCB - Polychlorinated byphenyl
4. Pest. - Pesticide
5. SVOC - Semi-volatile Organic Compounds
6. VOC - Volatile Organic Compounds
7. -- - Not Applicable

Table 4-1
Chemical-Specific ARARs and TBC Guidance
Former Pesticide Shop, Building 6621
Fort George G. Meade, Maryland

Media	Authority	Regulation	Synopsis	Status
Groundwater	Federal Regulatory Requirement	Safe Drinking Water Act (SDWA) National Primary Drinking Water Regulations *40 CFR 141*	This regulation sets Maximum Contamination Levels (MCLs), which are maximum allowable concentrations of specified contaminants, as enforceable standards for surface or groundwater to be used in the drinking water supply.	ARAR
	Federal Criteria, Advisories, and Guidance	USEPA Maximum Contaminant Level Goals (MCLGs), non-zero only	These values are threshold concentrations for chemical contaminants in drinking water below which there are no known or expected risks to health. MCLGs allow for a margin of safety and provide non-enforceable public health goals.	ARAR
Soil	Federal Criteria, Advisories, and Guidance	USEPA Regional Screening Levels, Residential Soil Supporting Table	The values from the *Regional Screening Level Tables* (USEPA, 2009) are suggested threshold concentrations for soil chemical contaminants that have been developed based on a combination of regional PRGs and similar regional risk-based screening levels to provide guidance for residential soil quality. Available at: http://www.epa.gov/region09/superfund/prg/	TBC
	Local Criteria, Advisories, and Guidance	FGGM Soil Background Concentrations	The *Soil Background Concentration Report of Fort George G. Meade Maryland* (Malcolm Pirnie, 2001) presents background concentrations of metals for surface and subsurface soils within FGGM and the USACE Baltimore District.	TBC

Table 4-2
Location-Specific ARARs and TBC Guidance
Former Pesticide Shop, Building 6621
Fort George G. Meade, Maryland

Feature	Authority	Regulation	Synopsis	Status
Anne Arundel County, Maryland	Federal Regulatory Requirement	Endangered Species Act *50 CFR 402* *16 USC 35*	This law requires that action be taken to conserve endangered or threatened species. In addition, actions must not destroy or adversely modify critical habitat. Several federal endangered species listed by the US Fish and Wildlife Service are found in Maryland and should be considered during the removal action.	ARAR
	State Regulatory Requirement	Threatened and Endangered Species *COMAR 08.03.08*	This statute provides for the protection of endangered or threatened wildlife. Several endangered and threatened species listed by the Maryland Department of Natural Resources are found in Anne Arundel County and should be considered in removal action if found on or adjacent to the project site.	ARAR
Patuxent River Watershed	State Regulatory Requirement	Erosion and Sediment Control *COMAR 26.17.01*	This regulation is applicable when excavation or on-site storage of contaminated soil and waste is contemplated. It sets criteria and procedures to protect the lands and waters comprising the watersheds of the state and prohibits discharge of raw sewage or waste into the Patuxent or Severn rivers or their watersheds. The limits for phosphorus and nitrogen in wastewater effluent are set at 0.3 mg/L and 3.0 mg/L, respectively.	ARAR

Table 4-3
Action-Specific ARARs and TBC Guidance
Former Pesticide Shop, Building 6621
Fort George G. Meade, Maryland

Activity	Authority	Regulation	Synopsis	Status
Excavation and Temporary On-site Staging	State Regulatory Requirement	Erosion and Sediment Control *COMAR 26.17.01*	This regulation is applicable when excavation or on-site storage of contaminated soil and waste is contemplated. It sets criteria and procedures to protect the lands and waters comprising the watersheds of the state and prohibits discharge of raw sewage or waste into the Patuxent or Severn rivers or their watersheds. The limits for phosphorus and nitrogen in wastewater effluent are set at 0.3 mg/L and 3.0 mg/L, respectively.	ARAR
Excavation and Off-site Disposal	State Regulatory Requirement	Disposal of Controlled Hazardous Substances *COMAR 26.13*	This regulation provides for the prevention, abatement, and control of contamination by addressing the generation and disposal of hazardous substances, and it authorizes the regulation of storage, treatment, transportation, and disposal of hazardous materials, controlled hazardous substances, and low level nuclear waste.	ARAR
General Remediation Activities	State Regulatory Requirement	Control of Noise Pollution *COMAR 26.02.03*	This regulation applies to activities that produce regular or continuous sound that exceeds or may exceed established limits. It restricts noise to a level that protects the health, general welfare, and property of the people of the state. It also establishes an Environmental Noise Advisory Council and authorizes standards for ambient noise levels and equipment noise performance levels to be promulgated by the Department of Environment.	ARAR

Table 4-4
Site Cleanup Levels for Soil
Former Pesticide Shop, Building 6621
Fort George G. Meade, Maryland

Compounds of Concern	Site Cleanup Levels
	Hazard Quotient = Compound-Specific
	(mg/kg)
Chlordane	16.21
Heptachlor epoxide[1]	0.77

Notes:

(1) The Heptachlor Epoxide SCL is based on the subchronic exposure to future construction worker scenario. For subchronic exposure scenarios, the Liver is the target endpoint for effects associated with exposure to the two soil COCs (chlordane and heptachlor epoxide) and two soil COPCs (gamma-chlordane and 4,4'-DDT; see HHRA in ARCADIS 2011). The soil cleanup goal is based on a target hazard index of 0.25 (representing a target hazard index of 1 divided by 4).

mg/kg = milligrams per kilogram

Table 4-5
Preliminary Remediation Goal Comparison to Surface Soil Data
Former Pesticide Shop, Building 6621
Fort George G. Meade, Maryland

Sample ID:	**Site Cleanup Levels for Soil (mg/kg)**	**S-1A**	**S-1B**	**S-2A**	**S-2B**	**S-3A**	**S-3B**	**S-4A**	**S-4B**	**B6621-SB1**	**B6621-SB1**
Depth of Sample Collection (ft bgs):		0.5 - 1	1 - 1.5	0.5 - 1	1 - 1.5	0.5 - 1	1 - 1.5	0.5 - 1	1 - 1.5	0 - 0.5	0.5 - 1
Date:		02/26/1997	02/26/1997	02/26/1997	02/26/1997	02/26/1997	02/26/1997	02/26/1997	02/26/1997	09/03/2003	09/03/2003
Analyte											
Chlordane	16.21	**160**	**450**	**110**	**180**	< 1 U	< 1 U	< 0.5 U	< 1 U	**84.6**	**198**
Heptachlor Epoxide	0.77	< 3 U	< 5 U	< 1 U	< 1 U	< 0.05 U	< 0.05 U	< 0.5 U	< 0.05 U	< 1.8 U	< 4.4 U

Notes:
Values exceeding the Site Cleanup Levels are boldfaced
ft bgs - foot below ground surface
mg/kg - milligram per kilogram
NA - not analyzed
E - Indicates that the sample exceeds calibration range.
J - Indicates an estimated result. Result is less than laboratory reporting limits.
U - Indicates an estimated result. Result is less than laboratory reporting limits.

Table 4-5
Preliminary Remediation Goal Comparison to Surface Soil Data
Former Pesticide Shop, Building 6621
Fort George G. Meade, Maryland

Sample ID:	Site Cleanup Levels for Soil (mg/kg)	B6621-SB2	B6621-SB3	B6621-SB02	B6621-SB03	B6621-SB04	B6621-SB05	B6621-SB06	B6621-SB07	B6621-SB08
Depth of Sample Collection (ft bgs):		0 - 0.5	0 - 0.5	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1
Date:		09/03/2003	09/03/2003	01/27/2004	01/27/2004	01/27/2004	01/27/2004	01/27/2004	01/27/2004	01/27/2004
Analyte										
Chlordane	16.21	< 0.018 U	0.534	< 0.018 U	0.398	2.05	**156**	**482**	**44**	1.06
Heptachlor Epoxide	0.77	< 0.0018 U	< 0.018 U	< 0.0018 U	< 0.0095 U	< 0.045 U	< 1.8 U	< 9.8 U	< 0.93 U	< 0.018 U

Notes:
Values exceeding the Site Cleanup Levels are boldfaced
ft bgs - foot below ground surface
mg/kg - milligram per kilogram
NA - not analyzed
E - Indicates that the sample exceeds calibration range.
J - Indicates an estimated result. Result is less than laboratory reporting limits.
U - Indicates an estimated result. Result is less than laboratory reporting limits.

Table 4-5
Preliminary Remediation Goal Comparison to Surface Soil Data
Former Pesticide Shop, Building 6621
Fort George G. Meade, Maryland

Sample ID:	**Site Cleanup Levels for Soil (mg/kg)**	**B6621-SB09**	**B6621-SB10**	**37-S**	**38-S**	**39-S**	**40-S**	**41-S**	**42-S**	**43-S**	**44-S**
Depth of Sample Collection (ft bgs):		0 - 1	0 - 1	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2
Date:		01/27/2004	01/27/2004	03/20/2006	03/20/2006	03/20/2006	03/22/2006	03/22/2006	03/22/2006	03/22/2006	03/22/2006
Analyte											
Chlordane	16.21	**47.1**	0.616	0.14 J	0.79	0.045	< 0.2 U	< 0.099 U	0.015 J	0.022 J	0.022 J
Heptachlor Epoxide	0.77	< 0.9 U	< 0.0091 U	< 0.018 U	0.044	< 0.0038 U	< 0.02 U	< 0.0099 U	< 0.0019 U	< 0.0037 U	< 0.0036 U

Notes:

Values exceeding the Site Cleanup Levels are boldfaced

ft bgs - foot below ground surface

mg/kg - milligram per kilogram

NA - not analyzed

E - Indicates that the sample exceeds calibration range.

J - Indicates an estimated result. Result is less than laboratory reporting limits.

U - Indicates an estimated result. Result is less than laboratory reporting limits.

Table 4-5
Preliminary Remediation Goal Comparison to Surface Soil Data
Former Pesticide Shop, Building 6621
Fort George G. Meade, Maryland

Sample ID:	**Site Cleanup Levels for Soil (mg/kg)**	**45-S**	**46-S**	**47-S**	**48-S**	**49-S**	**50-S**	**51-S**	**52-S**	**53-S**	**55-S**
Depth of Sample Collection (ft bgs):		0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2
Date:		03/22/2006	03/22/2006	03/20/2006	03/20/2006	03/20/2006	03/20/2006	03/20/2006	03/20/2006	03/20/2006	03/20/2006
Analyte											
Chlordane	16.21	< 0.018 U	0.94	4.1	0.76	**24**	6.8 J	**41**	15	0.31	**1000**
Heptachlor Epoxide	0.77	< 0.0018 U	< 0.018 U	< 0.18 U	< 0.035 U	0.42	< 0.88 U	< 0.88 U	< 0.48 U	< 0.0089 U	**4.4 J**

Notes:

Values exceeding the Site Cleanup Levels are boldfaced

ft bgs - foot below ground surface

mg/kg - milligram per kilogram

NA - not analyzed

E - Indicates that the sample exceeds calibration range.

J - Indicates an estimated result. Result is less than laboratory reporting limits.

U - Indicates an estimated result. Result is less than laboratory reporting limits.

Table 4-5
Preliminary Remediation Goal Comparison to Surface Soil Data
Former Pesticide Shop, Building 6621
Fort George G. Meade, Maryland

Sample ID:	**Site Cleanup Levels for Soil (mg/kg)**	**56-S**	**57-S**	**58-S**	**59-S**	**60-S**	**61-S**	**62-S**	**63-S**	**64-S**	**65-S**	**66-S**
Depth of Sample Collection (ft bgs):		0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2
Date:		03/20/2006	03/20/2006	03/22/2006	03/22/2006	03/22/2006	03/22/2006	03/20/2006	03/20/2006	03/20/2006	03/20/2006	03/20/2006
Analyte												
Chlordane	16.21	**55**	0.24	0.55	5.7	0.29 J	0.68 J	0.54 J	1	< 0.36 U	< 1.8 U	2.5
Heptachlor Epoxide	0.77	< 1.8 U	< 0.009 U	< 0.0018 U	0.064 J	< 0.039 U	< 0.091 U	< 0.089 U	< 0.088 U	< 0.036 U	< 0.18 U	< 0.18 U

Notes:

Values exceeding the Site Cleanup Levels are boldfaced

ft bgs - foot below ground surface

mg/kg - milligram per kilogram

NA - not analyzed

E - Indicates that the sample exceeds calibration range.

J - Indicates an estimated result. Result is less than laboratory reporting limits.

U - Indicates an estimated result. Result is less than laboratory reporting limits.

Table 4-5
Preliminary Remediation Goal Comparison to Surface Soil Data
Former Pesticide Shop, Building 6621
Fort George G. Meade, Maryland

Sample ID:	**Site Cleanup Levels for Soil (mg/kg)**	**67-S**	**68-S**	**70-S**	**71-S**	**72-S**	**83-S**
Depth of Sample Collection (ft bgs):		0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2
Date:		03/20/2006	03/20/2006	03/20/2006	03/22/2006	03/22/2006	03/22/2006
Analyte							
Chlordane	16.21	1.5	0.07 J	0.63	0.73 J	5.6	12
Heptachlor Epoxide	0.77	< 0.09 U	< 0.019 U	< 0.037 U	< 0.088 U	< 0.087 U	< 0.35 U

Notes:

Values exceeding the Site Cleanup Levels are boldfaced

ft bgs - foot below ground surface

mg/kg - milligram per kilogram

NA - not analyzed

E - Indicates that the sample exceeds calibration range.

J - Indicates an estimated result. Result is less than laboratory reporting limits.

U - Indicates an estimated result. Result is less than laboratory reporting limits.

Table 4-6
Preliminary Remediation Goals Comparison to Subsurface Soil Data
Former Pesticide Shop, Building 6621
Fort George G. Meade, Maryland

Sample ID:	Site Cleanup Levels for Soil (mg/kg)	B6621-SB01	B6621-SB01	B6621-SB02	B6621-SB03	B6621-SB04	B6621-SB05	B6621-SB05	B6621-SB06	B6621-SB06	B6621-SB07	B6621-SB07	B6621-SB08
Depth of Sample Collection (ft bgs):		1-2.5	2.5-4	1-2.5	1-2.5	1-2.5	1-2.5	2.5-4	1-2.5	2.5-4	1-2.5	2.5-4	1-2.5
Date		01/27/2004	01/27/2004	01/27/2004	01/27/2004	01/27/2004	01/27/2004	01/27/2004	01/27/2004	01/27/2004	01/27/2004	01/27/2004	01/27/2004
Analyte													
Chlordane	16.21	9.34	0.576	0.0917	0.11	0.0128 J	**60.3**	**48**	9.47 J	0.178	< 87 U	< 35 U	< 0.018 U
Heptachlor Epoxide	0.77	< 0.17 U	< 0.017 U	0.0015 J	< 0.0089 U	< 0.0018 U	< 0.89 U	< 0.88 U	< 1.7 U	< 0.0018 U	< 8.7 U	< 3.5 U	< 0.0018 U

Notes:
Values exceeding the Site Cleanup Levels are boldfaced
ft bgs - foot below ground surface
mg/kg - milligram per kilogram
NA - not analyzed
E - Indicates that the sample exceeds calibration range.
J - Indicates an estimated result. Result is less than laboratory reporting limits.
P - Indicates there is greater than 25% difference for detected concentrations between the two gas chromatography columns.
U - Indicates an estimated result. Result is less than laboratory reporting limits.

Table 4-6
Preliminary Remediation Goals Comparison to Subsurface Soil Data
Former Pesticide Shop, Building 6621
Fort George G. Meade, Maryland

Sample ID:	Site Cleanup Levels for Soil (mg/kg)	B6621-SB09	B6621-SB10	44-A	44-B	44-C	45-A	45-B	45-C	46-A	46-B	46-C	47-A	47-B	47-C
Depth of Sample Collection (ft bgs):		1-2.5	1-2.5	2-4	4-6	6-8	2-4	4-6	6-8	2-4	4-6	6-8	2-4	4-6	6-8
Date		01/27/2004	01/27/2004	03/16/2006	03/16/2006	03/16/2006	03/16/2006	03/16/2006	03/16/2006	03/16/2006	03/16/2006	03/16/2006	03/16/2006	03/16/2006	03/16/2006
Analyte															
Chlordane	16.21	0.797	1.27	< 0.038 U	< 0.04 U	< 0.0020 U	0.0049 J	0.0092 J	< 0.0017 U	1.4	< 0.0018 U	< 0.0018 U	< 0.018 U	< 0.0018 U	< 0.0019 U
Heptachlor Epoxide	0.77	< 0.017 U	< 0.018 U	< 0.0038 U	< 0.04 U	< 0.0020 U	< 0.0018 U	< 0.0018 U	< 0.0017 U	< 0.089 U	< 0.0018 U	< 0.0018 U	< 0.0018 U	< 0.0018 U	< 0.0019 U

Notes:

Values exceeding the Site Cleanup Levels are boldfaced

ft bgs - foot below ground surface

mg/kg - milligram per kilogram

NA - not analyzed

E - Indicates that the sample exceeds calibration range.

J - Indicates an estimated result. Result is less than laboratory reporting limits.

P - Indicates there is greater than 25% difference for detected concentrations between the two gas chromatography columns.

U - Indicates an estimated result. Result is less than laboratory reporting limits.

Table 4-6
Preliminary Remediation Goals Comparison to Subsurface Soil Data
Former Pesticide Shop, Building 6621
Fort George G. Meade, Maryland

Sample ID: / Depth of Sample Collection (ft bgs): / Date	Site Cleanup Levels for Soil (mg/kg)	48-A	48-B	48-C	51-A	51-B	51-C	52-A	52-B	52-C	53-A	53-B	53-C	55-A	55-B
		2-4	4-6	6-8	2-4	4-6	6-8	2-4	4-6	6-8	2-4	4-6	6-8	2-4	4-6
		03/16/2006	03/16/2006	03/16/2006	03/16/2006	03/16/2006	03/16/2006	03/16/2006	03/16/2006	03/16/2006	03/16/2006	03/16/2006	03/16/2006	03/15/2006	03/15/2006
Analyte															
Chlordane	16.21	< 0.018 U	< 0.0018 U	< 0.0018 U	0.14	< 0.0018 U	< 0.0018 U	0.017 J	< 0.0018 U	< 0.0018 U	0.028	0.15	0.43	1.4	7.1
Heptachlor Epoxide	0.77	< 0.0018 U	< 0.0018 U	< 0.0018 U	< 0.0089 U	< 0.0018 U	< 0.0018 U	< 0.0018 U	< 0.0018 U	< 0.0018 U	0.00083 J	< 0.0018 U	< 0.0090 U	< 0.036 U	< 0.088 U

Notes:
Values exceeding the Site Cleanup Levels are boldfaced
ft bgs - foot below ground surface
mg/kg - milligram per kilogram
NA - not analyzed
E - Indicates that the sample exceeds calibration range.
J - Indicates an estimated result. Result is less than laboratory reporting limits.
P - Indicates there is greater than 25% difference for detected concentrations between the two gas chromatography columns.
U - Indicates an estimated result. Result is less than laboratory reporting limits.

Table 4-6
Preliminary Remediation Goals Comparison to Subsurface Soil Data
Former Pesticide Shop, Building 6621
Fort George G. Meade, Maryland

Sample ID:	**Site Cleanup Levels for Soil (mg/kg)**	55-C	55-D	55-E	55-F	56-A	56-B	56-C	56-D	56-E	56-F	57-A	57-B	57-C	57-D
Depth of Sample Collection (ft bgs):		6-8	8-10	14-15	19-20	2-4	4-6	6-8	8-10	14-15	19-20	2-4	4-6	6-8	8-10
Date		03/15/2006	03/15/2006	03/15/2006	03/15/2006	03/15/2006	03/15/2006	03/15/2006	03/15/2006	03/15/2006	03/15/2006	03/15/2006	03/15/2006	03/15/2006	03/15/2006
Analyte															
Chlordane	16.21	**20**	0.046	0.31	0.015	**37**	0.014	< 0.0020 U	0.022	< 0.0020 U	< 0.0020 U	< 0.018 U	0.14	0.011	0.2
Heptachlor Epoxide	0.77	< 0.19 U	< 0.0020 U	< 0.01 U	< 0.0020 U	< 0.9 U	< 0.0018 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0020 U	< 0.0018 U	< 0.0018 U	< 0.0020 U	< 0.0018 U

Notes:
Values exceeding the Site Cleanup Levels are boldfaced
ft bgs - foot below ground surface
mg/kg - milligram per kilogram
NA - not analyzed
E - Indicates that the sample exceeds calibration range.
J - Indicates an estimated result. Result is less than laboratory reporting limits.
P - Indicates there is greater than 25% difference for detected concentrations between the two gas chromatography columns.
U - Indicates an estimated result. Result is less than laboratory reporting limits.

Table 4-6
Preliminary Remediation Goals Comparison to Subsurface Soil Data
Former Pesticide Shop, Building 6621
Fort George G. Meade, Maryland

Sample ID:	Site Cleanup Levels for Soil (mg/kg)	57-E	57-F	58-A	58-B	58-C	61-A	61-B	61-C	62-A	62-B	62-C	63-A	63-B	63-C
Depth of Sample Collection (ft bgs):		14-15	19-20	2-4	4-6	6-8	2-4	4-6	6-8	2-4	4-6	6-8	2-4	4-6	6-8
Date		03/15/2006	03/15/2006	03/16/2006	03/16/2006	03/16/2006	03/16/2006	03/16/2006	03/16/2006	03/16/2006	03/16/2006	03/16/2006	03/16/2006	03/16/2006	03/16/2006
Analyte															
Chlordane	16.21	< 0.0017 U	< 0.0020 U	< 0.018 U	< 0.0018 U	< 0.0019 U	< 0.018 U	< 0.0019 U	< 0.0019 U	< 0.018 U	< 0.0020 U	< 0.0018 U	< 0.018 U	< 0.0018 U	< 0.0019 U
Heptachlor Epoxide	0.77	< 0.0017 U	< 0.0020 U	< 0.0018 U	< 0.0018 U	< 0.0019 U	< 0.0018 U	< 0.0019 U	< 0.0019 U	< 0.0018 U	< 0.0020 U	< 0.0018 U	< 0.0018 U	< 0.0018 U	< 0.0019 U

Notes:
Values exceeding the Site Cleanup Levels are boldfaced
ft bgs - foot below ground surface
mg/kg - milligram per kilogram
NA - not analyzed
E - Indicates that the sample exceeds calibration range.
J - Indicates an estimated result. Result is less than laboratory reporting limits.
P - Indicates there is greater than 25% difference for detected concentrations between the two gas chromatography columns.
U - Indicates an estimated result. Result is less than laboratory reporting limits.

Table 4-6
Preliminary Remediation Goals Comparison to Subsurface Soil Data
Former Pesticide Shop, Building 6621
Fort George G. Meade, Maryland

Sample ID:	**Site Cleanup Levels for Soil (mg/kg)**	64-A	64-B	64-C	68-A	68-B	68-C	83-A	83-B	83-C
Depth of Sample Collection (ft bgs):		2-4	4-6	6-8	2-4	4-6	6-8	2-4	4-6	6-8
Date		03/16/2006	03/16/2006	03/16/2006	03/16/2006	03/16/2006	03/16/2006	03/16/2006	03/16/2006	03/16/2006
Analyte										
Chlordane	16.21	< 0.018 U	< 0.0018 U	< 0.0018 U	0.24 J	< 0.0018 U	< 0.0018 U	29 J	12	**53**
Heptachlor Epoxide	0.77	< 0.0018 U	< 0.0018 U	< 0.0018 U	< 0.037 U	< 0.0018 U	< 0.0018 U	< 3.6 U	< 3.6 U	< 18 U

Notes:
Values exceeding the Site Cleanup Levels are boldfaced
ft bgs - foot below ground surface
mg/kg - milligram per kilogram
NA - not analyzed
E - Indicates that the sample exceeds calibration range.
J - Indicates an estimated result. Result is less than laboratory reporting limits.
P - Indicates there is greater than 25% difference for detected concentrations between the two gas chromatography columns.
U - Indicates an estimated result. Result is less than laboratory reporting limits.

