FORMER NIKE CL-59 LAUNCH AREA
PARMA, CUYAHOGA COUNTY, OHIO

DERP FUDS PROJECT NUMBER G05OH005301

FOCUSED SITE INSPECTION

Final
Revision 0

February 2007

PREPARED FOR

U.S. ARMY CORPS OF ENGINEERS, LOUISVILLE DISTRICT
Contract Number: Contract Number: DACA27-98-D-0031
Delivery Order 0005

Prepared by
Plexus Scientific Corporation
9104 Guilford Road, Suite 1010
Columbia, Maryland 21046

CERTIFICATE OF INDEPENDENT TECHNICAL REVIEW

Plexus Scientific Corporation has completed this Focused Site Inspection for the Former Nike CL-59 Launch Area, Parma, Ohio. Notice is hereby given that an independent technical review has been conducted that is appropriate to the level of risk and complexity inherent in the project, as defined in the Quality Control Plan. During the independent technical review, compliance with established policy principles and procedures were verified utilizing justified and valid assumptions. Verification included review of assumptions; methods, procedures, and material used in analyses; alternatives evaluated; the appropriateness of data used and level of data obtained; and reasonableness of the results, including whether the product meets the customer's needs consistent with law and existing Corps policy.

Review documentation identifying any specific concerns identified during the technical review and their resolution is maintained in the project file.

______________________________ 02-07-07

Lance J. Dockter, Project Manager — Date

______________________________ 02/07/07

John Kearns, QA/QC Manager or his designee — Date

TABLE OF CONTENTS

TABLES

NUMBER **PAGE**

FIGURES

NUMBER **PAGE**

APPENDIXES

LIST OF ACRONYMS

ASTM	American Society of Testing and Materials
bgs	Below ground surface
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
C	Celsius
cm	Centimeter
COPCs	Contaminants of Potential Concern
CRDL	Contract required detection limit
DNR	Department of Natural Resources
DoD	Department of Defense
EM	Engineer Manual
FSI	Focused Site Inspection
FSP	Field Sampling Plan
GPS	Global positioning system
GSA	General Services Administration
HSA	Hollow-stem auger
ID	Inside diameter
IDW	Investigation derived waste
kg	kilogram
L	liter
LCG	*Louisville Chemistry Guideline*
MCL	Maximum Contaminant Level
MDL	Method Detection Limit
mg	milligram
MSL	Mean sea level
MW	Monitoring well
NTU	Nephelometric turbidity units
OEPA	Ohio Environmental Protection Agency
ORP	Oxidation reduction potential
PA	Preliminary Assessment
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
Plexus	Plexus Scientific Corporation
PRG	Preliminary remediation goal
PVC	Polyvinyl chloride
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RL	Reporting limit
RPD	Relative percent difference
sec	second
SI	Site Inspection
STL	Severn Trent Laboratories
SVOC	Semi-volatile organic compound
TAL	Target Analyte List

TCL	Target Compound List
TIC	Tentatively identified compound
TOC	Total organic carbon
μg	Microgram
UCL	Upper confidence limit
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
VA	Veterans Administration
VOC	Volatile organic compound

EXECUTIVE SUMMARY

The former Nike Site CL-59 Launch Area is located at the entrance of the Cuyahoga Community College off of West Pleasant Valley Road within the City of Parma, Cuyahoga County, Ohio. The Launch Area also extends to the west of the community college into Nike Park. The CL-59 Launch Area consisted of three underground missile magazines, Barracks, Missile Assembly and Test Building, Generator Building, and Acid Fueling Station. The site housed only Nike Ajax Missiles.

Former Nike Missile Site CL-59 was activated in July 1956 and was deactivated in 1961. After deactivation, the site was briefly used to support Army Reserve training and other Army activities. Cuyahoga Community College later acquired the property and demolished the westernmost of the three underground Nike missile magazines in 1972. In the late 1970s, the other two missile magazines were filled in with soil from an unknown source. The other structures at the Launch Area were demolished as part of the school development.

The Site Inspection (SI) included the collection of eight surface and 22 subsurface soil and one groundwater sample (collected from an open borehole). Based on the SI sampling, three polycyclic aromatic hydrocarbons (PAHs)—(benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene)—and five metals (aluminum, arsenic, iron, manganese, and thallium) were identified as compounds of potential concern (COPCs) in surface soil. No COPCs were identified for subsurface soils.

The SI groundwater sample was highly turbid and the detections may not accurately represent groundwater conditions. The sample contained two PAHs, a phthalate, arsenic, and thallium in excess of the Region 9 PRG for tap water. The one PAH (benzo(a)pyrene) for which there is a Maximum Contaminant Level (MCL) was just below the limit and thallium exceeded the MCL.

This Focused Site Inspection (FSI) was conducted to determine if the PAHs and metals detected in March 2005 during the SI are related to the Nike site activities or are present area-wide. The FSI included the collection and analysis of 12 surface soil samples to determine if SI COPCs are site-related. Samples were also analyzed for geotechnical and chemical characteristics relating contaminant transport and availability. The samples were analyzed for PAHs and metals. One off-site and two on-site monitoring wells were installed, sampled, and analyzed to determine groundwater quality.

The background (FSI) and on-site (SI) data sets for the soil COPCs were statistically compared. Only benzo(a)pyrene was statistically higher in the on-site samples at a confidence level of 0.05 or greater. The individual benzo(a)pyrene samples were then compared to the background 95 percent upper confidence limit (UCL); four on-site samples and a field duplicate were above the UCL. These samples were collected around the Magazine Area and near the Missile Assembly and Test Building. These results all exceed the Region 9 preliminary remediation goal (PRG) for residential soil (62 μg/kg), but only SS06 (400 μg/kg) and SS08 (520 μg/kg) exceed the industrial soil PRG (210 μg/kg).

During the FSI, three borings were installed at locations of structures formerly at the Nike site that may have impacted environmental quality. Two wells were constructed to give an indication of groundwater quality. An additional well was constructed west of the former Crile Hospital and the Nike Launch Area in an area believed unaffected by historical activities. Trichloroethene, benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene are possible COPCs in the well near the former Missile Assembly and Test Building. This well contained less than two feet of water. Arsenic (total and dissolved in one well), iron (total in the off-site well), and manganese (total and dissolved all samples) are also possible COPCs. However, neither trichloroethene nor arsenic were present above their MCLs.

Groundwater is not used for potable purposes within a one-mile radius of the site and its use between one and four miles from the site is likely to be limited as the area is served by municipal water systems.

The former Launch Area is currently used as an open space buffer between the college buildings and the neighborhood. The potential for exposure to contaminants in surface soils or fugitive dust is somewhat mitigated as the area is well vegetated and not heavily used.

Benzo(a)pyrene is a surface soil COPC as the on-site sample set is statistically different than the background sample set. Several samples exceed both the residential and industrial PRGs. Further evaluation of the risk posed by benzo(a)pyrene using site-specific exposure scenarios is recommended.

A volatile organic compound (VOC), three PAHs, and three metals were identified as potential COPCs in groundwater during the initial FSI sampling event. Based on these results, three additional groundwater sampling events were performed. For the three quarterly events, five VOCs were detected in the on-site monitoring wells; however, none were detected above MCLs. No PAHs were detected in any of the groundwater samples collected for the three sampling events; however, four metals (arsenic, iron, manganese, and thallium) were identified as potential COPCs. In one sample collected from an on-site monitoring well, arsenic was just above the MCL. In four samples collected from the monitoring wells (including the background well), thallium was detected at concentrations exceeding the MCL.

Based on the results gathered through the performance of the SI and FSI, no further evaluation concerning the groundwater is warranted for the Nike CL-59 site.

1. Introduction

The United States Army Corps of Engineers (USACE), Louisville District tasked Plexus Scientific Corporation (Plexus) (Contract Number DACA27-98-D-0031, Delivery Order 0005), to conduct a Preliminary Assessment (PA), Site Inspection (SI), and a Focused SI (FSI) at the Former Nike Missile Site CL-59 property. The PA addressed both the Launch and Control areas of the property while the SI and this FSI address only the former Launch Area. The Launch Area is in Parma, Cuyahoga County, Ohio. The PA was conducted to determine if there are any unidentified disposal areas related to past military use of the site. The Launch Area SI and FSI involved on-site sampling to determine the presence or absence of contamination related to historical use of the site. The SI results were screened against the U.S. Environmental Protection Agency (USEPA) Region 9 Preliminary Remediation Goals (PRGs) (USEPA, 2004). The objectives of the FSI are to collect analytical data to determine if the polycyclic aromatic hydrocarbons (PAHs) and metals detected during the SI are site-related or represent area-wide conditions. Monitoring wells were installed to determine if former site operations impacted groundwater resources. The ultimate goal is to either close the site should sampling determine that the detected compounds are at background levels or are not associated with past Department of Defense (DoD) use of the property, or to identify necessary follow-on activities.

The SI and FSI field activities were conducted and this report has been prepared in conformance with the requirements contained in the USEPA Region 5 Model Quality Assurance Project Plan (USEPA, undated), the USEPA *Guidance for Performing Site Inspections Under CERCLA* (USEPA, 1992) the USACE Engineer Manual (EM) 200-1-3, *Requirements for the Preparation of Sampling and Analysis Plans* (USACE, 2001), and the sampling and analysis plans developed for this project (Plexus, 2001a, 2004).

