Department of Energy
Washington, DC 20585

MND 1012

April 26, 2019

Mr. David Seely
Remedial Project Manager
Region 5 -SR-6J
US Environmental Protection Agency
77 West Jackson Boulevard
Chicago, IL 60604

Mr. Brian Nickel
EPA Supervisor, DERR
Ohio Environmental Protection Agency
401 East Fifth Street
Dayton, OH 45402

Subject: Final *Vapor Intrusion Assessment: Phase I Preliminary Screening and Conceptual Model for the Mound, Ohio, Site*

Dear Mr. Seely and Mr. Nickel:

Enclosed is the Department of Energy Office of Legacy Management (DOE-LM) final *Vapor Intrusion Assessment: Phase I Preliminary Screening and conceptual Model for the Mound, Ohio, Site* (LMS/MND/S15736) dated March 2019, transmitted to the U.S. Environmental Protection Agency (EPA) and Ohio EPA on March 19 for approval.

On April 3, the Ohio EPA provided a concurrence letter stating it had no comments on the report and on April 4, the EPA provided a concurrence letter stating it had no comments on the report. DOE-LM acknowledges the EPA provided observations regarding future vapor intrusion assessment efforts and I plan to implement the suggestions provided. This report will be placed in the Comprehensive Environmental Response, Compensation and Liability Act Administrative Record for the Mound, Ohio, Site, which is available on the DOE-LM public website at www.lm.doe.gov/mound.

Please call me at (513) 648-3333 if you have any questions or require additional information. Please send any correspondence to:

U.S. Department of Energy
Office of Legacy Management
10995 Hamilton-Cleves Hwy.
Harrison, OH 45030

Sincerely,

SUSAN SMILEY

Digitally signed by SUSAN SMILEY
DN: c=US, o=U.S. Government, ou=Department of Energy, cn=SUSAN SMILEY, 0.9.2342.19200300.100.1.1=8900100223787
Date: 2019.04.26 09:16:15 -04'00'

Susan Smiley
Mound Site Manager

Enclosure

cc w/o enclosure:
G. Hooten, DOE-LM (e)
B. Zimmerman, DOE-LM (e)
B. Cato, Navarro (e)
M. Lutz, Navarro (e)
J. Massie, Navarro (e)
DOE Read File
File: MND 0100.02 (records)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

Transmitted via Email correspondence

SR-6J

Ms. Susan Smiley
Mound Site Manager
U.S. Department of Energy
Office of Legacy Management
10995 Hamilton-Cleves Hwy.
Harrison, Ohio 45030

Subject: Concurrence Letter – Final Vapor Intrusion Assessment: Phase I Preliminary Screening and Conceptual Model for the Mound, Ohio, Site dated March 2019

Dear Ms. Smiley:

Thank you for your March 18, 2019 letter received via email transmitting the Final Vapor Intrusion Assessment: Phase I Preliminary Screening and Conceptual Model for the Mound, Ohio, Site. As noted in my February 25, 2019 email, U.S. Environmental Protection Agency (EPA) had reviewed the final draft of this report and had no further comments.

However, EPA noted a few observations during the review and requests DOE implement the suggestions below to ensure the decisions made within the document are not overlooked during future site or remedy evaluations or discussions.

The document identified areas which were screened out areas for further evaluations due to conditions which do not support future construction of buildings. Given that these areas do not include institutional controls preventing construction, DOE should verify the conditions of these areas during future Five-Year Reports evaluating the protectiveness of the implemented remedies to ensure these determinations remain valid.

Additionally, the document states that Phase II sampling will be deferred for Area 6. EPA recommends that Area 6 be carried into the Phase II sampling plan notating this deferral decision. A brief statement explaining the deferral and a reference back to this report for justification is expected to be sufficient. This deferral should also be carried through future Five-Year Review reports until this concern has been fully evaluated.

Please contact me if there are any questions or concerns.

Sincerely,

David P. Seely
Remedial Project Manager
Superfund Division
United States Environmental Protection Agency

ec: Brian Zimmerman, LM DOE
Melissa Lutz, Navarro, Mound Site Lead
Brian Nickel, Ohio EPA
Paul Lucas, US DOE-EMCBC

Ohio Environmental Protection Agency

Mike DeWine, Governor
Jon Husted, Lt. Governor
Laurie A. Stevenson, Director

April 3, 2019

Ms. Sue Smiley
Site Manager, Fernald Preserve
U.S. Doe, Office of Legacy Management
10995 Hamilton-Cleves Highway
Harrison, Ohio 45030

Re: DOE Mound Facility, Miamisburg
Remediation Response
Project Records
Remedial Response
Montgomery County
557000864003

Subject: Concurrence Letter - Final Vapor Intrusion Assessment: Phase I Preliminary Screening and Conceptual Model for the Mound, Ohio Site (LMS/MND/S15736), dated March 2019

Dear Ms. Smiley:

The Ohio Environmental Protection Agency (Ohio EPA) has completed our review of the "*Final Vapor Intrusion Assessment: Phase I Preliminary Screening and Conceptual Model for the Mound, Ohio Site, dated March 2019*". Ohio EPA has no additional comments. Should you or members of your staff have any questions or concerns, please do not hesitate to contact me at (937) 285-6468 or Brian.Nickel@epa.ohio.gov.

Sincerely,

Brian Nickel
Supervisor,
Division of Environmental Response and Revitalization
Remedial Response/Federal Facility Oversite Sections

ec: Brian Zimmerman, LM DOE
Melissa Lutz, Navarro, Mound Site Lead
Anthony T. Campbell, Site Coordinator, DERR-SWDO
David Seely, Remedial Project Manager, U.S. Environmental Protection Agency
Katie Moore, Geologist, DERR-SWDO
Charles Mellon, Senior Site Coordinator, DERR-SWDO

BN/bp

LMS/MND/S15736

MND 1012

Vapor Intrusion Assessment: Phase I Preliminary Screening and Conceptual Model for the Mound, Ohio, Site

March 2019

U.S. DEPARTMENT OF ENERGY | Legacy Management

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Abbreviations

BTEX	benzene, toluene, ethylbenzene, and xylene
BVA	Buried Valley Aquifer
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CSM	conceptual site model
cVOC	chlorinated volatile organic compound
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ERS	effluent recovery system
ft	feet
Hg	mercury
Hg^0	elemental mercury
IC	institutional control
lb	pounds
LM	Office of Legacy Management
MCL	maximum contaminant level
MDC	Mound Development Corporation
µg/L	micrograms per liter
mg/kg	milligrams per kilogram
mL	milliliters
MNA	monitored natural attenuation
ODH	Ohio Department of Health
Ohio EPA	Ohio Environmental Protection Agency
OU-1	Operable Unit 1
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PP	Plutonium Processing
P&T	pump and treatment
QAPP	Quality Assurance Project Plan
ROD	Record of Decision
RRE	residual risk evaluation
SAP	Sampling and Analysis Plan
SM	Special Metallurgical

TCE	trichloroethene
VC	vinyl chloride
VI	vapor intrusion
VISL	vapor intrusion screening level
VOC	volatile organic compound

1.0 Introduction

During the *Fourth Five-Year Review for the Mound, Ohio, Site* (DOE 2016), a review of historical sampling data indicated the presence of vapor-forming chemicals in the subsurface at the Mound site, at least as of the date of sampling. Some samples were taken prior to environmental remediation of the Mound site; therefore, they may not be representative of current site conditions, as many contamination sources have since been removed. Information reviewed at the time of the fourth Five-Year Review was not sufficient to evaluate whether there were complete exposure pathways under current or reasonably expected future conditions. The information reviewed did not prompt any immediate response actions but did require that this assessment report be provided to the Mound Core Team to summarize the historical data and determine whether future actions are required and, if there are, include a schedule for that work.

A *Vapor Intrusion Assessment Work Plan at the Mound, Ohio, Site* (DOE 2017) (Work Plan) presented the approach for ascertaining whether there were complete vapor intrusion (VI) exposure pathways at the Mound site and, if there were, whether exposures pose a risk to occupants in buildings (current or future). Due to the many variables that can influence the migration of vapors from the subsurface into buildings and structures, multiple lines of evidence are used to adequately evaluate whether VI pathways are complete. This assessment uses a phased approach to identify locations of potential vapor sources (soil and groundwater) and pathways that may warrant additional characterization. The three phases identified in the Work Plan are:

- Phase I—Preliminary Screening and Conceptual Site Model Development
- Phase II—Vapor Source Characterization and Building Foundation Assessment
- Phase III—Near-Building and Indoor Air-Quality Determination

This assessment report details the initial conceptual site model (CSM) for the Mound site and the results of the Phase I screening of historical soil, groundwater, and soil-gas data. Preliminary screening included several steps to determine what contaminants would be retained for further evaluation in later phases and what areas of the site would require additional characterization. Details for any additional investigation and an associated schedule for completion are also included. Updates on additional activities and the schedule will be provided to the Core Team during routine meetings.

2.0 Preliminary Conceptual Site Model

A CSM is being developed based on available data as part of the assessment of potential VI pathways at the Mound site. The CSM evaluates actual or predicted relationships between vapor-forming contaminants at the site and receptors. It includes locations of contaminated soil and groundwater, transport mechanisms, possible subsurface migration routes, and potential receptors. The purpose of this CSM is to provide site-specific information that will be used to determine whether pathways can be considered complete. A complete VI pathway indicates that there is an opportunity for human exposure, which warrants further analysis to determine whether there is a basis for undertaking a response action.

This preliminary CSM presents a summary of available information about the Mound site for an initial determination of potential vapor exposure pathways or identification of data gaps. This preliminary information includes the historical use of the site, contamination and remedial actions, hydrogeology, and future land-use plans. The CSM is a dynamic tool that will be updated as new information becomes available or its scope is narrowed to focus more on areas of concern. Updated information may include more detailed information about soil type, occurrence of and depth to groundwater, distribution of vapor-forming constituents in soil and groundwater, locations of utility lines, and distance of sources from buildings or future building areas. Existing buildings will be assessed to determine the susceptibility for vapor entry and this information will be added to the CSM, as appropriate.

2.1 Site Description

The Mound site is located in Miamisburg, Ohio, approximately 10 miles southwest of Dayton, and currently consists of 11 buildings on 306 acres of land (Figure 1). The Mound Plant operated as an integrated research, development, and production facility in support of the U.S. Department of Energy (DOE) nuclear weapons and energy program. At one time, the plant consisted of 130 buildings and the primary production facilities were on the Main Hill and on the Special Metallurgical/Plutonium Processing (SM/PP) Hill. The project had an extensive history of manufacturing and working with non-nuclear energetic materials, such as explosives, pyrotechnics, and thermites. Other processes included precision machining and the manufacture of plastics and ceramics, weapons components, flexible circuits, and rare gases.

Operable Unit 1 (OU-1) is located in the southwestern portion of the Mound site. It encompassed a historical waste disposal area (landfill) and the plant production wells (removed from service in 2005). Volatile organic compounds (VOCs) were detected in the groundwater in this area. There were both radiologically and chemically contaminated soil and materials within the OU-1 area, however, it was determined that excavation of the landfill was not warranted under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Under two actions that were not associated with CERCLA, the landfill was excavated to allow for development of the area and this work was completed in 2010.

Three areas of the site have remedies that address VOC and tritium contamination in the underlying groundwater. These areas and their associated contaminants of concern are listed in Table 1 below:

Table 1. Contaminants in Groundwater by Area

Area	Remedy	Goals for Contaminants
Phase I	MNA	Attain MCLs for trichloroethene and *cis*-1,2-dichloroethene in bedrock groundwater and one seep
Parcels 6, 7, and 8	MNA	Attain MCLs for trichloroethene and tritium in groundwater and seeps
OU-1	P&T	Hydraulic capture of VOC-impacted groundwater, treatment, and disposal

Abbreviations:
MCL = maximum contaminant level
MNA = monitored natural attenuation
P&T = pump and treatment