Table 5-1
Screening of the Soil Remedial Alternatives for the Former Pesticide Shop
Former Pesticide Shop, Building 6621
Fort George G. Meade, Maryland

Criteria	Technology 1 No Action	Technology 2 Land Use Controls	Technology 3 Excavation of Impacted Soil
Implementability	Readily implemented	Readily implemented	Low complexity for implementation to engineer and complete the excavation
Effectiveness	Does not achieve remedial action objectives.	If properly enforced, land-use restrictions are an effective means of preventing exposure to contaminated media. Because the site is a controlled military base, access is already restricted to authorized personnel only.	Provides protection to human health by permanently removing constituents in soil. There is no unacceptable risk to ecological receptors under this alternative.
Cost	Low capital cost, no O&M cost	Low capital cost, low O&M cost	Moderate capital cost, low O&M cost
Screening Result	Retained	Retained	Retained
Notes	The no action alternative must be fully evaluated according to 40 CFR 300.43(e)(6).		Permanent remedy for soil

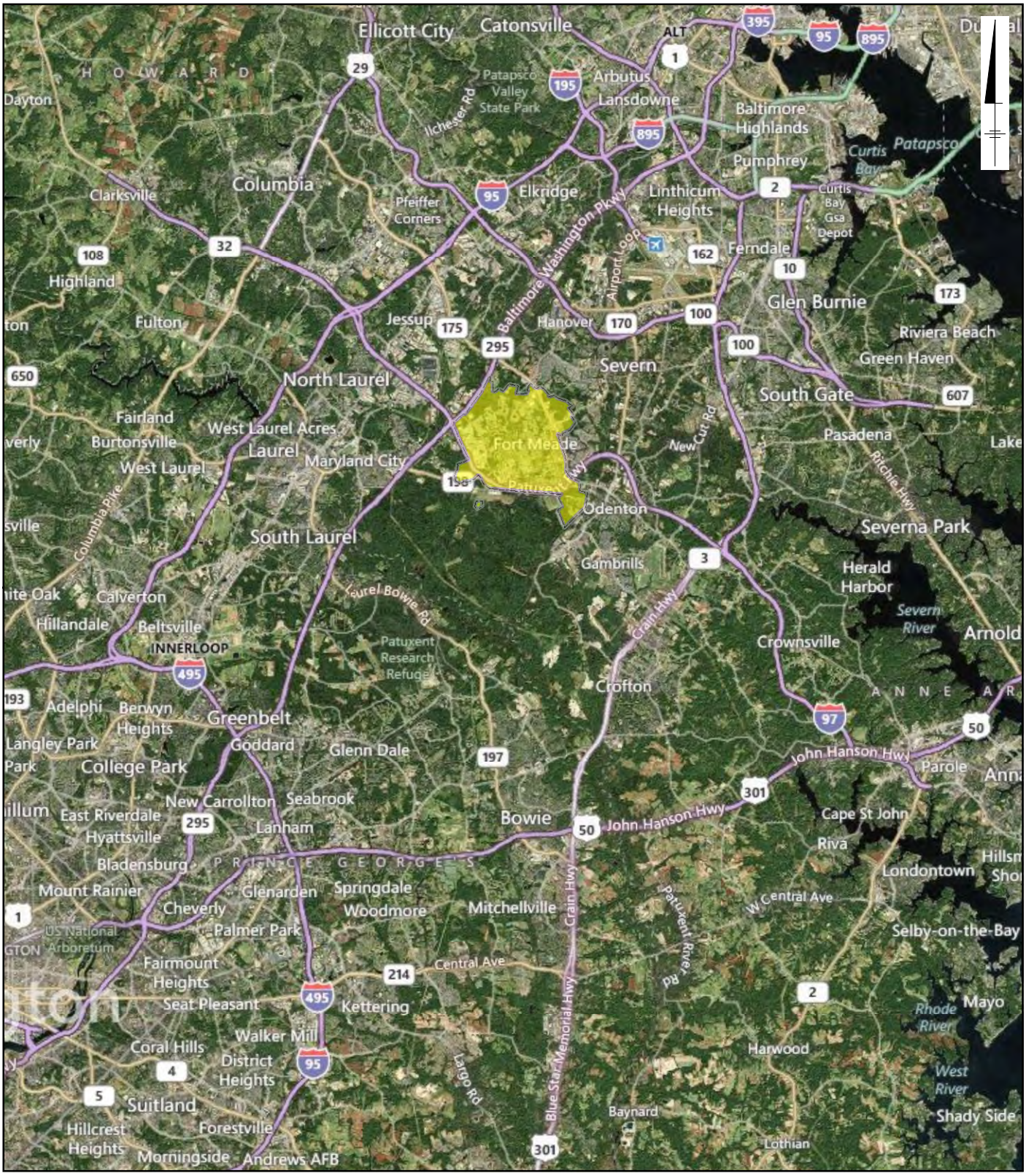
Table 5-2
Screening of the Groundwater Alternatives for the Former Pesticide Shop
Former Pesticide Shop, Building 6621
Fort George G. Meade, Maryland

Criteria	Technology 1 No Action	Technology 2 Land Use Controls	Technology 3 Enhanced Reductive Dechlorination
Implementability	Readily implemented	Readily implemented	Low complexity for implementation to engineer and complete the direct injection of the carbon substrate.
Effectiveness	Does not achieve remedial action objectives.	If properly enforced, land-use restrictions are an effective means of preventing exposure to contaminated media. Because the site is a controlled military base, access is already restricted to authorized personnel only.	Provides protection to human health by treating constituents in groundwater. There is no unacceptable risk to ecological receptors under this alternative.
Cost	Low capital cost, no O&M cost	Low capital cost, low O&M cost	Moderate capital cost, low O&M cost
Screening Result	Retained	Retained	Retained
Notes	The no action alternative must be fully evaluated according to 40 CFR 300.43(e)(6).		Permanent remedy for groundwater

Table 7-1
Comparative Analysis of the Remedial Alternatives for the Former Pesticide Shop
Former Pesticide Shop, Building 6621
Fort George G. Meade, Maryland

Criteria	Alternative 1 No Action	Alternative 2 Land Use Controls	Alternative 3 Excavation of Impacted Soil and Enhanced Reductive Dechlorination
Overall Protection of Human Health and the Environment	There is no unacceptable risk to human health for current use, but future use scenarios show unacceptable risk. There is no unacceptable risk to ecological receptors if no action is taken.	Provides protection to human health through the use of institutional or land use controls to prevent site constituents from reaching human populations. There is no unacceptable risk to ecological receptors under this alternative.	Provides protection to human health by permanently removing constituents in soil. There is no unacceptable risk to ecological receptors under this alternative.
Compliance with ARARs	Would not be incompliance with chemical-specific ARARs because constituents would remain in soil and groundwater. Location- and action-specific ARARs would not apply to this alternative.	Would not be in compliance with chemical specific ARARs because constituents would remain in soil and groundwater. The alternative would comply with both location- and action-specific ARARs.	Would comply with chemical-specific ARARs for soil and groundwater. Would be implemented in compliance with location- and action-specific ARARs.
Long-Term Effectiveness and Permanence	Magnitude of the residual risk would remain unchanged and the adequacy and reliability of this alternative would be poor.	Land use controls would be effective in the long-term. The permanence would require that the land use controls be maintained.	Effective in the long-term because constituents will be permanently removed.
Reduction of Toxicity, Mobility, and Volume through Treatment	No reduction of toxicity, mobility or volume.	No reduction of toxicity, mobility or volume.	Reduction of toxicity, mobility, and volume through removal of constituents in soil.
Short-Term Effectiveness	Because there is no change to the existing risk to human health, this alternative is considered ineffective.	This alternative is effective in the short-term considering that there is no risk under current use scenarios.	This alternative is effective in the short-term because there will be no unacceptable risk upon completion of the excavation.
Implementability	Readily implemented.	Readily implemented.	Low complexity for implementation to engineer and complete the excavation
Cost	Low cost because of no capital or overhead costs.	Low to moderate cost associated with maintaining the land use controls (Total Present Worth Cost - $113,900).	Moderate capital cost and low O&M cost (Total Present Worth Cost - $303,000)

Figures



Legend:

Installation Boundary

0 1 2 3 4 Miles

GRAPHIC SCALE

FGGM-13 FORMER PESTICIDE SHOP, BUILDING 6621
FORT GEORGE G. MEADE, MARYLAND

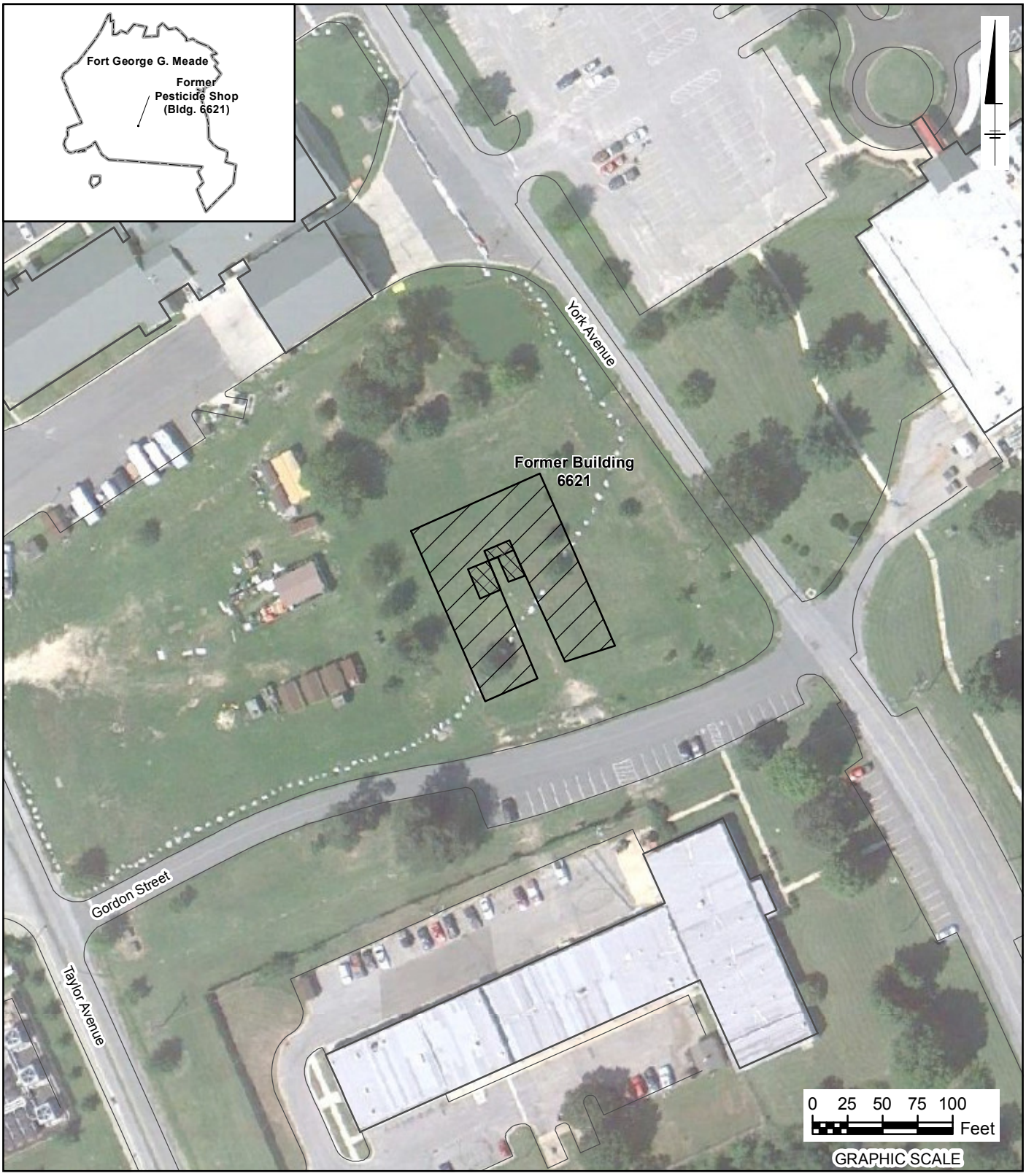
Fort George G. Meade
Location Map

ARCADIS

FIGURE
1-1

Notes:

1. Imagery accessed through Bing Maps via ArcGIS Online Layer Packages by ESRI (12/1/2010) (C) 2010 Microsoft Corporation and its data suppliers accessed on 5/1/2012 through ArcGIS 10



Legend:

- Former Pesticide Shop Areas
- Former Building 6621

Notes:

1. Imagery 8/29/2010 Google Earth Pro, Accessed 5/1/2012

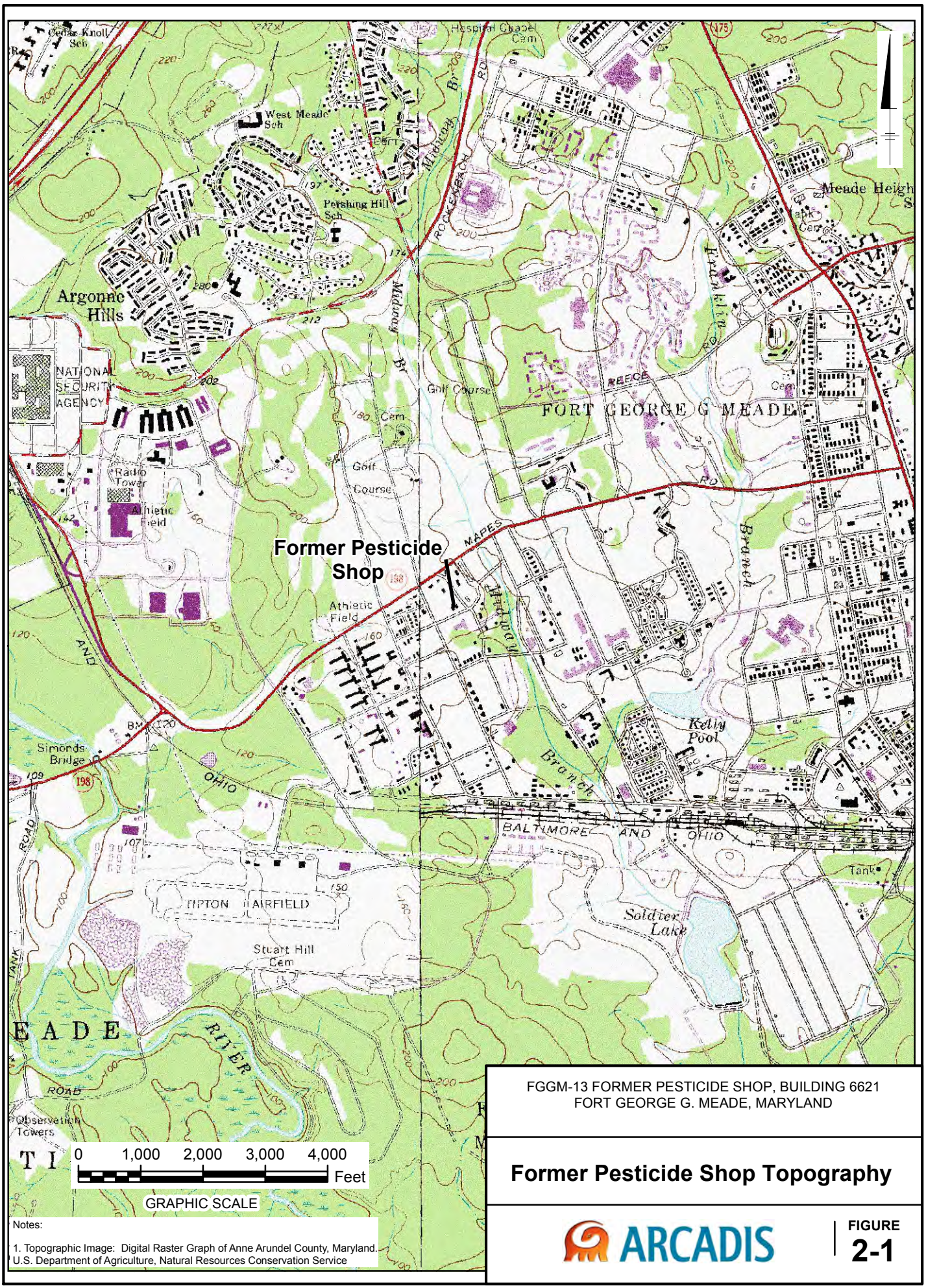
© 2012 Google, 2012 Geoeye, U.S. Geological Survey

FGGM-13 FORMER PESTICIDE SHOP, BUILDING 6621
FORT GEORGE G. MEADE, MARYLAND

Former Building 6621 Location

ARCADIS

FIGURE
1-2



Notes:

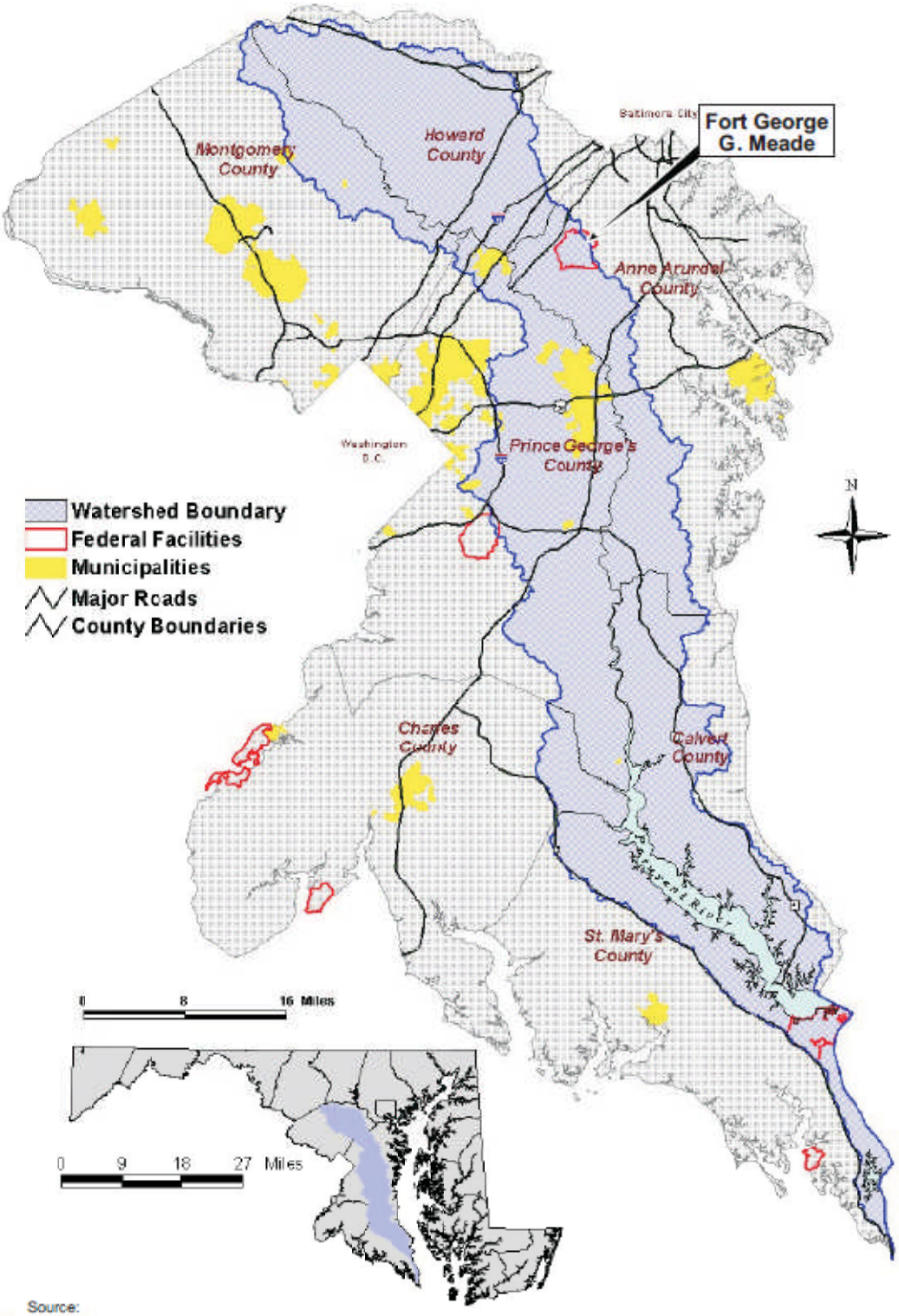
1. Topographic Image: Digital Raster Graph of Anne Arundel County, Maryland. U.S. Department of Agriculture, Natural Resources Conservation Service

FGGM-13 FORMER PESTICIDE SHOP, BUILDING 6621
FORT GEORGE G. MEADE, MARYLAND

Former Pesticide Shop Topography

ARCADIS

FIGURE
2-1



Source:
MDP Maryland Department of Planning
Planning Coordination and Resource Managment
May 2000

Note:
Figure derived from Section 2 of Draft Final Remedial Investigation Report (URS, 2007)

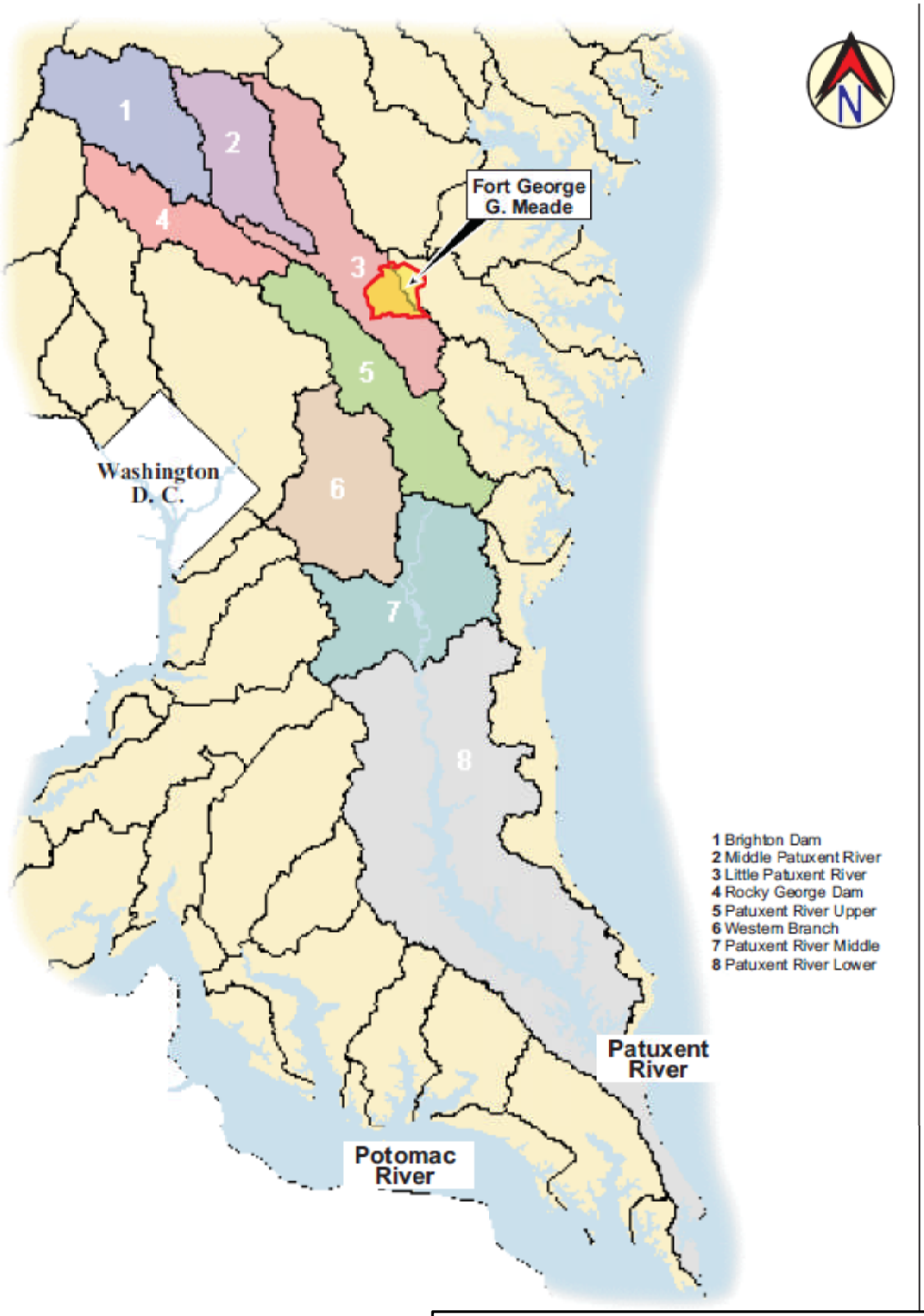
FGGM-13 FORMER PESTICIDE SHOP, BUILDING 6621
FORT GEORGE G. MEADE, MARYLAND

Patuxent River Watershed

ARCADIS

FIGURE
2-2

CITY: MPLS DIV/GROUP: IM DB: MG LD: RK
FORT MEADE
G:\GIS\Projects\Fort_Meade\ArcMap\Pesticide_Shop\Fig_2_2.mxd - 6/21/2010 @ 9:42:43 AM



Note:
Figure derived from Section 2 of Draft Final Remedial Investigation Report (URS, 2007)

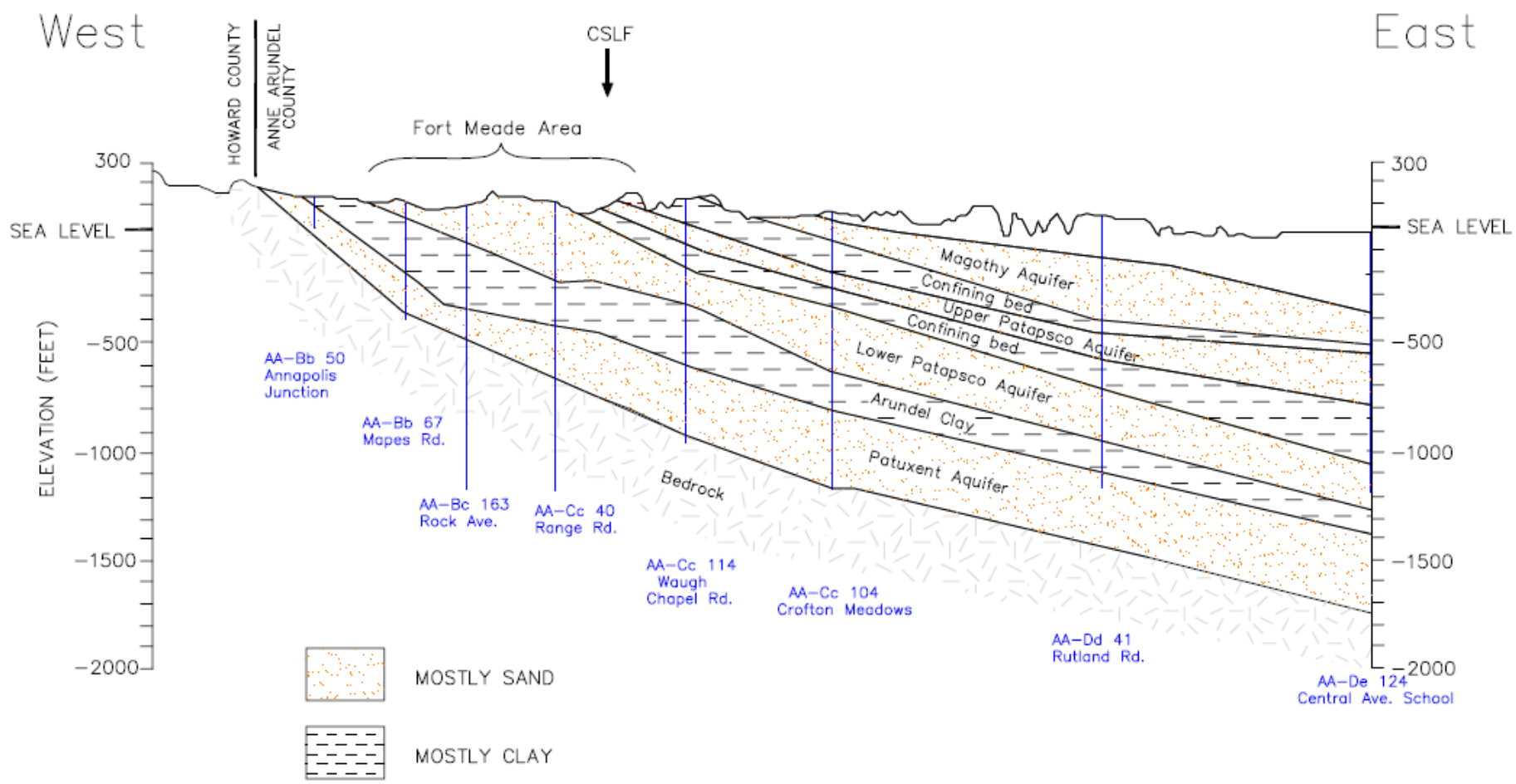
FGGM-13 FORMER PESTICIDE SHOP, BUILDING 6621
FORT GEORGE G. MEADE, MARYLAND

Patuxent River Watershed Sub-Basins

ARCADIS

FIGURE
2-3

CITY: MPLS DIV/GROUP: IM DB: MG LD: RK
FORT MEADE
G:\GIS\Projects\Fort_Meade\ArcMap\Pesticide_Shop\Fig_2_3.mxd - 6/21/2010 @ 9:46:32 AM



Source: Mack and Achmad (1986)

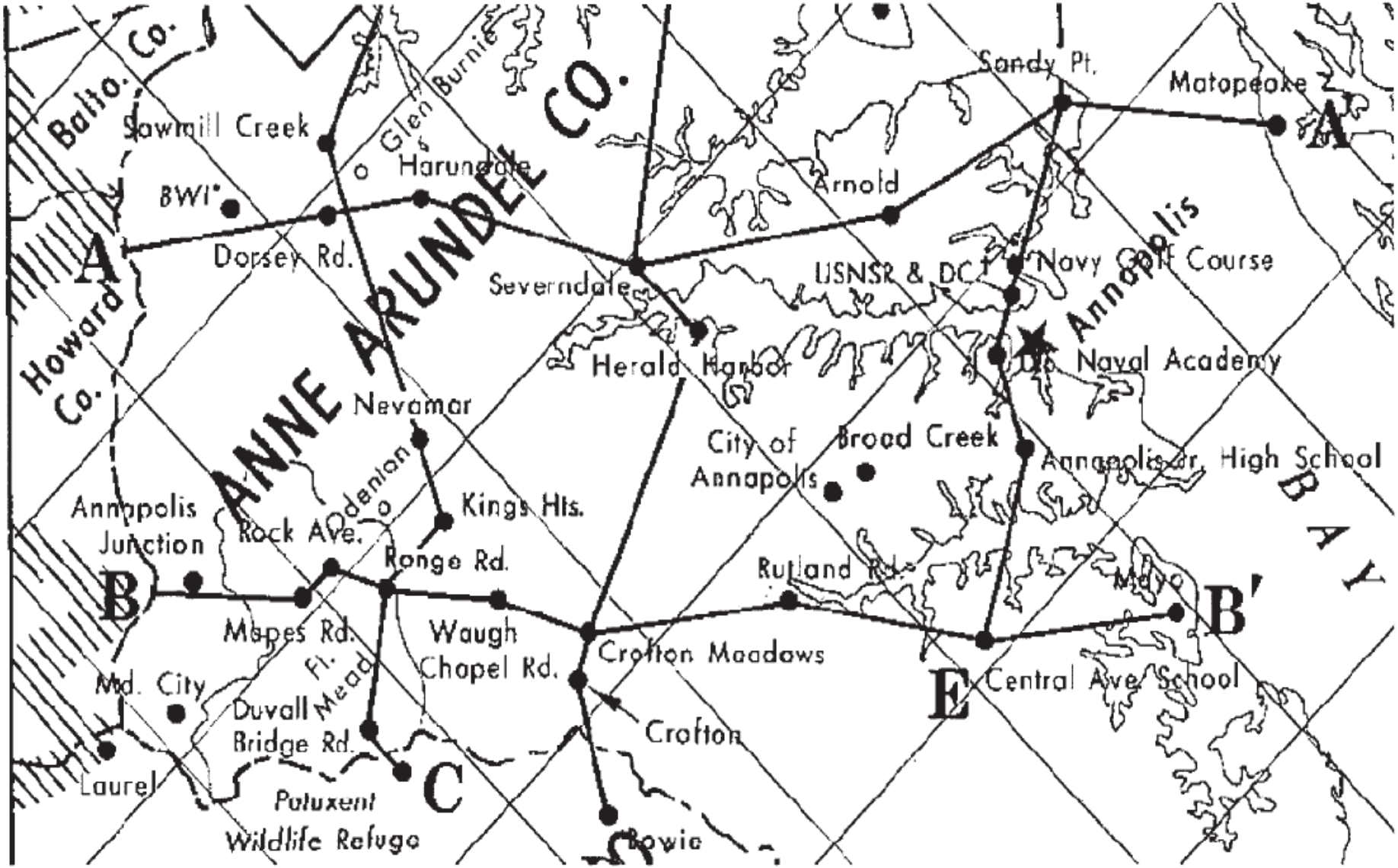
Note:
Figure derived from Section 2 of Draft Final Remedial Investigation Report (URS, 2007)

