EXECUTIVE SUMMARY
WASTE DISPOSAL ENGINEERING STUDY NO. 37-24-J2KZ-94
SITE ASSESSMENTS
HUNTER ARMY AIRFIELD
SAVANNAH, GEORGIA
29 NOVEMBER - 3 DECEMBER 1993 AND 3-7 JANUARY 1994

1. PURPOSE. This study was conducted to assess soil and ground water for possible contamination at four sites on Hunter Army Airfield for protection of human health and the environment.

2. CONCLUSIONS.

a. Soil Study.

(1) Site 1.

(a) Three feet of soil should be removed from the bermed area corresponding to sample point 1-1. Prior to replacement with uncontaminated soil, sampling and analysis of exposed soil should be performed to ensure the remaining soil meets cleanup levels. This Agency can assist in the conformational sampling and analyses.

(b) Soil in the area bordered by sample points 1-9 to 1-13 contain levels of benzo(a)pyrene, dibenzo(a,h)anthracene, and arsenic above suggested action levels. Prior to a decision on the need for remediation of this area, a study to determine the relationship between contamination at the site to the coal pile situated near the site should be performed. Soil remediation may serve no practical purpose as long as potential external sources remain. This Agency can assist in this effort.

(c) Site 1 workers should use proper clothing and adequate hygiene practices to minimize exposure at this site.

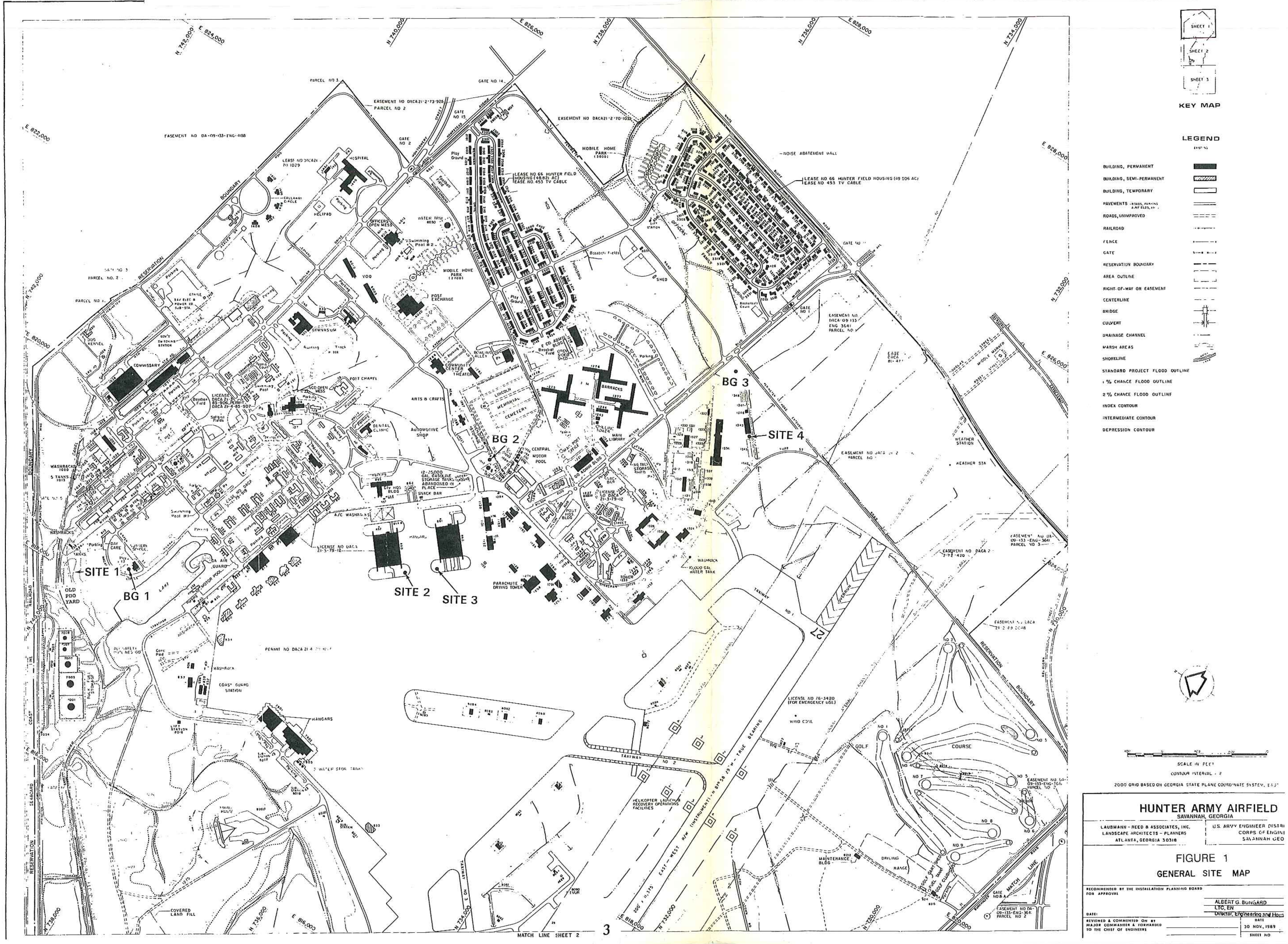
(d) All actions taken at this site should be coordinated with the Environmental Protection Division of the State of Georgia Department of Natural Resources. This includes the disposal of removed soil.

