DRAFT-FINAL

ENGINEERING EVALUATION / COST ANALYSIS FOR ARSENIC AND OTHER SELECTED CHEMICALS IN SOIL –

VOLUME I

SPRING VALLEY OPERABLE UNITS 4 AND 5 WASHINGTON, D.C.

CONTRACT DAHA90-94-D-0010, TASK ORDER DA01
DERP-FUDS HTRW PROJECT NO. C03DC091802

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ARSENIC SPLP TECHNICAL MEMO

AUES LIST SAMPLING - REPORT OF RESULTS

SAMPLING PROCEDURES - SUPPORTING STATISTICS MEMORANDA

1 **ACRONYM LIST**

ABPs	Agent Breakdown Products
ANOVA	Analysis of Variance
ARARs	Applicable or Relevant and Appropriate Requirements
AU	American University
AUES	American University Experiment Station
bgs	Below Ground Surface
CDC	Child Development Center
CENAB	Corps of Engineers Baltimore District
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CF	Conversion Factor
COC	Chemical of Concern
COPC	Chemicals of Potential Concern
CSA	Comprehensive Sampling Area
CSM	Conceptual Site Model
CSS	Chemical Safety Submission
CTA	Central Testing Area
CVAA/CVAO	Chlorovinylarsonic acid/Chlorovinylarsine oxide
CWA	Clean Water Act
CWM	Chemical Warfare Materiel
DA	Department of the Army
DoD	Department of Defense
DCEHA	District of Columbia Environmental Health Administration
DERP/FUDS	Defense Environmental Restoration Program/Formerly Used Defense Sites
EA	Exposure Area
EE/CA	Engineering Evaluation/Cost Analysis
EPC	Exposure Point Concentration
EPCRA	Emergency Planning and Community Right-to-Know Act
FUDS	Formerly Used Defense Site
GSD	Geometric Standard Deviation

H	Mustard Agent
HBESL	Health-Based Environmental Screening Level
HEAST	Health Effects Assessment Summary Tables
HI	Hazard Index
HQ	Hazard Quotient
ICP	Inductively Coupled Plasma
IR	Soil Ingestion Rate
IRIS	Integrated Risk Information System
IUR	Inhalation Unit Risk
L	Lewisite
LDRs	Land Disposal Restrictions
LOAEL	Lowest-Observed-Adverse-Effect Level
MCLs	Maximum Contaminant Levels
Mg	Manor Glenelg
mg/kg	Milligram per Kilogram
mph	Miles per hour
NCP	National Contingency Plan
NOAEL	No-Observed-Adverse-Effect Level
NTCRA	Non-Time Critical Removal Action
OE	Ordnance and Explosives
OSHA	Occupational Safety and Health Act
OSR	Operation Safe Removal
OSR FUDS	Operation Site Removal Formerly Used Defense Site
OU-3	Operable Unit 3
OU-4	Operable Unit 4
OU-5	Operable Unit 5
PEF	Particulate Emission Factor
POI	Point of Interest
PPM	Part-per-Million
PQL	Practical Quantitation Limit
PRGs	Preliminary Remediation Goals
PRSCs	Post Removal Site Controls

RA	Risk Assessment
RBCs	Risk-Based Concentrations
RCRA	Resource Conservation and Recovery Act
RfC	Reference Concentration
RfD	Reference Dose
RME	Reasonable Maximum Exposure
SDA	Small Disposal Area
SF	Slope Factor
SOW	Scope Of Work
SPLP	Synthetic Precipitate Leaching Procedure
SSLs	Soil Screening Levels
SSS	Site Safety Submission
SVOCs	Semi-Volatile Organic Compounds
TAL	Target Analyte List
TCL	Target Compound List
TCRA	Time Critical Removal Action
TEC	Topographic Engineering Center
UCL	Upper Confidence Limit
ULB	Urban Land Brandywine
ULMg	Urban Land-Manor Glenelg
ULSC	Urban Land-Sassafras Chillum
USACE	U.S. Army Corps Of Engineers
USAESCH	U.S. Army Engineering and Support Center, Huntsville
USEPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compound

EXECUTIVE SUMMARY

E.1 EE/CA OVERVIEW

E.1.0.1 This Engineering Evaluation/Cost Analysis (EE/CA) for arsenic and other selected chemicals at Spring Valley Operable Unit 4 and Operable Unit 5 contains: a summary of the site history; a description of the site investigation and summary of the site investigation results; a description of the nature and extent of arsenic contamination; a risk evaluation summarizing remediation endpoints and comparison criteria; the objective and goal of the removal action; an analysis of identified removal action alternatives; and, a recommendation for the selected alternative. This document does not evaluate future actions related to non-arsenic compounds.

E.2 BACKGROUND AND SITE DESCRIPTION

E.2.0.1 To address potential contamination associated with activities conducted at the former American University Experiment Station (AUES), located in Spring Valley, Washington, DC, an investigation was undertaken by the U.S. Army Corps of Engineers (USACE). A remedial investigation (RI) of the Operation Safe Removal Formerly Used Defense Site (OSR FUDS) completed by the USACE in June 1995 (USACE, 1995) determined that no further action was required, with the exception of potential future characterization activities at an area designated as the Spaulding and Captain Rankin Areas. During a 1997 review of the 1995 RI (USACE 1998), it became apparent that the area investigated during the 1995 RI as Point of Interest (POI) No. 24 was actually located in the vicinity of 4801 Glenbrook Road, and not on the American University campus as originally thought. A geophysical investigation of the grounds at 4801 Glenbrook Road determined that two geophysical anomalies had the potential characteristics of burial pits or trenches. The pits were subsequently excavated and all Chemical Warfare Materiel (CWM), ordnance and explosive (OE) items, and hazardous items were removed for appropriate off-site disposal.

E.2.0.2 To address concerns voiced by the District of Columbia Environmental Health Administration (DCEHA), the United States Environmental Protection Agency (USEPA), Region III, collected surface soil and subsurface soil samples in and around 4801, 4825, and 4835 Glenbrook Road to supplement their Risk Assessment (USEPA, 1999a). Based on the interim results from the USEPA Region III sampling, historical information, and the USEPA Risk Assessment, it was determined that the soil of these three properties (4801, 4825, and 4835 Glenbrook Road) could have been impacted by AUES activities in the vicinity of the two burial pits. To evaluate the potential impact, the USACE performed a site investigation to determine the nature and extent of contamination found in the surface and subsurface soils of 4801 Glenbrook Road. This area was designated as Operable Unit 3 (OU-3).

E.2.0.3 The analysis of the USACE site investigation data and the USEPA data indicated elevated levels of arsenic at 4801, 4825, and 4835 Glenbrook Road. The subsurface samples identified elevated levels of arsenic in areas where the surface soil sample results also detected elevated levels of arsenic. Based on the results of the OU-3 site investigation, an EE/CA (OU-3 EE/CA) (USACE, 2000b) and baseline risk assessments for 4801, 4825, and 4835 Glenbrook Road were prepared to respond to the potential hazard associated with arsenic contamination in the soil.

E.2.0.4 Based on the findings of the above investigations, an expanded area (approximately 91 acres) was further investigated as Operable Unit 4 (OU-4). OU-4 included approximately 80 private residences and significant portions of the current American University. This investigation indicated arsenic concentrations above risk-based concentrations and above normal background levels. In consultation with the USEPA and the DCEHA, the USACE then undertook an extensive characterization of the remaining Spring Valley FUDS boundary, some 577 acres, designated as Operable Unit 5 (OU-5). The soils of both OUs were characterized for arsenic and selected chemicals associated with AUES activities. This EE/CA addresses the findings of the OU-4 and OU-5 soil investigations.

E.3 OU-4 AND OU-5 CHARACTERIZATION

E.3.0.1 Within OU-4 and OU-5, all acreage, residential and non-residential, was divided into one-half acre (approximate) exposure areas, or sites, for sampling purposes. 1,483 sites were investigated and the soil characterized for arsenic contamination. Of these, 287 sites also had the soil characterized for selected CWM constituents representative of past practices at that specific site. The findings indicate that approximately 11% of the sites had arsenic above the screening criteria of 12.6 mg/kg (95th percentile of the background data set). Although some of the OU-4 and OU-5 sites were found to contain other compounds/elements, none of the sites contained any of these other compounds/elements at levels above their respective screening/health criteria.

E.4 EE/CA OBJECTIVE

E.4.0.1 The objective of this EE/CA is to evaluate and analyze site data and to recommend and justify a preferred alternative to address the contamination in the soil. The selected removal action alternative must be protective of human health and the environment. To ensure that the selected removal action alternative is also protective of groundwater and the potential for construction worker exposure, this EE/CA also addresses the potential for vertical migration of arsenic. The objective of this EE/CA does not include evaluation of future actions related to non-arsenic compounds in soil. This document does not address groundwater; a separate groundwater investigation is planned for the near future.

E.5 REMOVAL ACTION ALTERNATIVES

E.5.0.1 In order to satisfy the objectives, the following removal action alternatives were identified and evaluated:

- No Action;
- Institutional Controls and Engineering Controls;
- Phytoremediation (the use of plants to remove arsenic contamination);
- Soil Stabilization (the use of cement-like substances to prevent migration);
- Soil Washing (the use of solvents to remove arsenic contamination); and
- Excavation and Landfill Disposal (physical removal and landfilling of arsenic contamination).

E.6 RECOMMENDED ALTERNATIVE

E.6.0.1 Excavation and landfill disposal was selected as the recommended alternative for those areas of Spring Valley FUDS identified as having arsenic in the soil above the remediation endpoint. This is the most effective alternative, achieves the project objectives in the timeliest manner, and has already been successfully implemented at various portions of the site.

1. INTRODUCTION

1.1 PROJECT AUTHORIZATION

1.1.0.1 This project addresses the Spring Valley Formerly Used Defense Site (FUDS) and falls under the Defense Environmental Restoration Program/Formerly Used Defense Sites (DERP/FUDS). This work is being performed under Contract DAHA90-94-D-0010, Task Order DA01, DERP/FUDS Project no. C03DC091802, for the U.S. Army Corps of Engineers (USACE), Baltimore District (CENAB). The work scope and objectives are in accordance with the response program identified in the National Contingency Plan (NCP), 40 CFR 300, and particularly subpart E, sections 300.400 through 300.415 and subpart I, sections 300.800 through 300.825. The United States Environmental Protection Agency's (USEPA) *Guidance on Conducting Non-Time Critical Removal Actions Under CERCLA* (USEPA, 1993) was also used for this project. All activities involving work in areas potentially contaminated with ordnance and explosives (OE) and chemical warfare materiel (CWM) was conducted in full compliance with U.S. Army Engineering and Support Center, Huntsville (USAESCH), CENAB, Department of the Army (DA), and Department of Defense (DoD) requirements.

1.2 SCOPE AND OBJECTIVE

1.2.0.1 The scope of this Engineering Evaluation/Cost Analysis (EE/CA) is to characterize and evaluate potential soil contamination within the Spring Valley Formerly Used Defense Site (Spring Valley site), located in the Spring Valley neighborhood of Washington, DC. The presence of arsenic resulting from past U.S. Army activities has been documented in the soil within the Spring Valley site. This document does not address groundwater; a separate groundwater investigation is planned for the near future. The regional map showing the Spring Valley site relative to Washington, DC is shown in Figure 1-1. The Spring Valley site location map is presented as Figure 1-2.

1.2.0.2 The objective of this EE/CA is to evaluate and analyze site data and to recommend and justify a preferred alternative to address the contamination in the soil. The selected alternative must protect human health and the environment. To perform the analysis and evaluation, the following tasks were completed:

- Determined the nature and extent of arsenic and other constituents in the surface and subsurface soils at the site;
- Performed a streamlined risk evaluation of contaminants found in soils at the site;
- Identified requirements that were applicable or relevant and appropriate to the hazard and removal action and set cleanup goals where no such requirements were identified;
- Identified and developed removal action alternatives;
- Screened the removal action alternatives; and
- Performed a comparative analysis of the remaining removal action alternatives.

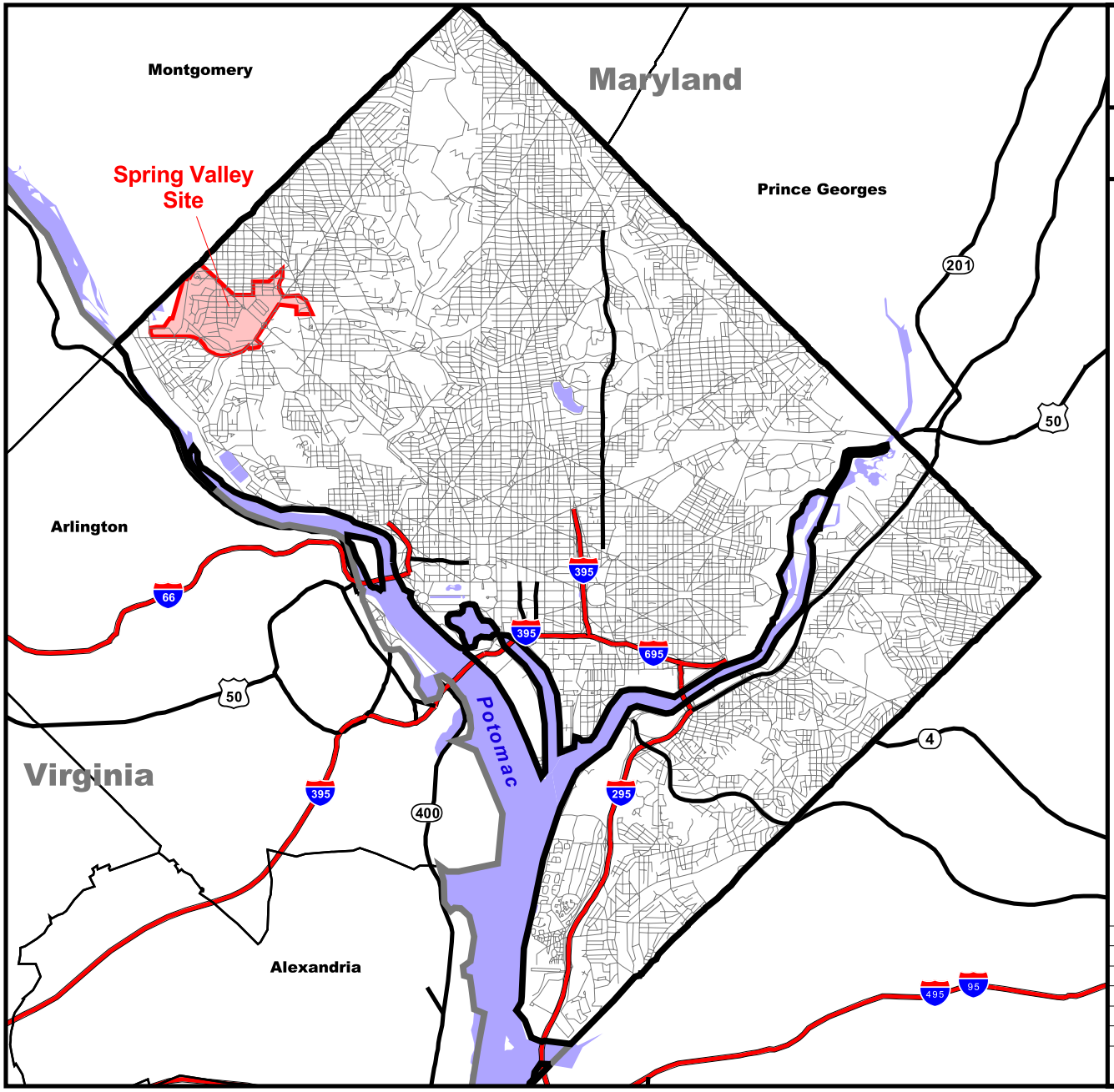

Figure 1-1
Location Map

Spring Valley Site-Wide
Washington D.C.

Legend

- District of Columbia
- States
- Counties

Major Roads

- Interstate
- Urban Freeway
- Streams & Lakes
- DC Local Streets
- Spring Valley Site

N W E S

2 0 2 Miles

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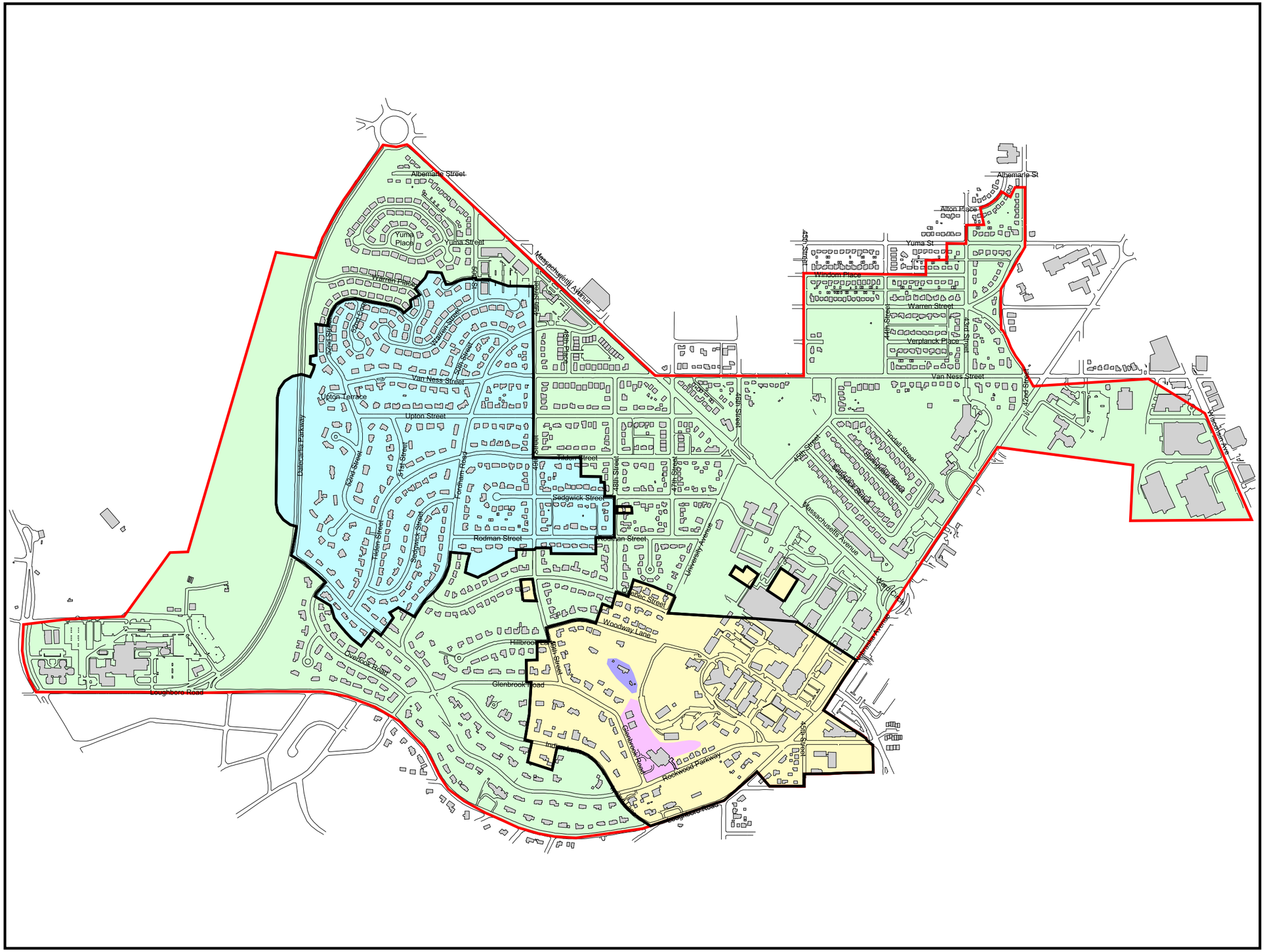

Figure 1-2
Site Location Map

Spring Valley Operable Units 4 & 5
Washington D.C.

Legend

- Spring Valley Boundary
- Buildings
- Roads
- OU-2
- OU-3
- OU-4
- Central Testing Area (CTA)
- Comprehensive Sampling Area (CSA)

Note:
OU-5 area is CTA plus CSA

N
W E
S

0 1000 Feet

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1.3 SITE BACKGROUND

1.3.0.1 The U.S. Army operated the former American University Experiment Station (AUES) in a portion of Spring Valley during World War I. In January 1993, a utility contractor accidentally uncovered buried ordnance at a property in Spring Valley. Following removal of the ordnance, the USACE conducted an investigation of the area. A Remedial Investigation (RI) documenting the Operation Safe Removal FUDS (OSR FUDS) activities completed by the USACE in June 1995 (USACE, 1995) determined that no further action was required, with the exception of potential future characterization activities at an area designated as the Spaulding and Captain Rankin Areas (Operable Unit 2). During a 1997 review (RI Evaluation Report, USACE, 1998) of the 1995 OSR FUDS RI Report, initiated by the District of Columbia Environmental Health Administration (DCEHA), it became apparent that the area investigated during the 1995 RI as Point of Interest (POI) No. 24 was actually located in the vicinity of 4801 Glenbrook Road and not on the American University campus as originally thought. It was determined that two geophysical anomalies on the grounds of 4801 Glenbrook Road had the potential characteristics of pits or trenches. The pits were excavated and all CWM, OE items, and hazardous items, were removed for appropriate off-site disposal.

1.3.0.2 To address concerns of DCEHA, the USEPA Region III collected surface soil and subsurface soil samples in and around 4801, 4825, and 4835 Glenbrook Road to supplement their Risk Assessment (USEPA, 1999). It was determined that the soil of these three properties could have been impacted by AUES activities in the vicinity of the two burial pits. The USACE performed an EE/CA (USACE, 2000b) to determine the nature and extent of contamination found in the surface and subsurface soils of the three properties. The area of these three properties was designated as Operable Unit 3 (OU-3).

1.3.0.3 Based on these events, a partnership was formed with the relevant agencies involved in the decision-making process. The Spring Valley Partners (Partners), the USACE, USEPA, and DCEHA, ensure that the concerns of all parties are addressed. Additionally, advisory entities were created, including the Restoration Advisory Board (RAB) and the Scientific Advisory Panel. The Partners work together to focus the investigations, allow input from the community, and respond to issues that could impact the Spring Valley neighborhood.

1.4 CURRENT INVESTIGATION

1.4.0.1 Based on the findings of the above investigations and the recommendation of DCEHA, an expanded area (approximately 91 acres) was further investigated as Operable Unit 4 (OU-4). OU-4 included approximately 80 private residences and significant portions of the current American University (AU). This investigation indicated arsenic concentrations above risk-based concentrations and above normal background levels. In consultation with the USEPA and the DCEHA, the USACE then undertook an extensive characterization of the remaining Spring Valley FUDS, some 577 acres, designated as Operable Unit 5 (OU-5). The soils of both Operable Units were characterized for arsenic and selected CWM compounds associated with AUES activities. This EE/CA addresses the findings of the OU-4 and OU-5 investigations.

1.4.0.2 Within OU-4 and OU-5, all acreage, residential and non-residential, was divided into one-half acre (approximate) exposure areas, or sites, for sampling purposes. To date, 1,483 sites

have been investigated and the soil characterized for arsenic contamination. Of these, 287 sites also had the soil characterized for selected CWM constituents representative of past practices at that specific site. The findings indicate that approximately 11% of the sites had arsenic above the screening criteria. Although a small number of samples had detections for possible CWM degradation products, none of the sites contained any of the CWM or CWM degradation products at levels above their respective screening criteria.

1.5 REPORT ORGANIZATION

1.5.0.1 This EE/CA comprises three volumes. The EE/CA report in Volume I consists of an Executive Summary, 10 sections, and 2 appendices. Section 1 contains an introduction to the project. Section 2 provides a site description and history. Section 3 discusses the field investigation performed and the results of that investigation. Section 4 discusses the source, nature, and extent of contamination. Section 5 contains a risk evaluation, including a discussion of the applicable comparison criteria and remediation endpoints. Section 6 discusses the removal action goal and objectives. Section 7 provides the identification and analysis of the removal action alternatives. Section 8 provides the comparative analysis of removal action alternatives. Section 9 describes the recommended removal action alternative. Section 10 provides the references. Appendix A contains detailed maps of individual sites and features relevant to the sampling effort. Appendix B contains a detailed presentation of the costs associated with the recommended alternative.

1.5.0.2 Volume II, Sampling Results and Data Validation, presents all OU-4 and OU-5 sample data organized by type of sampling and the associated data validation reports, as well as the USEPA split sampling results.

1.5.0.3 Volume III, Technical Memoranda and Other Supporting Data, presents the following memoranda and data reports relevant to the characterization of OU-4 and OU-5:

- Arsenic Speciation Technical Memorandum
- Arsenic Bioavailability Technical Memorandum
- Arsenic SPLP Technical Memorandum
- AUES List Sampling – Report of Results
    - 3819 48th Street, 4710 Quebec Street, 4625 & 4633 Rockwood Parkway
    - AU Lot 12 and Child Development Center
    - Sedgwick Trench Area
- Sampling Procedures – Supporting Statistics Memoranda

2. SITE CHARACTERIZATION

2.1 SITE DESCRIPTION

2.1.1 Site Location and History

2.1.1.1 The Spring Valley site is located in the Spring Valley neighborhood of northwest Washington, DC. The 668-acre area currently includes approximately 1,200 private residences, foreign embassies, AU, Wesley Seminary, and numerous commercial properties. It includes the former AUES and Camp Leach. The area was originally 661 acres, but further refinement of the boundary at the northeastern extension (between 42nd Street and Wisconsin Avenue) and the southeastern area (around Newark and 345th Street) added approximately seven acres. During World War I, the U.S. Government established the AUES to investigate the testing, production, and effects of noxious gases, antidotes, and protective masks. The AUES was located on the grounds of the current AU and used additional portions of property in the vicinity to conduct this research and development of CWM (including mustard, Lewisite, and Adamsite agents), irritants, and smokes. The areas not used for testing were used to house and train troops (Camp Leach). Some areas that were part of AUES, but which are not within the current 668- acre FUDS boundary, will be addressed under future investigations.

2.1.1.2 In the spring of 1921, the Construction Division began salvage and restoration work and all temporary facilities were dismantled. At the end of the war, interest in buying properties for residential use slowly grew. Those properties formerly occupied by the AUES, but not part of the university property, were developed for housing (USACE, 1995).

2.1.2 Structure and Topography

2.1.2.1 Cut and fill maps were generated by USACE for the OSR FUDS RI (USACE, 1995) by merging 1918 and 1983 topographic maps. The 1983 topographic map was based on elevation data revised in 1965. The maps were digitized and then horizontally aligned by using features common to both maps (e.g. roads, street intersection and buildings). The vertical alignment was performed by digitally correcting the scale followed by a comparison of the contour lines. Vertical alignment was also confirmed by identifying two peak elevations with no apparent changes between 1918 and 1991. Based on the subsurface soil borings collected at 4801 Glenbrook Road it was confirmed that the cut and fill maps accurately depict areas of cut and fill within OU-3 vicinity

2.1.2.2 This information was supplemented by an aerial survey conducted in November 2000 for the OU-4 investigation. This provided updated 2-foot elevation contour intervals. The cut and fill maps were regenerated based on the 1918 topographic map's 10-foot elevation contour intervals and the new contour intervals.

2.1.3 Geology and Soil Information

2.1.3.1 Four geological formations are apparent in the vicinity of the site. These formations (from west to east) are the Sykesville Formation, the Dalecarlia Intrusive Suite, an Actinolite Schist, and the Coastal Plain Terrace Formation (USGS 1994). The Sykesville Formation is

sedimentary melange consisting of fragments of metagraywacke, migmatites, amphibolite, and actinolite schist in a quartzofeldspathic matrix. The Dalecarlia Intrusive Suite consists of massive to well-foliated biotite monzogranite and lesser granodiorites. The Actinolite Schist unit consists of actinolite schist, actinofels, actinolite-chlorite schist and lesser talc bearing rocks. The Coastal Plain Terrace Gravel consists of highly weathered, crudely bedded gravel, sand, silt, and clay (Fleming, A. H., Drake, A. A., Jr., McCartan, Lucy, 1994). The Piedmont Formations are igneous or metamorphic in origin. The Coastal Plain Terrace Formation is fluvial in origin (Fleming, A. H., Drake, A. A., Jr., McCartan, Lucy, 1994). Schistosity is the major structural feature of the Piedmont rocks and saprolite at the site.

2.1.3.2 Four soil associations are present within Spring Valley: the Urban Land-Sassafras Chillum (ULSC), the Urban Land-Manor Glenelg (ULMg), Manor Glenelg (Mg), and Urban Land Brandywine (ULB). The ULMg soil association is a well to moderately well drained soil resulting from the weathering of the basement rocks (schist). The ULSC soil results from the weathering of Coastal deposits. However, typically these soils have been greatly disturbed by construction and landscaping activities. The bedrock consists of a variety of metasedimentary rocks of actinolite schist. Relatively competent saprolite material is encountered at depth that ranges between 6 to 10 feet below ground surface (bgs). This material appears to be the transition between loose soil material and highly competent bedrock. During the 4801 Glenbrook Road burial pit investigation, extremely competent saprolite was still being encountered after excavation to 18 feet.

2.1.4 Groundwater

2.1.4.1 Groundwater depth at the site is not known. During the investigation of the burial pits at 4801 Glenbrook Road, one pit extended as deep as 18 feet and at no time was groundwater encountered. There are various aquifer systems associated with the site vicinity. These include terrace gravels and fracture system aquifers associated with the Piedmont formations, saprolite systems, and fill systems. Groundwater may be found in any and all of these aquifers, however, the majority of the groundwater would be expected to be found in the underlying bedrock that comprises the fracture system aquifer. Additionally, there are a number of major fault and fold systems in the site vicinity. These features, as well as the topography of the site, will affect the general flow of groundwater.

2.1.4.2 There is no evidence to suggest that the groundwater aquifers are used for drinking water. The District of Columbia is supplied water by a treated and tested water distribution system. However, it is the DCEHA position that all groundwater could potentially be used for drinking water and therefore, DCEHA has requested a groundwater investigation. This investigation is planned for the near future.

2.1.5 Surrounding Land Use and Populations

2.1.5.1 Land use in and around Spring Valley is primarily low-density residential (three to four dwellings per acre). The campus of AU is considered institutional use. Zoning on site is also predominantly for single-family detached housing except on the AU Campus, which is zoned for apartments.

2.2 SENSITIVE ECOSYSTEMS

2.2.1 Flora and Fauna

2.2.1.1 During the OSR FUDS RI, research was conducted into the nature and type of fauna and flora found within Washington, DC. Due to the extensive development of Spring Valley, native vegetation is generally limited to narrow bands associated with the intermittent streams or the area west of Dalecarlia Parkway. The dominant plant species are red maple, white oak, red oak, chestnut oak, mountain laurel, and greenbriar. The District of Columbia exhibits a diverse fauna for an area that is principally urban in character. Approximately 35 species of mammals and 175 species of birds occur within the District of Columbia throughout the year. The occurrence of parklands generally determines the relative abundance and location of wild life (USACE, 1995).

2.2.2 Aquatic Life and Wetlands

2.2.2.1 There are numerous small creeks and streams throughout the District of Columbia. For the OU-3 EE/CA, the small creek located east of the house at 4801 Glenbrook Road was reviewed in more detail than any other creeks or streams. It was determined that the small size and the extensive development of the area would limit the types of aquatic organisms that might be present. The stream may contain frogs, toads, oligocheates (worms), snails, and assorted aquatic insects. No evidence that the creek supports a population of native fish was found. Wetlands in the site vicinity are limited. No wetlands were impacted by the OU-4 and OU-5 investigation activities.

2.2.3 Wildlife and Endangered Species

2.2.3.1 Because Spring Valley is largely developed, wildlife species found are typical of those found in most urban-suburban areas. Mammals that can be found in and around the site include its most visible diurnal mammal, the gray squirrel, as well as raccoon, opossum, eastern chipmunk, field mice, deer, voles, and moles (USACE, 1995).

2.2.3.2 Common birds in the area include those that have adapted to an urban-suburban environment such as the American robin, catbird, mockingbird, Carolina chickadee, Carolina wren, downy woodpecker, common flicker, European starling, house sparrow, rock dove, mourning dove, and song sparrow. Black vultures and turkey vultures have aerial coverage throughout the vicinity. Migrating birds such as Canadian geese and other waterfowl frequent the area (USACE, 1995). Because Spring Valley and the areas surrounding it are mostly developed, they provide little habitat for rare, threatened, or endangered species. However, the District of Columbia is home to a federal endangered isopod that lives in Piedmont springs.

2.3 METEOROLOGY

2.3.1.1 Observational records have been kept continuously at locations within the District of Columbia since November 1870. These weather-monitoring stations were relocated to Reagan National Airport and Dulles International Airport when these airports opened in the 1940s and 1970, respectively. The District of Columbia area has an average yearly temperature of 54.5ºF, and the climate in the area is classified as modified continental. The average length of the

growing season is 200 days. The coldest average daily temperatures are in late January and early February (upper 20sºF), and the warmest average daily temperatures are in mid-July (upper 80sºF).

2.3.1.2 Normal annual precipitation is approximately 41 inches and is distributed evenly throughout the year. Thunderstorms may occur at any time, but are most frequent during the later spring and summer. Downpours and gusty winds most often accompany the storms. Tropical storms can bring heavy rains. Hailstorms can occur in the spring. Rainfalls of over 7 inches have occurred during hurricanes. Average snowfall is approximately 20 inches per year. Although a snowfall of 10 inches or more in 24 hours is unusual, several notable snowfalls of more the 25 inches within 24 hours have occurred. Winds are generally light and variable, but thunderstorms can bring gusty winds. Usually, the gusts from windstorms are not severe. Prevailing wind direction is from the northwest. The average wind speed in the Washington D.C. area is approximately 9 miles per hour (mph). Wind gusts can be expected to peak at approximately 40 mph, but may occasionally reach approximately 60 mph. Tornadoes and tropical storms occur infrequently, but these storms can and have caused damage in the District of Columbia area.

2.4 RELATED REMOVAL ACTIONS/INVESTIGATIONS

2.4.1 OSR FUDS Remedial Investigation

2.4.1.1 In January 1993, a utility contractor accidentally uncovered buried ordnance at a property in Spring Valley. Following removal of the ordnance, the USACE conducted a Remedial Investigation [OSR FUDS RI (USACE, 1995)] of the entire area within the OSR FUDS boundary. During the investigation, some 53 areas of potential hazards were identified and designated as POIs. The investigation utilized geophysical technology to identify buried ordnance and soil sampling to identify areas of soil contamination. In June 1995, the USACE determined that no further action was required at the Spring Valley site, with the exception of a portion of the site known as the Spaulding and Captain Rankin Areas.

2.4.1.2 In June 1994, an EE/CA was performed for the Spaulding and Captain Rankin Areas (USACE 1996a) to determine the appropriate action for addressing the soil and material contained within the former shell pits and surrounding areas. The shell pits had the potential to contain: intact OE items; scrap OE items; and, intact containers filled with CWM and CWM breakdown products. Some OE-related items were encountered, including OE scrap, frag, and fused components. The only compounds identified that posed an unacceptable risk to human health were lead and arsenic in the soil. During the removal, all material was taken off site for disposal. In June 1996, the USACE recommended that no further action be taken at the Spaulding and Captain Rankin Areas.

2.4.2 Burial Pit EE/CA Investigation

2.4.2.1 During a 1997 review (RI Evaluation Report, USACE, 1998) of the 1995 RI, it became apparent that the area investigated during the 1995 RI as POI No. 24 was not the actual location of POI 24. POI 24 had been identified as a probable pit through interpretation of a 1918 aerial photograph. However, POI 24 was actually located in the vicinity of 4801 Glenbrook

Road, and not on the AU campus as originally thought. To further evaluate the situation, the USACE performed a geophysical investigation of the grounds at 4801 Glenbrook Road to locate and characterize the potential burial pit. It was determined that two geophysical anomalies on the grounds of 4801 Glenbrook Road had the potential characteristics of pits or trenches. Nine other anomalies did not have the characteristics of pits or trenches. All eleven anomalies were investigated and resolved.

2.4.2.2 To perform this work, a Site Safety Submission (SSS) [*Site Safety Submission, Spring Valley, Operable Unit 3, Washington, DC*, prepared for the U.S. Army Engineering and Support Center, Huntsville (USAESCH), by Parsons Engineering Science, Inc. (USACE 1999b), as changed, amended, and approved by the Department of Defense Explosive Safety Board (DDESB) and the U.S. Army Technical Center for Explosives Safety (USATCES)], was prepared. Investigative work on the two burial pits at 4801 Glenbrook Road began in March 1999 and concluded approximately one year later. The objective of the investigation was to determine the extent and nature of the material contained within the two burial pits. Approximately 288 pieces of ordnance, 14 of which were chemical munitions; 175 glass bottles, 77 of which contained acids and other chemicals; 39 cylinders, and 9 metal drums, were recovered. Additional compounds detected in soil samples included various volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and metals (most notably arsenic). The excavation of the pits concluded when the pit characterization soil samples (floor and wall samples) did not detect CWM, CWM breakdown products, or elevated levels of VOCs, SVOCs, or metals. All recovered material was disposed off site at a facility appropriate for the type of material and level of contamination, as follows: all CWM contaminated scrap, or CWM contaminated soil was disposed at a licensed industrial waste disposal incinerator; material determined to be hazardous under the Resource Conservation and Recovery Act (RCRA) guidelines was disposed of at a RCRA subtitle C landfill; material considered RCRA non-hazardous or not contaminated with CWM was disposed of in a sanitary landfill.

2.4.2.3 Another burial pit (Test Pit 23), partially on 4801 Glenbrook Road and partially on the adjacent 4825 Glenbrook Road property was investigated in the same manner (Site Safety Submission, Addendum 10, USACE, March 2001). Several hundred OE items and a three CWM-related items were recovered from this pit. The 4801 Glenbrook Road portion was cleared, backfilled, and restored, while the 4825 Glenbrook Road site was temporarily backfilled pending resolution of various administrative issues.

2.4.3 Small Disposal Area

2.4.3.1 In April 1999, during a USEPA environmental sampling event, a DCEHA representative discovered surface debris located on AU property in the vicinity of the 4801 Glenbrook Road site. The area, designated as the Small Disposal Area (SDA) was thought to be a burial site potentially associated with AUES CWM research and testing activities. The investigation was conducted under the Site Safety Submission, Addendum 09, USACE, October 2000. In January 2001, debris including old used oil filters, glass and labware, and other miscellaneous debris, was removed from the SDA by the USACE. Soil contaminated with elevated levels of arsenic, lead, and mercury was encountered. Historical evidence suggests that during the operation of the AUES, the SDA was very close to the perimeter fence of the AUES. However, an archaeological review of the items recovered during the excavation concluded that

the disposal occurred in the early 1930's. The area was backfilled and closed following the 2001 removal.

2.4.4 Time Critical and Non-Time Critical Removal Actions

2.4.4.1 To address concerns of the DCEHA, the USEPA Region III collected surface soil and subsurface soil samples in and around 4801, 4825, and 4835 Glenbrook Road to supplement their Risk Assessment (USEPA, 1999). It was determined that the soil of these three properties could have been impacted by AUES activities in the vicinity of the two burial pits. The USACE performed grid sampling to determine the nature and extent of contamination found in the surface and subsurface soils of the three properties (OU-3). The OU-3 EE/CA and baseline risk assessments for 4801, 4825, and 4835 Glenbrook Road addressed the potential hazard associated with arsenic contamination in the soil. A Non-Time Critical Removal Action (NTCRA) was performed to address the arsenic-contaminated soil at 4825 and 4801 Glenbrook Road. The soil removal was conducted from December 2000 to August 2002. The soil at 4835 Glenbrook Road is expected to be addressed in a future removal action.

2.4.4.2 Grid sampling conducted in January 2001 as part of the OU-4 and OU-5 investigation identified arsenic contamination in the surface soils at the Child Development Center (CDC). This property, located on AU property within the boundaries of OU-4, was formerly used for AUES activities. A Time Critical Removal Action (TCRA) was performed to address contaminated soil at the CDC. The soil removal was completed by November 2001 *(Post Removal Action Report, USACE, Draft Final, December 2002).*

2.4.4.3 Grid sampling conducted in March 2001 as part of the OU-4 and OU-5 investigation identified arsenic contamination in the surface soils on other portions of the AU campus. A TCRA was also conducted to address this arsenic contaminated soil at the AU athletic fields and other AU lots located within OU-4. These areas include grids associated with AU lots 8, 10, 11, 12, 13, 14, and 15; soil borings that were sampled in AU Lots 16, 19, 23 and 24; and the grounds around Kreeger Hall and Watkins Hall. These areas were also formerly used for AUES activities. The soil removal was begun in the summer of 2002 and is on-going (*Removal Action Design, Final USACE, June 2002)*.