2. Site Description

2.1 Location

The former Nike Site CL-59 Launch Area is located at the entrance of the Cuyahoga Community College off of West Pleasant Valley Road within the City of Parma, Cuyahoga County, Ohio (Figure 2-1). The Launch Area also extends to the west of the community college into Nike Park. The geographic coordinates of the site are 41° 21' 49.4" north latitude and 81° 45' 56.9" west longitude (USGS, 1963). To reach the Launch Area, take State Route 71 to Bagley Road east, which becomes West Pleasant Valley Road. The Control Area located in the City of Parma Heights is approximately ½ mile northwest of the Launch Area and is now known as Nathan Hale Park (Sebesta & Associates, 1998; USGS, 1963). The geographic coordinates of the Control Area are 41° 22' 12" north latitude and 81° 46' 34" west longitude (USGS, 1963). This FSI addresses only the Launch Area.

2.2 Site Description

The former Launch Area lies on the property of Cuyahoga Community College and the City of Parma. The site is bordered to the north by the college, to the west by Nike Park, by residential areas to the south, and a commercial area to the east (Plexus, 2002a; Sebesta & Associates, 1998; USGS, 1963). The fenced portion of the Launch Area was approximately 22 acres, which was utilized for the storage, maintenance, refueling, and launching of missiles. The Launch Area is currently being used as open area, roads, and parking for the community college (Plexus, 2002a).

Only four buildings relating to the Nike site activity still remain. They are a former Nike Maintenance Building located about 1,800 feet west of the former Launch Area, and a guardhouse, administrative building, and motor pool building in the Control Area. The maintenance building is in Nike Park and is in use by the City of Parma Service Department (Sebesta & Associates, 1998; USGS, 1963).

Presently, the entrance road to the college off Pleasant Valley Road is about 400 feet west of the former entrance road to the Launch Area and the college entrance crosses the former Launch Area (Plexus, 2002a; Sebesta & Associates, 1998; USGS, 1963). The former Nike Site Launch Area is well vegetated with little evidence of the facility. There are some scattered areas where pavement—presumably from the site—is visible (Plexus, 2002a).

2.3 Operational History and Waste Characteristics

Only a brief overview of the site history, Nike site operations, Nike facilities, and typical waste types is provided in the FSI. A complete discussion is included in the PA and SI reports.

Former Nike Missile Site CL-59 was activated in July 1956 and deactivated in 1961 (Lonnquest and Winkler, 1996; Morgan and Berhow, 1996). After deactivation, the site was briefly used to support Army Reserve training and other Army activities (Genetti, 1992).

The Army acquired the property by permit from the Veterans Administration (VA) by letter transfer in 1957. In January 1968, the site was reported excess to the General Services

Administration (GSA). The property was disposed of to various local public entities between 1969 and 1971 (Genetti, 1992).

The Nike CL-59 Launch Area was built south of Crile Hospital. The hospital was built in 1943 and in 1946 the hospital was transferred to the newly created VA. The Crile Hospital was closed in 1964. Cuyahoga Community College was created in 1965 and moved into the vacated Crile Hospital facility (Sebesta & Associates, 1998). The Nike CL-59 Launch Area was not constructed on any area actively utilized by the hospital.

The CL-59 Launch Area had three underground missile magazines (Lonnquest and Winkler, 1996). One was a design modified to handle both Ajax and Hercules missiles and the other two magazines were designed for the Ajax missile only (Carlson et al., 1996; Lonnquest and Winkler, 1996; Morgan and Berhow, 1996). The site was equipped with 30 Ajax Missiles (Lonnquest and Winkler, 1996; Morgan and Berhow, 1996). Ajax missiles had a solid fueled booster, a liquid fueled sustainer motor, and a three high-explosive warheads (Carlson et al., 1996). Other structures at the Launch Area included Barracks, Missile Assembly and Test Building, Generator Building, and Acid Fueling Station (Figure 2-2) (Carlson et al., 1996; Sebesta & Associates, 1998).

Cuyahoga Community College demolished some of Crile Hospital to make room for new buildings in 1972. The westernmost of the three underground Nike missile magazines was demolished and the other two missile magazines were filled in with soil from an unknown source (Madison, 1972; Sebesta & Associates, 1998; USACE, 2000). The buildings at the Launch Area were demolished as part of the school development. The college never used either the missile magazines or any other Launch Area building (USACE, 2000).

An overlay of the former Launch Area features on a 1994 orthophoto quadrangle is presented as Figure 2-3.

2.4 Previous Environmental Investigations

In 1998, a Limited Phase I Environmental Site Assessment of the land formerly occupied by the Crile Hospital and Nike Site CL-59 was conducted for Cuyahoga Community College. The assessment concluded that "there is no evidence that the site may have been extensively contaminated by the operation of either Crile Hospital or the Nike Missile Site but there is some potential for localized environmental impairments directly associated with specific work and research operations including the use of degreasers and solvents, operations related to petroleum underground storage tanks and hydraulic elevators, battery maintenance operations and incinerator ash disposal [incinerator was associated with hospital operations]." The report recommended that documents be reviewed to determine the status of all underground and aboveground storage tanks that may have been located at the site. If documents could not confirm the removal of all underground storage tanks from the site, the report recommended that a magnetometer survey, soil borings, and other site assessment studies be conducted to locate the tanks and measure any site-related contamination (Sebesta & Associates, 1998).

A PA covering both the Launch and Control Areas of former Nike Site CL-59 was completed on behalf of USACE in 2002 (Plexus, 2002a). As part of the PA, analysis of historic aerial photographs (covering the period from 1952 through 1994) was performed. As depicted on the 1959 and 1962 aerial photographs, two ground scars were identified on the northern portions of the former launch area site. The location of the two ground scars (identified as scar #1 and #2) are depicted on Figure 2-3, which includes an overlay of the 1962 aerial photograph. One scar (scar #1) has a crescent-shaped configuration and is located north of what is presumed to be the Missile Assembly and Test Building. This scar measures approximately 200 feet long (east to west extremes) and approximately 60 feet wide at its greatest width. A faintly visible linear feature runs from the corner of a concrete and asphalt pad on the west side of the building to the scar. The scarred area shows no evidence of being caused by vehicular activity; however, it may have resulted from the release of liquids. The second scar (scar #2) is situated north of the missile magazines and east of the Acid Fueling Station in an open, grass-covered field. This scar exhibits a generally mottled, disturbed appearance; evidence of vehicular activity is also noted. A portion of this area appears to be mounded and darker in appearance. Vegetative cover that differs from the surrounding grass-covered grounds may be the cause of this darkened condition. This roughly circular scar occupies and area estimated to measure approximately 50 feet in diameter.

The findings of the PA relating to the Launch Area were utilized in determining the sampling locations and analytical suite for the SI.

During the SI field effort, eight surface and 22 subsurface soil samples were collected. The samples were analyzed for Target Compound List (TCL) volatile organic compounds (VOCs), TCL semivolatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), and Target Analyte List (TAL) metals. Six borings were installed at locations of former structures at the Nike site that may have impacted environmental quality. One groundwater sample was collected from an open borehole adjacent to the easternmost missile magazine to give an indication of groundwater quality in that location. Groundwater did not accumulate in any other borehole. Two of the borings were in areas of ground disturbance identified from historic aerial photographs during the PA (Plexus, 2002b).

Soil sampling resulted in the detection of a variety of organic compounds and metals. The analytical results were compared to USEPA Region 9 residential soil and tap water PRGs. PRGs are risk-based screening tools for evaluating the need for further investigation or remediation at potentially contaminated sites. The PRGs were compared point-by-point to the concentrations of contaminants identified to establish contaminant of potential concern (COPCs). Presence of a contaminant below the PRG indicates that the compound is unlikely to present a threat to human health. An exceedance of a PRG indicates that a contaminant should be further evaluated to determine if it poses a threat to human health. Carcinogenic compounds were screened against the full Region 9 PRG, while noncarcinogenic compounds were screened against 1/10 of the PRG value to be protective in the event of additive effects from multiple chemicals (Plexus, 2002b). SI sample numbers, location, analysis, and detections exceeding screening values are provided in Table 2-1, and locations are shown on Figure 2-4. The concentrations for the detected constituents are listed in Tables 5-1 and 5-2.

No VOCs exceeded the screening values. PCBs were not detected in either soils or the groundwater sample. The groundwater sample alone was also analyzed for pesticides and none were detected (Plexus, 2002b).

Total PAH concentrations ranged from 104 to 4,373 µg/kg in surface soil and from non-detect to 833 µg/kg in the subsurface soil samples. The greatest number and concentrations of PAHs were at or near the ground surface on the south and east portions of the site. Three PAHs, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene, were detected in surface soils above PRGs but none of the subsurface soil samples exceed PRGs (Plexus, 2002b).

Benzo(a)pyrene and benzo(a)anthracene exceed the Region 9 PRG for tap water. Benzo(a)pyrene was just below the 0.2 µg/L Maximum Contaminant Level (MCL) for drinking water. There is no MCL for benzo(a)anthracene. The detection may not accurately represent groundwater conditions, as the groundwater sample was highly turbid (Plexus, 2002b).

Bis(2-ethylhexyl)phthalate exceeded the Region 9 tap water PRG in one sample but was not detected in the field duplicate. Phthalates were only detected in one of the 29 soil samples collected during the SI (Plexus, 2002b).

Two metals, arsenic and iron, were detected in both surface and subsurface soils above PRGs. Arsenic exceeded PRGs in all samples collected. Iron was detected in all soil samples collected and exceeded the Region 9 PRGs in seven of the eight surface soil samples and 12 of the 22 subsurface soil samples (Plexus, 2002b).