(2) Sites 2-4. Based on the variability of total petroleum hydrocarbon (TPH) concentration exhibited in the site and background samples and the absence of benzene, toluene, ethylbenzene, and xylene in the site samples, no further action at these sites appear justified. Once plans are implemented to construct concrete containment slabs at Sites 2 and 3, some sampling and analysis of soils under the existing containment system should be performed to ensure the absence of contaminants directly below the present storage area. This Agency can assist in this effort. Concurrence for this approach should be sought from the Environmental Protection Division of the State of Georgia Department of Natural Resources.

b. Ground-Water Study.

(1) Site 1. Ground water at this site is contaminated with tetrachloroethene at concentrations above the maximum contaminant level (MCL) for drinking water. Concentrations of antimony and lead are also above their respective MCLs at some monitoring points including the upgradient monitoring point, which indicates the Old PDO Yard is not the source of these metals.

DOCUMENT 1



HUNTER ARMY AIRFIELD
SAVANNAH, GEORGIA

LAUBMANN - REED & ASSOCIATES, INC.
LANDSCAPE ARCHITECTS - PLANNERS
ATLANTA, GEORGIA 30318

U.S. ARMY ENGINEER DISTRI
CORPS OF ENGINI
SAVANNAH GEO

FIGURE 1
GENERAL SITE MAP

RECOMMENDED BY THE INSTALLATION PLANNING BOARD FOR APPROVAL

ALBERT G. BUNGARD
LTC, EN
Director, Engineering and Hous

DATE:

REVIEWED & COMMENTED ON BY MAJOR COMMANDER & FORWARDED TO THE CHIEF OF ENGINEERS

DATE
30 NOV., 1989

SHEET NO

(2) Sites 2-4. Based on the TPH analysis results, ground water at these sites is not contaminated with waste fuel or waste oil from the suspected sources.

c. Health Risk Characterization, Site 1.

(1) The calculated carcinogenic risk level for worker exposure at the site exceeded the study's threshold of 1 X 10^{-6}.

(2) The calculated hazard index for workers at Site 1 exceeded the U.S. Environmental Protection Agengy established threshold of 1.0 adopted for this assessment.

(3) Both the carcinogenic risk and the noncarcinogenic risk are attributed to both the dermal absorption of chemicals and the incidental ingestion of soil at the site.

(4) Because of the limitations and assumptions used, this assessment must not be used as an absolute determination of the probability of health effects from the possible contaminants at these sites. This assessment should only be used as guidance for making decisions about using this area.

3. RECOMMENDATIONS.

a. Soil Study.

(1) Initiate plans to remove soil from the Site 1 area corresponding to sample point 1-1.

(2) Investigate the impact of the coal pile near the Site 1 area defined by sample points 1-9 through 1-13.

(3) Ensure workers at Site 1 wear proper protective clothing and use adequate hygiene practices to minimize exposure to contaminants.

(4) Investigate possible soil contamination under existing petroleum, oil, and lubricant storage at Sites 2 and 3 once new storage is established at these sites.

(5) Coordinate all actions taken at these sites with the Environmental Protection Division of the State of Georgia Department of Natural Resources. This includes the disposal of removed soil.

b. Ground-Water Study. Determine the rate and extent of ground-water contamination at Site 1. A study to implement this recommendation is planned for 18-22 April 1994 by this Agency.