2.4.4.4 The USACE determined that TCRAs would also be performed at several residential properties. The prioritization of these properties was based on the results of the arsenic testing. An Exposure Point Concentration (EPC), derived from the 95 percent Upper Confidence Limit (UCL) of the grid data, was used as the primary prioritization strategy. Other factors involved in the prioritization included access agreements and proximity logistics, where otherwise lower priority sites close to high priority sites were also scheduled. This work was begun in July 2002 and is on-going. The following list could be expanded based on additional sampling. Therefore it is not intended to be a final list. These properties include:

- 4446 Tindall Street
- 4438 Tindall Street
- 4219 50th Street
- 4119 45th Street
- 4460 Springdale Street
- 4115 45th Street
- 4456 Springdale Street
- 4442 Tindall Street
- 4434 Tindall Street
- 4425 Upton Street

- 4637 Rockwood Prkwy
- 5001 Rockwood Prkwy
- 4624 Van Ness Street
- 4655 Massachusetts Avenue
- Group 5, Lot 15
- 4850 Rockwood Prkwy
- 3800 52nd Street
- 4641 Rockwood Prkwy
- 4230 Fordham Street
- 4647 Massachusetts Avenue
- 4007 49th Street
- 3709 Corey Street
- 4651 Massachusetts Avenue

2.4.5 OE/CWM Investigations

2.4.5.1 Various investigations focusing on identification of geophysical anomalies and the search for and subsequent remediation of OE/CWM burial pits (if present) have been undertaken or are in the process of being conducted. Because those investigations focus on finding OE/CWM burial pits and therefore have different objectives than the subject of this document (arsenic-contaminated soil), only a general summary of those activities is presented here.

2.4.5.2 The USACE, DCEHA, and USEPA developed a prioritization scheme to focus on those areas requiring additional geophysical investigation and those anomalies requiring intrusive investigation. A Chemical Safety Submission (CSS) was prepared as a site-wide plan to address the safe performance of the investigation and recovery of OE or CWM items associated with the AUES. As described in the CSS, based on the site history and previous investigations, the following items could be present: empty or CWM-filled ordnance, including 75mm rounds, Livens projectors, 3-inch Stokes mortars; or related items such as ceramic jars potentially containing CWM. In addition to the intrusive investigation described in section 2.4.2, anomalies were investigated and/or excavated at a POI known as the Sedgwick Trench area and also on portions of the current AU Campus (AU Lots).

2.4.6 Other

2.4.6.1 In the 1930's a house was built at 4801 Glenbrook Road. In the early 1980's this house was demolished and the residence for the Ambassador of the Republic of South Korea to the United States was constructed. The two remaining lots north of 4801 Glenbrook Road remained undeveloped until 1992. In 1992 two houses were built north of 4801 Glenbrook Road on the lots of 4825 and 4835 Glenbrook Road. During the construction of the 4825 house, some glassware was encountered, and construction workers reportedly complained about an exposure during work activities. During the construction of the house at 4835 Glenbrook Road a closed 55-gallon drum, laboratory jars and equipment, and ceramic pieces were encountered. The soil where this material was encountered was characterized as having had a "rotten odor". The site was evaluated by Environmental Management Systems Inc. (EMS) who performed a site investigation and deemed the site "okay" to continue work (Apex, 1996). In 1996 workers at 4835 Glenbrook Road were excavating to install trees and experienced irritation to the eyes and respiratory system. Laboratory glassware was observed in this excavation. Apex Environmental over-excavated the holes and performed a site investigation of 4835 Glenbrook Road. Other than the material removed, Apex concluded that there were no significant levels of contamination.

3. SAMPLE PROGRAM AND RESULTS

3.1 SAMPLE PROGRAM OVERVIEW

3.1.0.1 The sample program for OU-4 and OU-5 was designed using the *Soil Screening Guidance: User's Guide, (USEPA, July 1996)* [Soil Screening Guidance]. Detailed procedures for conducting the sample program are contained in the *Final Work Management Plan for Spring Valley Operable Unit 4 (Parsons ES, August 2000)* and the *Final Work Management Plan for Spring Valley Operable Unit 5 (Parsons, October 2002)* [WMP].

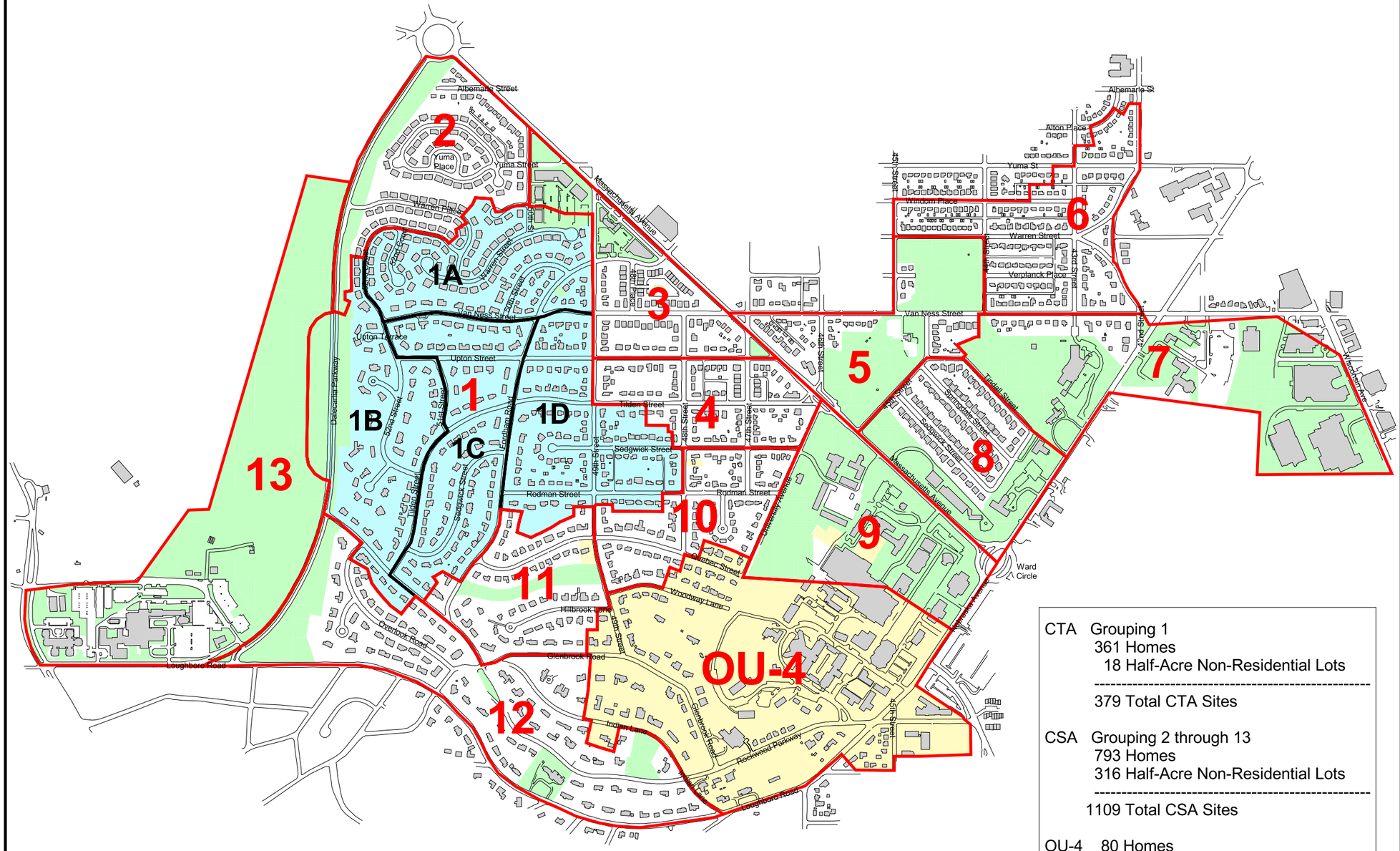
3.1.0.2 Both OUs contain residential properties and non-residential acreage (commercial property, undeveloped areas, parks, etc.). In accordance with the Soil Screening Guidance, this acreage was divided into one-half acre lots (approximate) to represent discrete exposure areas (EAs). Each EA, whether residential property or non-residential acreage, was considered a "site", i.e., a discrete exposure area to be sampled. For tracking purposes, the sites were further categorized by type of exposure area as either residential properties (homes) or non-residential acreage (lots).

3.1.0.3 Figure 3-1 presents the entire Spring Valley site boundary with the OU-4 and OU-5 boundaries indicated. Detailed maps of individual sites showing cut and fill contours, groundscar data, surveyed boring locations, and other information relevant to understanding the sampling effort are contained in Appendix A.

3.1.0.4 The sampling effort for OU-4 began in August 2000 and for OU-5 in June 2001; the effort is on-going as of the date of this document. A cut-off date of May 31, 2003 was used to present and discuss sample data for this document. This represents more approximately 93% of all available sites in OU-4 and OU-5. Complete validated sampling results for each site and each type of sampling through May 31, 2003, are contained in the data tables in Volume II (Sampling Results and Data Validation).

3.1.1 OU-4

3.1.1.1 The area defined as OU-4 is approximately 91 acres of residential properties and non-residential acreage, including 80 homes and 34 lots (114 total sites). This acreage total does not include the area of commercial or other non-residential buildings that could not be sampled, but does include the acreage of paved areas such as parking lots. This count is based on aerial photographic surveys and available real estate records. The lots are mainly AU property (AU Lots). Some properties outside of the established OU-4 boundary were sampled as OU-4 sites to accommodate specific requests, prior to the establishment of OU-5. As indicated on Figure 3-1, the area of OU-3 is contained within the OU-4 boundary. Sites sampled within OU-3 were addressed in the OU-3 EE/CA.



CTA Grouping 1
361 Homes
18 Half-Acre Non-Residential Lots
---
379 Total CTA Sites

CSA Grouping 2 through 13
793 Homes
316 Half-Acre Non-Residential Lots

1109 Total CSA Sites

OU-4 80 Homes
34 Half-Acre Non-Residential Lots
---
114 Total OU-4 Sites

Figure 3-1 Geographical Groupings

Spring Valley Operable Units 4 & 5
Washington D.C.

Legend

- CTA Groupings
- Groupings
- Buildings
- Roads
- Non-Residential Acreage
- CTA
- OU-4

Note:
OU-5 Acreage comprises groupings 1 through 13.

CSA is groupings 2 through 13.

Note:
- Single family houses and each townhouse count as 1 residential lot.
- Commercial and other types of buildings are not included in the residential count.
- The non-residential acreage count does not include the area of the commercial building, but does include paved parking lots and other potentially inaccessible areas. Sampling of these lots will be based on open accessible portions determined in the field.

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3.1.2 OU-5 Central Testing Area (CTA)

3.1.2.1 Based on the past usage of areas within OU-5, the OU-5 soil sampling effort was divided into two phases: 1) the Central Testing Area (CTA), and 2) the Comprehensive Sampling Area (CSA). The CTA includes the POIs where AUES CWM field testing was documented based on aerial and ground photographs, testing reports, and other historical documents. The CTA boundary was established by including a 200-foot buffer around the POIs with documented field testing. Once each POI 200-foot buffer was established, the CTA boundary line connected all the POI 200-foot outer boundary lines, enclosing all of that acreage within a larger area designated as the CTA. The CTA is approximately 132 acres. The CTA contains 361 homes and 18 lots (379 total sites).

3.1.3 OU-5 Comprehensive Sampling Area (CSA)

3.1.3.1 The CSA includes all the remaining acreage outside of the CTA (not including the OU-3 and OU-4 area. The CSA is approximately 445 acres. The CSA contains 793 homes and 316 lots (1109 total sites).

3.1.4 Geographical Groupings

3.1.4.1 In order to most efficiently perform the sampling, the OU-5 sites were geographically grouped (Figure 3-1). For OU-5, the CTA is one grouping, while the CSA is divided into 12 groupings. The arbitrary boundaries of the groupings were intended to be approximately equal work efforts to help plan the sampling. The groupings also helped track specific samples by providing location-based nomenclature.

3.1.4.2 Table 3.1 summarizes the total site count organized by OU and Geographical Groupings.

3.2 SAMPLE PROCEDURES

3.2.1 Quadrant Surface Sampling – OU-4 and CTA

3.2.1.1 In general accordance with the Soil Screening Guidance, each OU-4 and CTA site was divided into four equal areas called quadrants. Six (6) surficial soil samples (sub-samples) were collected per quadrant. These sub-samples were composited to make one sample for the quadrant for submittal to the analytical laboratory (4 samples per site). The sub-samples were collected from random locations within the quadrant. For CTA properties approximately two acres or larger, the property was divided into approximately half-acre lots. Each of those half-acre lots received the quadrant sampling described above. For OU-4 properties approximately two acres or larger, each quadrant received 12 random sub-samples. Samples were not collected where cultural features and/or current site features prevented access to the surface soils (i.e. equipment sheds, patios, gravel roads etc.). Samples were collected from the first six inches of surficial soil.

3.2.1.2 It should be noted that the actual procedure used to collect quadrant samples deviated slightly from the Soil Screening Guidance. The Soil Screening Guidance calls for six total samples per site, with each sample comprising one sub-sample from each of the four quadrants.

A statistical analysis was performed to ensure that the deviation from the Soil Screening Guidance procedure would not compromise attainment of the project decision error goals described in the WMP. The statistical memorandum describing this analysis is contained in Volume III of this document.

Table 3.1
Site Count

Geographical Grouping	Homes	Lots	Total Sites
OU-4			
OU-4 Totals	**80**	**34**	**114**
OU-5 (CTA)			
1A	104	3	107
1B	57	15	72
1C	85	0	85
1D	115	0	115
CTA Total	**361**	**18**	**379**
OU-5 (CSA)			
2	109	11	120
3	79	8	87
4	90	0	90
5	46	33	79
6	149	0	149
7	17	66	83
8	76	20	96
9	0	47	47
10	83	0	83
11	59	6	65
12	85	21	106
13	0	104	104
CSA Total	**793**	**316**	**1109**
OU-5 Totals	**1154**	**334**	**1488**
OU-4 + OU-5			
OU-4 + OU-5 Totals	**1234**	**368**	**1602**

3.2.2 Half Surface Sampling – CSA

3.2.2.1 The CSA sampling design considered that this acreage did not contain documented CWM field testing areas. Therefore, fewer samples were collected (in general, because of the documented CWM field testing, the CTA included a more focused sampling approach than the

CSA). Each CSA site was divided into two equal halves (essentially the front and backyard for a home). Eight (8) surficial soil samples (sub-samples) were collected from each half. This number of sub-samples maintained the relative statistical power of the quadrant sampling approach used for OU-4 and the CTA. Samples were not collected where cultural features and/or current site features prevented access to the surface soils. Samples were collected from the first six inches of surficial soil. For properties approximately two acres or larger, the property was divided into approximately half-acre lots. Each of those half-acre lots received the half sampling described above. A statistical analysis was also performed to demonstrate that the CSA sampling approach maintained the relative statistical power of the quadrant approach and to show that the project decision error goals described in the WMP could be achieved using this procedure. The CSA statistical memorandum is also contained in Volume III of this document.

3.2.2.2 Figure 3-2 presents the example sampling configurations for each approach.

3.2.3 Subsurface Sampling – OU-4

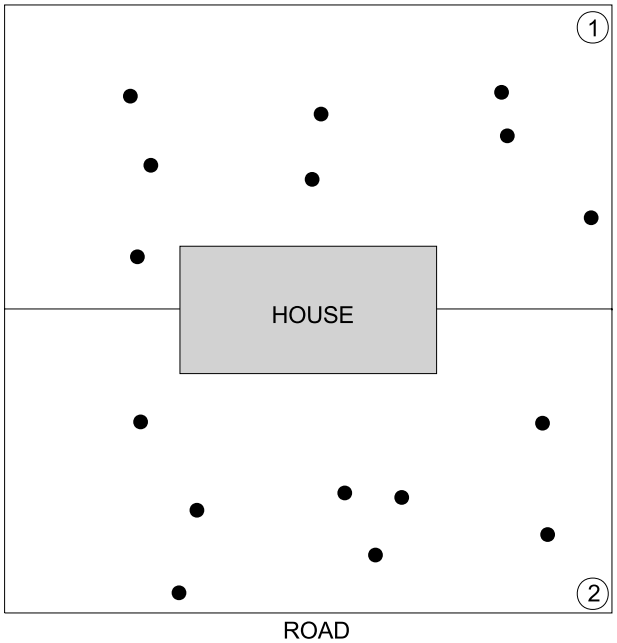
3.2.3.1 In general, one subsurface boring was advanced at each site. For properties approximately two acres or larger, two borings were advanced per lot. Subsurface borings were advanced following clearance by the anomaly avoidance personnel. Sampling of the boring was continuous. A direct push Geoprobe contractor was used to obtain the boring samples. To help site the boring, the cut and fill map developed during the 1995 RI was used to determine which areas represent fill material since 1918 levels. The standard rationale for siting a boring was as follows: the boring locations reflected the USEPA Photographic Interpretation Center (EPIC) identified groundscars and stressed vegetation (features that may indicate areas potentially related to the former AUES activities). If none were present, the boring was located in a fill area, with the boring extending two feet beyond the fill (to a maximum depth of 10 feet). In an area of cut or a level area, the boring was advanced six feet below ground surface (bgs).

3.2.4 Subsurface Sampling – CTA

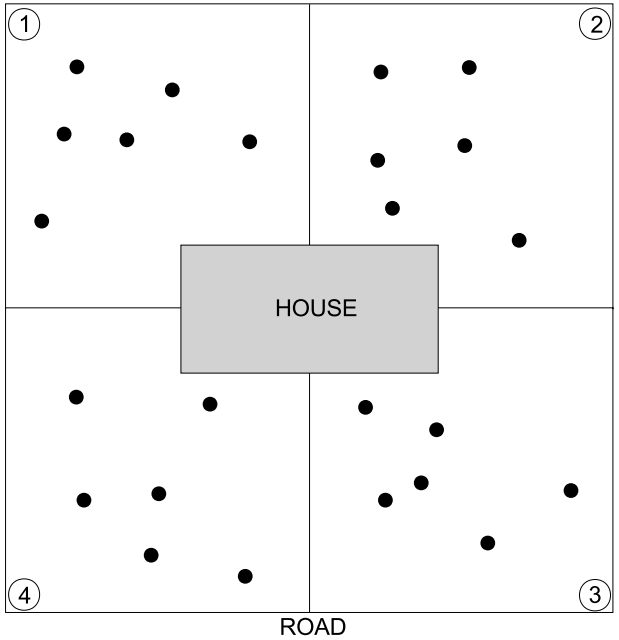
3.2.4.1 In general, one subsurface boring was advanced at each site. For properties approximately two acres or larger, the property was divided into approximately half-acre lots and one boring was advanced per lot. Subsurface borings were advanced following clearance by the anomaly avoidance personnel. Sampling of the boring was continuous. A direct push Geoprobe contractor was used to obtain the boring samples.

3.2.4.2 For most sites, the standard rationale described below directed where the boring was located. Certain CTA-POI locations followed a different rationale; those are also described below.

3.2.4.3 To help site the boring, the cut and fill map developed during the 1995 RI was used to determine which areas represent fill material since 1918 levels. The standard rationale for siting a boring was as follows: the boring locations reflected the USEPA Photographic Interpretation Center (EPIC) identified groundscars or stressed vegetation. If none were present, the boring was located in a fill area, with the boring extending two feet beyond the fill (to a maximum depth of 10 feet). In an area of cut or a level area, the boring was advanced six feet below ground surface (bgs). Areas of fill that contain groundscars or stressed vegetation were the priority location for the boring.



Example Half Sampling Configuration - CSA
(8 sub-samples composited into 1 for the half)



Example Quadrant Sampling Configuration - CTA & OU4
(6 sub-samples composited into 1 for the quadrant)

Figure 3-2
Example - Quadrant and Half Sampling Configuration

Spring Valley Operable Units 4 & 5
Washington D.C.

Legend

- ● Sub-Sample Location Randomly Placed
- (1) Quadrant or Half

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3.2.5 Subsurface Sampling – CSA

3.2.5.1 Within the CSA, borings were placed on approximately 15% of the sites (approximately 166 sites). The sites were selected based on the prioritization analysis listed in Table 3.2 with borings in the highest priority sites (Priority 1) selected first, then Priority 2, etc., until the total amount (15% or 166 sites) was reached. Once a CSA site was selected using the prioritization logic, the standard rationale for locating the boring at the site was used. Additionally, for CSA sites that exceeded the arsenic screening level (discussed in section 3.2.6), that did not originally get a subsurface boring using the prioritization logic, borings were placed based on grid sampling results as follows: if any CSA half arsenic result was greater than 43 milligrams per kilogram (mg/kg), a boring with analytical parameters as discussed in Section 3.3.2 was placed.

Table 3.2
Subsurface Boring Placement Rationale (In Order of Priority)

1.	Overlapping ground scars in undisturbed area (cut/fill ≤ 4 ft.)
2.	Overlapping ground scars in disturbed area (cut/fill: 4 ft. < cut ≤ 10 ft., 4 ft. < fill ≤ 10 ft.
3.	Ground scar and later stressed vegetation or single 1918 ground scar in undisturbed area.
4.	Ground scar and later stressed vegetation or single 1918 ground scar in disturbed area.
5.	Single ground scar (post 1918) in undisturbed area.
6.	Single ground scar (post 1918) in disturbed area.
NOTES:	♦ Cut and fill refers to the ground scar or stressed vegetation, not the entire lot. ♦ Borings must be placed in ≤ 8 ft. fill for lots with existing houses and ≤ 10 ft. fill for undeveloped lots.

3.2.6 Grid Sampling

3.2.6.1 Sites containing surface sample results exceeding the screening level of 12.6 mg/kg [also described as parts-per-million (ppm)] arsenic received further investigation. Development of the screening level and a discussion of other comparison criteria, are presented in Section 5. Sites with at least one quadrant or half sample exceeding 12.6 mg/kg arsenic were grid sampled. The grid system consisted of 20-foot by 20-foot squares (grids) oriented across the entire site, with a single discrete sample collected at the grid center. On a case-by-case basis, some sites received a tighter grid system (10-foot by 10-foot), for example, some residences near the Sedgwick Trench Area. Also, some sites that had sample results less than the screening level, but which were in close proximity to other sites that contained screening level exceedances, were also grid sampled.

3.2.6.2 Table 3.3 summarizes the sample count by site type and analytical parameter. The table includes sampling through May 31, 2003.

Table 3.3
Sample Count

Area	Arsenic Surface	Arsenic Sub-surface [1]	Specialty Parameters [2]	Arsenic Grid
OU-4	330	648	30	1,291
OU-5 CTA	1,556	2,538	101	2,369
OU-5 CSA	2,138	1,387	184	3,696
Total	4,024	4,573	315	7,356

[1] Includes all soil boring samples collected during both quadrant/half & grid sampling. This counts all sample intervals in a single boring.

[2] Includes all specialty parameter samples collected during both quadrant/half & grid sampling.

3.3 ANALYTICAL PROGRAM

3.3.1 Surface Sample Analyses

3.3.1.1 The quadrant and half surface samples are composites. With the exception of the AU Lots and 4835 Glenbrook Road, these were analyzed for arsenic only. Surface samples for the AU Lots and 4835 Glenbrook Road also received mustard agent breakdown product (ABP) analysis. The grid samples are discrete samples; they were also analyzed for arsenic only.

3.3.2 Subsurface Sample Analyses

3.3.2.1 The subsurface samples were discrete samples collected at the bottom of each one-foot interval in the boring and analyzed for arsenic. Additionally, specific lists of compounds to be analyzed, based on the documented AUES activities, were developed for the CTA POI sites (POIs are shown on Figure 3-3, presented later in the discussion). These POI-specific lists of compounds were organized into sample plans as shown in Table 3.4. All CSA borings were analyzed for Sample Plan 2 parameters. These sample plans were collectively designated as "Specialty Parameters" to distinguish from arsenic-only analysis.

3.3.2.2 The POI-specific specialty parameters were only collected from one interval in the boring. With the exception of the POI 13 and Sedgwick Trench borings, the selected one-foot interval was the 1918 level (6 inches above and 6 inches below) as determined by the cut and fill data. In cut areas, or zero cut/fill, the specialty parameter sample was collected at 0-12 inches bgs. The trench boring samples were collected at the trench bottom, the most likely area of residual contaminants.

3.3.2.3 Subsurface sample analyses for the OU-4 samples were different from the OU-5 analyses. The OU-4 sites that were part of the AU campus (AU Lots) received a boring with arsenic analysis at every foot, plus mustard ABP analysis for the subsurface sample collected at the 1918 level. Table 3.4. indicates the specific mustard ABPs. The OU-4 sites that were private

homes only received arsenic analyses for the subsurface samples, with the exception of portions of the sampling described in sections 3.8 through 3.11 below.

Table 3.4
Subsurface Sample Plans

Sample Plan No.	Sample Plan 1	Sample Plan 2	Sample Plan 3	Sample Plan 4
Area	**POI 19**	**POIs 15R & 16R, and CSA Subsurface**	**POIs 7R, 13, 39**	**POI 38**
Compounds	Arsenic	Arsenic	Arsenic	Arsenic
	Mustard	Mustard	Mustard	Tetryl
	Mustard ABPs (Oxathiane, Dithiane, Thiodiglycol)	Mustard ABPs (Oxathiane, Dithiane, Thiodiglycol)	Mustard ABPs (Oxathiane, Dithiane, Thiodiglycol)	Trinitrotoluene (TNT)
		Lewisite ABPs (CVAA/CVAO)	Lewisite ABPs (CVAA/CVAO)	Nitroglycerin
		Cyanide	Cyanide	2,4 dinitrotoluene (2,4-DNT)
			Tetryl	2,6 dinitrotoluene (2,6-DNT)
			Trinitrotoluene (TNT)	Nitrobenzene
			Nitroglycerin	
			2,4 dinitrotoluene (2,4-DNT)	
			2,6 dinitrotoluene (2,6-DNT)	
			Nitrobenzene	

3.4 OU-4 SAMPLING RESULTS

3.4.1 Arsenic Sampling Results

Through May 31, 2003, 107 sites (73 homes and 34 lots) had been sampled within OU-4. This includes surface and subsurface samples. Of these, 20 sites exceeded the screening level of 12.6 mg/kg arsenic and warranted follow-on grid sampling. The highest surface quadrant arsenic result was 101 mg/kg. The highest subsurface quadrant boring arsenic result was 124 mg/kg. This result was from the 0-1 foot bgs sample from the boring. The highest subsurface quadrant boring arsenic result at a depth greater than 1 foot bgs was 71.4 mg/kg. This result was from the 1-2 foot bgs sample from the boring. Based on arsenic concentrations in subsurface boring samples from four of the AU lots (AU lot 16, 19, 23, and 24), follow-on work was warranted as described in Section 2.4.4.

3.4.1.1 A summary of these results, as well as a summary of the following discussions, is presented in Table 3.5. The complete data tables for all the sampling can be found in Volume II.

Table 3.5
Results Summary

Sample Type	Highest Arsenic Result (mg/kg)	Location\1	Exceed Arsenic Screening Criteria?	Detected Specialty Parameter (compound) \2	Location\1	Exceed Specialty Screening Criteria?	Follow-on Action\3
OU-4 Surface	101	OU4-4625RP-3	YES	Thiodiglycol	AU lot 6	NO	Grid Sampling
OU-4 Subsurface	124	OU4-AU12-SB1	YES	Thiodiglycol	AU lot 24	NO	Removal
OU-4 Grid	498	OU4-CDC-(150,140)	YES	NONE	NA	NA	Removal
OU-5 CTA Surface	105	CTA-1A-4219(50)-4	YES	NONE	NA	NA	Grid Sampling
OU-5 CTA Subsurface	62.8	CTA-1C-5046Sedg-SB1	YES	Cyanide	CTA-1C-3940FR-SB(9-10)	NO	Removal
OU-5 CTA Grid	613	CTA-1B-3800(52)-(40,80)	YES	NONE	NA	NA	Removal
OU-5 CSA Surface	202	CSA-5-4115(45)-2	YES	NONE	NA	NA	Grid Sampling
OU-5 CSA Subsurface	20.6	CSA-9-L44-SB3	YES	Cyanide	CSA-2-5133YS-SB(2-3), CSA-3-4105(49)-SB(7-8), CSA-10-4813WL-SBB(2-3), and CSA-10-4813WL-SBA(8-9),	NO	TBD
OU-5 CSA Grid	529	CSA-5-4115(45)-(0,20)	YES	NONE	NA	NA	Removal

\1 Sample nomenclature explained in WMP and in Volume II.
\2 Compound was detected, but concentration was well below the screening level.
\3 Follow-on action based on arsenic results. Action may not have been completed by date of this report.
NA - Not applicable. TBD – To be determined

3.4.2 Specialty Parameters Sampling Results

3.4.2.1 The mustard ABPs collected on the AU lots are considered to be the specialty parameters for OU-4 sampling. Mustard ABPs were only detected in two samples, representing two different AU lots. The detected ABP was thiodiglycol, and each detection was well below the screening level for this compound. Discussion of the screening level for thiodiglycol, as well as for other comparison criteria, is presented in Section 5.

3.4.3 Grid Sampling Results

3.4.3.1 As indicated above, 20 of the 107 sampled OU-4 sites exceeded the arsenic screening level and received grid sampling. Additionally, as a conservative measure, one site (4629RP) that did not exceed the arsenic screening level was grid sampled because of proximity to numerous other sites that had arsenic screening level exceedances. A total of 21 OU-4 sites were grid sampled. The highest OU-4 grid sample arsenic result was 498 mg/kg.

3.4.3.2 Figure 3-3 presents the grid sampled site locations. This figure includes OU-4 and OU-5 sites sampled, and for which data had been validated, through May 31, 2003, in order to track with the data tables presented in Volume II. Individual site maps showing grid results are also included in Volume II.

3.5 OU-5 CTA SAMPLING RESULTS

3.5.1 Arsenic Sampling Results

3.5.1.1 Through May 31, 2003, 364 sites (355 homes and 9 lots) had been sampled within the OU-5 CTA. This includes surface and subsurface samples. Of these, 51 sites exceeded the screening level of 12.6 mg/kg arsenic and warranted follow-on grid sampling. The highest surface quadrant arsenic result was 105 mg/kg. The highest subsurface quadrant boring arsenic result was 62.8 mg/kg. This result was from the 0-1 foot bgs sample from the boring. The highest subsurface quadrant boring arsenic result at a depth greater than 1 feet bgs was 22.8 mg/kg. This result was from the 4-5 foot bgs sample from the boring. In September 2001, the USEPA took 16 split samples with the USACE at selected CTA locations. The results, which indicate no discrepancies between USEPA and USACE arsenic concentrations, are presented in Volume II.

3.5.2 Specialty Parameters Sampling Results

3.5.2.1 The only specialty parameter detected in an OU-5 CTA sample was cyanide. Cyanide was detected in only one of the 101 specialty samples collected in the CTA. The cyanide detection was well below the screening level for this compound. Discussion of the screening level for cyanide, as well as for other comparison criteria, is presented in Section 5.

3.5.3 Grid Sampling Results

3.5.3.1 As indicated above, 51 of the 364 sampled OU-5 CTA sites exceeded the arsenic screening level, warranting grid sampling. Of the 51 sites, 49 had been grid sampled through May 31, 2003. The highest OU-5 CTA grid sample arsenic result was 613 mg/kg. See Figure 3-3.

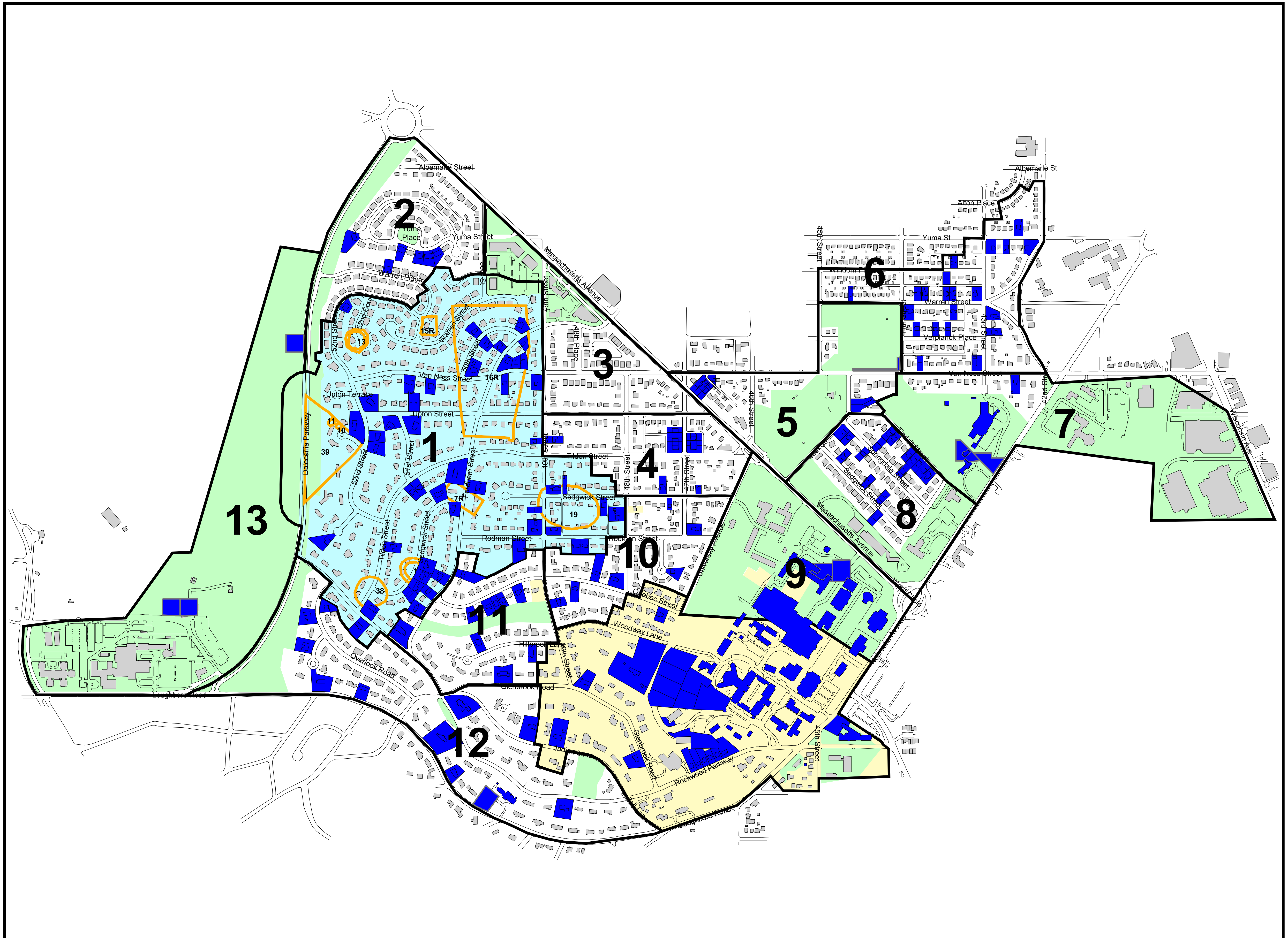

Figure 3-3
Grid Sampled Sites

Spring Valley Operable Units 4 & 5
Washington D.C.

Legend

- Grid Sampled Property
- Groupings
- POIs
- Buildings
- Roads
- Non-Residential Acreage
- CTA
- OU-4

Note:
OU-5 Acreage comprises groupings 1 through 13.

CSA is groupings 2 through 13.

0 1000 Feet

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3.6 OU-5 CSA SAMPLING RESULTS

3.6.1 Arsenic Sampling Results

3.6.1.1 Through May 31, 2003, 1012 sites (757 homes and 255 lots) had been sampled within the OU-5 CSA. This includes surface and subsurface samples. Of these, 100 sites exceeded the screening level of 12.6 mg/kg arsenic and warranted follow-on grid sampling. The highest surface composite sample arsenic result was 202 mg/kg. The highest subsurface boring arsenic result was 20.6 mg/kg. This result was from the 2-3 foot bgs sample from the boring.

3.6.2 Specialty Parameters Sampling Results

3.6.2.1 The only specialty parameter detected in an OU-5 CSA sample was cyanide. Cyanide was detected in only four of the 179 specialty samples collected in the CSA. Two of the four detections were from the same property (4813WL), although from different borings and at different depths. All of the cyanide detections were well below the screening level for this compound. Discussion of the screening level for cyanide, as well as for other comparison criteria, is presented in Section 5.

3.6.3 Grid Sampling Results

3.6.3.1 As indicated above, 100 of the 1012 sampled OU-5 CSA sites exceeded the arsenic screening level, warranting grid sampling. Of the 100 sites, 99 had been grid sampled through May 31, 2003. The highest OU-5 CSA grid sample arsenic result was 529 mg/kg. See Figure 3-3. In November 2001, the USEPA took 20 split samples with the USACE at selected CSA grid locations. The results, which indicate no discrepancies between USEPA and USACE arsenic concentrations, are presented in Volume II.

3.7 USEPA BACKGROUND SAMPLING ACTIVITIES

3.7.1 Sample Procedures and Analyses

3.7.1.1 In 1993 and 1994, the USEPA performed a background study of Spring Valley soils. The procedure was to collect 12 split samples from the background soil samples collected by USACE during the 1995 OSR FUDS RI. These samples were used in the USEPA Risk Assessment (USEPA, 1999). The samples were collected within the OSR FUDS boundary and represent the four soil associations (ULMg, ULSC, Mg, and ULB) encountered in Spring Valley. In August 1999, the USEPA collected 30 background samples from outside of the OSR FUDS boundary; these samples reflected the four soil associations present within Spring Valley and were collected to provide data to supplement the USEPA Risk Assessment. Figure 3-4 shows the background sampling locations.

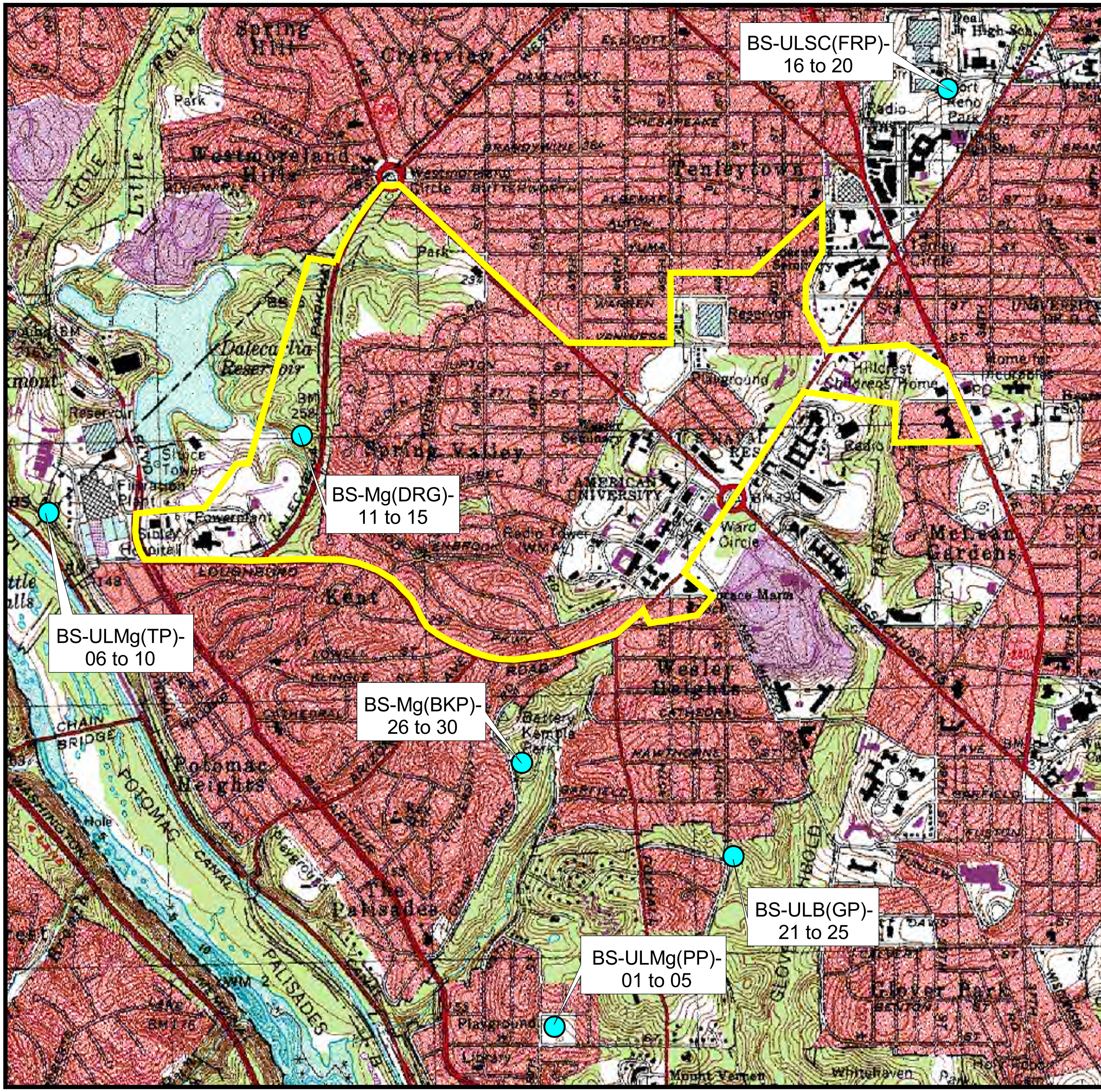

Figure 3-4
Background Sample Locations

Spring Valley Operable Units 4 and 5
Washington D.C.