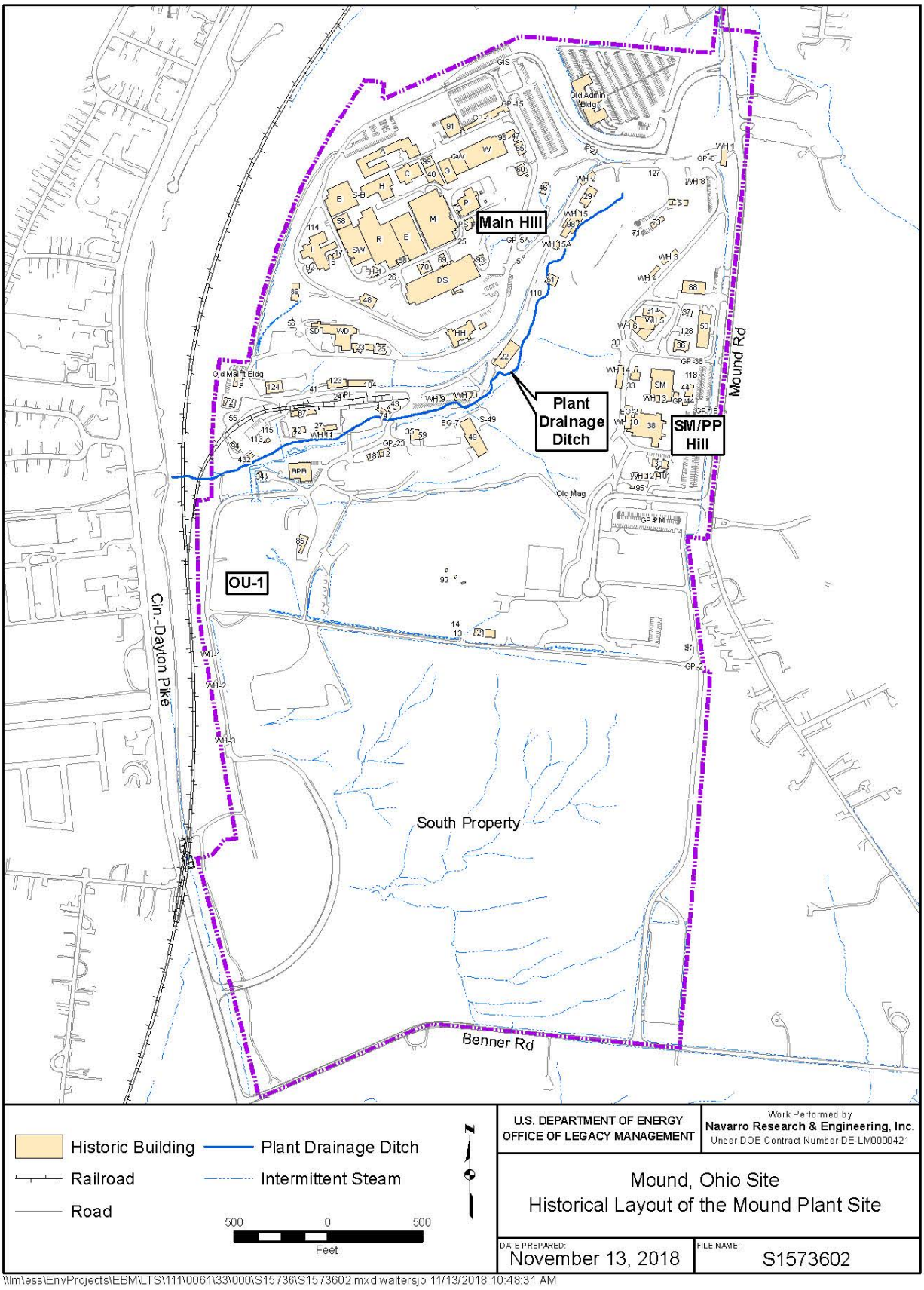

Figure 1. Historical Layout of the Mound Plant Site

2.2 Contamination

Beginning in 1948, the Mound site operated as an integrated research, development, and production facility that supported the nation's nuclear weapons and energy programs. Programs at the Mound site investigated the chemical and metallurgical properties of several radioisotopes for weapon and non-weapon use. The weapons program mission included process development, production, engineering, manufacturing, and surveillance of detonators, explosives, and nuclear components. During these operations, radiologically and chemically contaminated materials were released to the environment. Contamination was not widespread across the site; rather, contamination was limited to discrete areas associated with the production and manufacturing buildings, utility lines, and storage and disposal areas. The primary sources of contaminants were categorized into five groups:

- Drums, tanks, and waste lines
- Landfill and other covered disposal sites
- Retention basins and wastewater treatment system
- Surface disposal sites
- Buildings or operations areas

Each of these primary sources had associated soils that were either radiologically or chemically (or both) contaminated as a result of spills, leaks, leaching, infiltration, overflow, or runoff. Groundwater was impacted by liquids leaking from these primary sources or via infiltration of water through the associated contaminated soils.

As part of the remediation of the Mound site, DOE removed buildings, slabs, soils, underground tanks, and utility lines. The site was divided into release blocks or parcels, which were contiguous tracts of property designed for transfer of ownership (Figure 2). The Mound 2000 CERCLA cleanup process was developed as a framework for evaluating human health risks associated with residual levels of contamination and to provide an approach for remediation of the site. Under this process, each potential release site was evaluated by the Core Team, which recommended appropriate responses, including no further action. The soil on the property was remediated to the U.S. Environmental Protection Agency (EPA) risk-based standards for industrial/commercial use. Groundwater in three areas of the Mound site is currently being remediated to maximum contaminant levels (MCLs) via monitored natural attenuation (MNA) (Phase I and Parcels 6, 7, and 8) or a pump and treatment (P&T) system (OU-1/Parcel 9). As of September 2014, the OU-1 P&T was placed on standby in order to conduct the OU-1 Enhanced Attenuation Field Demonstration, which concluded in September 2018. The P&T system remains in standby mode as the Core Team evaluates the remedy.

As of August 2006, DOE had completed all soil and building remediation at the Mound site, except for the staging area where waste was loaded into rail cars. The staging area was remediated in December 2009. DOE received additional funding to perform two non-CERCLA removal actions at OU-1 to excavate the site's sanitary landfill. The overflow pond adjacent to the landfill was removed, and underground storm water drainage systems were installed north and south of the former landfill. This work was done intermittently from 2006 through 2010. All areas were sampled to verify that cleanup levels for radiological and chemical constituents were reached.

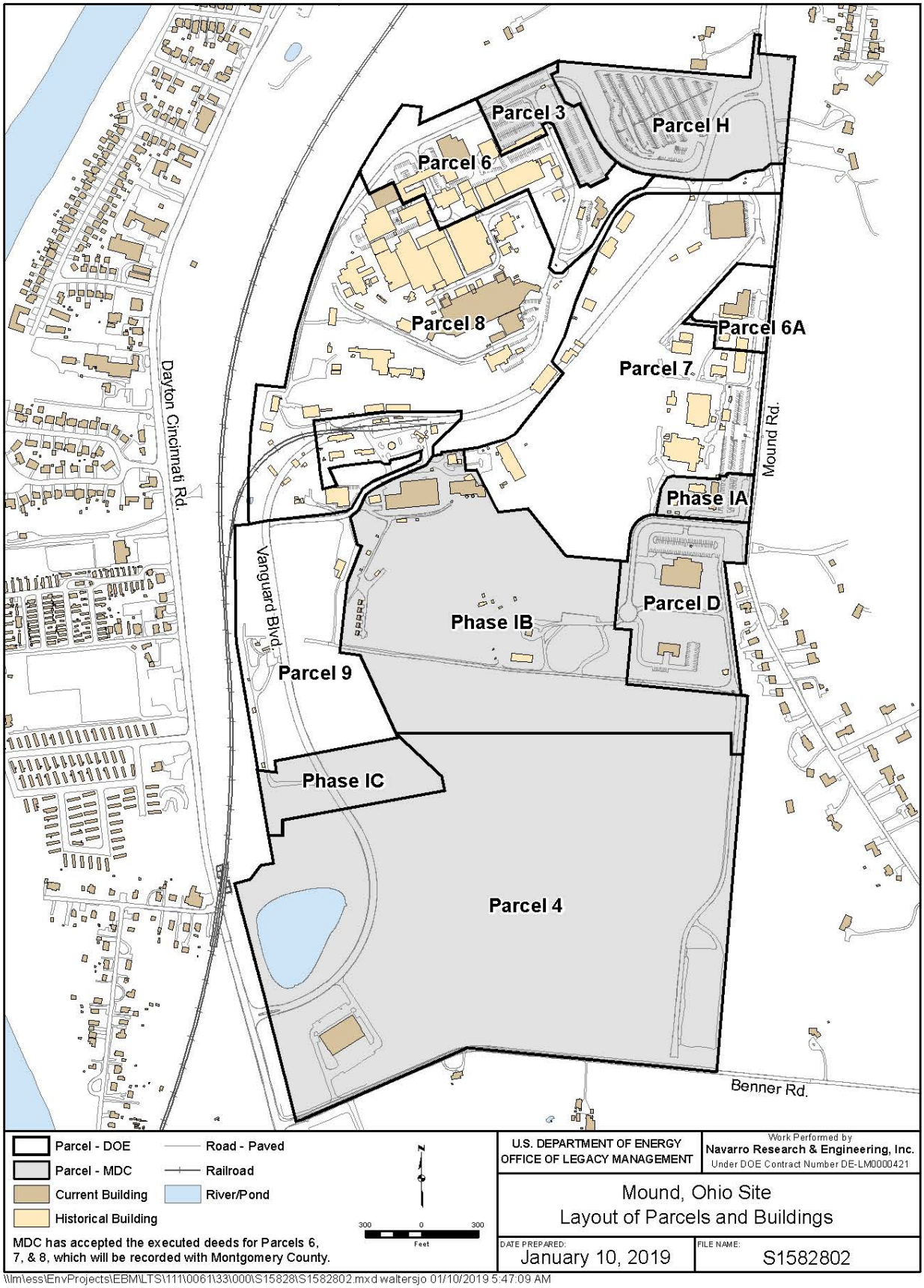

Figure 2. Layout of Parcels and Buildings

2.3 Site Hydrogeology

The Mound site sits atop an elevated area overlooking the city of Miamisburg, the Great Miami River, and the river plain to the west. A thin tributary valley divides the two main portions of the Mound site and contains an intermittent stream that drains to the river. Site elevations vary from 700 to 900 feet (ft) above sea level; most of the site is above 800 ft. The typical non-flood stage of the Great Miami River is 682 ft. A western portion of the Mound site overlies the edge of the Buried Valley Aquifer (BVA), a highly productive sole-source aquifer. The surficial geology near the Mound site consists of some exposed bedrock, unconsolidated deposits (alluvium, glacial till, and glacial outwash), and related soils.

The aquifer system at the Mound site consists of two different hydrogeologic environments: groundwater flow through the bedrock beneath the topographically higher eastern portions of the plant site (i.e., the Main Hill and the SM/PP Hill), and groundwater flow within the unconsolidated glacial deposits and alluvium associated with the BVA in the Great Miami River valley (Figure 3).

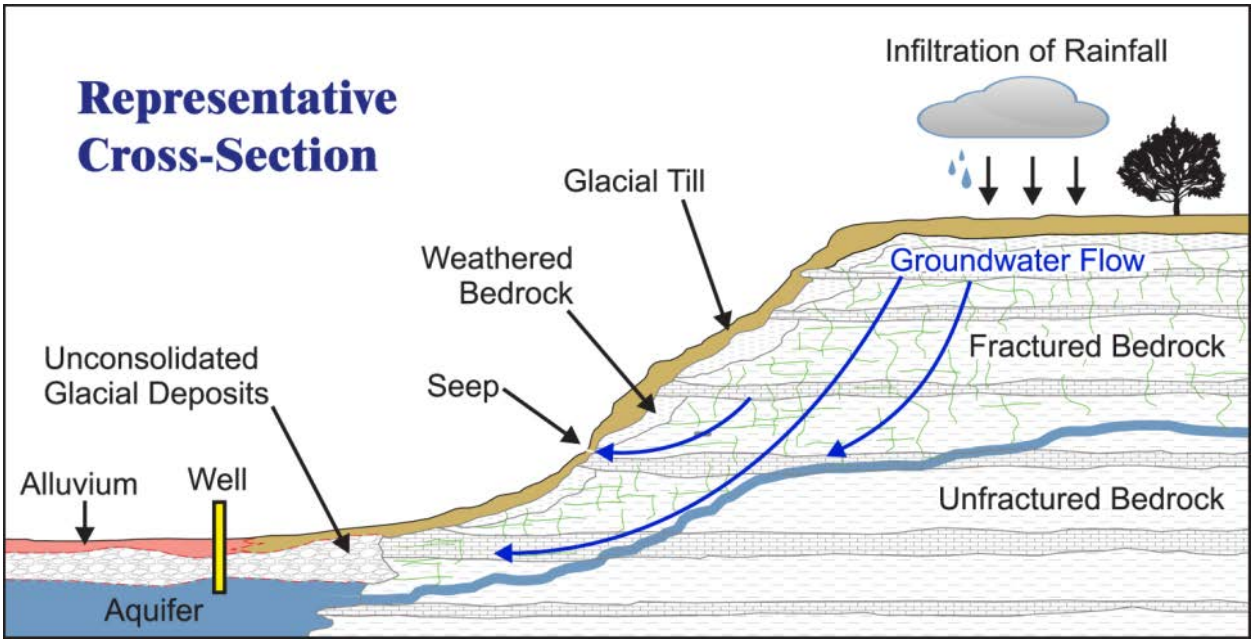

Figure 3. Generalized Cross-Section of the Mound Site Aquifer System

Limestone bedrock underlying the Mound site consists of thinly interbedded shale and limestone layers that control groundwater flow. The limestone beds range from 2 to 6 inches in thickness and generally comprise less than half of the bedrock unit. The shale beds vary from 1 to 8 ft thick. The bedrock flow system is dominated by fracture flow and is not considered a highly productive aquifer. The surface of the bedrock is a preglacial erosional surface that is weathered and has secondary permeability. This permeable weathered zone varies in thickness but grades rapidly into essentially impermeable material.

Glacial till is predominant on the Main Hill and the SM/PP Hill, overlying the bedrock. The till is composed of an unsorted, unstratified mixture of clay, silt, sand, and coarser materials. These materials typically have low permeability. The till ranges from less than 1 ft thick to more than 40 ft thick at the Mound site.

Along the western side of the site and in the tributary valley, the bedrock is overlain by both glacial outwash and alluvial deposits associated with the BVA. The outwash materials within the BVA thin both to the north and east in the OU-1 area as the buried valley bedrock wall elevation increases. The outwash is composed of well to moderately well sorted sand and gravel and the alluvium is mostly overbank deposits consisting of stratified fine sands, silts, and clays deposited along the southwestern portion of the site.

The overburden material on the Main Hill and SM/PP Hill are derived from glacial tills and have relatively low permeability due to the presence of silts and clays. The outwash materials in the tributary valley and OU-1 area are heterogeneous resulting from intermixed layers of sand, silt, and clay and the permeability can be variable.

Groundwater occurs between 50 and 60 ft below the surface on the Main Hill and between 20 and 30 ft below the surface on the SM/PP Hill. The bedrock structure is dominated by horizontal bedding that can control the movement of groundwater flow as well as limit the vertical migration of vapors.

The outwash materials are dominated by porous flow with interbedded gravel deposits providing the pathway for water movement. Groundwater occurs between 20 and 40 ft below the surface in the BVA and between 30 and 45 ft below the surface in the tributary valley.

2.4 Land Use

Institutional controls (ICs) restrict the land use of the site to commercial or industrial use only. ICs are described as restrictions and covenants in the quitclaim deeds or as activity and use limitations in the Environmental Covenant. ICs are also included in the general purpose lease agreement between DOE's Office of Legacy Management (LM) and the Mound Development Corporation (MDC) and passed on to any lessees. ICs run with the land through subsequent property transfers. Quitclaim deeds with environmental summaries, CERCLA Section 120(h) summary notices of hazardous substances, and environmental covenants are recorded with the Montgomery County, Ohio, Recorder's Office to ensure that future property owners are aware of the requirements and rationale behind each IC and quitclaim deed restriction.