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DEPARTMENT OF THE ARMY
U. S. ARMY ENVIRONMENTAL HYGIENE AGENCY
ABERDEEN PROVING GROUND, MARYLAND 21010-5422

REPLY TO
ATTENTION OF

HSHB-ME-SH

WASTE DISPOSAL ENGINEERING STUDY NO. 37-24-J2KZ-94
SITE ASSESSMENTS
HUNTER ARMY AIRFIELD
SAVANNAH, GEORGIA
29 NOVEMBER - 3 DECEMBER 1993 AND 3-7 JANUARY 1994

1. REFERENCES. A list of references is presented in Appendix A.

2. AUTHORITY. Memorandum, USAEHA, HSHB-ZA, 18 March 1993, subject: USAEHA Schedule of Field Services, FY 93.

3. PURPOSE. This study was conducted to assess soil and ground water for possible contamination at four sites on Hunter Army Airfield (HAAF) for protection of human health and the environment.

4. GENERAL.

a. Personnel Contacted.

(1) Ms. Angie Eason, Environmental Protection Specialist, HAAF.

(2) Mr. Thomas Houston, Environmental Resources Branch, Fort Stewart.

b. Study Personnel.

(1) Phase 1.

(a) Mr. Murray Brown, Environmental Scientist, U.S. Army Environmental Hygiene Agency (USAEHA).

(b) CPT Brian Copeland, Environmental Science Officer, USAEHA.

(2) Phase 2.

(a) Mr. Wayne A. Fox, Geologist, USAEHA.

(b) Mr. I. Richard Kestner, Engineering Technician, USAEHA.

(c) Ms. Kathleen R. Butoryak, Geologist, USAEHA.

(d) Mr. Steve C. Spradlin, Geologist, Probing Technologies Limited, Inc.

c. Background. The U.S. Forces Command (FORSCOM) requested USAEHA to assist HAAF, a sub-installation of Fort Stewart, in assessing four sites (Figure 1) identified in a Consent Order from the Georgia Department of Natural Resources (references 1 and 2). On 12-14 October 1993, USAEHA personnel visited HAAF to inspect and develop strategies for the characterization of surface soil, subsurface soil, and groundwater for these sites (reference 3). Phase 1 of this assessment was conducted from 29 November to 3 December 1993 to assess surface and shallow subsurface soils. Phase 2 was conducted during 3-7 January 1994 to assess ground water and deeper subsurface soils.

d. Site Description.

(1) Site 1, Old PDO Yard. This site is located near the northwestern boundary of HAAF (Figure 2). The site is fenced and has the approximate dimensions of 136 feet x 300 feet. The mainly unpaved yard is presently being used for the following purposes:

(a) An Accumulation Point for Used Oil and Off-specification JP-4. The used oil is accumulated in two 20,000-gallon aboveground tanks placed inside earthen berms. The JP-4 is accumulated in an aboveground 20,000-gallon tank located inside of one of the previously mentioned earthen berms.

(b) A 90-Day Hazardous Waste (HW) Storage Facility. This facility, an open shed on a 1,000 square foot concrete slab, has been in operation for about 1.5 years.

(c) Scrap Metal Storage.

(2) Site 2, Petroleum, Oil, and Lubricant (POL) Storage Near Hangar 850 (Figure 3). This site is 19 feet x 22 feet bermed and lined storage area containing a 600-gallon aboveground tank for used oil and a 1,000-gallon aboveground tank for off-specification JP-4. There is approximately 6 inches of sand, used as an absorbent, above the liner in the storage area. When POL spills occur within the bermed area, contaminated sand is removed and replaced with clean sand. Any accumulated rainwater has, in the past, been discharged outside the bermed area.

(3) Site 3, POL Storage Near Hangar 860 (Figure 4). This site is 15 feet x 26 feet bermed and lined storage area containing a 250-gallon aboveground tank for used oil and a 250-gallon aboveground tank for off-specification JP-4. There is approximately 6 inches