CLOSED SANITARY LANDFILL
FORT GEORGE G. MEADE, MARYLAND

Hydrogeologic Section B-B'

ARCADIS

FIGURE
2-4



Source: Mack and Admiral (1985)

FGGM-13 FORMER PESTICIDE SHOP, BUILDING 6621
FORT GEORGE G. MEADE, MARYLAND

Location of Geologic Section B - B'

ARCADIS

FIGURE
2-5

Note:
Figure derived from Section 2 of Draft Final Remedial Investigation Report (URS, 2007)

CITY: MPLS DIV/GROUP: IM DB: MG LD: RK
FORT MEADE
G:\GIS\Projects\Fort_Meade\ArcMap\Pesticide_Shop\Fig_2_5.mxd - 6/21/2010 @ 9:47:58 AM

Legend:

- No Exceedance
- Exceeds Maximum Background Concentration
- Former Pesticide Shop Areas
- Former Building 6621

Notes:

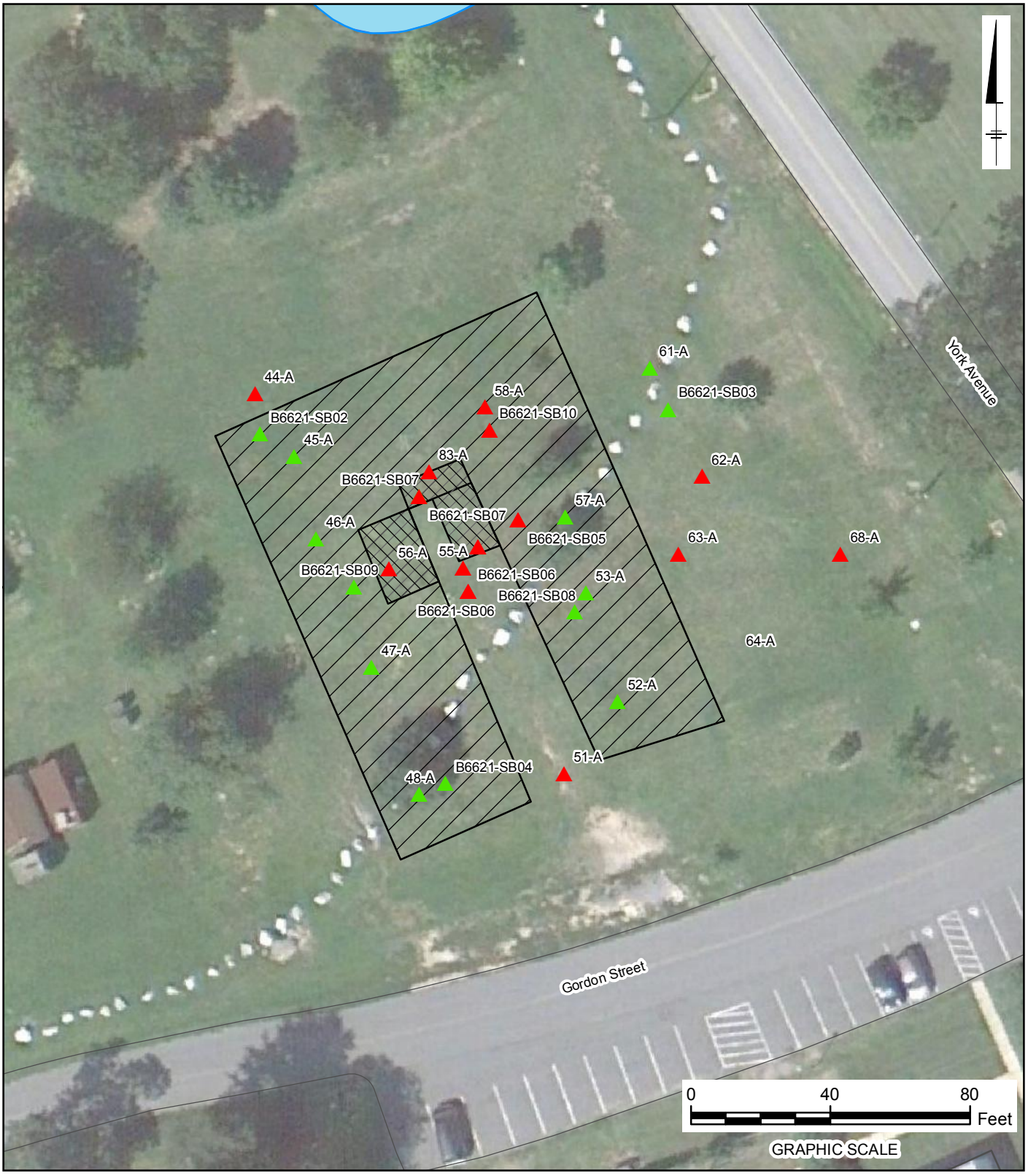
1. Background arsenic surface soil maximum background concentration = 4.84 mg/kg (Malcoolm Pirnie, 2001)
2. Imagery 8/29/2010 Google Earth Pro, Accessed 5/1/2012 © 2012 Google, 2012 Geoeye, U.S. Geological Survey

FGGM-13 FORMER PESTICIDE SHOP, BUILDING 6621
FORT GEORGE G. MEADE, MARYLAND

Surface Soil (0-2') Arsenic Screening Results

ARCADIS

FIGURE
3-1



Legend:

- No Exceedance
- Exceeds Maximum Background Concentration
- Former Pesticide Shop Areas
- Former Building 6621

Notes:

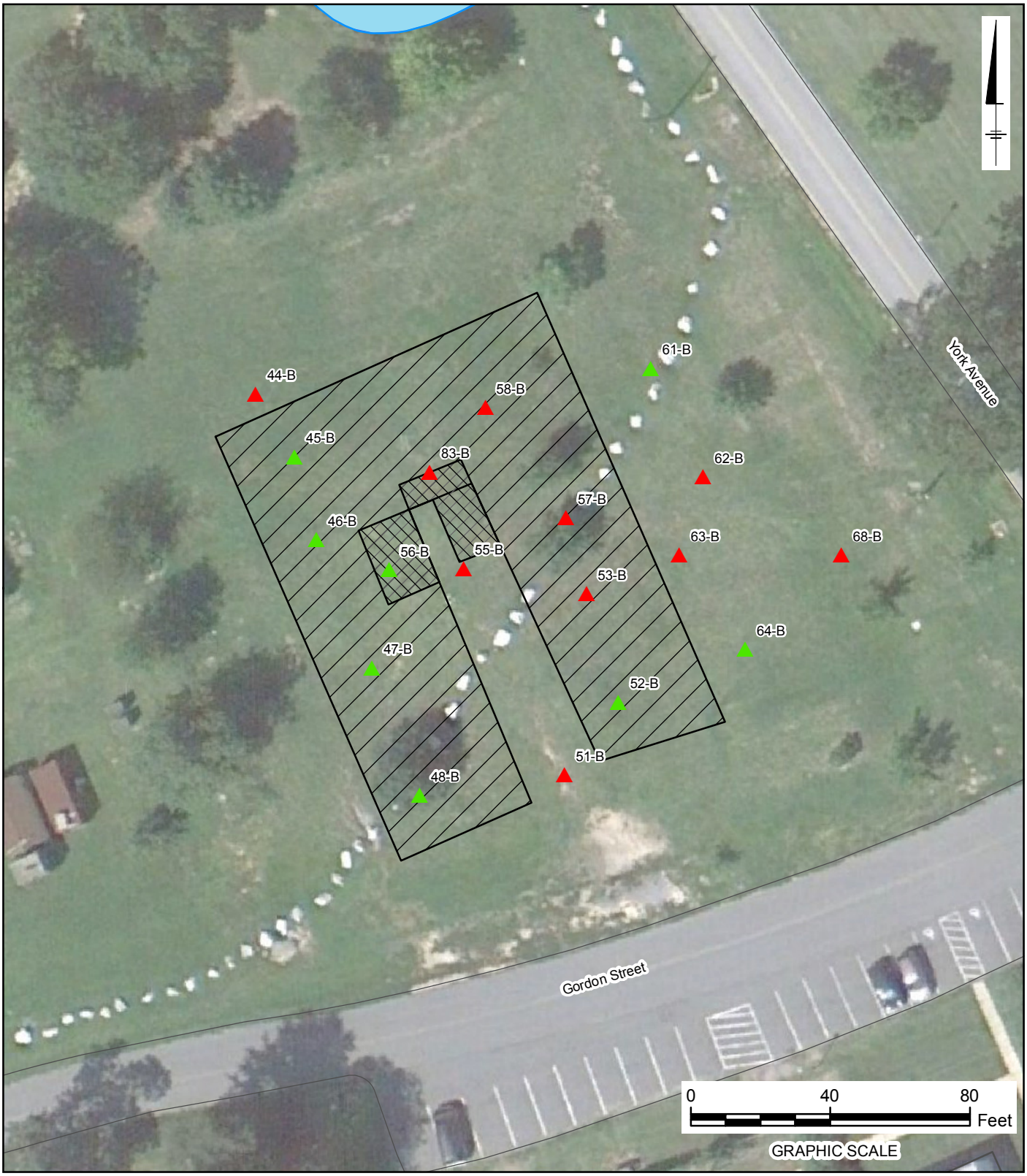
1. Background arsenic subsurface soil maximum background concentration = 1.67 mg/kg (Malcolm Pirnie, 2001)
2. Imagery 8/29/2010 Google Earth Pro, Accessed 5/1/2012 © 2012 Google, 2012 Geoeye, U.S. Geological Survey

FGGM-13 FORMER PESTICIDE SHOP, BUILDING 6621
FORT GEORGE G. MEADE, MARYLAND

Subsurface Soil (2-4') Arsenic Screening Results

ARCADIS

FIGURE
3-2



Legend:

- No Exceedance
- Exceeds Maximum Background Concentration
- Former Pesticide Shop Areas
- Former Building 6621

Notes:

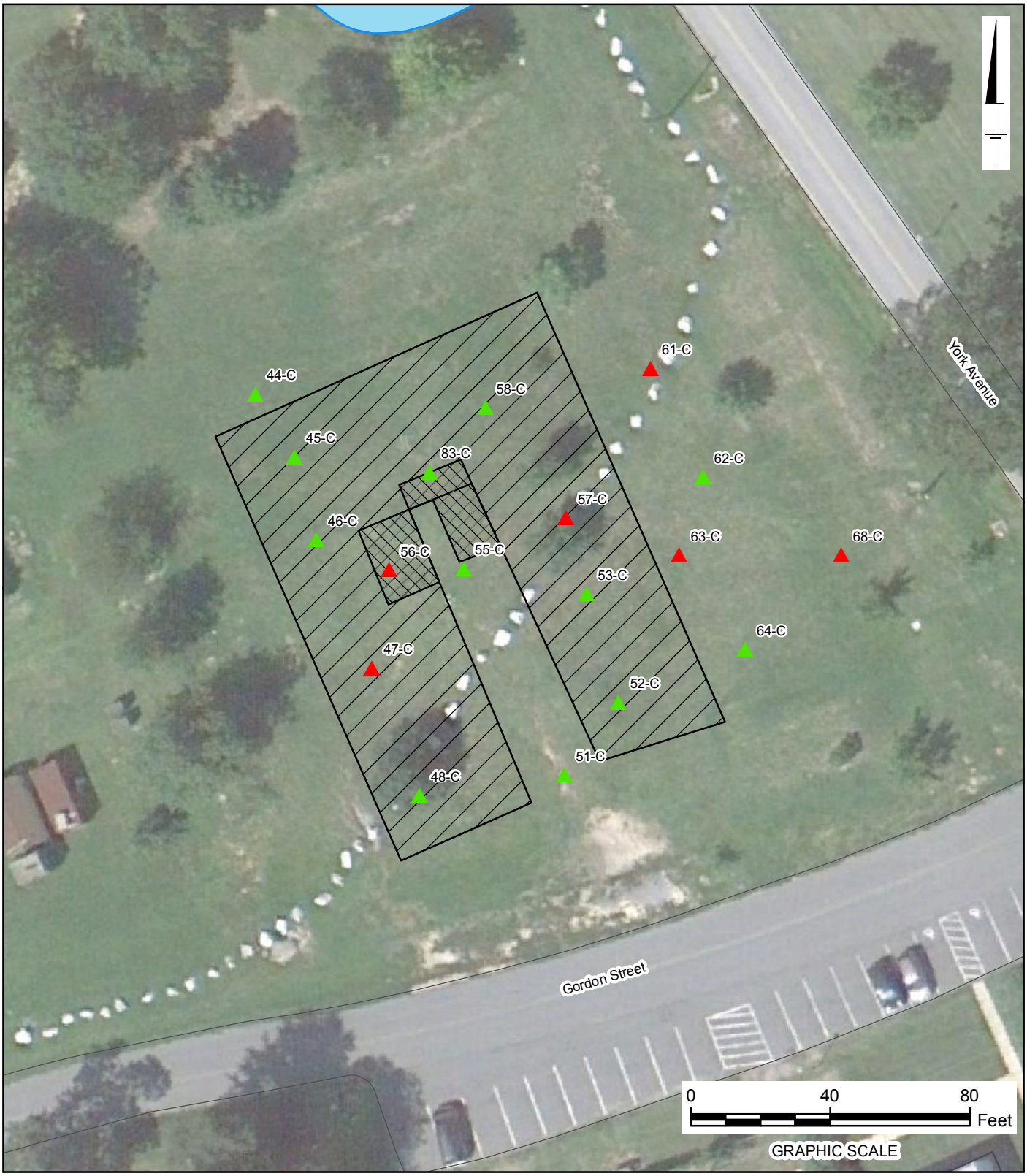
1. Background arsenic subsurface soil maximum background concentration = 1.67 mg/kg (Malcolm Pirnie, 2001)
2. Imagery 8/29/2010 Google Earth Pro, Accessed 5/1/2012 © 2012 Google, 2012 Geoeye, U.S. Geological Survey

FGGM-13 FORMER PESTICIDE SHOP, BUILDING 6621
FORT GEORGE G. MEADE, MARYLAND

Subsurface Soil (4-6') Arsenic Screening Results

ARCADIS

FIGURE
3-3



Legend:

- No Exceedance
- Exceeds Maximum Background Concentration
- Former Pesticide Shop Areas
- Former Building 6621

Notes:

1. Background arsenic subsurface soil maximum background concentration = 1.67 mg/kg (Malcolm Pirnie, 2001)
2. Imagery 8/29/2010 Google Earth Pro, Accessed 5/1/2012 © 2012 Google, 2012 Geoeye, U.S. Geological Survey

FGGM-13 FORMER PESTICIDE SHOP, BUILDING 6621
FORT GEORGE G. MEADE, MARYLAND

Subsurface Soil (6-8') Arsenic Screening Results

ARCADIS

FIGURE
3-4

Legend:

- No Exceedance
- Exceeds Maximum Background Concentration
- Former Pesticide Shop Areas
- Former Building 6621

Notes:

1. Background arsenic subsurface soil maximum background concentration = 1.67 mg/kg (Malcolm Pirnie, 2001)
2. Imagery 8/29/2010 Google Earth Pro, Accessed 5/1/2012 © 2012 Google, 2012 Geoeye, U.S. Geological Survey

FGGM-13 FORMER PESTICIDE SHOP, BUILDING 6621
FORT GEORGE G. MEADE, MARYLAND

Subsurface Soil (8-10') Arsenic Screening Results

ARCADIS

FIGURE
3-5

Legend:

- No Exceedance
- Exceeds Maximum Background Concentration
- Former Pesticide Shop Areas
- Former Building 6621

Notes:

1. Background arsenic subsurface soil maximum background concentration = 1.67 mg/kg (Malcolm Pirnie, 2001)
2. Imagery 8/29/2010 Google Earth Pro, Accessed 5/1/2012 © 2012 Google, 2012 Geoeye, U.S. Geological Survey

FGGM-13 FORMER PESTICIDE SHOP, BUILDING 6621
FORT GEORGE G. MEADE, MARYLAND

Subsurface Soil (14-15') Arsenic Screening Results

ARCADIS

FIGURE
3-6

Legend:

- No Exceedance
- Exceeds Maximum Background Concentration
- Former Pesticide Shop Areas
- Former Building 6621

Notes:

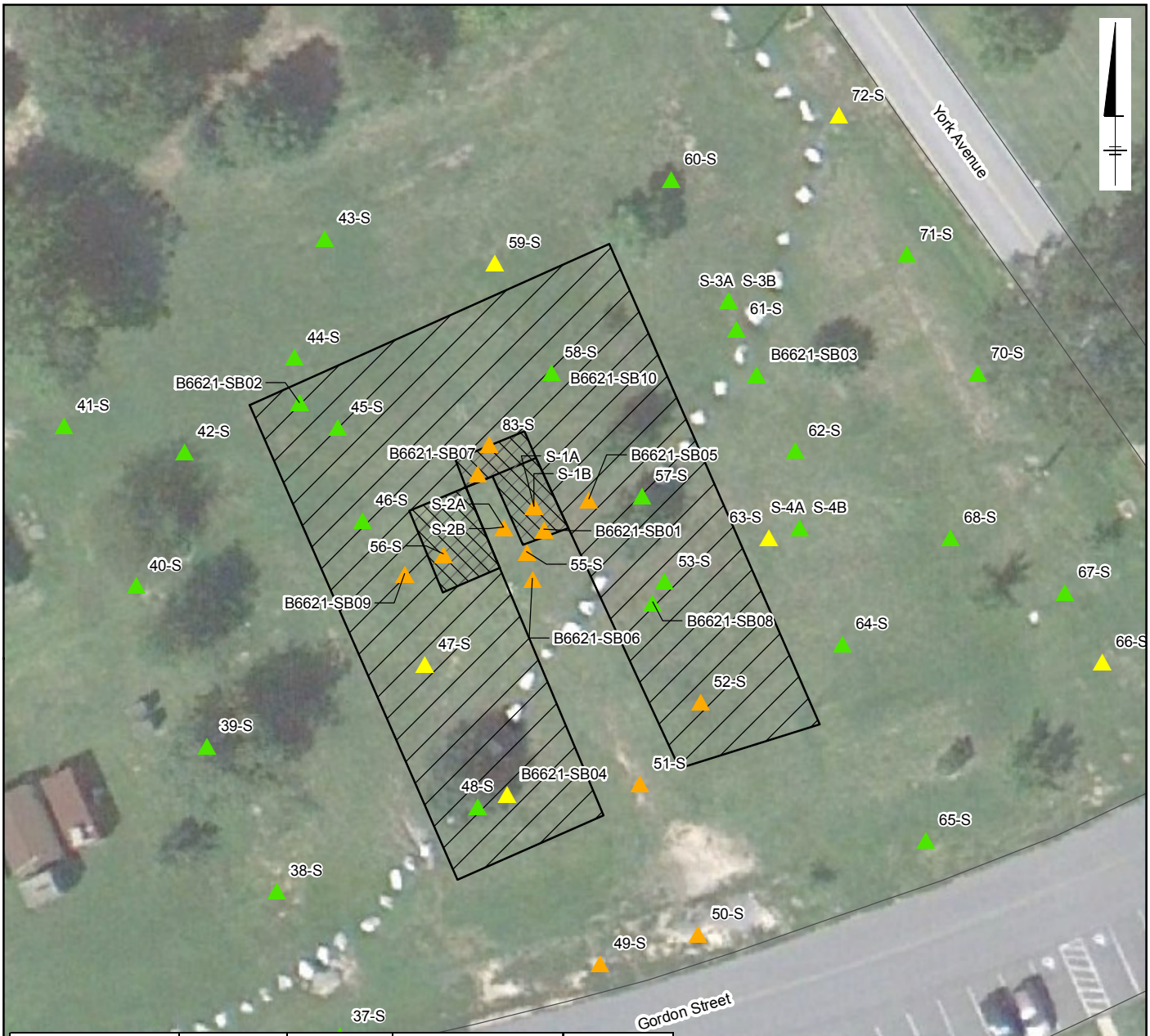
1. Background arsenic subsurface soil maximum background concentration = 1.67 mg/kg (Malcolm Pirnie, 2001)
2. Imagery 8/29/2010 Google Earth Pro, Accessed 5/1/2012 © 2012 Google, 2012 Geoeye, U.S. Geological Survey

FGGM-13 FORMER PESTICIDE SHOP, BUILDING 6621
FORT GEORGE G. MEADE, MARYLAND

Subsurface Soil (19-20') Arsenic Screening Results

ARCADIS

FIGURE
3-7



Analyte	Residential RSL (mg/kg)	Industrial RSL (mg/kg)	Maximum Concentration Detected (mg/kg)	Location of Maximum Concentration
4,4-DDD	2	7.2	260	S-1A
4,4-DDE	1.4	5.1	24	55-S
4,4-DDT	1.7	7	130	S-2B
Alpha-chlordane	1.5	6.5	91.1	B6621-SB06
Chlordane	1.5	6.5	1000	55-S
Dieldrin	0.03	0.11	1.5 J	56-S
Gamma-chlordane	1.5	6.5	80.7	B6621-SB06
Heptachlor	0.11	0.38	18	55-S
Heptachlor Epoxide	0.053	0.19	4.4 J	55-S

Legend:

- No Exceedance
- Exceeds Residential RSL
- Exceeds Residential and Industrial RSL
- Former Pesticide Shop Areas
- Former Building 6621

Notes:

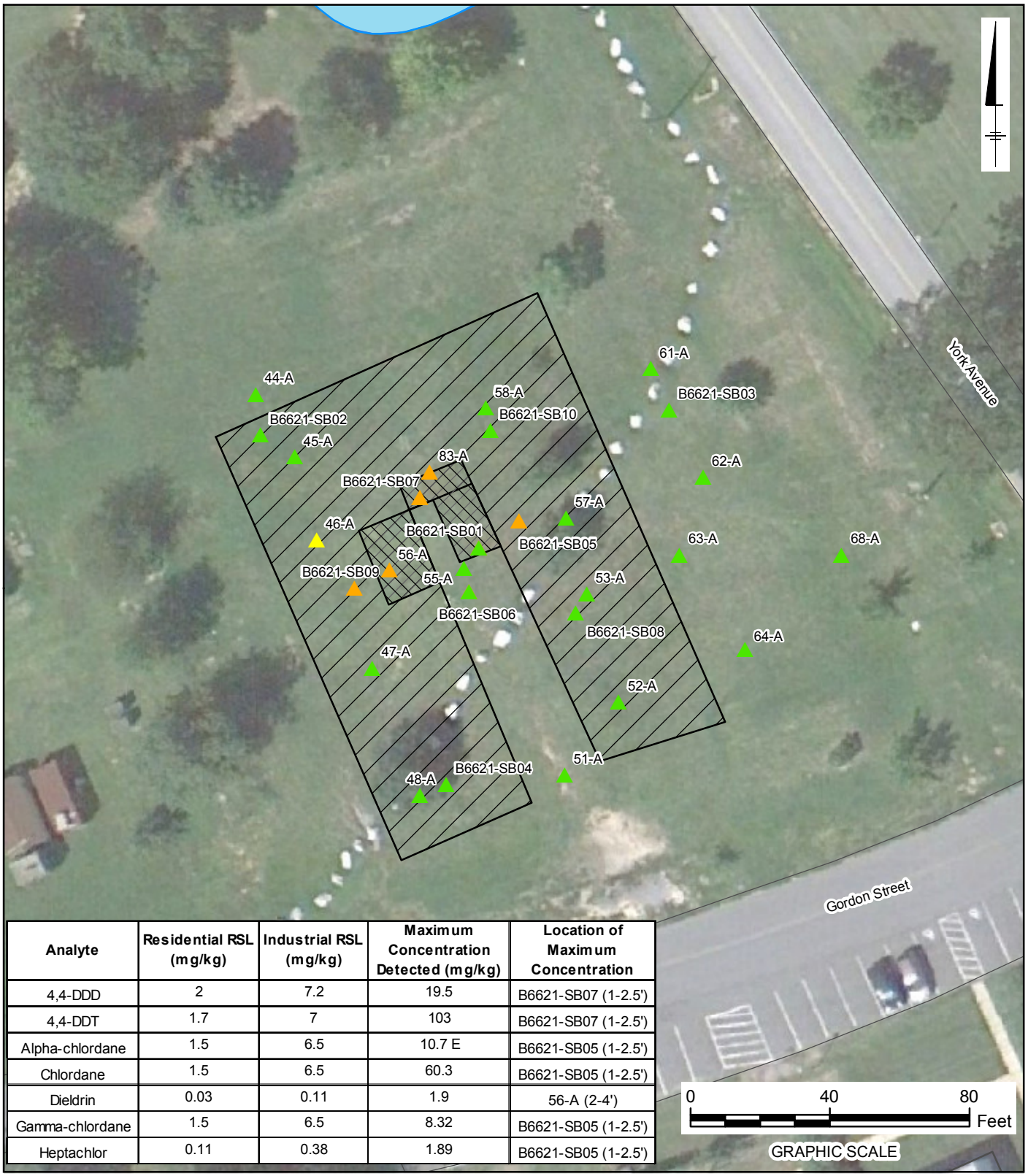
1. RSL = Regional Screening Level
2. mg/kg = Milligrams per kilogram
3. J = Analyte detected at an estimated concentration
4. Imagery 8/29/2010 Google Earth Pro, Accessed 5/1/2012 © 2012 Google, 2012 Geoeye, U.S. Geological Survey

FGGM-13 FORMER PESTICIDE SHOP, BUILDING 6621
FORT GEORGE G. MEADE, MARYLAND

Surface Soil (0-2')
Pesticide Screening Results

ARCADIS

FIGURE
3-8



Analyte	Residential RSL (mg/kg)	Industrial RSL (mg/kg)	Maximum Concentration Detected (mg/kg)	Location of Maximum Concentration
4,4-DDD	2	7.2	19.5	B6621-SB07 (1-2.5')
4,4-DDT	1.7	7	103	B6621-SB07 (1-2.5')
Alpha-chlordane	1.5	6.5	10.7 E	B6621-SB05 (1-2.5')
Chlordane	1.5	6.5	60.3	B6621-SB05 (1-2.5')
Dieldrin	0.03	0.11	1.9	56-A (2-4')
Gamma-chlordane	1.5	6.5	8.32	B6621-SB05 (1-2.5')
Heptachlor	0.11	0.38	1.89	B6621-SB05 (1-2.5')

Legend:

- No Exceedance
- Exceeds Residential RSL
- Exceeds Residential and Industrial RSL
- Former Pesticide Shop Areas
- Former Building 6621

Notes:

1. RSL = Regional Screening Level
2. mg/kg = Milligrams per kilogram
3. Imagery 8/29/2010 Google Earth Pro, Accessed 5/1/2012 © 2012 Google, 2012 Geoeye, U.S. Geological Survey

FGGM-13 FORMER PESTICIDE SHOP, BUILDING 6621
FORT GEORGE G. MEADE, MARYLAND

Subsurface Soil (2-4')
Pesticide Screening Results

ARCADIS

FIGURE
3-9

Analyte	Residential RSL (mg/kg)	Industrial RSL (mg/kg)	Maximum Concentration Detected (mg/kg)	Location of Maximum Concentration
4,4-DDD	2	7.2	6.2	83-B
4,4-DDT	1.7	7	51	83-B
Heptachlor	0.11	0.38	0.18	55-B