The Mound site remedy includes the following ICs:

- Maintenance of industrial/commercial or commercial land use and prohibition against residential land use
- Prohibition against the use of groundwater without prior written approval from the EPA and the Ohio Environmental Protection Agency (Ohio EPA)
- Prohibition against the removal of soil from within the original Mound site boundary to offsite locations without prior written approval from EPA, Ohio EPA, and the Ohio Department of Health (ODH)

- Prohibition against the removal of concrete floor material in specified rooms of T Building to offsite locations without prior written approval from EPA, Ohio EPA, and ODH
- Prohibition against the penetration of concrete floors in specified rooms of T Building locations without prior written approval from EPA, Ohio EPA, and ODH
- Allowing site access for federal and state agencies for the purpose of sampling and monitoring

2.4.1 Current Onsite Land Use

MDC has accepted ownership responsibility for approximately 92% of the site that is now known as the Mound Business Park. MDC actively markets buildings and unoccupied land for reuse. It has replatted the site into multiple lots, as shown on the conceptual lot layout plan in Figure 4. As detailed in the *Comprehensive Reuse Plan Update* (MMCIC 2003), the conceptual lot layout is intended to make the best possible use of the site's natural and physical characteristics, provide lot sizes and arrangements that optimize the buildable area on each lot, minimize common areas that require maintenance, and protect and link open green space. The open green space encompasses those areas that are least suitable for building, due to steep slopes.

LM plans to retain ownership of remaining areas within Parcel 9 (of which OU-1 is a portion) that are currently leased to MDC until the OU-1 groundwater remedy is completed. LM has jurisdictional responsibility for the entire Mound site and this facilitates LM's ability to ensure that the selected remedies remain functional and effective so that conditions at the site remain protective of human health and the environment. This jurisdictional responsibility includes not only properties still owned by LM, but all areas within the original Mound site boundary.

2.4.2 Future Onsite Land Use

There are no restrictions on future sales of property, although there are ICs that restrict certain activities at the Mound site, as discussed above. Figure 4 depicts the current lot layout developed by MDC for property sales; however, future sales of property at the Mound site could result in changes to the layout. The areas shaded in green in Figure 4 (i.e., conservation areas) are areas that MDC identified as unsuitable for future construction, whereas the remainder of the site is considered suitable for construction. A separate evaluation for building suitability was performed by LM for this VI assessment. This evaluation took into account site topography and depth to bedrock and indicated that the conservation areas shown in Figure 4 correspond to areas where there are excessive slopes or shallow bedrock. The evaluation used the assumption that areas with slopes less than 10% require minimal site preparation (i.e., excavation or backfilling) and areas with slopes between 10% and 20% require moderate site preparation. Areas with slopes greater than 20% would require more extensive site preparation. These conservation areas meet the requirements of the Ohio Building Code (*Ohio Administrative Code* 4101:1) and the *Planning and Zoning Code of the City of Miamisburg, Ohio* 1272.08(i)(2) that stipulate buildings should not be located on or in areas with slopes that exceed 30%.

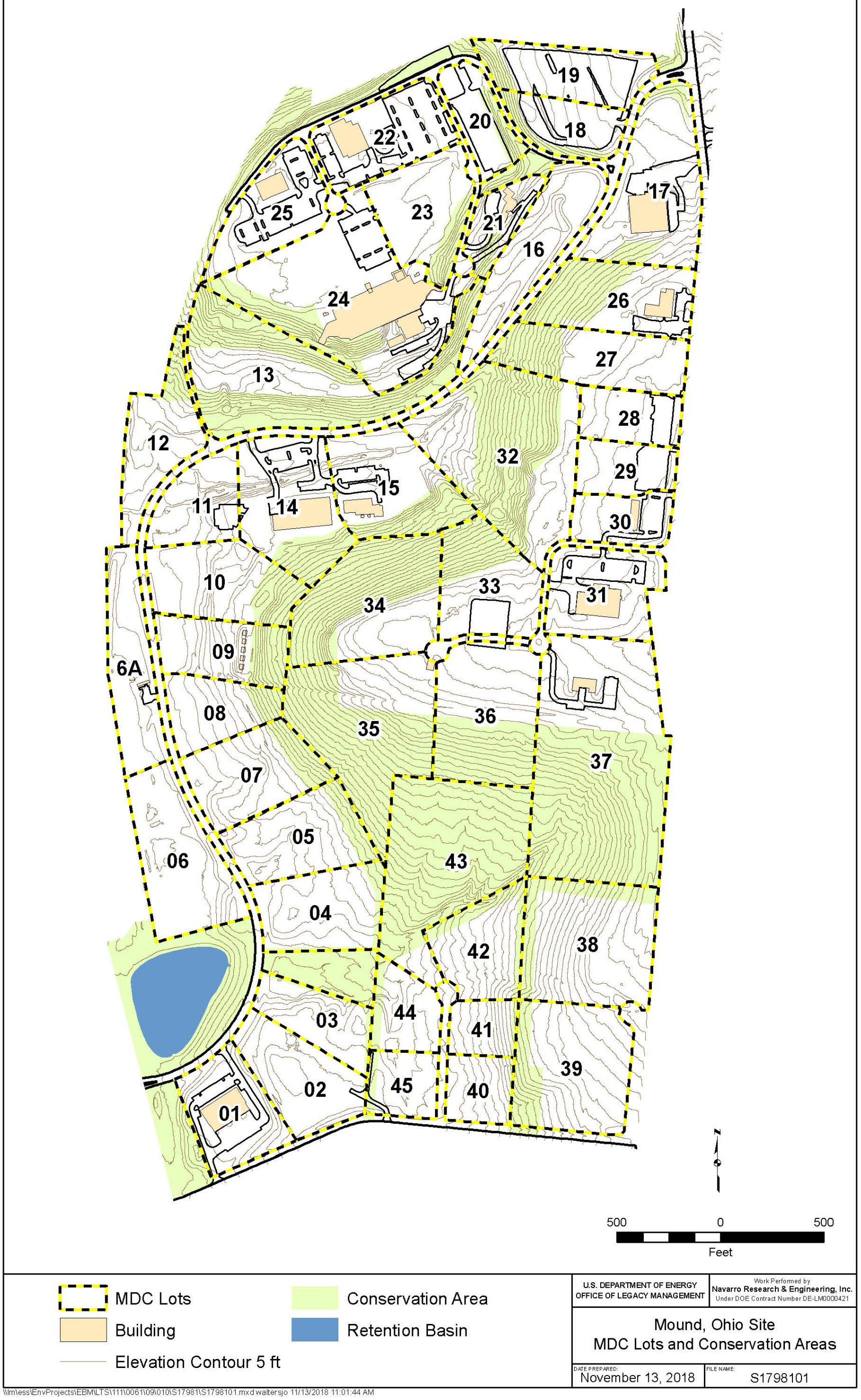

Figure 4. MDC Lots and Conservation Areas (from MMCIC 2003)

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The assumption for this VI assessment is that future buildings will be of a typical commercial/industrial design consisting of either slab foundations or a single story basements or service vaults (e.g., service lifts, elevators, etc.). Areas where excessive excavation to accommodate deeper basements or grading, typically areas where slopes are greater than 20%, were not considered suitable for building and were not included in this VI assessment; these are the areas depicted in green on Figure 4 (these include areas on or near slopes that exceed 30% where city and state building codes do not allow construction).

2.4.3 Offsite Land Use

The area surrounding the site is a mix of residential areas, parks, recreational areas, business, and light industry. Review of the surrounding land use will be used to evaluate potential offsite VI receptors. If it is determined there is a potential for vapor sources to impact offsite properties, then these areas will be evaluated as residential properties (to which the most stringent standards apply).

Figure 5 shows the current zoning for areas that surround and are part of the Mound site. There are residential properties adjacent to the site along the northeast boundary and the southeastern boundary. Many of the remaining properties that are adjacent to the site are zoned as residential, but are not used as residential. These areas include the Mound Golf Course and Miamisburg Mound Park, both located east of the Mound site on Mound Road, and the Miamisburg Community Park located along the western boundary of the site. Agricultural and light industrial parcels are along Benner Road to the south and southeast of the Mound site.

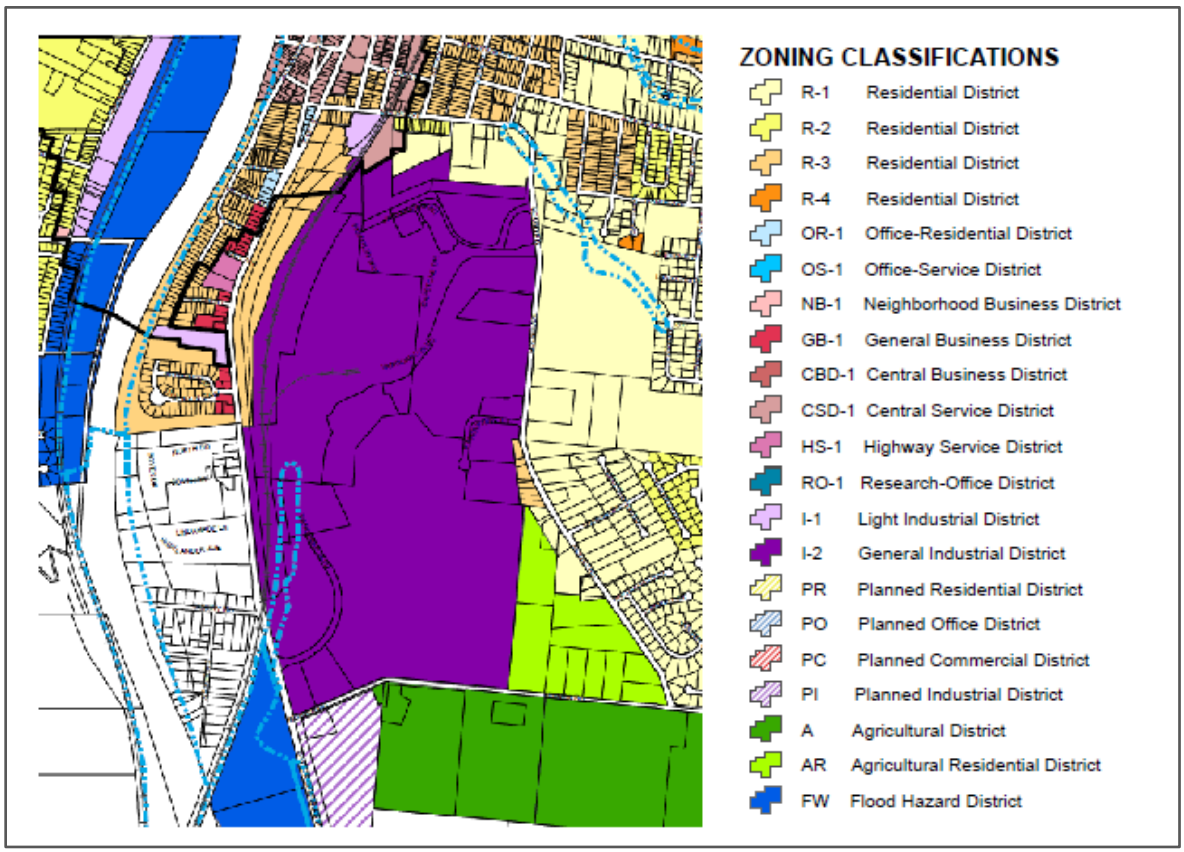

Figure 5. Zoning Around the Mound Site (from the City of Miamisburg, 2017)

2.5 Migration Pathways and Potential Receptors

Results from previous investigations and remedial actions indicated that there are potential vapor-forming contaminants in the soil and the groundwater at the Mound site. The limited soil-gas data available is not adequate to determine whether these contaminants are at concentrations that could pose a health risk, if there were complete exposure pathways.

Based on the types of chemicals at the site and the affected media (soil and groundwater), the following vapor transport mechanisms will be considered:

- Diffusion and advection of vapors from sources in the vadose zone (soil)
- Diffusion and advection of vapors from sources in the groundwater
- Migration of vapors through preferential pathways

2.5.1 Migration of Vapor Sources in Soil and Groundwater

Vapors diffusing from sources in soil and groundwater can migrate upward or laterally through the vadose zone. For sources in soil, migration is influenced by source strength and soil characteristics (e.g., permeability and structure). Migration of vapors from sources in groundwater is influenced by groundwater flow direction and pathways as well as the properties of the overlying vadose zone materials.

Vertical diffusion of vapors from sources (soil and groundwater) to buildings at the Mound site may be limited by the heterogeneous, low permeability soil materials that make up the overburden and glacial outwash. These units are comprised of silts and clays, intermixed with sand. At greater depths in the glacial outwash along the western boundary of the site, silts and clays are intermixed with sand and gravel. Groundwater within the bedrock preferentially flows along horizontal bedding plans in the interbedded limestone and shale that limits vertical movement of vapors diffusing from groundwater sources.

The depth of the contaminant of interest, as well as the overlying soil materials may limit the vertical migration of diffused vapors resulting in an incomplete pathway. Also, many contaminants can be sorbed onto low permeability clay and organic materials reducing the likelihood of vertical migration.

2.5.2 Migration of Vapors in Preferential Pathways

Vapors can migrate large distances through either natural or manmade pathways with high gas permeability. A large number of active and abandoned utility conduits are present at the Mound site that could allow for migration of vapors into buildings (existing or future). On the Main Hill, there is groundwater in the bedrock which flows through the upper weathered, fractured layer and discharges to the outwash at the edge of the BVA or to seeps located both onsite and offsite. The more permeable zone could allow for preferential migration of groundwater impacted with vapor-forming chemicals or vapors that diffuse off impacted groundwater.

2.5.3 Receptors

The primary receptors to vapors from soil or groundwater sources are occupants of onsite buildings. Presently, there are 10 occupied buildings at the Mound site; however, the VI assessment takes into account those areas of the site that are considered buildable (see Section 2.4.2) and could have receptors in the future. If there are sources that could generate vapors of sufficient concentrations, there is the potential for vapors to intrude into structures either through diffusion from sources or preferential migration through utility conduits.