Legend

SV FUDS Boundary

DRG - Dalecarlia Reservoir Grounds
FRP - Fort Reno Park
TP - West of Water Treatment Plant
BKP - Battery Kemble Park
GP - Glover Parkway
PP - Palisades Park

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3.7.2 Background Sampling Results

3.7.2.1 The USEPA 1993 and 1994 background sampling results are summarized in the USEPA Risk Assessment. The August 1999 background sampling results are summarized in the *Background Trip Report, Spring Valley OU3, Washington DC*, prepared for the USEPA Region III (Federal Facilities Branch) by Roy F. Weston (Site Assessment Technical Assistance Team) (USEPA, 1999d). The data from the two events were combined to provide a statistically more robust background data set. Background summary statistics for arsenic are presented in Table 3.6. Additional discussion of the use of these data is presented in Section 5.

Table 3.6
Background Summary Statistics

Parameter	Sample Number	Geometric Mean	Median	Minimum	Maximum	95th Percentile
Arsenic (mg/kg)	42	5.05	4.55	0.97	18	12.6

Note: In May 2002 it was discovered that one duplicate sample had inappropriately been used to calculate the above statistics. A recalculation indicated a 95th percentile of the data set to be 12.98 mg/kg. To be conservative, the lower of the two values (12.6 mg/kg) continued to be used as the screening criteria for the project.

3.8 SPECIATION SAMPLING ACTIVITIES

3.8.1 Sample Procedures and Analyses

3.8.1.1 Arsenic speciation sampling was conducted in November 2002 to provide a better understanding of arsenic speciation (trivalent vs. pentavalent arsenic and organic vs. inorganic arsenic compounds) in site-specific soils. The objective of the study was to determine if there were differences between site-specific soils and background soils in terms of arsenic speciation (trivalent vs. pentavalent arsenic and organic vs. inorganic arsenic compounds). Differences in arsenic species could be attributed to anthropogenic (resulting from influences of human beings) sources of arsenic. Anthropogenic sources of arsenic may be associated with AUES activities, but could also be associated with the use of pressure-treated lumber, pesticides, herbicides, coal, or fertilizer. All speciation sampling was performed in accordance with the *Final WMP Amendment 3, (October 2002)*.

3.8.1.2 Based on the results of the grid sampling, grids with relatively high arsenic concentrations, distributed throughout Spring Valley, were sampled for speciation in November 2002. Additionally, six background samples representing the four soil types were collected from the same locations the USEPA sampled; these were also analyzed for arsenic speciation. These background samples were collected to ensure that the site sample soil types were represented for the purposes of comparing site data and background data. However, only three of the four soil types were present in the sampled site soils. Samples were sent to the Battelle Marine Science Laboratories for arsenic speciation testing. The samples were analyzed by Battelle Marine

Sciences Laboratories for inorganic arsenic (IA), arsenite (As+3), arsenate (As+5), monomethylarsonic acid (MMA), and dimethylarsinic acid (DMA). Battelle Marine Sciences Laboratories followed the procedures outlined in *Method 1632, Chemical Speciation of Arsenic in Water and Tissue by Hydride Generation Quartz Furnace Atomic Absorption Spectrometry, Revision A*.

3.8.2 Speciation Sampling Results

3.8.2.1 The following discussion is a summary of the Technical Memorandum contained in Volume III of this EE/CA. Of the 15 samples (including QA/QC) analyzed for arsenic speciation, all of the samples had detectable concentrations of total arsenic and As^{+5}, and 14 of the 15 samples had detectable concentration of As^{+3}. Of the 15 samples collected, 7 were considered background samples and 7 were collected as site samples. The lab randomly selected an internal duplicate to make a total of 15 samples analyzed.

3.8.2.2 The reason for attempting to quantify the different forms of arsenic at the site was to determine if the species can be determined to be site-related or the result of releases that are not related to AUES activities. Differences in the pattern of background arsenic compared to the site-related samples could indicate the source of the arsenic (i.e., naturally occurring vs. anthropogenic). If the species are site-related, then it may be possible to make some conclusions regarding the relative risk associated with site-related contamination compared to the risk associated with exposure to naturally occurring arsenic.

3.8.2.3 The results indicate that concentrations of Total Arsenic, As^{+5}, and As^{+3}, appear elevated in the site samples when compared to background samples. Also, the ratio of As^{+5}/Total As was significantly higher in the site samples. While there is no indication that anthropogenic activities would specifically contribute one species of arsenic over another, naturally occurring arsenic would likely have the same profile of arsenic species. This profile is indicated by the ratios of the arsenic species to total arsenic. Differences in the ratios of As^{+5}/Total As between site samples and background samples is a possible indicator of potential anthropogenic sources of arsenic contamination. In addition, no organic arsenic compounds were detected in either site or background samples.

3.8.2.4 The findings indicate that, due to the significant difference in the As^{+5}/Total As ratios, the arsenic observed in the site samples may be from a different source than the arsenic in the background samples. Based solely on this study, the source of the As^{+3} and As^{+5} in the site samples cannot be determined. While the findings show that there may be an anthropogenic source of arsenic at the site, because of the uncertainties associated with the types of arsenic originally used at the site and the effects that more than 80 years of weathering may have, the findings cannot clearly indicate what that source may be. The anthropogenic source of arsenic may be associated with AUES, but it could also be associated with the use of pressure-treated lumber, pesticides, herbicides, coal, or fertilizer.

3.9 BIOAVAILABILITY SAMPLING ACTIVITIES

3.9.1 Sample Procedures and Analyses

3.9.1.1 Arsenic bioavailability sampling was conducted to provide a better understanding of the site-specific bioavailability (that fraction absorbed into the bloodstream of the human body) of arsenic and to provide more information for human health risk evaluations. All bioavailability sampling was performed in accordance with the *WMP Amendment 3, Final (October 2002)*. A more detailed presentation of investigation objectives, background, and procedures, is contained in the *Technical Memorandum for Arsenic Bioavailability Study, USACE, (January 2002)*, included in Volume III of this EE/CA.

3.9.1.2 In March 2001, the three highest arsenic concentrations inside the AU CDC area and the three highest outside the CDC (but within AU Lot 12) were sampled for bioavailability. Additionally, six background samples representing the four soil types were collected from the same locations the USEPA sampled. These were the same sample locations as the initial speciation sampling described in Section 3.8. All samples were collected as discrete surface soil samples, from 0-6 inches in depth. These samples were collected to match the soil types within Spring Valley to ensure that each of the four soil types were represented for the purposes of comparing site data and background data. The samples were submitted to the Laboratory for Environmental and Geological Studies, University of Colorado, at Boulder. Specifically, samples were submitted for determinations of the bioavailability of arsenic from soil. In addition, a determination of the types of particles (inorganic vs. organic) that contain bound arsenic was conducted.

3.9.2 Bioavailability Sampling Results

3.9.2.1 The following discussion is a summary of the Technical Memorandum contained in Volume III. Of the fifteen samples (including QA/QC) analyzed for bioavailability, only eleven samples had detectable concentrations in the test solution that could be used to derive a percent bioavailability. For those samples with detectable concentrations, the percent bioavailability ranged from 3% to 50%.

3.9.2.2 The data presented can be interpreted to conclude that risk estimates derived using detected concentrations of arsenic will likely overestimate the potential risks and hazards associated with exposures to the soils. Based on a bioavailability factor of 3%, these risks and hazards will be overestimated by up to a factor of 33 and remediation criteria developed without accounting for bioavailability will result in criteria that can be up to 33 times too stringent. Even using the most conservative of these bioavailability values (50%) results in the reduction of risk and hazard estimates by one-half and an increase of any calculated remediation criteria by a factor of two.

3.9.2.3 In addition to the bioavailability study, a determination of the types of arsenic-bearing particles was conducted using both electron microprobe and chemical analysis. In general the data indicated the arsenic-bearing phases to be either iron oxides, manganese oxides, iron arsenic sulfates or clays, as determined by particle analysis. An interpretation of the data, when compared to the bioavailability data discussed above, shows that for the four samples where the arsenic-bearing phase was predominantly iron oxides (97 – 100%), and where clays were not

identified as an arsenic-bearing phase, the bioavailability ranged from 7 – 22%. For the single sample that had clays identified as an arsenic-bearing phase (OU4-CDC, 150,140), the bioavailability was determined to be 50%. Data from the single sample suggests that arsenic in clays may be more bioavailable and that risk estimates will likely be overestimated for soils where the arsenic-bearing phase is exclusive of clays.

3.9.2.4 Due to the limited amount of data available, a regression model was not developed to determine a bioavailability adjustment factor (BAF) for use at Spring Valley. However, the most conservative assumption would be to use a BAF of 50%, based on the single highest bioavailability obtained from any sample. The range of bioavailability in the remaining samples was 3%-22%, with a mean of 10%. Finally, although these findings indicate that assuming 100% bioavailability is conservative, no project decisions were based on the measured bioavailability range. That is, 100% bioavailability was assumed for the project.

3.10 SPLP SAMPLING ACTIVITIES

3.10.1 Sample Procedures and Analyses

3.10.1.1 Synthetic Precipitation Leaching Procedure (SPLP) sampling was performed to help evaluate the potential leachability of arsenic from the soil to groundwater. The objective was to help evaluate the potential leachability of arsenic from the soil to groundwater. Specifically, the objective was to determine the concentration of arsenic in soil that, upon leaching from soil to groundwater, will not result in an arsenic concentration that exceeds the groundwater Maximum Contaminant Level (MCL). A more detailed presentation of investigation objectives, background, and procedures, is contained in the *Technical Memorandum for SPLP Arsenic Sampling, USACE, (January 2002),* included in Volume III of this EE/CA.

3.10.1.2 SPLP sampling performed in support of the OU-3 EE/CA as well as additional SPLP sampling conducted for OU-4 is discussed in the Technical Memorandum. In May 2000, Parsons collected SPLP soil samples (42 total samples) at 4801 Glenbrook Road in support of the OU-3 EE/CA. In February 2001, composited 0-2 foot intervals from the grids with the highest 5% of arsenic concentrations (4 total samples) within the CDC were analyzed for SPLP arsenic. All sampling for the OU-3 EE/CA was performed in accordance with *Change 05, Revised Sampling and Analysis Plan*, 4801 Glenbrook Road, (May 2000). All sampling at the CDC was performed in accordance with the *WMP Amendment 1, Revised Final (February 2001)*.

3.10.1.3 According to USEPA guidance (USEPA, 1996), a leach test may be more appropriate to help evaluate the potential leachability of arsenic from the soil to groundwater. USEPA guidance (USEPA, 1995) states that the SPLP was originally designed as an alternative to the Toxicity Characteristic Leaching Procedure (TCLP). The SPLP is designed to determine the mobility of both organic and inorganic contaminants contained in wastes and is intended to simulate the effect of acid rain on land-disposed wastes. The primary difference between the two tests is the composition of the leaching medium. While the TCLP relies on extraction fluids that simulate the organic acids that would form from decomposing wastes in a landfill, the SPLP requires the use of extraction fluids that simulate acid rain.

3.10.2 SPLP Sampling Results

3.10.2.1 The following discussion is a summary of the Technical Memorandum contained in Volume III. A total of 46 samples were collected and subjected to the procedure. Of these 46 samples, only seven resulted in detectable concentrations of arsenic in the leachate. Six of the seven samples (total arsenic of 11.5, 25.9, 16, 66.2, 217, and 668 mg/kg) with detectable arsenic in leachate had a high correlation between soil concentration and leachability. The correlation coefficient for these six samples was 0.99. When the seventh detected sample (total arsenic of 498 mg/kg) was included in the data set, the correlation coefficient dropped to 0.36. Using all the data points, a soil concentration of 217 mg/kg arsenic was the highest that did not exceed the 50 ug/L arsenic MCL. USEPA revised the arsenic MCL to 10 ug/L [Federal Register (66 FR 6975)] on January 22, 2001. Using all the data points, a soil concentration of 66.2 mg/kg arsenic was the highest that did not exceed the revised 10 ug/L MCL. Using the linear regression equation from the six samples with high correlation indicates that concentrations in soils up to 244 mg/kg would not result in an exceedance of the MCL of 50 ug/L. Using the same linear regression equation from the six samples with high correlation, a soil concentration of up to 56 mg/kg would not result in an exceedance of the revised MCL of 10 ug/L.

3.10.2.2 These concentrations indicate that arsenic leaching to groundwater does not appear to be a significant pathway since concentrations that result in an MCL exceedance are greater than the remediation endpoint concentrations proposed for soil (20 mg/kg, discussed further in Section 5). That is, soil greater than 20 mg/kg arsenic would be identified for removal action. The possibility that arsenic may have already leached to groundwater from soil, prior to removal actions, would be addressed in a future groundwater investigation.

3.11 AUES LIST SAMPLING ACTIVITIES

3.11.1 Sample Procedures and Analyses

3.11.1.1 Three investigations were performed to assess for the presence of the AUES list of chemicals. The AUES list of chemicals is a list of approximately 200 chemicals or compounds with documented usage at the AUES. Some of these were common, but most were specific to AUES activities. Sampling was performed at three different areas, reflecting different types of sites and past practices. Each of the three efforts was performed as a separate investigation, with separate reports of results submitted. The three areas were:

- 3819 48th Street, 4710 Quebec Street, 4625 and 4633 Rockwood Parkway;
- CDC/AU Lot 12; and
- Sedgwick Trench Area.

3.11.1.2 A more detailed presentation of results is contained in the: Report of Analytical Results (3819 48th Street, 4710 Quebec Street, 4625 and 4633 Rockwood Parkway), USACE, (May 2002); Report of Analytical Results (CDC/AU Lot 12), USACE, (April 2002); and Report of Analytical Results (Sedgwick Trench Area), USACE, (April 2002). Each of these reports is included in Volume III of this EE/CA.

3.11.1.3 In accordance with the *Revised Final Work Management Plan for Follow-on Sampling for OU-4 Residential Lots, Amendment 2 (Parsons, April 2001),* Parsons collected soil samples from four residences. These locations were selected because of relatively high arsenic concentrations, or information from other sources suggesting a high likelihood of finding potential contamination. The effort included three AUES List samples each from 4710 Quebec Street, 4625 Rockwood Parkway, and 4633 Rockwood Parkway, and four AUES List samples from 3819 48th Street, for a total of 13 AUES List samples. The samples were discrete samples collected at 0-6 inches bgs, 9-15 inches bgs, or 12-18 inches bgs, depending on location.

3.11.1.4 In accordance with the *Revised Final Work Management Plan, Amendment 1, AU Lot 12/Child Development Center (Parsons, February 2001),* Parsons collected 32 soil samples from the CDC/AU Lot 12 area. Of the 32 samples, 16 were analyzed directly for the AUES List chemicals. The other 16 were analyzed for various parameters as detailed in Volume III. The samples were discrete samples collected primarily at 0-6 inches bgs, with some taken at varying depths.

3.11.1.5 In accordance with the *Revised Final Work Plan for Sedgwick Trench Area Investigation (Parsons, June 2001),* Parsons collected five soil samples (four samples plus one duplicate sample) from the Sedgwick Trench. The samples were discrete samples collected at the presumed bottom of the trench.

3.11.1.6 Because many of the CWM-related compounds were not common and did not have established or routine analytical methodologies, the analytical plan called for analysis for related chemicals that had routine analytical methodologies and that could be directly analyzed. These included Target Compound List (TCL) and Target Analyte List (TAL) constituents, CWM compounds, and CWM degradation products. For the AUES List chemicals that could not be directly analyzed, indicator compounds were developed to make determinations of whether the chemicals could be present. Therefore, the final list of parameters included TCL compounds and CWM degradation products.

3.11.2 AUES List Sampling Results

3.11.2.1 This EE/CA discusses how the AUES List investigation was performed and presents the data (Volume III). However, because of the complex nature of the data and the need for careful interpretation of the results, no evaluation of the results is included in this document. Pending completion of this evaluation, separate reports addressing all results will be submitted.

3.11.2.2 Because many of the AUES List chemicals were not common and did not have established or routine analytical methodologies, the possible presence or absence of these chemicals was inferred by the presence or absence of its indicator compound. Of the approximately 200 AUES List chemicals, 138 could be analyzed using the methods described above. Of the 138 chemicals, only 59 could be directly analyzed; for the remaining 79 chemicals, presence or absence of the chemical could only be inferred.

3.11.2.3 For the chemicals that could be directly analyzed, detections were compared to appropriate criteria as discussed further in Section 5. Where the presence or absence of the chemical could only be inferred, it is likely that some false positives resulted. For example, because potassium chlorate does not have a routine analytical method, chloride and potassium

were used as the indicator compounds for this chemical. The presence of both compounds in detectable amounts resulted in a conclusion that the presence of potassium chloride in the sample could not be ruled out. However, since potassium and chloride are common compounds and would be expected even in the absence of potassium chloride, this could result in false positives.

3.11.2.4 Upon further discussion of these results by the Spring Valley Partners, the USEPA recommended additional ways to focus the conclusions of the analytical results. The recommendations included: stoichiometry analysis to see if the concentrations of the indicator compounds relative to the parent chemical could provide stronger support for a presence/absence conclusion; fate and transport analysis to see if the parent chemical or its indicators would likely be present more than 80 years after the chemical was used at AUES; and, relative toxicity evaluations to examine whether the indicator compounds detected might be more harmful than the parent chemical, thereby reducing the importance of the absolute determination of the presence of the parent chemical. The rest of the Spring Valley Partners agreed with the recommendations. Pending completion of this analysis, separate reports evaluating all results will be submitted.

3.11.2.5 Figure 3-5 presents the locations of the speciation, bioavailability, SPLP, and AUES List samples.

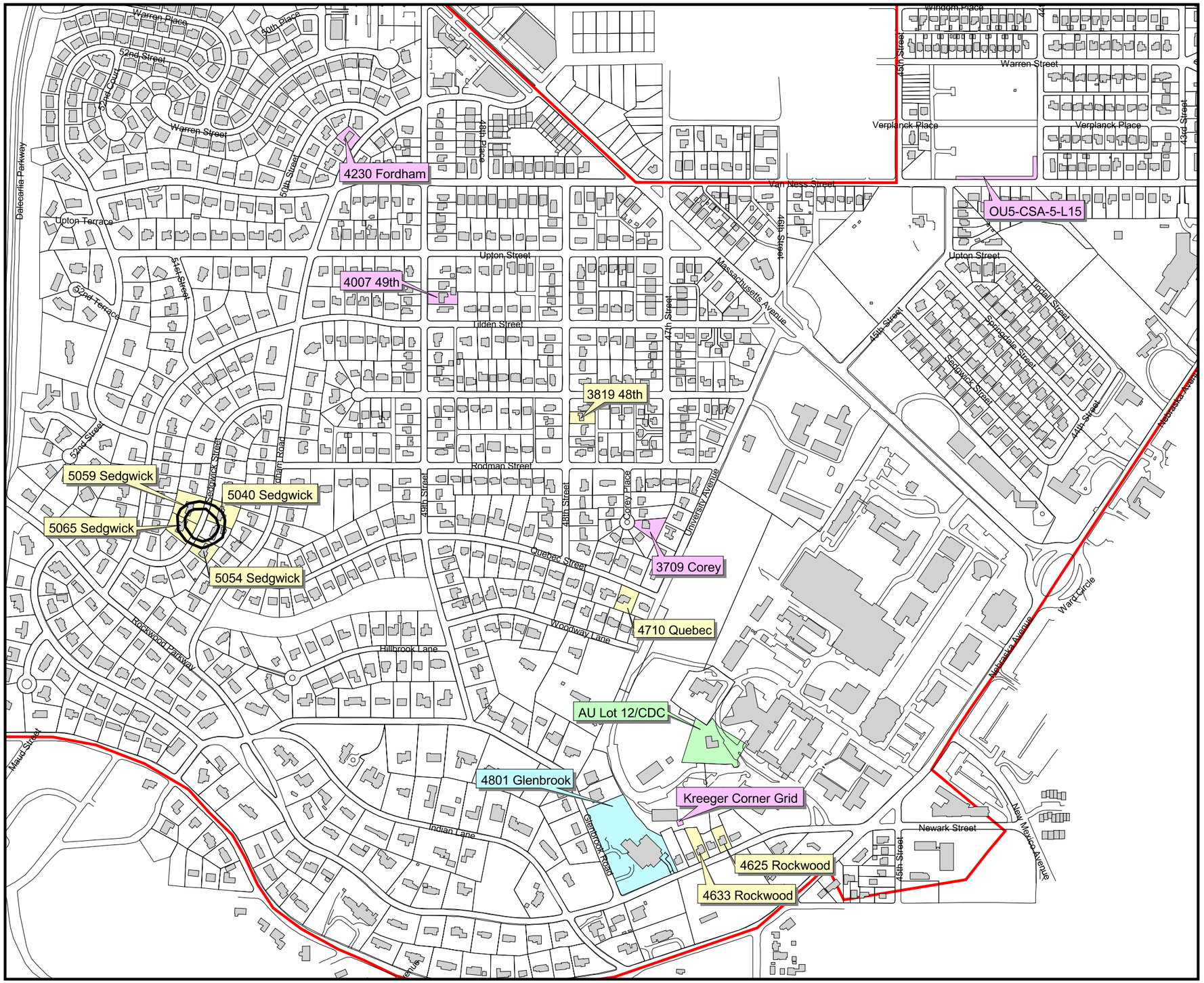

Figure 3-5
Sample Location Overview

Spring Valley Operable Units 4 & 5
Washington D.C.

Legend

- Sedgwick Trench
- Roads
- Buildings
- Speciation Samples
- AUES List, Bioavailability, and SPLP Samples (CDC)
- AUES List Samples
- SPLP Samples
- Parcels
- SV Boundary

Note:
Background sampling locations associated with speciation and bioavailability are shown in figure 3-4.

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1 inch = 500 feet

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4. SOURCE, NATURE, AND EXTENT OF CONTAMINATION

4.1 SOURCE

4.1.1.1 Arsenic has been identified as a Chemical of Concern (COC) in the soil at Spring Valley. This identification is based on the concentrations discussed in Section 3 and a comparison of those concentrations to screening criteria as discussed in Section 5. This is also based on the findings of previous investigations, including the OU-3 EE/CA Risk Assessments (USACE, October 2000 and April 2002). There are likely several sources of arsenic in the soil at Spring Valley. Arsenic is naturally occurring and widely distributed in the environment. Arsenic levels may have been increased by human activities other than those associated with the AUES, including fertilizer, pesticide and herbicide usage, and coal burning. One of the most wide-spread sources of arsenic is the use of pressure treated wood (chromated copper arsenate or CCA). Arsenic in the soil could also be related to AUES activities, as several AUES List compounds, most notably Lewisite, contain arsenic.

4.2 NATURE AND PHYSICAL CHARACTERISTICS OF ARSENIC

4.2.1.1 The Chemical Abstract Service (CAS) number for arsenic is 744-03-82. The molecular weight of arsenic is 75 and the specific gravity of arsenic is 5.73. The following description is from the Agency for Toxic Substances and Disease Registry (ATSDR) fact sheet. Arsenic is a naturally occurring element widely distributed in the earth's crust. In the environment, arsenic combines with oxygen, chlorine, and sulfur to form inorganic compounds. Arsenic in plants and animals combines with carbon and hydrogen to form organic arsenic compounds. Organic arsenic is usually less harmful than inorganic arsenic. Inorganic arsenic compounds are mainly used to preserve wood, but can also be used to make insecticides and weed killers. Organic arsenic compounds are sometimes used as pesticides. The Department of Health and Human Services and the USEPA have determined that inorganic arsenic is a human carcinogen (ATSDR, July 2001).

4.2.1.2 Arsenic also exists in different electronic valence states. Among the inorganic arsenic compounds, the trivalent arsenites are somewhat more toxic than the pentavalent arsenates. Arsenite compounds are 4 to 10 times more soluble than arsenate compounds. The arsenates will fix to soil more easily and are therefore not very mobile. The adsorption of arsenite is highly dependent upon the pH range. Under anaerobic conditions, arsenate may be reduced to arsenite. Arsenite is more subject to leaching because of its higher solubility. The transport of arsenic through the soil column is highly dependent upon these physical and chemical properties as well as that of the soil. Arsenic is readily and strongly bound to the soil by the presence of fixing agents such as iron. Surface dust and erosion are common mechanisms of arsenic transport.

4.2.1.3 At Spring Valley, arsenic speciation (Section 3.8) indicates possible anthropogenic sources when compared to the background samples. In particular, As^{+5} is significantly higher on site than in the background samples. As indicated in that section, the nature of the anthropogenic source, AUES activities or other (coal, fertilizer, pesticides use, etc.), could not be determined. The bioavailability study (Section 3.9) suggests that the arsenic bearing phases in Spring Valley soils are mainly iron oxides, manganese oxides, iron arsenic sulfates, or clays. Soil type does not

appear to be a major factor in arsenic concentrations as there appeared to be little difference between arsenic concentrations among the four soil types sampled.

4.3 EXTENT OF ARSENIC CONTAMINATION

4.3.1 Surface Soil

4.3.1.1 As discussed in more detail in Section 5, composite surface soil arsenic concentrations greater than 12.6 mg/kg triggered further investigation and the resulting grids containing arsenic concentrations greater than 20 mg/kg (remediation endpoint) were identified for removal action. The grid sampling focussed the extent and distribution of arsenic contamination by identifying those grids containing arsenic concentrations greater than 20 mg/kg.

4.3.1.2 Figure 4-1 presents the sites throughout Spring Valley that received grid sampling. The individual sites have been color-coded on the figure to indicate relative arsenic concentrations. The color-coding was applied to the entire site if one or more samples were above the designated arsenic concentration. Some sites that were grid sampled showed no arsenic concentrations greater than 20 mg/kg. Those sites are shown on the figure although they are not identified for removal activity. As discussed in more detail in Section 5, the color increments on the figure represent grids exceeding 20 mg/kg, 43 mg/kg and 150 mg/kg arsenic. Further discussion of the rationale for the arsenic concentration increments is contained in Section 5.

4.3.1.3 As shown on the figure, 64 sites had at least one grid result greater than 20 mg/kg arsenic, but less than or equal to 43 mg/kg arsenic. 64 sites had at least one grid result greater than 43 mg/kg arsenic, but less than or equal to 150 mg/kg arsenic. 19 sites had at least one grid result greater than 150 mg/kg arsenic. Note that most of the residential sites scheduled for a TCRA (Section 2.4.4) contained at least one grid result greater than 150 mg/kg arsenic. Volume II contains individual grid result maps for every grid-sampled site as well as a large-scale fold out map for finding specific sites by street address.

4.3.1.4 Based on the planning for the NTCRAs to be completed, there are approximately 800 grids (greater than 20 mg/kg) to be removed. This represents a volume of almost 24,000 cubic yards of arsenic contaminated soil.

4.3.2 Subsurface Soil

4.3.2.1 Few subsurface samples exhibited levels of arsenic greater than 20 mg/kg. As previously indicated in Section 3.4.1, subsurface arsenic concentrations resulted in removals at AU lots 16, 19, 23, and 24. In general, where elevated arsenic levels were found in subsurface samples, the depth was the 0-1 foot bgs interval.

4.3.3 Migration Potential

The migration potential for arsenic in the soils at Spring Valley was evaluated through the SPLP sampling discussed in Section 3.10. The SPLP concentrations indicate that arsenic leaching to groundwater does not appear to be a significant pathway. This is because the arsenic soil concentrations that would result in an arsenic MCL exceedance were greater than the remediation

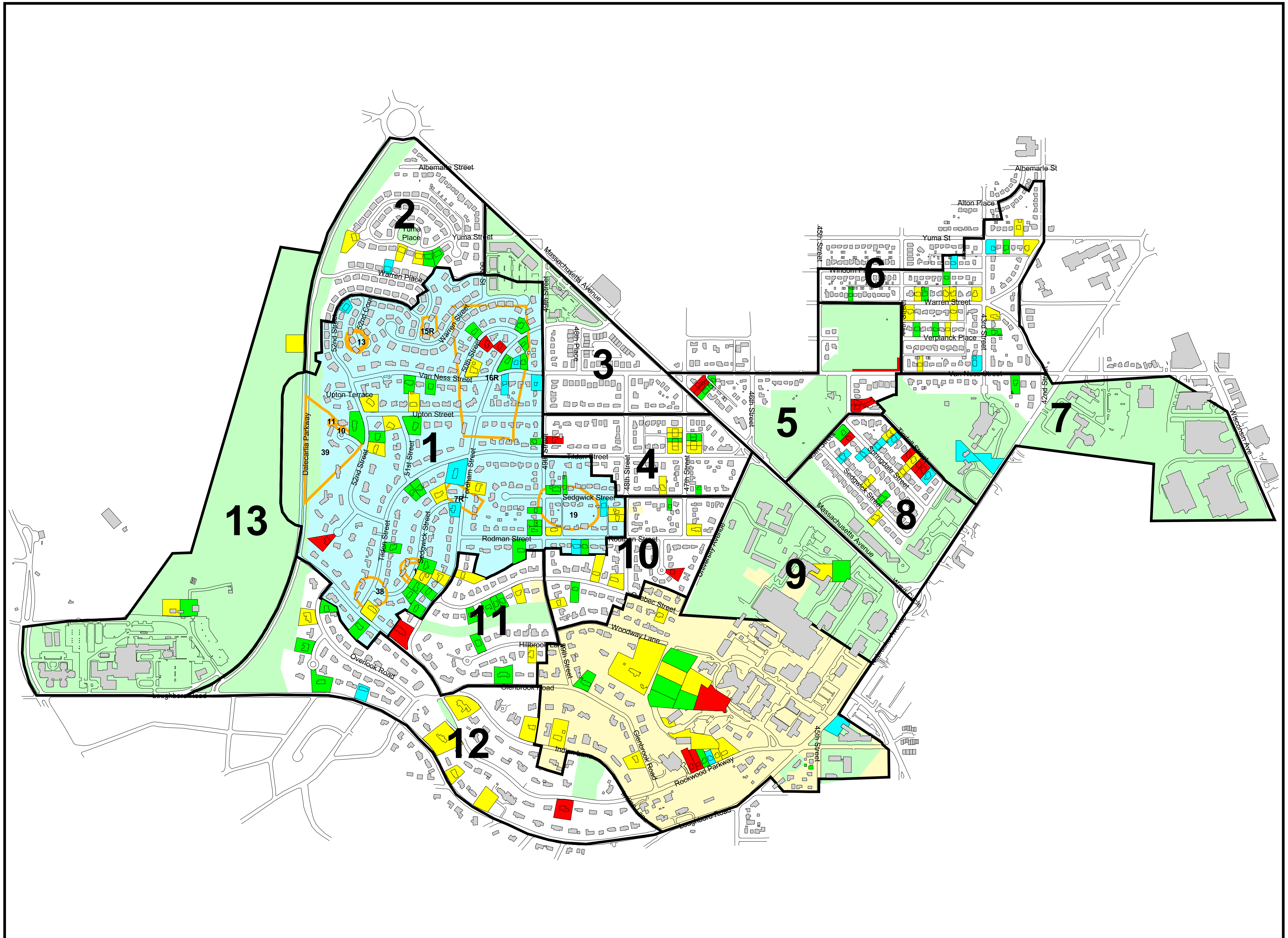

Figure 4-1
Grid Sampled Sites (Showing Relative Arsenic Concentrations)

Spring Valley Operable Unit 4 & 5
Washington D.C.

Legend

At least one grid sample

- > 0 - 20 ppm As (22)
- > 20 - 43 ppm As (64)
- > 43 - 150 ppm As (64)
- > 150 ppm As (19)
- Groupings
- POIs
- Buildings
- Roads
- Non-Residential Acreage
- CTA
- OU-4

Note:
OU-5 Acreage comprises groupings 1 through 13.

CSA is groupings 2 through 13.

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endpoint (discussed further in Section 5) and would therefore be removed. The possibility that arsenic may have already leached to groundwater from soil, prior to removal actions, would be addressed in a future groundwater investigation.

4.4 EXTENT OF SPECIALTY PARAMETER DETECTIONS

4.4.0.1 This discussion does not address the AUES List sampling summarized in Section 3.11 (those results, which are presented in Volume III of this EE/CA, require further analysis and the evaluation will be presented in a separate document). For the OU-4 and OU-5 sampling other than the AUES List sites, few compounds other than arsenic were detected. Figure 4-2 indicates detections of thiodiglycol (a non-specific mustard ABP, i.e., thiodiglycol is not necessarily the result of mustard) and cyanide at six sites. These are detections of the parameter, not exceedances of their screening criteria. The detected concentrations were well below the screening criteria (see Table 5.1). Thiodiglycol was detected in two OU-4 sites (AU Lots). One detection was in a surface sample and one was in a subsurface sample. Cyanide was detected in five samples (representing four sites). Each of these detections was from a subsurface sample. While these detections are below screening criteria, the need for further sampling will be evaluated by the USACE with input from USEPA and DCEHA.

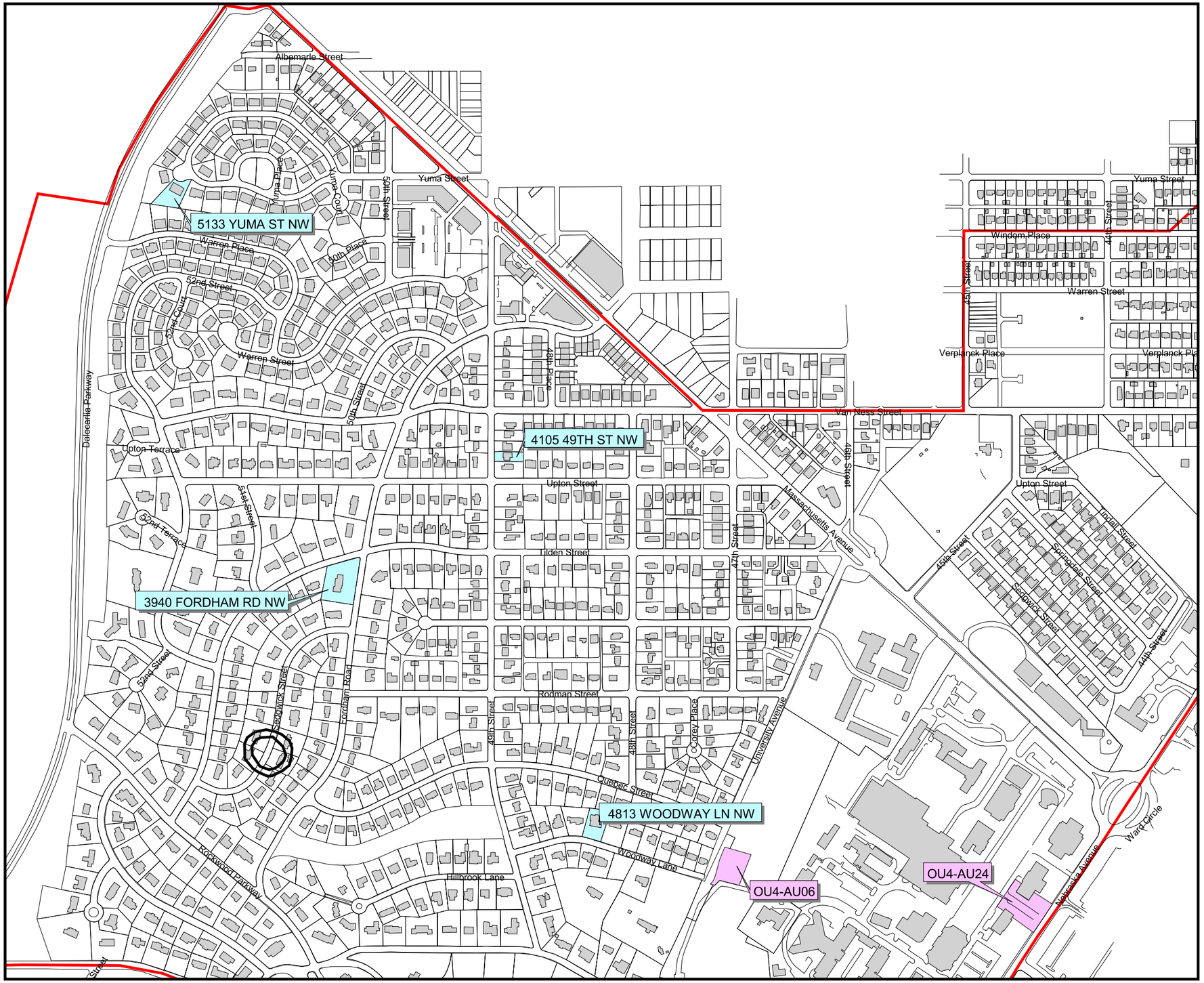

Figure 4-2
Specialty Parameter Detections
(Not Including AUES List Sampling)

Spring Valley Operable Units 4 & 5
Washington, D.C.

Legend

- Sedgwick Trench
- Roads
- Buildings
- Parcels
- SV Boundary

Specialty Parameter Detections:
- Thiodiglycol
- Cyanide

Note:
These are detections. None of the detections exceeded the screening criteria for the parameter.

With the exception of AU06, all detections were from subsurface samples.

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5. STREAMLINED RISK EVALUATION

5.1 INTRODUCTION

5.1.0.1. Risk Assessments (RA), associated with the OU-3 EE/CA, were performed to estimate the potential risks/hazards to current and future receptors from site related contamination at 4801, 4825, and 4835 Glenbrook Road. The initial RA at 4801 and 4825 Glenbrook (USACE, October 2000) was supplemented by additional data from 4835 (USACE, April 2002) Glenbrook. Some of the information presented in this section was derived from those RAs. A summary of the soil screening levels, comparison criteria, and remediation endpoints developed for the analytical parameters for the project is presented in Table 5.1.

5.2 ARSENIC SCREENING LEVEL

5.2.0.1 The RAs determined arsenic to be the COC. A toxicity screening was performed by comparing the maximum detected concentrations of arsenic to USEPA Region III Residential Risk-Based Concentrations (RBCs). For compounds such as arsenic, where natural background concentrations are greater than RBCs, the toxicity screening can be performed using the background concentrations. Therefore, as discussed in Section 3.7, a background study was performed. The 95th percentile of the background arsenic data set was 12.6 mg/kg whereas the Region III residential RBC is 0.43 mg/kg. Thus, the screening level for arsenic at the Spring Valley site was established at 12.6 mg/kg. That is, the arsenic screening level is based on a comparison to background.

5.3 ARSENIC REMEDIATION ENDPOINT

5.3.0.1 A remediation endpoint for arsenic of 20 mg/kg was jointly proposed by the Spring Valley Partners. The endpoint is that soil arsenic concentration above which remediation will be recommended. This concentration is background-based and is considered protective of human health and the environment. The Scientific Advisory Panel, established to assist the community in understanding the overall approach to technical issues affecting Spring Valley, recommended adoption of this remediation endpoint, saying that "the level should not pose a health hazard to the community and should not threaten the natural ecological systems of northwest Washington, DC." (*Scientific Advisory Panel Report*, May 29, 2002 Meeting).

5.3.0.2 The remediation endpoint of 20 mg/kg approximates the highest background sample collected (18 mg/kg) and is less than the calculated, non-cancer Soil Screening Level (SSL) of 23.5 mg/kg (based on a child resident receptor). In addition, the 20 mg/kg level is conservative in that it does not make use of the actual bioavailability factor, as discussed in Section 3.9.

5.3.0.3 Prior to acceptance of this concentration, some of the earlier removals, such as the CDC (section 2.4.4) used a remediation endpoint of 26 mg/kg arsenic. This was the 99.8th percentile of the background arsenic data set, or approximately twice the screening level of 12.6 mg/kg.

5.3.0.4 Figure 4-1 indicates other comparison criteria for arsenic. These are intended simply to organize the presentation of the data. The USEPA emergency removal concentration is 43 mg/kg arsenic. This is a risk-based value for a residential surface soil scenario corresponding to

a cancer risk of 1 in 10,000. The 150 mg/kg level was a value agreed upon by the Partners to help plan and prioritize the TCRAs (see Section 2.4.4).

5.4 SPECIALTY PARAMETERS

5.4.0.1 A summary of the soil screening levels, comparison criteria, and remediation endpoints developed for the analytical parameters for the project, including arsenic, is presented in Table 5.1.