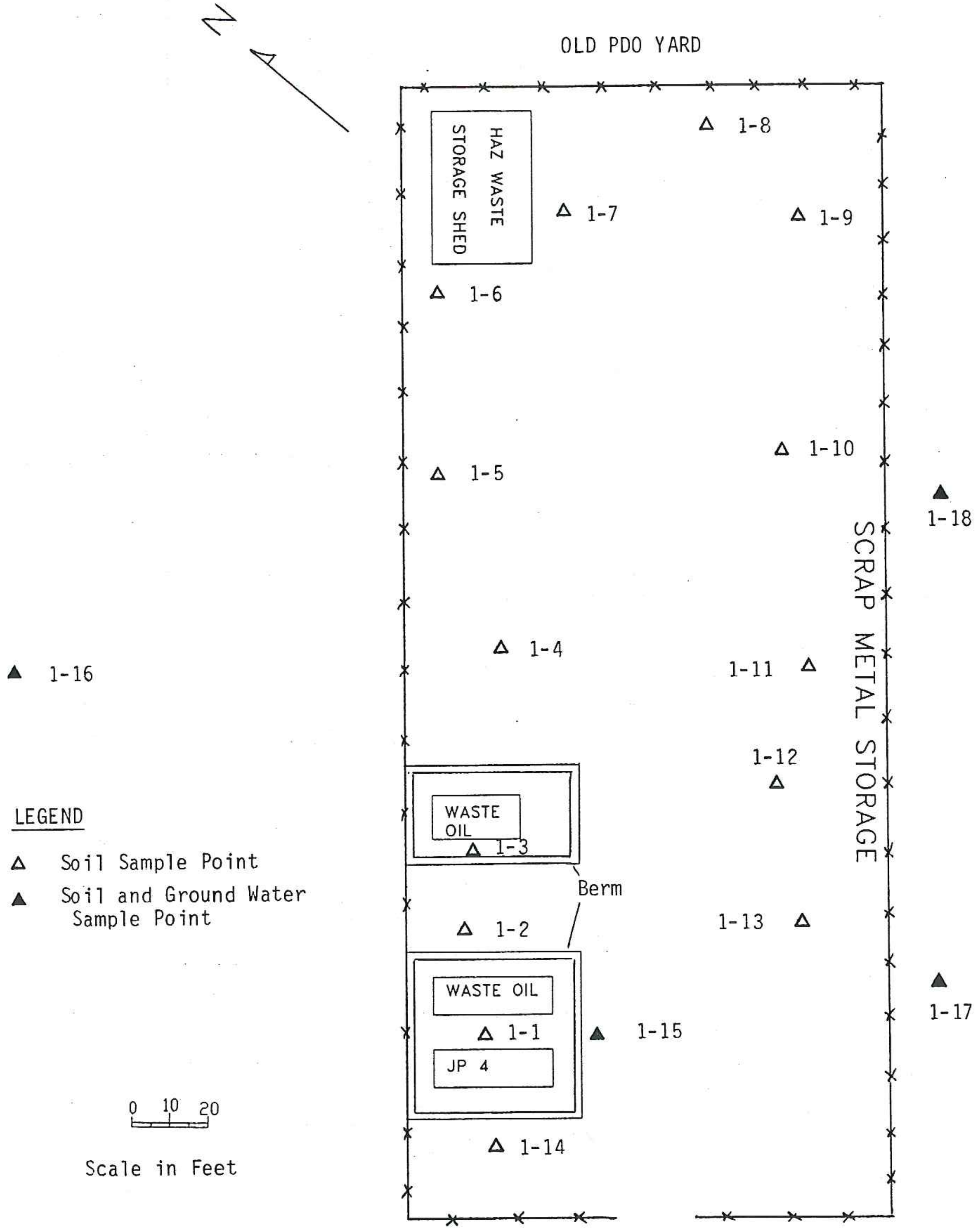


FIGURE 2. Sampling Locations, Site 1

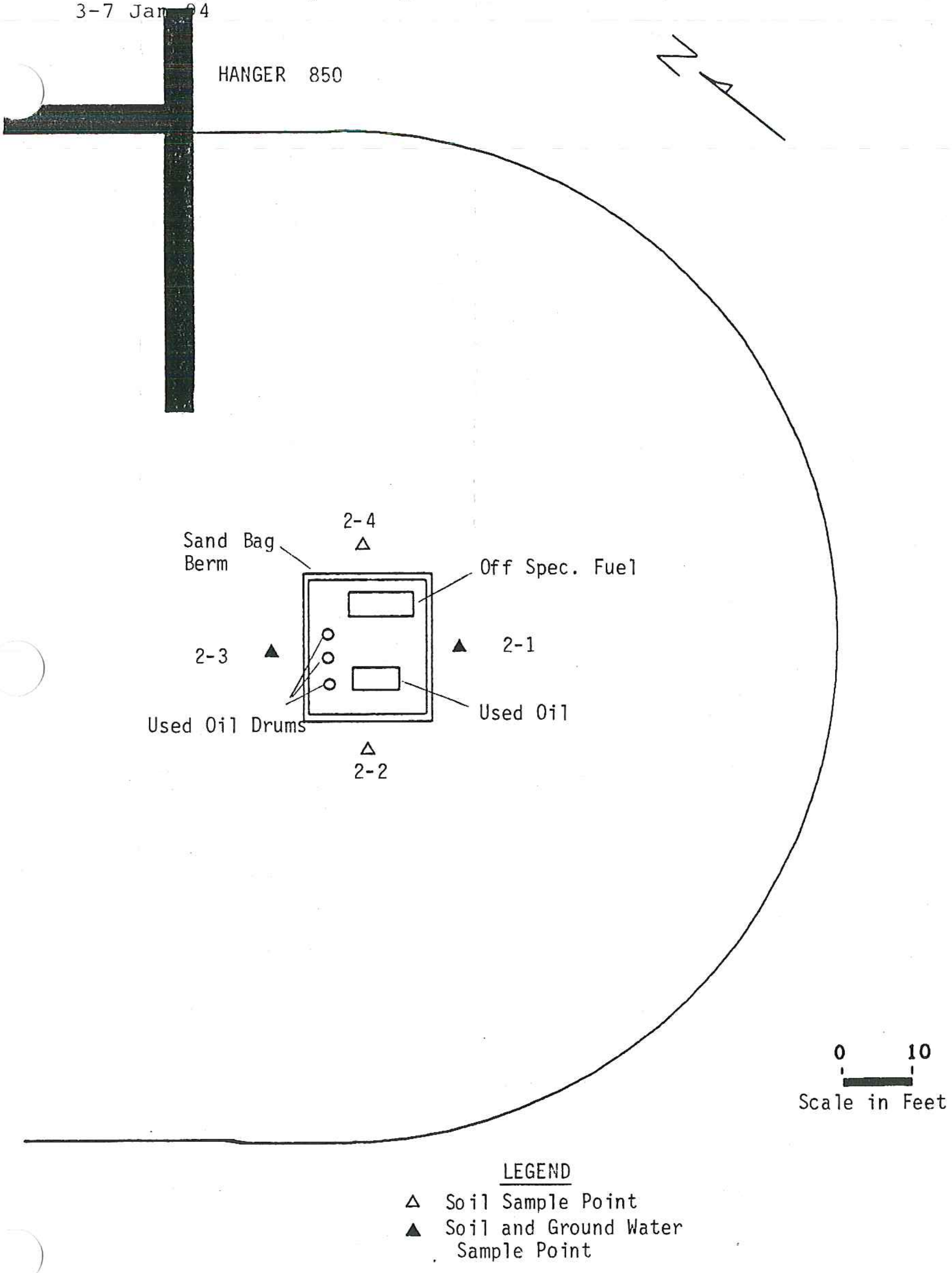


FIGURE 3. Sampling Locations, Site 2