Arsenic and thallium in groundwater exceeded both the tap water PRGs and thallium also exceeded the MCL. The groundwater sample is not considered representative of water in the formation as it was not collected from a monitoring well but from an open borehole (Plexus, 2002b).

TABLE 2-1
SI SAMPLE SUMMARY, LOCATION, ANALYSIS, AND DETECTIONS EXCEEDING SCREENING VALUES
FORMER NIKE SITE CL-59 LAUNCH AREA, PARMA, OHIO

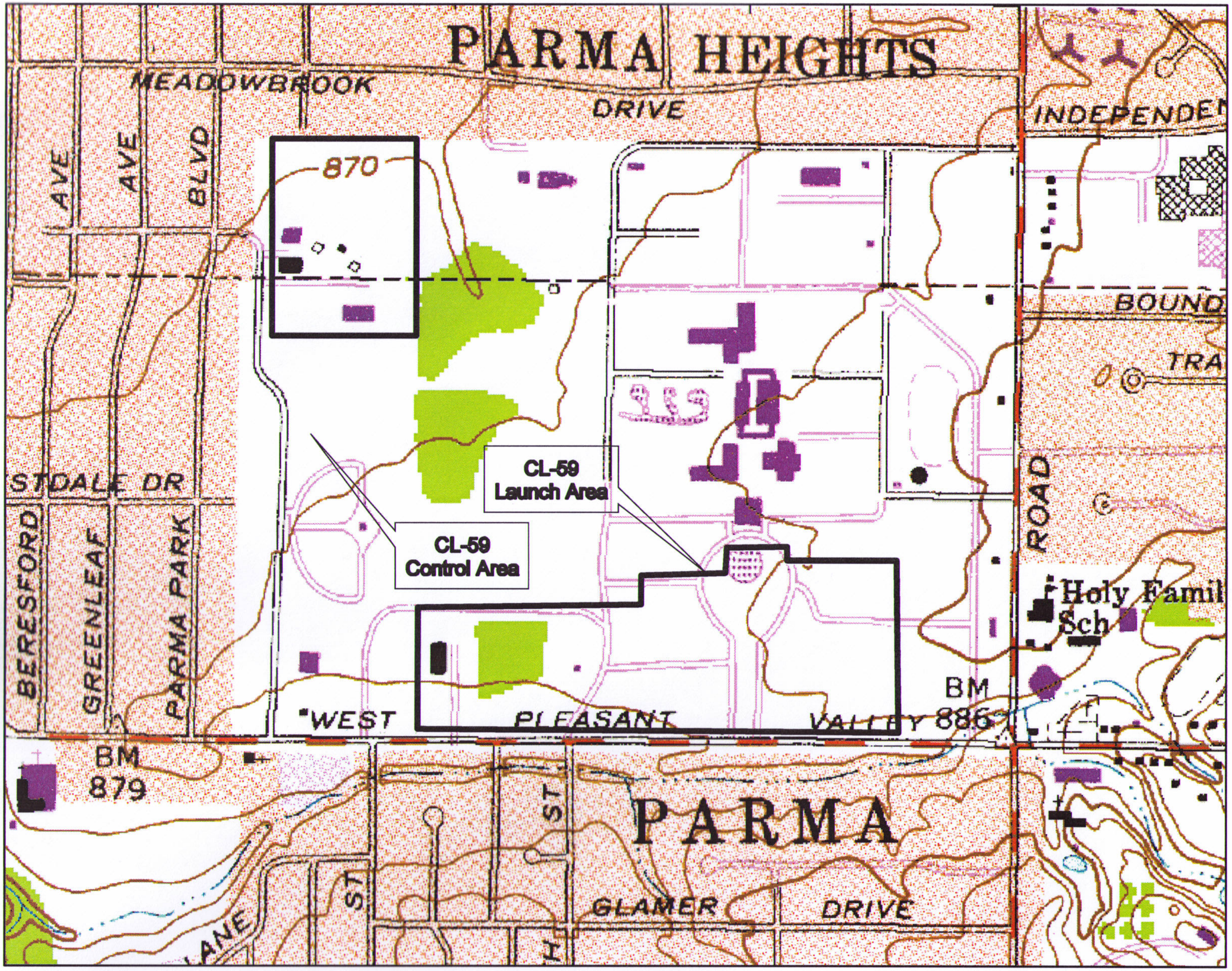
Sample Number	Location	Analysis	Detected Compounds	Detections Exceeding Human Health Screening Values[1, 2, 3]
Scars				
CL59-SS01	Collected in scar 1 near west side of traffic circle at a depth of 0 to 1 foot bgs to determine the presence or absence of contamination in surface soil.	TCL VOC, TCL SVOC, TAL Metals, PCBs	1 Volatile 10 PAHs 18 Metals	Aluminum**,** **Arsenic**, Iron, Manganese
CL59-SB01A	Shallow subsurface soil collocated with SS01 at a depth of 2 to 4 feet bgs to determine the presence or absence of contamination in subsurface soil indicating possible contaminant migration.	TCL VOC, TCL SVOC, TAL Metals, PCBs	1 Volatile 1 PAH 18 Metals	Aluminum**,** **Arsenic**, Iron, Manganese
CL59-SS02	Collected in scar 2 near east side of traffic circle at a depth of 0 to 1 foot bgs to determine the presence or absence of contamination in surface soil indicating possible contaminant migration.	TCL VOC, TCL SVOC, TAL Metals, PCBs	1 Volatile 15 PAHs 19 Metals	Aluminum**,** **Arsenic**, Iron, Manganese
CL59-SB02A	Shallow subsurface soil collocated with SS02 at a depth of 3 to 4 feet bgs. To determine the presence or absence of contamination in subsurface soil.	TCL VOC, TCL SVOC, TAL Metals, PCBs	3 PAHs 17 Metals	Aluminum**,** **Arsenic**, Iron, Manganese
Acid Fueling Station				
CL59-SS03	Collected south of the center of traffic circle in former Acid Fueling Station at a depth of 0 to 1 foot bgs to determine the presence or absence of contamination in surface soil.	TCL VOC, TCL SVOC, TAL Metals	14 PAHs 19 Metals	Aluminum**,** **Arsenic**, Iron, Manganese, Thallium
CL59-SB03A	Subsurface soil collocated with SS03 at a depth of 3 to 5 feet bgs to determine the presence or absence of contamination in subsurface soil indicating possible contaminant migration.	TCL VOC, TCL SVOC, TAL Metals	16 PAHs 18 Metals	Aluminum**,** **Arsenic**, Iron, Manganese, Thallium
CL59-SB03B	Subsurface soil collocated with SS03 at a depth of 9 to 10.5 feet bgs to determine the presence or absence of contamination in subsurface soil indicating possible contaminant migration.	TCL VOC, TCL SVOC, TAL Metals	1 PAH 17 Metals	**Arsenic**, Iron, Manganese
CL59-SB03C	Subsurface soil collocated with SS03 at a depth of 13 to14.3 feet bgs (just above bedrock) to determine the presence or absence of contamination in subsurface soil indicating possible contaminant migration.	TCL VOC, TCL SVOC, TAL Metals	3 Volatiles 5 PAHs 18 Metals	**Arsenic**, Iron, Manganese

Sample Number	**Location**	**Analysis**	**Detected Compounds**	**Detections Exceeding Human Health Screening Values[1, 2, 3]**
Generator And Missile Assembly and Test Buildings				
CL59-SS04	Collected on south edge of traffic circle at the former Missile Assembly and Test Building site at a depth of 0 to 1 foot bgs to determine the presence or absence of contamination in surface soil.	TCL VOC, TCL SVOC, TAL Metals, PCBs	1 phthalate 18 PAHs 18 Metals	**Benzo(a)pyrene** Aluminum**,** **Arsenic**, Iron, Manganese
CL59-SB04A	Subsurface soil collocated with SS04 at a depth of 3 to 4 feet bgs to determine the presence or absence of contamination in subsurface soil indicating possible contaminant migration.	TCL VOC, TCL SVOC, TAL Metals, PCBs	9 PAHs 17 Metals	Aluminum**,** **Arsenic**, Iron, Manganese
CL59-SB04B	Subsurface soil collocated with SS04 at a depth of 9 to 10 feet bgs to determine the presence or absence of contamination in subsurface soil indicating possible contaminant migration.	TCL VOC, TCL SVOC, TAL Metals, PCBs	2 Volatiles 17 Metals	**Arsenic,** Iron, Manganese
CL59-SB04C	Subsurface soil collocated with SS05 at a depth of 11 to 13 feet bgs (13 to 15 feet bgs for Atterburg limits and grain size) to determine the presence or absence of contamination in subsurface soil indicating possible contaminant migration.	TCL VOC, TCL SVOC, TAL Metals, PCBs, Atterburg Limits, Grain size	19 Metals	**Arsenic,** Iron, Manganese, Thallium
CL59-SS05/105	Collected on south edge of traffic circle at the former Generator Building site at a depth of 0 to 1 foot bgs to determine the presence or absence of contamination in surface soil.	TCL VOC, TCL SVOC, TAL Metals, PCBs, Atterburg Limits, Grain size	2 Volatiles 18 PAHs 21 Metals	**Benzo(a)pyrene,** Aluminum**,** **Arsenic**, Iron, Manganese, Thallium
CL59-SB05A	Subsurface soil collocated with SS05 at a depth of 4 to 5 feet bgs to determine the presence or absence of contamination in subsurface soil indicating possible contaminant migration.	TCL VOC, TCL SVOC, TAL Metals, PCBs	2 PAHs 19 Metals	Aluminum**,** **Arsenic**, Iron, Manganese, Thallium
CL59-SB05B	Subsurface soil collocated with SS05 at a depth of 8 to 9.5 feet bgs to determine the presence or absence of contamination in subsurface soil indicating possible contaminant migration.	TCL VOC, TCL SVOC, TAL Metals, PCBs	18 Metals	**Arsenic** Iron, Manganese
CL59-SB05C	Subsurface soil collocated with SS05 at a depth of 13 to 14 feet bgs to determine the presence or absence of contamination in subsurface soil indicating possible contaminant migration.	TCL VOC, TCL SVOC, TAL Metals, PCBs	1 Volatile 4 PAHs 20 Metals	**Arsenic,** Iron, Manganese, Thallium

