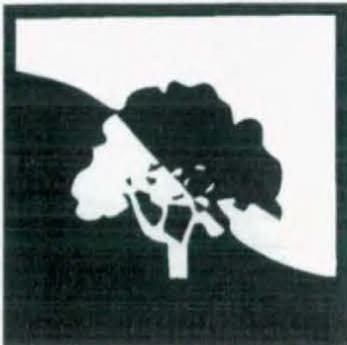


MOUND



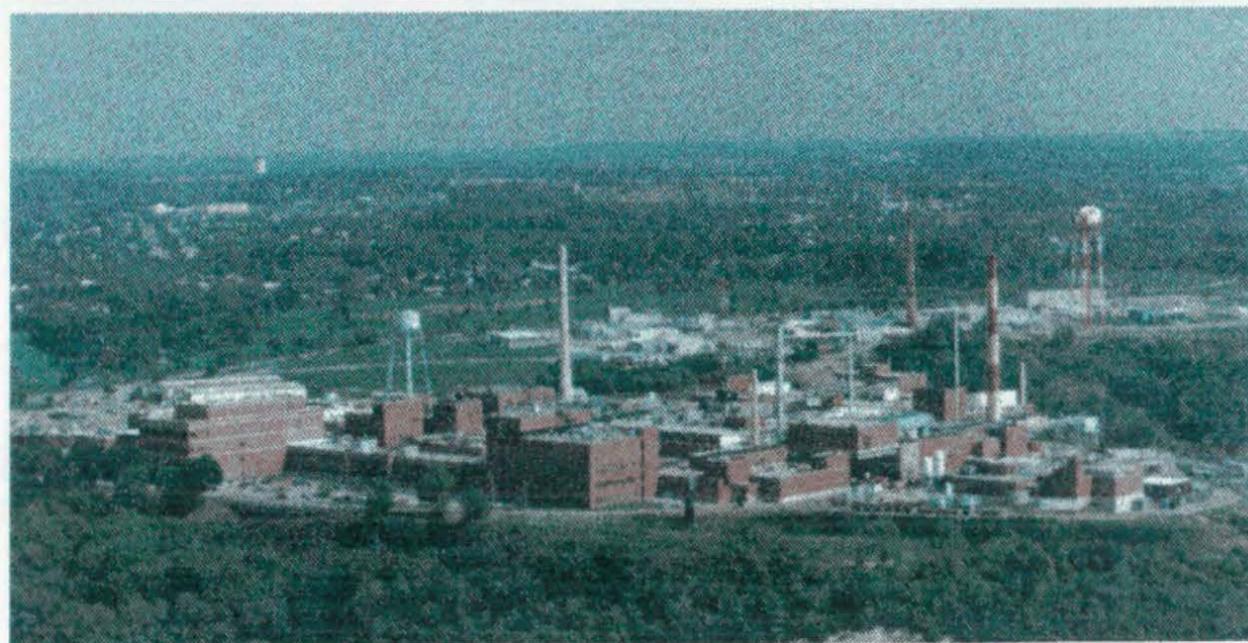
Environmental
Restoration
Program



MOUND PLANT

Potential Release Site Package

PRS # 384



MOUND



Environmental
Restoration
Program

MOUND PLANT POTENTIAL RELEASE SITE PACKAGE

Notice of Public Review Period

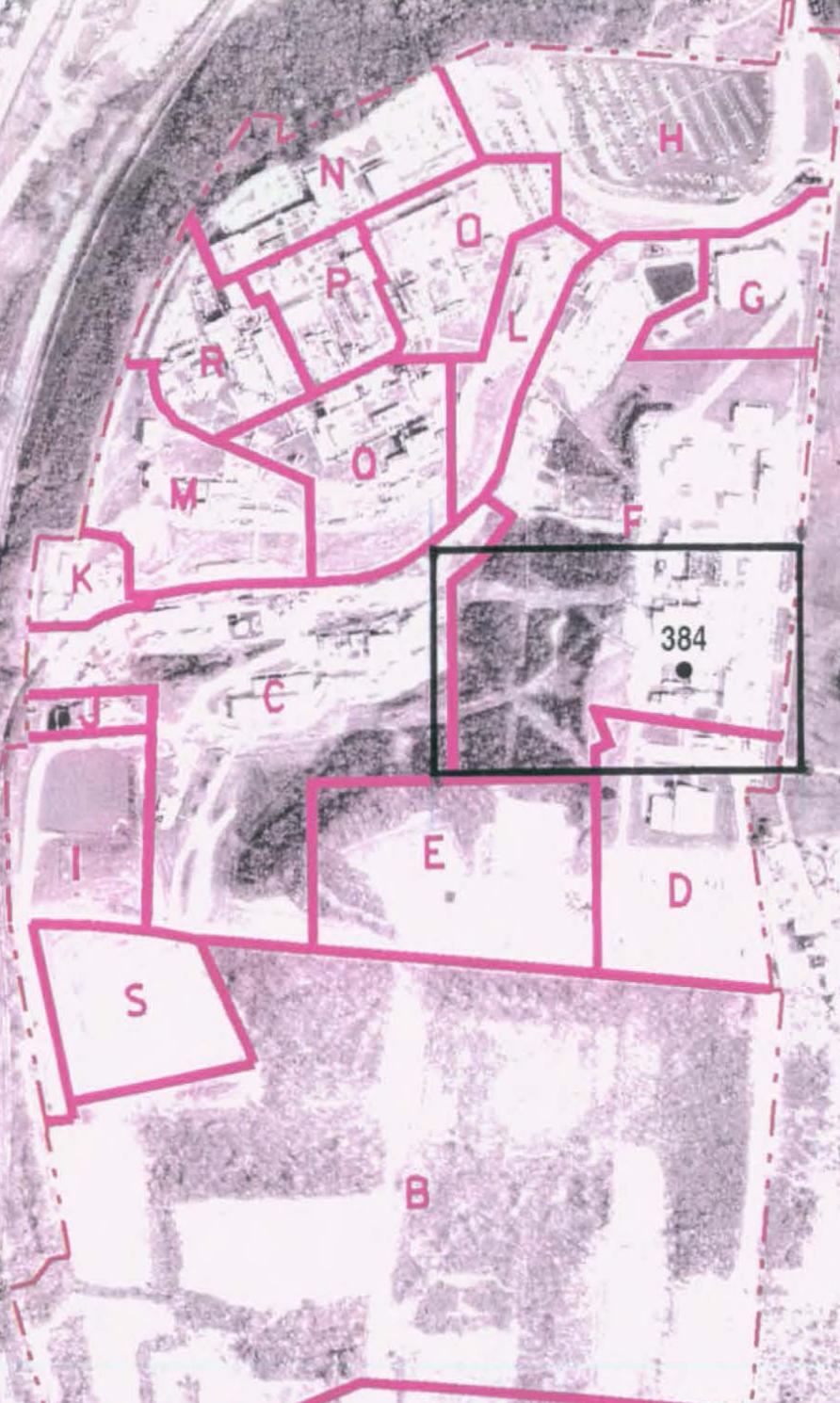
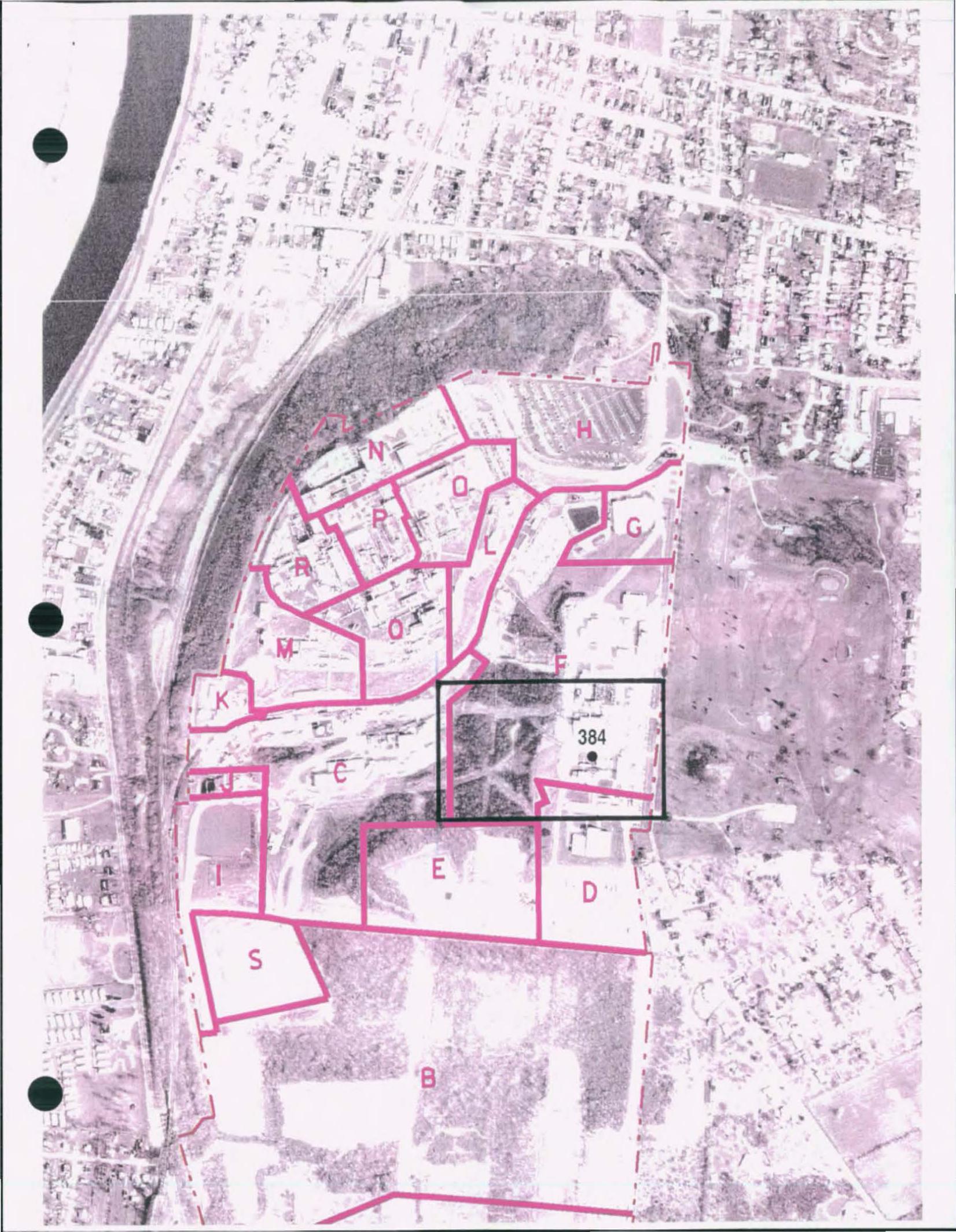


The following potential release site (PRS) packages will be available for public review in the CERCLA Public Reading Room, 305 E. Central Ave., Miamisburg, Ohio beginning December 19, 1996. Public comment will be accepted on these packages from December 19, 1996, through January 23, 1997.