Legend:

- No Exceedance
- Exceeds Residential RSL
- Exceeds Residential and Industrial RSL
- Former Pesticide Shop Areas
- Former Building 6621

Notes:

1. RSL = Regional Screening Level
2. mg/kg = Milligrams per kilogram
3. Imagery 8/29/2010 Google Earth Pro, Accessed 5/1/2012 © 2012 Google, 2012 Geoeye, U.S. Geological Survey

FGGM-13 FORMER PESTICIDE SHOP, BUILDING 6621
FORT GEORGE G. MEADE, MARYLAND

Subsurface Soil (4-6')
Pesticide Screening Results

ARCADIS

FIGURE
3-10

Analyte	Residential RSL (mg/kg)	Industrial RSL (mg/kg)	Maximum Concentration Detected (mg/kg)	Location of Maximum Concentration
4,4-DDD	2	7.2	19	83-C
4,4-DDT	1.7	7	230	83-C
Chlordane	1.6	6.5	53	83-C

Legend:

- No Exceedance
- Exceeds Residential RSL
- Exceeds Residential and Industrial RSL
- Former Pesticide Shop Areas
- Former Building 6621

Notes:

1. RSL = Regional Screening Level
2. mg/kg = Milligrams per kilogram
3. Imagery 8/29/2010 Google Earth Pro, Accessed 5/1/2012 © 2012 Google, 2012 Geoeye, U.S. Geological Survey

FGGM-13 FORMER PESTICIDE SHOP, BUILDING 6621
FORT GEORGE G. MEADE, MARYLAND

Subsurface Soil (6-8')
Pesticide Screening Results

ARCADIS

FIGURE
3-11

Legend:

- No Exceedance
- Exceeds Residential RSL
- Exceeds Residential and Industrial RSL
- Former Pesticide Shop Areas
- Former Building 6621

Notes:

1. RSL = Regional Screening Level
2. mg/kg = Milligrams per kilogram
3. Imagery 8/29/2010 Google Earth Pro, Accessed 5/1/2012 © 2012 Google, 2012 Geoeye, U.S. Geological Survey

FGGM-13 FORMER PESTICIDE SHOP, BUILDING 6621
FORT GEORGE G. MEADE, MARYLAND

Subsurface Soil (8-10')
Pesticide Screening Results

ARCADIS

FIGURE
3-12

Legend:

- No Exceedance
- Exceeds Residential RSL
- Exceeds Residential and Industrial RSL
- Former Pesticide Shop Areas
- Former Building 6621

Notes:

1. RSL = Regional Screening Level
2. Imagery 8/29/2010 Google Earth Pro, Accessed 5/1/2012 © 2012 Google, 2012 Geoeye, U.S. Geological Survey

FGGM-13 FORMER PESTICIDE SHOP, BUILDING 6621
FORT GEORGE G. MEADE, MARYLAND

Subsurface Soil (14-15')
Pesticide Screening Results

ARCADIS

FIGURE
3-13

Legend:

- No Exceedance
- Exceeds Residential RSL
- Exceeds Residential and Industrial RSL
- Former Pesticide Shop Areas
- Former Building 6621

Notes:

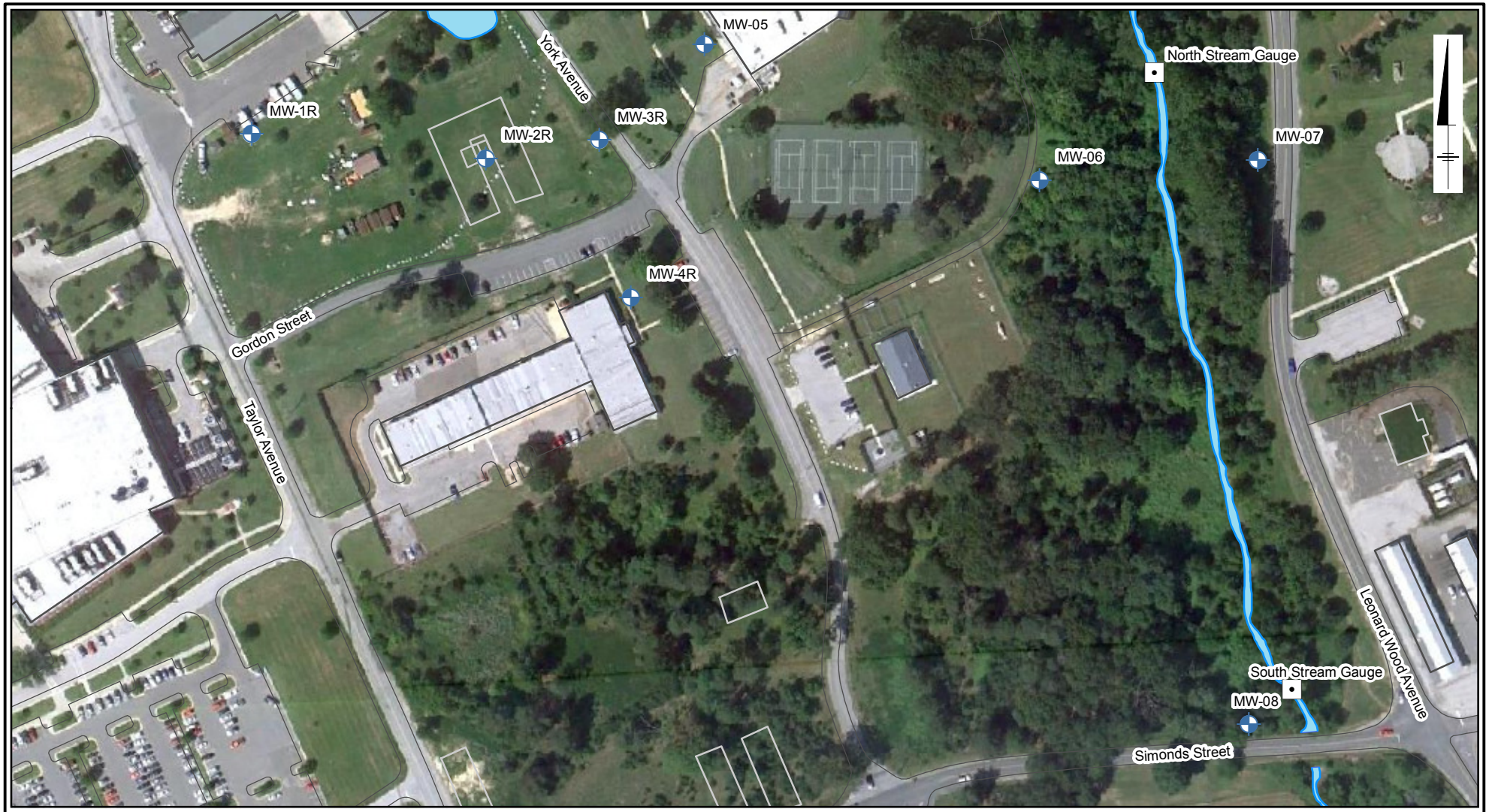
1. RSL = Regional Screening Level
2. Imagery 8/29/2010 Google Earth Pro, Accessed 5/1/2012 © 2012 Google, 2012 Geoeye, U.S. Geological Survey

FGGM-13 FORMER PESTICIDE SHOP, BUILDING 6621
FORT GEORGE G. MEADE, MARYLAND

Subsurface Soil (19-20')
Pesticide Screening Results

ARCADIS

FIGURE
3-14



LEGEND:

- Well
- Stream Gauge
- Road
- Railroad
- Demolished Structures
- Existing Structures
- Surface Water
- Installation Boundary

0 100 200 Feet

GRAPHIC SCALE

Notes:

1. Imagery 8/29/2010 Google Earth Pro, Accessed 5/1/2012 © 2012 Google, 2012 Geoeye, U.S. Geological Survey

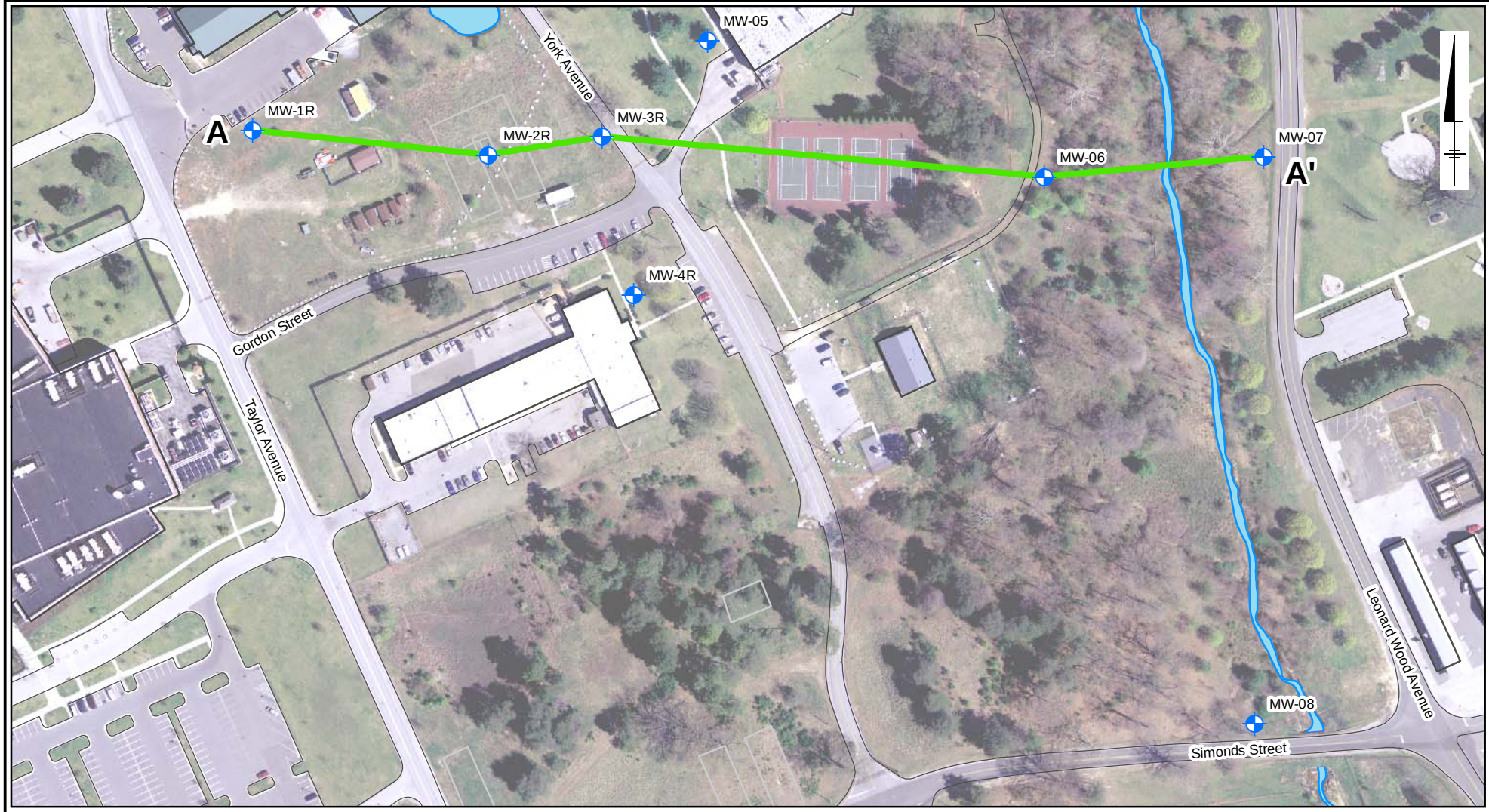
FGGM-13 FORMER PESTICIDE SHOP, BUILDING 6621
FORT GEORGE G. MEADE, MARYLAND

Monitoring Well Locations

ARCADIS

FIGURE
3-15

CITY: MPLS DIV/GROUP: IM DB: MG LD: RK
FT MEADE (GP09MEAD.C000)
G:\GIS\Projects\Fort_Meade\ArcMap\Pesticide_Shop\2011\Cross_Section_20111221.mxd: 12/21/2011: 9:30:11 PM



Legend:

- Well
- Geologic Cross-Section Location
- Road
- Demolished Structures
- Existing Structures
- Surface Water

0 100 200 Feet

GRAPHIC SCALE

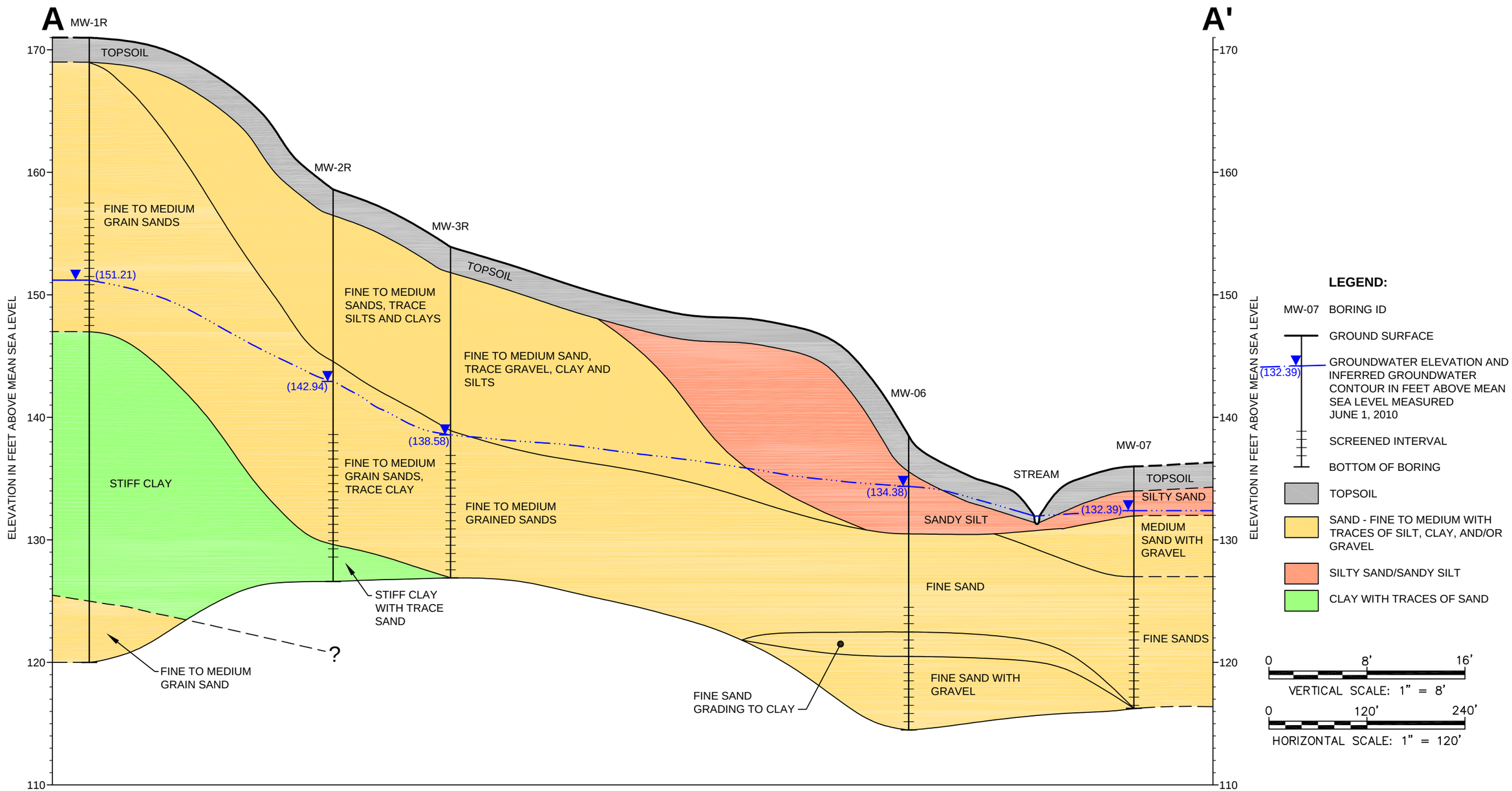
NOTES:
Aerial Image: SEAMLESS.USGS.GOV, 2007, 0.5 FEET

FGGM-13 FORMER PESTICIDE SHOP, BUILDING 6621
FORT GEORGE G. MEADE, MARYLAND

Former Pesticide Shop
Geologic Cross-Section Location

ARCADIS

FIGURE
3-16



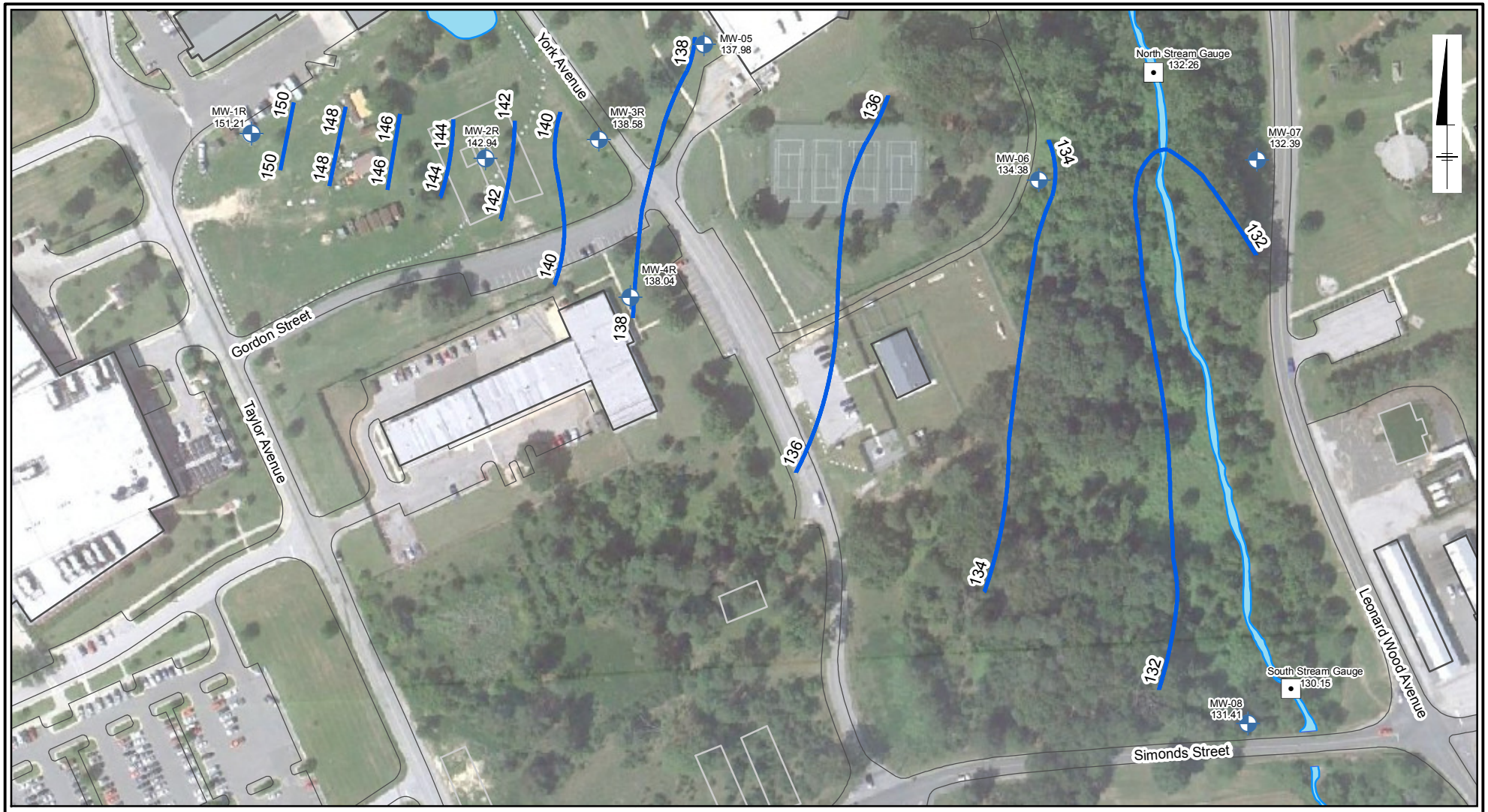
FGGM-13 FORMER PESTICIDE SHOP, BUILDING 6621
FORT GEORGE G. MEADE, MARYLAND

Former Pesticide Shop
Geologic Cross-section

ARCADIS

FIGURE
3-17

CITY: SYRACUSE, NY GROUP: ENVCAD DB: P. LISTER PM: T. LLEWELLYN TM: B. STEMPOWSKI TR: R. KAHL LYR: ON=*;OFF=REF
G:\ENVCAD\SYRACUSE\ACT\GP09MEAD\PEST\DA001\DWG\DA001V01.dwg LAYOUT: 4-2 SAVED: 6/23/2010 12:48 PM ACADVER: 17.0S (LMS TECH) PAGESETUP: ######################## PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 6/23/2010 12:48 PM BY: LISTER, PAUL
XREFS: IMAGES: PROJECTNAME: ----
Proposed_Wells_contours_20100324.tif



Legend:

- Well
- Stream Gauge
- Groundwater Elevation Contour
- Road
- Demolished Structures
- Existing Structures
- Surface Water

0 100 200 Feet

GRAPHIC SCALE

Notes:

1. Imagery 8/29/2010 Google Earth Pro, Accessed 5/1/2012 © 2012 Google, 2012 Geoeye, U.S. Geological Survey

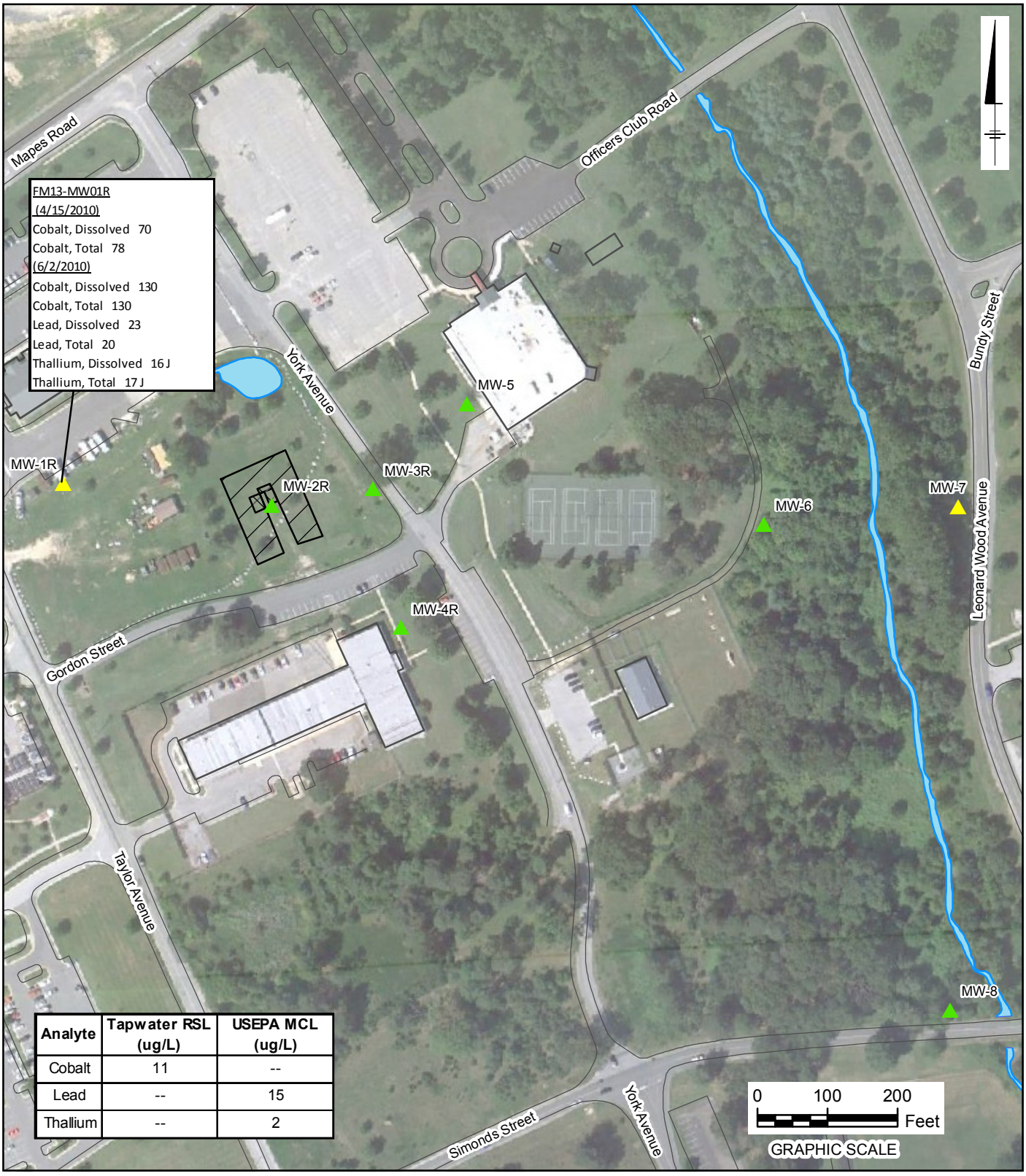
2 Groundwater elevation data were collected on 1 June 2010 and are presented in feet above mean sea level.