It is possible that offsite residents could be receptors but only if there were sources of sufficient concentration within the Mound site boundary or the sources extended offsite *and* there was a complete exposure pathway. The most likely source to offsite receptors would be vapors diffusing from contaminants in groundwater.

3.0 Preliminary Screening

Preliminary screening included several steps to determine what contaminants exceeded screening levels and what areas of the site required additional investigation (i.e., soil-gas characterization). This screening was used to ensure that those areas of the site that may pose unacceptable risk from VI are evaluated. Screening levels were obtained using the Vapor Intrusion Screening Level (VISL) Calculator, Version 3.5.1 (EPA 2016).

All historical soil and soil-gas characterization data, groundwater monitoring data, as well as any post-remediation data were evaluated to determine potential vapor source areas. The data were filtered such that data from samples from locations that later underwent remediation and were removed were excluded. In addition, for groundwater locations, the most recent data or data that is the most representative of current conditions were used. The dataset evaluated for this VI assessment is provided in Appendix A (on a CD).

When evaluating groundwater or soil-gas concentrations at a site, the VISL Calculator allows for inputs of site-specific exposure scenarios, target risk for carcinogens, target hazard quotient for noncarcinogens, and average in situ groundwater temperature. For this assessment, the following assumptions were used for the Mound site:

- Onsite exposure scenario, commercial (present and future land use)
- Offsite exposure scenario, residential
- Target risk for carcinogens = 1×10^{-6}
- Target hazard quotient for noncarcinogens = 0.1
- In situ groundwater temperature = 15 °C

3.1 Soil Data Screening

The locations of soil with detectable concentrations of vapor-forming constituents listed in the VISL Calculator and initially identified in the residual risk evaluations (RREs) for each area were mapped to determine possible source areas. The results indicated five major sets of

contaminants (Table 2) that had detectable concentrations or concentrations greater than background in post-excavation soil samples. The distributions of these groups of contaminants, chlorinated volatile organic compounds (cVOCs), benzene, toluene, ethylbenzene, and xylene (BTEX), polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), miscellaneous VOCs, and mercury (Hg) are shown in Figure 6 through Figure 10.

Table 2. Contaminant Groups in Soil

Grouping	Contaminants
cVOCs	Tetrachloroethene, trichloroethene, vinyl chloride, 1,2-dichloroethane, and 1,1,1-trichloroethane
BTEX	Benzene, toluene, ethylbenzene, total xylene
PCBs and PAHs	Aroclor 1242, Aroclor 1248, Aroclor 1254, Aroclor 1260, benz[*a*]anthracene, and naphthalene
Miscellaneous VOCs	2-Butanone, 2-hexanone, carbon tetrachloride, and chloroform
Mercury	Mercury