**PRS 346/347/348/355/370,
351/352/353/357/359/360/361/362/385/386/387,
364, 369, 384, 388, 389/392**

Questions can be referred to Mound's Community Relations at (937) 865-4140.

REV	DESCRIPTION	DATE
<p>0</p> <p>PUBLIC RELEASE</p>	<p>Available for comment.</p>	<p>Dec. 19, 1996</p>
<p>1</p> <p>FINAL</p>	<p>Comment period expired. No comments. Recommendation page annotated.</p>	<p>Jan. 28, 1997</p>

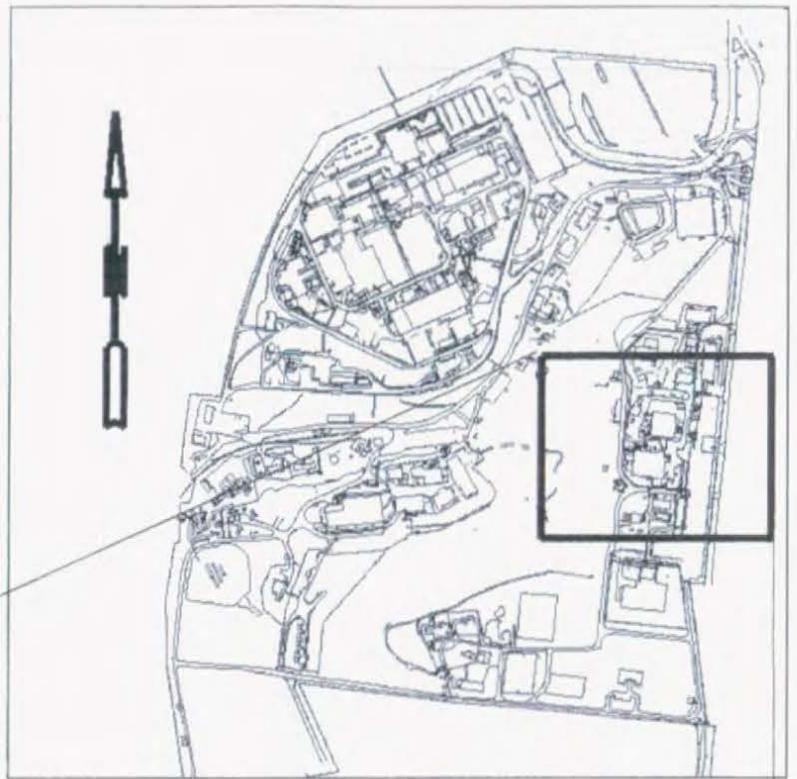


384

Mound Plant Release Block F

Potential Release Site

PRS 384





PRS 384

PRS HISTORY:

PRS 384 is located on the Special Metallurgical/Plutonium Processing (SM/PP) Hill, east of the water tank, and south of the road opposite Building 38, near Building 39. This soils location became a PRS due to relatively high organic detections found during a PETREX soil gas investigation.² There is no history of any known radioactive waste generating processes at this location.³ The site is adjacent to Building 39 where equipment is maintained and repaired (e.g. air conditioner, vacuum pumps), and general fabrications are done. Prior to 1990, fiber glass applications required adhesives and solvents.³

CONTAMINATION:

In 1983, the *Radiological Site Survey*¹ analyzed one surface soil sample in the vicinity of PRS 384. The sample was analyzed for radioactivity via Mound Soil Screening, radiochemistry, and gamma spectroscopy. Results of the analysis showed that the plutonium-238 concentration was 1.64 pCi/g (compared to Mound ALARA for plutonium of 25 pCi/g), and the thorium concentration was below 2 pCi/g (regulatory guideline criteria 5 pCi/g).⁴ No other radionuclides were detected.

In 1994, the *OU5 Operational Area Phase I Investigation*² performed a PETREX qualitative soil gas survey that detected relatively high amounts of aromatic and petroleum hydrocarbons at PRS 384. The OU5 Operational Area Phase I investigation also performed a radionuclide study. One surface soil sample was taken at PRS 384 and analyzed for plutonium-238 and thorium-232. Sample results failed to find any plutonium and thorium was detected at 0.5 pCi/g (compared to a guideline criteria of 5 pCi/g).⁴

In 1996, the *Soil Gas Confirmation Investigation*⁵ sampled within 25 feet of PRS 384 (see map on page 29). Sample number 000010 was taken over a depth of 1 to 3 feet and analyzed for volatiles, semivolatiles, PCBs, pesticides, metals, radionuclides and explosives. Results of the investigation showed:

All concentrations of volatiles, semivolatiles, PCBs, pesticides, metals, radionuclides and explosives in the soils were below their respective ALARA, regulatory, or 10^{-6} Risk Based Guideline Criteria.^{4,5,6}

READING ROOM REFERENCES:

- 1) Operable Unit 9, Site Scoping Report: Volume 3 - Radiological Site Survey, 1993.
(pages 6- 8)
- 2) Operable Unit 5, Operational Area Phase I Investigation Non-AOC Field Report, June 1995.
(pages 9-22)

OTHER REFERENCES:

- 3) Private Communication with John V. Adams (Area Supervisor).
- 4) Code of Federal Regulations 40CFR 192.41 and 40 CFR 192.12.
- 5) Further Assessment, Soil Gas Confirmation Sampling, Rev 0, May 1996. (pages 23-35)
- 6) Risk-Based Soil Guideline Values, December 1995, Final, Revision 0.

PREPARED BY:

Dean A. Buckner, Member of EG&G Technical Staff

**MOUND PLANT
PRS 384
SOIL CONTAMINATION**

RECOMMENDATION:

Potential Release Site (PRS) 384 was identified due to elevated qualitative PETREX hydrocarbon levels. During the 1996 soil gas confirmation investigation all concentrations of volatile, semivolatile, PCBs, pesticides, metals, radionuclides, and explosives, in the soils, were below their respective ALARA, regulatory, 10^{-6} Risk Based Guideline Criteria, or background levels. Therefore, NO FURTHER ASSESSMENT is recommended.

CONCURRENCE:

DOE/MB:

Arthur W. Kleinrath 11/20/96
Arthur W. Kleinrath, Remedial Project Manager (date)

USEPA:

Timothy J. Fischer 11/20/96
Timothy J. Fischer, Remedial Project Manager (date).

OEPA:

Brian K. Nickel 11/20/96
Brian K. Nickel, Project Manager (date)

SUMMARY OF COMMENTS AND RESPONSES:

Comment period from 12/19/96 to 1/23/97



No comments were received during the comment period.



Comment responses can be found on page _____ of this package.

REFERENCE MATERIAL
PRS 384

ENVIRONMENTAL RESTORATION PROGRAM

**OPERABLE UNIT 9, SITE SCOPING REPORT:
VOLUME 3 - RADIOLOGICAL SITE SURVEY**

**MOUND PLANT
MIAMISBURG, OHIO**

June 1993

**DEPARTMENT OF ENERGY
ALBUQUERQUE FIELD OFFICE**

**ENVIRONMENTAL RESTORATION PROGRAM
EG&G MOUND APPLIED TECHNOLOGIES**

FINAL

Map Location ^a	Coordinates		MRC ID No.	Mo-Yr	Depth (Inch)	Pu-238 (pCi/g)	Thorium ^b (pCi/g)	Tritium (pCi/mL)	Co-60 (pCi/g)	Cs-137 (pCi/g)	Ra-226 (pCi/g)	Am-241 (pCi/g)
	South	West										
S0626	3200	2375	2393	08-83	0	NR	NR		LDL	LDL	1.1	LDL
→ S0627	3225	2365	4122	10-83	0	1.64	b					
S0628	3225	2575	4124	10-83	0	1.14	b		LDL	0.5	1.2	LDL
S0629	3275	2265	4121	10-83	0	1.14	b					
S0630	3275	2415	6557	08-84	0	2.29	b					
S0631	3275	2495	4123	10-83	0	3.15 ^c	b					
S0632	3275	2565	4125	10-83	0	2.18	b					
C0158	3000	2620	8285	10-84	36	1.95	b					
			8286	10-84	7	25.00 ^c	b					
S0633	3025	2645	2923	10-83	0	47.45 ^c	b	6.84				
S0634	3050	2845	6667	12-84	0	0.31	b					
S0635	3075	2870	6665	12-84	0	0.34	b					
C0159	3100	2620	8283	10-84	108	18.90	b					
			8284	10-84	19	6.91	b					
S0636	3100	2820	8666	12-84	0	1.84	b					
S0637	3125	2670	6791	09-84	0	1.45	b					

^aC denotes core location and S denotes surface sample location on Plate 1.

^bThorium results of ≤ 2 pCi/g are listed as "b".