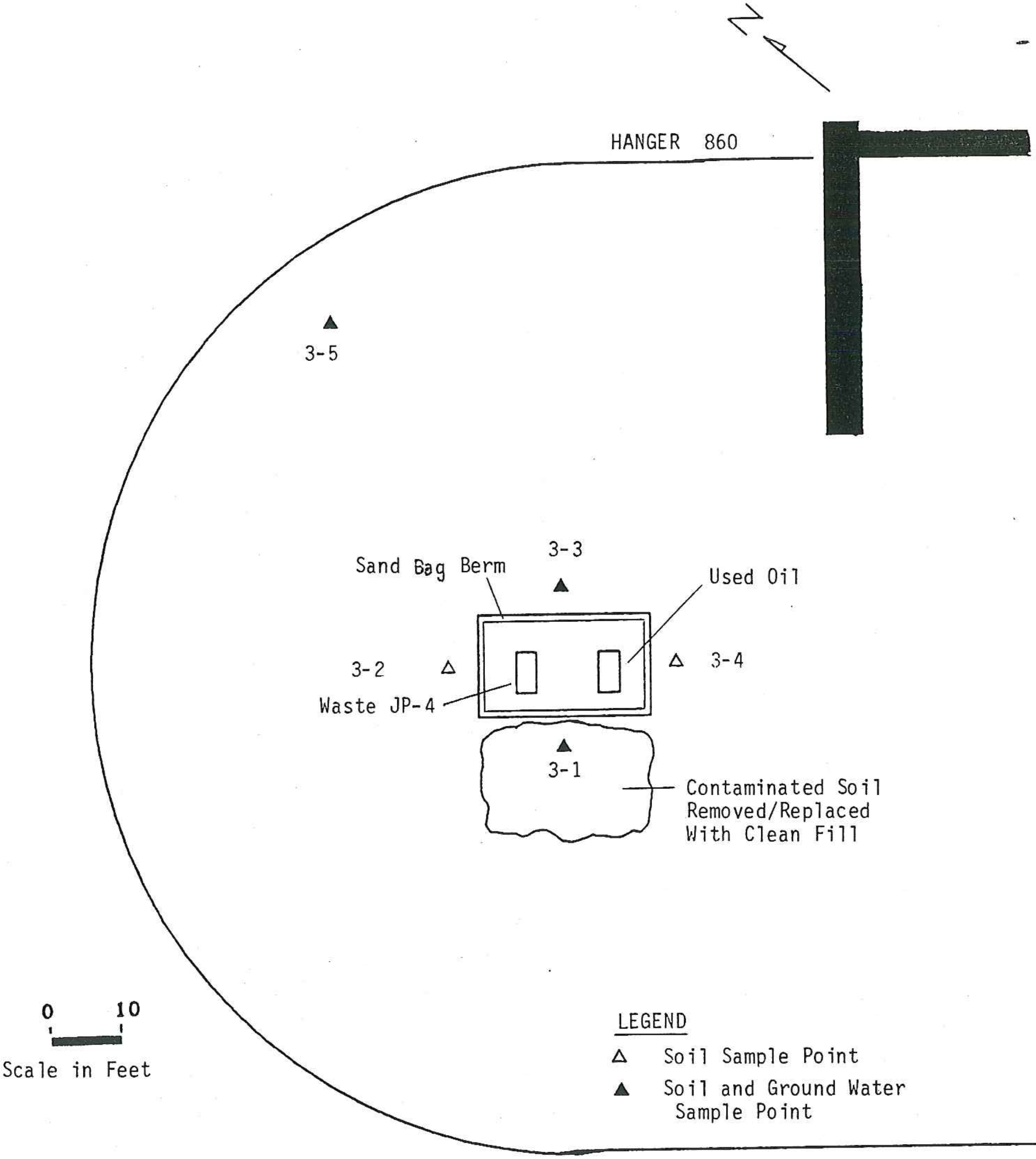


FIGURE 4. Sampling Locations, Site 3

of sand above the liner in the storage area. When POL spills occur within the bermed area, contaminated sand is removed and replaced with clean sand. Any accumulated rainwater has, in the past, been discharged outside the bermed area.