Table 5.1
Analytical Parameters and Comparison Criteria

Parameter	Units	Comparison Criteria			Remediation Endpoint[\4]
		RBC[\1]	Background[\2] (screening level)	Other[\3]	
Arsenic	mg/kg	0.43	12.6		20
Specialty Parameters:					
CVAA/CVAO	ug/kg	890[\a]			NA
Sulfur Mustard	ug/kg			10	NA
1,4-Dithiane	ug/kg	78,000[\b]			NA
1,4-Oxathiane	ug/kg	78,000[\a, b]			NA
Thiodiglycol	ug/kg	39,100[\a, b]			NA
2,4-Dinitrotoluene	ug/kg	16,000[\b]			NA
2,6-Dinitrotoluene	ug/kg	7,800[\b]			NA
2,4,6-Trinitrotoluene	ug/kg	21,000			NA
Nitrobenzene	ug/kg	3,900[\b]			NA
Nitroglycerine	ug/kg	46,000			NA
Tetryl	ug/kg	78,000[\b]			NA
Cyanide, Total	mg/kg	160[\b]			NA

\1 USEPA's published Risk-Based Concentrations.
\2 95th Percentile of arsenic background samples.
\3 US Army Center for Health Promotion and Preventive Medicine (USACHPPM) residential Health-Based Environmental Screening Level (HBESL).
\4 Only arsenic required development of a remediation endpoint, as no other parameters were detected above the comparison criteria listed.
NA - Not Applicable.
\a Concentration derived for the 1995 RI (USACE, 1995).
\b Non-carcinogen adjusted downward by a factor of 10 to account for cumulative effect of several compounds possibly present.

5.4.0.2 For the most part, RBCs were used as the comparison criteria for the specialty parameters. Typical risk assessment practice is to adjust the RBC downward by a factor of ten, based on non-carcinogenic effects, to account for potential cumulative toxicologic effects of several compounds being present in a sample. For those compounds without published RBCs, these were either specifically derived for the parameter or another standard was used. The RBCs for Lewisite ABPs (CVAA/CVAO), 1,4-Oxathiane, and thiodiglycol, were derived for the 1995

RI (USACE, 1995). The mustard comparison standard was based on the US Army Center for Health Promotion and Preventive Medicine (USACHPPM) residential Health-Based Environmental Screening Level (HBESL). Table 5.1 indicates which compounds had adjusted RBCs and which compounds had derived RBCs.

5.5 GROUNDWATER

5.5.0.1 Groundwater will be addressed in a future investigation. However, the potential risk from arsenic in soil leaching to groundwater was evaluated through the SPLP study described in Section 3.10. This study indicated that arsenic leaching to groundwater does not appear to be a significant pathway assuming the removal actions for soil greater than the remediation endpoint of 20 mg/kg. The possibility that arsenic may have already leached to groundwater from soil, prior to removal actions, would be addressed in a future groundwater investigation.

6. IDENTIFICATION OF REMOVAL ACTION OBJECTIVES

6.1 REMOVAL ACTION OBJECTIVES

6.1.0.1 The objectives established for this removal action guide the development of the alternatives and provide focus to the comparison of acceptable removal action alternatives. These objectives also assist in clarifying the goal of reducing the hazard posed by elevated arsenic concentrations in the surface soils and achieving an acceptable level of protection to the public and environment. These objectives include:

- Prevent exposure to elevated levels of arsenic in surface and subsurface soils; and
- Prevent future migration of arsenic contamination.

6.2 REMOVAL ACTION GOAL

6.2.0.1 In order to achieve the objectives of this removal action, a removal goal was established. As discussed in Section 5, the remediation goal or endpoint established for arsenic for the Spring Valley FUDS is 20 mg/kg (with the exception of some earlier removal efforts as described in section 5.3). The goal of this removal action is to reduce the hazard to human health and the environment posed by arsenic concentrations greater than 20 mg/kg in surface and subsurface soils at the Spring Valley FUDS. Based on the results of the site investigation, addressing soil with arsenic concentrations greater than 20 mg/kg will also remove the potential for downward migration of leachable arsenic to the groundwater.

6.3 EXTENT OF REMOVAL ACTION

6.3.0.1 As described in Section 4, a grid system consisting of 20-foot by 20-foot grid squares (or 10-foot by 10-foot in some cases) was established during the site investigation. All grids containing a sample greater than 20 mg/kg of arsenic were identified for removal action. These sites are shown in Figure 4-1.

6.4 SCHEDULE

The proposed removal actions (some TCRAs have been completed as described in Section 2.4.4) for the arsenic contamination in soils at the Spring Valley Site are scheduled to begin immediately after the public comment period on this EE/CA has ended. It is expected that the removal work will take several years to complete.

7. IDENTIFICATION & ANALYSIS OF REMOVAL ACTION ALTERNATIVES

7.0.0.1 This section describes the removal action alternatives identified for this project and the individual analysis of each alternative. The criteria used to evaluate the alternatives are defined below.

7.0.0.2 The following analysis also considers that a single remedy for potentially 140 plus sites throughout Spring Valley may not be practical and that private home owners may opt for less intrusive alternatives. Therefore, some alternatives that may have otherwise been screened out, were carried through to the final comparison for the purpose of providing additional information on those less intrusive or disruptive alternatives that might be applicable to a specific property.

7.1 IDENTIFICATION OF REMOVAL ALTERNATIVES

7.1.0.1 The USACE has identified six removal alternatives. These include:

- Alternative 1: No Action;
- Alternative 2: Institutional Controls and Engineering Controls;
- Alternative 3: Phytoremediation;
- Alternative 4: Soil Stabilization;
- Alternative 5: Soil Washing; and
- Alternative 6: Excavation and Landfill Disposal.

The following sections provide a brief description of each identified alternative.

7.1.1 Alternative 1: No Action

7.1.1.1 The no action alternative would involve leaving the properties in their current state. The no action alternative provides a comparative baseline against which other alternatives can be evaluated. Under this alternative, no removal action will be taken, and any identified contaminants are left "as is," without the implementation of any containment, removal, treatment, or other protective actions. This alternative does not provide for the monitoring of soil, and does not provide for any active or passive institutional controls to reduce the potential for exposure (e.g., physical barriers, deed restrictions).

7.1.1.2 No potential action-specific ARARs are identified for this alternative.

7.1.2 Alternative 2: Institutional Controls and Engineering Controls

7.1.2.1 The institutional controls alternative would include limiting access to areas with elevated arsenic concentrations in the surface soil and developing deed restrictions. The areas identified are located in the yards of residential properties. Limiting access to these areas could be achieved in a variety of ways, depending on the specific location and orientation of contaminated grids within a particular property and the desires of the individual property owner.

Options could include fencing the area; covering the area with concrete or brick for use as a patio or sitting area, for example; or planting the area with groundcover plants that do not require routine maintenance. These options would all prevent physical contact with the contaminated soil and would reduce or eliminate runoff from the contaminated surface soil and thus reduce the spread of the contamination. This alternative would also include the development of deed restrictions to legally bind the current and future property owner to appropriate access and use restrictions. The deed restrictions would include prohibition of gardening and routine landscaping activities in these areas. Finally, an institutional control plan would be developed in cooperation with the property owners and local agencies and would include a delineation of enforcement and maintenance responsibilities.

7.1.2.2 No potential action-specific ARARs are identified for this alternative.

7.1.3 Alternative 3: Phytoremediation

7.1.3.1 Phytoremediation is an innovative remedial technology in which plants are used to remove contaminants from the environment. In the case of arsenic contaminated soils, this method can also be described as phytoaccumulation/phytoextraction and refers to the uptake and translocation of metal contaminants in the soil by plant roots into the aboveground portions of the plants. Certain plants called hyperaccumulators absorb unusually large amounts of metals in comparison to other plants. One or a combination of these plants is selected and planted at a site based on the type of metals present and other site conditions.

7.1.3.2 A treatability study would be conducted to determine the appropriateness of this alternative to site-specific conditions. If the treatability study determines that this technique is appropriate for a site, the selected plants would be installed in the contaminated areas. Based on the removal rates and capacities determined during the treatability study, the plants are harvested periodically and disposed appropriately. The harvested plants would be replaced with new plants, as necessary, in order to achieve the remediation endpoint.

7.1.3.3 The treatment program would be monitored and maintained on a regular basis and would likely require some type of institutional controls (i.e., temporary access controls such as fencing) to address exposure to contamination in the interim between installing the plants and achieving the remediation endpoints. The duration of operation and maintenance for this technology is very site-specific and can vary depending on cleanup goals, contaminant concentrations, growth rate of the plantings, depth of contamination, and climate (e.g., temperature, precipitation, etc.).

7.1.3.4 No potential action-specific ARARs are identified for this alternative.

7.1.4 Alternative 4: Soil Stabilization

7.1.4.1 Soil stabilization is a remediation technique in which contaminated soil is treated with a binding/stabilizing agent such as iron to minimize the rate of contaminant migration and to reduce the toxicity of the soil. Stabilization may be achieved through *in situ* (in place) or *ex situ* (out of place) treatment approaches. A treatability study would be conducted to determine the appropriateness of this alternative to site-specific conditions. If the treatability study determines that this technique is appropriate for a site, specific design parameters would be determined. Soil

in those areas identified as requiring removal would be treated on site, either in situ or excavated and transported to an on-site treatment facility, and then replaced in the excavation. Soil would initially be excavated to a depth of two feet below ground surface. Soil samples would be collected from the bottom of these excavations and analyzed for confirmation purposes. All excavated soil would be treated and returned to the excavation. Clean fill from an off-site source would be used on top of the replaced soil as necessary to fill the excavation to grade. However, the most likely scenario is that the soil volume will increase during the stabilization process such that it would not fit into the original excavation.

7.1.4.2 The regulatory provisions governing erosion and sediment control, storm water management, fugitive dust emissions, noise control, hazardous waste accumulation, and land disposal are identified in section 7.3.2.5 as potential action-specific ARARs for this proposed removal action.

7.1.5 Alternative 5: Soil Washing

7.1.5.1 Soil washing is a remediation technique in which contaminants are separated from the soil particles to which they are sorbed. This is achieved through washing of the soil with a leaching agent, surfactant, or chelating agent or through pH adjustments. For the removal of heavy metals such as arsenic, chelating agents are most commonly used. A treatability study would be conducted to determine the appropriateness of this alternative to site-specific conditions. If the treatability study concludes that this technology is appropriate to this site, an on-site treatment facility would be designed and constructed. Excavation of contaminated soil would proceed as described in the previous section. A portion of the treated soil could be used as backfill although it would be necessary to supplement this soil with clean backfill from off site. This is due to the fact that some of the soil volume would be included in the contaminated sludge generated during the process. This sludge would be disposed at an appropriate off-site facility.

7.1.5.2 The regulatory provisions governing erosion and sediment control, storm water management, fugitive dust emissions, noise control, hazardous waste accumulation, hazardous waste storage tank management, and land disposal are identified in section 7.3.2.5 as potential action-specific ARARs for this proposed removal action.

7.1.6 Alternative 6: Excavation and Landfill Disposal

7.1.6.1 The excavation and landfill disposal alternative would involve excavating soils in areas identified as requiring removal. Excavation of contaminated soil would proceed as described in Section 7.6.6. Excavated soil would be characterized and transported to an appropriate off-site disposal facility. The excavated soil would be characterized in accordance with the requirements of the disposal facility. If the soil is characterized as RCRA hazardous, it would be transported to a RCRA subtitle C landfill where it would be pretreated and disposed. If the soil is characterized as RCRA non-hazardous, it would be transported to a sanitary landfill for disposal.

7.1.6.2 The regulatory provisions governing erosion and sediment control, storm water management, fugitive dust emissions, noise control, and hazardous waste accumulation are identified in section 7.3.2.5 as potential action-specific ARARs for this proposed removal action.

7.2 INTRODUCTION TO EVALUATION CRITERIA

7.2.0.1 The USEPA provides specific criteria by which to judge removal actions in EE/CAs in their document *Guidance on Conducting Non-Time Critical Removal Actions Under CERCLA* EPA/540-R-93-057 (USEPA, 1993). The three general categories are effectiveness, implementability, and cost.

7.2.0.2 The effectiveness of an alternative refers to its ability to meet the cleanup objective within the scope of the removal action. This criterion also evaluates whether the alternative can be conducted in a manner that is safe to the public, the workers, and the environment. The effectiveness category is divided into four evaluation criteria that roll up into one overall criterion, Overall Protection of Human Health and the Environment. The four subcriteria are: Compliance with Applicable or Relevant and Appropriate Requirements (ARARs); Long-Term Effectiveness; Reduction of Toxicity, Mobility, or Volume through Treatment; and Short-Term Effectiveness.

7.2.0.3 The implementability category includes the technical and administrative feasibility of implementing an alternative; the availability of various services and materials required during its implementation; and the acceptance that local residents and agencies have expressed towards the various alternatives. Site conditions, characteristics of each technology, availability and reliability, the regulatory climate, and community concerns are considered under this criterion. The implementability category is divided into five evaluation criteria including: Technical Feasibility; Administrative Feasibility; Availability of Services and Materials; State (Support Agency) Acceptance; and Community Acceptance.

7.2.0.4 Finally, each alternative is evaluated to determine its projected overall implementation cost. Included in the cost calculation is an estimate of time necessary to complete the proposed alternative. Each of the evaluation criteria introduced above is discussed in greater detail in the following paragraphs.

7.3 EVALUATION CRITERIA: EFFECTIVENESS

7.3.1 Overall Protection of Public Health and Environment

7.3.1.1 This criterion evaluates each alternative on how well it can achieve and maintain protection of public health and the environment. This criterion draws on assessments of the four subcriteria described below.

7.3.2 Compliance with Applicable or Relevant and Appropriate Requirements

7.3.2.1 Section 121(d)(1) of CERCLA, 42 U.S.C. § 9621(d)(1), requires that on-site removal actions attain federal standards, requirements, criteria, limitations or more stringent state standards determined to be legally applicable or relevant and appropriate to the circumstances at a given site. For removal actions, compliance with ARARs is required to the extent possible based on the urgency of the situation and the scope of the action contemplated. 40 C.F.R. § 300.415(j).

7.3.2.2 Applicable requirements are those cleanup standards, controls, and other substantive environmental protection requirements promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, removal action, location, or other circumstance found at a CERCLA site. 40 C.F.R. § 300.400(g)(1). Relevant requirements are those that are not applicable to a specific release or removal action, but are sufficiently similar to the circumstances of the release or removal action and therefore relevant and appropriate. 40 C.F.R. § 300.400(g)(2). Only state standards that are more stringent than the federal requirements may be considered ARARs. Generally, ARARs fit into three categories: chemical-specific, location-specific, and action-specific ARARs. The following are potential ARARs that may apply.

7.3.2.3 **Chemical-Specific ARARS**. Chemical-specific ARARs set health or risk-based concentration limits in various environmental media for specific hazardous substances, pollutants, or contaminants. These ARARs establish either protective cleanup levels for the chemical of concern in the designated media or indicate the appropriate level of concern.

- **ARSENIC:** Arsenic has been identified as a substance found at the site for which consideration of any potential chemical-specific ARARs is warranted. As discussed in Section 5, analysis of soil samples collected at the site detected the presence of arsenic in concentrations exceeding the screening levels. The medium of concern is soil.

7.3.2.3.1 **Soil** – There are no current chemical-specific ARARs for arsenic in soil. No directly applicable requirements that address the level of arsenic in soil were identified. Treatment levels under the land disposal restriction (LDR) regulations, see 40 C.F.R. §§ 268.34(a) and 268.48, were considered as potentially relevant and appropriate and rejected in accordance with 40 C.F.R. § 300.400(g)(2). Specifically, while the LDR treatment level in question may be relevant in the instant case because it applies to arsenic in soil, the requirement is inappropriate. LDRs are triggered by "placement" of restricted RCRA hazardous wastes in land-based units. Placement occurs when wastes are land disposed in on-site or off-site land-based RCRA units, such as landfills or surface impoundments. Placement does not occur if wastes are left in place. See memorandum from Jonathan Z. Cannon, Acting Assistant Administrator Office of Solid Waste and Emergency Response, *Policy for Superfund Compliance With the RCRA Land Disposal Restrictions* OSWER Directive 9347.1-0 (Nov. 8, 1986).

7.3.2.4 **Location-Specific ARARs**. Location specific ARARs prevent damage to unique or sensitive areas, such as floodplains, wetlands, and fragile ecosystems. They also restrict activities that may be harmful as a result of the characteristics of the site or the immediate environment. These requirements function like and may overlap the potential action-specific ARARs discussed below.

- Based on the identified grids with arsenic exceedances, removal activities are not expected to impact floodplains, wetlands, or sensitive ecosystems. As a result, no location-specific ARARs are identified for the Spring Valley site.

7.3.2.5 **Action-Specific ARARs**. Action-specific ARARs set controls or restrictions on specific removal activities at a site. They specify performance levels, actions or technologies, as well as specific levels for discharges or residual chemicals. Potential action-specific ARARs are addressed below.

7.3.2.5.1 **Erosion and Sediment Control** – The following regulatory provisions qualify as potential action-specific ARARs for this purpose:

Removal actions are required to comply with the underlying substantive requirements of 21 D.C.M.R. § 502.1. As such, removal activities must address and comply with erosion and sediment control requirements during and after completion of all land disturbing activities where applicable.

The District of Columbia Department of Consumer and Regulatory Affairs 1987 Standards and Specifications for Soil Erosion and Sediment Control are incorporated into the D.C.M.R. by reference at 21 D.C.M.R. § 501.4. Compliance with erosion and sediment regulations will ensure compliance with surface water quality consistent with District of Columbia antidegradation policy. Additional erosion and sediment control requirements include 21 D.C.M.R. § 539, which prescribes principles for designing erosion and sediment control measures, including the maximum allowable period of exposure and the maximum area that can be exposed.

7.3.2.5.2 **Storm Water Management** – The following regulatory provisions qualify as potential action-specific ARARs for this purpose:

21 D.C.M.R. § 526.1 requires appropriate storm water management measures to control or manage run-off during any earth moving or land change activity, unless the activity is exempt. Exempt activities include construction or grading operations that disturb less than 5,000 square feet of land. Based on an average of seven grids requiring removal per site, less than 5,000 square feet of land will be disturbed per site. However, some sites will exceed that limit. Additional storm water management requirements include:

- 21 D.C.M.R. § 528 – Provides for a waiver or variance from the storm water management requirements if the applicant can demonstrate that storm water runoff from the property in question will not adversely impact receiving wetlands, water courses, or waterways.
- 21 D.C.M.R. § 529 – Prescribes the minimum storm water management requirement that must be met before any land may be developed in the District.
- 21 D.C.M.R. § 530 – Identifies minimum storm water management measures that, singly or in combination, must be implemented by developments constructed in the District.

The requirements of 21 D.C.M.R. § 529 and 21 D.C.M.R. § 530 are not applicable but are relevant and appropriate because storm water management must be considered when disturbing more than 5,000 square feet of land.

7.3.2.5.3 **Fugitive Dust Emissions** – 21 D.C.M.R. § 605 qualifies as a potential action-specific ARAR for this purpose. It requires the taking of reasonable precautions to minimize the emission of fugitive dust into the outdoor atmosphere. Regulated activities include unpaved roads and parking lots, vehicles transporting dusty material or with wheels that

accumulate dirt, the loading and unloading of dusty materials, and the stockpiling of dusty material.

7.3.2.5.4 **Noise Control**–20 D.C.M.R. § 2802.2 qualifies as a potential action-specific ARAR for this purpose. It prescribes a maximum noise level of 60 decibels for construction activities conducted in residential areas between the hours of 7:00 a.m. and 7:00 p.m. Construction noise levels are measured 25 feet from the outermost limit of the site. 20 D.C.M.R. § 2802.3.

7.3.2.5.5 **Hazardous Waste Determination-**40 C.F.R. § 261 determination of whether the arsenic-laden soil is a hazardous waste subject to the hazardous waste storage, transportation, manifest, land disposal restrictions, and other hazardous waste requirements in 40 C.F.R. parts 260 - 268 and the comparable DC Hazardous Waste Management Act and Munitions Regulation. PARAG Nos. OFF FROM HERE ON

7.3.2.5.6 **Accumulation of Hazardous Waste**–40 C.F.R. § 262.34 qualifies as a potential action-specific ARAR for this purpose. It prescribes standards for the temporary accumulation of hazardous waste on site, including labeling, container, and storage requirements.

7.3.2.5.7 **Hazardous Waste Storage Tank Management**—40 C.F.R. part 264, subpart J qualifies as a potential action-specific ARAR for this purpose. It prescribes requirements for managing tank systems that are used to treat hazardous wastes.

7.3.2.5.8 **Land Disposal**–40 C.F.R. § 268.40 qualifies as a potential action-specific ARAR for any potential on-site land placement of hazardous soil. It prohibits the land disposal of arsenic waste unless the waste has been treated to concentrations at or below 1.4 mg/L in wastewater or 5.0 mg/L TCLP in non-wastewater.

7.3.3 Long-Term Effectiveness

7.3.3.1 This criterion measures how an alternative maintains the protection of human health and the environment after the removal objective has been met. The analysis focuses on:

- The permanence of the removal action alternative;
- The magnitude of residual risk following completion of the removal action; and
- The need for and the adequacy and reliability of any post removal site controls (PRSCs) (e.g., access limitations, deed restrictions, long-term monitoring etc.) used to manage the treated residuals or untreated wastes that remain at the site following the removal action.

7.3.4 Reduction of Toxicity, Mobility or Volume through Treatment

7.3.4.1 Based on the USEPA's preference that a chosen removal alternative will reduce toxicity, mobility, or volume through treatment, an alternative must be evaluated based upon the following (USEPA 1993):

- The treatment processes(es) employed and the material(s) it will treat;

- The amount of hazardous materials to be destroyed or treated;
- The degree of reduction expected in toxicity, mobility, or volume;
- The degree to which the treatment will be irreversible;
- The type and quantity of residuals that will remain after treatment; and
- Whether the alternative meets the USEPA's preference for treatment.

7.3.5 Short-Term Effectiveness

7.3.5.1 This criterion addresses the effects of an alternative during the implementation phase, prior to the removal objectives being met. More specifically, each alternative will be examined for:

- Protection of the community and workers during the removal action;
- Adverse environmental impacts resulting from construction and implementation; and
- The time required to meet the removal objectives.
- This criterion accounts for factors such as air quality, fugitive dust, transportation of hazardous materials, potential threats to worker and the reliability of mitigation measures, and potential environmental impacts including spills and releases.

7.4 EVALUATION CRITERIA: IMPLEMENTABILITY

7.4.1 Technical Feasibility

7.4.1.1 This criterion evaluates the ease of implementing a specific alternative. This criteria evaluates:

- The reliability of the technology and operational difficulties;
- The ability to perform the alternative in the allotted time;
- The need and ease of conducting future removal actions following the initial undertaking; and
- The environmental conditions with respect to set-up, construction and operation of the alternative.

7.4.2 Administrative Feasibility

7.4.2.1 This criterion focuses on the planning stages for each alternative and includes consideration of:

- Adherence to non-environmental laws (e.g., Siting of a treatment plant in a residential neighborhood);
- Coordinating services needed to carry out an alternative;
- Arranging the delivery of services in a timely manner; and

- Addressing the concerns of other regulatory agencies.

7.4.3 Availability of Services and Materials

7.4.3.1 This criterion evaluates the following sub-criteria:

- Availability of the technology and the personnel needed to perform the operation based on schedule;
- Availability of off-site treatment, storage and disposal for materials; and
- Need for and availability of supporting services (e.g., Power lines, laboratory services etc.).

7.4.4 State (Support Agency) and Community Acceptance

7.4.4.1 This criterion evaluates technical and administrative concerns of the supporting agency. Community acceptance of the alternative(s) is also evaluated. These concerns may include the time it takes to initiate the alternative and the time it takes to reach the endpoint.

7.5 EVALUATION CRITERIA: COST

7.5.0.1 This criterion determines and evaluates projected costs. These costs include direct capital costs (i.e., costs to perform the alternative), indirect capital costs (e.g., design expenses, legal fees, and permit fees), and post removal site control costs (e.g., monitoring, operation and maintenance costs).

7.6 EVALUATION OF ALTERNATIVES

7.6.0.1 This section details the analysis of each individual alternative with respect to the evaluation criteria described previously. Where known, indications of regulator, property owner, and community reaction, based on comments at past meetings, is provided for informational purposes only. Input received from stakeholders during the public comment period for this EE/CA report will be incorporated into the Final EE/CA and may affect the alternatives evaluation.

7.6.1 Alternative 1: No Action

Effectiveness: The No Action alternative would not provide for overall protection of human health and the environment. Section 4 identifies areas where arsenic concentrations in surface soil exceeded removal action goals. Arsenic concentrations in the surface soils would not be expected to decrease over time with no treatment. Therefore, this alternative would not be effective in achieving the removal goals and objectives of this EE/CA in the short-term or long-term, nor does it reduce toxicity, mobility or volume.

Implementability: The no action alternative, though implementable, will be technically ineffective and administratively impossible. Also, based on past comments, DCEHA, USEPA, and the community are unlikely to accept this alternative as it fails to achieve the removal goals and objectives. No services or materials would be required to implement this alternative.

Cost: There are no costs associated with the no action alternative.

Outcome: The no action alternative will not be further evaluated because it fails the effectiveness and implementability criteria.

7.6.2 Alternative 2: Institutional Controls and Engineering Controls

Effectiveness: In order to be protective of human health and the environment, the institutional controls alternative would have to prevent contact with the surface soil. This alternative does not achieve any reduction in toxicity, mobility, or volume through treatment; however, limiting access to the contaminated soil would limit potential exposure and, depending on the specific type of access control implemented, mobility may also be reduced through the reduction of infiltration and/or surface runoff from the soil during precipitation events. Although this alternative may be effective in the short term with the cooperation and understanding of current owners/residents and the proper protection of workers involved in the implementation, the long-term effectiveness of institutional controls such as access restrictions and limitations is difficult to ensure, particularly since these are private residences. Even if a current owner agrees to abide by the institutional controls, a future owner may not agree and could demand an alternate removal action.

Implementability: It is technically feasible to design and install physical barriers such as fences, concrete or brick patios, or groundcover plantings to limit access to the surface soils as well as to develop deed restrictions. The materials and services required to implement this alternative are available. The administrative feasibility of institutional controls is less certain as it would require the cooperation of many parties, including the property owners/residents, and numerous local agencies. An institutional control plan describing the controls as well as delineating responsibility for enforcement and maintenance of the controls must also be developed and agreed to by all parties. DCEHA, USEPA, property owner, and community acceptance has not been established.

Cost: The cost for this alternative ranges from approximately $20 per ton of contaminated soil removed for a concrete patio; approximately $90 per ton of contaminated soil removed for a brick patio; or approximately $29 per ton for ground cover plants. These costs are based on approximately 45 tons of soil removed per 20-foot by 20-foot by 2-foot grid. Decorative fencing (6 feet tall with no gates) would cost approximately $4800 per grid (i.e., $107 per ton of contaminated soil). These costs do not include maintenance (e.g., irrigation for ground cover plants), the development of deed restrictions, or costs otherwise associated with institutional control implementation.

Outcome: This alternative provides limited effectiveness and could be difficult to implement. However, individual residents may prefer this alternative to other removal alternatives that would require potentially extensive land disturbing activities on their property. Therefore, this alternative will be further evaluated.

7.6.3 Alternative 3: Phytoremediation

Effectiveness: A treatability study would be required to determine the potential effectiveness of this alternative at a particular site. If the treatability study indicates that phytoremediation is

appropriate to site-specific conditions, this alternative would be protective of human health and the environment in the long-term, once the endpoints are achieved. However, the substantial time it would likely take to reach the remediation endpoints makes it ineffective in the short-term. During the potentially long interim period, the alternative would require regular monitoring, maintenance and access limitations. Phytoremediation would reduce mobility and toxicity in the soils, however, the toxic constituents would be transferred to the plants which would require periodic harvesting, disposal and replacement. Appropriate health and safety precautions would be required during construction and maintenance of this alternative in order to protect workers and the community during implementation.

Implementability: This alternative would require a treatability study to determine its technical feasibility. The technology in general is still largely in the developmental stages. Administratively, this alternative would require long-term plans for maintenance and monitoring. Enforcement would also be required during the interim between installing the plants and reaching the endpoints to ensure that the plants are being maintained and to ensure compliance with access controls established to protect human health in the interim. Availability of materials will depend on the specific materials identified during the treatability study. Restrictions in place during the phytoremediation effort would limit the resident's ability to utilize a portion of the property. DCEHA, USEPA, property owner, and community acceptance has not been established.

Cost: Based on a review of the literature, this alternative would cost between $15 and $31 per ton of soil. These costs include planting of the selected species, harvesting and disposal. The cost will vary based on various factors including the type of plant(s) required, climate factors (e.g., amount of irrigation needed), nutrient requirements, the number of harvesting and replanting cycles required, and disposal requirements. These costs do not include the costs for the treatability study required to determine the technical feasibility and design parameters for this alternative. This alternative may also involve an additional cost of approximately $20 per ton for fencing (three foot high wooden picket fence with gate) which may be necessary to restrict access to the area during treatment.

Outcome: The technical feasibility of this alternative for the site-specific conditions is unknown. Therefore, implementation of this alternative would be delayed pending completion of the treatability study. However, phytoremediation may be effective and implementable for certain individual properties where the owner may not want the potentially extensive land disturbing activities required for some of the other alternatives. Thus, this alternative will be further evaluated.

7.6.4 Alternative 4: Soil Stabilization

Effectiveness: This alternative would achieve protection of human health and the environment through immobilization of arsenic, thus reducing toxicity and mobility. During implementation of this alternative, proper controls would be required to minimize dust generated during the excavation and mixing process. In designing the stabilization process for the site, one consideration would be the long-term stability of the treated material (i.e., the potential that the material would degrade under site conditions, thus releasing arsenic to the environment). More specifically, the following issues would require consideration:

- Hazards from the operation of heavy equipment, damage to underground utilities, or other occupational injuries;
- Airborne contaminated dusts and waste materials;
- Weathering of the treated material such that the ability to maintain the immobilization of contaminants is compromised; and
- Confirmatory sampling.

Implementability: This technology is available. However, a treatability study would be required to determine the technical feasibility of this alternative for site-specific conditions. The study would require a determination regarding the variability of site conditions within Spring Valley between the individual residential properties or lots included in this EE/CA (i.e., the scope of the study could require evaluation of multiple site conditions in order to determine the effectiveness of this alternative for an individual site). The soil at the site, which has typically been classified as clayey silt, may cause problems with the stabilization process because in general the higher the clay content the more difficult the procedure becomes. It also may not be possible to construct an on-site treatment plant either at the site because it is located in a residential neighborhood, or at the Federal Property. It would be very labor intensive to construct an on-site treatment plant. Because of the bulking of soil during this process, this alternative could create difficulties for future landscaping and construction activities, or alternatively, could require relocation/disposal of the soil volume that does not fit back into the original excavation. Hauling of soil through the neighborhood would be disruptive and potentially create opportunities for spills. DCEHA, USEPA, property owner, and community acceptance has not been established.

Cost: This alternative would cost approximately $38/ton for *ex-situ* treatment or approximately $35/ton for *in-situ* treatment. This does not include costs for handling any treated soil volume that cannot be replaced in the excavation (i.e., due to soil bulking). These costs also do not include the costs for the treatability study required to determine the technical feasibility and design parameters for this alternative.

Outcome: The technical feasibility of this alternative for the site-specific conditions is unknown. Therefore, implementation of this alternative would be delayed pending completion of the treatability study. This alternative may not be effective in the long-term due to degradation of the stabilized soil replaced on-site. In addition, this alternative may not be administratively implementable due to issues of siting an on-site treatment plant in a residential neighborhood or at the Federal Property. Because of the bulking of soil during this process, this alternative could create difficulties for future landscaping and construction activities. Therefore, this alternative will not be further evaluated.

7.6.5 Alternative 5: Soil Washing

Effectiveness: This alternative would be protective of human health and the environment. It will remove the arsenic from site soils to levels below the cleanup level, thus reducing the mobility, toxicity, and volume of contaminated soil. The arsenic removed from the soil will be contained in the sludge and wastewater generated during the washing process which would require proper handling and disposal appropriate for the concentrations of arsenic in the waste stream. This alternative would be effective in the long-term as the arsenic concentrations in the soil will be

reduced below the cleanup levels. During implementation of this alternative, proper controls would be required to minimize dust generated during the excavation and washing process. Additionally, the materials used in the washing process may pose a risk to human health and the environment during implementation of this alternative. More specifically, the following issues would require consideration:

- Hazards from the operation of heavy equipment, damage to underground utilities, or other occupational injuries;
- Airborne contaminated dusts and waste materials;
- Confirmatory sampling;
- Additional management of waste generated by soil washing process; and,
- Emissions from extracting agents or solvents used in the solvent extraction process or the wastes generated during the extraction/washing process.

Implementability: This alternative would require a treatability study to determine whether it is technically feasible for site-specific conditions. In general, the clayey silt content of the soils at the site will make it more difficult to achieve the desired endpoints using this technology. It is uncertain whether soil washing could take place on-site or at the Federal Property location due to the chemicals needed in the process, the waste generated, and the potential for spills of these materials. Hauling of soil through the neighborhood, if needed for this alternative, would be disruptive and potentially create opportunities for spills. Although this technology exists, it is labor intensive and vendors utilizing this technology are few. Parsons was unable to obtain a removal or cost from any vendors utilizing this technology. This alternative may also complicate landscaping efforts due to soil sterility issues. DCEHA, USEPA, property owner, and community acceptance has not been established.

Cost: This alternative would cost approximately $190 per ton of soil treated [Cost from RS-MEANS document, *Environmental Remediation Cost Data 6th Annual Edition* (RS-MEANS 2000)]. This cost does not include the costs for the treatability study required to determine the technical feasibility and design parameters for this alternative.

Outcome: The technical feasibility of this alternative for the site-specific conditions is unknown. Therefore, implementation of this alternative would be delayed pending completion of the treatability study. Furthermore, it may not be possible to construct a treatment plant on site or at the Federal Property location. The materials and services required to implement this alternative are not widely available, based on the lack of response from potential vendors contacted by Parsons. Therefore, this alternative will not be further evaluated.

7.6.6 Alternative 6: Excavation and Landfill Disposal

Effectiveness: This alternative would be protective of human health and the environment. It will remove the arsenic from site soils to levels below the cleanup level, thus eliminating the arsenic's mobility and reducing the toxicity and volume of contaminated soil at the site. This alternative would be effective in the long-term as the soils with elevated arsenic concentrations will be removed from the site and it will require only a short period of time until the endpoints

are reached. During implementation of this alternative, controls would be required to minimize dust generated during the excavation.

The excavated soils must be disposed, consistent with 40 C.F.R. § 300.440, in a treatment, storage, or disposal facility that EPA determines to be acceptable. If the excavated soils are characterized as RCRA hazardous, they would have to be stabilized by the RCRA Subtitle C hazardous waste landfill and then deposited in the landfill. If they are not considered RCRA hazardous, they can be disposed of directly into a sanitary landfill. It should be noted that past experience at the site has shown that the vast majority of the soil would be characterized as non-hazardous. Sanitary landfills are required to have liners and caps such that the residential human health hazard presented by the soils would be controlled. Even after closure of the sanitary landfill, the soils would be controlled as part of landfill management.

More specifically, the following issues would require consideration:

- Hazards from the operation of heavy equipment, damage to underground utilities, or other occupational injuries;
- Airborne contaminated dusts and waste materials;
- Confirmatory sampling; and
- Storage, labelling, and transportation requirements.

Implementability: This alternative is technically and administratively feasible. The materials and services required to implement this alternative are readily available. DCEHA, USEPA, property owner, and community acceptance has been established through the on-going TCRA and NTCRA efforts described in Section 2.

Cost: This alternative would cost approximately $422 per ton (disposal of material as RCRA non-hazardous at a sanitary landfill), and approximately $531 per ton (disposal of material as RCRA hazardous at a RCRA Subtitle C landfill).

Outcome: This alternative is both effective and implementable. It will be retained for further evaluation.

8. COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES

8.0.0.1 Based on the individual analysis of alternatives presented in Section 7, the remaining alternatives include:

- Institutional Controls
- Phytoremediation
- Excavation and Landfill Disposal

The three other alternatives identified in Section 7 were eliminated during the individual analysis for various reasons including lack of effectiveness and/or implementability. This section presents a comparative analysis of the remaining alternatives to determine their relative performance in relation to each of the criteria. The purpose of this analysis is to identify the advantages and disadvantages of the remaining alternatives relative to one another so that key factors that would affect the remedy selection can be identified. Table 8.1 presents a summary of the comparative analysis.

8.1.1 Effectiveness

The excavation and landfill disposal alternative would be most protective of human health and the environment overall:

- This alternative will be conducted in a manner that complies with the following action-specific ARARs:
  - **Erosion and Sediment Control**—21 D.C.M.R. §§ 501.4, 502.1 and 539 (discussed in paragraph 7.3.2.5.1 above) are applicable ARARs for this removal action.
  - **Storm Water Management**—21 D.C.M.R. §§ 529 and 530 (discussed in paragraph 7.3.2.5.2 above) are relevant and appropriate ARARs for this removal action.
  - **Fugitive Dust Emissions**—21 D.C.M.R. § 605 (discussed in paragraph 7.3.2.5.3 above) is an applicable ARAR for this removal action.
  - **Noise**—20 D.C.M.R. § 2802.2 and 2802.3 (discussed in paragraph 7.3.2.5.4 above) are applicable ARARs for this removal action.
  - **Accumulation of Hazardous Waste**—40 C.F.R. § 262.34 (discussed in paragraph 7.3.2.5.5 above) is a relevant and appropriate ARAR for this removal action.
  - **Hazardous Waste Storage Tank Management**—40 C.F.R. § 264, Subpart J, (discussed in paragraph 7.3.2.5.6 above) is a relevant and appropriate ARAR for this removal action.
  - **Land Disposal**—40 C.F.R. § 268.40 (discussed in paragraph 7.3.2.5.7 above) is a relevant and appropriate ARAR for this removal action.

- At best, it would be difficult, if not improbable, to attain all of these same ARARs through either the institutional controls alternative or the phytoremediation alternative (depending on the results of the treatability study).
- This alternative is also effective in the long-term whereas there may be problems with the institutional controls alternative in the long-term regarding enforcement of compliance with use limitations, particularly if the property is transferred to a new owner.
- Assuming that a treatability study indicates that phytoremediation would be effective for a particular site, the phytoremediation alternative would be more favorable compared to the excavation and landfill disposal alternative in terms of reduction of toxicity, mobility, and volume **through treatment**. However, the excavation and landfill disposal alternative will remove the arsenic contaminated soil from the site for placement into a controlled landfill, thereby reducing the toxicity and mobility of the soil through the controls in place at the landfill and reducing the volume of contaminated soil at the site.
- The excavation and landfill disposal alternative is the most favorable in terms of short-term effectiveness. The appropriate controls for protection of workers, the community and the environment during implementation of the alternative are readily available and easily implemented. This alternative will achieve the removal objectives in a substantially shorter time frame than the phytoremediation alternative or the institutional controls alternative, which is likely to require substantial time to develop an institutional control plan delineating enforcement and maintenance responsibilities.

Table 8.1
Summary of Comparative Alternatives Analysis

Screening Criterion	Institutional Controls	Phytoremediation	Excavation and Landfill Disposal
Effectiveness			
Protection of Human Health and Environment	○	◑	●
Compliance with ARARs	○	◑	●
Long-Term Effectiveness	○	◑	●
Reduction of Toxicity, Mobility, and Volume through Treatment/1	○	●	◑
Short-Term Effectiveness	◑	○	●
Implementability			
Technical Feasibility	◑	○	●
Administrative Feasibility	○	◑	●
Availability of Materials and Services	●	○	●
Supporting Agency Acceptance	○	○	●
Community Acceptance	○	○	●
Cost ($/ton)	$127 to $197 /a	$35 to $51 /b	$422 to $531/c
Recommended	○	◑	●

● = Favorable

◑ = Fair

○ = Not Favorable/Potential Problems

/1 Reflects EPA's preference for treatment (i.e., for technologies that will permanently and significantly reduce toxicity, mobility or volume of the hazardous substances as their principal element), *EPA 540-R-93-057, Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA*

/a Includes between $20 per ton for a concrete patio and $90 per ton for a brick patio; plus $107 per ton for decorative 6' fencing. These costs do not include maintenance (e.g., irrigation for ground cover plants), the development of deed restrictions, or the development of the institutional control plan.

/b Includes between $15 and $31 per ton for planting of the selected species, harvesting and disposal, and $20 per ton of soil for temporary 3' picket fencing. These costs do not include the costs for the treatability study required to determine the technical feasibility and design parameters for this alternative.

/c $422 per ton (disposal of material as RCRA non-hazardous at a sanitary landfill, most likely scenario based on past site experience); $531 per ton (disposal of material as RCRA hazardous at a RCRA Subtitle C landfill).