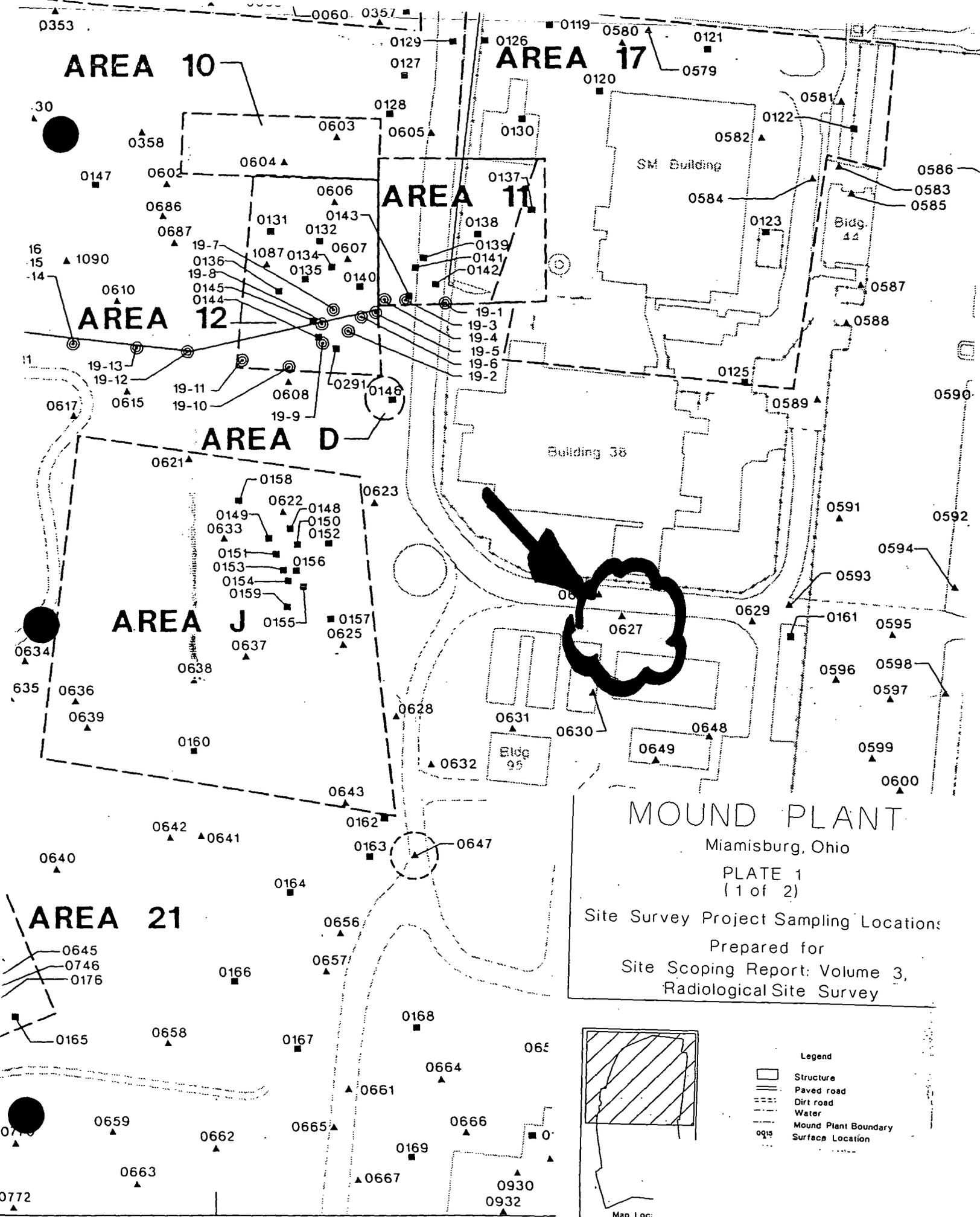
^cVerification sample analyzed for QA/QC.

^dNo MRC ID assigned because *in situ* gamma spectrometry was performed for thorium-232.

^eGamma results could not be confirmed using the gamma spectroscopy printout given in this appendix.

^fThe depth for this sample was given as "SS". For mapping purposes (Plates 1 and 5), this is assumed to be a surface sample.

^gSample results were given isotopically for this sample and included 0.99 pCi/g thorium-228; 321 pCi/g thorium-230; and 1.5 pCi/g thorium-232, for a total of 323.5 pCi/g.



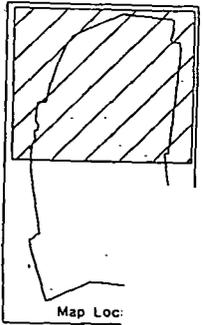
MOUND PLANT

Miamisburg, Ohio

PLATE 1
(1 of 2)

Site Survey Project Sampling Locations
Prepared for
Site Scoping Report: Volume 3,
Radiological Site Survey

- Legend**
-  Structure
 -  Paved road
 -  Dirt road
 -  Water
 -  Mound Plant Boundary
 -  Surface Location



Environmental Restoration Program

**OPERABLE UNIT 5
OPERATIONAL AREA PHASE I INVESTIGATION
NON-AOC FIELD REPORT**

**MOUND PLANT
MIAMISBURG, OHIO**

VOLUME II - APPENDICES A-G

June 1995

Final (Revision 0)

**U.S. Department of Energy
Ohio Field Office**



EG&G Mound Applied Technologies

APPENDIX E
SOIL GAS SURVEY REPORT

**Final Report of the PETREX® Soil Gas Survey
Of The Non-Area of Concern, Operable Unit 5**

**U.S. Department of Energy Mound Facility
Miamisburg, Ohio**

2.0 INTRODUCTION

~~With the aid of Northeast Research Institute LLC (NERI), Science Applications International Corporation (SAIC) recently completed a Petrex soil gas survey of the NonArea of Concern (NonAOC) of Operable Unit -5 (OU-5) of the U. S. Department of Energy's Mound Facility in Miaminburg, Ohio. The survey of the NonAOC was performed as part of a larger soil-gas survey of the entire OU-5 area including seven defined Areas of Concern.~~

~~The NonAOC encompasses the majority of the facility within the boundaries of OU-5, excepting the smaller, embedded Areas of Concern (AOC-3, AOC-7, AOC-13, AOC-21, AOC-22, AOC-J, and Area-SDB). The NonAOC was divided-up into four geographical units, NonAOC-South, NonAOC-West, NonAOC-East, and NonAOC-North to accommodate practical limitations in field operations. Two subunits of NonAOC-North, Area-61 and the Fuel Area, were also recognized (see Plate 1). Samplers from individual geographical units were collected and analyzed in separate phases of the larger soil-gas survey of OU-5.~~

~~Past and current land use within the NonAOC varies. Some portions of the NonAOC may consist of undisturbed ground while other areas may have been extensively regarded and used for storage of facility wastes. Some portions of the NonAOC currently house structures in which various chemical products are stored or processed. Due to this diverse history, subsurface contamination by numerous volatile and semivolatile organic compounds (VOC's and SVOC's) is suspected. These compounds include components of petroleum products (fuels, oils, and lubricants), coal tar products (such as creosote), halogenated and nonhalogenated solvents (such as xylenes, and PCE), and refrigerants (CFC's or Freons). The purpose of this Petrex soil gas survey was to locate areas within the NonAOC which exhibit potential subsurface contamination by VOC's and SVOC's. The information generated by this survey could then be used to 1) determine what compounds may impact soil or groundwater quality, 2) locate areas of greatest potential impact and areas where these compounds might have been buried or released, and 3) strategically plan quantitative testing of soil and groundwater to determine the regulatory significance of findings site-wide.~~

3.0 OBJECTIVES

The technical objectives of the Petrex soil gas survey of the NonAOC were to:

1. Collect and identify VOC's and SVOC's in the subsurface.
2. Report results for targeted VOC's and SVOC's and illustrate their areal distribution on-site through mapping of results.
3. Determine the location of possible sources of subsurface contamination and identify areas meriting quantitative investigation.

The majority of the soil gas samples from the NonAOC-West demonstrated only mildly elevated levels of light weight aromatics, alkanes, cycloalkanes/alkenes, and cycloalkenes/dienes. All of these compounds are components of fuels or oils and, thus, may have originated through dispersion and migration, over time, from the same occurrences of weathered fuels or oils indicated by the samples named above. The collection points of samples containing the highest levels of petroleum hydrocarbons may correspond to source areas or former points of release of petroleum products.

Prominent levels of halogenated hydrocarbons were detected rarely within the NonAOC-West. The highest levels of PCB were detected in samples #1024, and #1028. The highest levels of TCE were detected in samples #1010, #1058, #1066, and #1066. A mildly elevated level of dichlorobenzene was detected in sample #963. Trace levels of dichloroethane (DCA) were detected in samples #964, #1001, and #1021. Low levels of trichlorofluoromethane (Freon-11) were detected in samples #964, #969, #1007, #1004, #1007, #1028, #1034, #1060, and #1092 (see the mass spectrum of sample #1004).

Five samples from the NonAOC-West yielded a high response to ions derived from petroleum hydrocarbons which have the same atomic mass as the principal ions derived from the halogenated hydrocarbons also targeted by this survey (see response to total halogenated hydrocarbons in Table 2 and Plate 5). This high response and coincidence of atomic masses has masked response to halogenated hydrocarbons of similar or lesser magnitude in these samples. Of these five, only samples #1027 and #1071 contain levels of hydrocarbons capable of masking levels of halogenated hydrocarbons greater than 100,000 ion counts. To determine whether elevated levels of halogenated organics may also be present in these two samples, sample duplicates have been submitted for TD-GC/MS analysis. Chromatographic separation of individual compounds in each sample afforded by this analytical process should resolve between elevated levels of any halogenated compounds and petroleum hydrocarbons. TD-GC/MS analysis of these five samples is pending. Results will be reported as a separate document as soon as they are available.

8.2.3 NonAOC-East

LOCATION 11 NORTH 5 WEST (SEE PG 22)

Numerous soil gas samples from the NonAOC-East showed similar combinations of petroleum hydrocarbons. Samples #909, #911, #919, and #1067 demonstrated the most elevated levels of a combination of compounds typical of the vapor of weathered light to medium weight fuels. Furthermore, samples #912, #928, and #929 exhibited singularly high levels of toluene and ethylbenzene/xylenes which could indicate the presence in the subsurface of the components of solvents or thinners. Samples #923, #925, #946, #948, #955, #995, and #994 contained elevated

levels of a combination of C₄ to C₁₄ hydrocarbons typical of the composition of vapor from weathered medium to heavy weight fuels or oils. Soil gas samples representative of the balance of the NonAOC-East principally demonstrated only low relative levels of a combination of light weight aromatics, alkanes, and cycloalkanes/alkenes which are common to most petroleum products. Similar to the findings for the NonAOC-West, results of the survey of the NonAOC-East suggest the presence of source areas or points of release of various petroleum products and

Elevated levels of the halogenated organic compound PCE were also detected at several points with Area-61. The most pronounced occurrence of PCE was detected in the soil gas at the collection point of sample #775.

Due to high levels of petroleum hydrocarbons it is unclear whether levels of the halogenated organics PCE and TCE (on the order of 100,000 ion counts) may also be present in samples #770, #771, #772, #777, and #778. To determine whether elevated levels of halogenated organics are present in these samples, the duplicates of these samples have been submitted for TD-GC/MS analysis. TD-GC/MS sample analysis is pending. Results will be reported as soon as they are available.