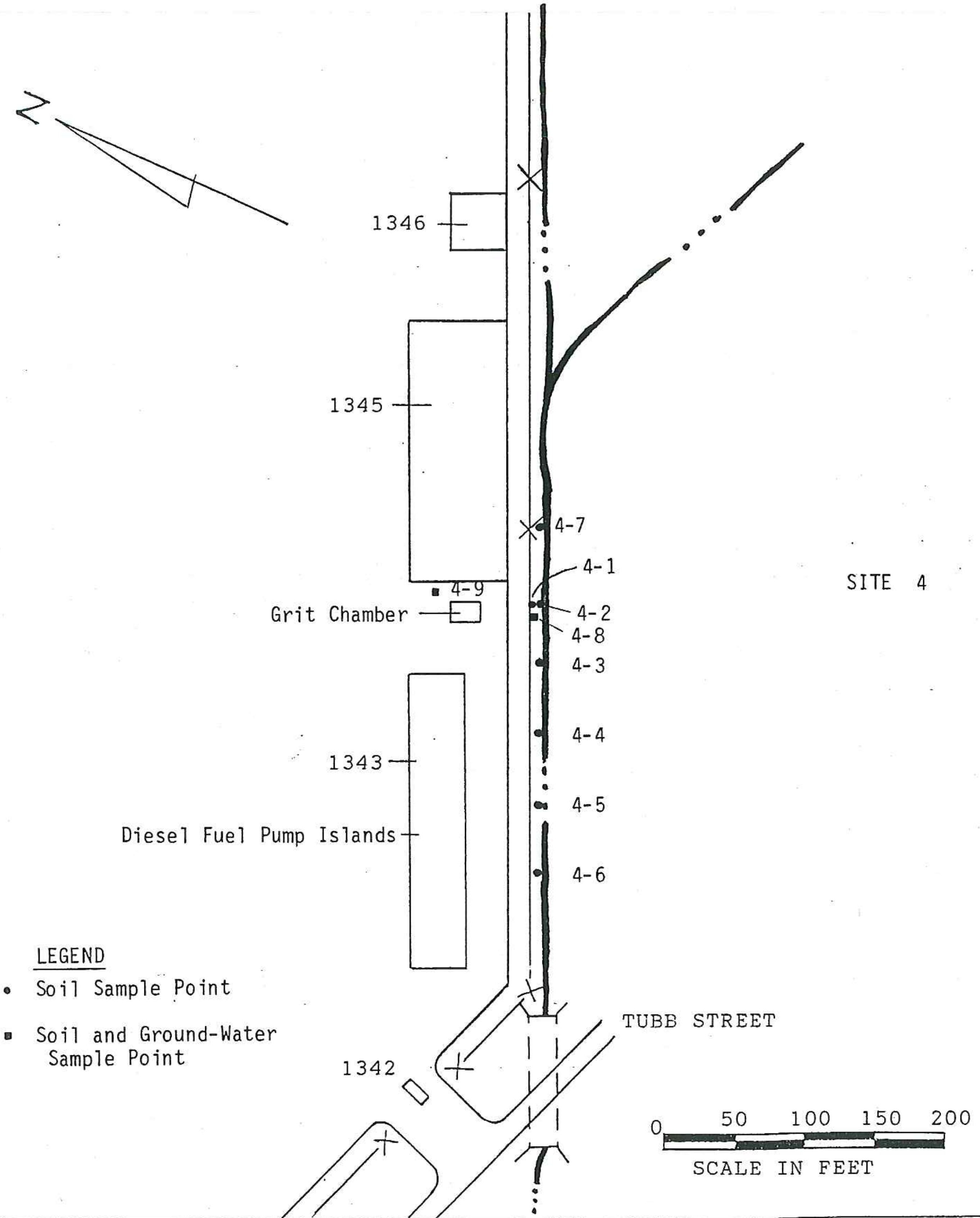
(4) Site 4, Ditch Near Building 1345 (Figure 5). Storm water from the area near several diesel fuel dispensing pumps and from a vehicle washrack discharged into a grit chamber near Building 1345. Water from the grit chamber discharged into a ditch that runs parallel to Building 1345 from northeast to southwest. The length of the 5 foot wide ditch from the point of discharge from the grit chamber to the point it passes under Tubb Road is approximately 267 feet. The discharge pipe from the grit chamber has been plugged for approximately 6 months. At the time of the Phase 1 assessment, the ditch contained approximately 2 inches of water flowing to the southwest.

e. Geologic Setting. Hunter Army Airfield is in the Southern Atlantic Coastal Plain physiographic province. This province is characterized by a wedge of unconsolidated and semi-consolidated sediments that gently dip and thicken toward the southeast. The sediments in this region are dominated by clastics (sand, silt, and clay) in the updip areas, and become more non-clastic (limestone and dolomite) near the coast. The ages of these sediments range from Recent to Cretaceous. Underlying the coastal plain sediments are a variety of igneous and metamorphic rocks known as the basement complex, which range in age from Precambrian to Triassic. These rocks dip at about 5.7 m per km in a southeast direction from the fall line near Macon and Augusta, where they appear at the surface, and drop to approximately 1,220 m below land surface in the Savannah area (references 18 and 19).

f. Water Supply Wells. There are 16 water supply wells within a 3-mile radius of the study sites, and the HAAF #1 well is within a half-mile radius of the site. The following Table is a list of these wells and two additional wells (#5 and #7) which are located on the installation beyond the 3-mile radius.

5. SITE SAMPLING. The Sampling Plan used by project personnel during Phases 1 and 2 is contained in Appendix B. The plan outlines the methodologies, approximate sample locations, analytical methods, parameters, and analysis objectives selected for this study. Three surface and subsurface background soil samples were taken in areas where minimal industrial activities had occurred. Background sample locations are presented in Figure 1. Sampling locations for each site are presented in Figures 2-5.

a. Modifications to the Phase 1 Sampling Plan. No shallow subsurface soil sample was taken at sample point 1-10, Site 1. The soil in this area of the PDO Yard, from sample points 1-9 to 1-13, contained varying amounts of coal, most likely from an adjacent coal pile on the other side of the fence. At sample point 1-10 it was impossible to hand auger below 6 inches.