Sample Number	Location	Analysis	Detected Compounds	Detections Exceeding Human Health Screening Values[1, 2, 3]
Missile Magazines				
CL59-SS06/106	Collected on south side of western most Missile Magazine at a depth of 0 to 1 foot bgs to determine the presence or absence of contamination in surface soil.	TCL VOC, TCL SVOC, TAL Metals, PCBs	3 Volatiles 19 PAHs 21 Metals	**Benzo(a)pyrene,** **Dibenz(a,h)anthracene** Aluminum**,** **Arsenic**, Iron, Manganese, Thallium
CL59-SB06A	Subsurface soil collocated with SS06 at a depth of 6 to 8 feet bgs to determine the presence or absence of contamination in subsurface.	TCL VOC, TCL SVOC, TAL Metals, PCBs	1 PAH 18 Metals	Aluminum**,** **Arsenic**, Iron, Manganese
CL59-SB06B	Subsurface soil collocated with SS06 at a depth of 10 to 12 feet bgs to determine the presence or absence of contamination in subsurface.	TCL VOC, TCL SVOC, TAL Metals, PCBs	1 Volatile 17 Metals	**Arsenic**, Iron
CL59-SB06C	Subsurface soil collocated with SS06 at a depth of 12 to 13.75 feet bgs (just above bedrock) to determine the presence or absence of contamination in subsurface.	TCL VOC, TCL SVOC, TAL Metals, PCBs	2 PAHs 17 Metals	**Arsenic,** Iron, Manganese
CL59-SS07/107	Collected on slope on north side of middle Missile Magazine at a depth of 0 to 1 foot bgs to determine the presence or absence of contamination in surface soil.	TCL VOC, TCL SVOC, TAL Metals, PCBs	8 Volatiles 15 PAHs 22 Metals	**Benzo(a)pyrene,** Aluminum, **Arsenic,** Iron, Manganese, Thallium
CL59-SB07A	Subsurface soil collocated with SS07 at a depth of 6 to 8 feet bgs to determine the presence or absence of contamination in subsurface.	TCL VOC, TCL SVOC, TAL Metals, PCBs, Atterburg Limits, Grain size	3 PAHs 18 Metals	Aluminum, **Arsenic,** Iron, Manganese
CL59-SB07B	Subsurface soil collocated with SS07 at a depth of 10 to 12 feet bgs to determine the presence or absence of contamination in subsurface.	TCL VOC, TCL SVOC, TAL Metals, PCBs	1 Volatile 2 PAHs 17 Metals	Aluminum, **Arsenic,** Iron, Manganese
CL59-SB07C	Subsurface soil collocated with SS07 at a depth of 14 to 16 feet bgs to determine the presence or absence of contamination in subsurface.	TCL VOC, TCL SVOC, TAL Metals, PCBs	9 PAHs 19 Metals	**Arsenic,** Iron, Manganese
CL59-SB07D	Subsurface soil collocated with SS07 at a depth of 18 to 19.1 feet bgs to determine the presence or absence of contamination in subsurface.	TCL VOC, TCL SVOC, TAL Metals, PCBs	9 PAHs 20 Metals	**Arsenic**, Iron, Manganese
CL59-SB07E	Subsurface soil collocated with SS07 at a depth of 20 to 21.1 feet bgs to determine physical characteristic of geologic material.	Grain size	Not applicable	Not applicable
CL59-SS08/108	Collected on slope on south side of easternmost Missile Magazine at a depth of 0 to 1 foot bgs to determine the presence or absence of	TCL VOC, TCL SVOC, TAL Metals, PCBs	9 Volatiles 1 Phthalate 1 Furan 19PAHs	**Benzo(a)pyrene,** **Benzo(b)fluoranthene,** **Dibenz(a,h)anthracene,** Aluminum,

Sample Number	Location	Analysis	Detected Compounds	Detections Exceeding Human Health Screening Values[1, 2, 3]
	contamination in surface soil.		21 Metals	**Arsenic**, Iron, Manganese, Thallium
CL59-SB08AA	Subsurface soil collocated with SS08 at a depth of 5 to 7 feet bgs to determine the presence or absence of contamination in subsurface.	TCL VOC, TCL SVOC, TAL Metals, PCBs	2 Volatiles 18 Metals	Aluminum, **Arsenic**, Iron, Manganese
CL59-SB08A	Subsurface soil collocated with SS08 at a depth of 12 to 14 feet bgs (10 to 12 feet bgs for grain size and Atterburg limits) to determine the presence or absence of contamination in subsurface.	TCL VOC, TCL SVOC, TAL Metals, PCBs, Atterburg Limits, Grain size	1 Volatile 8 PAHs 18 Metals	Aluminum, **Arsenic,** Iron, Manganese
CL59-SB08B	Subsurface soil collocated with SS08 at a depth of 16 to 18 feet bgs to determine the presence or absence of contamination in subsurface.	TCL VOC, TCL SVOC, TAL Metals, PCBs	2 Volatiles 9 PAHs 18 Metals	Aluminum, **Arsenic,** Iron, Manganese
CL59-SB08C	Subsurface soil collocated with SS08 at a depth of 24 to 25.5 feet bgs (just above bedrock) to determine the presence or absence of contamination in subsurface.	TCL VOC, TCL SVOC, TAL Metals, PCBs	1 Volatile 12 PAHs 21 Metals	Aluminum, **Arsenic**, Iron, Thallium
CL59-GW08	To provide an indication of groundwater quality at the east end of the former Missile Magazine Area.	TCL VOC, TCL SVOC, TAL Metals (dissolved), PCBs, Pesticides	6 Volatiles 8 PAHs 1 Phthalate Caprolactam 13 Metals	**Bis(2-ethylhexyl)phthalate,** **Benzo(a)anthracene,** **Benzo(a)pyrene,** Naphthalene, Antimony, **Arsenic**, Thallium

[1] Compounds not in bold text exceed 10 percent of USEPA Region 9 PRG values for noncarcinogens. Tap water and residential soil PRGs were utilized.
[2] Compounds in bold exceed the full value of USEPA Region 9 PRGs for carcinogens.
[3] Concentrations for the detected constituents are listed in Tables 5-1 and 5-2.



N

200 0 200 400 Feet

Source: 7.5 MINUTE QUARDRANGLE BEREA, OHIO, 1963 (PHOTOREVISED, 1984).