8.1.2 Implementability

The excavation and landfill disposal alternative is the most implementable of the three remaining alternatives:

- In terms of technical feasibility, the excavation and landfill disposal alternative is favorable in comparison to the other remaining alternatives. It is more reliable than the other alternatives and would have fewer operational difficulties; it can be performed in a shorter period of time; and there will not be a need to conduct future removal actions. Most importantly, this alternative has been performed at various areas throughout the Spring Valley site as discussed in Section 2 and associated unknowns or potential problems have been identified and largely resolved.
- In terms of administrative feasibility, the excavation and landfill disposal alternative is favorable in comparison to the other remaining alternatives. The institutional controls alternative could have substantial problems during implementation due to the required coordination amongst various government agencies and the individual property owners to select an access control option appropriate for each site (i.e., concrete vs. brick vs. groundcover). Development of an institutional control plan agreed to and complied with by all parties could also present administrative difficulties for the institutional controls alternative. The phytoremediation alternative could also have problems in terms of administrative feasibility due to the required maintenance of the plants and compliance with temporary access controls.
- The materials and services for both the institutional controls alternative and the excavation and landfill disposal alternative are readily available. The availability of materials and services could be an issue for the phytoremediation alternative depending on the type of the plants identified during the treatability study and because it is an innovative technology.
- Based on historical removal actions involving the excavation and landfill disposal of arsenic contaminated soil from other portions of the Spring Valley site, it has been assumed that the excavation and landfill disposal option is acceptable to DCEHA, USEPA, the property owner, and the community. Input received from these stakeholders during the public comment period for this EE/CA report will be incorporated into the Final EE/CA and may affect the alternatives evaluation.

8.1.3 Cost

Table 8.1 summarizes the estimated costs for each alternative. Costs were developed using standard cost estimating tools, literature values, estimates from remedial contractors, and costs for similar work previously conducted by the USACE. The excavation and landfill disposal alternative specifically reflects the actual costs from the portions of the work described in Section 2.4 that the USACE performed. As described in Sections 7.6.2 and 7.6.3, Institutional Controls and Phytoremediation involve some costs that were not included in the summary costs presented in the table.

9. RECOMMENDED REMOVAL ACTION ALTERNATIVE

9.0.0.1 The analysis considered that a single remedy for potentially 140 plus sites throughout Spring Valley may not be practical and that private home owners may opt for less intrusive alternatives. Therefore, it is recognized that some alternatives, such as phytoremediation, although not the one recommended in the formal analysis, may be appropriate on a limited basis for a specific property.

9.1 RECOMMENDED REMOVAL ACTION ALTERNATIVE

9.1.0.1 Based on the evaluations presented in Sections 7 and 8, the recommended alternative is excavation and landfill disposal. This alternative satisfies the removal action goal of reducing the risk posed by elevated arsenic concentrations in surface soil at the sites. This alternative satisfies the evaluation criteria because it will meet the removal objectives in an acceptable amount of time, pose limited risk during implementation, is readily implementable both from a technical and administrative standpoint, and can be accomplished at a reasonable cost. This alternative was selected after evaluating six alternatives separately under each criterion.

9.1.0.2 Figure 4-1 illustrates the areas requiring removal. Soil will initially be excavated to a depth of two feet below ground surface in these areas. Soil samples will be collected from the bottom and sidewalls of these excavations and analyzed for total arsenic. If the arsenic concentrations in the soil samples exceed 20 mg/kg, additional soil will be excavated in that area. This excavation and sampling procedure will continue until the samples collected do not exceed 20 mg/kg arsenic. Clean fill from an off-site source will be used to fill the excavation to grade. The excavated areas would be re-landscaped to conditions equivalent to the pre-existing condition.

9.1.0.4 Excavated soil would be characterized and transported to an appropriate off-site disposal facility. The excavated soil would be characterized in accordance with the requirements of the disposal facility. If the soil is characterized as hazardous, it will be transported to a RCRA subtitle C landfill where it will be pretreated and disposed. If the soil is characterized as non-hazardous, it will be transported to a sanitary landfill for disposal where it will be disposed of directly, without pretreatment. Past experience at the site has shown that the vast majority of the soil would be characterized as non-hazardous.

9.2 DETAILED COST ESTIMATE

9.2.0.1 A detailed cost estimate was prepared for the recommended alternative and is presented in Appendix B. The alternative was costed for two scenarios: disposal at a hazardous waste facility and disposal at a non-hazardous waste facility. These costs include excavation, transportation, disposal, and support requirements for the recommended alternative. The excavation and landfill disposal alternative specifically reflects the actual costs from the portions of the work described in Section 2.4 that the USACE performed. As noted above, although both costs are included, past experience at the site has shown that the vast majority of the soil would be characterized as non-hazardous.

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APPENDIX A

SITE DETAIL MAPS BY GEOGRAPHICAL GROUPING

1

GEOGRAPHICAL GROUPINGS
(OU-4, CTA & CSA)

OU-4 GROUPING A (DETAIL)
OU-4 GROUPING B (DETAIL)
OU-4 GROUPING C (DETAIL)

CTA GROUPINGS
- CTA GROUPING 1A
- CTA GROUPING 1B–North (DETAIL)
- CTA GROUPING 1B-South (DETAIL)
- CTA GROUPING 1C-North (DETAIL)
- CTA GROUPING 1C-South (DETAIL)
- CTA GROUPING 1D

CSA GROUPING 2
- CSA GROUPING 2A (DETAIL)
- CSA GROUPING 2B (DETAIL)

CSA GROUPING 3
- CSA GROUPING 3A (DETAIL)
- CSA GROUPING 3B (DETAIL)

CSA GROUPING 4

CSA GROUPING 5
- CSA GROUPING 5A (DETAIL)
- CSA GROUPING 5B (DETAIL)

CSA GROUPING 6
- CSA GROUPING 6A (DETAIL)
- CSA GROUPING 6B (DETAIL)

CSA GROUPING 7
- CSA GROUPING 7A (DETAIL)
- CSA GROUPING 7B (DETAIL)

CSA GROUPING 8

CSA GROUPING 9

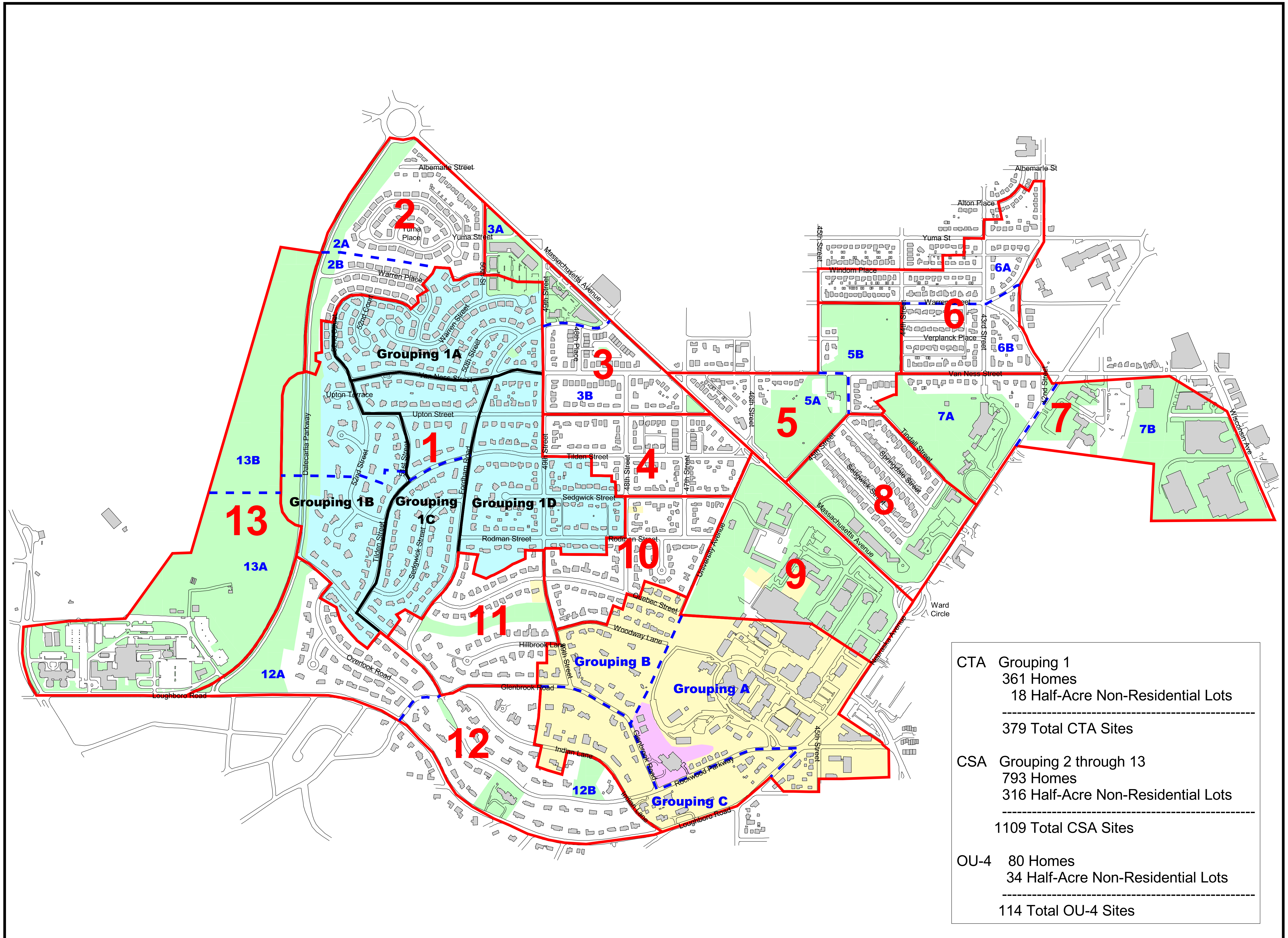
CSA GROUPING 10

CSA GROUPING 11

CSA GROUPING 12
- CSA GROUPING 12A (DETAIL)
- CSA GROUPING 12B (DETAIL)

CSA GROUPING 13
- CSA GROUPING 13A (DETAIL)
- CSA GROUPING 13B (DETAIL)

2



Geographical Groupings

Spring Valley
Operable Units 4 & 5
Washington D.C.

Legend

- Grouping Divisions
- Central Testing Area Divisions
- Groupings
- Buildings
- Roads
- Non-Residential Acreage
- CTA (Group 1)
- OU-3
- OU-4

Note:
OU-5 Acreage comprises groupings 1 through 13.

CSA is groupings 2 through 13.

Note:
- Single family houses and each townhouse count as 1 residential lot.
- Commercial and other types of buildings are not included in the residential count.
- The non-residential acreage count does not include the area of the commercial building, but does include paved parking lots and other potentially inaccessible areas. Sampling of these lots will be based on open accessible portions determined in the field.

0 1000 Feet

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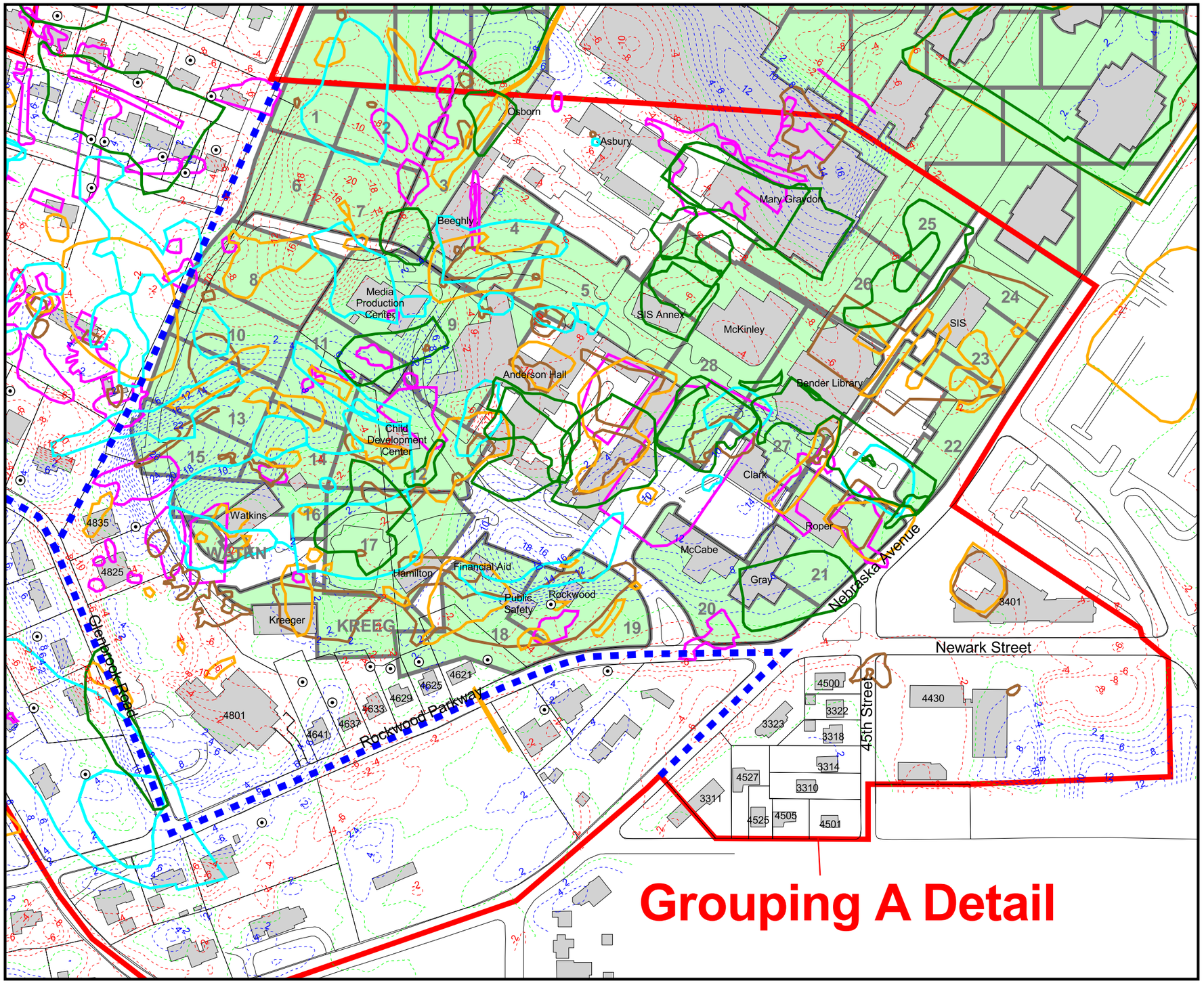

Operable Unit 4
Grouping A Detail

Spring Valley Operable Unit 4
Washington D.C.

Legend

- Boring Locations
- Boundary between A, B & C Detail
- Stressed Vegetation
- 1928 Ground Scars
- 1927 Ground Scars
- 1922 Ground Scars
- 1918 Ground Scars

Cut & Fill
- Cut
- Level
- Fill

- Parcels
- OU-4
- Buildings
- Roads
- Non-Residential Lots

Note:
- Single family houses and each townhouse count as 1 residential lot.
- Commercial and other types of buildings are not included in the residential count.
- The non-residential acreage count does not include the area of the commercial building, but does include paved parking lots and other potentially inaccessible areas.
- Non-residential acreage is divided into 1/2 acre (approximate) lots.

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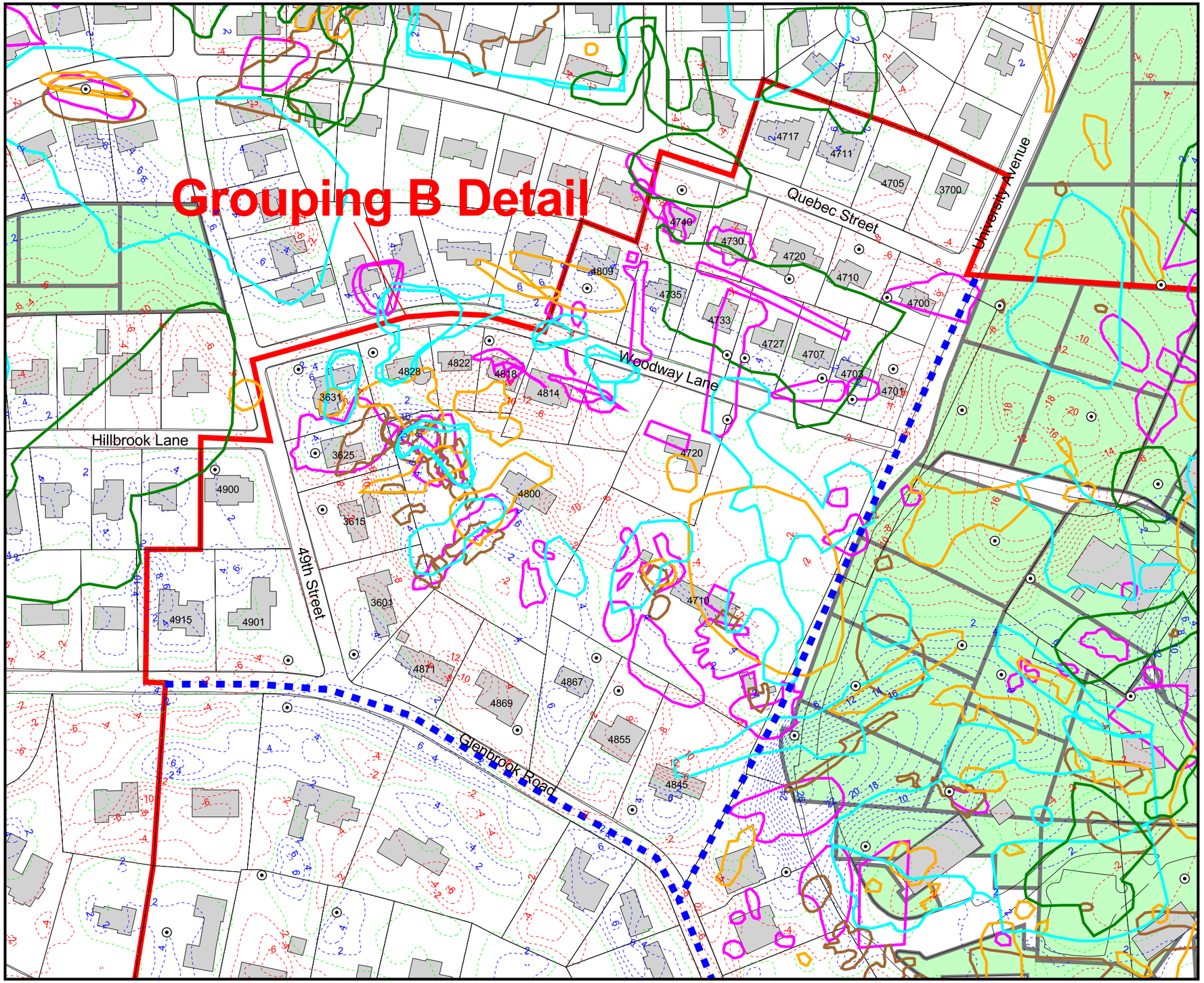

Operable Unit 4
Grouping B Detail

Spring Valley Operable Unit 4
Washington D.C.

Legend

- Boring Locations
- Boundary between A, B & C Detail
- Stressed Vegetation
- 1928 Ground Scars
- 1927 Ground Scars
- 1922 Ground Scars
- 1918 Ground Scars

Cut & Fill
- Cut
- Level
- Fill

- Parcels
- OU-4
- Buildings
- Roads
- Non-Residential Lots

Note:
- Single family houses and each townhouse count as 1 residential lot.
- Commercial and other types of buildings are not included in the residential count.
- The non-residential acreage count does not include the area of the commercial building, but does include paved parking lots and other potentially inaccessible areas.
- Non-residential acreage is divided into 1/2 acre (approximate) lots.

150 0 150 Feet

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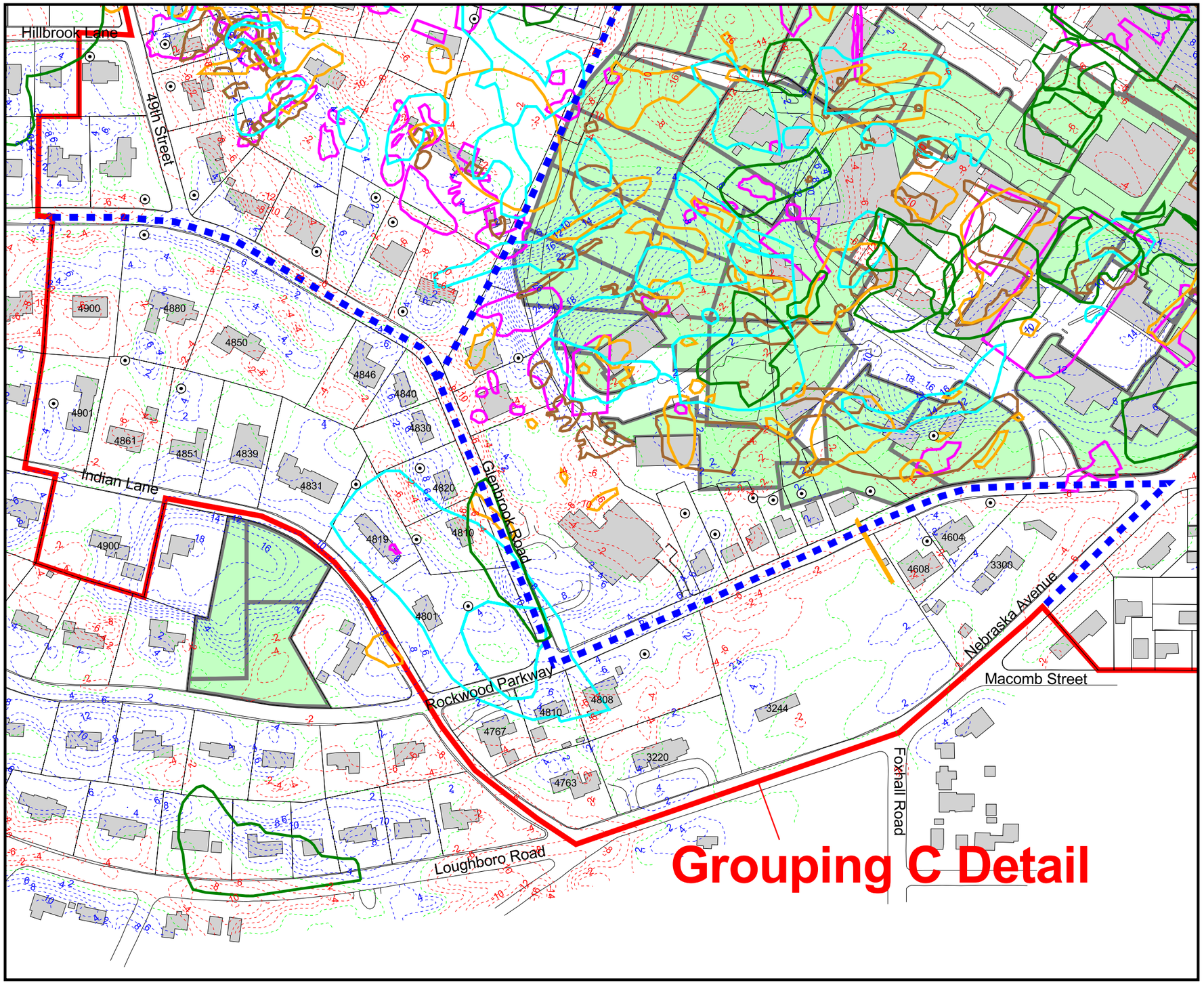

Operable Unit 4
Grouping C Detail

Spring Valley Operable Unit 4
Washington D.C.

Legend

- Boring Locations
- Boundary between A, B & C Detail
- Stressed Vegetation
- 1928 Ground Scars
- 1927 Ground Scars
- 1922 Ground Scars
- 1918 Ground Scars

Cut & Fill

- Cut
- Level
- Fill
- Parcels
- OU-4
- Buildings
- Roads
- Non-Residential Lots

Note:

- Single family houses and each townhouse count as 1 residential lot.
- Commercial and other types of buildings are not included in the residential count.
- The non-residential acreage count does not include the area of the commercial building, but does include paved parking lots and other potentially inaccessible areas.
- Non-residential acreage is divided into 1/2 acre (approximate) lots.

200 0 200 Feet

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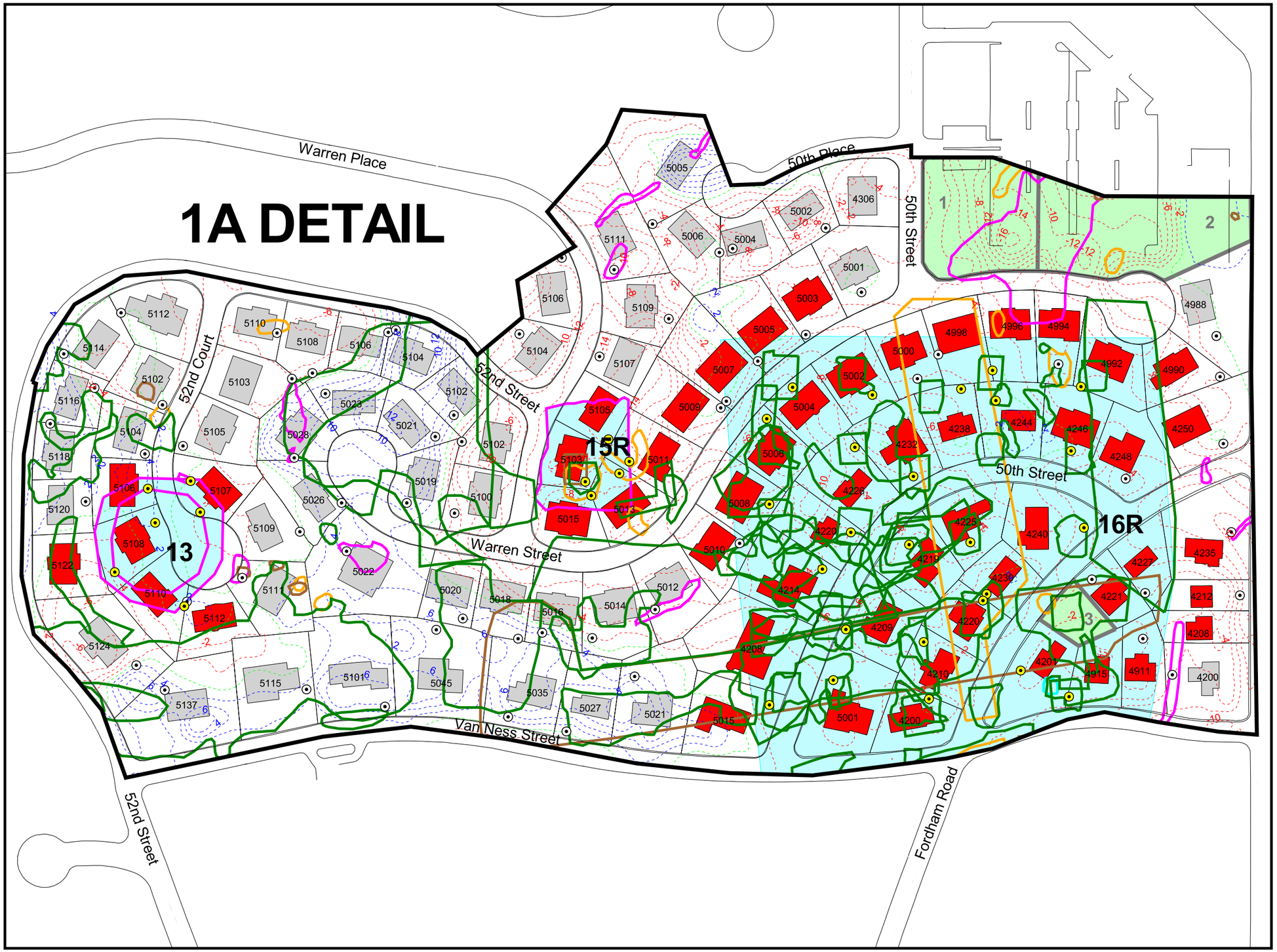

CTA
Grouping 1A

Spring Valley Operable Unit 5
Washington D.C.

Legend

Boring Location
- Arsenic
- POI-Specific Parameters

Roads
Stressed Vegetation
1928 Ground Scars
1927 Ground Scars
1922 Ground Scars
1918 Ground Scars

Cut & Fill
- Cut
- Level
- Fill

Parcels
Non-Residential Lots
CTA Grouping 1A
Residence Within a POI
Building
POIs

Note:
- Single family houses and each townhouse count as 1 residential lot.
- Commercial and other types of buildings are not included in the residential count.
- The non-residential acreage count does not include the area of the commercial building, but does include paved parking lots and other potentially inaccessible areas.
- Non-residential acreage is divided into 1/2 acre (approximate) lots.

0 200 Feet

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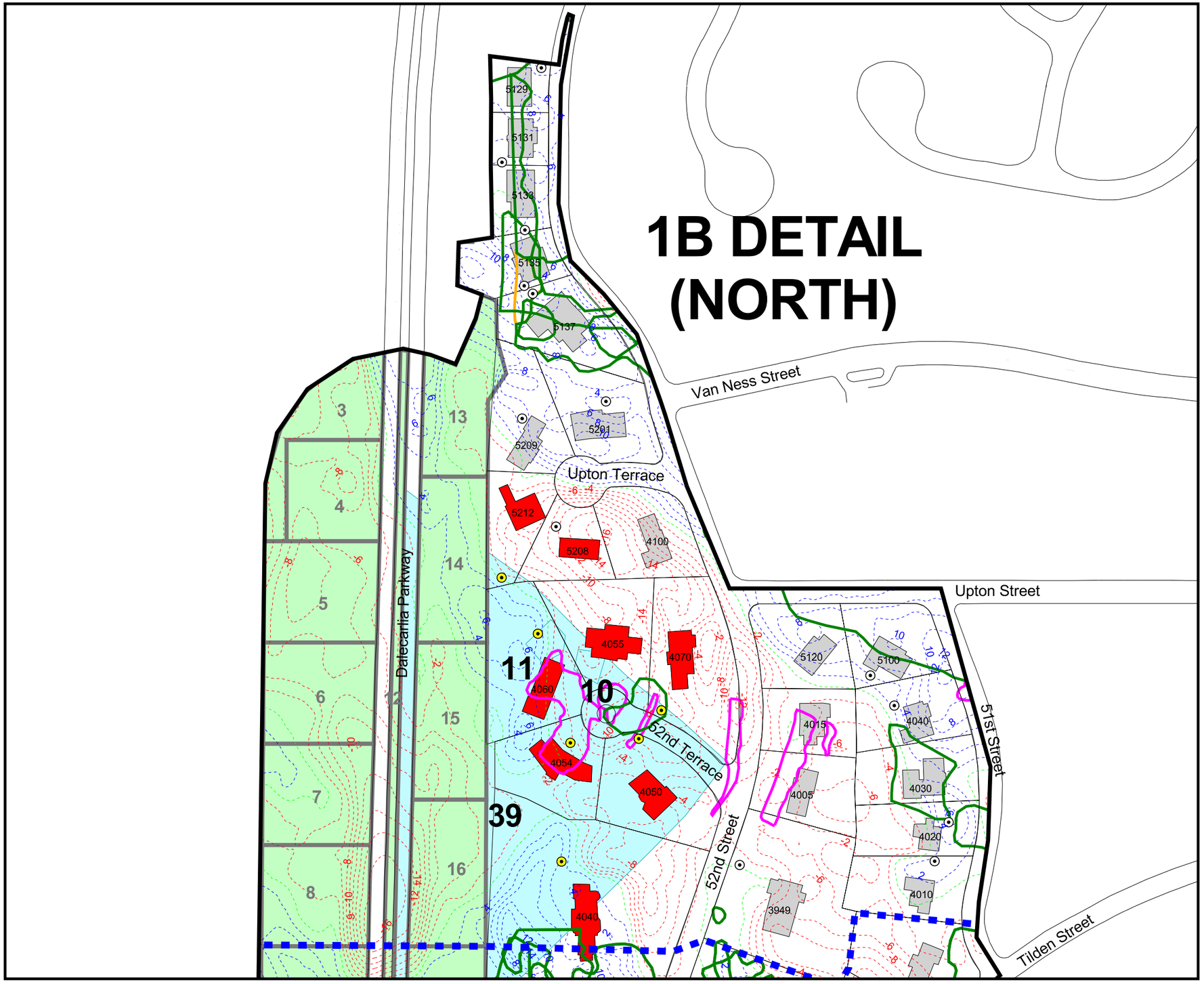

CTA
Grouping 1B-North Detail

Spring Valley Operable Unit 5
Washington D.C.

Legend

Boring Locations
- Arsenic
- POI-Specific Parameters

Boundary between North & South Detail
Roads
Stressed Vegetation
1928 Ground Scars
1927 Ground Scars
1922 Ground Scars
1918 Ground Scars
Cut & Fill
- Cut
- Level
- Fill

Parcels
Non-Residential Lots
CTA Grouping 1B
Residence Within a POI
Building
POIs

Note:
- Single family houses and each townhouse count as 1 residential lot.
- Commercial and other types of buildings are not included in the residential count.
- The non-residential acreage count does not include the area of the commercial building, but does include paved parking lots and other potentially inaccessible areas.
- Non-residential acreage is divided into 1/2 acre (approximate) lots.

150 0 150 Feet

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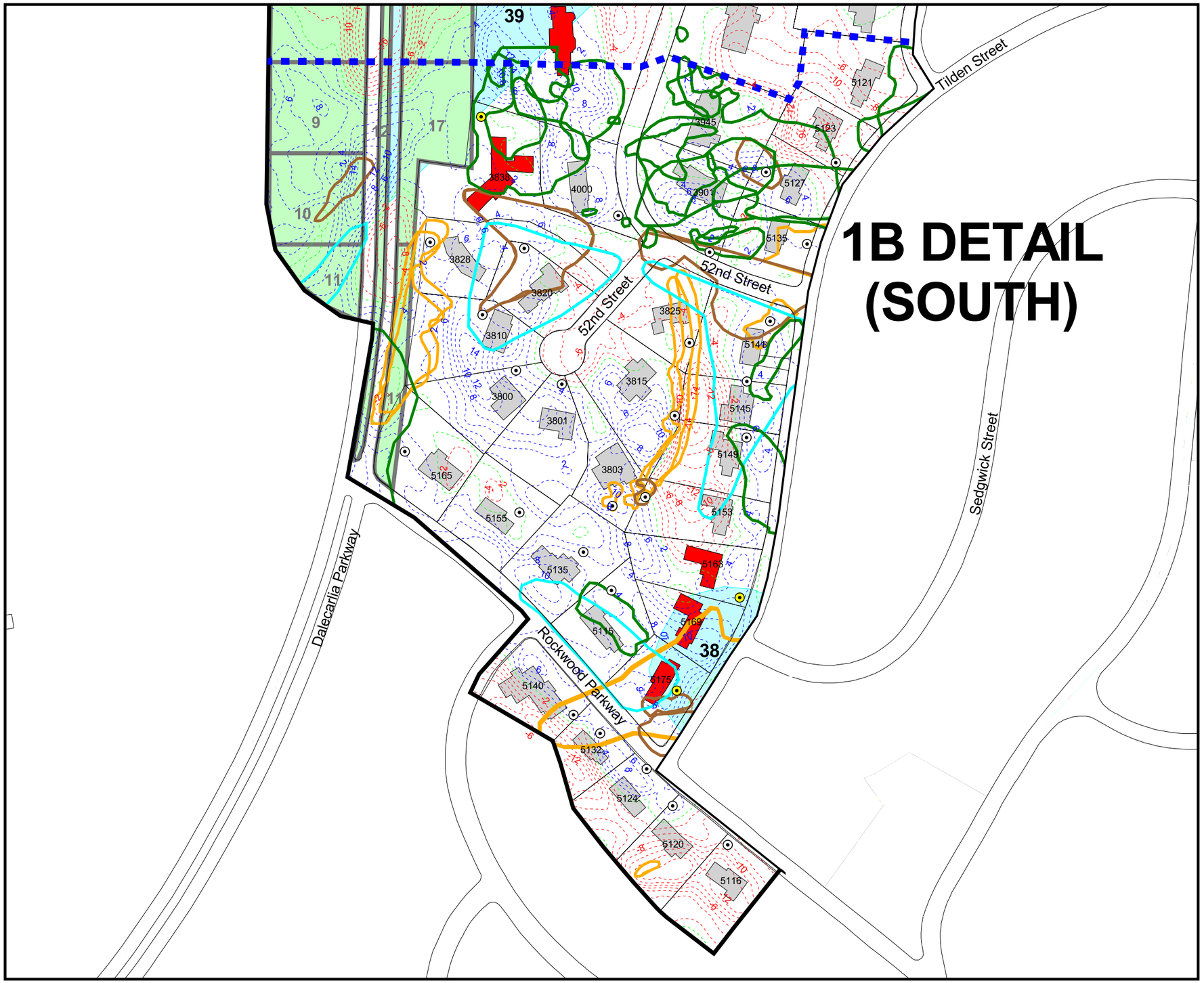

CTA
Grouping 1B-South Detail

Spring Valley Operable Unit 5
Washington D.C.

Legend

Boring Locations
- Arsenic
- POI-Specific Parameters

Boundary between North & South Detail
Roads
Stressed Vegetation
1928 Ground Scars
1927 Ground Scars
1922 Ground Scars
1918 Ground Scars

Cut & Fill
- Cut
- Level
- Fill

Parcels
Non-Residential Lots
CTA Grouping 1B
Residence Within a POI
Building
POIs

Note:
- Single family houses and each townhouse count as 1 residential lot.
- Commercial and other types of buildings are not included in the residential count.
- The non-residential acreage count does not include the area of the commercial building, but does include paved parking lots and other potentially inaccessible areas.
- Non-residential acreage is divided into 1/2 acre (approximate) lots.

150 0 150 Feet

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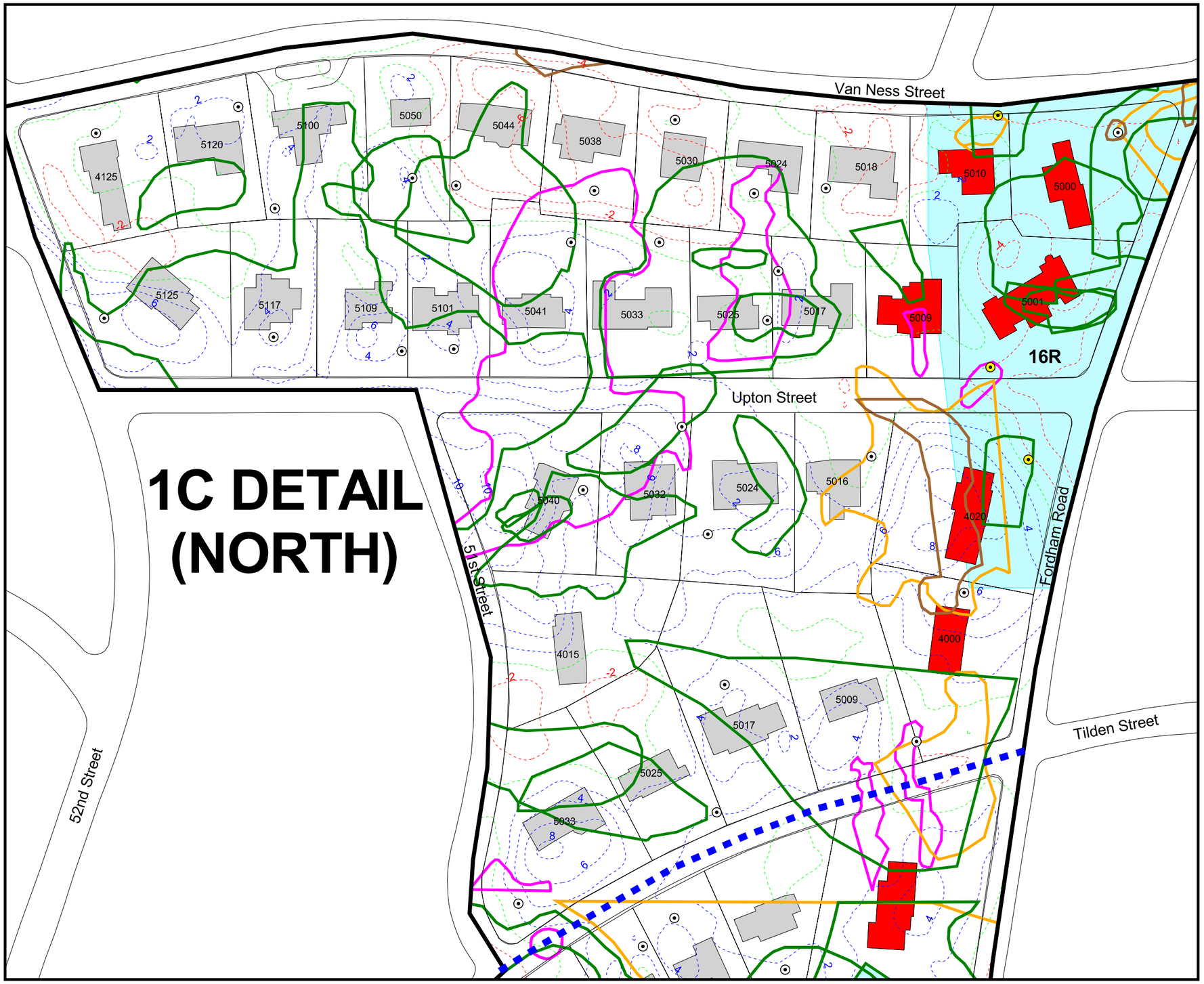

CTA
Grouping 1C-North Detail

Spring Valley Operable Unit 5
Washington D.C.