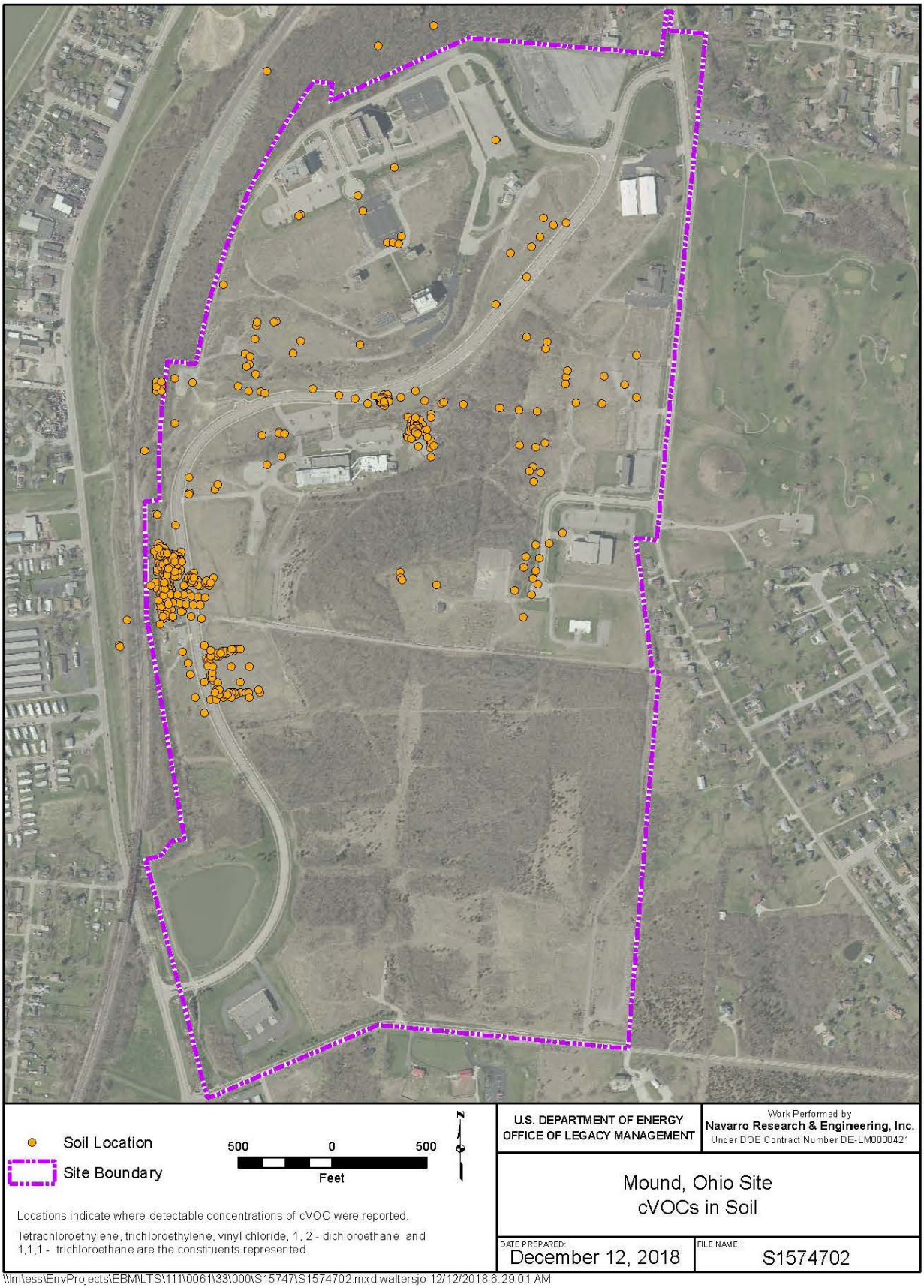

Figure 6. cVOCs in Soil

Figure 7. BTEX in Soil

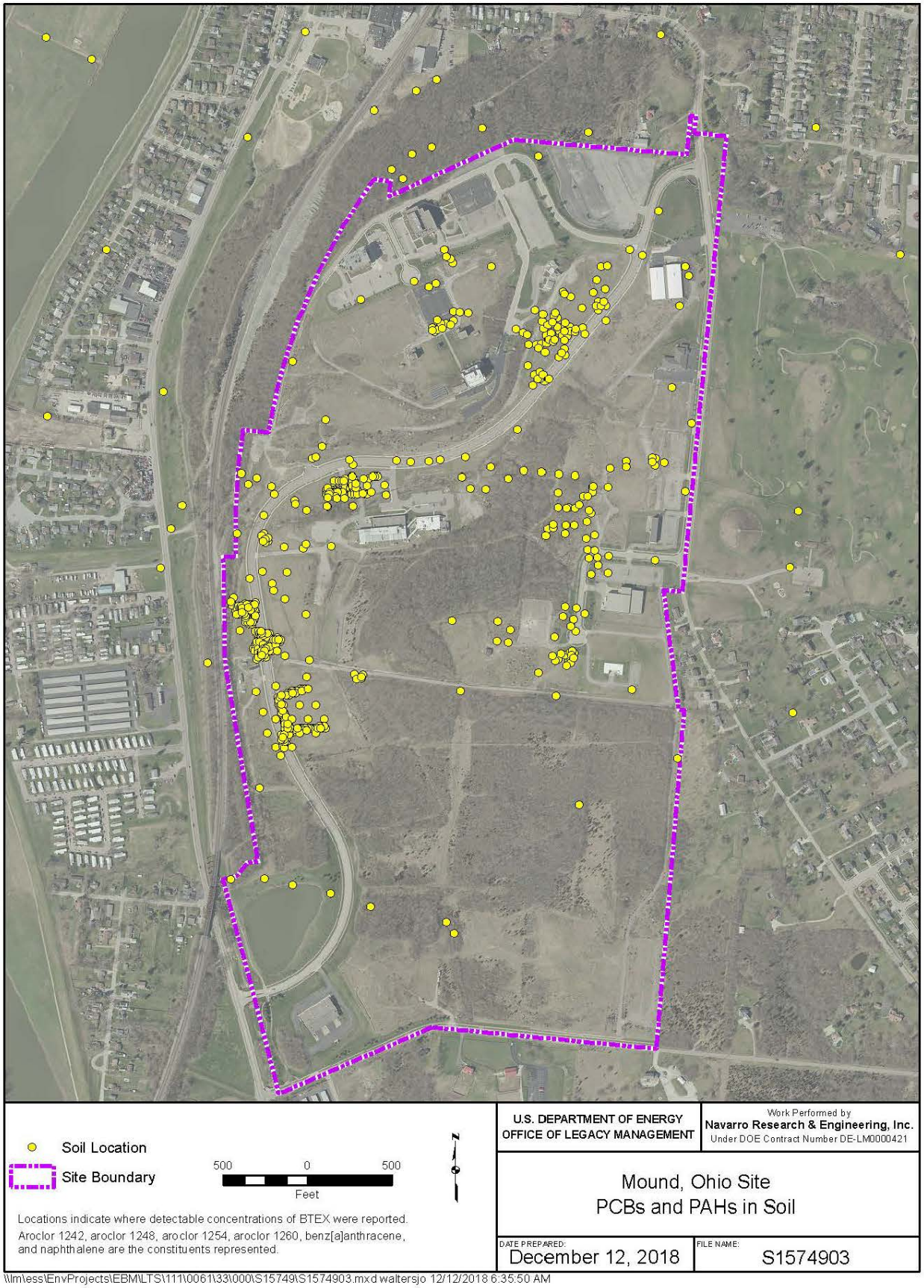

Figure 8. PCBs and PAHs in Soil

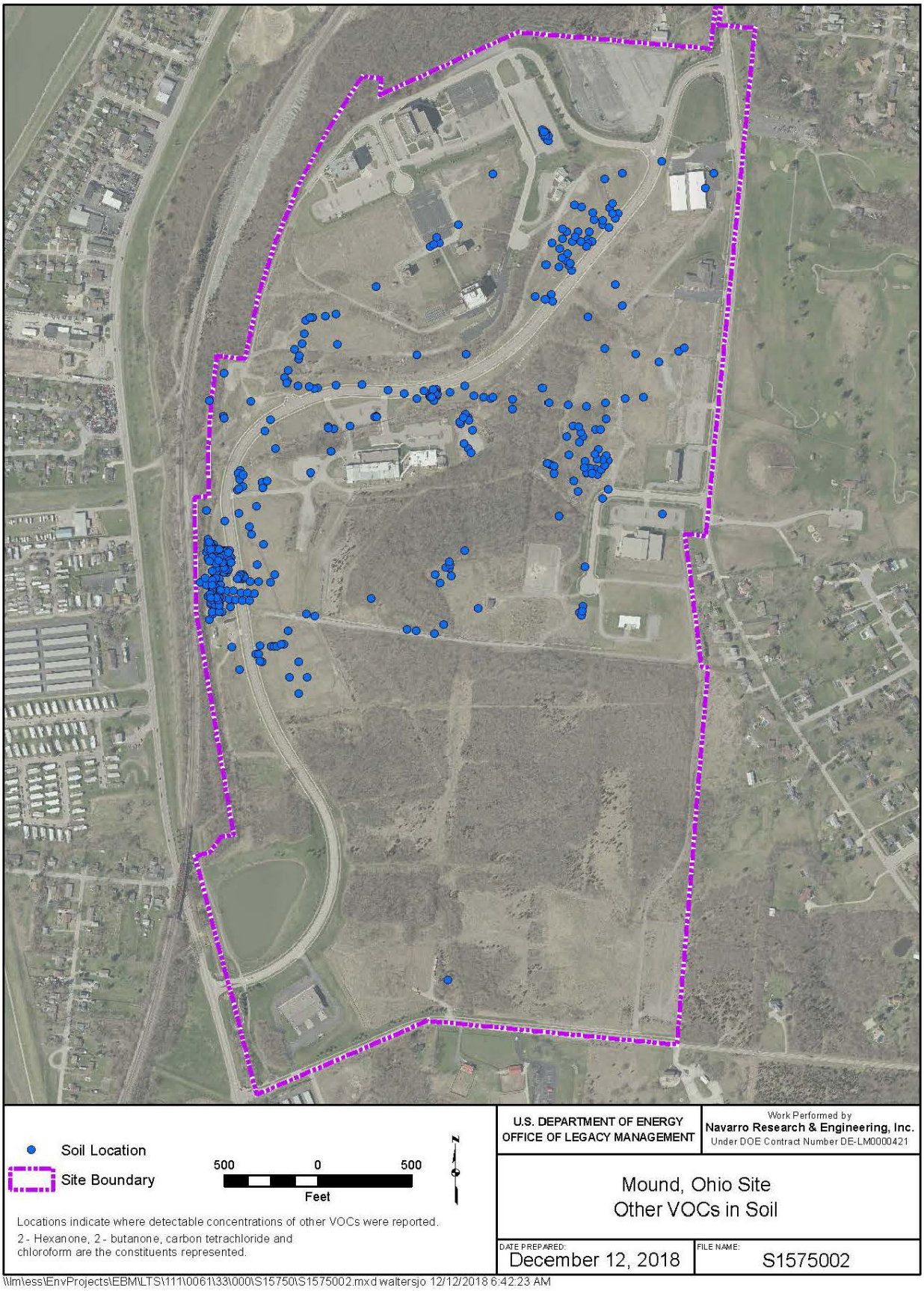

Figure 9. Other VOCs in Soil

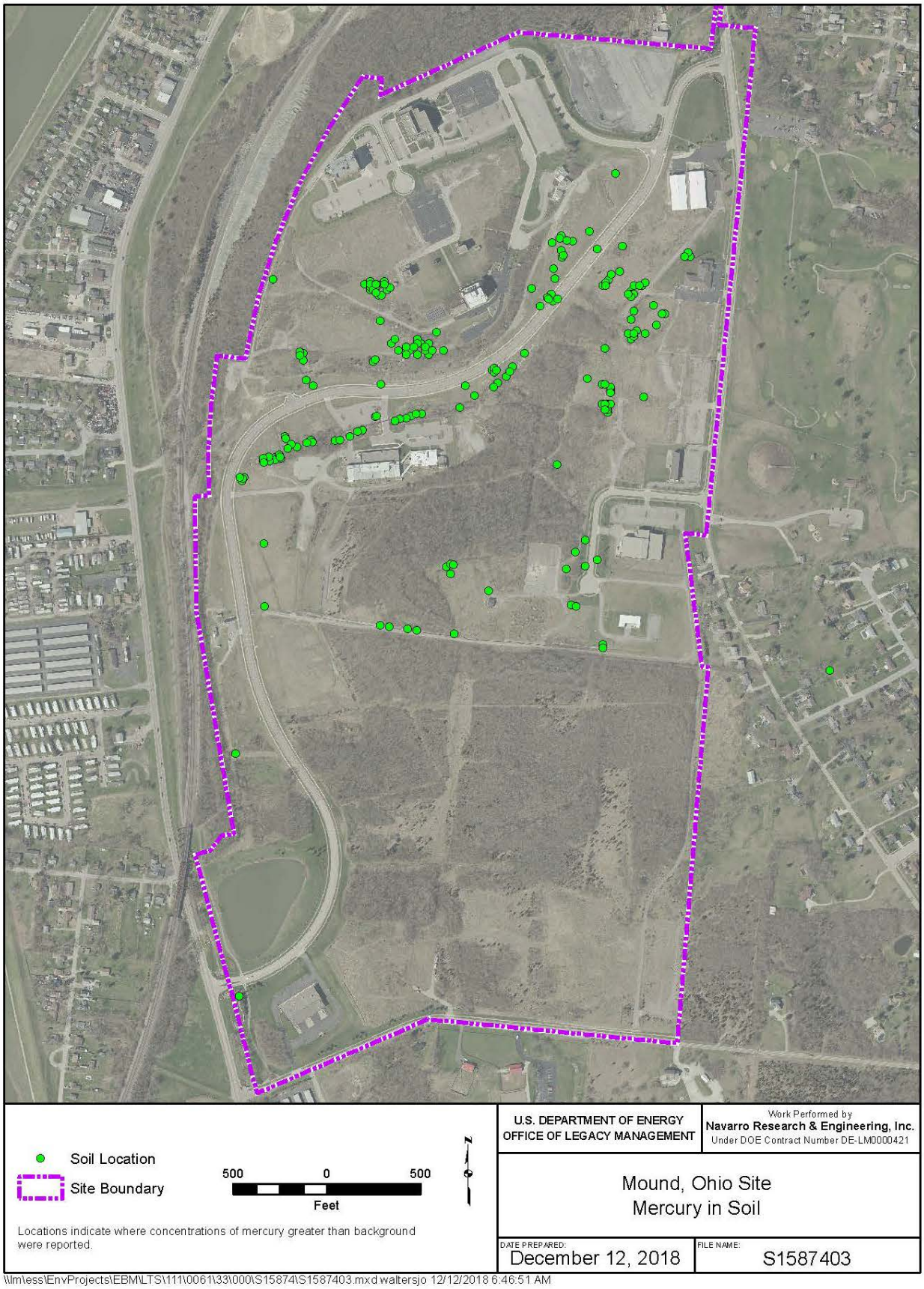

Figure 10. Mercury in Soil

3.2 Groundwater Data Screening

Historical groundwater data was evaluated to determine areas where concentrations exceeded VISL screening levels. Focus was placed on more recent groundwater data (2015–2016) to evaluate current conditions. Groundwater data collected between 2015 and 2016 indicated that exceedance of VISL screening levels were primarily for trichloroethene (TCE) and vinyl chloride (VC) in four areas (Figure 11). Screening levels for chloroform and carbon tetrachloride were also exceeded in OU-1. A fifth area near Building 49 was identified from groundwater data collected prior to soil remediation in the area; however, this area has been included since no data was collected after soil remediation to verify that groundwater concentrations are less than VISL. The areas and contaminants that exceeded screening levels are summarized in Table 3. Residential screening levels were applied to offsite locations and commercial screening levels were applied to onsite locations.

Table 3. Groundwater Areas with Contaminants Exceeding VISL Screening Levels at the Mound Site

Area	Contaminants	VISL Screening Levels (μg/L)
Main Hill (seeps)	Trichloroethene	3.6 (commercial) 0.85 (residential)
Tributary Valley	Trichloroethene	3.6
Building 49	Trichloroethene	3.6
	Vinyl chloride	3.3
Phase I	Trichloroethene	3.6
OU-1	Trichloroethene	3.6
	Vinyl chloride	3.3
	Chloroform	5.5
	Carbon tetrachloride	2.9

Notes: Target risk = 1×10^{-6}; Target hazard quotient = 0.1.

Abbreviation: μg/L = micrograms per liter

3.3 Soil-Gas Data Screening

Soil-gas data indicated three areas where one or more constituents exceeded the VISL Calculator screening levels in soil vapors (Figure 12). The areas and contaminants that exceeded screening levels are summarized in Table 4.

Table 4. Soil-Gas Areas with Contaminants Exceeding VISL Screening Levels at the Mound Site

Area	Contaminants	VISL Screening Levels (μg/m^3)
Main Hill/Building M	Tetrachloroethene	580
	1,1,1-Trichlorethane	73,000
	1,2-Dichloroethane	16
	Toluene	73,000
Main Hill/Solvent Storage Shed	Trichloroethene	29
OU-1	Trichloroethene	29

Notes: Target risk = 1×10^{-6}; Target hazard quotient = 0.1.

Abbreviation: μg/m^3 = micrograms per cubic meter

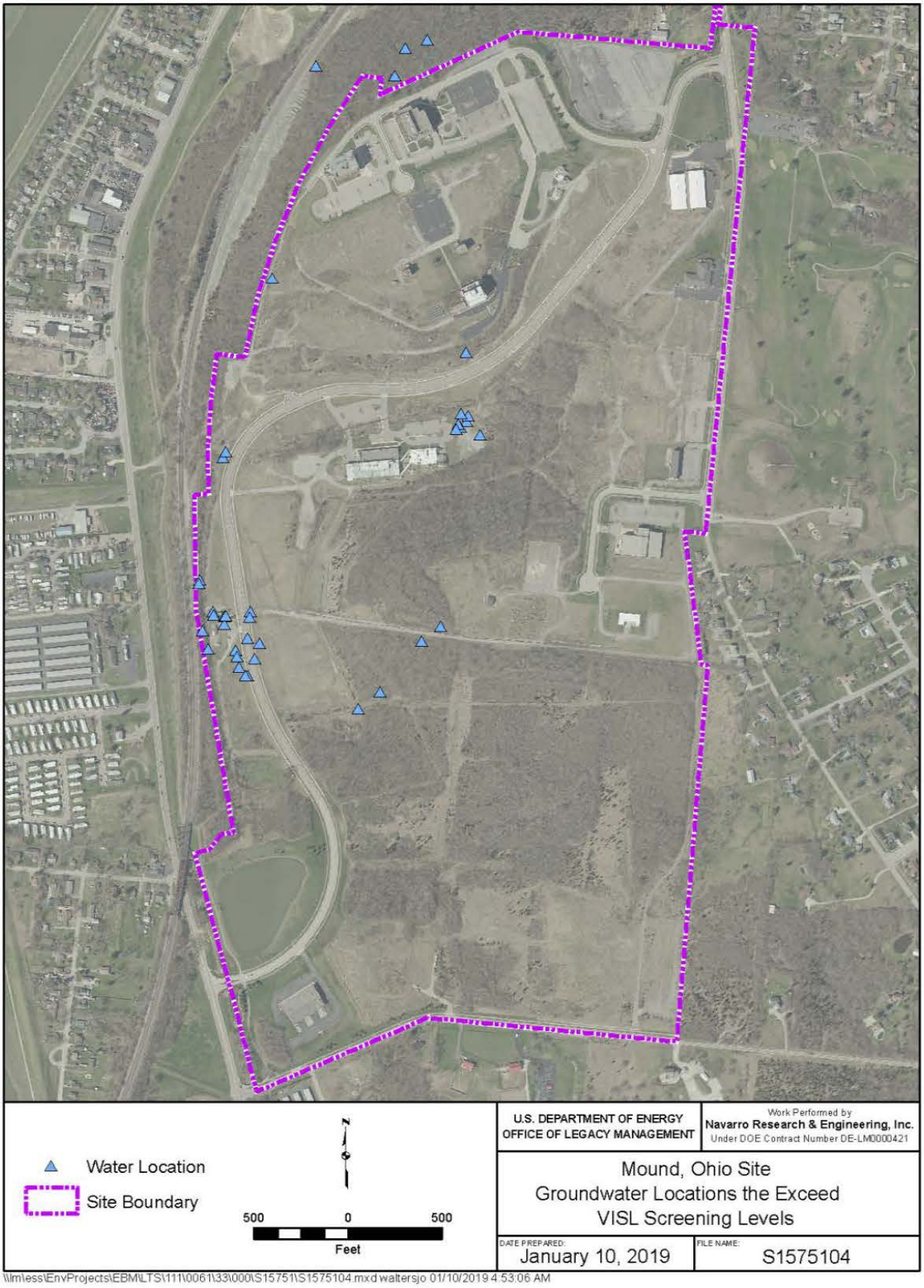

Figure 11. Groundwater Locations that Exceed VISL Calculator Screening Levels

Figure 12. Soil-Gas Locations that Exceed VISL Calculator Screening Levels

4.0 Source Assessment

VI was not evaluated in the Mound 2000 RRE process as a potential exposure pathway for the Mound site. The recommendation from the fourth Five-Year Review was that an assessment of current site data should be performed to evaluate existing and potential exposure to occupants in buildings and structures (current and future). Areas identified for additional investigation as part of Phase II include those: (1) with a large number of soil samples with detectable concentrations of vapor-forming chemicals, (2) with groundwater or soil-gas values that exceed VISL Calculator screening levels, and (3) are within or in close proximity to processing, storage, or disposal areas that could be considered sources of contamination to soil and groundwater.

4.1 Identification of Vapor Forming Chemicals

Results of the preliminary screening (Section 3.0) of soil, groundwater, and soil-gas data indicated there are six major groups of contaminants considered vapor-forming chemicals at the Mound site. These contaminant groups are:

- cVOCs
- BTEX
- PCBs
- PAHs
- Miscellaneous VOCs
- Mercury

A comprehensive review of the mercury data, elemental mercury and mercury compounds in the environment, and the usage of elemental mercury at the Mound Plant site was performed to assess whether mercury should be part of the VI assessment in the future. Although concentrations of mercury in soil exceed background, it has been determined that the likelihood of elemental mercury being in the surface and subsurface soils is low based on two factors: 1) mercury soil data represent total mercury in soil and the analytical methods did not differentiate between elemental mercury and mercury compounds, and 2) the use of elemental mercury at the Mound site was limited during the plant operations. A detailed evaluation is presented in Appendix A.

On the basis of this review, mercury has been removed from further consideration in this VI assessment primarily because there was a limited amount of elemental mercury at the Mound site and any spills of elemental mercury that occurred were contained inside buildings. Although there are concentrations of mercury (up to 65 milligrams per kilogram [mg/kg]) in soil and within site drainages, it is unlikely that these concentrations reflect the presence of elemental mercury in surface and subsurface soils. If released to the environment, elemental mercury volatilizes when exposed to air or binds to organics or reacts with other inorganics in soil resulting in mercury compounds or salts that are not considered sufficiently volatile to be included in a VI assessment.

The Ohio EPA VI guidance (Ohio EPA 2010) indicates that PCBs could be evaluated on a case by case basis. Section 3.1 of the Ohio EPA guidance notes that “it is not likely that sites with

minor PCB issues, such as the presence of transformer pads, will necessitate an evaluation for the vapor intrusion pathway." A comprehensive review of the PCB data in soil and groundwater as well as the usage of PCBs at the Mound Plant site was performed to assess whether PCBs should be part of the VI assessment in the future. The following was determined from this evaluation:

- Concentrations of PCBs in soil are low. The majority of the PCB data (58 out of 422 samples [14%] with detectable concentrations) are low (less than 1 mg/kg) and only one sample exceeds 10 mg/kg (Aroclor-1248 reported at 38 mg/kg).
- No PCBs were reported in groundwater.
- There were small quantities of PCBs in small equipment (e.g., transformers, switches, and light ballasts).
- A PCB spill occurred from a transformer on the west side of the Powerhouse (P) Building.

A PCB spill (approximately 2.5 quarts of Aroclor-1260) from a spare electrical transformer stored near the power house (P Building) was reported in April 1990. Sampling and remediation of this spill are documented in *Main Hill Seeps, OU-2, On-Scene Coordinator Report for CERCLA Section 104 Removal Action, West Powerhouse PCB Site* (DOE 1991). During the cleanup of the spill, another pocket of oil (determined to be Aroclor-1260) was encountered at a depth below the original spill. It was concluded that this contamination was not from the spill that occurred in April 1990, but from a separate incident, because of the small volume of the April 1990 release. The cleanup of both of these spills was handled as a removal action under CERCLA and all soil and concrete debris with PCB concentrations greater than 10 mg/kg was removed in March 1991. Excavation continued until all soil was removed to the top of bedrock (8.5 ft below ground surface). Confirmation data indicates the concentration of PCBs in the remaining soil were less than 3 mg/kg.