FGGM-13 FORMER PESTICIDE SHOP, BUILDING 6621
FORT GEORGE G. MEADE, MARYLAND

Groundwater Table Contour Map

ARCADIS

FIGURE
3-18



Analyte	Tapwater RSL (ug/L)	USEPA MCL (ug/L)
Cobalt	11	--
Lead	--	15
Thallium	--	2

Legend:

- No Exceedance
- Exceeds Tapwater RSL
- Exceeds USEPA MCL
- Exceeds Tapwater RSL and USEPA MCL
- Former Pesticide Shop Areas
- Former Building 6621

Notes:

1. Sample concentrations are presented in units of µg/L.
2. MCL = United States Environmental Protection Agency Maximum Contaminant Level
3. RSL = Regional Screening Level
4. µg/L = Micrograms per liter
5. Imagery 8/29/2010 Google Earth Pro, Accessed 5/1/2012 © 2012 Google, 2012 Geoeye, U.S. Geological Survey

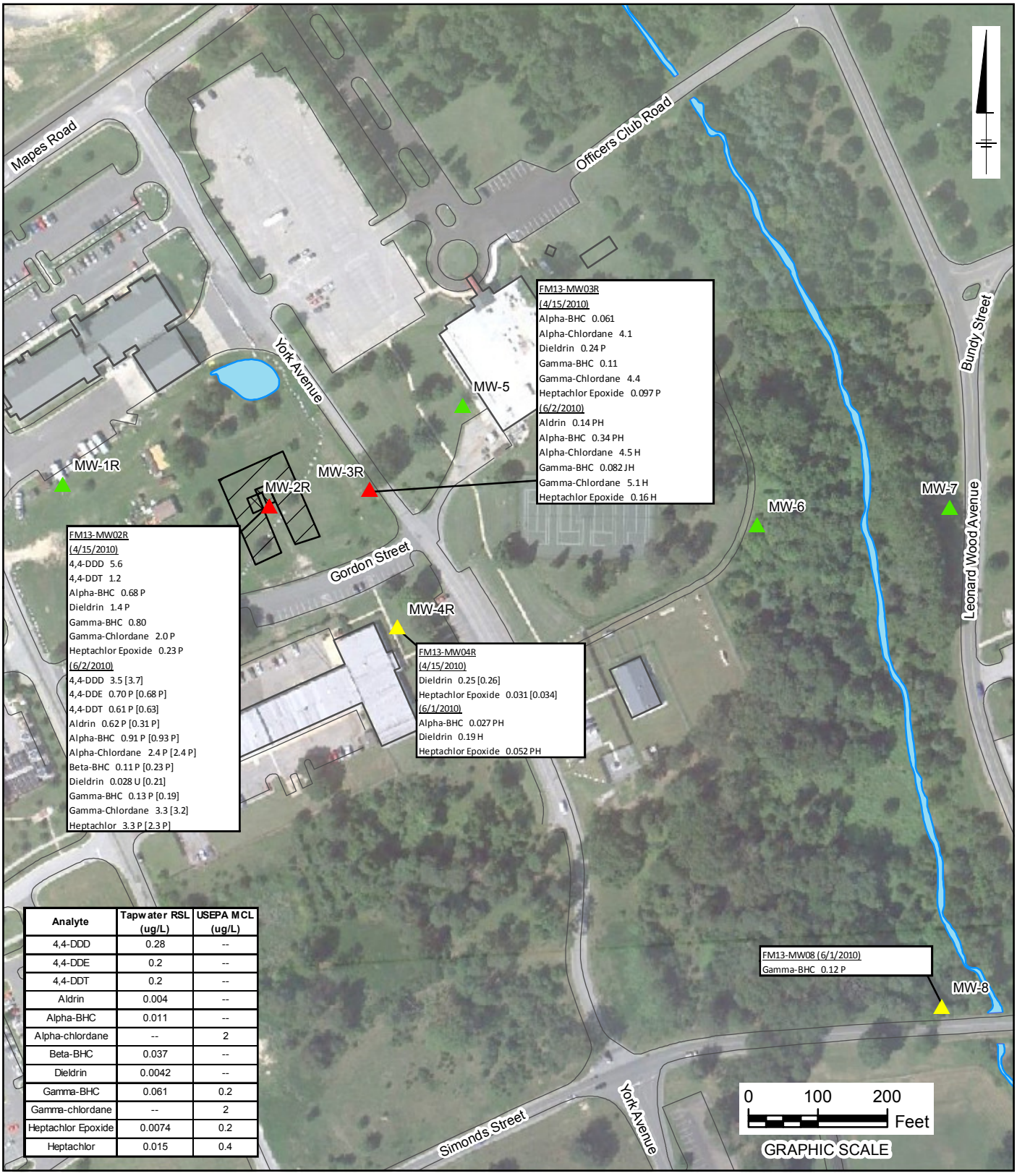
FGGM-13 FORMER PESTICIDE SHOP, BUILDING 6621
FORT GEORGE G. MEADE, MARYLAND

Groundwater Metals Screening Results

ARCADIS

FIGURE
3-19

CITY: CLE DIV/GROUP: IM DB:L.GREENE MG LD: RK
FT MEADE (GP09MEAD.C000)
G:\GIS\Projects\Fort_Meade\ArcMap\Pesticide_Shop\2012\GW_Metals_20120515.mxd - 5/15/2012 @ 10:26:37 AM



Analyte	Tapwater RSL (ug/L)	USEPA MCL (ug/L)
4,4-DDD	0.28	--
4,4-DDE	0.2	--
4,4-DDT	0.2	--
Aldrin	0.004	--
Alpha-BHC	0.011	--
Alpha-chlordane	--	2
Beta-BHC	0.037	--
Dieldrin	0.0042	--
Gamma-BHC	0.061	0.2
Gamma-chlordane	--	2
Heptachlor Epoxide	0.0074	0.2
Heptachlor	0.015	0.4

Legend:

- No Exceedances
- Exceeds Tapwater RSL
- Exceeds USEPA MCL
- Exceeds Tapwater RSL and USEPA MCL
- Former Pesticide Shop Areas
- Former Building 6621

Notes:

1. Sample concentrations are presented in units of µg/L.
2. MCL = United States Environmental Protection Agency Maximum Contaminant Level
3. RSL = Regional Screening Level
4. µg/L = Micrograms per liter
5. Imagery 8/29/2010 Google Earth Pro, Accessed 5/1/2012 © 2012 Google, 2012 Geoeye, U.S. Geological Survey

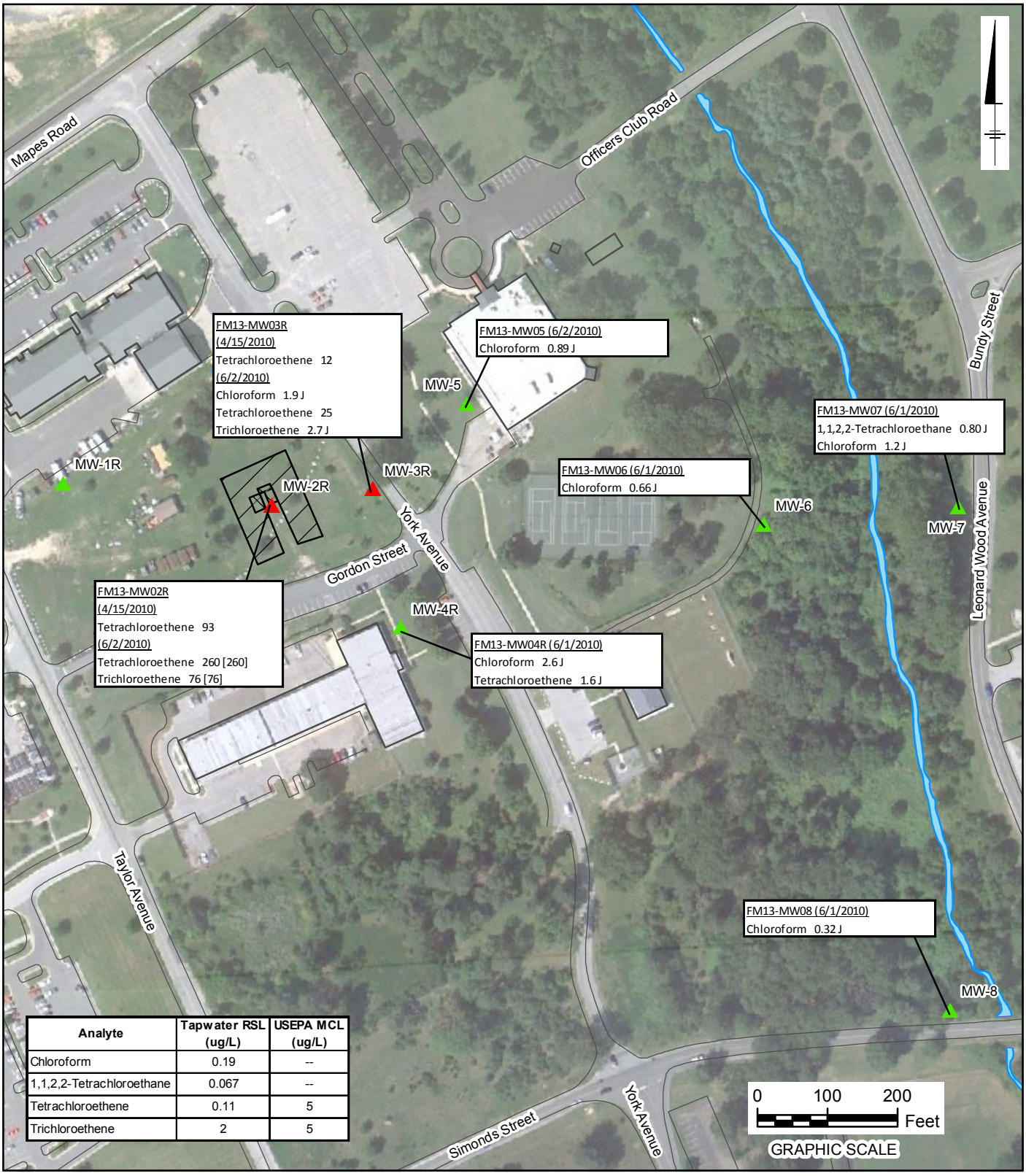
FGGM-13 FORMER PESTICIDE SHOP, BUILDING 6621
FORT GEORGE G. MEADE, MARYLAND

Groundwater Pesticide Screening Results

ARCADIS

FIGURE
3-20

CITY: CLE DIV/GROUP: IM DB: L. GREENE MG LD: RK
FT MEADE (GP09MEAD.C000)
Path: G:\GIS\Projects\Fort_Meade\ArcMap\Pesticide_Shop\2012\GW_Pest_20120515.mxd Date Saved: 5/15/2012 10:36:31 AM



Analyte	Tapwater RSL (ug/L)	USEPA MCL (ug/L)
Chloroform	0.19	--
1,1,2,2-Tetrachloroethane	0.067	--
Tetrachloroethene	0.11	5
Trichloroethene	2	5

Legend:

- No Exceedance
- Exceeds Tapwater RSL
- Exceeds USEPA MCL
- Exceeds Tapwater RSL and USEPA MCL
- Former Pesticide Shop Areas
- Former Building 6621

Notes:

1. Sample concentrations are presented in units of µg/L.
2. MCL = United States Environmental Protection Agency Maximum Contaminant Level
3. RSL = Regional Screening Level
4. µg/L = Micrograms per liter
5. Imagery 8/29/2010 Google Earth Pro, Accessed 5/1/2012 © 2012 Google, 2012 Geoeye, U.S. Geological Survey

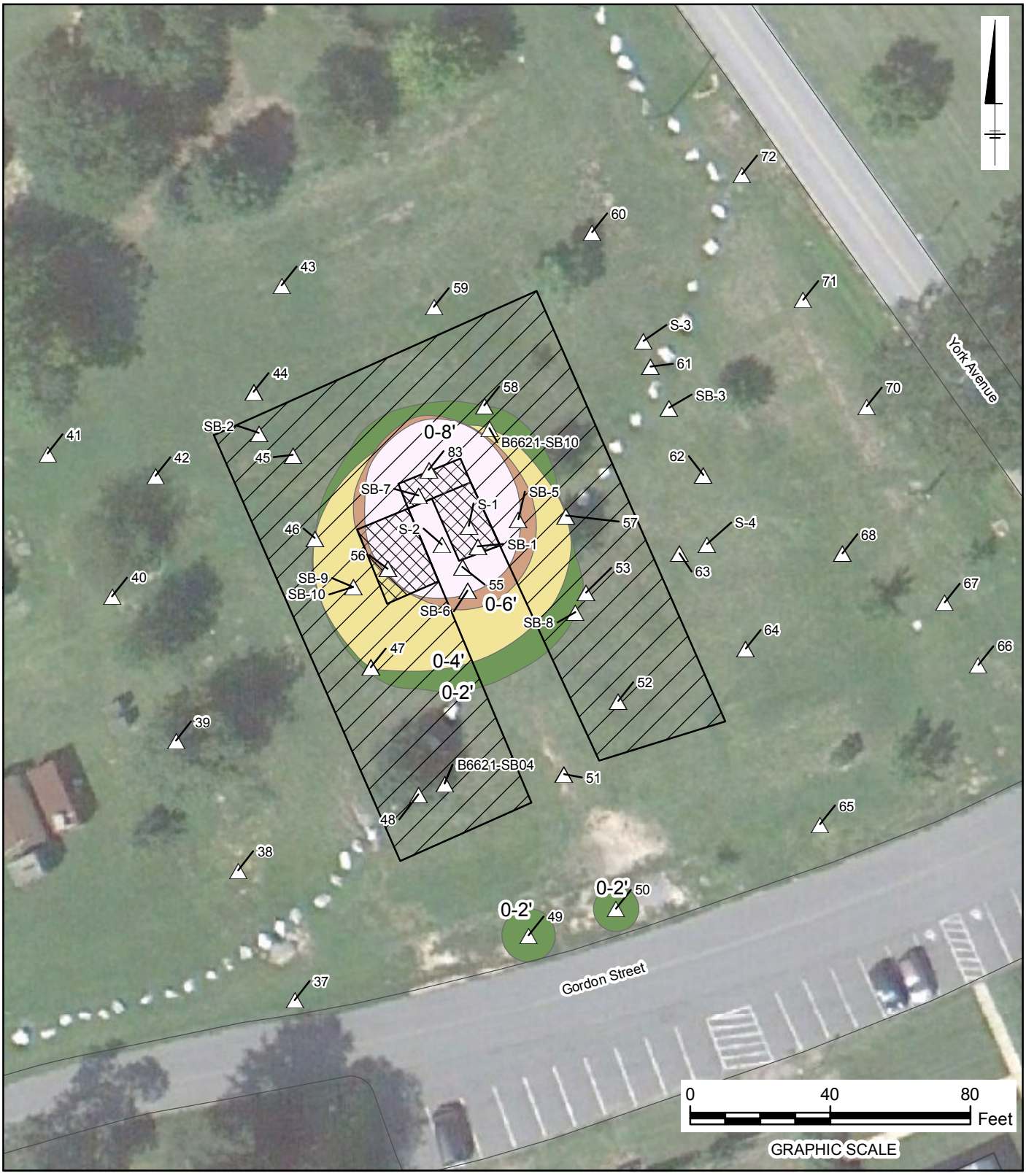
FGGM-13 FORMER PESTICIDE SHOP, BUILDING 6621
FORT GEORGE G. MEADE, MARYLAND

Groundwater VOCs Screening Results

ARCADIS

FIGURE
3-21

CITY: MPLS DIV/GROUP: IM DB: MG LD: RK
FT MEADE (GP09MEAD.C000)
Path: G:\GIS\Projects\Fort_Meade\ArcMap\Pesticide_Shop\2012\GW_VOCs_20120515.mxd Date Saved: 5/15/2012 10:40:25 AM



Legend:

Former Pesticide Shop Areas

Former Building 6621

Soil Boring Location

Estimated Extent of Excavation in ft bgs

0-2'

0-6'

0-4'

0-8'

Notes:

1. Imagery 8/29/2010 Google Earth Pro, Accessed 5/1/2012
© 2012 Google, 2012 Geoeye, U.S. Geological Survey

FGGM-13 FORMER PESTICIDE SHOP, BUILDING 6621
FORT GEORGE G. MEADE, MARYLAND

Estimated Excavation Limits

ARCADIS

FIGURE
6-1

Appendix A

Preliminary Remediation Goal Calculations

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MEMO

To:
Rusty Kahl, ARCADIS
Brian Stempowski, ARCADIS

Copies:

From:
Barbara Pugh

Date:
July 2012

ARCADIS Project No.:
GP09MEAD.PEST

Subject:
Derivation of Primary Cleanup Goals
FGGM-13, Former Pesticide Shop
Fort George G. Meade, Maryland

This document presents the derivation of the preliminary cleanup goals (PRGs) that are protective of human exposures to constituents of concern (COCs) in soil at the Former Pesticide Shop site located at Fort George G. Meade (FGGM) in Anne Arundel County, Maryland. The COCs were identified in a baseline human health risk assessment (HHRA) for the Former Pesticide Shop as part of a Remedial Investigation (ARCADIS, 2011). The derivation of the PRGs was conducted in accordance with USEPA guidance (USEPA, 2010, 1991a, and 1991b).

Soil PRGs Protective of Human Exposures

As presented in the HHRA (ARCADIS, 2011), there is no current use of this Site, although the Site is located on a military base. Portions of the ground surface at the Site are currently paved with asphalt or gravel-covered while the remainder is vegetated with grass or weeds. Although there are buildings located in the general vicinity that are used for commercial and military purposes, there is no building or other permanent structure present at the Site. A building was present at the Site but was demolished in 1996 and the ground was graded into its current state. Historically, the building was reportedly used as a prisoner mess hall during the 1940s, an area for mixing and storing pesticides (1958 to 1978), and more recently, as a maintenance facility for landscape equipment.

For the sole purpose of conducting the HHRA, conservative assumptions were made about current and future potential exposures to the following hypothetical future receptors:

- Military workers who are similar to commercial office workers (Commercial/Military Office Worker). Although the potential exposures considered in the HHRA included inhalation of volatile compounds in indoor air as the result of vapor intrusion from subsurface, this exposure pathway was not a significant source of potential exposure for this receptor.

- Military workers who work outdoors maintaining the hypothetical landscape (outdoor Military Maintenance Worker).

- Construction Worker involved with excavations as part of future redevelopment activities.

- Resident (adult and child). For the purpose of the baseline HHRA, a future residential use scenario was evaluated.

The conclusions of the HHRA are:

- There is no unacceptable risk under current use scenarios.

- Potential exposures to constituents of potential concern (COPCs) in soil and groundwater by future hypothetical residents result in cancer risk and noncancer hazard estimates above the upper end of the target cancer risk range (1×10^{-4}) and the target endpoint-specific hazard limit of 1, respectively. Based on the exceedances of the cancer and noncancer risk management limits for the future hypothetical residential-use scenario, the following COCs were defined in soil: aldrin, gamma-chlordane, chlordane, 4,4'-DDD, 4,4'-DDT, heptachlor epoxide, arsenic, and dieldrin. In groundwater, the COCs under the hypothetical residential-use scenario are aldrin, 4,4'-DDD, 4,4'-DDT, 4,4'-DDE, alpha-BHC, alpha-chlordane, gamma-chlordane, dieldrin, heptachlor, heptachlor epoxide, PCE, and arsenic.

- There is no unacceptable risk or hazard associated with potential exposures to soil by future military workers (indoor office and outdoor maintenance workers). Exposures to groundwater were not complete for this receptor group.

- Potential exposures to COPCs in soil and groundwater by future construction workers are within the target cancer risk range. However, potential exposures to COPCs in soil by this receptor group exceed the target hazard index limit of 1 based on cumulative non-cancer hazard estimates for the liver endpoint. Potential exposure to COPCs in soil was the primary exposure pathway, with chlordane and heptachlor epoxide defined as soil COCs for this receptor group.

For the purpose of the Focused Feasibility Study (FFS) and derivation of PRGs, it is assumed that institutional controls (e.g., deed or use restriction) will be implemented to restrict future use of the site to industrial use only. Therefore, the Site will not be used for residential use or any use that would allow the

continued presence of children (e.g., daycare, school). It is also assumed that institutional controls will prevent the use of groundwater as a source of potable water at the site. Because institutional controls are assumed to be implemented in the future, PRGs are not derived for COCs identified based on the future hypothetical residential use scenarios.

Based on the conclusions of the HHRA, PRGs protective of future construction worker exposures to soil were derived for chlordane and heptachlor epoxide. Although the conclusions of the HHRA were that these COCs did not pose an unacceptable risk to military workers (indoor office and outdoor maintenance workers), soil PRGs were also derived for these future use scenarios to determine soil PRGs that are also protective of potential exposures to future military workers. The derived soil PRGs are presented in Table 1.

The remaining portion of this appendix documents the PRGs developed for the COCs in soil in the Site where potential exposure is assumed to be limited by means of institutional controls (e.g., deed or use restriction) to commercial and military office workers, or workers involved with minimal landscape activity (e.g., lawn mowing). The PRGs are chemical specific concentrations in soil derived in a similar manner described in the HHRA (ARCADIS, 2011). That is, PRGs are risk-based concentrations derived using exposure parameters and factors that represent Reasonable Maximum Exposure conditions for potential exposures at this Site.

Toxicity Values

Similar to the Toxicity Assessment step of the HHRA, risk-based concentrations quantify the relationship between the magnitude of potential exposure via a particular exposure pathway and the likelihood of an adverse health effect. Adverse health (i.e. toxic) effects are characterized by USEPA as carcinogenic or non-carcinogenic. Toxic effects are defined by USEPA for oral and inhalation routes of exposure. Toxicity values (i.e. the dose at which a constituent is considered toxic or the rate at which it potentially causes cancer) are developed by USEPA and state regulatory agencies after a comprehensive scientific review of all available toxicological literature information for a constituent. The toxicity values used to develop PRGs were obtained from the following sources, in order of priority:

- USEPA's Integrated Risk Information System (IRIS) (USEPA, 2011)
- USEPA Regional Screening Levels Table (USEPA, 2010)

Carcinogens are conservatively assumed to have some probability of causing an adverse health response (cancer) at any dose. That is, the threshold dose for any carcinogen is assumed to be zero. The cancer-causing potency of known or potential carcinogens is estimated based on laboratory animal toxicological data and human epidemiological data. There is uncertainty in extrapolating observed responses from high doses in laboratory experiments or occupational settings, to the expected responses from low doses

typically encountered in environmental settings. USEPA therefore conservatively assumes that the dose-response curve for carcinogens is linear at all doses, i.e., every unit increase of constituent dose corresponds to the same unit increase in the lifetime probability of cancer. The numerical estimate of the cancer-causing potency of a carcinogen is referred to by the USEPA as the Cancer Slope Factor (CSF) for oral exposures. For inhalation exposures, the numerical estimate is expressed as either a unit risk (UR) factor or CSF. CSFs and URs for carcinogenic COCs are summarized in Attachment 1, Tables 1 and 2.

USEPA has developed Reference Doses (RfDs) and Reference Concentrations (RfCs) for non-carcinogenic constituents by applying uncertainty factors to this threshold dose, to account for uncertainties associated with using an animal study to derive a human dose-response value, extrapolating from the high doses used in the laboratory experiment to the low doses typically encountered in environmental settings, and evaluating sensitive subpopulations. This provides reasonable certainty that if the dose of a given constituent is below its exposure limit, then no non-carcinogenic health effects are expected to occur even if a highly-susceptible person were to be exposed daily for his or her entire lifetime. RfDs and RfCs for COCs are summarized in Attachment 1, Tables 3 and 4.

Compound-specific information is provided in Attachment 1, Table 5 to determine if other exposure pathways should be considered. The identified COCs are not volatile, as defined by USEPA. As a result, inhalation of these compounds in the vapor phase is not considered a relevant exposure pathway.

Receptors and Exposure Scenarios

As described in the HHRA, hypothetical receptors were defined for evaluating potential exposures. Conservative assumptions were used to estimate their potential exposure. The soil PRGs for the COCs are based on the same exposure assumptions defined in the HHRA for the hypothetical receptors considered relevant for future potential conditions at this Site. The tables documenting the algorithm and parameter assumptions for each of the receptors are presented in Attachment 1 as follows:

Commercial/Military Office Worker (chronic exposure scenario):

- Table 6: Ingestion and Dermal Exposures
- Table 7: Inhalation Exposures

Military Maintenance Worker (chronic exposure scenario):

- Table 8: Ingestion and Dermal Exposures
- Table 9: Inhalation Exposures

Construction Worker (subchronic exposure scenario):

- Table 10: Ingestion and Dermal Exposures
- Table 11: Inhalation Exposures

Derivation of Preliminary Remediation Goals in Soil

To identify the preliminary remediation goals for each COC in soil, risk-based concentrations were derived based on non-carcinogenic health effects and on carcinogenic effects where they exist.

For all compounds considered to potentially elicit carcinogenic effects, risk-based concentrations were calculated to correspond with three incremental target risk levels for an individual developing cancer over a lifetime--one in one million ($1x10^{-6}$), one in one hundred thousand ($1x10^{-5}$), and one in ten thousand ($1x10^{-4}$), representing the target risk range that USEPA uses to make remedial action decisions under CERCLA (USEPA, 1990).

The risk-based concentrations for compounds with health effects other than cancer (noncancer endpoints) are generally derived using a target hazard index of one (1). The target hazard index is the level of exposure to a chemical from all significant exposure pathways in the media of interest (soil), below which it is unlikely for even sensitive populations to experience adverse health effects. The liver is a common target organ for the toxicity values for chronic health effects (e.g., the RfD and the RfC) for pesticide compounds of potential concern (COPCs) evaluated in the HHRA, including chlordane and heptachlor epoxide, the two COCs considered in this FFS; and the COPC pesticides also evaluated in the HHRA, including gamma-chlordane, aldrin, 4,4'-DDT and dieldrin (ARCADIS, 2011). As a result, risk-based soil concentrations based on chronic exposures (e.g., Commercial/Military Office Worker and Military Maintenance Worker) to COCs with non-carcinogenic effects are based on an adjusted target hazard index of 0.17 (or 1/6) (see Attachment 1, Table 3).

Subchronic toxicity values have been derived to evaluate subchronic exposures, which are defined by USEPA are less than 10% of an average human lifespan (USEPA, 2011) and generally range from two weeks to seven years in duration (USEPA, 2010). The exposure scenario for the construction worker (an exposure duration of less than one year) represents a subchronic exposure. Therefore, subchronic toxicity values were identified where they exist from USEPA's Provisional Peer Reviewed Toxicity Values for Superfund (PPRTV) Assessments Electronic Library (accessed via http://hhpprtv.ornl.gov/) and Minimal Risk Levels (MRLs) developed for intermediate exposure durations (defined as greater than 14 days, up to 365 days) by Agency for Toxic Substances and Disease Registry (ATSDR) (accessed via http://www.atsdr.cdc.gov/mrls/index.asp). No subchronic toxicity values were identified for either chlordane or heptachlor epoxide. Chronic toxicity values were used as subchronic values for these COCs. Subchronic toxicity values exist for the other pesticide COPCs evaluated in the HHRA (ARCADIS, 2011),

with a total of four pesticides sharing the liver as a target endpoint (the COCs chlordane and heptachlor epoxide; and COPCs gamma chlordane and 4,4'-DDT). As a result, risk-based soil concentrations based non-carcinogenic health effects associated with subchronic exposures by the Construction Worker to pesticide COCs are based on an adjusted target HI of 0.25 (or 1/4 based on liver effects).

For those compounds that elicit both carcinogenic effects and non-carcinogenic effects, the recommended soil PRG for that receptor is based on the lower of the risk-based concentration based on a target cancer risk limit of $1x10^{-6}$ and the compound-specific target hazard index. A summary of the draft PRGs is presented in Table 1. For each compound, the risk-based value representing the lowest receptor-specific PRG is the recommended draft soil PRG for this Site, based on future restricted use of the site. The recommended PRGs are highlighted.

Tables

Table 1 – Preliminary Cleanup Goals for Soil

Attachments

Attachment 1 – Detail Calculation Tables

References

ARCADIS, 2011. Human Health Risk Assessment, FGGM-13, Former Pesticide Shop, Building 6621. Fort George G. Meade, Anne Arundel County. Maryland. May.

United States Environmental Protection Agency (USEPA). 1990. National Oil and Hazardous Substances Pollution Contingency Plan. Final rule. Federal Register March 8: 8670-8852

USEPA, 1991a. Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals). 9285.7-01B. December.

USEPA. 1991b. Role of Baseline Risk Assessment in Superfund Remedy Selection Decisions. Office of Solid Waste and Emergency Response (OSWER) 9355.0-30.

USEPA. 1997. Exposure Factors Handbook. Office of Research and Development, Washington, DC. PB98-124217. August 1997. Final.

USEPA, 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency. OSWER 9355.4-24. 2002

USEPA, 2004. Risk Assessment Guidance for Superfund (RAGS), Volume I: Human Health Evaluation Manual (Part E), Supplemental Guidance for Dermal Risk Assessment, Final. Office of Emergency and Remedial Response. 2004

USEPA. 2010. Regional Screening Levels—Master Table and User's Guide. November. (accessed via http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm; February 2011).

USEPA, 2011. Integrated Risk Information System (IRIS). http://www.epa.gov/iris/.

Tables

Table 1
Preliminary Remediation Goals for Soil (mg/kg)
Former Pesticide Shop, Fort George G. Meade, MD

Compounds of Concern	Commercial/Military Outdoor Worker (3) (Chronic Exposure)				Commercial/Military Office Worker (3) (Chronic Exposure)				Construction Worker (3) (Subchronic Exposure)			
	Target Risk = $1x10^{-4}$	Target Risk = $1x10^{-5}$	Target Risk = $1x10^{-6}$	Hazard Quotient = Compound-Specific[1]	Target Risk = $1x10^{-4}$	Target Risk = $1x10^{-5}$	Target Risk = $1x10^{-6}$	Hazard Quotient = Compound-Specific[1]	Target Risk = $1x10^{-4}$	Target Risk = $1x10^{-5}$	Target Risk = $1x10^{-6}$	Hazard Quotient = Compound-Specific[2]
Chlordane	2961	296	30	308	1621	162	16.21	169	10821	1082	108	33
Heptachlor epoxide	90	9	0.9	6	62	6	0.62	4	368	37	4	0.77

Notes:

(1) For chronic exposure scenarios, the Liver is the target endpoint for effects associated with exposure to each of the 2 COCs and 4 COPCs (total of 6 pesticide compounds; see HHRA in ARCADIS 2011). The soil cleanup goal is based on an adjusted target hazard index of 0.167 (or a target hazard index of 1 divided by 6).

(2) For subchronic exposure scenarios, the Liver is the target endpoint for effects associated with exposure to the two soil COCs (chlordane and heptachlor epoxide) and two soil COPCs (gamma-chlordane and 4,4'-DDT; see HHRA in ARCADIS 2011). The soil cleanup goal is based on a target hazard index of 0.25 (representing a target hazard index of 1 divided by 4).