FIGURE 2-1
SITE LOCATION

FORMER NIKE MISSILE
SITE CL-59
LAUNCH AREA

PARMA, CUYAHOGA COUNTY OHIO

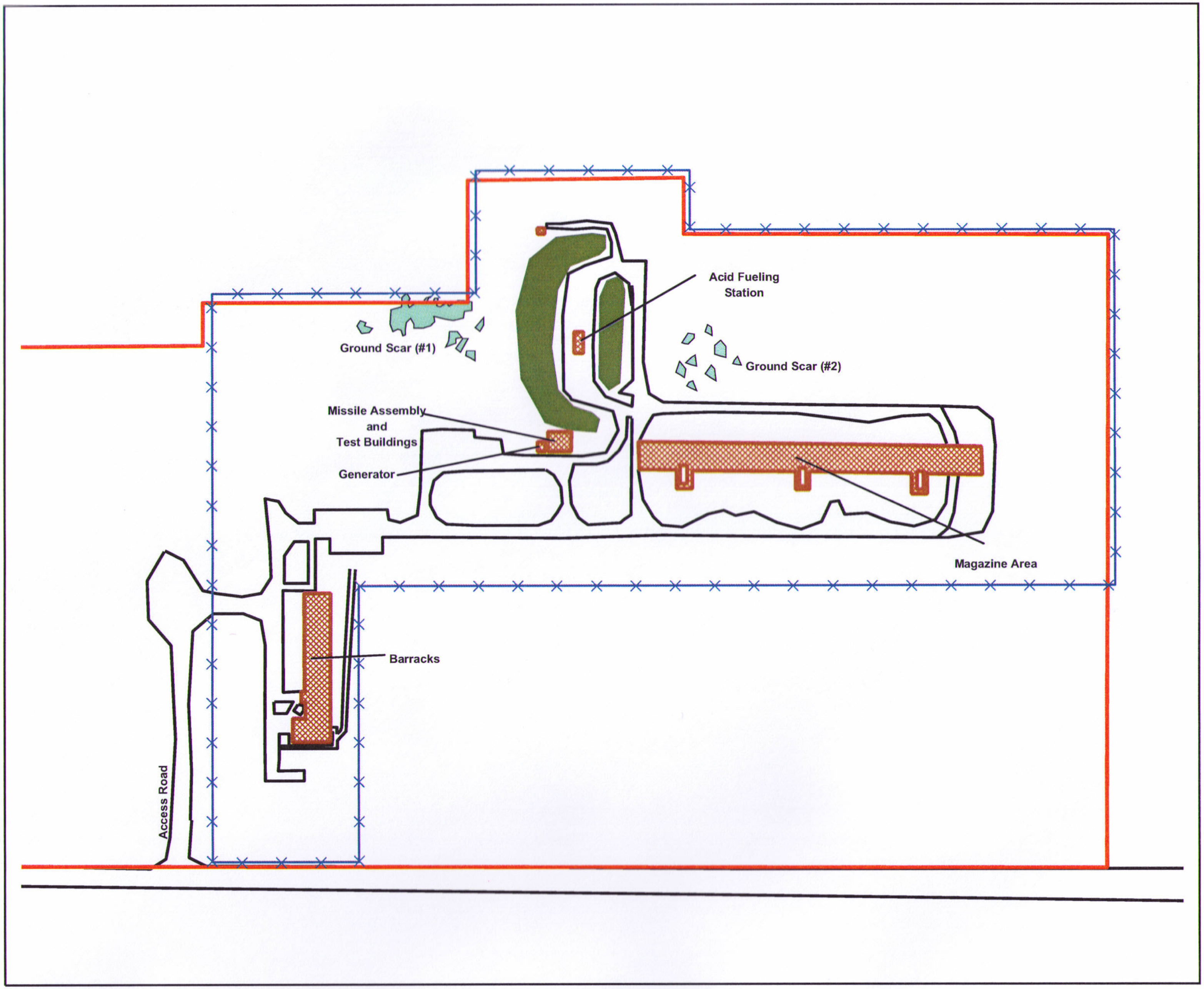
U.S. Army Corps of Engineers

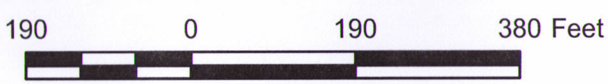
U.S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY

PLEXUS scientific

PROJECT NO. 0032-005B

FILE NO. 0032-005B-102





Legend

- Nike Structures
- Nike Berm (removed)
- Launch Area Boundary
- Roads 1962

Source: Sebesta & Associates, Inc.,1998; USGS Digital Orthophoto Quadrangle (DOQ) Data, Berea,1994; Aerial Photography, May 3, 1962

FIGURE 2-2
SITE LAYOUT

FORMER NIKE MISSILE
SITE CL-59
LAUNCH AREA

PARMA, CUYAHOGA COUNTY OHIO

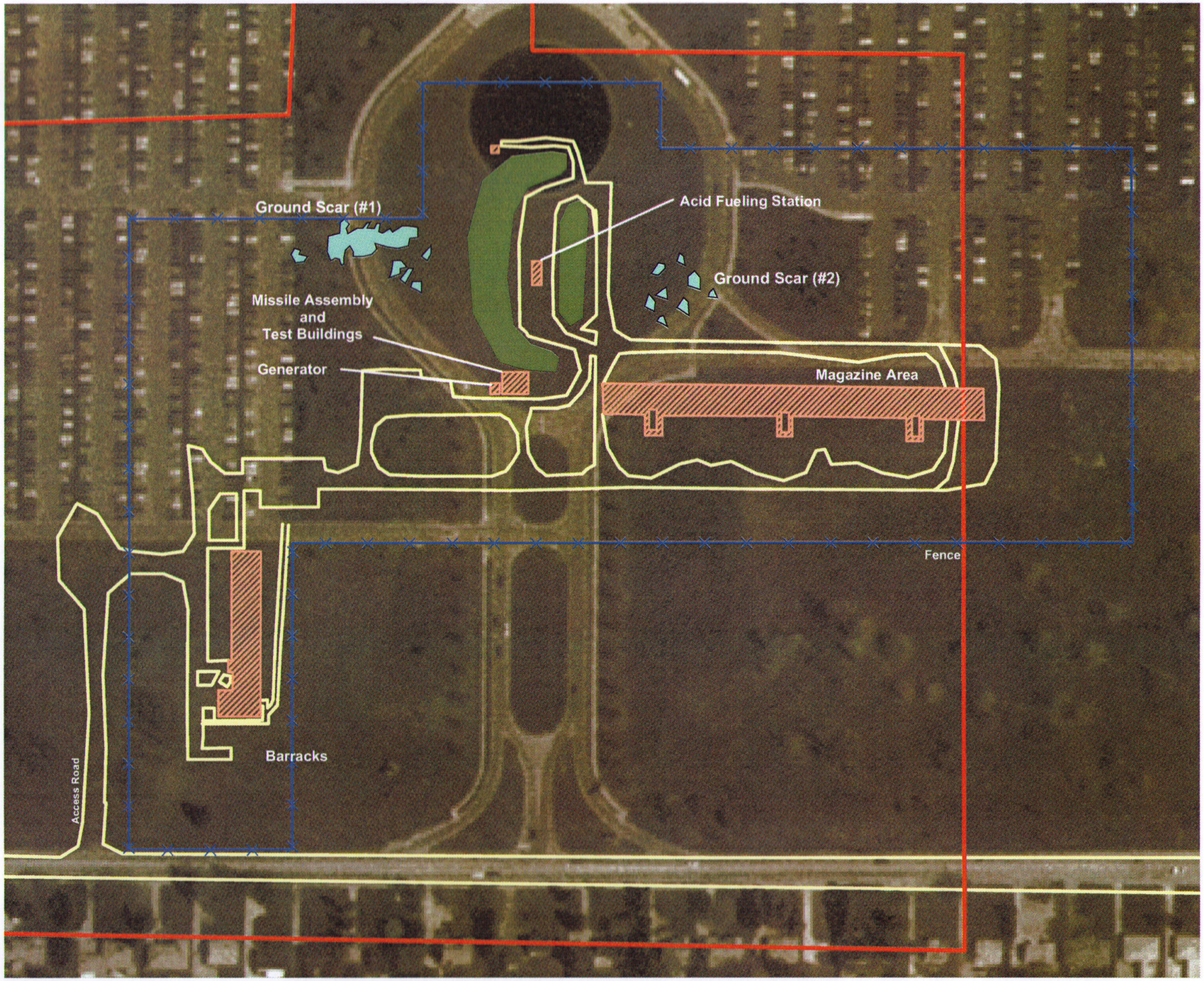
U.S. Army Corps of Engineers

U.S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY

PLEXUS scientific

PROJECT NO. 0032-005B

FILE NO. 0032-005B-201



N

Legend

- Nike Structures
- Nike Berm (removed)
- Launch Area Boundary

200 0 200 400 Feet

Source: Sebesta & Associates, Inc.,1998; USGS Digital Orthophoto Quadrangle (DOQ) Data, Berea,1994; Aerial Photography, May 3, 1962