On the basis of this review, PCBs have been removed from further consideration in this VI assessment primarily because the concentrations of PCBs at the Mound site are low and all PCB spills were remediated. Although there are concentrations of PCBs (up to 38.8 mg/kg) in soil, the majority of the concentrations are less than 1 mg/kg and it is unlikely that these concentrations represent PCB sources in surface and subsurface soils.

4.2 Potential Vapor Source Investigation Areas

During plant operations, contamination was limited to discrete areas associated with production and manufacturing buildings, utility lines, and storage and disposal areas (see Section 2.2). These areas (Figure 13) typically had soils that were radiologically or chemically (or both) contaminated as a result of spills, leaks, leaching, infiltration, overflow, or runoff. Groundwater was impacted by liquids leaking from lines and basins or via infiltration of water through the contaminated soils. The soil on the Mound site was remediated to EPA's risk-based standards for industrial/commercial use, however, the scope for the cleanup approved by the regulator did not include evaluation of the potential for VI. Therefore, the current assessment process is being conducted to assess the VI pathways using a data-driven approach where all current site data were included and evaluated in the Phase I assessment. The data that are presented include samples that exceed the VISL screening levels for either groundwater or soil-gas or have detectable concentrations of a potentially vapor-forming chemical in soil (this standard is used

because there are no VISL screening levels for soil). The data presented in this section is a subset of the dataset described above.

Nine areas have been identified as potential vapor source areas that may require additional investigation to evaluate the VI pathways. These areas are shown on Figure 14 and summarized in Table 5, which includes a summary of the dataset (soil, groundwater, or soil-gas) that supported the selection of each area, as well as the primary contaminant groups identified. Figure 14 was created by overlying information from the following datasets to identify general areas where soil-gas data are needed to assess VI:

- The distribution of detectable concentrations of cVOCs, BTEX, PAHs, and other VOCs in soil (Figure 6 through Figure 9)
- The occurrence of contaminants that exceed VISL screening levels in groundwater (Figure 11)
- The occurrence of contaminants that exceed VISL screening levels in soil-gas (Figure 12)
- Areas associated with production and manufacturing buildings, utility lines, and storage and disposal areas (Figure 13)

Generally, the boundaries were established to incorporate process or production areas where similar activities were performed that resulted in impact to the subsurface soil and groundwater. Areas that were identified as unsuitable for future construction (Section 2.4.2) were not included within the boundaries. The boundaries indicate general areas where additional investigation is necessary to better determine the occurrence and concentration (source strength) of potentially vapor-forming chemicals in the subsurface; they should not be interpreted as definitive boundaries of the area where VI will be evaluated.

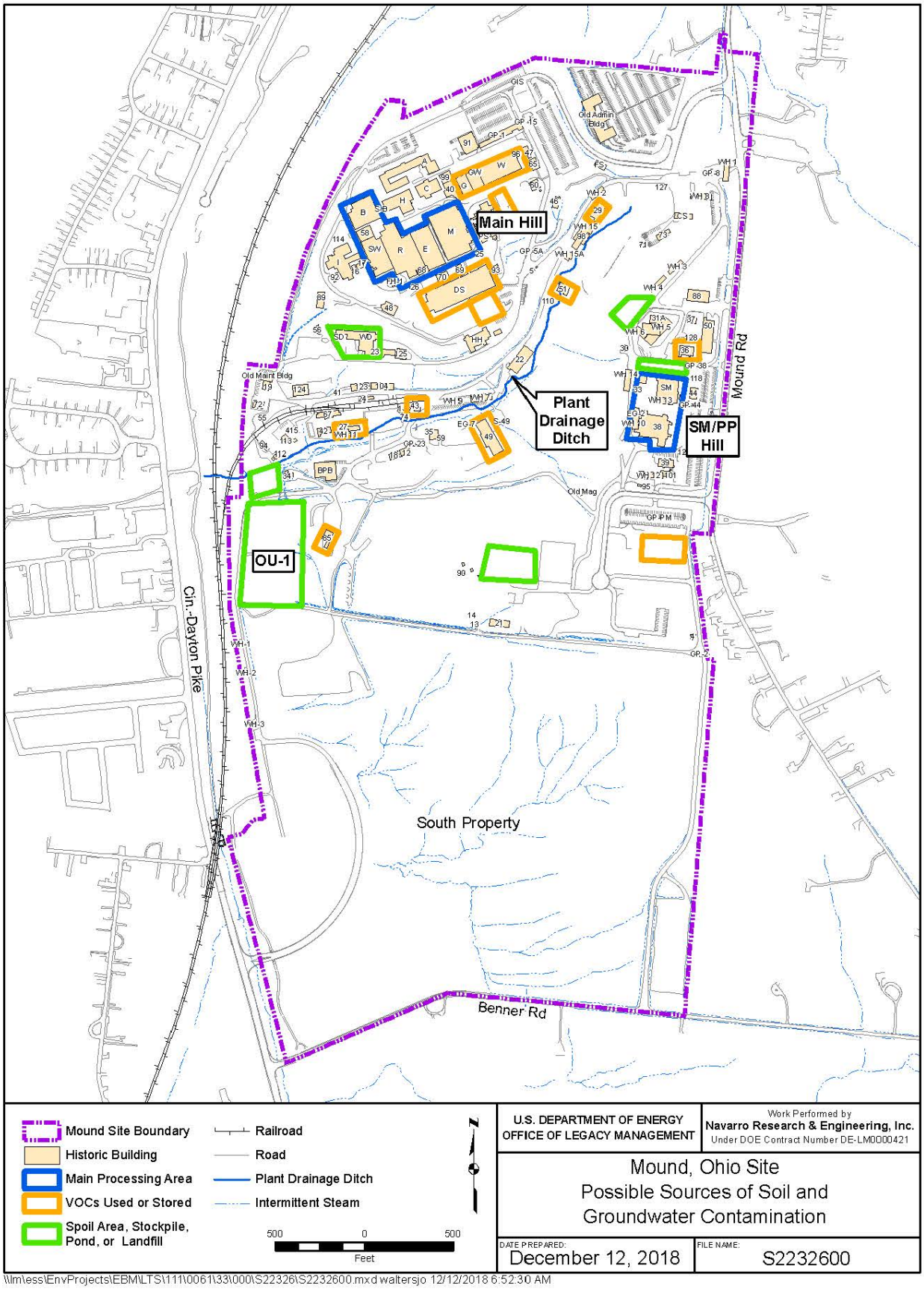

Figure 13. Possible Sources of Soil and Groundwater Contamination

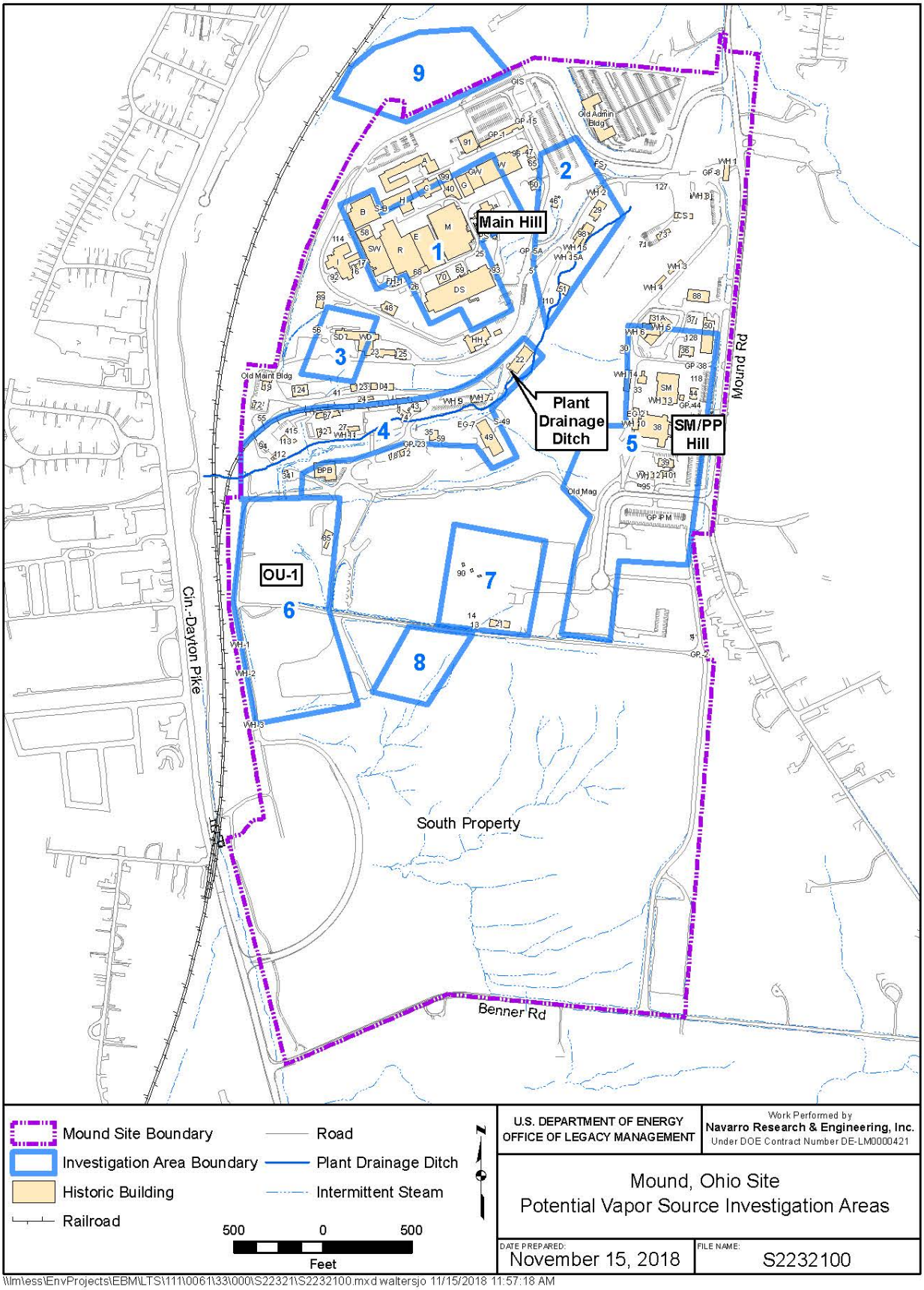

Figure 14. Potential Vapor Source Investigation Areas

Table 5. Summary of Areas Identified as Potential Vapor Sources at the Mound Site

Area	Location	Supporting Dataset	Contaminant Groups[a]
1	Main Hill Production Area	Soil Soil-gas	cVOCs BTEX PAHs Miscellaneous VOCs
2	Main Hill Support Area and Power Plant	Soil	cVOCs BTEX PAHs Miscellaneous VOCs
3	Former WD Building area and sewage sludge drying pits	Soil	cVOCs BTEX PAHs Miscellaneous VOCs
4	Test Fire Valley and Parcels 6, 7, and 8 groundwater (Tributary Valley)	Soil Groundwater	cVOCs BTEX PAHs Miscellaneous VOCs
5	SM/PP Hill Production Area	Soil	cVOCs BTEX PAHs Miscellaneous VOCs
6	Former OU-1 landfill, overflow pond, spoils area, and groundwater plume	Soil Groundwater Soil-gas	cVOCs BTEX PAHs Miscellaneous VOCs
7	Orphan Soil Storage Area	Soil	cVOCs BTEX PAHs Miscellaneous VOCs
8	Phase I groundwater	Groundwater	cVOCs
9	Main Hill seeps (offsite)	Groundwater	cVOCs

Note:
[a] Contaminant group constituents are identified in Table 2.

Abbreviation:
WD = Waste Disposal

4.3 Areas Not Retained for Phase II Sampling

The following areas will not be included in Phase II sampling at this time:

- OU-1 landfill and groundwater area
- Offsite seeps

4.3.1 OU-1 Area (Area 6)

Based on the results of the Phase I VI assessment, Area 6 (shown in Figure 14) of the Mound site has elevated concentrations of cVOCs in soil, as well as some soil-gas and groundwater concentrations (primarily for TCE and VC) that exceed the screening levels presented in the VISL Calculator. Therefore, it is recognized that under current conditions, if new construction was to occur in Area 6, there may be potential for a complete exposure pathway to any building occupants. The majority of Area 6 falls in Parcel 9, specifically, that portion of the parcel that

includes the OU-1 compliance boundary (as defined in the 1995 OU-1 Record of Decision [ROD] [DOE 1995]), additional property to the east that was included in the Parcel 9 footprint (as defined in the 2011 Amendment of the OU-1 ROD [DOE 2011]), and the VOC-contaminated groundwater plume that falls within the OU-1 compliance boundary and includes an extension to the immediate south of that boundary. The entire plume falls within Parcel 9 and has never left the original Mound site footprint. At the present time, DOE still owns Parcel 9 and there are no buildings on the parcel; however, MDC plans for future expansion at the Mound Business Park include areas of the parcel where new construction is likely. MDC is not interested in assuming title to areas of Parcel 9 that are impacted by OU-1.

The OU-1 Enhanced Attenuation Field Demonstration, completed in 2018, relied on reductive dechlorination and aerobic cometabolism of VOCs in groundwater to reduce concentrations below the MCLs. At this time, concentrations of TCE exceed the VISL screening level of 3.6 micrograms per liter (µg/L). Also, concentrations of degradation products, namely VC, have exceeded the VISL screening level of 3.3 µg/L at some locations, primarily in the vicinity of the former OU-1 landfill. Ongoing natural attenuation of VOCs in groundwater may result in continued elevated VC (attributable to the reductive dechlorination of TCE) at concentrations that exceed VISL screening levels; however, the treatment approach is designed to eventually attenuate VC to concentrations below the MCL.

After completion of the OU-1 Enhanced Attenuation Field Demonstration, the Core Team approved continued standby of the OU-1 approved remedy (pumping and treatment of groundwater) while natural attenuation of VOCs continues. This passive treatment technology has the potential to accelerate completion of the OU-1 groundwater remedy, as compared to the estimated completion time frame (2041) for pumping and treatment of groundwater.