Legend

Boring Locations
- Arsenic
- POI-Specific Parameters

Boundary between North & South Detail
Roads
Stressed Vegetation
1928 Ground Scars
1927 Ground Scars
1922 Ground Scars
1918 Ground Scars

Cut & Fill
- Cut
- Level
- Fill

Parcels
Non-Residential Lots
CTA Grouping 1C
Residence Within a POI
Building
POIs

Note:
- Single family houses and each townhouse count as 1 residential lot.
- Commercial and other types of buildings are not included in the residential count.
- The non-residential acreage count does not include the area of the commercial building, but does include paved parking lots and other potentially inaccessible areas.
- Non-residential acreage is divided into 1/2 acre (approximate) lots.

100 0 100 Feet

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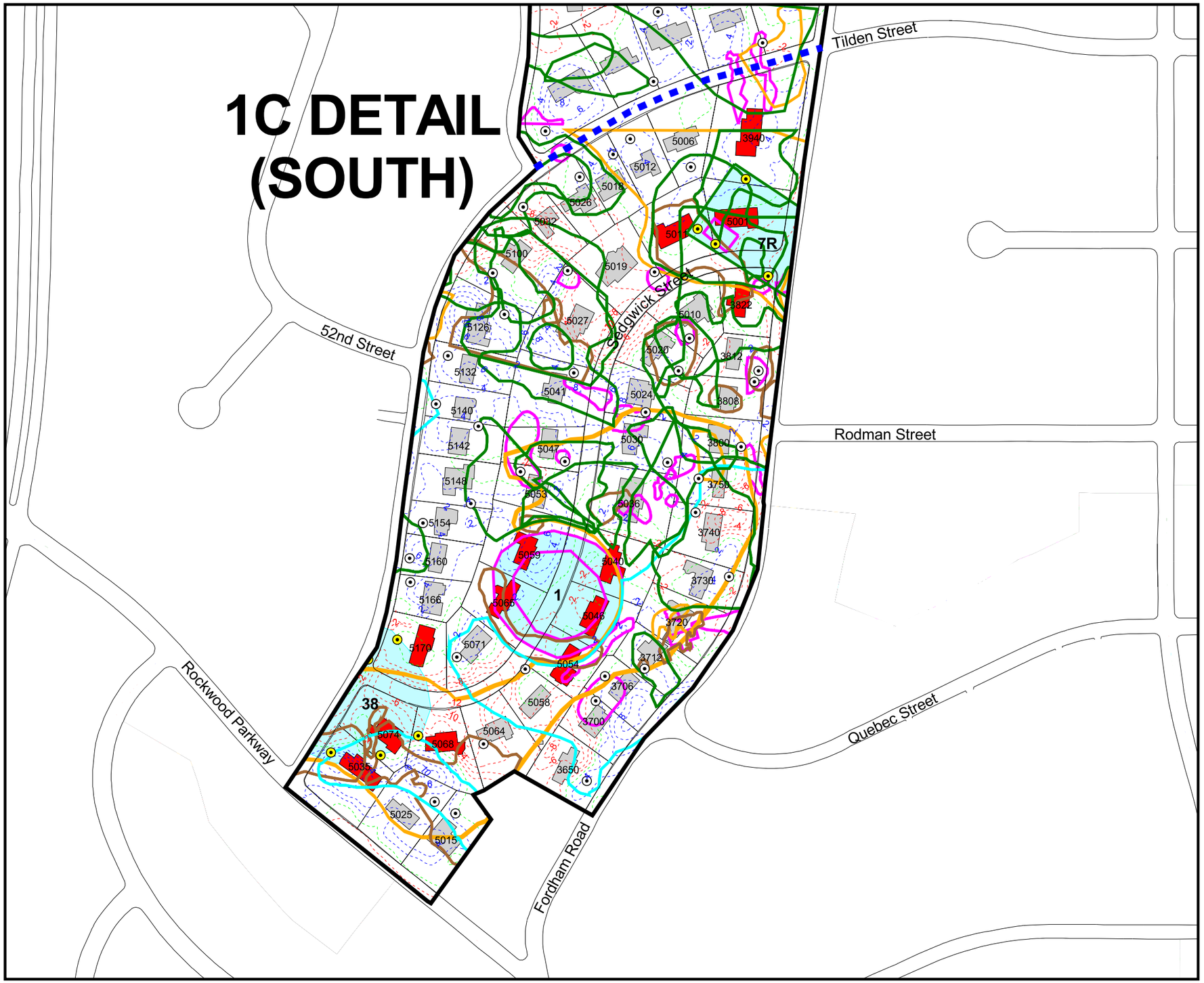

CTA
Grouping 1C-South Detail

Spring Valley Operable Unit 5
Washington D.C.

Legend

Boring Locations
- Arsenic
- POI-Specific Parameters

Boundary between North & South Detail
Roads
Stressed Vegetation
1928 Ground Scars
1927 Ground Scars
1922 Ground Scars
1918 Ground Scars

Cut & Fill
- Cut
- Level
- Fill

Parcels
Non-Residential Lots
CTA Grouping 1C
Residence Within a POI
Building
POIs

Note:
- Single family houses and each townhouse count as 1 residential lot.
- Commercial and other types of buildings are not included in the residential count.
- The non-residential acreage count does not include the area of the commercial building, but does include paved parking lots and other potentially inaccessible areas.
- Non-residential acreage is divided into 1/2 acre (approximate) lots.

200 0 200 Feet

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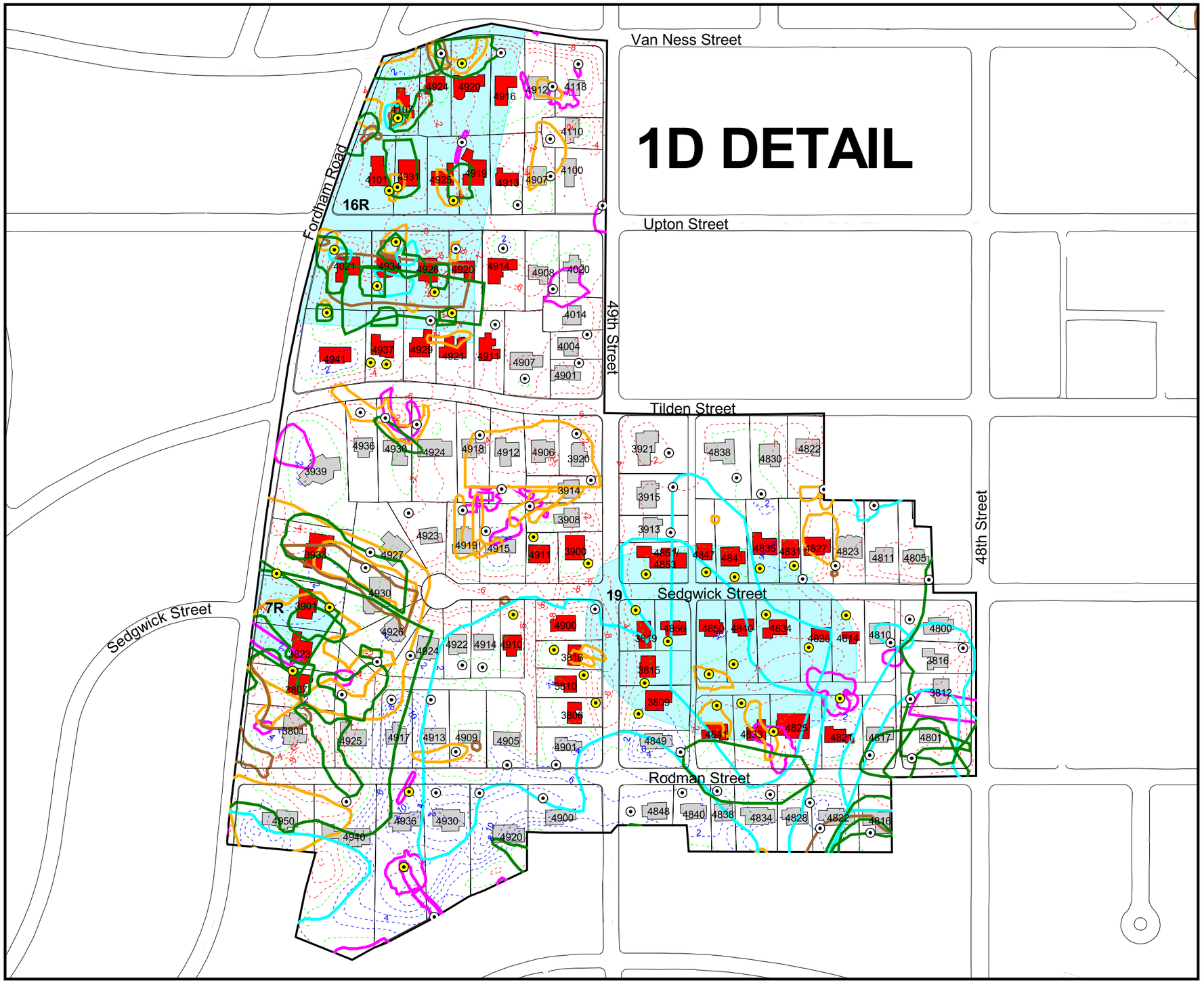

CTA
Grouping 1D

Spring Valley Operable Unit 5
Washington D.C.

Legend

Boring Location
- Arsenic
- POI-Specific Parameters

Roads
Stressed Vegetation
1928 Ground Scars
1927 Ground Scars
1922 Ground Scars
1918 Ground Scars
Cut & Fill
- Cut
- Level
- Fill

Parcels
Non-Residential Lots
CTA Grouping 1D
Residence Within a POI
Building
POIs

Note:
- Single family houses and each townhouse count as 1 residential lot.
- Commercial and other types of buildings are not included in the residential count.
- The non-residential acreage count does not include the area of the commercial building, but does include paved parking lots and other potentially inaccessible areas.
- Non-residential acreage is divided into 1/2 acre (approximate) lots.

200 0 200 Feet

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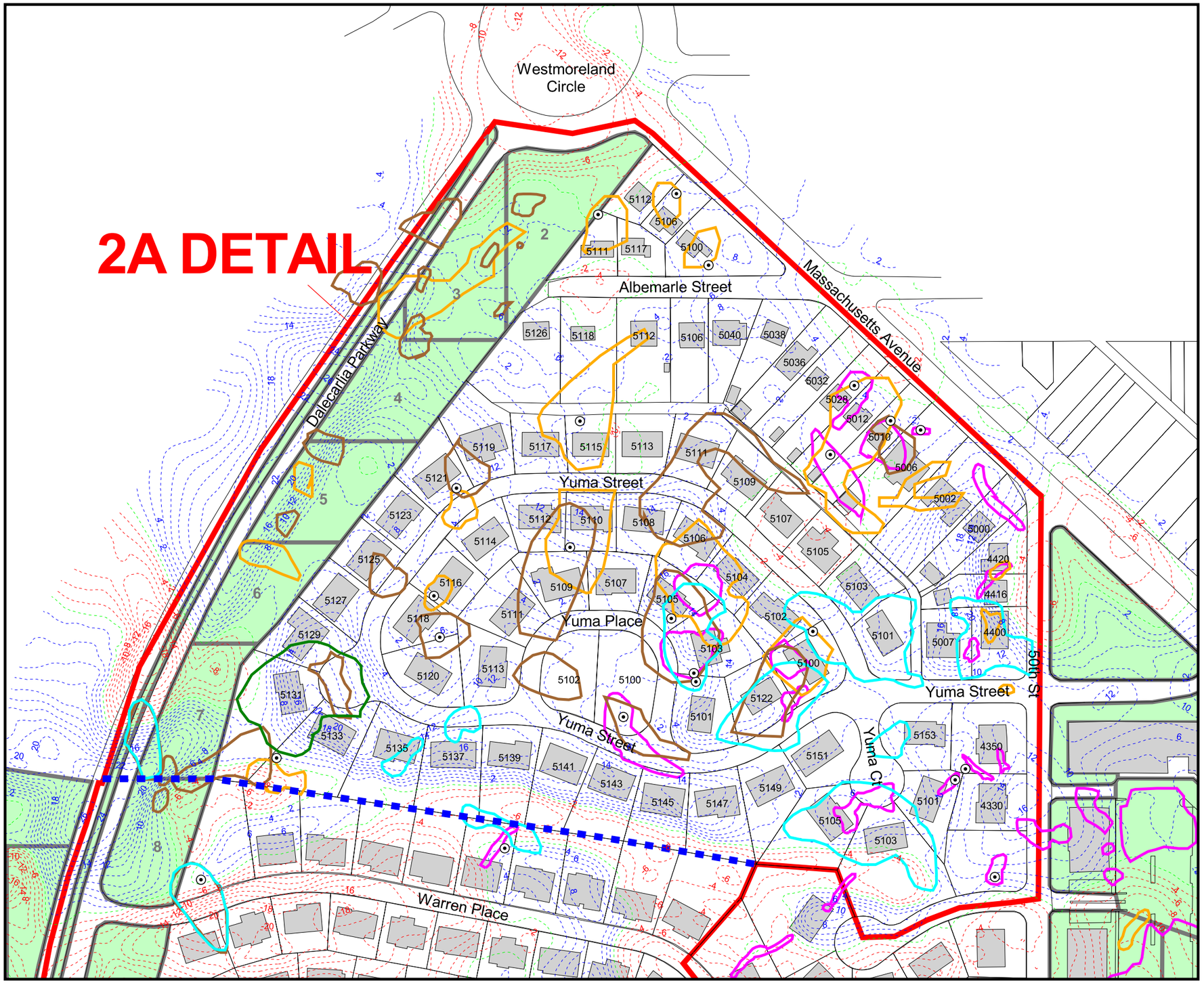

CSA
Grouping 2A Detail

Spring Valley Operable Unit 5
Washington D.C.

Legend

- Boring Locations
- Boundary between A & B Detail
- Stressed Vegetation
- 1928 Ground Scars
- 1927 Ground Scars
- 1922 Ground Scars
- 1918 Ground Scars

Cut & Fill
- Cut
- Level
- Fill

- Parcels
- Grouping 2
- Buildings
- Roads
- Non-Residential Lots

Note:
- Single family houses and each townhouse count as 1 residential lot.
- Commercial and other types of buildings are not included in the residential count.
- The non-residential acreage count does not include the area of the commercial building, but does include paved parking lots and other potentially inaccessible areas.
- Non-residential acreage is divided into 1/2 acre (approximate) lots.

150 0 150 Feet

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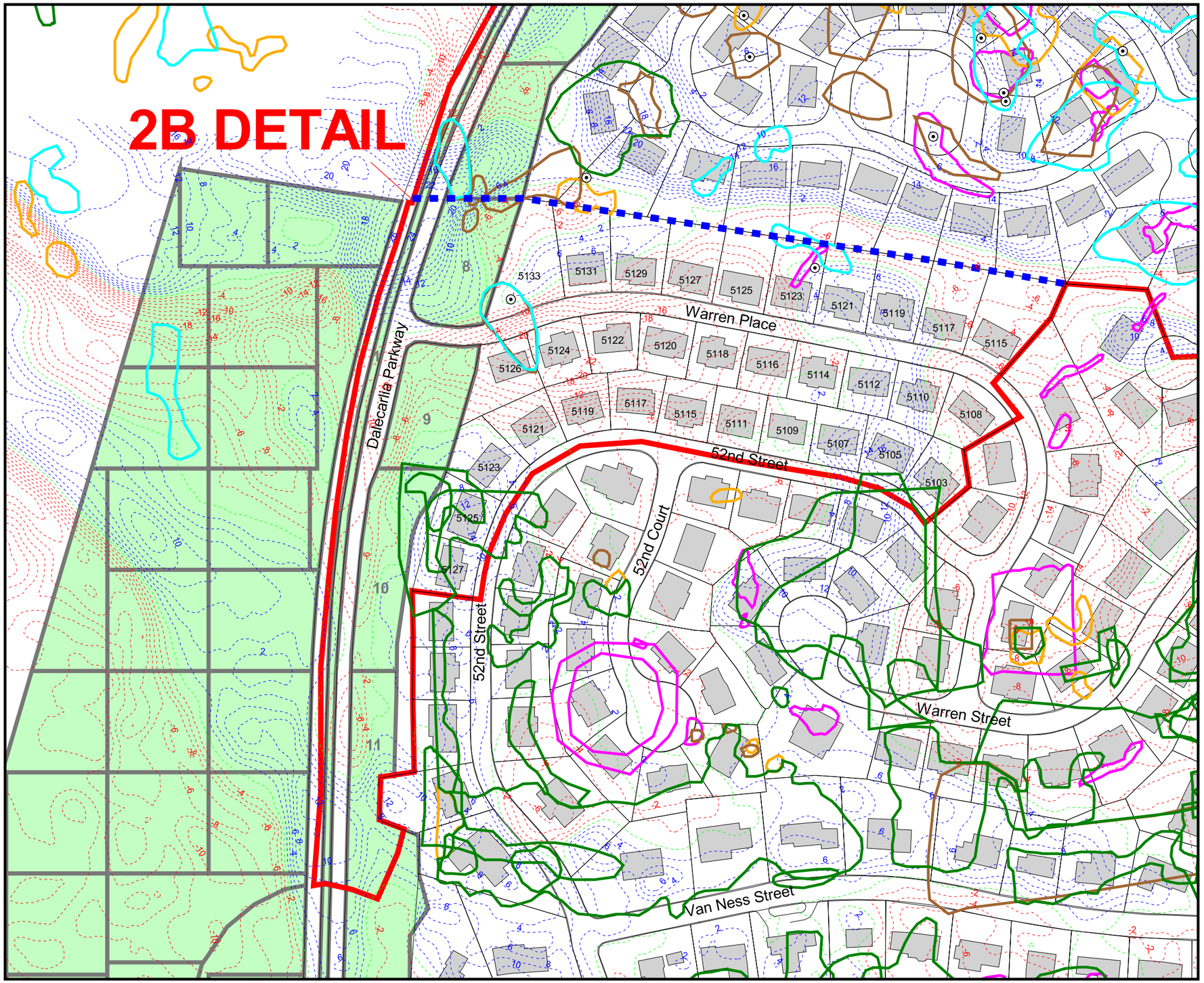

CSA
Grouping 2B Detail

Spring Valley Operable Unit 5
Washington D.C.

Legend

- Boring Locations
- Boundary between A & B Detail
- Stressed Vegetation
- 1928 Ground Scars
- 1927 Ground Scars
- 1922 Ground Scars
- 1918 Ground Scars

Cut & Fill
- Cut
- Level
- Fill

- Parcels
- Grouping 2
- Buildings
- Roads
- Non-Residential Lots

Note:
- Single family houses and each townhouse count as 1 residential lot.
- Commercial and other types of buildings are not included in the residential count.
- The non-residential acreage count does not include the area of the commercial building, but does include paved parking lots and other potentially inaccessible areas.
- Non-residential acreage is divided into 1/2 acre (approximate) lots.

150 0 150 Feet

Scale:	1 : 1800
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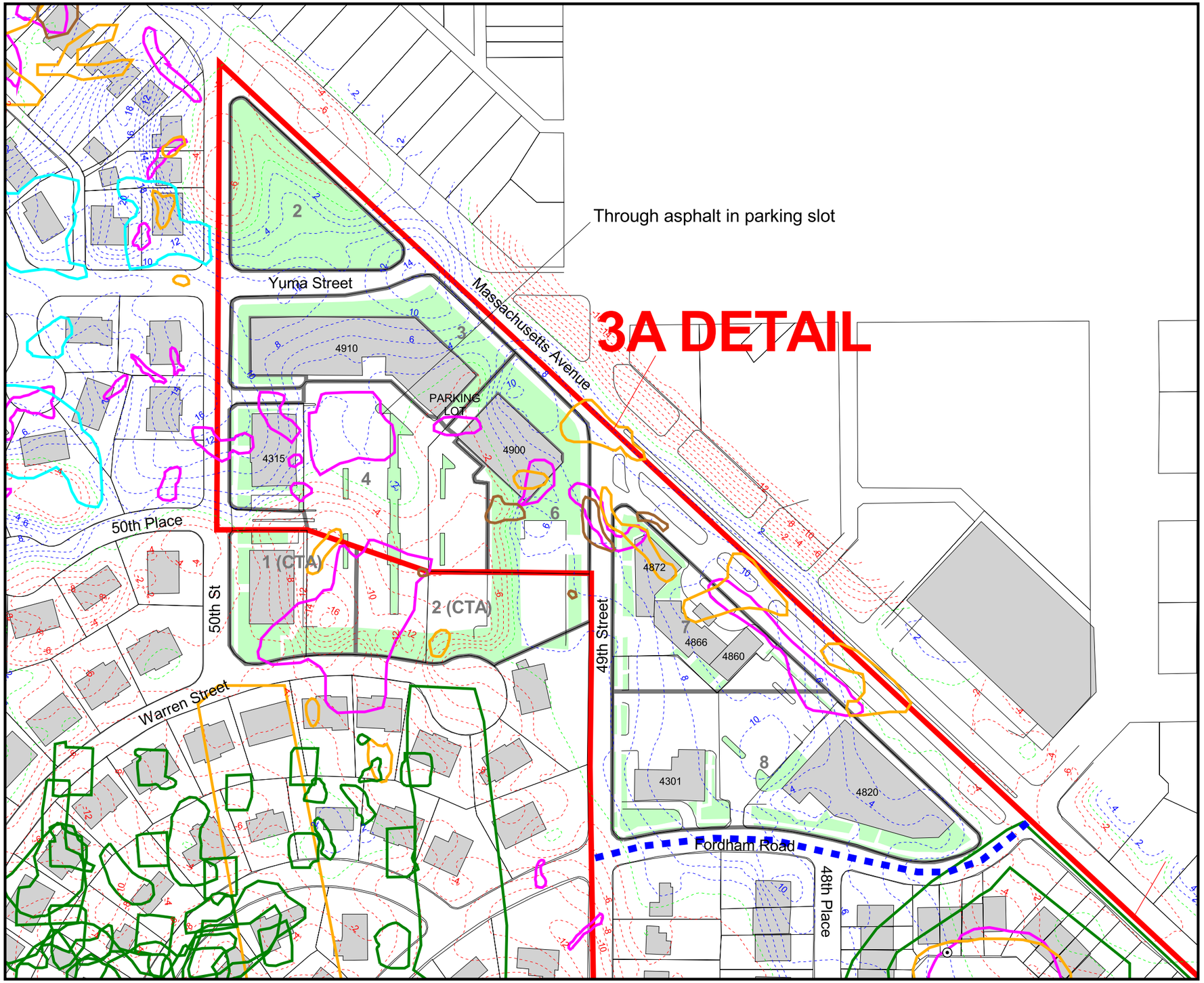

CSA
Grouping 3A Detail

Spring Valley Operable Unit 5
Washington D.C.

Legend

- Boring Locations
- Boundary between A & B Detail
- Stressed Vegetation
- 1928 Ground Scars
- 1927 Ground Scars
- 1922 Ground Scars
- 1918 Ground Scars

Cut & Fill
- Cut
- Level
- Fill

- Parcels
- Grouping 3
- Buildings
- Roads
- Non-Residential Lots

Note:
- Single family houses and each townhouse count as 1 residential lot.
- Commercial and other types of buildings are not included in the residential count.
- The non-residential acreage count does not include the area of the commercial building, but does include paved parking lots and other potentially inaccessible areas.
- Non-residential acreage is divided into 1/2 acre (approximate) lots.

150 0 150 Feet

Scale:	1 : 1600
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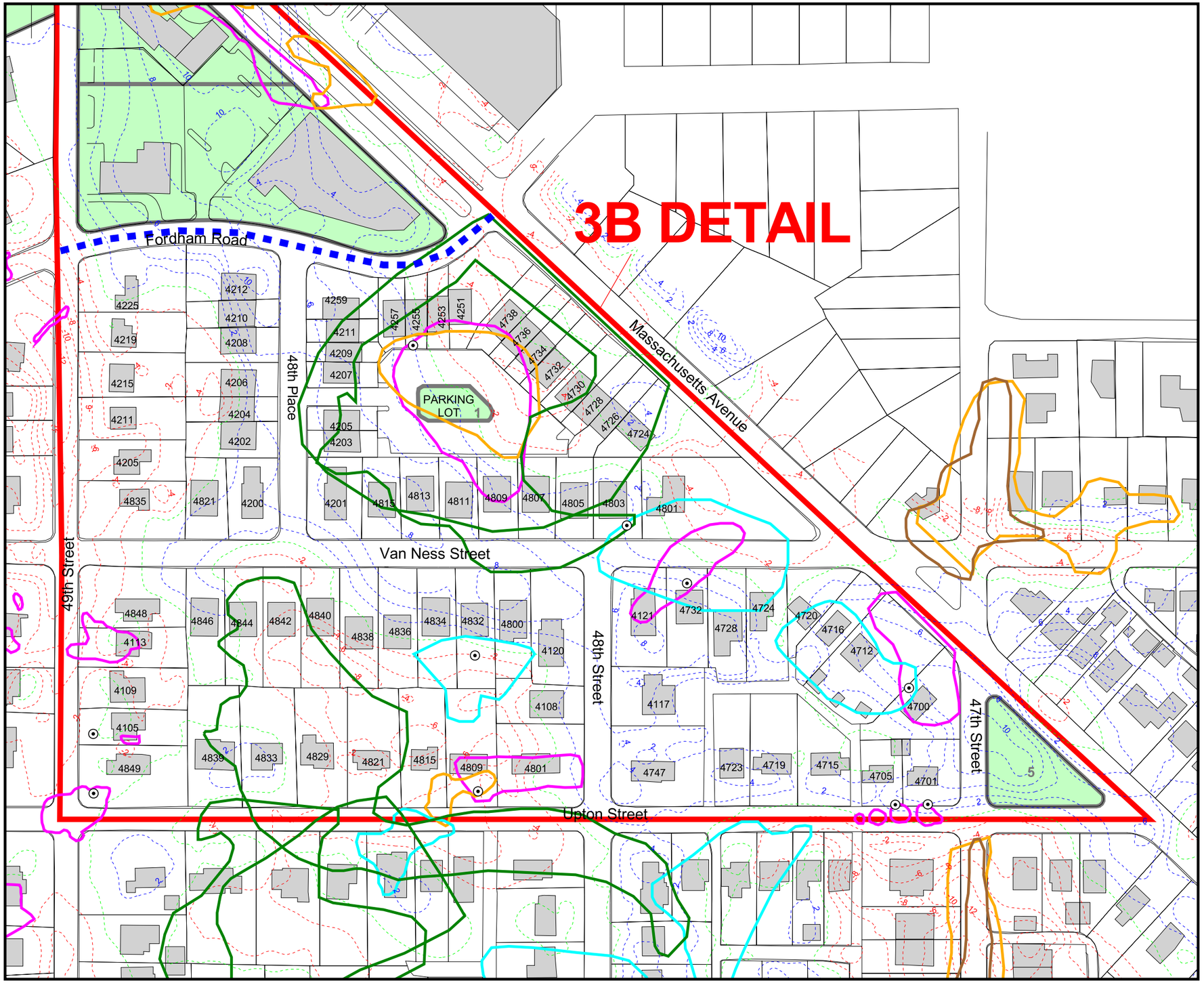

CSA
Grouping 3B Detail

Spring Valley Operable Unit 5
Washington D.C.

Legend

- Boring Locations
- Boundary between A & B Detail
- Stressed Vegetation
- 1928 Ground Scars
- 1927 Ground Scars
- 1922 Ground Scars
- 1918 Ground Scars

Cut & Fill
- Cut
- Level
- Fill
- Parcels
- Grouping 3
- Buildings
- Roads
- Non-Residential Lots

Note:
- Single family houses and each townhouse count as 1 residential lot.
- Commercial and other types of buildings are not included in the residential count.
- The non-residential acreage count does not include the area of the commercial building, but does include paved parking lots and other potentially inaccessible areas.
- Non-residential acreage is divided into 1/2 acre (approximate) lots.

150 0 150 Feet

Scale:	1 : 1600
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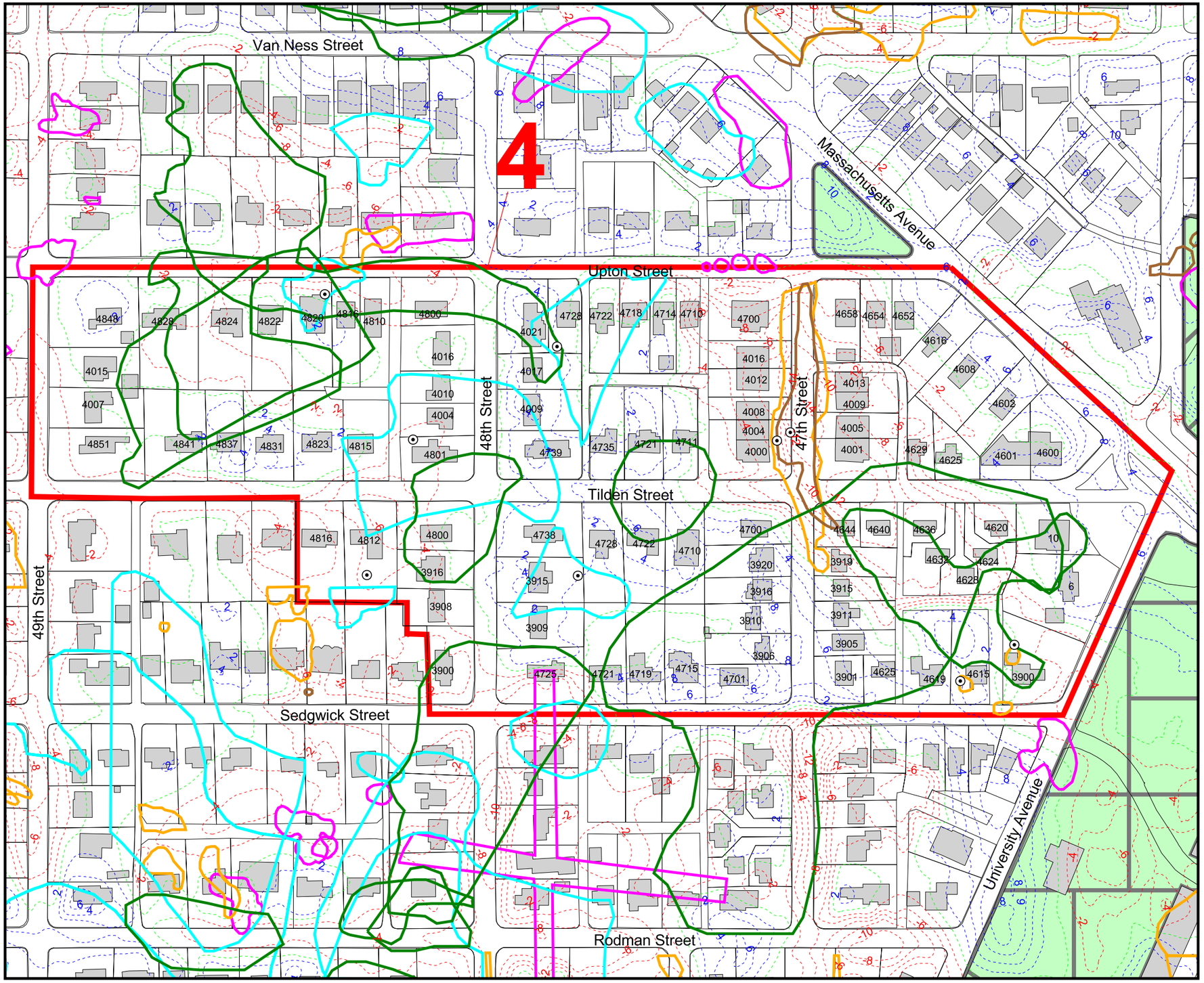

CSA
Grouping 4

Spring Valley Operable Unit 5
Washington D.C.

Legend

- Boring Locations
- Stressed Vegetation
- 1928 Ground Scars
- 1922 Ground Scars
- 1927 Ground Scars
- 1918 Ground Scars

Cut & Fill
- Cut
- Level
- Fill

- Parcels
- Grouping 4
- Buildings
- Roads
- Non-Residential Lots

Note:
- Single family houses and each townhouse count as 1 residential lot.
- Commercial and other types of buildings are not included in the residential count.
- The non-residential acreage count does not include the area of the commercial building, but does include paved parking lots and other potentially inaccessible areas.
- Non-residential acreage is divided into 1/2 acre (approximate) lots.

200 0 200 Feet

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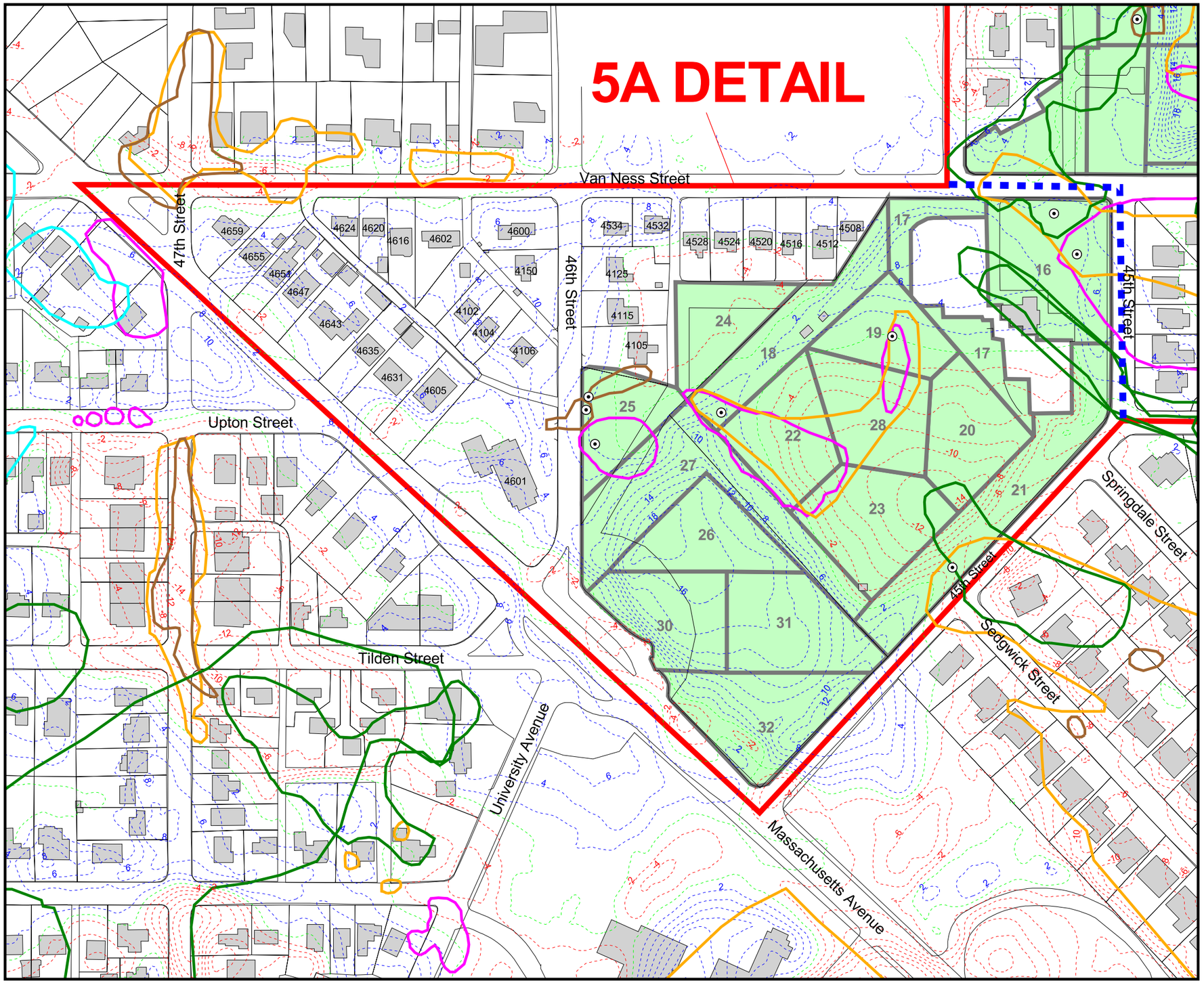

CSA
Grouping 5A Detail

Spring Valley Operable Unit 5
Washington D.C.

Legend

- Boring Locations
- Boundary between A & B Detail
- Stressed Vegetation
- 1928 Ground Scars
- 1927 Ground Scars
- 1922 Ground Scars
- 1918 Ground Scars

Cut & Fill
- Cut
- Level
- Fill
- Parcels
- Grouping 5
- Buildings
- Roads
- Non-Residential Lots

Note:
- Single family houses and each townhouse count as 1 residential lot.
- Commercial and other types of buildings are not included in the residential count.
- The non-residential acreage count does not include the area of the commercial building, but does include paved parking lots and other potentially inaccessible areas.
- Non-residential acreage is divided into 1/2 acre (approximate) lots.

150 0 150 Feet

Scale:	1 : 1800
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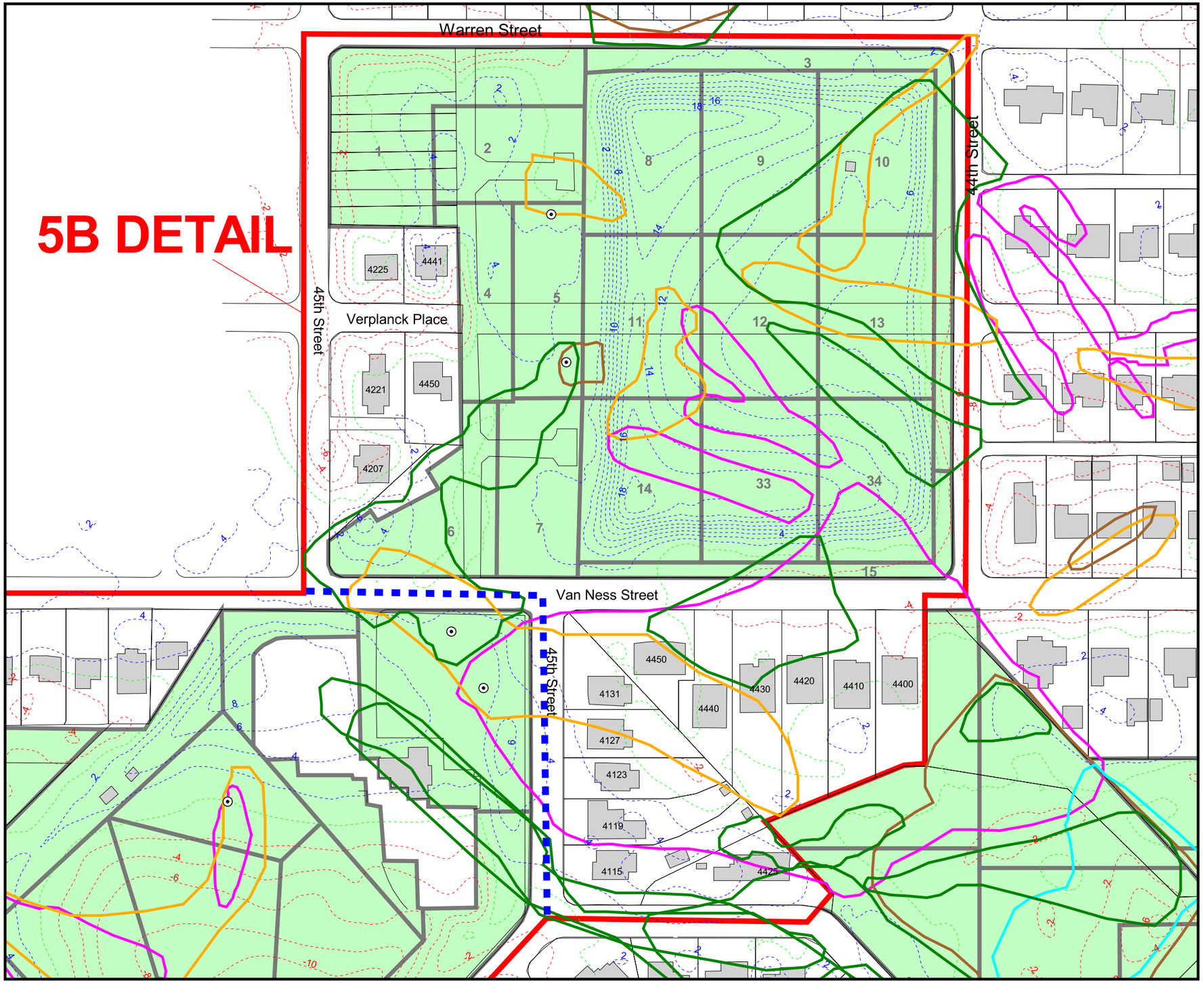

CSA
Grouping 5B Detail

Spring Valley Operable Unit 5
Washington D.C.

Legend

- Boring Locations
- Boundary between A & B Detail
- Stressed Vegetation
- 1928 Ground Scars
- 1927 Ground Scars
- 1922 Ground Scars
- 1918 Ground Scars

Cut & Fill
- Cut
- Level
- Fill

- Parcels
- Grouping 5
- Buildings
- Roads
- Non-Residential Lots

Note:
- Single family houses and each townhouse count as 1 residential lot.
- Commercial and other types of buildings are not included in the residential count.
- The non-residential acreage count does not include the area of the commercial building, but does include paved parking lots and other potentially inaccessible areas.
- Non-residential acreage is divided into 1/2 acre (approximate) lots.