FIGURE 2-3
LAUNCH AREA
OVERLAY

FORMER NIKE MISSILE
SITE CL-59
LAUNCH AREA

PARMA, CUYAHOGA COUNTY OHIO

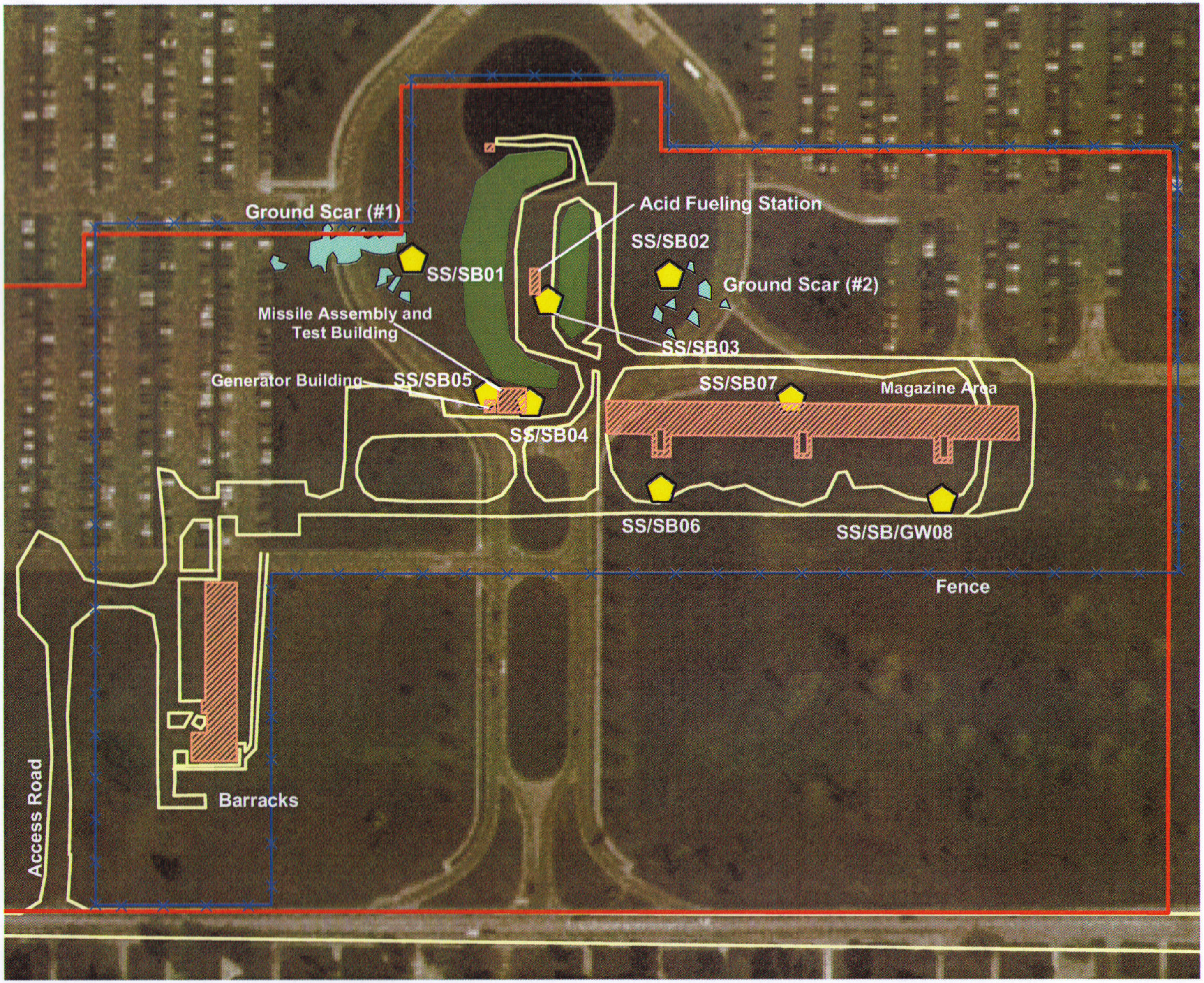
U.S. Army Corps of Engineers

U.S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY

PLEXUS scientific

PROJECT NO. 0032-005B

FILE NO. 0032-005B-201



N

Legend

- SI Sample Locations
- Nike Structures
- Nike Berm (removed)
- Launch Area Boundary

200 0 200 400 Feet

Source: Sebesta & Associates, Inc.,1998; USGS Digital Orthophoto Quadrangle (DOQ) Data, Berea,1994; Aerial Photography, May 3, 1962

FIGURE 2-4
SI SAMPLE LOCATIONS OVERLAY

FORMER NIKE MISSILE SITE CL-59 LAUNCH AREA

PARMA, CUYAHOGA COUNTY OHIO

U.S. Army Corps of Engineers

U.S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY

PLEXUS scientific

PROJECT NO. 0032-005B

FILE NO. 0032-005B-201

3. PHYSICAL CHARACTERISTICS OF THE STUDY AREA

The former Nike Missile Site CL-59 lies in the Appalachian Plateaus physiographic province. Within this province, the site lies in the Killbuck-Glaciated Allegheny Plateaus (ODGS, 1998). The surface soils at the site consisted of loose to medium dense sands ranging from one to two feet in thickness. The sands contained gravel, silts and clay-sized particles with fragmented gravel-sized, gray shale particles (USDA, 1980).

Geologic borings completed at CL-59 during the SI confirmed that glacial tills dominate the surficial geology of the site. These moraine deposits are mostly heterogeneous and consist of silt, clay, sand, and gravel from subangular to rounded in shape. The gravel-sized clasts contained in the clayey till were mostly comprised of shale and sandstone particles. Glacial tills at the former Nike Site range from 13 to 25 feet in thickness and groundwater was found to be approximately 25 feet below the ground surface (bgs). Groundwater was only encountered in one of the geologic borings during the SI, and therefore, shallow groundwater flow direction and its continuity across the site were not determined.

Bedrock in the area consists of gray to brown shale and interbedded sandstones and siltstones. Mapped as the Cuyahoga Formation the bedrock was encountered at between 14 and 26 feet bgs. The depth below ground surface that bedrock was encountered appeared to generally increase towards the west of the site. Where mapped in portions of northern Ohio, the thickness of the Cuyahoga Formation ranges from 0 to 180 feet (ODGS, 1996). The geology encountered during SI drilling operations was consistent with the formations described in ODGS, 1999.

The borings installed during the FSI correspond with those installed during the SI and do not impact the geological descriptions.

The wells were surveyed and groundwater elevations were collected. The groundwater elevations are shown in Table 4-4 and Figure 4-2. The water elevations for the westernmost well (MW-100) are approximately 10 feet higher than the water elevations of MW-101. Similarly, the water elevations of the easternmost well (MW-102) are approximately 13.5 feet higher than the water elevations of MW-101.

Based on these water table elevations, the shallow depth to bedrock, and the clayey glacial soils encountered, it was initially determined that these wells were not hydraulically connected. A lack of continuity between groundwater-bearing units is a common characteristic of glacial till deposits (Freeze and Cherry, 1979). However, based on a review of the Ohio Department of Natural Resources (DNR) maps entitled, "Potentiometric Surface of the Unconsolidated Aquifers in Cuyahoga County" and "Potentiometric Surface of the Consolidated Aquifers in Cuyahoga County", groundwater in both the unconsolidated (sand and gravels) and consolidated (bedrock) aquifers of the area of the former Nike Launch site generally flows in a westerly direction (Raab, 2005a; Raab, 2005b). A review of the water table elevations for wells MW-100 and MW-102 indicates that this data is consistent with the regional trend.

4. FIELD INVESTIGATION

The FSI analytical program is based on the results of the SI and regulatory agency comments. The following section describes methods and field procedures used to implement the sampling program, including soil borings, surface and subsurface soil sampling, well installation, well development, and groundwater sampling. FSI sample numbers, location, analysis, and detections exceeding screening values are provided on Table 4-1, and locations are shown on Figure 4-1. The concentrations for the detected constituents are listed in Tables 5-1 and 5-2.

In March 2005, the following activities were conducted:

- Background surface soil sampling;
- Boring installation;
- Monitoring well construction;
- Well development;
- Slug testing;
- Groundwater sampling;
- Location survey; and
- Chemical and physical analysis.

Follow-on activities included:

- Quality assurance/quality control (QA/QC) assessment;
- Data evaluation; and
- Statistical assessment.

Three groundwater, twelve surface soil, and three subsurface soil samples were collected from the former Launch Area as part of the field activities. Surface soil samples were collected from areas that were historically used as open space and were not impacted by Nike site activities. Three monitoring wells were installed and sampled. The field program centered on determining background PAH and metal concentrations in surface soil and characterizing groundwater quality. The SI and FSI sample locations are presented in Figure 4-1. FSI sample numbers, location, analysis, and detections exceeding screening values are provided on Table 4-1. Figure 4-2 depicts the sample locations in relation to the former Launch Area and current site features.

4.1 Sample Locations and Rationale

The location and analytical suite for the samples was determined based on the results of the SI, a review of aerial photographs of CL-59, and comments from Ohio Environmental Protection Agency (OEPA).

4.1.1 Soil Sampling

Surface soil samples were collected in order to identify contamination in the surface soil and to evaluate potential threats due to direct contact with surface soils. Background soil chemistry was determined using a random sampling approach. The number of samples required to establish background was calculated using the method specified in SW-846 (USEPA, 1996, Chapter 9) for a small sample set. A one-sided t-test with a 95 percent confidence level was used. The analysis revealed that 11 samples would be sufficient for establishing background for PAHs and only one for arsenic, but 12 background samples were collected to allow for possible analytical failure and to satisfy OEPA requests. Analytical and preparation methods are presented in Table 4-2.

Aerial photographs from 1952 through 1994 were analyzed to identify locations on the grounds of Cuyahoga Community College that were historically used as open space. Four areas were identified as not impacted by site activities. These areas were gridded and a random number generator was used to select background sample locations. Sample locations are shown on Figure 4-1. Surface soils for bulk density and porosity analysis were collected with a Shelby Tube.

The site and surrounding areas are described by the U.S. Department of Agriculture (USDA) as having deep, somewhat poorly drained Mahoning soil and urban land in broad undulating areas on till plains and on higher parts of lake plains. The areas with Mahoning soil and urban land are intricately mixed. This soil is typical of heavily disturbed areas. Low areas have been filled and leveled during construction, and other small areas have been cut up, built up, or smoothed (USDA, 1980). Soils at the site and the background sampling locations are all included in this soil description.

Three subsurface soil samples were collected to provide information on contaminant transport. The samples were collected with split-spoon samplers.

4.1.2 Groundwater

Groundwater samples were collected from the three monitoring wells to determine the presence of potential contaminants and to provide an indication of the overall groundwater quality at the site. Plans called for installation of four borings and construction of monitoring wells in each. Three of the borings were to be installed adjacent to the locations of former Nike buildings. These three boring locations closely matched the borings installed during the SI. The fourth boring was installed northwest of the site in an area believed to be upgradient of the Nike site and other areas where significant activities occurred.

Only three of the four planned wells were installed, as groundwater was not encountered at the Acid Fueling Station. As presented on the boring log for SB-103 (Appendix A), bedrock/refusal was encountered at 9 feet bgs at this location. This depth to bedrock is generally consistent with the reported depth to shale (ranging from 15 to 20 feet) in wells installed in the area (ODNR, 2005). Clayey soils (CL-SC) were present in this boring from land surface to 9 feet bgs. This location was dry during the SI and FSI activities. Following March 15, 2005 discussions with OEPA representative, Mr. Todd Fisher, it was determined that a monitoring well would not be installed at this location.

A monitoring well (MW100) was installed west of the former Crile Hospital and the Nike Launch Area in an area believed unaffected by historical activities. One monitoring well was installed adjacent to the former Missile Test and Assembly Building (MW101) location, and one was installed adjacent to the Missile Magazines (MW102).

The analytical suite for groundwater was selected based on knowledge of the materials typically used at Nike sites and the results from the groundwater and soil samples collected during the SI.