The areal distribution of the targeted compounds within the NonAOC are discussed in greater detail in section 9.0, below.

The high sensitivity to organic compounds inherent in the Petrex Technique must be considered in the evaluation of these findings. Elevated relative levels of VOC's and SVOC's in the soil gas detected in this Petrex survey may derive from concentrations of these VOC's and SVOC's in subsurface media which are below the threshold of detection of most quantitative analyses.

9.0 DISCUSSION

9.1 Distribution of Total Aromatic Hydrocarbons

Total Aromatic Hydrocarbons are reported as the combined level of C₆ to C₁₅ aromatic (benzene based) hydrocarbon compounds detected in the soil gas samples. The majority of the samples contained only the lighter weight (C₆ through C₉) aromatics. Very few samples were observed to contain C₁₀ and heavier aromatic hydrocarbons.

The areal distribution of Total Aromatic Hydrocarbons in the soil gas across the NonAOC is displayed by Plate 2. The areas demonstrating the greatest potential impact by aromatics are the northern and southern reaches of the NonAOC-East and large portions of the Fuel Area and Area-61.

As discussed in section 8.2.4, aromatics in the soil gas across much of the NonAOC-East occur with combinations of other hydrocarbons in mixtures which are characteristic of weathered fuels. The near isolated occurrence of C₇ and C₈ aromatics, toluene and ethylbenzene/xylenes in several samples may also indicate the presence of components of solvents or thinners in the subsurface.

Note that the zone of high response to aromatics in the central western portion of the NonAOC-East is continuous to the border of the NonAOC-East where it approaches AOC-J and the large aboveground tank. This finding may indicate that the elevated levels of hydrocarbons detected in both of these survey areas are related.

As observed in the Fuel Area, the highest levels of aromatics occur in the soil gas in the vicinity of the pumps and of the separator. These findings are likely due to one or more surface or near surface releases of fuels handled in this area.

Elevated levels of aromatics occur within Area-61 principally as components of mixtures of C₄ to C₁₃ hydrocarbons common to medium to heavy weight fuels. The zone of elevated levels of aromatics within Area-61 extends the full length of the border of the survey area where it adjoins Building No. 61. This distribution may indicate that high levels of aromatics (and petroleum hydrocarbons in general) exist beneath Building No. 61 beyond survey Area-61 boundaries and may originate from sources associated with Building No. 61. Note that elevated levels of aromatics also occur in zones extending to the north and west of Building No. 61.

Spot occurrences of aromatic hydrocarbons in the soil gas across the rest of the NonAOC likely derive from various small scale releases of common petroleum products, especially fuels. It is important to note that numerous structures with the NonAOC such as paved roads, railroad spurs, and other structures to which petroleum products may be applied in building or maintenance may be sources of hydrocarbons in the near surface soil gas yet not be significant contaminants of subsurface media. The potential for this condition is exemplified by the detection of high levels of aromatics in the soil gas at the collection points of samples #229, #855, #1008, #1015, and #1022 (at grid coordinates 7N26W, 25N5W, 11N18W, 13N26W, 12N21W). This condition should be considered when evaluating results of sampling within or very near such structures.

At some locations within the NonAOC, particularly within the NonAOC-West and the NonAOC-North, elevated levels of aromatics (and other petroleum hydrocarbons) occur at points that are seemingly distant and isolated from structures which could be sources of these compounds. The detection of elevated levels of aromatics at the collection points of samples #10, #25, #889, #963, and #1001 (from grid coordinates 9N13W, 2N18W, 19N8W, 9N11W, and 11N11W) are examples of this. These findings may indicate the occurrences of VOC's and SVOC's derive from past-land use.

9.2 The Distribution of Total Semivolatile Hydrocarbons

Total semivolatile hydrocarbons are reported as the combined response to naphthalene, C₁₀ through C₁₅ alkyl naphthalenes, and C₁₂, C₁₄, and C₁₆ polycyclic hydrocarbons. These compounds are constituents of creosote, coal tar, and other heavy, high boiling point fraction petroleum products. Naphthalene and C₁₁ and C₁₂ alkyl naphthalenes (e.g., methylnaphthalene and ethyl- or dimethylnaphthalene) are also often found in medium to heavy weight fuels and fuel oils. A review of the mass spectra of all samples which yielded an elevated response to semivolatiles indicated that very few semivolatile compounds over C₁₁ in molecular weight may be present in the soil gas and that the majority of the responses derive from the presence of naphthalene.

The distribution of semivolatile hydrocarbons in the soil gas across the NonAOC is displayed by Plate 3.

9.3 The Distribution of Total C₅ to C₁₁ Petroleum Hydrocarbons

Total C₅ to C₁₁ petroleum hydrocarbons reported here include alkanes, cycloalkanes, alkenes, cycloalkenes, dienes (referred to collectively as aliphatics), plus aromatic and naphthalenic compounds. In various combinations, these compounds, together, make up the bulk of most petroleum fuels, oils, and lubricants. Total C₅ to C₁₁ petroleum hydrocarbons are reported to best illustrate the occurrence in the soil gas of petroleum product vapor of which aromatic and semivolatile compounds may not be prominent components. Although C₄ hydrocarbons were also detected in most samples, the levels of C₄ compounds are excluded from reporting as they (and lighter weight species) are commonly found in most environments.

The areal distribution of total C₅ to C₁₁ petroleum hydrocarbons in the soil gas on-site is displayed in Plate 4. Zones of elevated levels of total petroleum hydrocarbons coincide, in most instances, with zones of elevated levels of aromatic hydrocarbons. This finding supports earlier observations that the majority of the hydrocarbons in the soil gas likely derive from fuels which contain abundant levels of both aromatics and a broad assortment of aliphatic compounds. Differences between the distribution of total petroleum hydrocarbons and aromatic hydrocarbons in the soil gas apparent in a comparison of plates 4 and 2 indicate some variation in soil gas composition from one portion of the NonAOC to another. Namely, aromatics alone occur more widely across the NonAOC-East, and may be of greater impact to the subsurface within both the Fuel Area and Area-61.

Throughout the NonAOC-South and the NonAOC-West the distribution of elevated levels of total petroleum hydrocarbons is nearly identical to that of aromatics and accentuates several large areas which may be impacted by releases of petroleum. Elevated levels of aromatic and aliphatic hydrocarbons occur in several zones surrounding AOC-3 and Area-SDB (at grid coordinates 9N25W, 9½N25½W, 12N24W, and 13N26W). These zones likely relate to elevated levels of hydrocarbons detected at numerous points within the margins of AOC-3 and Area-SDB (see report of findings of the Petrex soil gas surveys of AOC-3 and Area-SDB, dated 10/7/94 and 10/10/94, respectively). Another zone of elevated response to total petroleum hydrocarbons occurs in the northwest of the site, northwest of the access road which parallels the northwest border of OU-5 (at grid coordinates 14N15W, 15N14W, and 16N12W). The location of this zone suggests that it may derive from a source of petroleum which resides outside of OU-5 to the northwest. Similarly, the occurrence of elevated levels of petroleum hydrocarbons on the northern border of the NonAOC-North (at grid coordinates 27N4W and 27N5W) may derive in part from sources of petroleum located further to the north.

9.4 The Distribution of Total Halogenated Hydrocarbons

Total Halogenated Hydrocarbons are reported as the combined levels in the soil gas of tetrachloroethene (PCE), trichloroethene (TCE), trichloroethane (TCA), tetrachloroethane (Freon-11), trichlorotrifluoroethane (Freon-113), dichlorobenzene (DCB), and chloroform. The majority of these compounds are used most often as solvents and cleaning agents. The Freons detected here may also have been used as refrigerants.

The areal distribution of halogenated hydrocarbons in the soil gas is displayed in Plate 5. PCE was detected much more frequently in the soil gas than were the other halogenated organics. Thus, the majority of the elevated responses to Total Halogenated Hydrocarbons shown in Tables 1 through 5 and on Plate 5 principally reflects the presence of PCE in the soil gas. Significant exceptions to this rule were the occurrence of pronounced levels of TCE at the collection points of samples #239, #956, #977, #1010, #1058, 1066, #1069, #1077, and #1096 (grid coordinates 4N14W, 9N6W, 20N10W, 9N21W, 10N14W, 10N13W, 3½N15½W, 19N10¼W, and 8N25W, respectively); dichlorobenzene at the collection point of sample #25 (grid coordinate 2N18W); and chloroform at the collection point of samples #887 and #890 (from grid coordinates 20N7W and 18N8W). The highest levels of PCE were detected in the soil gas at the collection points of samples #94, #775, #941, #1024, and #1077 (at grid coordinates 7N13W, 20N2¼W, 13N1W, 12N18W, and 19N10¼W).

The occurrence of elevated levels of TCE and dichlorobenzene in the soil gas at sampling points #25 and #239 is the most salient feature of the distribution of halogenated compounds within the NonAOC-South. Although the structure nearest the collection point of sample #239 may relate to a source of halogenated compounds, the collection point of sample #25 appears to be isolated from any potential source and thus may show impact due to past land use.

The occurrence of high levels of halogenated compounds in the center of the NonAOC-West may relate to nearby operations within neighboring Buildings No. 49 and No. 51. Similarly, the zone of elevated halogenated hydrocarbons located immediately to the northwest of nearby Buildings No. 36, No. 59, and No. 63 may also relate to local operations. The distribution of halogenated organics in the soil gas throughout the NonAOC is limited and suggests that any occurrence of halogenated organics in the subsurface is the result of localized small scale releases.