100 0 100 Feet

Scale:	1 : 1200
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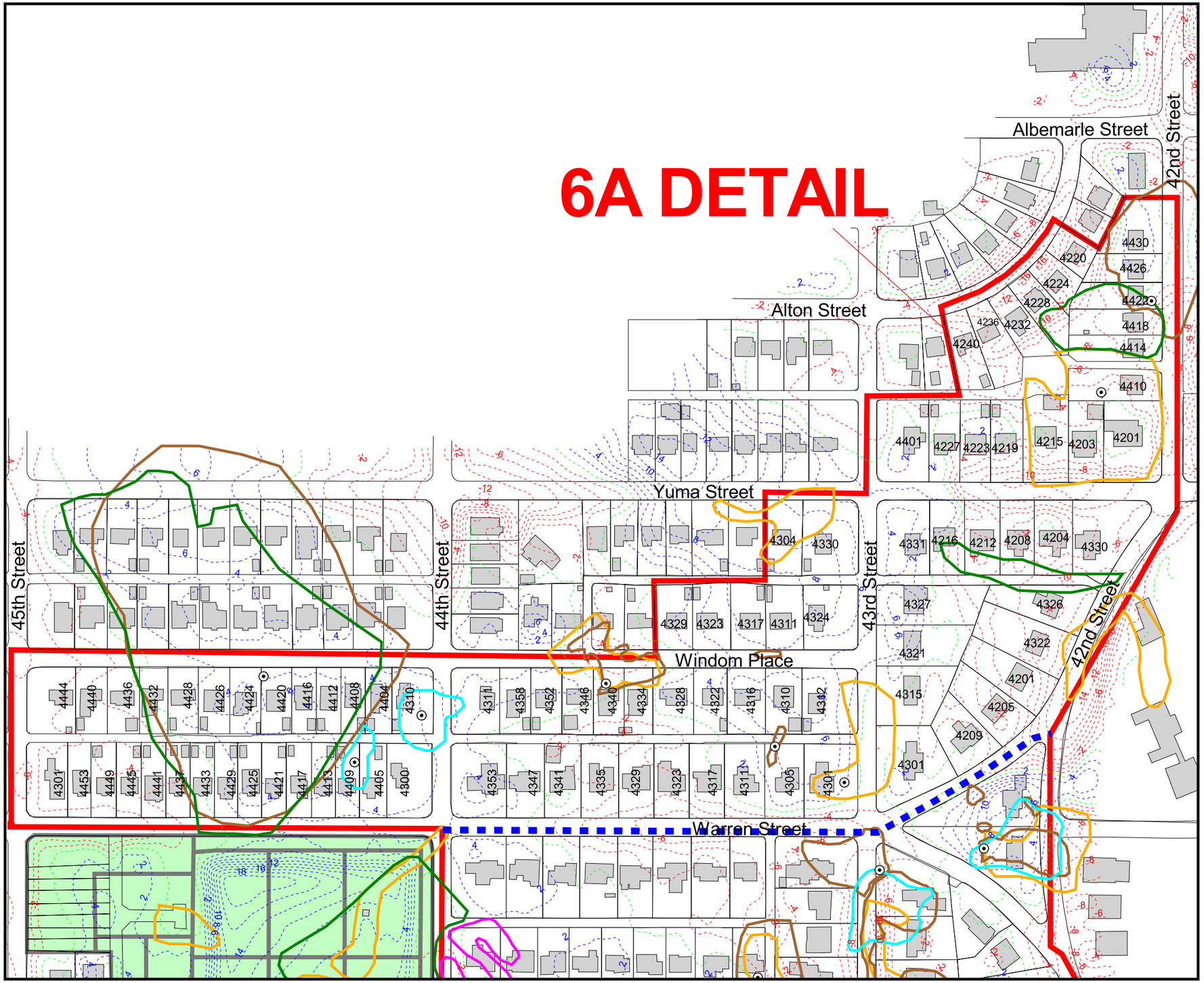

CSA
Grouping 6A Detail

Spring Valley Operable Unit 5
Washington D.C.

Legend

- Boring Locations
- Boundary between A & B Detail
- Stressed Vegetation
- 1928 Ground Scars
- 1927 Ground Scars
- 1922 Ground Scars
- 1918 Ground Scars

Cut & Fill
- Cut
- Level
- Fill

- Parcels
- Grouping 6
- Buildings
- Roads
- Non-Residential Lots

Note:
- Single family houses and each townhouse count as 1 residential lot.
- Commercial and other types of buildings are not included in the residential count.
- The non-residential acreage count does not include the area of the commercial building, but does include paved parking lots and other potentially inaccessible areas.
- Non-residential acreage is divided into 1/2 acre (approximate) lots.

200 0 200 Feet

Scale:	1 : 2400
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Figure Number:	
Page Number:	

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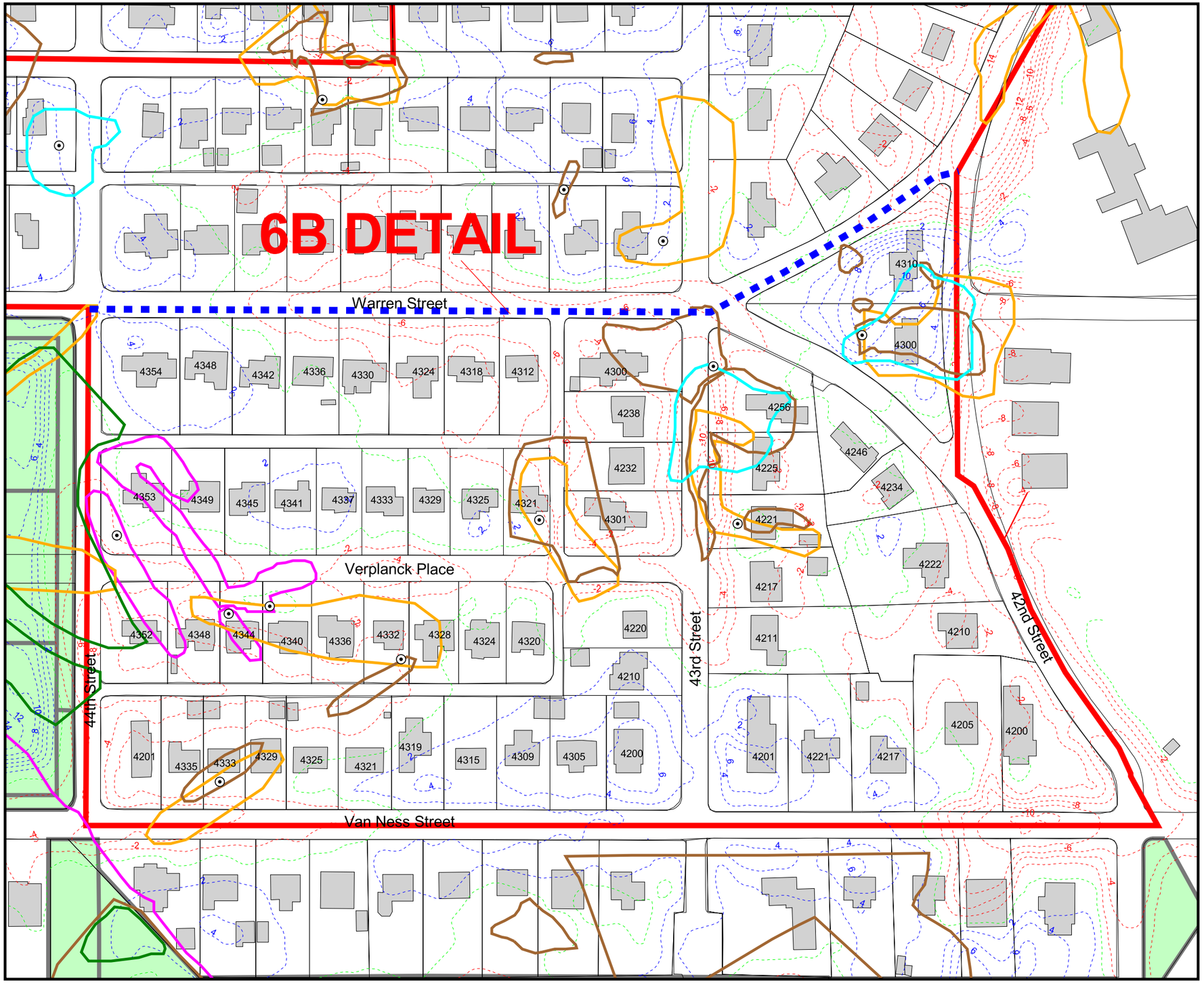

CSA
Grouping 6B Detail

Spring Valley Operable Unit 5
Washington D.C.

Legend

- Boring Locations
- Boundary between A & B Detail
- Stressed Vegetation
- 1928 Ground Scars
- 1927 Ground Scars
- 1922 Ground Scars
- 1918 Ground Scars

Cut & Fill
- Cut
- Level
- Fill

- Parcels
- Grouping 6
- Buildings
- Roads
- Non-Residential Lots

Note:
- Single family houses and each townhouse count as 1 residential lot.
- Commercial and other types of buildings are not included in the residential count.
- The non-residential acreage count does not include the area of the commercial building, but does include paved parking lots and other potentially inaccessible areas.
- Non-residential acreage is divided into 1/2 acre (approximate) lots.

100 0 100 200 Feet

Scale:	1 : 1200
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Page Number:	

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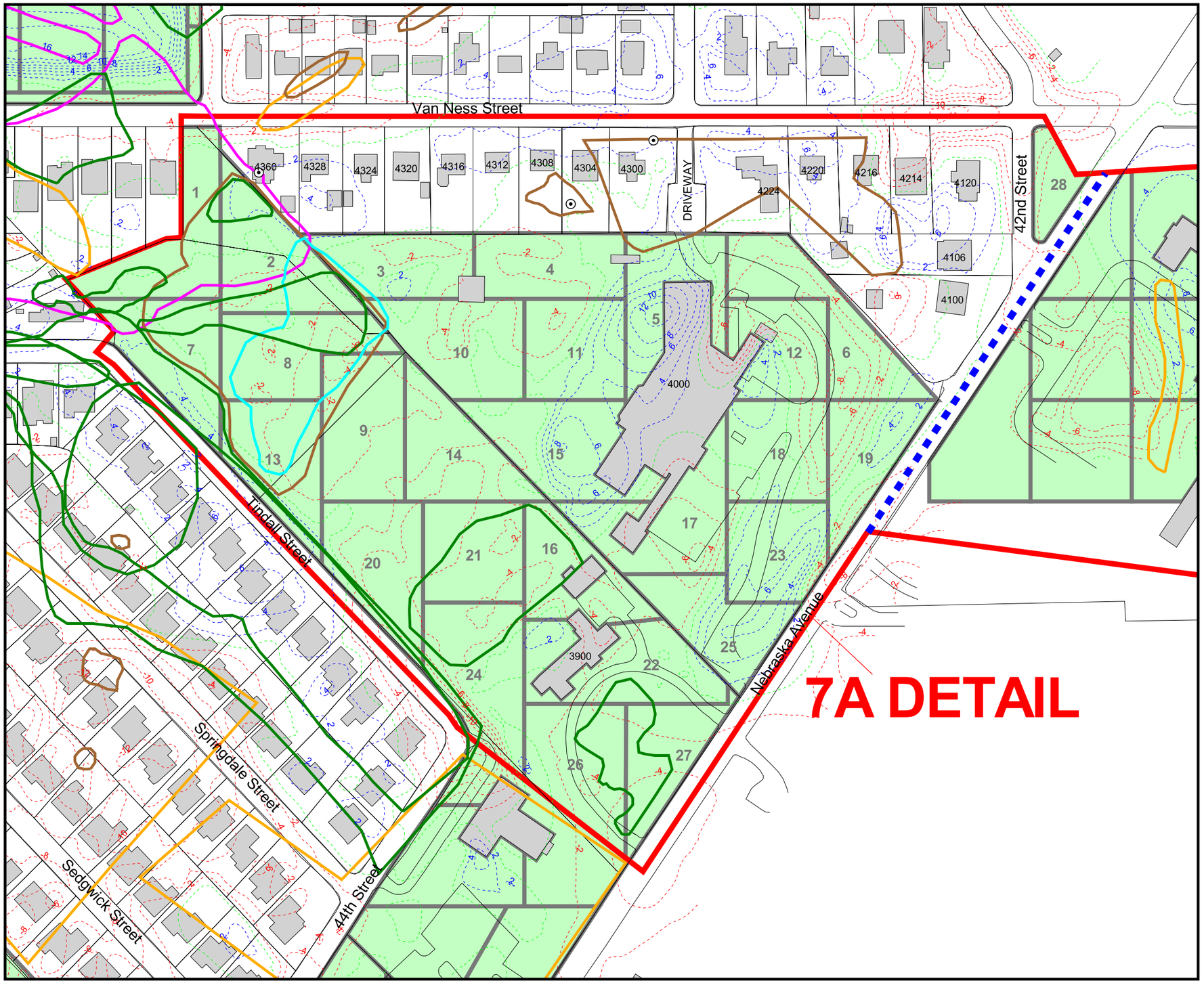

CSA
Grouping 7A Detail

Spring Valley Operable Unit 5
Washington D.C.

Legend

- Boring Locations
- Boundary between A & B Detail
- Stressed Vegetation
- 1928 Ground Scars
- 1927 Ground Scars
- 1922 Ground Scars
- 1918 Ground Scars

Cut & Fill
- Cut
- Level
- Fill

- Parcels
- Grouping 7
- Buildings
- Roads
- Non-Residential Lots

Note:
- Single family houses and each townhouse count as 1 residential lot.
- Commercial and other types of buildings are not included in the residential count.
- The non-residential acreage count does not include the area of the commercial building, but does include paved parking lots and other potentially inaccessible areas.
- Non-residential acreage is divided into 1/2 acre (approximate) lots.

150 0 150 Feet

Scale:	1 : 1800
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Page Number:	

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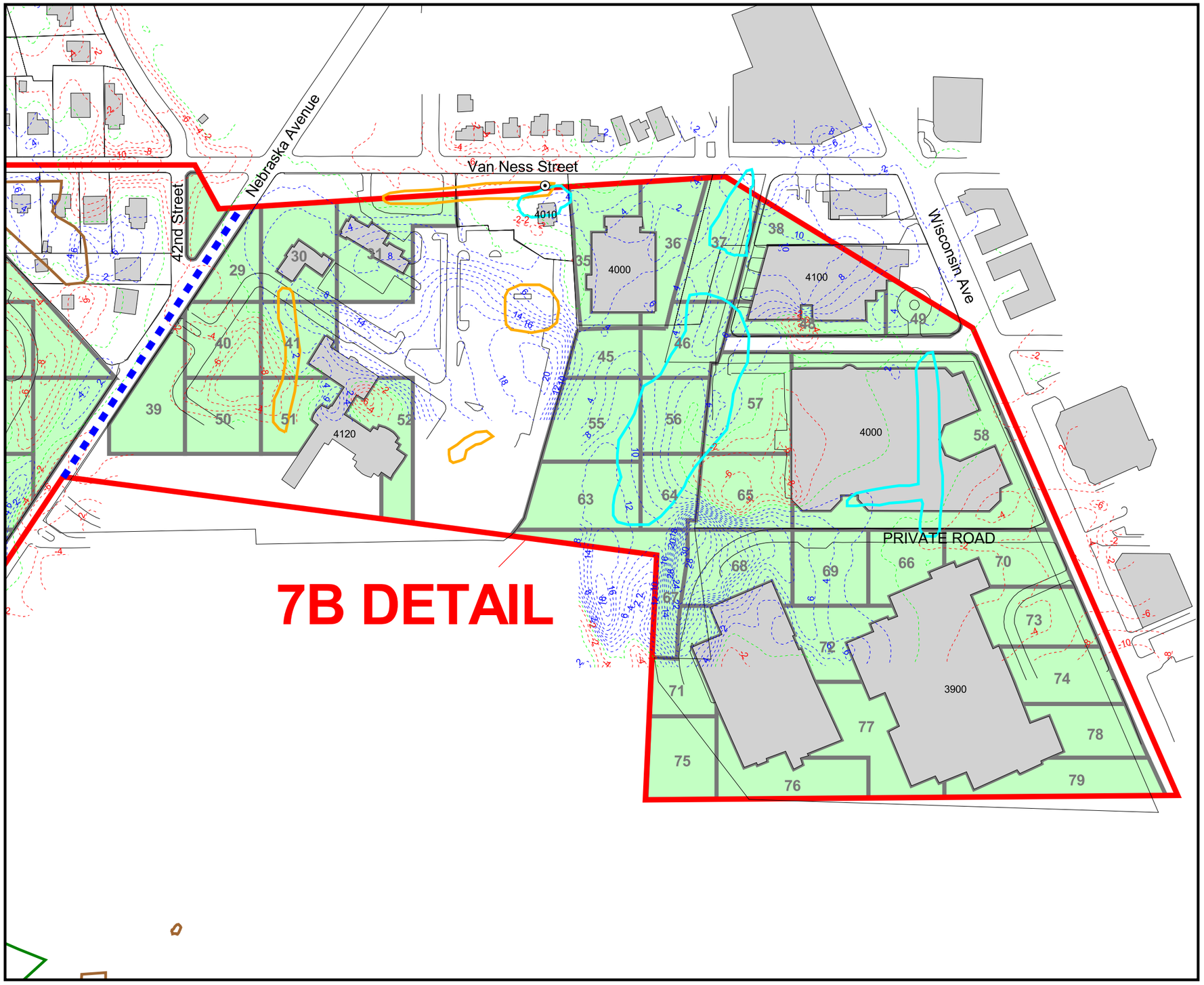

CSA
Grouping 7B Detail

Spring Valley Operable Unit 5
Washington D.C.

Legend

- Boring Locations
- Boundary between A & B Detail
- Stressed Vegetation
- 1928 Ground Scars
- 1927 Ground Scars
- 1922 Ground Scars
- 1918 Ground Scars

Cut & Fill
- Cut
- Level
- Fill

- Parcels
- Grouping 7
- Buildings
- Roads
- Non-Residential Lots

Note:
- Single family houses and each townhouse count as 1 residential lot.
- Commercial and other types of buildings are not included in the residential count.
- The non-residential acreage count does not include the area of the commercial building, but does include paved parking lots and other potentially inaccessible areas.
- Non-residential acreage is divided into 1/2 acre (approximate) lots.

200 0 200 Feet

Scale:	1 : 2400
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Date:	10/02/2002
Figure Number:	
Page Number:	

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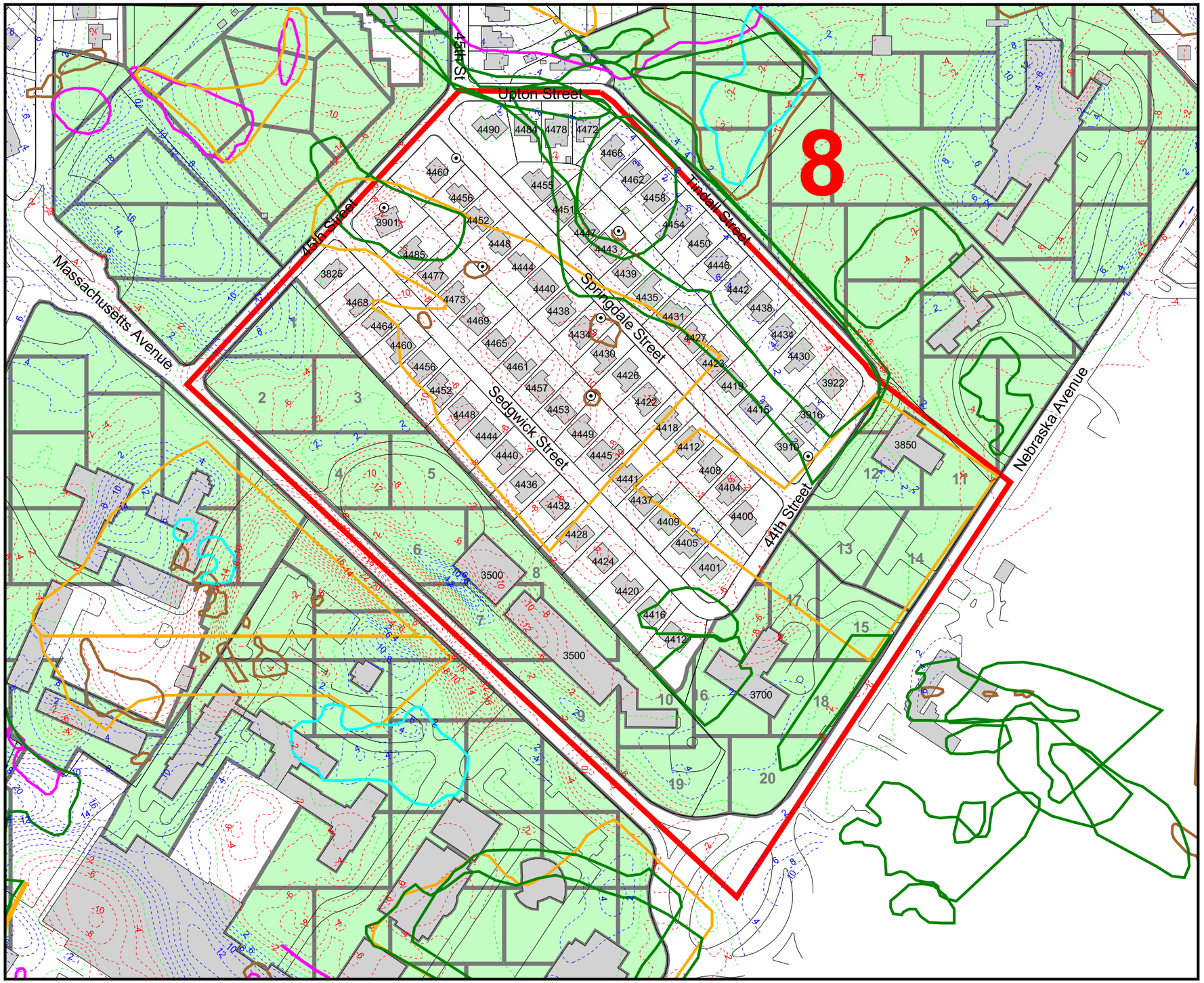

CSA
Grouping 8

Spring Valley Operable Unit 5
Washington D.C.

Legend

- Boring Locations
- Stressed Vegetation
- 1928 Ground Scars
- 1922 Ground Scars
- 1927 Ground Scars
- 1918 Ground Scars

Cut & Fill
- Cut
- Level
- Fill

- Parcels
- Grouping 8
- Buildings
- Roads
- Non-Residential Lots

Note:
- Single family houses and each townhouse count as 1 residential lot.
- Commercial and other types of buildings are not included in the residential count.
- The non-residential acreage count does not include the area of the commercial building, but does include paved parking lots and other potentially inaccessible areas.
- Non-residential acreage is divided into 1/2 acre (approximate) lots.

200 0 200 Feet

Scale:	1 : 2400
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File:	Y:\Projects\Fed\Usace\springva\springva.APR
Date:	10/02/2002
Figure Number:	
Page Number:	

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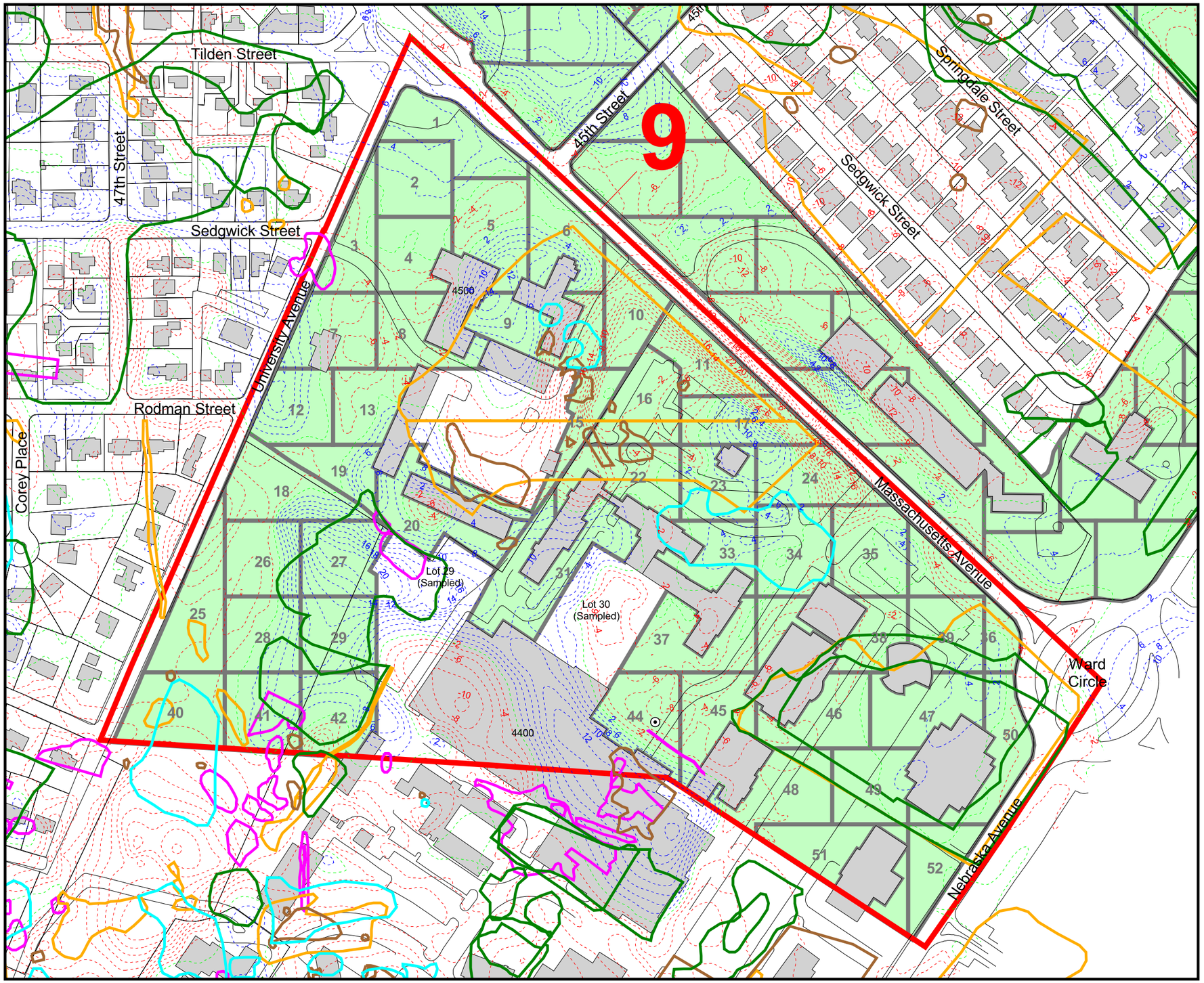

CSA

Grouping 9

Spring Valley Operable Unit 5
Washington D.C.

Legend

- Boring Locations
- Stressed Vegetation
- 1928 Ground Scars
- 1922 Ground Scars
- 1927 Ground Scars
- 1918 Ground Scars

Cut & Fill
- Cut
- Level
- Fill

- Parcels
- Grouping 9
- Buildings
- Roads
- Non-Residential Lots

Note:
- Single family houses and each townhouse count as 1 residential lot.
- Commercial and other types of buildings are not included in the residential count.
- The non-residential acreage count does not include the area of the commercial building, but does include paved parking lots and other potentially inaccessible areas.
- Non-residential acreage is divided into 1/2 acre (approximate) lots.

200 0 200 Feet

Scale:	1 : 2400
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Page Number:	

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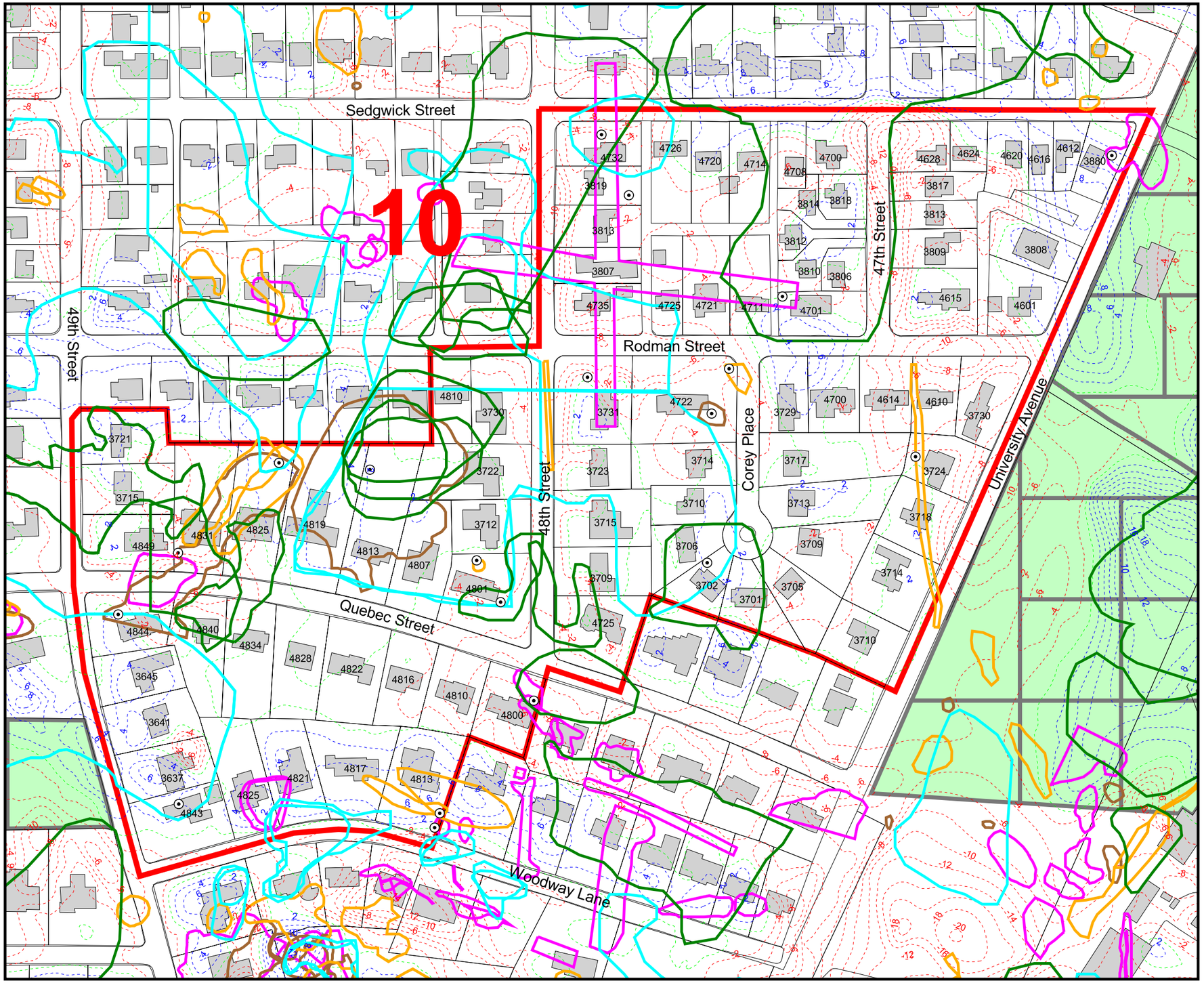

CSA
Grouping 10

Spring Valley Operable Unit 5
Washington D.C.

Legend

- Boring Locations
- Stressed Vegetation
- 1928 Ground Scars
- 1922 Ground Scars
- 1927 Ground Scars
- 1918 Ground Scars

Cut & Fill
- Cut
- Level
- Fill

- Parcels
- Grouping 10
- Buildings
- Roads
- Non-Residential Lots

Note:
- Single family houses and each townhouse count as 1 residential lot.
- Commercial and other types of buildings are not included in the residential count.
- The non-residential acreage count does not include the area of the commercial building, but does include paved parking lots and other potentially inaccessible areas.
- Non-residential acreage is divided into 1/2 acre (approximate) lots.

150 0 150 Feet

Scale:	1 : 1800
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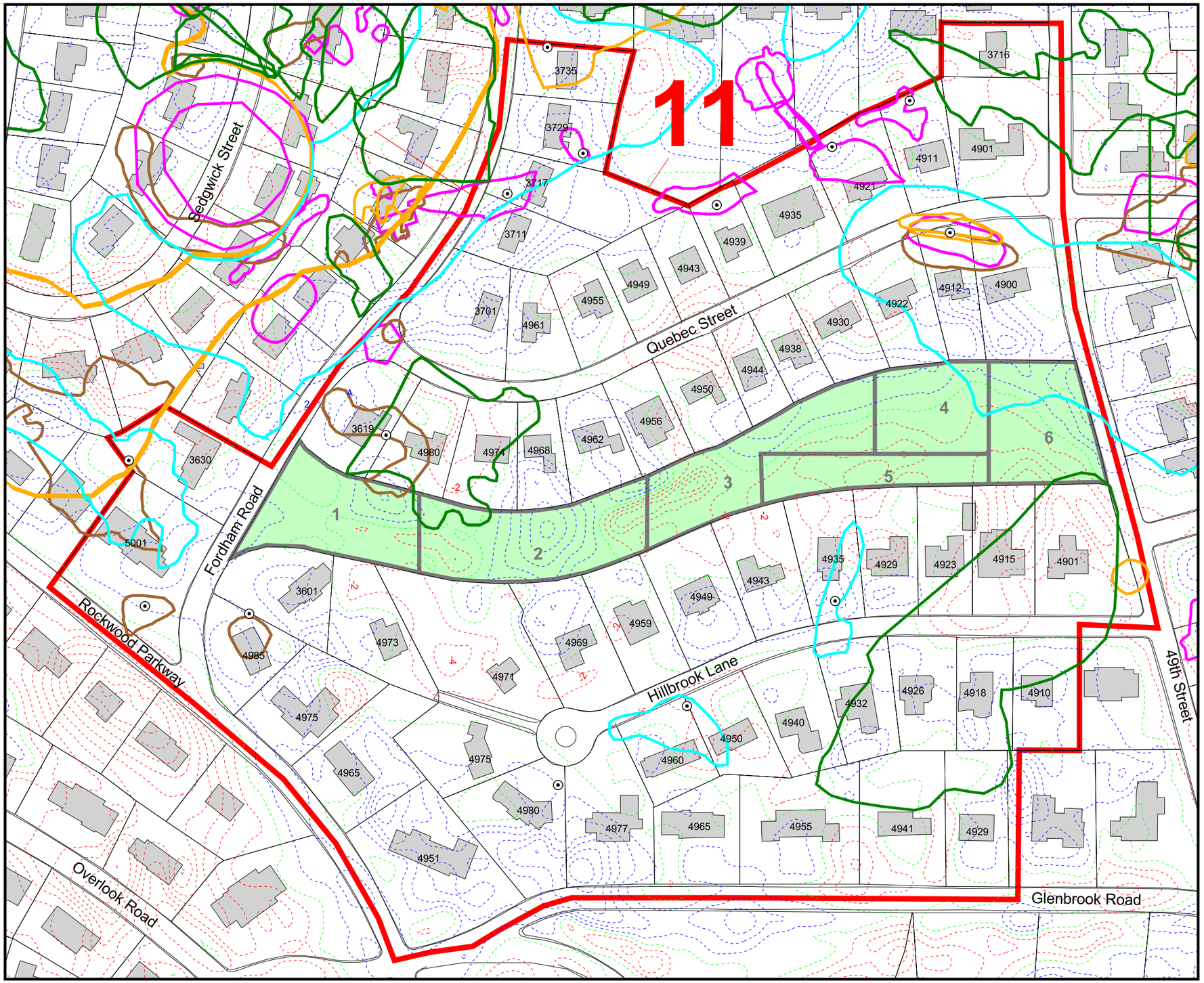

CSA
Grouping 11

Spring Valley Operable Unit 5
Washington D.C.

Legend

- Boring Locations
- Stressed Vegetation
- 1928 Ground Scars
- 1922 Ground Scars
- 1927 Ground Scars
- 1918 Ground Scars

Cut & Fill
- Cut
- Level
- Fill

- Parcels
- Grouping 11
- Buildings
- Roads
- Non-Residential Lots

Note:
- Single family houses and each townhouse count as 1 residential lot.
- Commercial and other types of buildings are not included in the residential count.
- The non-residential acreage count does not include the area of the commercial building, but does include paved parking lots and other potentially inaccessible areas.
- Non-residential acreage is divided into 1/2 acre (approximate) lots.

150 0 150 Feet

Scale:	1 : 1600
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Date:	10/02/2002
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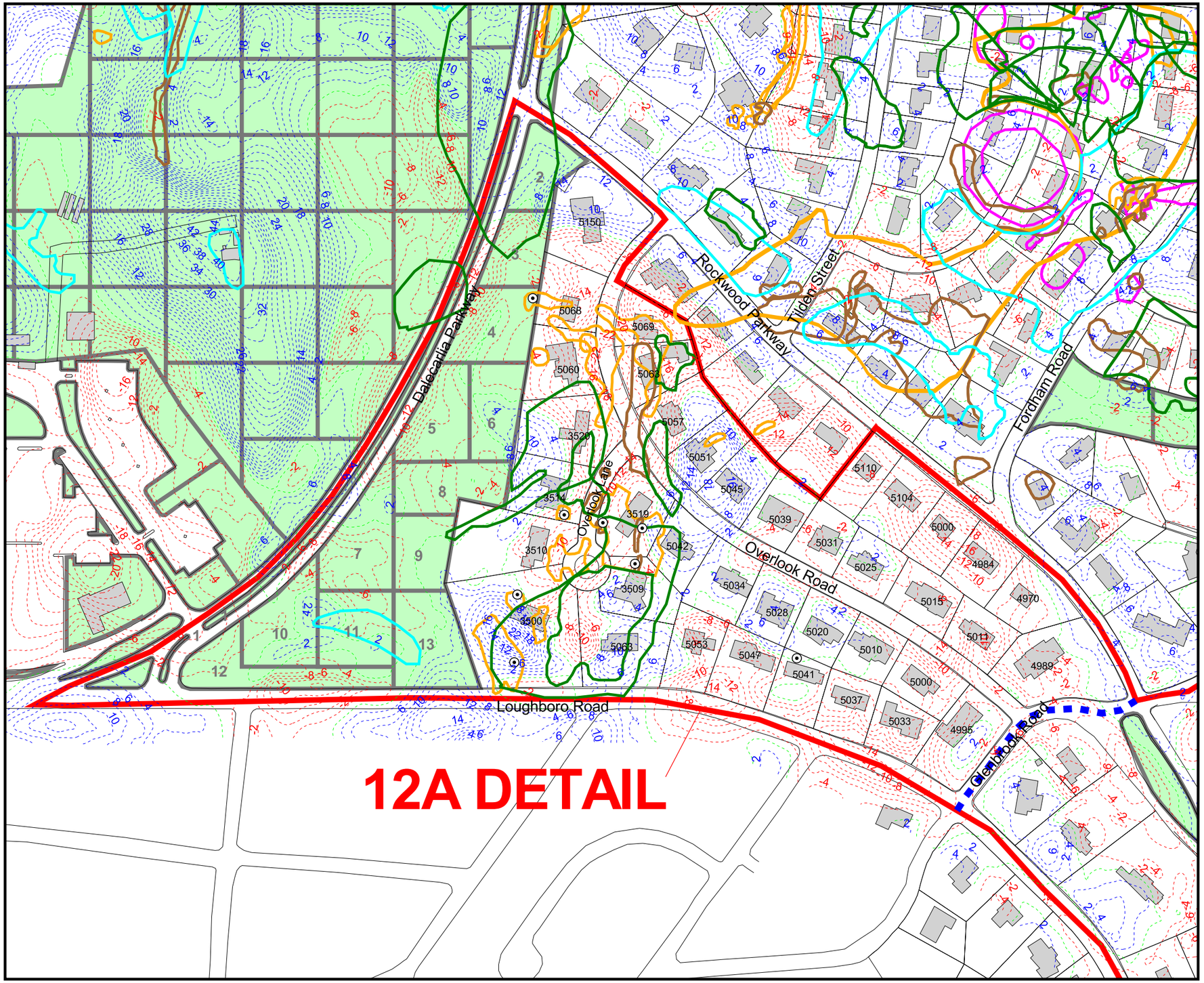

CSA
Grouping 12A Detail

Spring Valley Operable Unit 5
Washington D.C.

Legend

- Boring Locations
- Boundary between A & B Detail
- Stressed Vegetation
- 1928 Ground Scars
- 1927 Ground Scars
- 1922 Ground Scars
- 1918 Ground Scars

Cut & Fill
- Cut
- Level
- Fill

- Parcels
- Grouping 12
- Buildings
- Roads
- Non-Residential Lots

Note:
- Single family houses and each townhouse count as 1 residential lot.
- Commercial and other types of buildings are not included in the residential count.
- The non-residential acreage count does not include the area of the commercial building, but does include paved parking lots and other potentially inaccessible areas.
- Non-residential acreage is divided into 1/2 acre (approximate) lots.