4.2 Boring Installation, Monitoring Well Construction, and Development

Three monitoring wells were installed as part of the FSI: two within the boundary of the former Launch Area and one in an area unaffected by historical activities at the site. These wells are being used to determine groundwater quality in the area. Four quarterly groundwater sampling events were performed; this report includes the results of the first event. The results of the second, third, and fourth quarter sampling events are summarized in Table 5-2, Section 6, and copies of the quarterly reports are included in Appendix G. A well was installed west of the former Crile Hospital and the former Nike Launch Area in a portion of the property with no previous activities of significance. One well was installed adjacent to the former Missile Test and Assembly Building location, and one well was installed just south of the Missile Magazines. The boring at the Acid Fueling Station was dry; therefore no well was installed. Well and boring locations are shown on Figures 4-1 and 4-2.

4.2.1 Boring Installation

Four soil borings were installed, and three were sampled as part of this project. Drilling and sampling equipment (split spoons) were decontaminated on arrival at the facility and between each groundwater monitoring well. The augers were steam-cleaned between holes and the split spoons were scrubbed with detergent and rinsed with deionized water between samples. Hollow-stem augers (HSAs) with an inside diameter (ID) of 4.25 inches were used for the borings, and standard split-spoon sample methods (ASTM D1586) were used to collect unconsolidated soil samples from the borings. HSA methodology was performed in accordance with ASTM D5784-95.

Three of the borings were installed adjacent to locations where borings with continuous split-spoon sampling were previously installed. Descriptions of the lithology at these locations were verified from the drill cuttings and split-spoon samples collected approximately every five feet. For all borings, soils were collected to provide samples for lithologic interpretation, or geotechnical analysis. A geologist supervised the installation of the soil borings. The geologist logged the subsurface conditions encountered in the boring and recorded the information on a soil boring log. Boring logs are included in Appendix A. Due to the presence of gravel, thin-wall samples from the saturated zone were not collected, and instead geotechnical samples were collected with split spoons. The samples were sent off-site for anion, soil porosity, bulk density, and grain-size analysis. Soil porosity, bulk density, and specific gravity are provided in Table 4-3. Grain-size analysis is provided in Appendix B. All investigation derived waste (IDW) generated during drilling and sampling activities was handled in accordance with the Field Sampling Plan (FSP).

4.2.2 Monitoring Well Installation

Boreholes for the monitoring wells were advanced in the unconsolidated residuum using the HSA drill method. A geologist supervised the drilling of each borehole. The screened interval for the wells is ten feet, and all wells were installed within the water table aquifer within the residuum. Upon reaching the total borehole depth, the wells were installed through the HSA. Monitoring wells were constructed of 2-inch ID, schedule 40 polyvinyl chloride (PVC), flush-threaded well casing, and 0.010-inch slotted well screen. A filter pack, consisting of 20/30 grade silica sand, was placed to approximately two feet above the screened interval in the wells. A two foot-thick layer of bentonite pellets was poured into the hole and hydrated with water to form a seal above the filter pack. The remaining annulus was grouted with a neat cement/bentonite (3 to 5 percent) mixture using the pump-down method.

Flush mount protective casings and padlocks were provided for the monitoring wells. A concrete pad measuring 3 by 3 feet by 0.5 foot was constructed and centered on the casing of each monitoring well.

Drilling and sampling equipment (split spoons) was decontaminated on arrival at the facility and between each groundwater monitoring well. Split-spoon samplers were decontaminated following the procedures discussed in the FSP.

A well installation diagram illustrating the depth of the boring, screen location, sand filter pack material, seal thickness, grout thickness, and other well construction information was prepared by the field geologist at the time of well installation. The well installation diagrams and boring logs are provided in Appendix A.

4.2.3 Well Development

After construction, each well was developed to restore the natural hydraulic characteristics of the aquifer nearby. Wells were developed by pumping or bailing. Equipment used in conjunction with well development was decontaminated in accordance with procedures described in the FSP. All purged water was containerized at the well site and handled in accordance with procedures presented in the FSP. During development, the pump inlet was moved through the entire screened interval in the well. Field sheets documenting the development are provided in Appendix A.

4.2.4 Slug Testing

Slug tests were performed on wells MW100 and MW102 to evaluate the hydraulic conductivity of the water-bearing unit. MW101 did not have an adequate water column to perform the test. ASTM field method D4044 for slug tests was used. The first step was to record the depth to groundwater at the well to be tested. A transducer was placed in the well near the bottom to record the changes in water elevation. The transducer automatically collected depth readings. Readings were measured on a logarithmic scale. The readings were very close together early in the process and became less frequent as the test went forward. A slug was placed in the well and the transducer recorded the rise in groundwater elevation as the slug was inserted and the groundwater gradually returned to the pre-slug level. Once the groundwater level stabilized, the transducer was reset and the slug was removed. The transducer recorded the drop in elevation and the gradual return to the original water level. Once the water level stabilized, the test was over. The data from the transducer were recorded electronically and evaluated using AQTESOLV.

4.3 Sample Collection

4.3.1 Soil Sampling

Twelve soil samples were collected to establish surface soil background chemistry. The soils were analyzed for metals, PAHs, anions, pH, total organic carbon (TOC), grain size, bulk density, and soil porosity. The need for metals and PAH analysis was based on exceedances in the on-site samples collected during the SI risk screening. The other parameters provide empirical data used in performing human and ecological risk characterizations if necessary. FSI sample numbers, location, analysis, and detections exceeding screening values are provided in Table 4-1, and locations are shown on Figure 4-1. The actual locations closely corresponded to those proposed in the work plans.

All surface samples were taken from the 0-to-12-inch depth interval using a stainless hand auger. A stainless steel spoon and bowl were used for homogenizing the soil samples before they were placed in containers. The sampling and mixing equipment was thoroughly decontaminated prior to use at each location.

Subsurface soil samples were collected from split spoons at depths ranging from 15 to 22 feet below ground surface (bgs). Intervals for individual samples are presented in Table 4-1. Soil characteristics and anion determinations were made. Soil characteristics are summarized in Table 4-3, and the full results are presented in Appendix B.

A geologist observed completion of all soil borings. The geologist logged the subsurface conditions encountered in the boring and recorded the information on a soil boring log.

4.3.2 Monitoring Well Sampling

Groundwater samples were collected from the three monitoring wells to determine the presence of potential contaminants and to provide an indication of the overall groundwater quality at the site. Groundwater samples were collected and shipped in pre-preserved containers provided by the laboratory. All wells were purged prior to sampling.

Prior to sampling, the depth to water and the total depth of the groundwater monitoring well were measured with an electrical probe and recorded. This information was used to calculate the volume of water in the monitoring well. All measurements were documented on the sample data sheet. Groundwater level measurements are summarized in Table 4-4.

Purging was accomplished using low-flow techniques to remove groundwater from the monitoring well using a peristaltic pump and new, decontaminated Teflon® tubing. All water removed was handled in accordance with Section 6 of the FSP. The tubing was replaced at each well.

Temperature, pH, turbidity, dissolved oxygen, oxidation reduction potential (ORP), and conductivity measurements were taken and recorded before, during, and after purging the well. Purging continued until measurements collected by in-line instrumentation stabilized to ± 10 percent for turbidity, ±0.2 pH units, ±5 percent for conductivity, and ±1°C for temperature over at least three successive measurements taken at 5-minute intervals. The volume removed was determined by direct measurement of the purged volume. The field data sheets are provided in Appendix A. Groundwater sample field parameters are summarized in Table 4-5.

Following the purging process and after disconnecting the flow through cell, samples were collected into appropriate sample containers at the end of the tubing, with the pump set for low flow. Groundwater VOC samples were collected during low-flow sampling with special care taken not to volatize the sample while filling the bottles.

Groundwater samples were collected to assess the presence of potential contaminants and to provide an indication of the overall groundwater quality at the site. Groundwater samples were analyzed for TAL metals, TCL VOCs, PAHs, and anions (phosphate, nitrate, nitrite, sulfate, fluoride, bromide, chloride). The samples were collected and containerized according to the volatility of the target analytes. Refer to Table 4-2 for preparation and analytical methods.

The turbidity of the purged groundwater from MW101 and MW102 was not less than 10 nephelometric turbidity units (NTUs), and therefore groundwater samples from these wells collected for metals analysis were field-filtered using dedicated 0.45-micron capsule filters attached to the end of the Teflon® tubing and allowing the water to flow into the sample collection bottle. Both filtered and non-filtered metals samples were collected at these locations. Field sheets documenting the sampling are provided in Appendix A.

4.3.3 Slug Testing

Slug tests were performed on wells MW100 and MW102 to evaluate the hydraulic conductivity of the water-bearing unit. MW101 did not have an adequate water column to perform the test. The calculated hydraulic conductivity for MW100 is 5.41 x 10^{-3} cm/sec and for MW102 is 8.97 x 10^{-2} cm/sec. The analysis is provided in Appendix D.

4.3.4 Investigation Derived Waste

Installation of the soil borings resulted in the generation of five 55-gallon drums of soil cuttings. Well development, sampling, and equipment decontamination generated five 55-gallon drums of aqueous waste. One soil sample (WSTSoil) and an aqueous waste (WSTH_2O) sample were collected from the drums and analyzed. Analytical results are presented in Appendix C. Both waste streams were nonhazardous and were disposed of at a properly permitted site by Better Management Corporation of Ohio. A copy of the non-hazardous waste manifest is included as Appendix H.