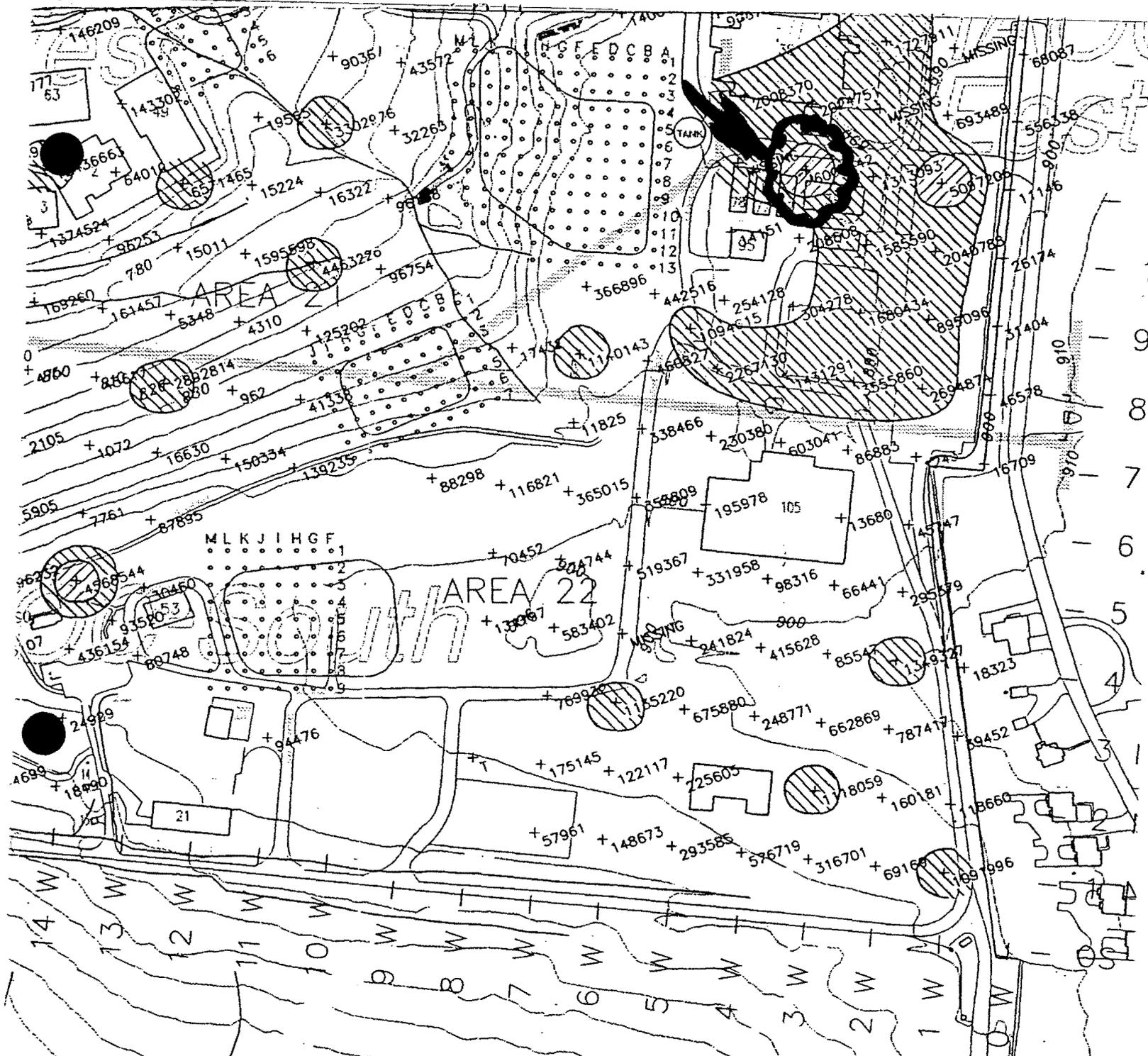
Prominent occurrences of halogenated hydrocarbons in the soil gas at points in the south of the NonAOC-East and the NonAOC-North generally appear distant from existing structures from which they may originate. Thus, these occurrences may derive from past land use.

10.0 CONCLUSIONS

From the findings of this Petrex soil gas survey the following conclusions may be drawn:

1. Elevated levels of petroleum hydrocarbons occur in the subsurface in many areas of the NonAOC and are likely the result of the release of any of various grades of fuels. However, the potential exists for some occurrences of aromatics to derive from releases of solvents or thinners.
2. The Fuel Area, Area-61, and large portions of the NonAOC-East demonstrate the greatest potential impact to the subsurface by hydrocarbons. Aromatic hydrocarbons which are components of most fuels show the greatest areal distribution within the NonAOC and may pose the greatest risk to subsurface media quality. Principal source areas of petroleum hydrocarbons within the NonAOC include the fuel pumps, separator, and aboveground fuel

- storage tank within the Fuel Area, Building No. 61 or operations within Building No. 61, and operations throughout the central portion of the NonAOC-East. Potential sources of petroleum hydrocarbons from outside the NonAOC may exist to the north of the NonAOC-West and to the north of the NonAOC-North.
3. Elevated levels of hydrocarbons detected in the soil gas in the southwestern portion of the NonAOC-East may relate to analogous levels of these same compounds detected in the earlier survey of AOC-J. Elevated levels of hydrocarbons at numerous locations in the far western sector of the NonAOC-West may relate to the occurrence of hydrocarbons in the soil gas detected in the surveys of AOC-3 and Area-SDB.
 4. Elevated levels of halogenated hydrocarbon compounds occur in the subsurface within the NonAOC, but mostly only in numerous small zones which suggest only very limited subsurface impact. The locations of specific source areas of most of the halogenated compounds detected within the NonAOC are unclear. Sources of the majority of the occurrences of halogenated hydrocarbons detected in this survey likely relate to past land use.
 5. The areal distribution of halogenated hydrocarbons in the soil gas survey wide suggests that these compounds where they occur in the subsurface, are not subject to widespread subsurface dispersion or migration.
 6. Any verification of soil gas results for petroleum hydrocarbons should include quantitative testing of soil and groundwater from the collection points of samples #94 (at 7N15W) and #239 (at 4N14W) within the NonAOC-South; samples #1015 (at 13N26W), #1022 (at 12N21W), #1056 (at 10N15W), #1065 (at 14N15W), and #1072 (at 9N24½W) within the NonAOC-West; samples #912 (at 11N2W), #928 (at 11N4W), and #946 (at 11N2W) within the NonAOC-East; and samples #853 (at 26N4W), #974 (at 27N5W), and #1014 (at 16N13W) within the NonAOC-North. Within Area-61 and the Fuel Area, quantitative testing should include soil and groundwater from the collection points of samples #771, #786, #1072, #1074, and #1075.
 7. Any verification of soil gas results for halogenated hydrocarbons should include quantitative testing of soil and groundwater from the collection points of samples #25 (at 2N18W) and #239 (at 4N14W) from within the NonAOC-South; samples #956 (at 9N6W), #1028 (at 12N17W), and #1066 (at 10N13W) within the NonAOC-West; sample #912 (at 13N1W) from the NonAOC-East; and samples #890 (at 18N8W), #901 (at 15N12W), and #976 (at 20N10W) from within the NonAOC-North. Within Area-61 and the Fuel Area, quantitative testing should include soil and groundwater from the collection points of samples #778 and #1077.
 8. The environmental significance of the existence of petroleum hydrocarbons and halogenated hydrocarbons in the subsurface can only be evaluated through quantitative testing of soil and groundwater.



Unit-5
 Facility
 h

NonAOC--South		NonAOC--Wes	
 ≥ 4,200,000	 ≥ 20,000,000	 850,000-4,199,999	 2,600,000-19,9

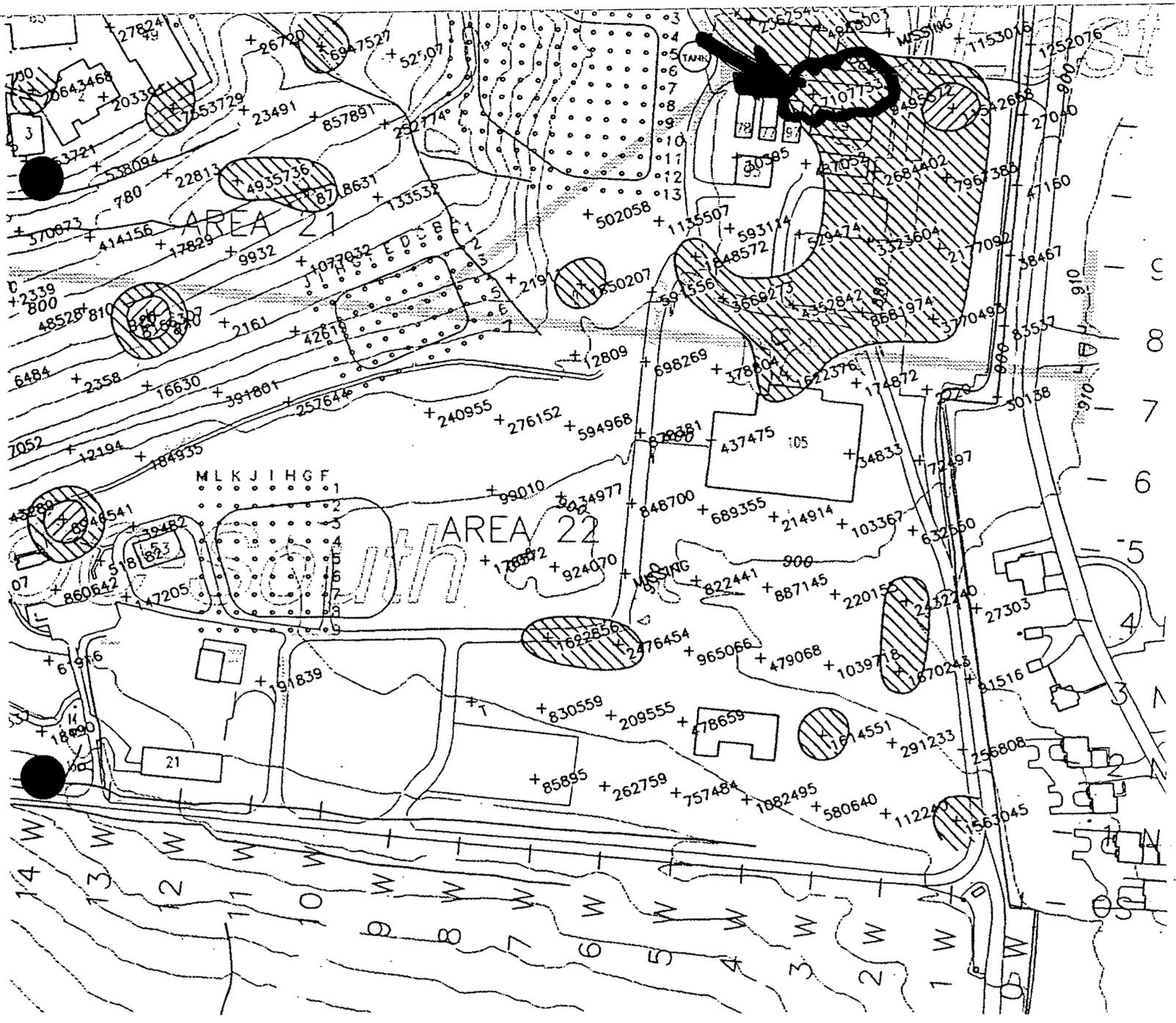
Relative Response
 Total Aromatic
 Hydrocarbons
 Plate 2



rit-5
 cility
 ●

NonAOC-South		NonAOC-West	
 ≥ 70,000	 ≥ 1,000,000		
 7,000-69,999	 100,000-999,999		