Continued DOE ownership of the portion of Area 6 that falls within Parcel 9 ensures the property will not be disturbed while natural attenuation mechanisms continue to degrade residual VOCs to the point that groundwater MCLs are met. The Core Team's decision to defer Phase II soil-gas sampling in Area 6 is driven by the desire to allow undisturbed continuation of natural attenuation of VOCs in the OU-1 groundwater. Once MCLs are met, DOE will assess the VI pathway for Area 6 to determine if any pathway has the potential to cause a human health concern if a building was constructed in that area.

Although the Core Team approved deferral of soil-gas sampling, DOE reserves the right to perform sampling in targeted areas within Area 6; an example would be if DOE considers transferring title of portions of Parcel 9 that may not be impacted by OU-1. Given the Core Team's decision to defer sampling of Area 6 as a whole, DOE and the regulators would have to revisit the deferral decision and determine if sampling of certain areas can proceed. The Core Team would need to approve an amendment to the Phase II Sampling and Analysis Plan (SAP) and, based on the results of that sampling, determine whether that area has been impacted by OU-1 (e.g., whether groundwater or soil-gas levels exceed VISL screening levels). If VISL levels have been exceeded the Core Team would need to determine whether additional action is warranted. Because DOE still owns the property, DOE could retain ownership of that area until soil-gas and groundwater concentrations are below VISL; this would by default act as an IC preventing construction in that area until subsequent sampling confirmed vapors had attenuated and no longer posed an exposure concern. This would give the Core Team time to evaluate whether addition of a VI-specific IC to the current remedy is warranted. Any VI-specific land

use restriction would be defined in the appropriate CERCLA decision document (e.g., Explanation of Significant Difference, OU-1 ROD Amendment) and passed on to future property owner(s) via a quitclaim deed.

4.3.2 Main Hill Seeps (Area 9)

Concentrations of TCE in seeps 0605, 0606, 0607, and 0608 (Area 9 on Figure 14) exceed the residential VISL screening level of 0.85 μg/L for TCE. These locations were evaluated to the residential screening levels because they are located outside the Mound site boundary. These four seeps are located on the steep slopes of the north side of the Main Hill. Currently, seeps 0605, 0606, and 0607 are located on property zoned as general industrial. Seep 0608 is located along the Norfolk-Southern Railway Company right-of-way, which is also zoned as general industrial.

Soil-gas sampling in the vicinity of the seeps will not be performed for the following reasons:

- The area where seeps are is not suitable for conventional residential construction because it has steep slopes and shallow bedrock.
- The seeps are currently on property that is zoned industrial and seep 0608 is located along the Norfolk-Southern Railway Company right-of-way, preventing residential construction.
- The closest residential properties to these seeps are approximately 250 ft.
- Groundwater data from wells located between the seeps and these properties do not show TCE concentrations greater than the residential VISL screening level.

5.0 Additional Work and Schedule

The Work Plan outlined two additional activities that may be required to support this VI assessment, depending upon the results of the preliminary screening. These activities were:

- Phase II—Vapor Source Characterization and Building Foundation Assessment
- Phase III—Near-Building and Indoor Air-Quality Determination

On the basis of the results of this preliminary screening and source assessment, the areas identified in Table 5 (with the exceptions of areas 6 and 9, as discussed in Section 4.3) will be sampled during Phase II to determine the occurrence and concentration of soil vapor in these potential VI source areas. Two types of sampling (systematic and targeted) will be performed to obtain data to better determine the occurrence and concentration (source strength) of vapor-forming chemicals in the subsurface. A sitewide grid will be used to identify sample locations that provide systematic coverage within each of the potential vapor source areas shown on Figure 14. Samples will also be collected at two depth intervals at each grid point for the contaminant groups listed in Section 4.1. To augment this systematic approach, samples will be collected at targeted locations that exhibit higher concentrations or where there are higher densities of detections in samples.

A SAP will be written for the Phase II work and include the locations and depths from which to collect soil-gas samples, the required collection methods, the list of contaminants of concern, and analytical methods to be used. Results from the Phase II sampling will be used to identify areas

where: (1) low (or no) concentrations of vapor-forming chemicals are present in the subsurface or (2) source strength may pose a health concern and where there is the likelihood for complete exposure pathways for buildings (current and future). Also as part of Phase II, the construction and current conditions of area buildings will be evaluated to determine the susceptibility for soil-gas entry via utility conduits or other preferential routes of vapor entry. The CSM may also be updated with information from Phase II, if necessary.

If the results from the Phase I and Phase II characterization determine that additional investigation is needed, Phase III sampling can be conducted to determine whether there is a complete exposure pathway and to determine indoor-air quality. A SAP for Phase III would outline the locations for collecting soil-gas samples inside selected buildings and the locations for indoor and exterior ambient air-quality sampling. The required collection methods, list of contaminants, analytical methods, and quality assurance requirements would also be included.

A Quality Assurance Project Plan (QAPP) will be written and will describe the environmental sampling associated with Phase II and Phase III (if warranted) of this VI assessment. The QAPP will outline the requirements for the collection and analysis of samples, data quality evaluations, and data management.

A VI summary report will be issued to the Core Team. It will detail the results of Phase II sampling and any Phase III sampling (if performed) and identify any further actions required. A proposed schedule will be included if further actions are warranted.

Table 6 outlines a proposed general schedule for this work. EPA and Ohio EPA must approve the VI assessment report before the draft QAPP and Phase II SAP are submitted to the Core Team for review. The draft QAPP and Phase II SAP will be submitted to the Core Team no later than 60 days after the VI assessment report has been approved.

If at any time during this assessment, results indicate that there may be an immediate health risk to building occupants, the Core Team will be notified, and a course of action will be developed in accordance with Section 9.0 of the fourth CERCLA Five-Year Review (DOE 2016). Response actions and time frames outlined in the *Recommendations Regarding Response Action Levels and Timeframes for Common Contaminants of Concern at Vapor Intrusion Sites in Ohio* (Ohio EPA 2016) will also be reviewed and applied, as appropriate.

Table 6. Proposed Schedule for Phases II and III of the VI Assessment at the Mound Site

Task Name	Performance Period	Duration (days)
QAPP (Phases II and III) —Core Team Review and Approval	May 2019—Jul 2019	75
Phase II SAP—Core Team Review and Approval		
Phase II Sampling	Jul—Sept 2019	45
Phase III SAP—Core Team Review and Approval	Nov—Dec 2019	60
Phase III Sampling	Q2CY2020	18
Summary Report—Core Team Review and Approval	Q3CY2020	60

Abbreviations:
CY = calendar year
Q = quarter

6.0 References

DOE (U.S. Department of Energy), 1991. *Main Hill Seeps, OU-2, On-Scene Coordinator Report for CERCLA Section 104 Removal Action, West Powerhouse PCB Site*, October.

DOE (U.S. Department of Energy), 1995. *Operable Unit 1 Record of Decision*, June.

DOE (U.S. Department of Energy), 2011. *Amendment of the Operable Unit 1 Record of Decision*, August.

DOE (U.S. Department of Energy), 2016. *Fourth Five-Year Review for the Mound, Ohio, Site, Miamisburg, Ohio*, LMS/MND/S14085, Office of Legacy Management, September.

DOE (U.S. Department of Energy), 2017. *Vapor Intrusion Assessment Work Plan at the Mound, Ohio, Site*, LMS/MND/S15242, Office of Legacy Management, January.

EPA (U.S. Environmental Protection Agency), 2016. *Vapor Intrusion Screening Level (VISL) Calculator*, Version 3.5.1.

MMCIC (Miamisburg Mound Community Improvement Corporation), 2003. *Comprehensive Reuse Plan Update*, December.

Ohio EPA (Ohio Environmental Protection Agency), 2010. *Sample Collection and Evaluation of Vapor Intrusion to Indoor Air, For Remedial Response and Voluntary Action Programs, Guidance Document*. May.

Ohio EPA (Ohio Environmental Protection Agency), 2016. *Recommendations Regarding Response Action Levels and Timeframes for Common Contaminants of Concern at Vapor Intrusion Sites in Ohio*, OEPA Guidance Document, August.

Appendix A

Review of Mercury in Soil at the Mound Plant Site

(dataset is provided on the accompanying CD)

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The preliminary screening of soil data indicated concentrations of mercury greater than the background value of 0.15 mg/kg in soil (DOE 1994) in many areas of the Mound site (Figure 10). Based on the criteria in the VI Work Plan, an area exhibiting an abundance of detectable concentrations of vapor-forming constituents listed in the VISL Calculator and initially identified in the RREs in soil would be considered a possible source area requiring further evaluation.

A.1 Occurrence of Mercury in Onsite Soil

Mercury was evaluated as part of the preliminary screening, noted as mercury (elemental) in the Mound site database and identified in the database with the CAS number 07439-97-6. Elemental mercury (Hg^0) is an element that has not reacted with another substance. When mercury reacts with another substance, it forms a compound. The compounds most likely to be found under environmental conditions are mercuric salts (mercury chloride, mercury(II) hydroxide, and mercury sulfide) and methylmercury compounds (methylmercuric chloride and methylmercuric hydroxide). Inorganic Hg(II) compounds form complexes with minerals and organic soil matter. Most of the mercury encountered in environmental media (i.e., soil, water, sediment, and biota) is in the form of inorganic mercuric salts and organomercurics (EPA 1997).

The concentrations of mercury in soil remaining onsite range from below background (0.15 mg/kg) to 65.7 mg/kg. The distribution of mercury in soil (Figure 10 in the report to which this is an appendix) shows the remaining impacted soil is primarily near process buildings and drainages. It should be noted that remediation efforts targeted the primary sources of contamination at the site; therefore, the dataset that has been used as part of this evaluation does not include data points that were removed as part of the remedial efforts.

Soil data were reported as mercury (elemental); however, the analytical methods used to determine mercury concentrations for site investigations result in mercury compounds being reduced to elemental mercury via digestion of the sample; therefore, the reported results reflect the "total" mercury in the soil sample and do not differentiate whether elemental (or metallic) mercury or mercury compounds are in the soil. The VISL Calculator indicates that only elemental mercury is sufficiently volatile to cause VI issues and that mercuric chloride and other mercury compounds and salts are not sufficiently volatile.

A.2 Review of Mercury Usage at the Mound Plant Site

A comprehensive review of the use of elemental mercury and mercury containing compounds at the Mound site was performed to determine where mercury-containing materials, primarily elemental mercury, were used during plant operations. Table A-1 summarizes the results of this review and lists each building, a brief description of each building, whether elemental mercury or mercury containing chemicals were used or stored there, and if mercury was identified, what type and in what quantity.

A total of 162 buildings on the Mound site were initially considered in this evaluation. This included the buildings that remain and those that were dismantled as part of the site cleanup.

A preliminary screening identified 78 buildings that would not require further evaluation because they fell into one of two categories:

- Non-process buildings (e.g., administrative offices, cafeterias, and guard posts)
- Buildings that had specific, known functions (e.g., the magazines, warehouses, or storage sheds) that did not entail any use or storage of mercury

Document reviews were used to evaluate the remaining 84 buildings. Building data package reports, removal action memorandums, engineering evaluation / cost analysis reports, closeout reports, on-scene coordinator reports, and the environmental appraisal reports were the primary documents used for this task. A complete listing of all the documents used as part of this evaluation is provided in this appendix.

There were five buildings in which the use or storage of elemental mercury was documented. These buildings are noted below:

- DS—Development and Standards Building
  - Approximately 1.5 pounds (lb) of elemental mercury was used annually in the laboratory.
  - Mercury was in equipment (e.g., switches, thermometers, and manometers).
- E/E Annex—Analytical services and production offices
  - Elemental mercury was used as an analytical reagent for metals analyses.
  - Approximately 16 lb of elemental mercury removed as waste.
- R—Research Building
  - Specific volumes of elemental mercury were used for standards in laboratories.
  - Mercury was in equipment (e.g., switches, thermometers, manometers, and batteries).
- SW—Semi Works Building
  - Mercury was used as part of the tritium effluent recovery system (ERS) in the 1950s and early 1970s.
  - Two spills of elemental mercury were reported in this building.
  - Mercury was in equipment (e.g., switches, thermometers, and manometers).
  - 5.7 L of elemental mercury was removed as waste.
- 61—Warehouse
  - Temporary storage of mercury and equipment containing mercury.
  - One spill of elemental mercury was reported in this building.

As noted above, the document review indicated that three mercury spills were reported during the period in which the Mound Plant was operated. Two were in the SW Building, which has since been removed and the third was in the warehouse (Building 61), which has since been released for future purchase. A summary of the spills is given below:

- SW—Semi Works Building
  - Two spills of elemental mercury were reported in 1960, both times in room SW-8. Mercury was spilled after a manostat bellow pump in the thermal diffusion system failed (reported in May 1960). It is estimated that a maximum of 18.5 milliliters (mL) of mercury could have spilled from the pump. Hot mercury spilled from a gauge and was reported in July 1960 (DOE 1992).
- 61—Warehouse
  - A spill from a broken blood pressure cuff gauge was reported in October 1995. Cleanup of the spill was performed by the site fire department and the materials were disposed of by the waste management department. It was confirmed by the manufacturer that the volume of mercury spilled could be no more than 8.4 mL (DOE 2006).

A.3 Summary and Conclusions

The results of this review indicate the following:

- The concentrations of mercury in soil remaining onsite range from below background (0.15 mg/kg) to 65.7 mg/kg.
- Mercury results for soil represent total mercury, which does not differentiate between elemental mercury and mercury compounds.
- The VISL Calculator indicates that only elemental mercury is sufficiently volatile to cause VI issues and that mercuric chloride and other mercury compounds and salts (which typically occur in the environment) are not sufficiently volatile to cause VI issues.
- There were limited quantities of elemental mercury at the Mound site, primarily in small equipment or instruments (e.g., thermometer, manometers, or switches) or as laboratory standards and reagents.
- There were five buildings (DS, E/E Annex, R, SW, and 61) in which elemental mercury was used or stored or from which elemental mercury was removed as a waste.
- Three spills of elemental mercury were recorded; however, no elemental mercury from these spills was released outside of any buildings during the operating period of the Mound site.