(3) Highlighted values represent the lower of the risk-based concentrations protective of cancer (at 1×10^{-6} target risk limit) and non-cancer effects

mg/kg = milligrams per kiligram

Attachment 1

Detail Calculation Tables

Attachment 1 Table 1
Cancer Toxicity Data - Oral and Dermal
Former Pestice Shop, Fort George G. Meade, MD

CAS No.	Chemical of Potential Concern	Oral Cancer Slope Factor	GI Absorption Factor[1]	Dermal Absorption Factor[2]	Dermal Cancer Slope Factor[3]	Units	Weight of Evidence/ Cancer Guideline Description[4]	Slope Factor Source	Slope Factor Source Date[5]	Slope Factor Study Reference	Slope Factor Study Date	Slope Factor Study Species	Search Date[5]
12789-03-6	Chlordane	3.5E-01	100%	0.04	3.5E-01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	2/7/1998	Khasawinah and Grutsch	1989	mouse	5/4/2011
1024-57-3	Heptachlor epoxide	9.1E+00	100%	0.1	9.1E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	3/1/1991	Davis, Velsicol,	1965 1973	mouse/C3H (Davis), mouse/CD1 (Velsicol)	5/4/2011

Notes:

(1) - Gastrointestinal absorption data were obtained from RAGS Part E (Final, 2004), Exhibit 4-1.
(2) - Dermal absorption factors were obtained from RAGS Part E (Final, 2004), Exhibit 3-4. Did not evaluate if not available.
(3) - The absorbed dermal slope factor was derived by dividing the oral slope factor by the GI absorption factor.
(4) - Carcinogenic weight-of-evidence is a qualitative designation for potential carcinogens (USEPA 1986):
A - Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data is available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D- Not classifiable as to human carcinogenicity
(5) - Date searched IRIS.

mg/kg-day = milligrams per kilogram per day
IRIS = United States Environmental Protection Agency Integrated Risk Information System (http://www.epa.gov/iris)
GI = Gastrointestinal
RAGS = Risk Assessment Guidance for Superfund
USEPA = United States Environmental Protection Agengy
DDT = dichlorodiphenyltrichloroethane

Attachment 1 Table 2
Cancer Toxicity Data - Inhalation
Former Pesticide Shop, Fort George G. Meade, MD

CAS No.	Chemical of Potential Concern	Volatilization Factor[1]	Inhalation Unit Risk	Units	Weight of Evidence/ Cancer Guideline Description[2]	Unit Risk Source	Unit Risk Date	Slope Factor Study Reference	Slope Factor Study Date	Slope Factor Study Species	Search Date[3]
12789-03-6	Chlordane	NV	1.0E-01	$(mg/m^3)^{-1}$	B2	IRIS	2/7/1998	IRDC, 1973 NCI, 1977 Khasawinah and Grutsch 1989		mouse/ CD-1 (IRDC); mouse/ B6C3F1(NCI); mouse/ ICR (Khasawinah and Grutsch)	5/4/2011
1024-57-3	Heptachlor epoxide	NV	2.6E+00	$(mg/m^3)^{-1}$	B2	IRIS	3/1/1991	Davis, 1965 Velsicol 1973		mouse/C3H (Davis); mouse/CD1 (Velsicol)	5/4/2011

Notes:
(1) Volatile compounds are defined in accordance with USEPA (2010): Henry's Law Constant greater than $1x10^{-5}$ atm-m^3/mol and molecular weight less than 200 mol.

(2) - Carcinogenic weight-of-evidence is a qualitative designation for potential carcinogens (USEPA 1986):
- A - Human carcinogen
- B1 - Probable human carcinogen - indicates that limited human data is available
- B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
- C - Possible human carcinogen
- D- Not classifiable as to human carcinogenicity

mg/m^3 = milligrams per cubic meter
IRIS = United States Environmental Protection Agency Integrated Risk Information System (http://www.epa.gov/iris)
atm-m3/mol = atmospheres-cubic meters per mole
NV = Not Volatile
USEPA = United States Environmental Protection Agency

(3) - Date searched IRIS, USEPA Regional Screen Level table (November 2010), or PPRTV documents.

Attachment 1 Table 3
Non-Cancer Toxicity Data - Oral and Dermal
Former Pesticide Shop, Fort George G. Meade, MD

CAS No.	Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD Value	Oral RfD Units	Oral Absorption Efficiency for Dermal[1]	Dermal Absorption Factor[2]	Dermal RfD[3]	Dermal RfD units	Primary Target Organ	Critical Effect	Combined Uncertainty/ Modifying Factors	RfD Source	RfD Source Date	RfD Study Reference	RfD Study Date	RfD Study Species	Search Date[4]	Target Hazard Limit[5]
Chronic Effects																		
12789-03-6	Chlordane	Chronic	5.0E-04	mg/kg-day	100%	0.04	5.0E-04	mg/kg-day	liver	hepatic effects	300	IRIS	2/7/1998	Khasawinah and Grutsch,	1989	mouse	5/4/2011	0.17
1024-57-3	Heptachlor epoxide	Chronic	1.3E-05	mg/kg-day	100%	0.1	1.3E-05	mg/kg-day	liver	Increased liver-to-body weight ratio in both males and females	1000	IRIS	3/1/1991	Dow Chemical Co.,	1958	dog	5/4/2011	0.17
Subchronic Effects																		
12789-03-6	Chlordane	Subchronic	5.0E-04	mg/kg-day	100%	0.04	5.0E-04	mg/kg-day	liver			Chronic value					5/4/2011	0.25
1024-57-3	Heptachlor epoxide	Subchronic	1.3E-05	mg/kg-day	100%	0.1	1.3E-05	mg/kg-day	liver			Chronic value					5/4/2011	0.25

Notes:

(1) Gastrointestinal absorption data were obtained from RAGS Part E (Final, 2004), Exhibit 4-1.

(2) Dermal absorption factors were obtained from RAGS Part E (Final, 2004), Exhibit 3-4. Did not evaluate if not available.

(3) The absorbed dermal RfD was derived by multiplying the oral absorption efficiency by the oral RfD.

(4) Date searched IRIS, PPRTV documents, or HEAST tables.

(5) The target hazard limits for preliminary cleanup goals for soil were calculated to account for cumulative non-carcinogenic effects on target organs. The calculated hazard limit was based on the number of compounds (COCs and COPCs as presented in the ARCADIS, 2011) impacting the same target organ.

(6) Subchronic toxicity values were obtained where available from USEPA's PPRTV database (http://hhpprtv.ornl.gov) or ATSDR's Minimal Risk Level (MRL) for Intermediate effects (accessed via www.atsdr.cdc.gov/)

ATSDR = Agency for Toxic Substances and Disease Registry
HEAST = Health Effects Assessment Summary Tables
IRIS = United States Environmental Protection Agency Integrated Risk Information System (http://www.epa.gov/iris)
mg/kg-day = milligrams per kilogram per day
NA = Not Applicable
RAGS = Risk Assessment Guidance for Superfund
PPRTV = Provisional Peer-Reviewed Toxicity Values
RfD = Reference Dose
USEPA = United States Environmental Protection Agency

Attachment 1 Table 4
Non-Cancer Toxicity Data - Inhalation
Former Pesticide Shop, Fort George G. Meade, MD

CAS No.	Chemical of Potential Concern	Volatilization Factor[1]	Chronic/ Subchronic	Inhalation RfC Value	Inhalation RfC Units	Primary Target Organ	Combined Uncertainty/ Modifying Factors	RfC Source[2, 4]	RfC Source Date	RfC Study Reference	RfC Study Date	RfC Study Species	Search Date[2]	Target Hazard Quotient[3]
Chronic Effects														
12789-03-6	Chlordane	NV	Chronic	7.0E-04	mg/m^3	liver	1000	IRIS	2/7/1998	Khasawinah et al.,	1989	rat	5/4/2011	0.17
1024-57-3	Heptachlor epoxide	NV	Chronic	NTV		NA	NA	NA	NA	NA		NA	5/4/2011	0.17
Subchronic Effects														
12789-03-6	Chlordane	NV	Subchronic	2.0E-04	mg/m^3	liver	100	ATSDR (4)	5/1994	NA		NA	5/4/2011	0.25
1024-57-3	Heptachlor epoxide	NV	Subchronic	NTV		NA	NA	NTV	NA	NA		NA	5/4/2011	0.25

Notes:

(1) Volatile compounds are defined in accordance with USEPA (2010): Henry's Law Constant greater than $1x10^{-5}$ atm-m^3/mol and molecular weight less than 200 mol.

(2) Date searched IRIS, USEPA Regional Screen Level table (November 2010), PPRTV or ATSDR websites.

(3) The target hazard limits for preliminary cleanup goals for soil were calculated to account for cumulative non-carcinogenic effects on target organs. The calculated hazard limit was based on the number of compounds (COCs and COPCs as presented in the ARCADIS, 2011) impacting the same target organ.

(4) Subchronic toxicity values were obtained where available from USEPA's PPRTV database (http://hhpprtv.ornl.gov) or ATSDR's Minimal Risk Level (MRL) for Intermediate effects (accessed via www.atsdr.cdc.gov/)

ATSDR = Agency for Toxic Substances and Disease Registry
IRIS = United States Environmental Protection Agency Integrated Risk Information System (http://www.epa.gov/iris)
mg/m^3 = milligrams per cubic meter
NA = Not Applicable
NTV = No Toxicity Value
NV = Not Volatile
PPRTV = Provisional Peer-Reviewed Toxicity Values
RfC = Reference Concentration
USEPA = United States Environmental Protection Agency

Attachment 1 Table 5
Calculation of Volatilization Factors
Former Pesticide Shop, Fort George G. Meade, MD

	Parameter:	Molecular Weight	Henry's Law Constants		Density	Diffusivity in Air	Diffusivity in Water	Partition Coefficient	Water Solubility	Calculation of Volatilization Factor (VF)[2]		
	[1]Sources:	EPI Dermwin v.2.0	EPI HenryWin v.3.2		CRC 89th Ed	EPA 1987; EPA 2001; EPA 2002	EPA 1987; EPA 2001; EPA 2002	EPI KOCWIN v.2.0	CRC 89th Ed; Lange's 15th Ed; EPI WATERNT			
CAS No.	Analyte	MW	H` (unitless)	HLC (atm-m^3/mole)	Density (g/cm^3)	Dia (cm^2/s)	Diw (cm^2/s)	Koc (L/kg)	S (mg/L)	Volatile?[3]	Calculated Apparent Diffusivity ($D_{A)}$	Calculated VF (m^3/kg)
12789-03-6	Chlordane	409.78	1.99E-03	4.86E-05	1.60E+00			3.38E+04	5.60E-02	NV	NV	NV
1024-57-3	Heptachlor epoxide	389.32	8.59E-04	2.10E-05				1.01E+04	2.00E-01	NV	NV	NV

Symbol	Parameter	Default Value (USEPA 2002)
Q/C	Inverse of the ratio of the geometric mean air concentration to the volatilization flux at center of square source (g/m2-s per kg/m3)	68.81
T	Exposure interval (s)	9.50E+08
Pb	Dry soil bulk density (g/cm3)	1.5
theta (a)	Air-filled soil porosity (Lair/Lsoil) (n - theta(w))	0.28
n	Total soil porosity (Lpore/Lsoil) (1 - (Pb/Ps))	0.43
theta (w)	Water-filled soil porosity (Lwater/Lsoil)	0.15
Ps	Soil particle density (g/cm3)	2.65
Dia	Diffusivity in air (cm2/s)	chemical-specific
H'	Dimensionless Henry's law constant	chemical-specific
Diw	Diffusivity in water (cm2/s)	chemical-specific
Kd	Soil-water partition coefficient (cm3/g) (organics: Koc x foc; inorganics: chemical-specific)	chemical-specific
Koc	Soil organic carbon-water partition coefficient (cm3/g)	
foc	Organic carbon content of soil (g/g)	0.006

Notes:

(1) - Sources as presented in United States Environmental Protection Agency (USEPA) Regional Screening Level parameters table (November 2010)

(2) - Volatilization factor calculated per USEPA (2002) Soil Screening Guidance.
(3) - Volatile compounds are defined in accordance with USEPA 2010: Compounds whose Henry's Law Constant (HLC) is greater than $1x10^{-5}$ atmospheres-cubic meters per mole ($atm\text{-}m^3/mol$) and have a molecular weight less than 200 grams per mole (g/m).

NA = Value Not Available.

m^3/kg = cubic meters per kilogram

L/kg = liters per kilogram

mg/L = milligrams per Liter

cm^2/s - centimeter squared per second
g/cm^3 = grams per cubic centimeter

ATTACHMENT 1 TABLE 6
DEVELOPMENT OF SOIL CLEANUP GOALS FOR NON-RESIDENTIAL SOIL (COMMERCIAL/MILITARY OUTDOOR WORKER) -- INGESTION AND DERMAL EXPOSURES
REASONABLE MAXIMUM EXPOSURE
Former Pesticide Shop, Fort George G. Meade, MD

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Soil

Exposure Route	Receptor Population	Receptor Age **(1)**	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Algorithm for Soil Cleanup Goal **(2)**
Ingestion	Commercial / Military Worker	Adult	Soil	CS_{ing-c} or CS_{ing-n}	Soil Cleanup Goal	Chemical Specific	mg/kg	Calculated	Soil Cleanup Goal for noncancer health effects: CS_{ing-n} = (THI x AT-N x BW_a) / (EF_a x ED_a x IR_a x RAF x CF x 1/RfDo)
				IR_a	Soil Ingestion Rate	100	mg/day	USEPA, 2004 **(5)**	
				CF	Conversion Factor	1.0E-06	kg/mg	--	
				RAF	Relative Absorption Factor	Chemical Specific	--	**(3)**	
				EF_a	Exposure Frequency	57	days/year	USEPA, 2002 **(5)**	Soil Cleanup Goal for carcinogenic effects based on lifetime exposures: CS_{ing-c} = TR x BW_a x AT-C / (IR_a x EF_a x ED_a x RAF x CF x CSFo)
				ED_a	Exposure Duration	25	years	USEPA, 1991a	
				BW_a	Body Weight	70	kg	USEPA, 1991a	
				AT-N	Averaging Time (non-cancer)	9125	days	USEPA, 1989	
				AT-C	Averaging Time (cancer)	25550	days	USEPA, 1989	
				CSF	Cancer Slope Factor	Chemical Specific	$(mg/kg\text{-}day)^{-1}$	USEPA 2011 **(4)**	
				RfDo	Reference Dose	Chemical Specific	mg/kg-day	USEPA 2011 **(4)**	
Dermal	Commercial / Military Worker	Adult	Soil	CS_{derm-n} or CS_{derm-c}	Soil Cleanup Goal	Chemical Specific	mg/kg		Soil Cleanup Goal for noncancer health effects: CS_{derm-n} = (THI x AT-N x BW_a) / (EF_a x ED_a x SA_a x AF_a x ABS_a x CF x 1/RfDadj)
				CF	Conversion Factor	1.0E-06	kg/mg	--	
				SA_a	Skin Surface Area	2636	cm2/day	USEPA, 2004 **(6)**	
				AF_a	Adherence Factor	0.2	mg/cm^2	USEPA, 2004 **(6)**	
				ABSa	Dermal Absorption Factor	Chemical Specific	unitless	**(6)**	
				EF_a	Exposure Frequency	57	days/year	USEPA, 2002 **(5)**	Soil Cleanup Goal for carcinogenic effects based on lifetime exposures: CS_{derm-c} (mg/kg) = (TR x BW_a x AT-C) / (CSFadj x EF_a x ED_a x SA_a x AF_a x ABS_d x CF)
				ED_a	Exposure Duration	25	years	USEPA, 1991a	
				BW_a	Body Weight	70	kg	USEPA, 1991a	
				AT-N	Averaging Time (non-cancer)	9125	days	USEPA, 1989	
				AT-C	Averaging Time (cancer)	25550	days	USEPA, 1989	
				RfDadj	Reference Dose	Chemical Specific	mg/kg-day	USEPA 2011 **(4)**	
				CSFadj	Cancer Slope Factor	Chemical Specific	$(mg/kg\text{-}day)^{-1}$	USEPA 2011 **(4)**	

Notes:

(1) Assumes an adult commercial or military maintance worker whose job includes outdoor work.

(2) Information regarding modeled intake development can be found in the exposure assessment section of the baseline human health risk assessment (ARCADIS, 2011).

(3) RAFs are 1 for all compounds

(4) See Attachment 1 Tables 1 through 4 for cancer and noncancer toxicity values

(5) The military maintenance worker is primarily an outdoor worker. The Supplemental Soil Screening Guidance recommends the ingestion rate of 100 milligrams per day (mg/day) and an EF of 225 days/year (45 work weeks) for the outdoor worker (United States Environmental Protection Agency [USEPA], 2002). It is assumed that the military worker mows the lawn 2 times a week during the summer months (12 weeks - June through August) and visits the site 1 time a week for the remaining 33 weeks to perform outdoor maintenance activities.

(6) SA represents the average of total mean surface area of face, forearms, and hands for adult males and females from Risk Assessment Guidance for Superfund (RAGS) Part E (USEPA 2004). AF represents the 95th percentile value for landscapers as presented in Exhibit 3-3 RAGS Part E (USEPA, 2004).

TR = Target Risk Limit; THI = Target Hazard Index; mg/kg = milligrams per kilogram; kg/mg = kilograms per milligram; mg/kg-day = milligrams per kilogram per day; cm^2/day = centimeters squared per day; mg/cm^2 = milligrams per centimeters squared

ARCADIS, 2011: Human Health Risk Assessment, FGGM-13, Former Pesticide Shop, Building 6621. Fort George G. Meade, Anne Arundel County, MD. May 2011

USEPA, 1989: Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual, Part A. Office of Emergency and Remedial Response. USEPA/5440/1-89/002.

USEPA, 1991a: Risk Assessment Guidance for Superfund, Volume I - Human Health Evaluation Manual Supplemental Guidance, "Standard Default Exposure Factors." Interim Final. Office of Solid Waste and Emergency Response (OSWER) Directive 9285.6-03.

USEPA, 2002: Supplemental Guidance For Developing Soil Screening Levels For Superfund Sites. OSWER 9355.4-24. December 2002.

USEPA, 2004: Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual, Part E (Supplemental Guidance for Dermal Risk Assessment). Final. USEPA/540/R/99/005. July 2004.

USEPA, 2011: Integrated Risk Information System (IRIS). http://www.epa.gov/iris/. Accessed May, 2011.

ATTACHMENT 1 TABLE 7
DEVELOPMENT OF SOIL CLEANUP GOALS FOR NON-RESIDENTIAL SOIL (COMMERCIAL/MILITARY OUTDOOR WORKER) -- INHALATION EXPOSURES
REASONABLE MAXIMUM EXPOSURE
Former Pesticide Shop, Fort George G. Meade, MD

Scenario Timeframe: Current/Future
Medium: Soil derived particulates
Exposure Medium: Air

Exposure Route	Receptor Population	Receptor Age **(1)**	Exposure Points	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name **(2)**
Inhalation	Commercial / Military Worker	Adult	Particulates In Ambient Air	CS_{inh-n} or CS_{inh-c}	Soil Cleanup Goal	Chemical Specific	mg/kg	--	
				PEF	Particulate Emission Factor	6.61E+09	m^3/kg	USEPA, 2002 **(3)**	Soil Cleanup Goal for noncancer health effects:
				ET_a	Exposure Time	8	hour/day	Standard Work Day	CS_{inh-n} = THI x AT-N /
				EF_a	Exposure Frequency	57	days/year	USEPA, 2002 **(5)**	(EF_a x ED_a x ET_a x CF x (1/PEF) x 1/RfC)
				ED_a	Exposure Duration	25	years	USEPA, 2002	
				CF	Time Conversion Factor	1/24	days/hour		
				AT-N	Averaging Time (non-cancer)	9125	days	USEPA, 1989	Soil Cleanup Goal for carcinogenic effects based on lifetime exposures:
				AT-C	Averaging Time (cancer)	25550	days	USEPA, 1989	CS_{inh-c} = TR x AT-C /
				RfC	Reference Concentration	Chemical Specific	mg/m^3	USEPA, 2011 **(4)**	(EF_a x ED^a x ET_a x CF x (1/PEF) x IUR)
				IUR	Inhalation Unit Risk Value	Chemical Specific	$(mg/m^3)^{-1}$	USEPA, 2011 **(4)**	

Notes:

(1) Assumes an adult commercial or industrial worker whose job includes outdoor work.

(2) Information regarding modeled intake development can be found in the exposure assessment section of the baseline human health risk assessment (ARCADIS, 2011).

(3) See Table A-S3 in Human Health Risk Assessment (ARCADIS 2011)

(4) See Attachment 1 Tables 1 through 4 for cancer and noncancer toxicity values

(5) The military maintenance worker is primarily an outdoor worker. The Supplemental Soil Screening Guidance recommends an EF of 225 days/year (45 work weeks) for the outdoor worker (United States Environmental Protection Agency [USEPA], 2002). It is assumed that the military worker mows the lawn 2 times a week during the summer months (12 weeks - June through August) and visits the site 1 time a week for the remaining 33 weeks to perform outdoor maintenance activities.

TR = Target Risk Limit; THI = Target Hazard Index; mg/kg = milligrams per kilogram; mg/m^3 = milligrams per cubic meter

ARCADIS, 2011: Human Health Risk Assessment, FGGM-13, Former Pesticide Shop, Building 6621. Fort George G. Meade, Anne Arundel County, MD. May 2011

USEPA, 1989: Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual, Part A. Office of Emergency and Remedial Response. USEPA/5440/1-89/002.

USEPA, 2002: Supplemental Guidance For Developing Soil Screening Levels For Superfund Sites. Office of Solid Waste and Emergency Response 9355.4-24. December 2002.

USEPA, 2011: Integrated Risk Information System (IRIS). http://www.epa.gov/iris/. Accessed May, 2011.

ATTACHMENT 1 TABLE 8
DEVELOPMENT OF SOIL CLEANUP GOALS FOR NON-RESIDENTIAL SOIL (COMMERCIAL/MILITARY OFFICE WORKER) -- INGESTION AND DERMAL EXPOSURES
REASONABLE MAXIMUM EXPOSURE
Former Pesticide Shop, Fort George G. Meade, MD

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Soil

Exposure Route	Receptor Population	Receptor Age **(1)**	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Algorithm for Soil Cleanup Goal **(2)**
Ingestion	Commercial / Military Worker	Adult	Soil	CS_{ing-c} or CS_{ing-n}	Soil Cleanup Goal	Chemical Specific	mg/kg	Calculated	Soil Cleanup Goal for noncancer health effects: CS_{ing-n} = (THI x AT-N x BW_a) / (EF_a x ED_a x IR_a x RAF x CF x 1/RfDo)
				IR_a	Soil Ingestion Rate	50	mg/day	USEPA, 2002 **(5)**	
				CF	Conversion Factor	1.0E-06	kg/mg	--	
				RAF	Relative Absorption Factor	Chemical Specific	--	**(3)**	
				EF_a	Exposure Frequency	250	days/year	USEPA, 1991a	Soil Cleanup Goal for carcinogenic effects based on lifetime exposures: CS_{ing-c} = TR x BW_a x AT-C / (IR_a x EF_a x ED_a x RAF x CF x CSFo)
				ED_a	Exposure Duration	25	years	USEPA, 1991a	
				BW_a	Body Weight	70	kg	USEPA, 1991a	
				AT-N	Averaging Time (non-cancer)	9125	days	USEPA, 1989	
				AT-C	Averaging Time (cancer)	25550	days	USEPA, 1989	
				CSF	Cancer Slope Factor	Chemical Specific	$(mg/kg\text{-}day)^{-1}$	USEPA 2011 **(4)**	
				RfDo	Reference Dose	Chemical Specific	mg/kg-day	USEPA 2011 **(4)**	
Dermal	Commercial / Military Worker	Adult	Soil	CS_{derm-n} or CS_{derm-c}	Soil Cleanup Goal	Chemical Specific	mg/kg		Soil Cleanup Goal for noncancer health effects: CS_{derm-n} = (THI x AT-N x BW_a) / (EF_a x ED_a x SA_a x AF_a x ABS_a x CF x 1/RfDadj)
				CF	Conversion Factor	1.0E-06	kg/mg	--	
				SA_a	Skin Surface Area	1068	cm2/day	USEPA, 2004 **(7)**	
				AF_a	Adherence Factor	0.01	mg/cm^2	USEPA, 2004 **(7)**	
				ABSa	Dermal Absorption Factor	Chemical Specific	unitless	**(6)**	
				EF_a	Exposure Frequency	250	days/year	USEPA, 1991a	Soil Cleanup Goal for carcinogenic effects based on lifetime exposures: CS_{derm-c} (mg/kg) = (TR x BW_a x AT-C) / (CSFadj x EF_a x ED_a x SA_a x AF_a x ABS_d x CF)
				ED_a	Exposure Duration	25	years	USEPA, 1991a	
				BW_a	Body Weight	70	kg	USEPA, 1991a	
				AT-N	Averaging Time (non-cancer)	9125	days	USEPA, 1989	
				AT-C	Averaging Time (cancer)	25550	days	USEPA, 1989	
				RfDadj	Reference Dose	Chemical Specific	mg/kg-day	USEPA 2011 **(4)**	
				CSFadj	Cancer Slope Factor	Chemical Specific	$(mg/kg\text{-}day)^{-1}$	USEPA 2011 **(4)**	

Notes:

(1) Assumes an adult commercial or military worker whose job includes outdoor work.

(2) Information regarding modeled intake development can be found in the exposure assessment section of the baseline human health risk assessment (ARCADIS, 2011).

(3) RAFs are 1 for all compounds

(4) See Attachment 1 Tables 1 through 4 for cancer and noncancer toxicity values

(5)The commercial/military office worker is primarily an indoor worker. The Supplemental Soil Screening Guidance recommends the ingestion rate of 50 milligrams per day (mg/day) for the indoor worker and also does not evaluate dermal exposure for an indoor worker (United States Environmental Protection Agency [USEPA], 2002)

(6) Dermal absorption values were obtained from Risk Assessment Guidance for Superfund (RAGS) Part E (USEPA 2004).

(7) SA represents the average of male and female 95 percentile surface area values for hands. The AF represents the mean percentile value for grounds keeper (residential adults) as presented in Exhibit 3-3 of RAGS Part E (USEPA, 2004).

TR = Target Risk Limit; THI = Target Hazard Index; mg/kg = milligrams per kilogram; kg/mg = kilograms per millogram; mg/kg-day = milligrams per kilograms per day; cm^2/day = centimeters squared per day; mg/cm2 = milligrams per centimeters squared

ARCADIS, 2011: Human Health Risk Assessment, FGGM-13, Former Pesticide Shop, Building 6621. Fort George G. Meade, Anne Arundel County, MD. May 2011

USEPA, 1989: Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual, Part A. Office of Emergency and Remedial Response. US EPA/5440/1-89/002.

USEPA, 1991a: Risk Assessment Guidance for Superfund, Volume I - Human Health Evaluation Manual Supplemental Guidance, "Standard Default Exposure Factors." Interim Final. Office of Solid Waste and Emergency Response (OSWER) Directive 9285.6-03.

USEPA, 2002: Supplemental Guidance For Developing Soil Screening Levels For Superfund Sites. OSWER 9355.4-24. December 2002.

USEPA, 2004: Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual, Part E (Supplemental Guidance for Dermal Risk Assessment). Final. USEPA/540/R/99/005. July 2004.

USEPA, 2011: Integrated Risk Information System (IRIS). http://www.epa.gov/iris/. Accessed May, 2011.