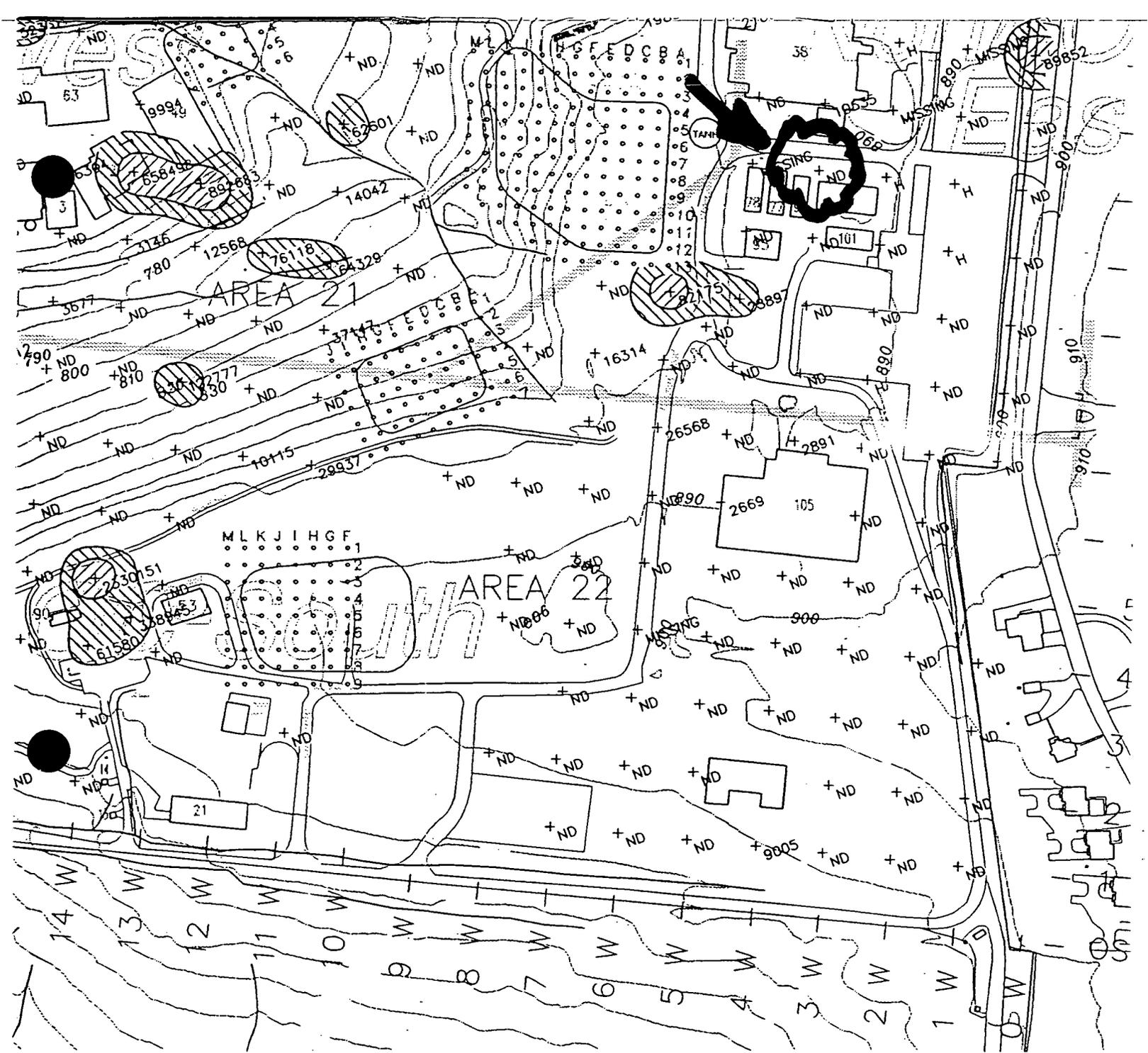
Relative Response
 Total Semivolatle
 Hydrocarbons:
 Plate 3



rit-5
 cility

		LE	
		Relative Response Values (in ion counts):	
NonAOC-South	NonAOC-West		
 ≥ 8,000,000  1,500,000-7,999,999	 ≥ 29,000,000  3,000,000-28,999,999		

Relative Response
 Total C5-C11
 Petroleum Hydrocarbons



Unit-5

Facility

hi

NOLOGY

NonAOC-South		NonAOC-Wes	
 ≥ 500,000	 ≥ 500,000	 50,000-499,999	 50,000-499,999

Relative Response

Total Halogenated Hydrocarbons

Plate 5

APPENDIX D

RADIOLOGICAL DATA (FIDLER SURVEY MOUND SOIL SCREENING FACILITY DATA) FOR NON-AOC POINTS

SMPID	FIDLER SURVEY DATA					MOUND SOIL SCREENING FACILITY DATA			
	Contamination Criteria CH1	FIDLER Readings CH1	Contamination Criteria CH2	FIDLER Readings CH2	FIDLER Readings Out Channel	Plutonium - 238		Thorium - 232	
	Units: CPM	Units: CPM	Units: KCPM	Units: KCPM	Units: KCPM	Units: pCi/g		Units: pCi/g	
	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	Note:	RESULTS	Note:
10N18	130	65	6.5	4.0	NC	21	a	0.7	a
10N19	130	80	6.5	8.0	NC	WIPE	c	WIPE	c
10N20	152.1	110	8.45	6.5	NC	0	a	1	a
10N21	152.1	70	8.45	5.0	NC	NC		NC	
10N22	152.1	85	8.45	4.0	NC	NC		NC	
11N01	253.5	150	12.48	9.5	NC	4	a	1	a
11N02	122.2	80	5.59	4.0	NC	WIPE	c	WIPE	c
11N03	122.2	80	5.59	4.0	NC	WIPE	c	WIPE	c
11N04	130	90	6.5	4.5	NC	0	a	0.5	a
11N05	122.2	80	5.59	4.0	NC	WIPE	c	WIPE	c
11N10	213.2	140	13.13	10.5	NC	18	a	1	a
11N11	213.2	130	13.13	11.0	NC	25	b	0.5	a
11N12	213.2	85	13.13	7.0	NC	7	a	1.1	a
11N14	130	90	6.5	5.0	NC	WIPE	c	WIPE	c
11N16	183.3	110	11.05	7.5	NC	19	a	0.5	a
11N17	130	50	6.5	4.0	NC	5	a	0.8	a
11N18	157.3	60	8.45	4.0	NC	WIPE	c	WIPE	c
11N19	157.3	85	8.45	7.5	NC	18	a	0.3	a
11N20	157.3	100	8.45	4.5	NC	WIPE	c	WIPE	c
11N21	87.1	75	5.85	4.5	NC	NC		NC	
11N22	87.1	75	5.85	4.5	NC	NC		NC	
11N23	157.3	55	8.45	5.5	NC	NC		NC	
12N01	253.5	160	12.48	9.0	NC	14	a	0.9	a
12N02	122.2	100	5.59	5.0	NC	WIPE	c	WIPE	c
12N03	130	90	6.5	5.0	NC	5	a	0.7	a
12N04	130	75	6.5	4.5	NC	0	a	0.3	a
12N05	130	110	6.5	5.0	NC	13	a	0.8	a
12N06	130	110	6.5	5.0	NC	17	a	0.8	a

MOUND



**Environmental
Restoration
Program**

Further Assessment

Soil Gas Confirmation Sampling

**Mound Plant
Miamisburg, Ohio**

May 1996

Revision 0

Department of Energy

EG&G Mound Applied Technologies

Table I.1 Soil Analyte ListVolatile Organic Compounds

Acetone	Dibromochloromethane	4-Methyl-2-Pentanone
Benzene	1,1-Dichloroethane	Styrene
Bromodichloromethane	1,2-Dichloroethane	1,1,2,2-Tetrachloroethane
Bromoform	1,1-Dichloroethene	Tetrachloroethene
Bromomethane	1,2-Dichloroethene (total)	1,1,1-Trichloroethane
2-Butanone	1,2-Dichloropropane	1,1,2-Trichloroethane-
Carbon Disulfide	cis-1,3-Dichloropropene	Trichloroethene
Carbon Tetrachloride	trans-1,3-Dichloropropene	Toluene
Chlorobenzene	Ethylbenzene	Vinyl Acetate
Chloroethane	2-Hexanone	Vinyl Chloride
Chloroform	Methylene Chloride	Xylenes (total)
Chloromethane		

Semivolatile Organic Compounds

Acenaphthene	Chrysene	Hexachlorobenzene
Acenaphthylene	Dibenz(a,h)anthracene	Hexachlorobutadiene
Anthracene	Dibenzofuran	Hexachlorocyclopentadiene
Benzo(a)anthracene	1,2-Dichlorobenzene	Hexachloroethane
Benzo(a)pyrene	1,3-Dichlorobenzene	Indeno(1,2,3-cd)pyrene
Benzo(b)fluoranthene	1,4-Dichlorobenzene	Isophorone
Benzo(g,h,i)perylene	3,3-Dichlorobenzidine	2-Methylnaphthalene
Benzo(k)fluoranthene	2,4-Dichlorophenol	2-Methylphenol
bis(2-Chloroethoxy)methane	Diethylphthalate	4-Methylphenol
bis(2-Chloroethyl)ether	2,4-Dimethylphenol	Naphthalene
bis(2-Ethylhexyl)phthalate	Dimethylphthalate	2-Nitroaniline
4-Bromophenyl-phenylether	Di-n-butylphthalate	3-Nitroaniline
Butylbenzylphthalate	Di-n-octylphthalate	4-Nitroaniline
Carbazole	4,6-Dinitro-2-methylphenol	Nitrobenzene
4-Chloroaniline	2,4-Dinitrophenol	2-Nitrophenol
4-Chloro-3-methylphenol	2,4-Dinitrotoluene	4-Nitrophenol
2-Chloronaphthalene	2,6-Dinitrotoluene	N-Nitroso-di-n-propylamine
2-Chlorophenol	Fluoranthene	N-Nitroso-diphenylamine
4-Chlorophenyl-phenylether	Fluorene	2,2-oxybis(1-Chloropropane)
Pentachlorophenol	Pyrene	2,4,5-Trichlorobenzene
Phenanthrene	1,2,4-Trichlorobenzene	2,4,6-Trichlorobenzene
Phenol		