On the basis of this review, mercury has been removed from further consideration in this VI assessment primarily because there was a limited amount of elemental mercury at the Mound site and any spills of elemental mercury were contained within buildings. Although there are concentrations of mercury up to 65 mg/kg in soil and within site drainages, it is unlikely that these concentrations represent the presence of elemental mercury in surface and subsurface soils. If released to the environment, elemental mercury volatilizes when exposed to air or binds to organics or reacts with other inorganics in soil, creating mercury compounds or salts that are not considered sufficiently volatile to be included in a VI assessment.

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Table A-1. Mercury Usage at the Mound Site by Building

Building	Building Name or Description	Elemental Hg or Hg-Containing Chemicals	Notes
A	Administrative, medical	No	Based upon building use, no review required.
B	Inert production	No	None.
C	Administrative, cafeteria, and records storage	No	None.
COS	Offices and labs	Yes	Mercury was likely present in small equipment such as manometers, thermometers, or calibration devices.
DS	Development and Standards Building (standards, labs, and offices)	Yes	Mercury and mercury-containing chemicals used as standards and laboratory reagents. There was a base amount of mercury (1.625 lb) available and in use at a time. Between 1965 and 1999, the total mercury used was 52 lb. Of that, 48 lb of mercury were removed as waste. Mercury-contaminated glassware and another 6.2 lb of mercury were listed as disposed. The amount used and the amount disposed identified in the records searched leads to the conclusion that all mercury used was later disposed of. No spills in the building and no releases to the environment were reported.
E/E Annex	Analytical services and production offices	Yes	Mercury-containing chemicals (mercuric oxide, mercuric thiocyanate), used as reagents for metals analysis. Mercury-containing thermometers and gauges identified. A total of 16.3 lb of Hg^0 was removed as waste.
G	Garage	No	None.
GH	Guard house, office, and administrative	No	None.
GIS	Security guard station	No	None.
GP-1	Guard post	No	Based upon building use, no review required.
GP-2	Guard post	No	Based upon building use, no review required.
GP-3	Guard post	No	Based upon building use, no review required.
GP-4	Guard post	No	Based upon building use, no review required.
GP-5	Guard post	No	Based upon building use, no review required.
GP-5A	Guard post	No	Based upon building use, no review required.
GP-8	Guard post	No	Based upon building use, no review required.
GP-8A	Guard post	No	Based upon building use, no review required.
GP-9	Guard post	No	Based upon building use, no review required.
GP-10	Guard post	No	Based upon building use, no review required.

Table A-1. Mercury Usage at the Mound Site by Building (continued)

Building	Building Name or Description	Elemental Hg or Hg-Containing Chemicals	Notes
GP-11	Guard post	No	Based upon building use, no review required.
GP-12	Guard post	No	Based upon building use, no review required.
GP-13	Guard post	No	Based upon building use, no review required.
GP-16	Guard post	No	Based upon building use, no review required.
GP-44	Guard post	No	Based upon building use, no review required.
GW	Old receiving and inspection	Yes	Storage of mercury and mercury-containing thermometers.
H	Environmental laboratory, laundry, and changing room	No	None.
HH	Hydrolysis house	Yes	Approximately 90 lb Hg^0 waste noted.
I	HE production	No	None.
M	Machine, electronics, and plating shops	Yes	Mercury-containing chemicals used as reagents for analysis.
OSE	Operational Support East Building (offices)	No	Based upon building use, no review required.
OSW	Operational Support West Building (offices)	No	Based upon building use, no review required.
P	Powerhouse Building (central utilities)	Yes	Mercury was not identified on chemical inventory lists, however, mercury was likely present in small equipment such as manometers, thermometers, switches, or calibration devices.
PH	Pump house	Yes	Mercury-containing small equipment or instruments such as switches, heater controls, and mercury vapor light fixtures were noted.
PP	Plutonium Processing Building	Yes	Refer to Building 38.
PS	Paint shop	No	None.
R	Research Building (operations labs, offices, and library)	Yes	Mercury and mercury-containing chemicals used as standards and laboratory reagents. Identified volumes: 0.026 lb Hg^0 standard; 44.9 lb Hg^0; and mercury batteries.
SD	Sewage Disposal Building (sanitary disposal, wastewater treatment plant)	No	The chemical and waste inventory does not list mercury or mercury compounds.
SM	Special Metallurgical Building	Unknown	Mercury was not used as part of the plutonium recovery processes; however, it is likely that there was mercury in small equipment or instruments (e.g., thermometers and manometers).

Table A-1. Mercury Usage at the Mound Site by Building (continued)

Building	Building Name or Description	Elemental Hg or Hg-Containing Chemicals	Notes
SST	Salt storage	No	Based upon building use, no review required.
SW	Semi Works Building (process, laboratory)	Yes	Mercury and mercury-containing chemicals used as standards and laboratory reagents. Identified volumes: mercury-containing thermometers and 170 lb of used Hg^0 (waste). A spill of mercury due to a pump failure in the thermal diffusion system in SW-8 was reported in May 1960. A spill of hot mercury from a gauge in room SW-8 was reported in July 1960.
T	Technical Building	No	Research did not identify mercury or mercury compounds used or generated as waste.
W	Warehouse Building (maintenance offices and shops, old warehouse)	Yes	Mercury and a mercury debris sample were temporarily stored.
WD	Waste Disposal Building (radioactive liquid processing, waste disposal)	No	No mercury or mercury compounds used or stored.
WH1	Production well	No	Based upon building use, no review required.
WH2	Production well	No	Based upon building use, no review required.
WH3	Production well	No	Based upon building use, no review required.
1	EM test facility	No	None.
2	EM test facility	Yes	Chemical inventory for this building was not found. Based on use of building, it would be safe to conclude that neither mercury nor mercury compounds would have been used in the processes conducted. Mercury was likely present in small equipment or instruments (e.g., thermometers).
3	EM test facility	No	None.
4	Dosimetry	No	None.
5	Magazine	No	Based upon building use, no review required.
6	Magazine	No	Based upon building use, no review required.
7	Magazine	No	Based upon building use, no review required.
8	Magazine	No	Based upon building use, no review required.
10	Magazine	No	Based upon building use, no review required.
11	Magazine	No	Based upon building use, no review required.
12	Warehouse—explosives	No	Based upon building use, no review required.
13	Magazine	No	Based upon building use, no review required.
14	Magazine (old lead melting)	No	Used as observation post for burn area.

Table A-1. Mercury Usage at the Mound Site by Building (continued)

Building	Building Name or Description	Elemental Hg or Hg-Containing Chemicals	Notes
15	Warehouse	No	Based upon building use, no review required.
16	Storage	No	None.
17	Warehouse	No	Building used to store chemicals for bonded stores in support of production. Process knowledge would lead to the conclusion that neither mercury nor mercury compounds were stored in the building.
18	Warehouse	No	Based upon building use, no review required.
19	Salvage and sales	Yes	Mercury was present in small equipment or instruments (e.g., thermometers and manometers).
20	Magazine	No	Based upon building use, no review required.
21	Material storage (thorium sludge)	No	Based upon building use, no review required.
22	Radioactive storage warehouse	Yes	Mercury was present in small equipment or instruments (e.g., switches).
23	Waste material storage center	Yes	Mercury was used and mercury wastes were stored in the building. Mercury was present in small equipment or instruments (e.g., switches).
24	Water treatment plant	Yes	Mercury was present in small equipment or instruments (e.g., switches, heater controls, and mercury-vapor light fixtures).
25	Weather / meteorological station	No	Based upon building use, no review required.
26	Maintenance shop	No	None.
27	Explosive processing facility	No	None.
28	Ceramic production (plastics development)	No	None.
29	Plastics formulation facilities	Yes	Mercury use was not identified as part of the process. Mercury was present in small equipment or instruments (e.g., thermometers). There was 444 mL Hg removed as waste.
30	Health physics (special metallurgical storage building)	No	None
31 & 31A	TRU waste storage (SM area)	No	None.
32	Unknown	Unknown	
33	Old SM maintenance shop / D&D storage	Yes	Mercury was present in small equipment or instruments (i.e., switches and thermostats).

Table A-1. Mercury Usage at the Mound Site by Building (continued)

Building	Building Name or Description	Elemental Hg or Hg-Containing Chemicals	Notes
34	Emergency brigade training facility	No	None.
35	Non-destructive testing facility	No	None.
36	Power systems technology assembly and testing support	No	None.
37	Heat source testing	Yes	Mercury and mercury-containing chemicals used as standards and laboratory reagents. Mercury(II) cyanide was noted on the chemical inventory.
38	PP Building	Yes	Mercury and mercury-containing chemicals used as standards and laboratory reagents. Mercury was present in small equipment or instruments (i.e., thermometers) and 30 lb Hg removed as waste.
39	Maintenance offices	No	None.
40	Print shop	Yes	Mercury and mercury-containing chemicals used as standards and laboratory reagents.
41	Pump station	No	Based upon building use, no review required.
42	HE production	Yes	Mercury was present in small equipment or instruments (i.e., thermometers). Mercury metal listed as waste but not as process material.
43	Devices development	No	None.
44	Cafeteria—SM area	No	Based upon building use, no review required.
45	Health physics calibration facility	No	None.
46	Weld development	No	None.
47	Security (old central fire station)	No	None.
48	Process mechanization facility / explosive surveillance	Yes	Mercury and mercury-containing chemicals used as standards and laboratory reagents.
49	Explosive fabrication facility	No	None.
50	PST assembly and testing, including red drain	No	None.
51	PST facility	No	None.
52	Magazine	No	Based upon building use, no review required.
53	Magazine	No	Based upon building use, no review required.
54	Magazine	No	Based upon building use, no review required.

Table A-1. Mercury Usage at the Mound Site by Building (continued)

Building	Building Name or Description	Elemental Hg or Hg-Containing Chemicals	Notes
55	Effluent monitoring (water)	No	None.
56	Water tank pump house	No	Based upon building use, no review required.
57	Sanitary sewage disposal plant	No	None.
58	Filter bank—SW Building	No	Based upon building use, no review required.
59	Neutron radiography facility	No	None.
60	Ceramic facility	No	None.
61	Warehouse (logistical support)	Yes	Spill of 0.3 lb Hg from a gauge was reported in 1995; however there was no release outside of building. This building was constructed in 1980 and may have been near the end of the time when mercury was used.
62	Research and testing of EM	Probably not	Refer to SW Building. Building 62 was incorporated into SW Building as rooms 149, 149a, and 149b.
63E/63W	Quality product testing	No	Based upon building use, no review required.
64	Magazine	No	Based upon building use, no review required.
65	Offices	No	Based upon building use, no review required.
66	Offices	No	Based upon building use, no review required.
67	Offices	No	Based upon building use, no review required.
68	Staging area (D&D dock)	No	Based upon building use, no review required.
69	Offices	No	Based upon building use, no review required.
70	Offices	No	Based upon building use, no review required.
71	Flammable liquids storage	No	None.
72	Hazardous waste storage	Yes	Mercury-containing waste temporarily stored and awaited shipment for disposal.
73	Gas cylinder storage	No	Based upon building use, no review required.
74	Magazine	No	Based upon building use, no review required.
75	Modular administrative building	No	Based upon building use, no review required.
76	Modular administrative building	No	Based upon building use, no review required.
77	Modular administrative building	No	Based upon building use, no review required.
78	Modular administrative building	No	Based upon building use, no review required.
79	Offices	No	Based upon building use, no review required.

Table A-1. Mercury Usage at the Mound Site by Building (continued)

Building	Building Name or Description	Elemental Hg or Hg-Containing Chemicals	Notes
80	Magazine	No	Based upon building use, no review required.
81	Magazine	No	Based upon building use, no review required.
82	Magazine	No	Based upon building use, no review required.
83	Magazine	No	Based upon building use, no review required.
84	Magazine	No	Based upon building use, no review required.
85	HE powder processing facility	No	Constructed but never used.
87	EM testing, research, and production	Yes	Mercury was present in small equipment or instruments (e.g., relay contacts and thermometers).
88	Offices	No	Based upon building use, no review required.
89	EM storage	No	None.
90	EM retort facility	No	None.
91	Offices and training	No	Based upon building use, no review required.
92	Training facility	No	Based upon building use, no review required.
93	Offices	No	Based upon building use, no review required.
94	Materials compatibility	No	None.
95	SM/PP area chiller plant	No	None.
96	Armored vehicle shelter	No	Based upon building use, no review required.
98	Central fire station	No	Based upon review of building use, no mercury identified.
99	Security operations facility	No	Based upon building use, no review required.
100	Training and offices	No	Based upon building use, no review required.
101	Modular offices	No	Based upon building use, no review required.
102	Offices (process support building)	No	Based upon building use, no review required.
104	Maintenance shop	No	Research did not identify mercury or mercury compounds being stored.
105	Parts machining	No	None.
106	Storage	No	Based upon building use, no review required.
110	Fuel facility	No	None.
112	Sand filters building	No	None.
113	Dewatering building	No	None.
114	Nitrogen separation	No	Based upon building use, no review required.

Table A-1. Mercury Usage at the Mound Site by Building (continued)

Building	Building Name or Description	Elemental Hg or Hg-Containing Chemicals	Notes
118	PST support building	No	None.
120	Health physics storage	No	None.
124	Central waste processing facility	No	Based upon building use, no review required.
125	Alpha treatment system	No	None.
126	Administration building	No	Based upon building use, no review required.
128	PST boiler building	No	Based upon building use, no review required.
300	OU-1 P&T—groundwater water system	No	Based upon building use, no review required.
301	OU-1 P&T—SVE system	No	Based upon building use, no review required.
415	Metal building adjacent to Building 113	No	None.
432	Sands filters building	No	Based upon building use, no review required.

Abbreviations:
D&D = decontamination and decommissioning
EM = energetic materials
HE = high explosives
PST = pilot scale test
SVE = soil vapor extraction
TRU = transuranic

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