200 0 200 Feet

Scale:	1 : 2400
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Date:	10/02/2002
Figure Number:	
Page Number:	

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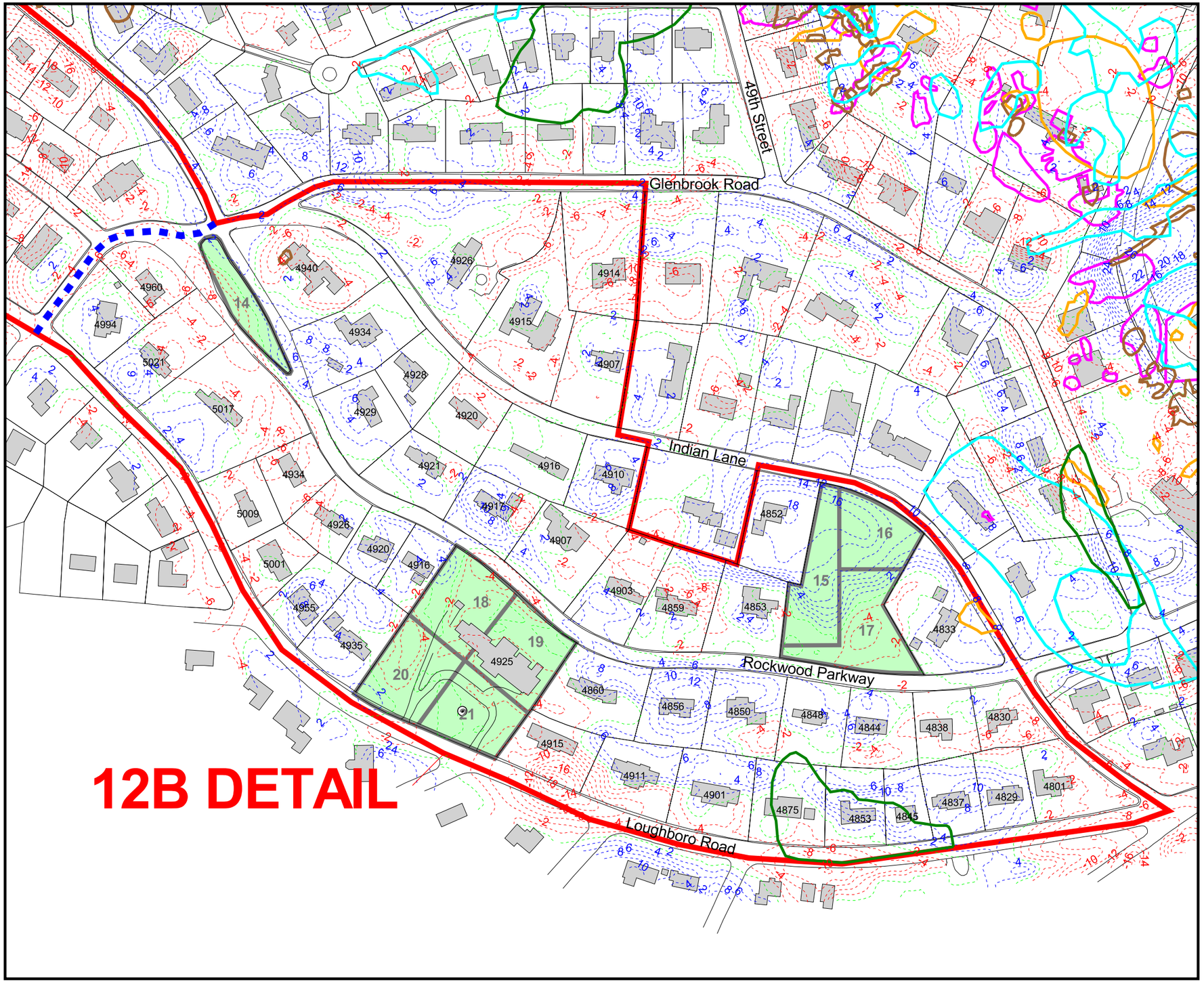

CSA
Grouping 12B Detail

Spring Valley Operable Unit 5
Washington D.C.

Legend

- Boring Locations
- Boundary between A & B Detail
- Stressed Vegetation
- 1928 Ground Scars
- 1927 Ground Scars
- 1922 Ground Scars
- 1918 Ground Scars

Cut & Fill
- Cut
- Level
- Fill

- Parcels
- Grouping 12
- Buildings
- Roads
- Non-Residential Lots

Note:
- Single family houses and each townhouse count as 1 residential lot.
- Commercial and other types of buildings are not included in the residential count.
- The non-residential acreage count does not include the area of the commercial building, but does include paved parking lots and other potentially inaccessible areas.
- Non-residential acreage is divided into 1/2 acre (approximate) lots.

200 0 200 Feet

Scale:	1 : 2400
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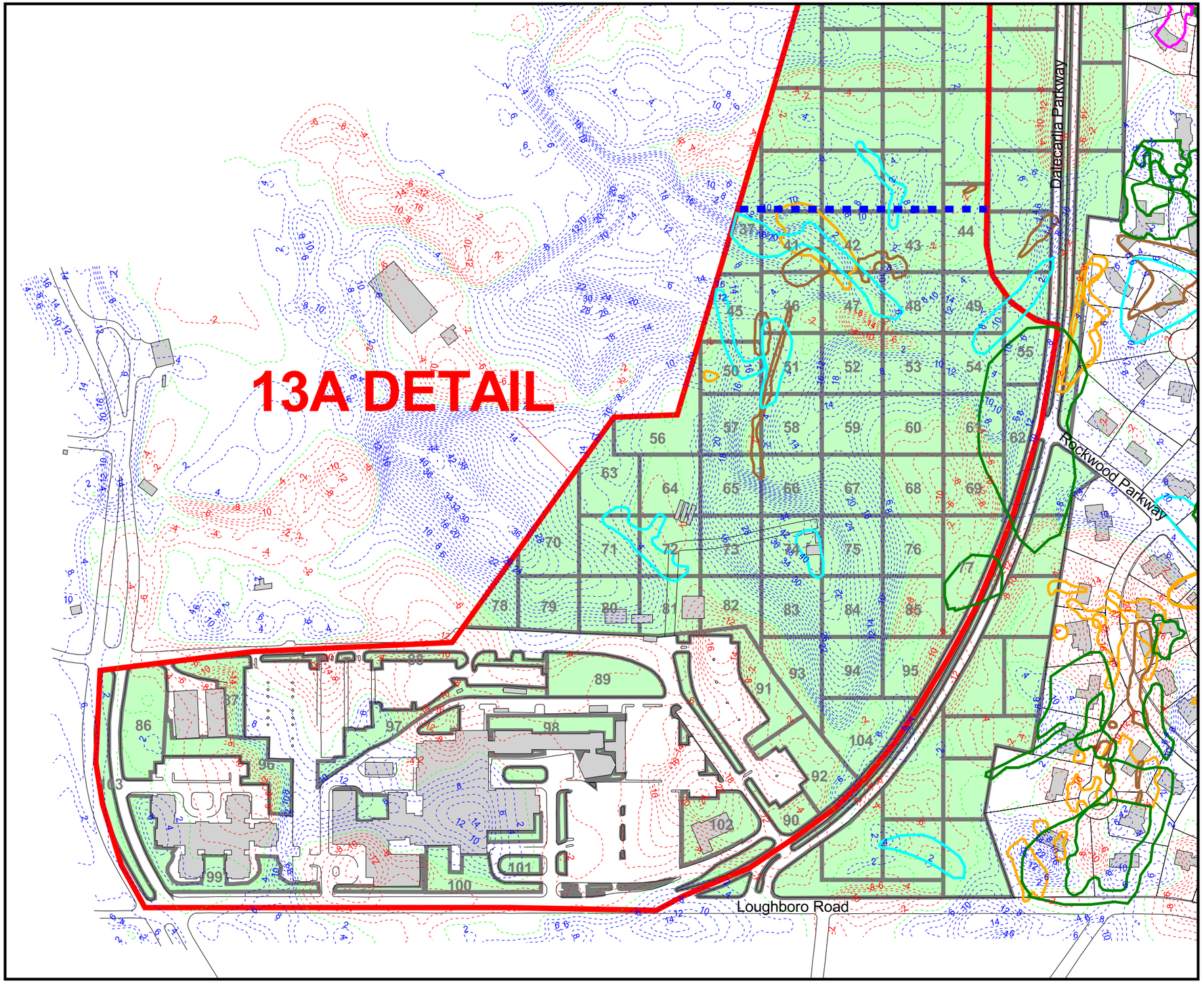

CSA
Grouping 13A Detail

Spring Valley Operable Unit 5
Washington D.C.

Legend

- Boring Locations
- Boundary between A & B Detail
- Stressed Vegetation
- 1928 Ground Scars
- 1927 Ground Scars
- 1922 Ground Scars
- 1918 Ground Scars

Cut & Fill
- Cut
- Level
- Fill

- Grouping 13
- Parcels
- Buildings
- Roads
- Non-Residential Lots

Note:
- Single family houses and each townhouse count as 1 residential lot.
- Commercial and other types of buildings are not included in the residential count.
- The non-residential acreage count does not include the area of the commercial building, but does include paved parking lots and other potentially inaccessible areas.
- Non-residential acreage is divided into 1/2 acre (approximate) lots.

300 0 300 Feet

Scale:	1 : 3000
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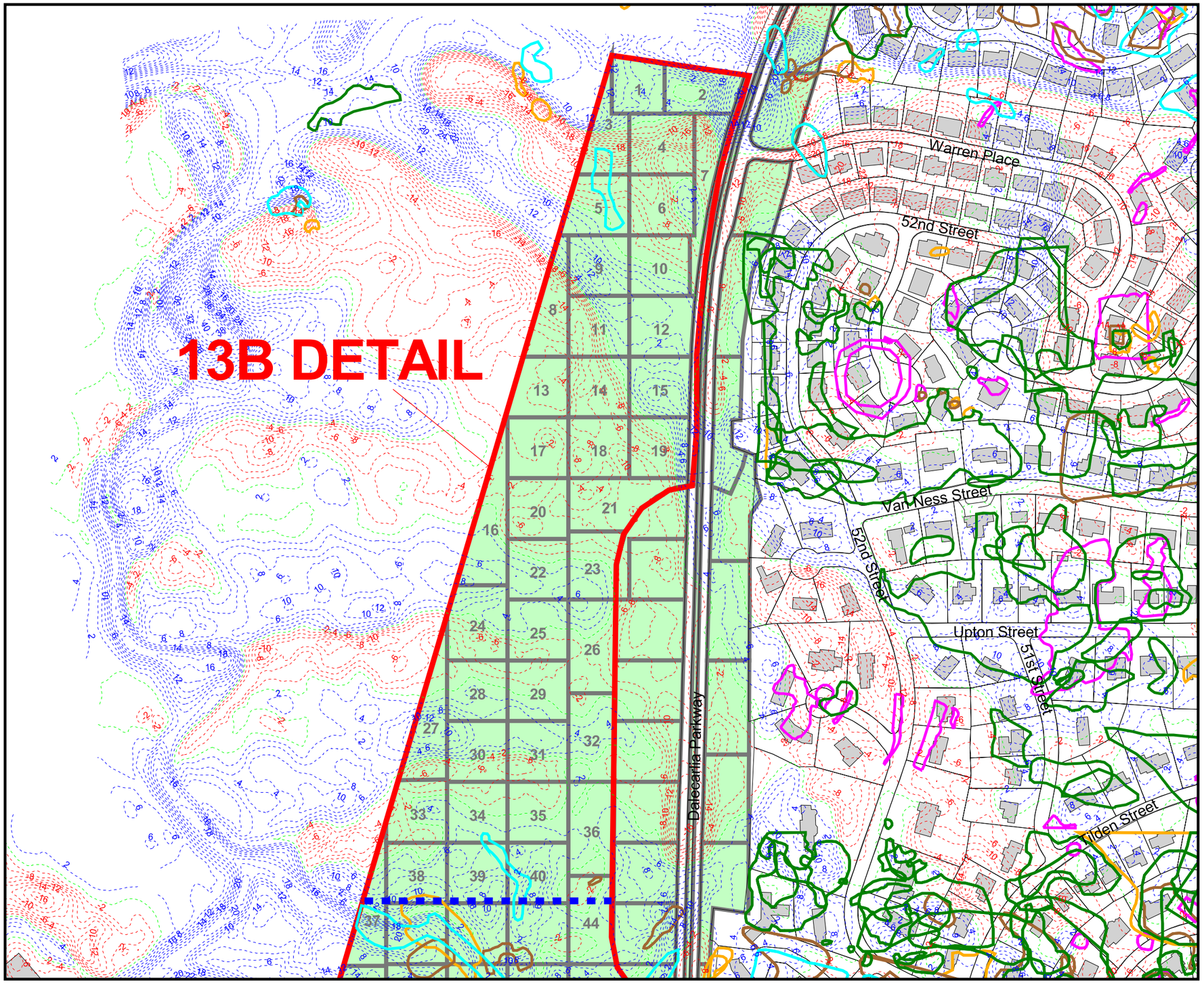

CSA
Grouping 13B Detail

Spring Valley Operable Unit 5
Washington D.C.

Legend

- Boring Locations
- Boundary between A & B Detail
- Stressed Vegetation
- 1928 Ground Scars
- 1927 Ground Scars
- 1922 Ground Scars
- 1918 Ground Scars

Cut & Fill
- Cut
- Level
- Fill

- Grouping 13
- Parcels
- Buildings
- Roads
- Non-Residential Lots

Note:
- Single family houses and each townhouse count as 1 residential lot.
- Commercial and other types of buildings are not included in the residential count.
- The non-residential acreage count does not include the area of the commercial building, but does include paved parking lots and other potentially inaccessible areas.
- Non-residential acreage is divided into 1/2 acre (approximate) lots.

300 0 300 Feet

Scale:	1 : 3000
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PARSONS

APPENDIX B

EXCAVATION AND LANDFILL DISPOSAL COST SUMMARY

(TABLES B-1 and B-2)

Table B-1 Detailed Cost Estimate

Soils Contaminated with Arsenic
(Excavation and Disposal - Non-Hazardous Landfill, 7 Grids)
Spring Valley OU-4 and OU-5 EECA

Cost Item						Bare Costs							
						Materials		Labor		Equipment		Cost Including O&P	
WBS	Task & Subtask	Item	Quantity	Units		$/Unit	Subtotal	$/Unit	Subtotal	$/Unit	Subtotal	$/Unit	Subtotal
33101	A.	**MOBILIZATION AND PREPARATORY WORK**											
	01	Mobilization of Construction Equipment and Facilities	1	LS		$ 2,000.00	$ 2,000.00	$ -	$ -	$ -	$ -	$ -	$ 2,000.00
	02	Mobilization of Personnel	1	LS		$ 1,000.00	$ 1,000.00		$ -		$ -		$ 1,000.00
	03	Remediation Work Plan	Senior Engineer	8	hr	$ -	$ -	$ 149.50	$ 1,196.00	$ -	$ -	$ -	$ 1,196.00
			Engineer	12	hr	$ -	$ -	$ 88.40	$ 1,060.80	$ -	$ -	$ -	$ 1,060.80
			CADD Operator/GIS	8	hr	$ -	$ -	$ 68.90	$ 551.20	$ -	$ -	$ -	$ 551.20
			Admin Aide	8	hr	$ -	$ -	$ 59.54	$ 476.32	$ -	$ -	$ -	$ 476.32
			Publication/Reproduction	10	copy	$ 20.00	$ 200.00	$ -	$ -	$ -	$ -	$ -	$ 200.00
	10	Population Relocation		1	LS	$ 7,000.00	$ 7,000.00		$ -		$ -		$ 7,000.00
	90	Permitting											
		- District of Columbia DCRA Land Disturbance		1	LS	$ 500.00	$ 500.00	$ -	$ -	$ -	$ -	$ -	$ 500.00
			SUBTOTAL				**$ 10,700.00**		**$ 3,284.32**		**$ -**		**$ 13,984.32**
33102	B.	**MONITORING, SAMPLING AND ANALYSIS**											
	06	Confirmation Soil Sampling	Analytical Costs	1	LS	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,489.00	$ 1,489.00
			SUBTOTAL				**$ -**		**$ -**		**$ -**		**$ 1,489.00**
33103	C.	**SITE WORK**											
	02	Clearing-Related Activities											
		- Tree removal	Cut and Chip Light trees	0.1	ACRE	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,875.00	$ 287.50
			Tree Removal w/ Chain Saws, 4-6" dia.	5	EA	$ -	$ -	$ -	$ -	$ -	$ -	$ 168.00	$ 840.00
			Tree Removal w/ Chain Saws, 8-12" dia.	5	EA	$ -	$ -	$ -	$ -	$ -	$ -	$ 252.00	$ 1,260.00
			Tree Subcontractor Service (Large Tree, including stump)	1	LS	$ -	$ -	$ 10,000.00	$ 10,000.00	$ -	$ -	$ -	$ 10,000.00
		- Stump removal											
			1-1/2 CY Backhoe, 4-6" diam.	5	EA	$ -	$ -	$ -	$ -	$ -	$ -	$ 29.50	$ 147.50
			1-1/2 CY Backhoe, 8-12" diam.	5	EA	$ -	$ -	$ -	$ -	$ -	$ -	$ 80.00	$ 400.00
	03	- Soil Excavation											
		Gross	Light Equipment w/ operator	80	CY	$ -	$ -	$ -	$ -	$ -	$ -	$ 50.15	$ 4,011.73
			1 CY Bucket w/ operator	65	CY	$ -	$ -	$ -	$ -	$ -	$ -	$ 23.04	$ 1,497.60
		By Hand (heavy soil or clay)	Laborer	65	CY	$ -	$ -		$ -	$ -	$ -	$ 100.00	$ 6,500.00
	05	- Fencing											
			Installing as Temporary	300	LF	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.80	$ 2,340.00
			Removal of Temporary Fencing	300	LF	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.45	$ 2,235.00
			Fence Material Allowance	1	LS	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,000.00	$ 2,000.00
			Reinstall Fence (Labor Only)	300	LF	$ -	$ -	$ 6.25	$ 1,875.00	$ -	$ -	$ -	$ 1,875.00

Table B-1 Detailed Cost Estimate

Soils Contaminated with Arsenic
(Excavation and Disposal - Non-Hazardous Landfill, 7 Grids)
Spring Valley OU-4 and OU-5 EECA

Cost Item						Bare Costs							
						Materials		Labor		Equipment		Cost Including O&P	
WBS	Task & Subtask		Item	Quantity	Units	$/Unit	Subtotal	$/Unit	Subtotal	$/Unit	Subtotal	$/Unit	Subtotal
	90	Surveying		1	DAY	$ -	$ -	$ -	$ -	$ -	$ -	$ 625.00	$ 625.00
	91	Miscellaneous Expenses	Per Diem	10	M/DAY	$ -	$ -	$ -	$ -	$ -	$ -	$ 200.00	$ 2,000.00
			Portable Water Tank	5	DAY	$ -	$ -	$ -	$ -	$ -	$ -	$ 95.50	$ 477.50
			SUBTOTAL				**$ -**		**$ 11,875.00**		**$ -**		**$ 36,496.83**
33105	**D.**	**EROSION AND SEDIMENT CONTROL**											
	13		Jute Fence	325	SY	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.21	$ 393.25
			Silt Fence	400	LF	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.73	$ 292.00
			Hay Bales	250	LF	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.00	$ 500.00
			Remove Hay Bales	1	TON	$ -	$ -	$ -	$ -	$ -	$ -	$ 385.00	$ 385.00
			SUBTOTAL				**$ -**		**$ -**		**$ -**		**$ 1,570.25**
33301	**E.**	**SUPERVISION AND ADMINISTRATION**											
			Construction Manager	28	hr	$ -	$ -	$ 85.80	$ 2,402.40	$ -	$ -	$ -	$ 2,402.40
			SSHO	28	hr	$ -	$ -	$ 80.60	$ 2,256.80	$ -	$ -	$ -	$ 2,256.80
			UXO Technician	28	hr	$ -	$ -	$ 65.00	$ 1,820.00	$ -	$ -	$ -	$ 1,820.00
			Per Diem	10	M/DAY	$ -	$ -	$ -	$ -	$ -	$ -	$ 200.00	$ 2,000.00
			SUBTOTAL				**$ -**		**$ 6,479.20**		**$ -**		**$ 8,479.20**
33119	**F.**	**DISPOSAL**											
	21	Hauling From Site to Landfill		315	tons	$ 20.00	$ 6,300.00	$ -	$ -	$ -	$ -	$ -	$ 6,300.00
	22	Non- Hazardous Soil Disposal		315	tons	$ 21.00	$ 6,615.00	$ -	$ -	$ -	$ -	$ -	$ 6,615.00
			SUBTOTAL				**$ 12,915.00**		**$ -**		**$ -**		**$ 12,915.00**
33120	**G.**	**SITE RESTORATION**											
	01	Earthwork											
		- Backfill	Material Only	273	LCY	$ -	$ -		$ -	$ -	$ -	$ 10.00	$ 2,730.00
		Gross	2-1/2 CY Loader w/ Operator	91	LCY	$ -	$ -		$ -	$ -	$ -	$ 2.39	$ 217.49
			Dozer w/ Operator	91	LCY	$ -	$ -		$ -	$ -	$ -	$ 2.87	$ 261.17
		By Hand	Laborer	91	LCY	$ -	$ -		$ -	$ -	$ -	$ 22.50	$ 2,047.50
		- Compaction											
		Gross	Air Tamp. W/ Operator	91	LCY	$ -	$ -		$ -	$ -	$ -	$ 8.30	$ 755.30
			Vibratory Plate w/ Operator	91	LCY	$ -	$ -		$ -	$ -	$ -	$ 5.75	$ 523.25
		By Hand	6" Layers	91	LCY	$ -	$ -		$ -	$ -	$ -	$ 13.10	$ 1,192.10

Table B-1 Detailed Cost Estimate

Soils Contaminated with Arsenic
(Excavation and Disposal - Non-Hazardous Landfill, 7 Grids)
Spring Valley OU-4 and OU-5 EECA

Cost Item						Bare Costs							
						Materials		Labor		Equipment		Cost Including O&P	
WBS		Task & Subtask	Item	Quantity	Units	$/Unit	Subtotal	$/Unit	Subtotal	$/Unit	Subtotal	$/Unit	Subtotal
	04	Revegetation and Planting											
		- Seeding and Sodding	Area of Approx. 2800 sf	1	LS	$ -	$ -		$ -	$ -	$ -	$ 1,200.00	$ 1,200.00
		- Landscape Restoration	Replace existing landscaping and features	1	LS	$ -	$ -		$ -	$ -	$ -	$ 25,000.00	$ 25,000.00
			SUBTOTAL				**$ -**		**$ -**		**$ -**		**$ 33,926.81**
33121	H.	**DEMOBILIZATION**											
		Demobilization		1	LS	LS	$ -	$ -	$ -	$ -	$ -	$ 2,000.00	$ 2,000.00
			SUBTOTAL				**$ -**		**$ -**		**$ -**		**$ 2,000.00**
33222	I.	**OTHER REQUIREMENTS**											
	90	POST REMEDIATION ACTIVITIES											
		-Closure Report	Senior Engineer	8	hr	$ -	$ -	$ 149.50	$ 1,196.00	$ -	$ -	$ -	$ 1,196.00
			Engineer	12	hr	$ -	$ -	$ 88.40	$ 1,060.80	$ -	$ -	$ -	$ 1,060.80
			CADD Operator	8	hr	$ -	$ -	$ 68.90	$ 551.20	$ -	$ -	$ -	$ 551.20
			Admin Aide	8	hr	$ -	$ -	$ 59.54	$ 476.32	$ -	$ -	$ -	$ 476.32
			Publication/Reproduction	10	per	$ 20.00	$ 200.00	$ -	$ -	$ -	$ -	$ -	$ 200.00
			SUBTOTAL				**$ -**		**$ 3,284.32**		**$ -**		**$ 3,484.32**

TOTAL COST SUMMARY

	Task	Total per Task
A.	MOBILIZATION AND PREPARATORY WORK	$13,984
B.	MONITORING, SAMPLING AND ANALYSIS	$1,489
C.	SITE WORK	$36,497
D.	EROSION AND SEDIMENT CONTROL	$1,570
E.	SUPERVISION AND ADMINISTRATION	$8,479
F.	DISPOSAL	$12,915
G.	SITE RESTORATION	$33,927
H.	DEMOBILIZATION	$2,000
I.	OTHER REQUIREMENTS	$3,484
	SUB-TOTAL	**$114,346**
	Contingency based on tasks C, D, F, G, H (10%	$7,399
	Project Management based on Tasks C, D, F, G, H (5%	$3,700
	Remedial Design based on Tasks C, D, F, G, H (10%)	$7,399
	TOTAL	**$132,844**

Per Grid Cost (30 CY)	Per Ton Cost (45 tons/grid)
$18,978	**$422**

Table B-1 Detailed Cost Estimate

Soils Contaminated with Arsenic
(Excavation and Disposal - Non-Hazardous Landfill, 7 Grids)
Spring Valley OU-4 and OU-5 EECA

Cost Item					Bare Costs							
					Materials		Labor		Equipment		Cost Including O&P	
WBS	Task & Subtask	Item	Quantity	Units	$/Unit	Subtotal	$/Unit	Subtotal	$/Unit	Subtotal	$/Unit	Subtotal

KEY - ASSUMPTIONS

O&P = Overhead and Profit

COST ESTIMATE REFLECTS AN AVERAGE SITE WITH **7 GRIDS REQUIRING REMOVAL** (Based on sampling to date).

A.	MOBILIZATION AND PREPARATORY WORK	-Assumed Draft and Final versions of Remediation Work Plan would be prepared. -Assumed electronic versions of existing site drawings will be adequate to produce excavation plans (I.e., additional surveying/creation of new base maps will not be required for planning). -Assumed existing health and safety documents would apply (I.e., no new health and safety submittals included). -Assumed existing quality assurance project plan would apply. -Permitting assumed fee based on amount of land disturbance. Includes application preparation time.
B.	MONITORING, SAMPLING, AND ANALYSIS	-Assumed 7 samples (1 confirmation sample per grid) analyzed for total arsenic ($65/sample) plus TCLP disposal characterization sample ($1,034). -Assumes each grid will meet the remedial objective at the initial excavation depth of 2 feet.
C.	SITE WORK	-Assumes a 1.5 factor for the soil conversion of CY to TON. -Assumes extent of soil contamination has been determined. -Assuming 30% of work can be done with "heavy" equipment, 40% with "light" equipment, and 30% of work done by hand. -Clearing: Up to 12" trees with manageable heights - remove with chain saws and stump removal equipment. 12" trees and larger, and any trees close to the houses, etc. - Utilize tree subcontractior to remove. The number of trees to remove is approximated as (5) 4-6" diameter, (5) 8-12" diameter per 7 grids excavated.
E.	SUPERVISION AND ADMINISTRATION	- Assumed that removal actions will occur in sequence (Site Manager, SSHO and UXO Tech. remain on-site from job to job)
F.	DISPOSAL	-Assumes non-hazardous landfill disposal
G.	SITE RESTORATION	-Assumed 1" topsoil layer and seeding. No other landscaping allowance. -Assumed equal compaction by methods of Air Tamping, Vibratory Plate, and Hand Methods. -Assumed 30% more soil required from backfill to allow for compaction.
I.	OTHER - POST REMEDIATION ACTIVITIES	-Assumed Draft and Final versions of closure report would be prepared. -Assumed closure report would simply describe the activities conducted.

Table B-2 Detailed Cost Estimate

Soils Contaminated with Arsenic
(Excavation and Disposal - Hazardous Landfill, 7 Grids)
Spring Valley OU-4 and OU-5 EECA

Cost Item						Bare Costs							
						Materials		Labor		Equipment		Cost Including O&P	
WBS	Task & Subtask	Item	Quantity	Units		$/Unit	Subtotal	$/Unit	Subtotal	$/Unit	Subtotal	$/Unit	Subtotal
33101	**A.**	**MOBILIZATION AND PREPARATORY WORK**											
	01	Mobilization of Construction Equipment and Facilities	1	LS		$ 2,000.00	$ 2,000.00	$ -	$ -	$ -	$ -	$ -	$ 2,000.00
	02	Mobilization of Personnel	1	LS		$ 1,000.00	$ 1,000.00		$ -		$ -		$ 1,000.00
	03	Remediation Work Plan	Senior Engineer	8	hr	$ -	$ -	$ 149.50	$ 1,196.00	$ -	$ -	$ -	$ 1,196.00
			Engineer	12	hr	$ -	$ -	$ 88.40	$ 1,060.80	$ -	$ -	$ -	$ 1,060.80
			CADD Operator/GIS	8	hr	$ -	$ -	$ 68.90	$ 551.20	$ -	$ -	$ -	$ 551.20
			Admin Aide	8	hr	$ -	$ -	$ 59.54	$ 476.32	$ -	$ -	$ -	$ 476.32
			Publication/Reproduction	10	copy	$ 20.00	$ 200.00	$ -	$ -	$ -	$ -	$ -	$ 200.00
	10	Population Relocation		1	LS	$ 7,000.00	$ 7,000.00		$ -		$ -		$ 7,000.00
	90	Permitting											
		- District of Columbia DCRA Land Disturbance		1	LS	$ 500.00	$ 500.00	$ -	$ -	$ -	$ -	$ -	$ 500.00
			SUBTOTAL				**$ 10,700.00**		**$ 3,284.32**		**$ -**		**$ 13,984.32**
33102	**B.**	**MONITORING, SAMPLING AND ANALYSIS**											
	06	Confirmation Soil Sampling	Analytical Costs	1	LS	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,489.00	$ 1,489.00
			SUBTOTAL				**$ -**		**$ -**		**$ -**		**$ 1,489.00**
33103	**C.**	**SITE WORK**											
	02	Clearing-Related Activities											
		- Tree removal	Cut and Chip Light trees	0.1	ACRE	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,875.00	$ 287.50
			Tree Removal w/ Chain Saws, 4-6" dia.	5	EA	$ -	$ -	$ -	$ -	$ -	$ -	$ 168.00	$ 840.00
			Tree Removal w/ Chain Saws, 8-12" dia.	5	EA	$ -	$ -	$ -	$ -	$ -	$ -	$ 252.00	$ 1,260.00
			Tree Subcontractor Service (Large Tree, including stump)	1	LS	$ -	$ -	$ 10,000.00	$ 10,000.00	$ -	$ -	$ -	$ 10,000.00
		- Stump removal											
			1-1/2 CY Backhoe, 4-6" diam.	5	EA	$ -	$ -	$ -	$ -	$ -	$ -	$ 29.50	$ 147.50
			1-1/2 CY Backhoe, 8-12" diam.	5	EA	$ -	$ -	$ -	$ -	$ -	$ -	$ 80.00	$ 400.00
	03	- Soil Excavation											
		Gross	Light Equipment w/ operator	80	CY	$ -	$ -	$ -	$ -	$ -	$ -	$ 50.15	$ 4,011.73
			1 CY Bucket w/ operator	65	CY	$ -	$ -	$ -	$ -	$ -	$ -	$ 23.04	$ 1,497.60
		By Hand (heavy soil or clay)	Laborer	65	CY	$ -	$ -		$ -	$ -	$ -	$ 100.00	$ 6,500.00
	05	- Fencing											
			Installing as Temporary	300	LF	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.80	$ 2,340.00
			Removal of Temporary Fencing	300	LF	$ -	$ -	$ -	$ -	$ -	$ -	$ 7.45	$ 2,235.00
			Fence Material Allowance	1	LS	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,000.00	$ 2,000.00
			Reinstall Fence (Labor Only)	300	LF	$ -	$ -	$ 6.25	$ 1,875.00	$ -	$ -	$ -	$ 1,875.00

Table B-2 Detailed Cost Estimate

Soils Contaminated with Arsenic
(Excavation and Disposal - Hazardous Landfill, 7 Grids)
Spring Valley OU-4 and OU-5 EECA

Cost Item						Bare Costs							
						Materials		Labor		Equipment		Cost Including O&P	
WBS	Task & Subtask		Item	Quantity	Units	$/Unit	Subtotal	$/Unit	Subtotal	$/Unit	Subtotal	$/Unit	Subtotal
	90	Surveying		1	DAY	$ -	$ -	$ -	$ -	$ -	$ -	$ 625.00	$ 625.00
	91	Miscellaneous Expenses	Per Diem	10	M/DAY	$ -	$ -	$ -	$ -	$ -	$ -	$ 200.00	$ 2,000.00
			Portable Water Tank	5	DAY	$ -	$ -	$ -	$ -	$ -	$ -	$ 95.50	$ 477.50
			SUBTOTAL				**$ -**		**$ 11,875.00**		**$ -**		**$ 36,496.83**
33105	**D.**	**EROSION AND SEDIMENT CONTROL**											
	13		Jute Fence	325	SY	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.21	$ 393.25
			Silt Fence	400	LF	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.73	$ 292.00
			Hay Bales	250	LF	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.00	$ 500.00
			Remove Hay Bales	1	TON	$ -	$ -	$ -	$ -	$ -	$ -	$ 385.00	$ 385.00
			SUBTOTAL				**$ -**		**$ -**		**$ -**		**$ 1,570.25**
33301	**E.**	**SUPERVISION AND ADMINISTRATION**											
			Construction Manager	28	hr	$ -	$ -	$ 85.80	$ 2,402.40	$ -	$ -	$ -	$ 2,402.40
			SSHO	28	hr	$ -	$ -	$ 80.60	$ 2,256.80	$ -	$ -	$ -	$ 2,256.80
			UXO Technician	28	hr	$ -	$ -	$ 65.00	$ 1,820.00	$ -	$ -	$ -	$ 1,820.00
			Per Diem	10	M/DAY	$ -	$ -	$ -	$ -	$ -	$ -	$ 200.00	$ 2,000.00
			SUBTOTAL				**$ -**		**$ 6,479.20**		**$ -**		**$ 8,479.20**
33119	**F.**	**DISPOSAL**											
	21	Hauling From Site for Treatment		315	tons	$ 25.00	$ 7,875.00	$ -	$ -	$ -	$ -	$ -	$ 7,875.00
	22	Hazardous Soil Disposal		315	tons	$ 125.00	$ 39,375.00	$ -	$ -	$ -	$ -	$ -	$ 39,375.00
			SUBTOTAL				**$ 47,250.00**		**$ -**		**$ -**		**$ 47,250.00**
33120	**G.**	**SITE RESTORATION**											
	01	Earthwork											
		- Backfill	Material Only	273	LCY	$ -	$ -		$ -	$ -	$ -	$ 10.00	$ 2,730.00
		Gross	2-1/2 CY Loader w/ Operator	91	LCY	$ -	$ -		$ -	$ -	$ -	$ 2.39	$ 217.49
			Dozer w/ Operator	91	LCY	$ -	$ -		$ -	$ -	$ -	$ 2.87	$ 261.17
		By Hand	Laborer	91	LCY	$ -	$ -		$ -	$ -	$ -	$ 22.50	$ 2,047.50
		- Compaction											
		Gross	Air Tamp. W/ Operator	91	LCY	$ -	$ -		$ -	$ -	$ -	$ 8.30	$ 755.30
			Vibratory Plate w/ Operator	91	LCY	$ -	$ -		$ -	$ -	$ -	$ 5.75	$ 523.25
		By Hand	6" Layers	91	LCY	$ -	$ -		$ -	$ -	$ -	$ 13.10	$ 1,192.10

Table B-2 Detailed Cost Estimate

Soils Contaminated with Arsenic
(Excavation and Disposal - Hazardous Landfill, 7 Grids)
Spring Valley OU-4 and OU-5 EECA

Cost Item						Bare Costs							
						Materials		Labor		Equipment		Cost Including O&P	
WBS		Task & Subtask	Item	Quantity	Units	$/Unit	Subtotal	$/Unit	Subtotal	$/Unit	Subtotal	$/Unit	Subtotal
	04	Revegetation and Planting											
		- Seeding and Sodding	Area of Approx. 2800 sf	1	LS	$ -	$ -		$ -	$ -	$ -	$ 1,200.00	$ 1,200.00
		- Landscape Restoration	Replace existing landscaping and features	1	LS	$ -	$ -		$ -	$ -	$ -	$ 25,000.00	$ 25,000.00
			SUBTOTAL				**$ -**		**$ -**		**$ -**		**$ 33,926.81**
33121	**H.**	**DEMOBILIZATION**											
		Demobilization		1	LS	LS	$ -	$ -	$ -	$ -	$ -	$ 2,000.00	$ 2,000.00
			SUBTOTAL				**$ -**		**$ -**		**$ -**		**$ 2,000.00**
33222	**I.**	**OTHER REQUIREMENTS**											
	90	POST REMEDIATION ACTIVITIES											
		-Closure Report	Senior Engineer	8	hr	$ -	$ -	$ 149.50	$ 1,196.00	$ -	$ -	$ -	$ 1,196.00
			Engineer	12	hr	$ -	$ -	$ 88.40	$ 1,060.80	$ -	$ -	$ -	$ 1,060.80
			CADD Operator	8	hr	$ -	$ -	$ 68.90	$ 551.20	$ -	$ -	$ -	$ 551.20
			Admin Aide	8	hr	$ -	$ -	$ 59.54	$ 476.32	$ -	$ -	$ -	$ 476.32
			Publication/Reproduction	10	per	$ 20.00	$ 200.00	$ -	$ -	$ -	$ -	$ -	$ 200.00
			SUBTOTAL				**$ -**		**$ 3,284.32**		**$ -**		**$ 3,484.32**

TOTAL COST SUMMARY

	Task	Total per Task
A.	MOBILIZATION AND PREPARATORY WORK	$13,984
B.	MONITORING, SAMPLING AND ANALYSIS	$1,489
C.	SITE WORK	$36,497
D.	EROSION AND SEDIMENT CONTROL	$1,570
E.	SUPERVISION AND ADMINISTRATION	$8,479
F.	DISPOSAL	$47,250
G.	SITE RESTORATION	$33,927
H.	DEMOBILIZATION	$2,000
I.	OTHER REQUIREMENTS	$3,484
	SUB-TOTAL	**$148,681**
	Contingency based on tasks C, D, F, G, H (10%)	$7,399
	Project Management based on Tasks C, D, F, G, H (5%)	$3,700
	Remedial Design based on Tasks C, D, F, G, H (10%)	$7,399
	TOTAL	**$167,179**

Per Grid Cost (30 CY)	Per Ton Cost (45 tons/grid)
$23,883	**$531**

Table B-2 Detailed Cost Estimate

Soils Contaminated with Arsenic
(Excavation and Disposal - Hazardous Landfill, 7 Grids)
Spring Valley OU-4 and OU-5 EECA

Cost Item					Bare Costs							
					Materials		Labor		Equipment		Cost Including O&P	
WBS	Task & Subtask	Item	Quantity	Units	$/Unit	Subtotal	$/Unit	Subtotal	$/Unit	Subtotal	$/Unit	Subtotal

KEY - ASSUMPTIONS

O&P = Overhead and Profit

COST ESTIMATE REFLECTS AN AVERAGE SITE WITH **7 GRIDS REQUIRING REMOVAL** (Based on sampling to date).

A.	MOBILIZATION AND PREPARATORY WORK	-Assumed Draft and Final versions of Remediation Work Plan would be prepared. -Assumed electronic versions of existing site drawings will be adequate to produce excavation plans (I.e., additional surveying/creation of new base maps will not be required for planning). -Assumed existing health and safety documents would apply (I.e., no new health and safety submittals included). -Assumed existing quality assurance project plan would apply. -Permitting assumed fee based on amount of land disturbance. Includes application preparation time.
B.	MONITORING, SAMPLING, AND ANALYSIS	-Assumed 7 samples (1 confirmation sample per grid) analyzed for total arsenic ($65/sample) plus TCLP disposal characterization sample ($1,034). -Assumes each grid will meet the remedial objective at the initial excavation depth of 2 feet.
C.	SITE WORK	-Assumes a 1.5 factor for the soil conversion of CY to TON. -Assumes extent of soil contamination has been determined. -Assuming 30% of work can be done with "heavy" equipment, 40% with "light" equipment, and 30% of work done by hand. -Clearing: Up to 12" trees with manageable heights - remove with chain saws and stump removal equipment. 12" trees and larger, and any trees close to the houses, etc. - Utilize tree subcontractior to remove. The number of trees to remove is approximated as (5) 4-6" diameter, (5) 8-12" diameter per 7 grids excavated.
E.	SUPERVISION AND ADMINISTRATION	- Assumed that removal actions will occur in sequence (Site Manager, SSHO and UXO Tech. remain on-site from job to job)
F.	DISPOSAL	-Assumes treatment prior to landfill disposal at a non-hazardous facility
G.	SITE RESTORATION	-Assumed 1" topsoil layer and seeding. No other landscaping allowance. -Assumed equal compaction by methods of Air Tamping, Vibratory Plate, and Hand Methods. -Assumed 30% more soil required from backfill to allow for compaction.
I.	OTHER - POST REMEDIATION ACTIVITIES	-Assumed Draft and Final versions of closure report would be prepared. -Assumed closure report would simply describe the activities conducted.