Table I.1 Soil Analyte List (Continued)

Pesticides/PCB's

Aroclor-1016	Delta-BHC	Endosulfan II
Aroclor-1221	Gamma-BHC	Endosulfan sulfate
Aroclor-1232	alpha-Chlordane	Endrin
Aroclor-1242	gamma-Chlordane	Endrin aldehyde
Aroclor-1248	4,4'-DDD	Endrin ketone
Aroclor-1254	4,4'-DDE	Heptachlor
Aroclor-1260	4,4'-DDT	Heptachlor epoxide
Aldrin	Dieldrin	Methoxychlor
Alpha-BHC	Endosulfan I	Toxaphene
Beta-BHC		

Inorganics

Aluminum	Copper	Potassium
Antimony	Cyanide	Selenium
Arsenic	Iron	Silver
Barium	Lead	Sodium
Beryllium	Lithium	Thallium
Bismuth	Magnesium	Tin
Cadmium	Manganese	Vanadium
Calcium	Mercury	Zinc
Chromium	Molybdenum	Nitrate/Nitrite
Cobalt	Nickel	Explosives (USATHAMA,PETN)

Radionuclides

Americium-241	Plutonium-238	Thorium-230
Bismuth-207	Plutonium-239/240	Thorium-232
Bismuth-210	Potassium-40	Uranium-234
Cesium-137	Radium-226	Uranium-235
Cobalt-60	Thorium-228	Uranium-238

1.2. SAMPLE NUMBERING SCHEME

The sample identification numbers were assigned by Mound to each location in the following format: XXX-AAA-#####. For each location, the first three characters were SGC, identifying the sample as part of the soil gas confirmation study. The next three characters represented the area from which each sample was taken:

A03 = Area 3
A07 = Area 7
A13 = Area 13
A21 = Area 21
A22 = Area 22
SDB = Area SDB
AOJ = Area AOJ
NAC = Non-AOC areas (Area of Concern)
SAN = Sanitary area

The final six digits were a sequential number beginning with 000001. The samples related to this study begin with 000001 and end with 000102. Due to an error in surveying, samples 000099 and 000100 were taken from the wrong locations. The sites were resurveyed and the samples were taken again, renamed as 000101 and 000102. No other problems arose with the sample identification.

1.3 SURVEYING

Prior to this sampling event, surveying relocated each of the 100 sites based on coordinates from a previous soil gas sampling event. Surveyors from Barge, Waggoner, Sumner and Cannon, of Miamisburg, Ohio, completed the task, using a benchmark map of approximately 50 locations with state plane coordinates provided by EG&G. Each point was relocated with an accuracy of ± 6 inches and identified with either a 3-foot stake with orange flagging tape and the sample identification number or a pin driven into the ground through orange flagging with the sample identification number written on the flagging. The surveyed sampling locations are shown on Figure 1.1.

1.4 UTILITIES CLEARANCE/VARIANCES

After surveying, all sites were checked for the presence of underground utilities by EG&G personnel. The requirement states that sample sites must be located five feet or more from utilities. Situations in which the 5-foot rule was not met were handled in one of three ways: 1) **relocations** - sample sites were placed 5 feet or more from utility markings and normal sampling procedures were followed; 2) **hand-digging** - the VOC sample soil was collected using the core sampler, which was driven only to the depth necessary to collect the VOC sample, and the remaining soil was collected using a hand auger; or 3) **variances to the 5-foot clearance requirement** - some sites were located near visible utilities, so after safe clearance was established, normal sampling procedures were followed. Alternatively, some locations had underground utilities at relatively deeper depths. At these locations, normal sampling procedures were followed except that digging/coring was limited to two feet instead of the established three feet. No utilities were damaged during the sampling event.

Some locations had no utility interference but still could not be sampled to three feet due to "refusal"--an inability to drive the sampler deeper. This usually indicates that bedrock or large gravel has been reached. In such cases, multiple shallow cores were taken.

A complete list of sites with variances to the original soil gas sampling location or depth can be found in Table I.2.

1.5 SOIL SAMPLING METHODOLOGY

Soil was collected at each location using either a van-mounted Geoprobe® rig equipped with a core sampler, an electric hammer equipped with a core sampler, or a hand auger. The device chosen depended upon the particulars of the location. Acetate liners were used in the Geoprobe® core barrel and the hand-held core sampler. The liners were cut open with utility knives, using a new blade at each site.

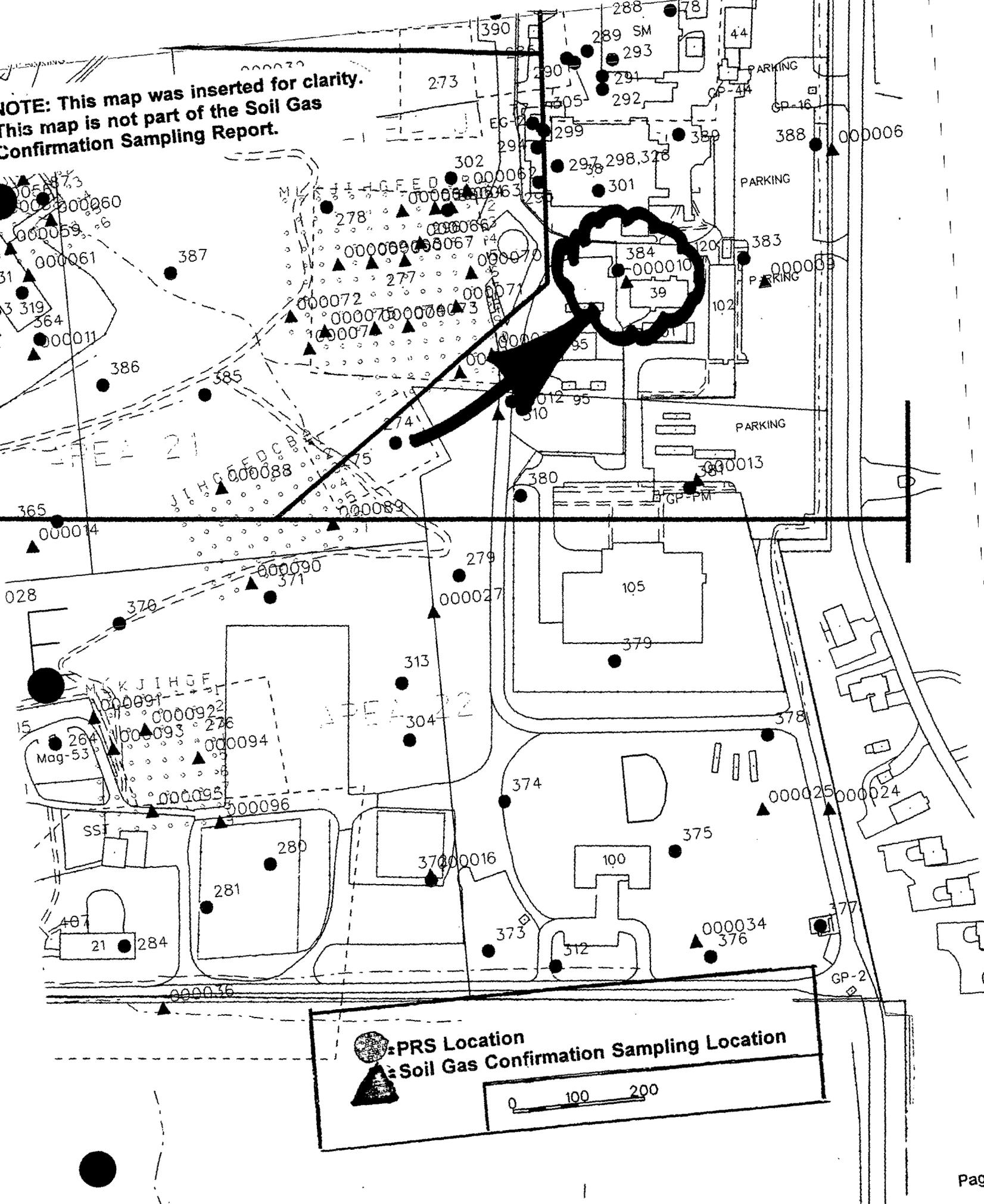
The first six inches of the core, designated for radionuclide analysis, were removed using a clean, stainless steel scoop and placed in a clean stainless steel bowl to be homogenized. Soil was cut from between the 6-inch and 1-1/2 foot depth and placed directly into jars appropriate for volatile organic compound (VOC) analysis, leaving as little headspace as possible. The remaining soil was then placed into another clean stainless steel bowl. If necessary to obtain sufficient sample volume, another core was taken, and the above process was repeated. When enough soil was collected to fill all the sample jars, the contents of both bowls were individually homogenized and used to fill their respective containers. The jars were labeled prior to being filled. Each sample was then secured with a custody seal, sealed in a plastic bag and stored in a refrigerator in Building 19. Radiological samples were delivered to the Mound Environmental Laboratory for screening. Several duplicate radiological samples were collected and set aside for later analysis by the Mound wet chemistry laboratory. After screening clearance was obtained from the Mound Environmental Laboratory, the samples were sealed in coolers and shipped to off-site contract laboratories for analysis. The contract laboratory for radionuclide analysis was Quanterra Environmental Services in Richland, Washington. All other analyses were completed by Roy F. Weston, Incorporated Laboratory in Lionville, Pennsylvania.