4.4 Surveying of Sample Locations

After installation, R.D. Zande & Associates, a registered land surveyor licensed to practice in Ohio, surveyed the monitoring wells and soil sampling locations. The Real-Time Kinematic Global Positioning System (GPS) survey was constrained to the existing National Geodetic Survey Control and is referenced to North American Datum 1983 horizontally and to North American Vertical Datum 1988 vertically. Final project coordinates are provided in Ohio State Plane Coordinates (Table 4-6). The Real-Time Kinematic Survey conforms to the geometric geodetic accuracy standards and specifications for using GPS relative positioning techniques, version 5.0, as published by the Federal Geodetic Subcommittee.

4.5 Sample Analysis

4.5.1 Chemical Analysis

Soil and groundwater samples were submitted for chemical analysis. The analytical methods used are identified on Table 4-2. The primary laboratory was Severn Trent Laboratories (STL) (North Canton, Ohio), with 10 percent sent to CompuChem (Cary, North Carolina) for quality assurance. Both laboratories hold current validation from the USACE Missouri River Division.

4.5.2 Quality Assurance/Quality Control Assessment

The elements of QA/QC applied in the course of the sampling and analysis program were (1) laboratory selection and certification; (2) pre-field planning and preparedness; (3) assessment of both field and laboratory activities during implementation; (4) collection and analysis of various field QC samples; and (5) third-party review of analytical data packages. The laboratories selected for the work were certified by the USACE for the analyses they performed.

A "readiness review" was conducted one week prior to the initiation of field activities to ensure that all necessary resources were available and that lines of communication were clearly established. In order to meet the QA objectives for this project, various field QC samples, including trip blanks, field duplicates, and QC split samples, were collected during sampling activities. The QA samples are used to verify sample collection techniques and sample integrity. A full discussion of the types, frequency, and use of QA samples is given in the Quality Assurance Project Plan (QAPP) (Plexus, 2001a). Analytical results from the trip blanks are presented in Appendix C. Chain of custody records are presented in Appendix E.

One triplicate sample was collected for every 10 media-specific (groundwater and soil) samples. Overall handling procedures for each portion are identical except that the first two portions are sent to the primary laboratory (Severn Trent Laboratories, North Canton) and the last is sent to QA laboratory (CompuChem, North Carolina) for external QA.

Data verification consists of a stringent review of each analytical chemical data package with respect to sample receipt and handling, analytical methods, data reporting, deliverables, and document control. The data were verified according to the USACE *Louisville Chemistry Guideline* (LCG), modified to reflect the level of review requested and the specific variances to the analytical method employed and the specific requirements of the Louisville District as indicated in Section 6 of the approved QAPP. The analytical methods were taken from SW-846

Test Method for Evaluating Solid Waste (USEPA, 1996), incorporating all of the then-current updates (i.e., Final Update III, July 1998). The applied data verification codes (Table 4-7) are further explained by reason codes (Table 4-8), which indicate the type of QC failure that leads to the application of the validation flag. The laboratory also applies flags (Table 4-9) to its data to call attention to various aspects of the results.

Analytical data received from both the primary (STL, North Canton) and QA (CompuChem) laboratories were subject to data review procedures as described in the approved QAPP. Those requirements were summarized in tables incorporated into the QAPP, which were used as checklists in the course of the review. The review incorporated agreed-upon variances previously negotiated between STL, Plexus, and the District.

To summarize the methodology applied in the review, data packages were received in both hard copy and electronic forms. The documents were reviewed for completeness, and any anomalies observed were resolved with the laboratories in the course of the data review. Each data package was broken down into subunits corresponding to the QC Requirements tables in the QAPP. Each subunit was compared point by point to the specifications described therein. If an anomaly was observed, the reviewer, generally following the guidelines provided in the tables, applied data-qualifying flags to the affected results. In some instances, which will be discussed in more detail below, the reviewer has applied professional judgment to modify some of the flagging specifications.

The QA laboratory (CompuChem) failed to perform the required method detection limit (MDL) and reporting limit (RL) standard verifications called for in the LCG and the QAPP. Although this is considered a serious oversight, the balance of the QC for those data packages displayed generally normal performance characteristics, and the data were still used to compare to the QA split samples analyzed by STL. Further discussion of QA split sample results follows.

The data from the primary laboratory, STL, also displayed generally acceptable performance. No data were rejected. Minor anomalies of note include the following:

- Three data points (0.8%) of the soil metals data were flagged “U” due to blank contamination.
- Sixty-two soil metals data points (16.9%) were flagged either “J” or “UJ” due to a combination of negative blank results, contract required detection limit (CRDL) recovery outside control limits, or various indications of matrix interference (e.g., matrix spike recovery, serial dilutions, duplicates).
- Thirty-six of the soil wet chemistry data points (9.8%) were flagged “J” due to either holding time or matrix spike anomalies.
- For aqueous metals, 21 data points (14.4%) were flagged “U” due to one form or another of blank contamination.
- For aqueous VOCs, four data points were flagged “J” and four were flagged “U” due to minor calibrations anomalies or blank contamination, respectively.
- For aqueous anions, 9 of 28 data points were flagged “J” due to matrix spike recovery anomalies.

The STL data displayed some anomalies in the RL Standard tests as well. However, applying professional judgment, the reviewer assigned these observations to the category of "sporadic marginal failures" as they were few in number, displayed positive bias, and were most frequently associated with non-detects. Thus, no data flags were applied.

Assessment of field duplicates and QA splits displayed excellent comparability between results with the exception of PAH data. One of two PAH field duplicates for soils displayed excessive variability, and both QA split samples displayed significant differences for most analytes. The data from the QA laboratory must be used cautiously due to the failure to analyze MDL and RL standards; nonetheless, it is apparent that there is significant variation in the PAH results. However, as the data from the primary laboratory (STL) display a positive bias relative to that from the QA laboratory, the use of these data may be considered conservative and has no significant bearing on data interpretation.

4.6 Data Evaluation

In order to streamline the risk decision-making process for screening COPCs at the site, USACE agreed with OEPA during the SI to compare the levels of constituents detected to the USEPA Region 9 PRGs (USEPA, 2004). PRGs are risk-based tools for evaluating and cleaning up contaminated sites. As part of the SI, PRGs have been compared point by point to the detected levels of contaminants to identify the COPCs. The point-by-point comparison is an extremely conservative method for identifying COPCs as more compounds are identified for further evaluation. The FSI analytical suite was selected to evaluate the detections against the SI COPCs.

The USEPA Region 9 PRGs are chemical concentrations that correspond to fixed levels of cancer risk (i.e., 1E-6) or a noncarcinogenic hazard quotient of one. For exposure to multiple chemicals across multiple pathways, the OEPA Office of Federal Facilities Oversight uses the target risk level of 1 E-5 (cumulative risk level) and the hazard quotient of 1 as the acceptable target levels for establishing acceptable cleanup goals for unrestricted reuse. Therefore, the whole Region 9 PRG value for carcinogenic constituents was used for screening analytical data and selecting COPCs for human health, and the Region 9 PRGs for noncarcinogenic constituents were adjusted by 1/10th of the Region 9 PRG value to ensure that the threshold of 1 (i.e., HQ = 1) is not exceeded as a result of exposure to multiple chemicals affecting the same target organ (i.e., assuming additivity).

The Region 9 PRGs combine current USEPA toxicity values with "standard" exposure factors to estimate contaminant concentrations in environmental media (soil, air, and water) that are considered protective of humans, including sensitive groups, over a lifetime. Chemical concentrations above these levels would not automatically designate a site as "dirty" or trigger a response action. However, exceeding a PRG suggests that further evaluation of the potential risks that may be posed by site contaminants is appropriate. Further evaluation may include additional sampling, consideration of ambient levels in the environment, or a reassessment of the assumptions contained in these screening-level estimates (e.g., appropriateness of route-to-route extrapolations, appropriateness of using chronic toxicity values to evaluate childhood exposures, appropriateness of generic exposure factors for a specific site).

Groundwater detections exceeding the screening values were also compared to the Safe Drinking Water Act MCLs. MCLs are the maximum permissible level of a contaminant in water delivered to users of a public water system.

4.7 Statistical Assessment

A statistical assessment comparing background to on-site concentrations of metals and PAHs for surface soil samples was performed. The assessment was carried out as follows:

First, an assessment was made of the frequency of non-detects in the data in order to determine the best approach for handling censored results. For the metals data, the vast majority of results were non-detects, with thallium posing the only significant exception. Thus, a substitution approach was applied to both the on-site and background data for the metals using one-half the RL in place of any reported non-detects. The vast majority of PAH data were non-detects. However, a comparison of the historical data to the present background data showed that the same pattern was observed in the on-site data and that the RLs used were approximately the same in both cases. Thus, the RLs were used in place of non-detects for both the background and on-site data.

Next, the distribution of the data was assessed using the Shapiro-Wilk test. While the background data displayed a reasonable degree of normality for most analytes, the on-site data displayed no discernible distribution pattern. This was true of the log-transformed data as well. Thus, a non-parametric approach to the comparison was used.

The Statistica® statistical analysis software was employed for this purpose. The data were sorted into two groups (background and on-site) for both the metals and the PAHs. Descriptive statistics were generated including a 95 percent Upper Confidence Limit (UCL), which was used as a secondary means of assessment. Appendix F provides the results of the Mann-Whitney U-test employed for this assessment. The U-test is a modification of the Rank sum test and is recommended as the most appropriate non-parametric method for comparing measures of central tendency (i.e., the median) between data sets of small to modest size (USEPA, 2002). The results of the statistical analysis are discussed in Section 6 of this FSI.