ATTACHMENT 1 TABLE 9
DEVELOPMENT OF SOIL CLEANUP GOALS FOR NON-RESIDENTIAL SOIL (COMMERCIAL/MILITARY OFFICE WORKER) -- INHALATION EXPOSURES
REASONABLE MAXIMUM EXPOSURE
Former Pesticide Shop, Fort George G. Meade, MD

Scenario Timeframe: Current/Future
Medium: Soil derived particulates
Exposure Medium: Air

Exposure Route	Receptor Population	Receptor Age **(1)**	Exposure Points	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name **(2)**
Inhalation	Commercial / Military Worker	Adult	Particulates In Ambient Air	CS_{inh-n} or CS_{inh-c}	Soil Cleanup Goal	Chemical Specific	mg/kg	--	
				PEF	Particulate Emission Factor	6.61E+09	m^3/kg	USEPA, 2002 **(3)**	Soil Cleanup Goal for noncancer health effects:
				ET_a	Exposure Time	8	hour/day	Standard Work Day	CS_{inh-n} = THI x AT-N /
				EF_a	Exposure Frequency	250	days/year	USEPA, 2002	(EF_a x ED_a x ET_a x CF x (1/PEF) x 1/RfC)
				ED_a	Exposure Duration	25	years	USEPA, 2002	
				CF	Time Conversion Factor	1/24	days/hour		
				AT-N	Averaging Time (non-cancer)	9125	days	USEPA, 1989	Soil Cleanup Goal for carcinogenic effects based on lifetime exposures:
				AT-C	Averaging Time (cancer)	25550	days	USEPA, 1989	CS_{inh-c} = TR x AT-C /
				RfC	Reference Concentration	Chemical Specific	mg/m^3	USEPA, 2011 **(4)**	(EF_a x ED^a x ET_a x CF x (1/PEF) x IUR)
				IUR	Inhalation Unit Risk Value	Chemical Specific	$(mg/m^3)^{-1}$	USEPA, 2011 **(4)**	

Notes:

(1) Assumes an adult commercial or industrial worker whose job includes outdoor work.

(2) Information regarding modeled intake development can be found in the exposure assessment section of the baseline human health risk assessment (ARCADIS, 2011).

(3) See Table A-S3 in Human Health Risk Assessment (ARCADIS 2011)

(4) See Attachment 1 Tables 1 through 4 for cancer and noncancer toxicity values

TR = Target Risk Limit; THI = Target Hazard Index; mg/kg = milligrams per kilogram; mg/m^3 = milligrams per cubic meter; m^3/kg = cubic meters per kilogram; USEPA = United States Environmental Protection Agency

ARCADIS, 2011: Human Health Risk Assessment, FGGM-13, Former Pesticide Shop, Building 6621. Fort George G. Meade, Anne Arundel County, MD. May 2011

USEPA, 1989: Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual, Part A. Office of Emergency and Remedial Response. USEPA/5440/1-89/002.

USEPA, 2002: Supplemental Guidance For Developing Soil Screening Levels For Superfund Sites. Office of Solid Waste and Emergency Response 9355.4-24. December 2002.

USEPA, 2011: Integrated Risk Information System (IRIS). http://www.epa.gov/iris/. Accessed May, 2011.

ATTACHMENT 1 TABLE 10
DEVELOPMENT OF SOIL CLEANUP GOALS FOR NON-RESIDENTIAL SOIL (CONSTRUCTION WORKER) -- INGESTION AND DERMAL EXPOSURES
REASONABLE MAXIMUM EXPOSURE
Former Pesticide Shop, Fort George G. Meade, MD

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Algorithm for Soil Cleanup Goal **(1)**
Ingestion	Utility Worker Construction Worker	Adult	Trench/ Excavation Soil	CS_{ing-c} or CS_{ing-n}	Soil Cleanup Goal	Chemical Specific	mg/kg	--	Soil Cleanup Goal for noncancer health effects: CS_{ing-n} = (THI x AT-N x BW_a) / (EF_a x ED_a x IR_a x RAF x CF x 1/RfDo)
				IR_a	Soil Ingestion Rate	330	mg/day	USEPA, 2002	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				RAF	Relative Absorption Factor	Chemical Specific	--	**(2)**	
				EF_a	Exposure Frequency	130	days/year	**(5)**	Soil Cleanup Goal for carcinogenic effects based on lifetime exposures: CS_{ing-c} = TR x BW_a x AT-C / (IR_a x EF_a x ED_a x RAF x CF x CSFo)
				ED_a	Exposure Duration	1	years	USEPA, 2002	
				BW_a	Body Weight	70	kg	USEPA, 2002	
				AT-N	Averaging Time (non-cancer)	180	days	**(5)**	
				AT-C	Averaging Time (cancer)	25550	days	USEPA, 1989	
				CSF	Cancer Slope Factor	Chemical Specific	$(mg/kg\text{-}day)^{-1}$	USEPA 2011 **(3)**	
				RfDo	Reference Dose	Chemical Specific	mg/kg-day	USEPA 2011 **(3)**	
Dermal	Utility Worker Construction Worker	Adult	Trench/ Excavation Soil	CS_{derm-n} or CS_{derm-c}	Soil Cleanup Goal	Chemical Specific	mg/kg		Soil Cleanup Goal for noncancer health effects: CS_{derm-n} = (THI x AT-N x BW_a) / (EF_a x ED_a x SA_a x AF_a x ABS_a x CF x 1/RfDadj)
				CF	Conversion Factor	1.0E-06	kg/mg	--	
				SA_a	Skin Surface Area	2636	cm^2/day	USEPA, 2004 **(6)**	
				AF_a	Adherence Factor	0.3	mg/cm^2	USEPA, 2002	
				ABSa	Dermal Absorption Factor	Chemical Specific	unitless	**(4)**	
				EF_a	Exposure Frequency	130	days/year	**(5)**	Soil Cleanup Goal for carcinogenic effects based on lifetime exposures: CS_{derm-c} (mg/kg) = (TR x BW_a x AT-C) / (CSFadj x EF_a x ED_a x SA_a x AF_a x ABS_d x CF)
				ED_a	Exposure Duration	1	years	USEPA, 2002	
				BW_a	Body Weight	70	kg	USEPA, 2002	
				AT-N	Averaging Time (non-cancer)	180	days	**(5)**	
				AT-C	Averaging Time (cancer)	25550	days	USEPA, 1989	
				RfDadj	Reference Dose	Chemical Specific	mg/kg-day	USEPA 2011 **(3)**	
				CSFadj	Cancer Slope Factor	Chemical Specific	$(mg/kg\text{-}day)^{-1}$	USEPA 2011 **(3)**	

Notes:

(1) Information regarding modeled intake development can be found in the exposure assessment section of the baseline human health risk assessment (ARCADIS, 2011).

(2) RAFs are 1 for all compounds

(3) See Attachment 1 Tables 1 through 4 for cancer and noncancer toxicity values

(4) Dermal absorption values were obtained from Risk Assessment Guidance for Superfund (RAGS) Part E (United States Environmental Protection Agency [USEPA], 2004).

(5) Conservatively assumes a 6 month construction project 5-days per week. The AT-N accounts for 2 days per week with no exposure (weekends). See ARCADIS, 2011.

(6) Represents the total mean surface area of face, forearms, and hands for adult males and females.

TR = Target Risk Limit; THI = Target Hazard Index; mg/kg = milligrams per kilogram; mg/day = milligrams per day; kg/mg = kilograms per milligram; mg/kg-day = milligrams per kilogram per day; cm2/day = centimeters squared per day; mg/cm2 = milligrams per centimeter squared

ARCADIS, 2011: Human Health Risk Assessment, FGGM-13, Former Pesticide Shop, Building 6621. Fort George G. Meade, Anne Arundel County, MD. May 2011

USEPA, 1989: Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual, Part A. Office of Emergency and Remedial Response. USEPA/5440/1-89/002.

EPA, 2002: Supplemental Guidance For Developing Soil Screening Levels For Superfund Sites. Office of Solid Waste and Emergency Response (OSWER) 9355.4-24. December 2002.

EPA, 2011: Integrated Risk Information System (IRIS). http://www.epa.gov/iris/. Accessed May, 2011.

ATTACHMENT 1 TABLE 11
DEVELOPMENT OF SOIL CLEANUP GOALS FOR NON-RESIDENTIAL SOIL (CONSTRUCTION WORKER) -- INHALATION EXPOSURES
REASONABLE MAXIMUM EXPOSURE
Former Pesticide Shop, Fort George G. Meade, MD

Scenario Timeframe: Current/Future
Medium: Soil derived particulates
Exposure Medium: Air

Exposure Route	Receptor Population	Receptor Age **(1)**	Exposure Points	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name **(2)**
Inhalation	Construction Worker	Adult	Particulates In Ambient Air During Excavation Scenario	CS_{inh-n} & CS_{inh-c}	Soil Cleanup Goal	Chemical Specific	mg/kg	--	
				PEF	Particulate Emission Factor	4.10E+06	m^3/kg	USEPA, 2002 **(2)**	Soil Cleanup Goal for noncancer health effects:
				ET	Exposure Time	8	hour/day	work day	CS_{inh-n} = THI x AT-N /
				EF	Exposure Frequency	130	days/year	**(3)**	(EF_a x ED_a x ET_a x CF x (1/PEF) x 1/RfC)
				ED	Exposure Duration	1	years	USEPA, 2002	
				CF	Time Conversion Factor	1/24	days/hour		Soil Cleanup Goal for carcinogenic effects based on lifetime exposures:
				AT-N	Averaging Time (non-cancer)	180	days	**(3)**	CS_{inh-c} = TR x AT-C /
				RfC	Reference Concentration	Chemical Specific	mg/m^3	USEPA, 2010 **(4)**	(EF_a x ED^a x ET_a x CF x (1/PEF) x IUR)
				AT-C	Averaging Time (cancer)	25550	days	USEPA, 1989	
				IUR	Inhalation Unit Risk Value	Chemical Specific	$(mg/m^3)^{-1}$	USEPA, 2011 **(4)**	

Notes:

(1) Information regarding modeled intake development can be found in the exposure assessment section of the baseline human health risk assessment (ARCADIS, 2011).

(2) See Table A-S3 in Human Health Risk Assessment (ARCADIS 2011)

(3) Conservatively assumes a 6 month construction project 5-days per week. The AT-N accounts for 2 days per week with no exposure (weekends). See ARCADIS, 2011.

(4) See Attachment 1 Tables 1 through 4 for cancer and noncancer toxicity values

TR = Target Risk Limit; THI = Target Hazard Index; mg/kg = milligrams per kilogram; m3/kg = cubic meters per kilogram; mg/m^3 = milligrams per cubic meter

ARCADIS, 2011: Human Health Risk Assessment, FGGM-13, Former Pesticide Shop, Building 6621. Fort George G. Meade, Anne Arundel County, MD. May 2011

United States Environmental Protection Agency (USEPA), 1989: Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual, Part A. Office of Emergency and Remedial Response. USEPA/5440/1-89/002.

USEPA, 2002: Supplemental Guidance For Developing Soil Screening Levels For Superfund Sites. Office of Solid Waste and Emergency Response 9355.4-24. December 2002.

EPA, 2011: Integrated Risk Information System (IRIS). http://www.epa.gov/iris/. Accessed May, 2011.

ATTACHMENT 1 TABLE 12
CALCULATION OF RISK-BASED SOIL CLEANUP GOALS: SOIL
REASONABLE MAXIMUM EXPOSURE
Commercial / Military Worker Outdoor Exposures - Former Pesticide Shop, Fort George G. Meade, MD

Scenario Timeframe: Current/Future
Receptor Population: Commercial/Military Worker (outdoor)
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern[1]	Chemical Specific Values RAF (oral), ABS (dermal) or VF (inh vapors)	Soil Cleanup Goal based on Cancer Endpoint (mg/kg)							Soil Cleanup Goal based on Non-Cancer Endpoint (mg/kg)				
						Intake/ Exposure Concentration		CSF/IUR		Cancer Risk	Cancer Risk	Cancer Risk	Intake/ Exposure Concentration		RfD/RfC		Target HQ = Compound-specific[1]
						Value	Units	Value	Units	1E-04	1E-05	1E-06	Value	Units	Value	Units	
Soil	Soil	Soil	Ingestion	Chlordane	1.0E+00	1.26E+07	day	3.5E-01	1/mg/kg-day	3.6E+03	3.6E+02	3.6E+01	4.48E+06	day	5.0E-04	mg/kg-day	3.7E+02
				Heptachlor epoxide	1.0E+00	1.26E+07	day	9.1E+00	1/mg/kg-day	1.4E+02	1.4E+01	1.4E+00	4.48E+06	day	1.3E-05	mg/kg-day	9.7E+00
			Dermal Contact	Chlordane	4.0E-02	5.95E+07	day	3.5E-01	1/mg/kg-day	1.7E+04	1.7E+03	1.7E+02	2.13E+07	day	5.0E-04	mg/kg-day	1.8E+03
				Heptachlor epoxide	1.0E-01	2.38E+07	day	9.1E+00	1/mg/kg-day	2.6E+02	2.6E+01	2.6E+00	8.50E+06	day	1.3E-05	mg/kg-day	1.8E+01
Soil	Air	Soil	Inhalation of Particulates	Chlordane		3.56E+11	m3/kg	1.0E-01	1/mg/m3	3.6E+08	3.6E+07	3.6E+06	1.27E+11	m3/kg	7.0E-04	mg/m3	1.5E+07
				Heptachlor epoxide		3.56E+11	m3/kg	2.6E+00	1/mg/m3	1.4E+07	1.4E+06	1.4E+05	1.27E+11	m3/kg	NTV		NTV
			Inhalation of Vapors	Chlordane	NV	NV		1.0E-01	1/mg/m3	NV	NV	NV	NV		7.0E-04	mg/m3	NV
				Heptachlor epoxide	NV	NV		2.6E+00	1/mg/m3	NV	NV	NV	NV		NTV		NV

Notes:

m^3/kg = cubic meters per kilogram
mg/kg = milligrams per kilogram
mg/m^3 = milligrams per cubic meters
NTV = No Toxicity Value Available
NV = Not Volatile
Vol = Volatile. If a compound is volatile (as defined by USEPA, 2010), the soil cleanup goal is based on inhalation of the vapor phase; otherwise, the soil cleanup goal is based on the inhalation of soil particulates.
RAF = Relative Absorption Factor
ABS = Dermal Absorption Factor
VF = Volatilization Factor
CSF = Cancer Slope Factor
IUR = Inhalation Unit Risk
RfD = Noncancer Reference Dose
RfC = Noncancer Reference Concentration
USEPA = United States Environmental Protection Agency

(1) For chronic exposure scenarios, the Liver is the target endpoint for effects associated with exposure to each of the 2 COCs and 4 COPCs (total of 6 pesticide compounds; see HHRA in ARCADIS 2011). The soil cleanup goal is based on an adjusted target hazard index of 0.167 (or a target hazard index of 1 divided by 6).

ATTACHMENT 1 TABLE 13
SUMMARY OF RISK-BASED SOIL CLEANUP GOALS: SOIL
REASONABLE MAXIMUM EXPOSURE
Commercial / Military Worker Outdoor Exposures - Former Pesticide Shop, Fort George G. Meade, MD

Scenario Timeframe: Current/Future
Receptor Population: Commercial/Military Worker (outdoor)
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Concern[1]	Soil Cleanup Goals based on Cancer Target Risk = $1x10^{-4}$				Soil Cleanup Goals based on Non-Cancer Hazard Index = 1				
				Ingestion Only	Inhalation Particulates / Vapors	Dermal Absorption Only	**Soil Cleanup Goal (Cancer Endpoints)**	Primary Target Organ(s)	Ingestion Only	Inhalation Particulates / Vapors	Dermal Absorption Only	**Soil Cleanup Goal (Non-Cancer Endpoints)**
Soil	Soil/Air	Soil	Chlordane	3.6E+03	3.6E+08	1.7E+04	**3.0E+03**	liver	3.7E+02	1.5E+07	1.8E+03	**3.1E+02**
			Heptachlor epoxide	1.4E+02	1.4E+07	2.6E+02	**9.0E+01**	liver	9.7E+00	NTV	1.8E+01	**6.4E+00**
				Cancer Target Risk = 1x10-5								
Soil	Soil/Air	Soil	Chlordane	3.6E+02	3.6E+07	1.7E+03	**3.0E+02**					
			Heptachlor epoxide	1.4E+01	1.4E+06	2.6E+01	**9.0E+00**					
				Cancer Target Risk = 1x10-6								
Soil	Soil/Air	Soil	Chlordane	3.6E+01	3.6E+06	1.7E+02	**3.0E+01**					
			Heptachlor epoxide	1.4E+00	1.4E+05	2.6E+00	**9.0E-01**					

Notes:

$$\text{Risk-based cleanup goal}_{soil} = \frac{1}{\frac{1}{CS_{ing}} + \frac{1}{CS_{derm}} + \frac{1}{CS_{inh}}}$$

Where:

CS_{ing} = Soil Cleanup Goal based on ingestion exposures

CS_{derm}= Soil Cleanup Goal based on dermal contact exposures

CS_{inh}= Soil Cleanup Goal based on inhalation of respirable dust

NTV = No Toxicity Value Available

ATTACHMENT 1 TABLE 14
CALCULATION OF RISK-BASED SOIL CLEANUP GOALS: SOIL
REASONABLE MAXIMUM EXPOSURE
Commercial / Military Office Worker Exposures - Former Pesticide Shop, Fort George G. Meade, MD

Scenario Timeframe: Current/Future
Receptor Population: Commercial/Military Office Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern[1]	Chemical Specific Values RAF (oral), ABS (dermal) or VF (inh vapors)	Soil Cleanup Goal based on Cancer Endpoint (mg/kg)							Soil Cleanup Goal based on Non-Cancer Endpoint (mg/kg)				
						Intake/ Exposure Concentration		CSF/IUR		Cancer Risk	Cancer Risk	Cancer Risk	Intake/ Exposure Concentration		RfD/RfC		Target HQ = Compound-specific[1]
						Value	Units	Value	Units	1E-04	1E-05	1E-06	Value	Units	Value	Units	
Soil	Soil	Soil	Ingestion	Chlordane	1.0E+00	5.72E+06	day	3.5E-01	1/mg/kg-day	1.6E+03	1.6E+02	1.6E+01	2.04E+06	day	5.0E-04	mg/kg-day	1.7E+02
				Heptachlor epoxide	1.0E+00	5.72E+06	day	9.1E+00	1/mg/kg-day	6.3E+01	6.3E+00	6.3E-01	2.04E+06	day	1.3E-05	mg/kg-day	4.4E+00
			Dermal Contact	Chlordane	4.0E-02	6.70E+08	day	3.5E-01	1/mg/kg-day	1.9E+05	1.9E+04	1.9E+03	2.39E+08	day	5.0E-04	mg/kg-day	2.0E+04
				Heptachlor epoxide	1.0E-01	2.68E+08	day	9.1E+00	1/mg/kg-day	2.9E+03	2.9E+02	2.9E+01	9.57E+07	day	1.3E-05	mg/kg-day	2.1E+02
Soil	Air	Soil	Inhalation of Particulates	Chlordane		8.11E+10	m3/kg	1.0E-01	1/mg/m3	8.1E+07	8.1E+06	8.1E+05	2.90E+10	m3/kg	7.0E-04	mg/m3	3.4E+06
				Heptachlor epoxide		8.11E+10	m3/kg	2.6E+00	1/mg/m3	3.1E+06	3.1E+05	3.1E+04	2.90E+10	m3/kg	NTV		NTV
			Inhalation of Vapors	Chlordane	NV	NV		1.0E-01	1/mg/m3	NV	NV	NV	NV		7.0E-04	mg/m3	NV
				Heptachlor epoxide	NV	NV		2.6E+00	1/mg/m3	NV	NV	NV	NV		NTV		NV

Notes:

NTV = No Toxicity Value Available
NV = Not Volatile
Vol = Volatile. If a compound is volatile (as defined by USEPA, 2010), the soil cleanup goal is based on inhalation of the vapor phase; otherwise, the soil cleanup goal is based on the inhalation of soil particulates.
RAF = Relative Absorption Factor
ABS = Dermal Absorption Factor
VF = Volatilization Factor
CSF = Cancer Slope Factor
IUR = Inhalation Unit Risk
RfD = Noncancer Reference Dose
RfC = Noncancer Reference Concentration
mg/m3 = milligrams per cubic meter
m3/kg = cubic meters per kilogram
USEPA = United States Environmental Protection Agency

(1) For chronic exposure scenarios, the Liver is the target endpoint for effects associated with exposure to each of the 2 COCs and 4 COPCs (total of 6 pesticide compounds; see HHRA in ARCADIS 2011). The soil cleanup goal is based on an adjusted target hazard index of 0.167 (or a target hazard index of 1 divided by 6).

ATTACHMENT 1 TABLE 15
SUMMARY OF RISK-BASED SOIL CLEANUP GOALS: SOIL
REASONABLE MAXIMUM EXPOSURE
Commercial / Military Office Worker Exposures - Former Pesticide Shop, Fort George G. Meade, MD

Scenario Timeframe: Current/Future
Receptor Population: Commercial/Military Office Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Concern[1]	Soil Cleanup Goals based on Cancer Target Risk = $1x10^{-4}$				Soil Cleanup Goals based on Non-Cancer Hazard Index = 1				
				Ingestion Only	Inhalation Particulates / Vapors	Dermal Absorption Only	**Soil Cleanup Goal (Cancer Endpoints)**	Primary Target Organ(s)	Ingestion Only	Inhalation Particulates / Vapors	Dermal Absorption Only	**Soil Cleanup Goal (Non-Cancer Endpoints)**
Soil	Soil/Air	Soil	Chlordane	1.6E+03	8.1E+07	1.9E+05	**1.6E+03**	liver	1.7E+02	3.4E+06	2.0E+04	**1.7E+02**
			Heptachlor epoxide	6.3E+01	3.1E+06	2.9E+03	**6.2E+01**	liver	4.4E+00	NTV	2.1E+02	**4.3E+00**
				Cancer Target Risk = 1x10-5								
Soil	Soil/Air	Soil	Chlordane	1.6E+02	8.1E+06	1.9E+04	**1.6E+02**					
			Heptachlor epoxide	6.3E+00	3.1E+05	2.9E+02	**6.2E+00**					
				Cancer Target Risk = 1x10-6								
Soil	Soil/Air	Soil	Chlordane	1.6E+01	8.1E+05	1.9E+03	**1.6E+01**					
			Heptachlor epoxide	6.3E-01	3.1E+04	2.9E+01	**6.2E-01**					

Notes:

$$\text{Risk-based cleanup goal}_{soil} = \frac{1}{\frac{1}{CS_{ing}} + \frac{1}{CS_{derm}} + \frac{1}{CS_{inh}}}$$

Where:

CS_{ing} = Soil Cleanup Goal based on ingestion exposures

CS_{derm}= Soil Cleanup Goal based on dermal contact exposures

CS_{inh}= Soil Cleanup Goal based on inhalation of respirable dust

NTV = No Toxicity Value Available

ATTACHMENT 1 TABLE 16
CALCULATION OF RISK-BASED SOIL CLEANUP GOALS: FACILITY SOIL
REASONABLE MAXIMUM EXPOSURE
Construction Worker Exposures - Former Pesticide Shop, Fort George G. Meade, MD

Scenario Timeframe: Current/Future
Receptor Population: Construction/Utility Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern[1]	Chemical Specific Values RAF (oral), ABS (dermal) or VF (inh vapors)	Soil Cleanup Goal based on Cancer Endpoint (mg/Kg)							Soil Cleanup Goal based on Non-Cancer Endpoint (mg/kg)				
						Intake/ Exposure Concentration		CSF/IUR		Cancer Risk	Cancer Risk	Cancer Risk	Intake/ Exposure Concentration		RfD/RfC (Subchronic)		Target HQ = Compound-specific[1]
						Value	Units	Value	Units	1E-04	1E-05	1E-06	Value	Units	Value	Units	
Soil	Soil	Soil	Ingestion Subchronic	Chlordane	1E+00	4.17E+07	day	3.5E-01	1/mg/kg-day	1.2E+04	1.2E+03	1.2E+02	2.94E+05	day	5.0E-04	mg/kg-day	3.7E+01
				Heptachlor epoxide	1E+00	4.17E+07	day	9.1E+00	1/mg/kg-day	4.6E+02	4.6E+01	4.6E+00	2.94E+05	day	1.3E-05	mg/kg-day	9.5E-01
			Dermal Contact Subchronic	Chlordane	4E-02	4.35E+08	day	3.5E-01	1/mg/kg-day	1.2E+05	1.2E+04	1.2E+03	3.06E+06	day	5.0E-04	mg/kg-day	3.8E+02
				Heptachlor epoxide	1E-01	1.74E+08	day	9.1E+00	1/mg/kg-day	1.9E+03	1.9E+02	1.9E+01	1.23E+06	day	1.3E-05	mg/kg-day	4.0E+00
Soil	Air	Soil	Inhalation of Particulates Subchronic	Chlordane		2.42E+09	m3/kg	1.0E-01	1/mg/m3	2.4E+06	2.4E+05	2.4E+04	1.70E+07	m3/kg	7.0E-04	mg/m3	3.0E+03
				Heptachlor epoxide		2.42E+09	m3/kg	2.6E+00	1/mg/m3	9.3E+04	9.3E+03	9.3E+02	1.70E+07	m3/kg	NTV	mg/m3	NTV
			Inhalation of Vapors Subchronic	Chlordane	NV	NV		1.0E-01	1/mg/m3	NV	NV	NV	NV		7.0E-04	mg/m3	NV
				Heptachlor epoxide	NV	NV		2.6E+00	1/mg/m3	NV	NV	NV	NV		NTV		NV

Notes:

(1) For subchronic exposure scenarios, the Liver is the target endpoint for effects associated with exposure to the two soil COCs (chlordane and heptachlor epoxide) and two soil COPCs (gamma-chlordane and 4,4'-DDT; see HHRA in ARCADIS 2011). The soil cleanup goal is based on a target hazard index of 0.25 (representing a target hazard index of 1 divided by 4).

ABS = Dermal Absorption Factor
CSF = Cancer Slope Factor
IUR = Inhalation Unit Risk
mg/kg = milligrams per kilogram
mg/m^3 = milligrams per cubic meter
NTV = No Toxicity Value Available
NV = Not Volatile
RAF = Relative Absorption Factor
RfC = Noncancer Reference Concentration
RfD = Noncancer Reference Dose
VF = Volatilization Factor
Vol = Volatile. If a compound is volatile (as defined by EPA, 2010), the soil cleanup goal is based on inhalation of the vapor phase; otherwise, the soil cleanup goal is based on the inhalation of soil particulates.

ATTACHMENT 1 TABLE 17
SUMMARY OF RISK-BASED SOIL CLEANUP GOALS: FACILITY SOIL
REASONABLE MAXIMUM EXPOSURE
Construction Worker Exposures - Former Pesticide Shop, Fort George G. Meade, MD

Scenario Timeframe: Current/Future
Receptor Population: Construction/Utility Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Concern[1]	Soil Cleanup Goals based on Cancer Target Risk = $1x10^{-4}$				Soil Cleanup Goals based on Non-Cancer Hazard Index = 1				
				Ingestion Only	Inhalation Particulates / Vapors	Dermal Absorption Only	**Soil Cleanup Goal (Cancer Endpoints)**	Primary Target Organ(s)	Ingestion Only	Inhalation Particulates / Vapors	Dermal Absorption Only	**Soil Cleanup Goal (Non-Cancer Endpoints)**
Soil	Soil/Air	Soil	Chlordane	1.2E+04	2.4E+06	1.2E+05	**1.1E+04**	liver	3.7E+01	3.0E+03	3.8E+02	**3.3E+01**
			Heptachlor epoxide	4.6E+02	9.3E+04	1.9E+03	**3.7E+02**	liver	9.5E-01	NTV	4.0E+00	**7.7E-01**
				Cancer Target Risk = $1x10^{-5}$								
Soil	Soil/Air	Soil	Chlordane	1.2E+03	2.4E+05	1.2E+04	**1.1E+03**					
			Heptachlor epoxide	4.6E+01	9.3E+03	1.9E+02	**3.7E+01**					
				Cancer Target Risk = $1x10^{-6}$								
Soil	Soil/Air	Soil	Chlordane	1.2E+02	2.4E+04	1.2E+03	**1.1E+02**					
			Heptachlor epoxide	4.6E+00	9.3E+02	1.9E+01	**3.7E+00**					

Notes:

$$\text{Risk-based cleanup goal}_{soil} = \frac{1}{\frac{1}{CS_{ing}} + \frac{1}{CS_{derm}} + \frac{1}{CS_{inh}}}$$

Where:

CS_{ing} = Soil Cleanup Goal based on ingestion exposures
CS_{derm}= Soil Cleanup Goal based on dermal contact exposures
CS_{inh}= Soil Cleanup Goal based on inhalation of respirable dust

NTV = No Toxicity Value Available

Appendix B

Remedial Alternatives Cost Estimates
Tables and ERD Memorandum

ARCADIS U.S., Inc.
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MEMO

To:
Rusty Kahl, ARCADIS
Brian Stempowski, ARCADIS

Copies:

From:
Chris Spooner

Date:
July 2012

ARCADIS Project No.:
GP09MEAD.PEST

Subject:
In-situ Biological Treatment Summary - Enhanced Reductive Dechlorination
FGGM-13, Former Pesticide Shop
Fort George G. Meade, Maryland

Applicability of Enhanced Reductive Dechlorination

At the Former Pesticide Shop, soil boring logs indicate fine to medium grained sands to depths of at least 30 feet bgs. A clay layer was encountered at approximately 24 feet bgs and 29 feet bgs in borings MW-1R and MW-2R, respectively, but not in other borings. The shallow subsurface is interpreted to be sands of the Lower Patapsco underlain by a clay layer that are typical within the Lower Patapsco sands.