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Table I.2. Variance From 3-Foot Sampling Depth Specification

Location	Description of Variance
SGC-NAC-000001	Core sampler hit refusal at 2 feet.
SGC-NAC-000002	Relocated due to utilities.
SGC-NAC-000003	Core sampler hit refusal at 2 feet.
SGC-NAC-000004	Core sampler hit refusal at 18 inches.
SGC-NAC-000005	Drilled to 1 foot, hand-augered rest due to utilities.
SGC-NAC-000006	Drilled to 1 foot, hand-augered rest due to utilities.
SGC-NAC-000007	Core sampler hit refusal at 18 inches.
SGC-NAC-000008	Drilled to 2 feet due to utilities.
SGC-NAC-000010	Drilled to 1 foot; hand-augered rest due to utilities; flag against building, so sample taken 6 feet from flag.
SGC-NAC-000012	Drilled to 2 feet due to utilities.
SGC-SAN-000018	Core sampler hit refusal at 2 feet; relocated from inside clarifier.
SGC-NAC-000029	Core sampler hit refusal at 18 inches.
SGC-A61-000043	Sampled 1 foot from flag.
SGC-A61-000047	Drilled to 2 feet due to utilities.
SGC-A61-000048	Drilled to 2 feet due to utilities.
SGC-A61-000049	Relocated due to utilities.
SGC-A61-000051	Core sampler hit refusal at 18 inches.
SGC-A61-000052	Relocated due to utilities; core sampler hit refusal at 18 inches.
SGC-A61-000053	Core sampler hit refusal at 2 feet.
SGC-A13-000056	Core sampler hit refusal at 18 inches
SGC-A13-000058	Drilled to 1 foot, hand-augered rest due to utilities.
SGC-A13-000060	Core sampler hit refusal at 1 foot.
SGC-AOJ-000064	Core sampler hit refusal at 2 - 3 inches.
SGC-AOJ-000066	Core sampler hit refusal at 4 inches.
SGC-AOJ-000067	Core sampler hit refusal at 6 inches.
SGC-AOJ-000069	Core sampler hit refusal at 2 feet.
SGC-A03-000080	Core sampler hit refusal at 20 inches
SGC-A03-000081	Drilled to 2 feet due to utilities.
SGC-A03-000082	Drilled to 1 foot, hand-augered rest due to utilities.
SGC-A03-000083	Sampled 25 feet from original location due to storm sewer; core sampler hit refusal at 18 inches.
SGC-A03-000087	Core sampler hit refusal at 2 feet.
SGC-A21-000088	Core sampler hit refusal at 18 inches.
SGC-A21-000090	Core sampler hit refusal at 20 inches.
SGC-SDB-000097	Relocated due to utilities.
SGC-SDB-000098	Relocated from inside a building.
SGC-SDB-000101	Relocation of SGC-SDB-000099; first location surveyed incorrectly.
SGC-SDB-000102	Relocation of SGC-SDB-000100; first location surveyed incorrectly.

NOTE: This map was inserted for clarity.
This map is not part of the Soil Gas
Confirmation Sampling Report.



The following tables contain the Soil Gas Confirmation Sampling results. Sampling was performed for the following categories of contaminants:

Volatiles

Semivolatiles

PCBs/pesticides

Metals

Radionuclides

Explosives

If no results are given for the contaminant categories listed above, then no detects were found for that category of contaminants.

This page was inserted for clarity. It is not part of the Soil Gas Confirmation Report.

Table A.1. Soil Gas Confirmation Detected Volatile Organic Compounds (cont.)

ANALYTE	SGC NAC 000010	SGC NAC 000011	SGC NAC 000012	SGC NAC 000013	SGC NAC 000014	SGC NAC 000015	Background	10 ⁶ Construction Worker Guidelines
VOLATILES (µg/Kg)								
Acetone							NA	105000000
1,2-Dichloroethene (total)						96	NA	21500000
2-Butanone			J	J			NA	46500000
Benzene						J	NA	8900
Carbon Disulfide				4	J		NA	1400000
Chloroform							NA	NA
Chloromethane	4	J					NA	NA
Ethylbenzene						1	NA	480
Methylene Chloride	8						NA	NA
Tetrachloroethene							NA	10500000
Toluene		2	J			28	NA	1250000
Trichloroethene				7		3	NA	41000
Xylene (total)					1	J	NA	215000000

Table A.2. Soil Gas Confirmation Detected Semivolatile Organic Compounds (cont.)

ANALYTE	SGC NAC 000008	SG NAC 000009	SGC NAC 000010	SGC NAC 000011	SGC NAC 000012	SG NAC 000013	Background	10 ⁶ Construction Worker Guidelines
SEMIVOLATILES (µg/Kg)								
Acenaphthene							NA	NA
Acenaphthylene							NA	NA
Anthracene							NA	320000000
Benzo(a)anthracene	5 J				8 J		NA	4100
Benzo(a)pyrene	65 J				21 J		NA	410
Benzo(b)fluoranthene	67 J				22 J		NA	4100
Benzo(g,h,i)perylene	26 J						NA	NA
Benzo(k)fluoranthene	58 J				7 J		NA	41000
Bis(2-ethylhexyl)phthalate		71 J		36 J	35 J		NA	215000
Butylbenzylphthalate							NA	215000000
Carbazole							NA	NA
Chrysene	68 J		20 J		22 J		NA	410000
Di-n-butyl phthalate							NA	105000000
Di-n-octyl phthalate							NA	21500000
Dibenz(a,h)anthracene							NA	410
Dibenzofuran							NA	NA
Diethyl phthalate							NA	NA
Fluoranthene	11 J		31 J		38 J		NA	42500000
Fluorene							NA	NA
Indeno(1,2,3-cd)pyrene	36 J						NA	4100
2-Methylnaphthalene							NA	NA
Naphthalene						61 J	NA	NA
Phenanthrene	5 J						NA	NA
Phenol							NA	650000000
Pyrene	120 J		31 J	20 J	37 J		NA	32000000

Table A.4. Soil Gas Confirmation Detected TAL Inorganics (cont.)

ANALYTE	SGC NAC 000007	SGC NAC 000008	SGC NAC 000009	SGC NAC 000010	SGC NAC 000011	SGC NAC 000012	Background	10 ⁶ Construction Worker Guidelines
INORGANICS (mg/kg)								
Aluminum	10200	2820	1000	7300	10300	13100	19000	NA
Antimony		0.27 B	0.91 B	0.21 B	1.2 B		NA	425
Arsenic	1.9 B		11.1	7.2	2.2 B	1.5 BJ	8.6	320
Barium	26.2 B	2300 B	163	64.7	13.5 B	78.4	180	75000
Beryllium	0.28		0.9 B	0.34	0.36 B	0.44	1.3	0.7
Bismuth			0.85 B		0.99 B		NA	NA
Cadmium	0.33 B	0.22 B	6	0.62 B	5.2	6.0	2.1	1050
Calcium	8390	113000	59000	41500	90800	100000 J	310000	NA
Chromium	14.3	5.7	10.3	12	11.9	11.3	20	1050000
Cobalt	11 B	13 B	13	7.9 B	13.7	12.7 J	19	NA
Copper	16.2	13.9	19.2	17.4	16.6	21.3	26	NA
Cyanide							ND	21400
Iron	23000	660	2400	17300	25600	27900	35000	NA
Lead	7.2	5.9	22.2	16.5	5.7	9.3 J	48	NA
Lithium	3.2 B	8.2 B	14.7 B	9.2 B	27.3		26	NA
Magnesium	21600	47900	4500	16700	12300	19500 J	40000	NA
Manganese	493	156	728	604	908	658	1400	135000
Mercury							NC	320
Molybdenum	0.63 B	1.4 B	1.8 B	2.3 B	0.58 B	1.3 B	27	NA
Nickel	22.6	8.1	2.5	16.5	21.6	26.4	32	21500
Potassium	1590	463 B	1420	794 B	2210 B	1630	1900	NA
Selenium					0.31 B		NA	NA
Silver							1700	5500000
Sodium	246		1010 B	82 B	288 B	2490	240	NA
Thallium							460	NA
Tin		4.5 B	5 B			1.6 B	20	NA
Vanadium	14.3	7.4	42.5	19.2	15.8	22.4	25	7500
Zinc	53.8	36.6	71.8	299	59.9	88.5	140	320000

Table A.3. Soil Gas Confirmation Detected Pesticides/PCB's

ANALYTE	SGC NAC 000008	SGC NAC 000010	SGC NAC 000031	SGC A66 000041	SGC A61 000044	SGC A13 000050	Background	10 ⁶ Construction Worker Guidelines
PESTICIDES/PCB (µg/kg)								
Aroclor-1248	48			110	98		ND	380
Aroclor-1254	4				55		ND	21500
Alpha-Chlordane							ND	NA
Gamma-Chlordane						3.7	ND	NA
4,4'-DDT							13000	9000
Dieldrin		4.4	5*				ND	185
Endosulfan I				4	2.4*		ND	NA
Endosulfan II							NA	NA
Endrin			11				ND	NA
Heptachlor						2	ND	NA

Table A.6. Soil Gas Confirmation Detected Radionuclides (cont.)

ANALYTE	SGC NAC 000008	SGC NAC 000009	SGC NAC 000010	SGC NAC 000011	SGC NAC 000012	SGC NAC 000013	SGC NAC 000014	Background	10 ⁶ Construction Worker Guidelines
RADIONUCLIDES (pCi/g)									
Americium-241					-0.238	0.0694		ND	4.95
Bismuth-207					0.0292	-0.0304		ND	0.175
Bismuth-210					0.0055	0.0297		ND	NA
Cesium-137					0.0371	0.0175	0.0001	0.42	0.46
Cobalt-60					0.0547	-0.028		NC	0.1
Plutonium-238	0.0826	0.0233	0.107	0.0718	0.0001	0.0001	0.671	0.13	5.5
Plutonium-239/240					0.0015	0.000127	0.0206	0.18	5.5
Potassium-40	7.72	1.9	15.0	7.8	15.5	4.65	2.5	37	NA
Radium-226	0.571	0.764	0.917	0.777	0.592	0.263	1.10	2	0.14
Thorium-228	0.678	0.779	0.914	0.913	0.697	0.47	1.18	1.5	0.85
Thorium-230	0.541	1.09	1.27	0.902	0.803	0.35	1.09	1.9	44
Thorium-232	0.554	0.82	0.708	0.830	0.769	0.210	1.08	1.4	50
Uranium-234	0.361	0.712	0.897	0.881	0.69	0.378	0.866	1.1	37.5
Uranium-235			0.0459		0.0081	0.0183	0.0001	0.11	3.35
Uranium-238	0.414	0.774	1.06	0.871	0.681	0.424	1.01	1.2	11