Groundwater at the Former Pesticide Shop is located in a surficial aquifer composed of Lower Patapsco sands (primarily fine to medium grained sands as described above). The groundwater table is located approximately 18 to 20 feet bgs on site (wells MW-2R and MW-3R). Groundwater flow is to the east-southeast toward Middle Branch which is a gaining stream at this location (based on surface water gauges installed as part of this study), and shallow groundwater discharges to this feature. There are no surface water bodies directly on the site. Based on the site geology developed from monitor well boring logs and the groundwater elevation injection of a carbon substrate is feasible.

Some of the chemicals reportedly stored at Building 6621 in the past include the pesticides dichlorodiphenyldichloroethane (DDD), dichlorodiphenyltrichloroethane (DDT), malathion, diazinon, baygon, chlordane, and several brands of rodenticides. Most of the listed chemical compounds are on the USEPA Mid-Atlantic Risk Assessment RSL Master Table (USEPA, 2009). Based on analytical results from the RI, metals (arsenic), pesticides, and CVOCs (PCE and TCE) were identified as COCs. Both PCE

and TCE are readily degradable by ERD. The injection of organic carbon as part of an ERD remedy typically results in a decline in pH in the injection zone due to the generation of organic acids during breakdown of the carbon substrate by the microbial community. At most sites, this drop in pH is short-lived, and a steady increase in pH is observed over time as continued carbon injection increases the alkalinity within the treatment zone. A drop in pH can cause metals to mobilize. Mobilization of metals is temporal and typically limited to the area where the pH has been depressed. Once the pH neutralized downgradient the metals typically become immobile. Selection of an appropriate carbon source can help mitigate pH effects of ERD. Selection of EVO as the carbon source will have an advantage over a more soluble donor, such as molasses, because of the stable release of total organic carbon (TOC) to feed the microbes rather than a high concentration slug of TOC from molasses and other sources.

Implementation Approach

EVO was selected as an alternate carbon source, because it is a slower release/longer term carbon source than soluble substrates like molasses, lactate, and ethanol. The primary benefit of using EVO is that less frequent injections will likely be required due to its longer residence time and slow release of organic carbon (typically a year or more).

Unlike many other carbon sources, EVO does not readily move down-gradient with groundwater flow. Instead EVO distribution is primarily achieved at the time of injection, and it serves as an on-going slow-release carbon source across the achieved injection radius. As a result, it is important to determine the achieved radius of influence from a given volume of injected material. To this end, injections will be completed in two stages to gather sufficient data to determine the achieved radius of influence leading to optimum injection spacing. The first stage will serve to determine whether the second stage of injections can be completed through direct-push locations or whether permanent injection wells would be necessary.

The data collected during the first stage will be utilized to determine whether additional application of EVO is appropriate throughout the defined impacted area (as defined during remedial investigation (RI) activities). It is expected that if the first stage proves favorable then the second stage application of the 3 percent EVO/water solution throughout the defined area would be completed.

For the purposes of costing, this remedial alternative assumes that EVO solution will be injected into the subsurface via 20 proposed direct-push borings as shown in **Figure B-1**. Two transects, one upgradient of MW-2R and MW-3R, are proposed perpendicular to groundwater flow. Transect 1, upgradient of MW-2R, is approximately 40 feet long. Transect 2, upgradient of MW-3R, is approximately 60 feet long. These transects are spaced approximately 125 feet apart, which represents approximately 6 months travel time. These proposed borings are located around monitor wells MW-2R and MW-3R to target dissolved-phase CVOCs and pesticides in the vicinity of these wells.

The target radius of influence (ROI) for the EVO solution is 2.5 feet. The target injection depth is 15 to 30 feet below ground surface, which is based on the typical depth to water and the total depth of monitor wells MW-2R and MW-3R. In order to determine the volume of solution required to reach the target ROI, the following formula is used:

$$V_{inj} = 7.48 \times \pi \times r_{inj}^{2} \times h \times \theta_m$$

Where:

V_{inj} = volume of injection (gallons)

r_{inj} = radius of influence (2.5 feet)

h = target interval thickness (15 feet)

θ_m = mobile porosity (assumed to be 10%)

7.48 = conversion factor (gallons per cubic foot)

Based upon these assumptions, the estimated volume of solution is 220 gallons for each injection point, or a total of 4,400 gallons for all 20 injection points. The number of injection points and estimated injection volumes may be refined during field implementation. Based on field observations (e.g., subsurface lithology, soil classification, etc.), volumes and injection point spacing may be adjusted to ensure delivery across the target area.

The EVO/water solution will be mixed in a polyethylene tank (poly tank) equipped with a pump for mixing of the solution. To obtain a 3% (by weight) batch solution, 25 lbs (~3.1 gallons) of EVO will be added to 100 gallons of potable water. Exact batch recipes will depend on the size and gradations of the poly tank procured for this work. As calculated above, 220 gallons of the 3% solution will be injected at each location. As batches are mixed, the solution will be injected using direct push rods screened in four foot intervals. Wide screen slot is recommended (approximately 0.04 inches) for maximum ease of injectability.

During injection activities, solution injection pressure will be monitored at the surface and will be kept below 30 psi. While this represents a maximum value, the injection pressure will be minimized to the extent possible to avoid exceeding the formation strength. During the field event, the injection flow rate and wellhead pressure will be balanced to support radial, controlled distribution to the extent possible, while minimizing the required labor costs to achieve the target volumes.

ERD performance monitoring will be conducted following completion of the injection. ERD performance monitoring wells will be MW-2R and MW-3R. Data collected from monitoring wells located within the injection ROI will be used to evaluate the adequate concentration and distribution of reagent. Performance and operational data will be collected to satisfy the following criteria:

- Confirm that the presence of excess organic carbon does not result in pH levels that inhibit microbial activity within the IRZ.
- Observe IRZ propagation at monitor wells MW-2R and MW-3R.
- Collect additional data to evaluate progress of the ERD process and to monitor the level of methanogenesis (dissolved methane concentrations) occurring within the IRZ.
- Trends in molar concentrations of parent compounds (PCE and TCE) and dechlorination products (cis-DCE, VC, ethene, and ethane) will be assessed over time within and downgradient of each IRZ system to evaluate IRZ system performance.

References

Suthersan, Suthan S. 2002. *Natural and Enhanced Remediation Systems.* Lewis Publishers, Boca Raton.

Nyer, Evan K. et al, 2001. *In Situ Treatment Technology, 2nd ed.* Lewis Publishers, Boca Raton.

Tables

Table B-1
Estimated Time for PCE Concentrations to Reach MCLs
Former Pesticide Shop, Fort George G. Meade, Maryland

Aquifer Parameters	Unit	Values
Total Porosity (θ_t)	--	0.25
Mobile Porosity (θ_m)	--	0.15
Immobile Porosity (θ_m)	--	0.1
Water Density (ρ_w)	g/cc	1
Soil Density (ρ_s)	g/cc	1.52
Bulk Density (ρ_b)	g/cc	1.216
Fraction Organic Carbon	--	0.001
Groundwater Velocity (V_{GW})	ft/day	0.72

Contaminant Parameters	Unit	Values
Log Koc	--	2.35
Kd	--	0.22
Retardation Factor (R)	--	2.09
Maximum / average PCE Concentration (C_{max})	ug/L	260
PCE Cleanup Goal (C_{goal})	ug/L	5
# of pore flushes to achieve cleanup	--	8.3
Current plume length	ft	271
Groundwater Travel Time through flushing zone	Year	1.0
Year to Cleanup	Year	**9**

Total number of years to achieve MCL: 9 years

Notes:
1. ft - feet
2. ft/day - feet per day
3. g/cc - grams per centimeters cubed
4. Kd - Solid-water partition coefficient
5. Koc - Organic carbon-water partition coefficient
6. MNA - Monitored Natural Attenuation
7. MCL - Maximum Contaminant Level
8. PCE - Tetrachloroethene
9. ug/L - micrograms per Liter

Table B-2
Alternative SL - 2 Cost Estimate
Land Use Controls for Soil
Former Pesticide Shop, Fort George G. Meade, Maryland

ITEM		QUANTITY	UNITS	UNIT COST	CAPITAL COST	ANNUAL O&M COST	PRESENT WORTH COST	ASSUMPTIONS
I. ADMINISTRATIVE ACTIONS								
1. Land-Use Restrictions		1	LS	$2,500	$2,500	$0	---	Engineering estimate for signs ($3000) and staff (20 hrs x $100/hr) to implement LUCs to manage any intrusive activity. Cost split between soil and GW.
2. Permitting		1	LS	$0	$0	$0	---	
3. Design		1	LS	$0	$0	$0	---	
SUBTOTAL					$2,500	$0	$0	
II. GENERAL ACTIONS AND SITE PREPARATION								
None		1	LS	$0	$0	$0	---	
SUBTOTAL					$0	$0	$0	
SUBTOTAL (I and II)					$2,500	$0	$0	
III. LONG-TERM MAINTENANCE, MONITORING & REVIEW								
1. Site Maintenance		1	LS	$1,000	$0	$1,000	$900	Maintain/replace signage ($1000)
2. Five Year Review Reports		6	LS	$2,500	$0	$15,000	$1,800	Engineering estimate to compile the Draft, Draft Final, and Final versions of the Five Year Review Report assuming all sites are combined. Cost split as above.
SUBTOTAL					$0	$16,000	$2,700	
SUBTOTAL (I, II and III)					$2,500	$16,000	$2,700	
IV. IMPLEMENTATION COSTS								
1. Administration and Legal	5% of Capital Costs	1	LS	$100	$100	$0	---	
2. Procurement	5% of Capital Costs	1	LS	$100	$100	$0	---	
3. Construction Management	1% of Capital Costs	1	LS	$300	$300	$0	---	
4. Completion Report		1	LS	$6,000	$6,000	$0	---	Engineering estimate to compile the Draft, Draft Final, and Final versions
5. Cost Contingency	10% of Capital Costs	1	LS	$300	$300	$0	---	
6. O&M Contingency	15% of O&M Costs	1	LS	$2,400	$0	$2,400	$1,000	
SUBTOTAL					$6,800	$2,400	$1,000	
SUBTOTAL (I, II, III, and IV)					$9,300	$18,400	$3,700	
A. TOTAL CAPITAL COSTS					$9,300			
B. TOTAL ANNUAL COSTS						$18,400		
C. TOTAL PRESENT WORTH OF ANNUAL COSTS							$3,700	
TOTAL PRESENT WORTH OF CAPITAL AND ANNUAL COSTS (A + C)							**$13,000**	

CY - Cubic Yard
EA - Each
LF - Linear Foot
LS - Lump Sum
SY - Square Yard
MGW - Methane Generating Waste
All construction and sampling assumed to be conducted in Level D PPE
Present worth costs are calculated using 7% interest and year 2010 dollars

Table B-3
Alternative GW - 2 Cost Estimate
Land Use Controls for Groundwater
Former Pesticide Shop, Fort George G. Meade, Maryland

ITEM		QUANTITY	UNITS	UNIT COST	CAPITAL COST	ANNUAL O&M COST	PRESENT WORTH COST	ASSUMPTIONS
I. ADMINISTRATIVE ACTIONS								
1. Land-Use Restrictions		1	LS	$2,500	$2,500	$0	---	Engineering estimate for signs ($3000) and staff (20 hrs x $100/hr) to implement LUCs to manage any intrusive activity. Cost split between Soil and GW.
2. Permitting		1	LS	$0	$0	$0	---	
3. Design		1	LS	$0	$0	$0	---	
SUBTOTAL					$2,500	$0	$0	
II. GENERAL ACTIONS AND SITE PREPARATION								
None		1	LS	$0	$0	$0	---	
SUBTOTAL					$0	$0	$0	
SUBTOTAL (I and II)					$2,500	$0	$0	
III. LONG-TERM MAINTENANCE, MONITORING & REVIEW								
1. Site Maintenance		1	LS	$1,000	$0	$1,000	$900	Maintain/replace signage ($1000)
2. Long Term Monitoring		10	YR	$6,500	$0	$65,000	$45,700	Begins in 2013. Annual monitoring for 5 years, followed by one event every 5 years through 2043.
3. Annual Reporting		10	YR	$5,000	$0	$50,000	$35,100	Ten annual reports total, one per event.
4. Five Year Review Reports		6	LS	$2,500	$0	$15,000	$1,800	Engineering estimate to compile the Draft, Draft Final, and Final versions of the Five Year Review Report assuming all sites are combined. Cost split as above.
SUBTOTAL					$0	$131,000	$83,500	
SUBTOTAL (I, II and III)					$2,500	$131,000	$83,500	
IV. IMPLEMENTATION COSTS								
1. Administration and Legal	5% of Capital Costs	1	LS	$100	$100	$0	---	
2. Procurement	5% of Capital Costs	1	LS	$100	$100	$0	---	
3. Construction Management	1% of Capital Costs	1	LS	$300	$300	$0	---	
4. Completion Report		1	LS	$6,000	$6,000	$0	---	Engineering estimate to compile the Draft, Draft Final, and Final versions
5. Cost Contingency	10% of Capital Costs	1	LS	$300	$300	$0	---	
6. O&M Contingency	15% of O&M Costs	1	LS	$19,700	$0	$19,700	$8,100	
SUBTOTAL					$6,800	$19,700	$8,100	
SUBTOTAL (I, II, III, and IV)					$9,300	$150,700	$91,600	
A. TOTAL CAPITAL COSTS					$9,300			
B. TOTAL ANNUAL COSTS						$150,700		
C. TOTAL PRESENT WORTH OF ANNUAL COSTS							$91,600	
TOTAL PRESENT WORTH OF CAPITAL AND ANNUAL COSTS (A + C)							**$100,900**	

CY - Cubic Yard
EA - Each
LF - Linear Foot
LS - Lump Sum
SY - Square Yard
MGW - Methane Generating Waste
All construction and sampling assumed to be conducted in Level D PPE
Present worth costs are calculated using 7% interest and year 2010 dollars

Table B-4
Alternative SL - 3 Cost Estimate
Excavation and Off-Site Disposal of Impacted Soils with LUCs
Former Pesticide Shop, Fort George G. Meade, Maryland

ITEM		QUANTITY	UNITS	UNIT COST	CAPITAL COST	ANNUAL O&M COST	PRESENT WORTH COST	ASSUMPTIONS
I. ADMINISTRATIVE ACTIONS								
1. Land-Use Restrictions		1	LS	$0	$0	$0	---	
2. Permitting		1	LS	$5,000	$5,000	$0	---	Engineering estimate for staff (50 hrs x $100/hr) to complete permits required by local, state, and federal governing agencies to conduct remedial activities
3. Design		1	LS	$7,500	$7,500	$0	---	Cost Split between GW and Soil Design - 7,500 for each (15K total)
SUBTOTAL					$12,500	$0	$0	
II. GENERAL ACTIONS AND SITE PREPARATION								
1. Mobilization / Demobilization		1	LS	$5,000	$5,000	$0	---	Engineering estimate to mobilize equipment and personnel to and from the site
2. Erosion and Sediment Control		1	LS	$2,500	$2,500	$0	---	Engineering estimate for furnishing, installing, and maintaining silt fence or straw bales
3. Clearing and Grubbing		0.04	Acre	$1,950	$78	$0	---	RS Means(2010) 31 11 10.10 0150
4. Air Monitoring		0	LS	$15,000	$0	$0	---	
5. Excavate Contaminated Soil		475	CY	$15.00	$7,125	$0	---	RS Means(2010) 31 23 16.13 0090
6. Waste Characterization		1	EA	$1,500	$1,500	$0	---	Engineering estimate for 1 sample per 500 cy of impacted soil and analysis of TCLP and RCRA 8 metals, VOCs, SVOCs, PAH, PCBs, Pesticides, and Herbicides
7. Transportation and Disposal of Soils Off-Site as Non-Hazardous		713	Ton	$65	$46,345	$0	---	Estimate from waste transportation contractor, assuming 100% of the spoils can be disposed of as non-hazardous and assuming a bulk density of 1.5 ton/CY
8. Transportation and Disposal of Soils Off-Site as Hazardous		0	Ton	$200	$0	$0	---	
9. Site Surveying		1	Days	$1,400	$1,400	$0	---	Estimate from surveying contractor for daily rate
10. Confirmation Sampling (Sidewall)		7	EA	$143	$1,000	$0	---	Engineering estimate for labor and materials for sampling (1 day x $300/day) and analytical charges ($100 each), assuming roughly 1 sample per 25 ft of wall
11. Confirmation Sampling (Floor)		2	EA	$175	$350	$0	---	Engineering estimate for labor and materials for sampling (1/2 day x $300/day) and analytical charges ($100 each), assuming 1 sample per 900 ft^2 of floor
12. Backfill Surface Soil Excavations (Common Borrow 18" Deep)		240	CY	$20	$4,800	$0	---	Engineering estimate to furnish and place common borrow to backfill the surface soil excavations, assuming a bulk density of 1.5 ton/CY
13. Backfill Surface Soil Excavations (Topsoil 6" Deep)		50	CY	$30	$1,500	$0	---	RS Means(2010) 32 91 19.13 0080
14. Seeding		1	LS	$2,500	$2,500	$0	---	RS Means(2010) 32 92 19.13 1000
15. Site Restoration		1	LS	$5,000	$5,000	$0	---	Engineering estimate to revegetate disturbed soil, remove silt fence, and conduct site clean-up as necessary
SUBTOTAL					$79,098	$0	$0	
SUBTOTAL (I and II)					$91,598	$0	$0	
III. LONG-TERM MAINTENANCE, MONITORING & REVIEW								
1. Cover Inspection and Maintenance		0	Years	$2,000	$0	$0	---	Assume no inspections of surface cover are required because of active GW treatment
2. Five Year Review Reports		1	LS	$5,000	$0	$5,000	$3,600	Engineering estimate to compile the Draft, Draft Final, and Final versions of the Five Year Review Report assuming all sites are combined
SUBTOTAL					$0	$5,000	$3,600	
SUBTOTAL (I, II and III)					$91,598	$5,000	$3,600	
IV. IMPLEMENTATION COSTS								
1. Administration and Legal	5% of Capital Costs	1	LS	$4,600	$4,600	$0	---	
2. Procurement	5% of Capital Costs	1	LS	$4,600	$4,600	$0	---	
3. Construction Management	1% of Capital Costs	1	LS	$9,200	$9,200	$0	---	
4. Completion Report		1	LS	$7,500	$7,500	$0	---	Engineering estimate to compile the Draft, Draft Final, and Final versions
5. Cost Contingency	10% of Capital Costs	1	LS	$9,200	$9,200	$0	---	
6. O&M Contingency	15% of O&M Costs	1	LS	$800	$0	$800	$300	
SUBTOTAL					$35,100	$800	$300	
SUBTOTAL (I, II, III, and IV)					$126,698	$5,800	$3,900	
A. TOTAL CAPITAL COSTS					$126,698			
B. TOTAL ANNUAL COSTS						$5,800		
C. TOTAL PRESENT WORTH OF ANNUAL COSTS							$3,900	
TOTAL PRESENT WORTH OF CAPITAL AND ANNUAL COSTS (A + C)							**$131,000**	

CY - Cubic Yard
EA - Each
LF - Linear Foot
LS - Lump Sum
SY - Square Yard
MGW - Methane Generating Waste
All construction and sampling assumed to be conducted in Level D PPE
Present worth costs are calculated using 7% interest and year 2010 dollars

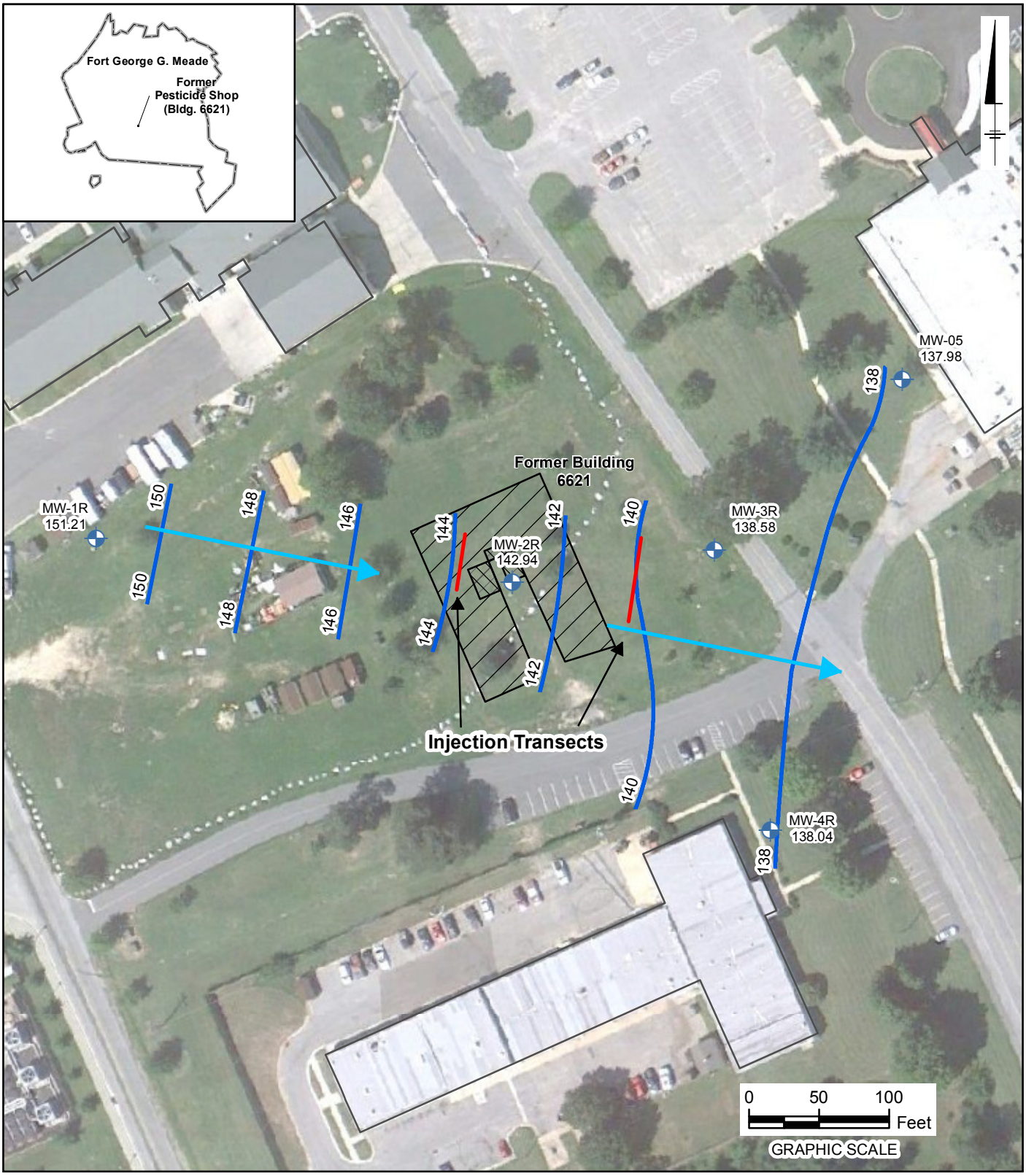
Table B-5
Alternative GW-3 Cost Estimate
Direct Push Injection of Carbon and Long Term Monitoring
Former Pesticide Shop, Fort George G. Meade, Maryland

ITEM		QUANTITY	UNITS	UNIT COST	CAPITAL COST	ANNUAL O&M COST	PRESENT WORTH COST	ASSUMPTIONS
I. ADMINISTRATIVE ACTIONS								
1. Permitting		1	EA	$5,000	$5,000	$0	---	Obtain UIC Permit
2. Design		1	EA	$7,500	$7,500	$0	---	Cost Split between GW and Soil Design (7,500 for each (15K total)
					$0	$0	---	
SUBTOTAL					$12,500	$0	$0	
II. LONG-TERM MAINTENANCE, MONITORING & REVIEW								
1. Long Term Monitoring		10	YR	$6,500	$0	$65,000	$45,700	Begins in 2013. Annual monitoring for 5 years, followed by one event every 5 years through 2043.
2. Annual Reporting		9	EA	$5,000	$0	$45,000	$32,600	Ten Annual reports total. One report assumed to be completion report included in the implementation costs
3. Five Year Review Reporting		6	EA	$5,000	$0	$30,000	$3,600	Engineering estimate to compile the Draft, Draft Final, and Final versions of the Five Year Review Report.
SUBTOTAL					$0	$140,000	$81,900	
SUBTOTAL (I, and II)					$12,500	$140,000	$81,900	
III. IMPLEMENTATION COSTS								
1. Administration and Legal	8% of net	1	LS	$1,760	$1,760	$0	---	8% of procurment and injection oversight labor
2. Procurement		1	LS	$5,000	$5,000	$0	---	Included implementation work plan development, subcontractor management, and equipment procurement
3. Injection Oversight		1	LS	$12,000	$12,000	$0	---	Injections completed over approximately 3 days (20 Inj points). Two DP rigs
4. Injection Subs and Expenses		1	LS	$26,600	$26,600	$0	---	2 Geoprobe rigs and crews for 3 days. All ARCADIS expenses
5. Completion Report		1	EA	$5,000	$5,000	$0	---	
6. Performance Monitoring		1	YR	$15,000	$15,000	$0	---	Quarterly performance monitoring for one year.
7. Capital Cost Contingency	5% Contingency	1	LS	$3,268	$3,268	$0	---	
8. O&M Contingency	15% Contingency	1	LS	$21,000	$0	$21,000	$8,700	
SUBTOTAL					$68,628	$21,000	$8,700	
SUBTOTAL (I, II and III)					$81,128	$161,000	$90,600	
A. TOTAL CAPITAL COSTS					$81,128			
B. TOTAL ANNUAL COSTS						$161,000		
C. TOTAL PRESENT WORTH OF ANNUAL COSTS							$90,600	
TOTAL PRESENT WORTH OF CAPITAL AND ANNUAL COSTS (A + C)							**$172,000**	

CY - Cubic Yard
EA - Each
LF - Linear Foot
LS - Lump Sum
YR - Year

All construction and sampling assumed to be conducted in Level D PPE
Present worth costs are calculated using 7% interest and year 2012 dollars

Figures



Legend:

- Well
- Injection Transects
- Groundwater Elevation Contour
- Former Pesticide Shop Buildings
- Former Building 6621
- Groundwater Flow Direction

2 direct push injection transects spaced 125 feet apart (~6 months)
Transect 1 - 40 feet - 8 direct push points
Transect 2 - 60 feet - 12 direct push points
Direct push points spaced 5 feet on center
Direct push points to ~30 ft bgs
15 feet treatment thickness
220 gallons per point - 4,400 gallons of solution
3% Emulsified vegetable oil solution by weight

Notes:

1. Groundwater elevation data were collected on 1 June 2010 and are presented in feet above mean sea level.

2. Imagery 8/29/2010 Google Earth Pro, Accessed 5/1/2012 © 2012 Google, 2012 Geoeye, U.S. Geological Survey

FGGM-13 FORMER PESTICIDE SHOP, BUILDING 6621
FORT GEORGE G. MEADE, MARYLAND

Proposed ERD Technology

ARCADIS

FIGURE
B-1