US ARMY ENVIRONMENTAL HYGIENE AGENCY
WASTE DISPOSAL ENGINEERING DIVISION
ABERDEEN PROVING GROUND, MARYLAND

FIGURE 5. Sampling Locations, Site 4

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Summary of Water System Survey Data
Hunter Army Airfield

Map Number	Well Owner and Number	Information Source	Depth of Well (ft)	Bottom of Casing (ft)	Discharge (GPM)	Primary Use of Water	Comments
1	Hunter Army Airfield #1	HAA/USGS	504	259	1300	Public	
2	Hunter Army Airfield #2	HAA/USGS	555	260	1440	Public	
3	Hunter Army Airfield #3	HAA/USGS	370	324	30	Public	
4	Hunter Army Airfield #4	HAA/USGS	300	90	---	Not Used	
4A	Hunter Army Airfield #4A	HAA/USGS	360	267	80	Public	
5	Hunter Army Airfield #5	HAA	380	85	30	Public	Outside 3-mile radius
6	Hunter Army Airfield #6	HAA/USGS	180	---	---	Not Used	
7	Hunter Army Airfield #7	HAA	450	330	70	Public	Outside 3-mile
8	Hunter Army Airfield #8	HAA/USGS	375	255	80	Public	
9	Hunter Army Airfield #9	HAA/USGS	623	270	1000	Emergency	
10	Hunter Army Airfield #10	HAA	---	---	180	Vehicle Wash	
11	City of Savannah #15	USGS/C of S	414	252	1000	Public	USGS has well listed as #36
12	Mrs. McCallan	USGS	341	146	---	Public	
13	Biltmore Gardens Mobile Home Park	USGS/Owner	380	290	150	Public	
14	City of Savannah #25	USGS/C of S	540	287	1100	Public	
15	City of Savannah #13	USGS/C of S	1000	270	1300	Public	
16	City of Savannah #9	USGS/C of S	710	267	1600	Public	
17	City of Savannah #6	USGS/C of S	750	240	1400	Public	

ABBREVIATIONS AND SYMBOLS:

Ft - Feet
GPM - Gallons Per Minute
HAA - Hunter Army Airfield
USGS - United States Geological Survey
C of S - City of Savannah

b. Sample Types and Analytical Parameters.

(1) Phase 1. Only soil samples were collected during the Phase 1 assessment. Samples were analyzed for total (heavy) metals, semivolatile organic compounds (SVOCs), volatile organic compounds (VOCs), polychlorinated biphenyls (PCBs)/pesticides, total petroleum hydrocarbons (TPH), and total benzene, toluene, ethylbenzene, and xylene (BTEX) at Site 1. The metals chosen encompass the eight heavy metals identified in the HW regulations. It was felt that these metals, as contaminants, would be the most likely driving forces for potential remediation and are most commonly found at these storage sites. Samples at Sites 2-4 were only analyzed for TPH and BTEX. Sample methods, parameters, and detection limits are presented in Appendix C. A discription of this Agency's Quality Assurance Program is presented in Appendix J.

(2) Phase 2. Phase 2 included deeper subsurface soils and ground-water investigations at all sites using the Geoprobe direct push sampling system as described in the sampling plan (Appendix B). Soil samples were taken with the Geoprobe piston core sampler with a 1-inch inside diameter. Soil samples for Sites 1 through 4 were analyzed for petroleum hydrocarbons using Method 418.1 (IR) and the Modified California Method (gasoline range). Ground-water samples were taken at the Geoprobe stainless steel wire screen implants. At Site 1 ground-water samples were analyzed for the following parameters: nonmetals, metals, SVOCs, VOCs, TPH, pesticide, and PCBs. At Sites 2 through 4 ground-water samples were analyzed for petroleum hydrocarbons using Method 418.1 (IR) and the Modified California Method (gasoline range). Sample methods, parameters, and detection limits are presented in Appendix C.

c. Sample Designation. Soil samples are designated by a three digit code, e.g., 1-1-0. The first digit refers to the site, the second to the sampling point at the site, and the third to the sample depth. The depths represented by the third digit are as follows: 0 is 0-0.5'; .5 is 0.5'-1.5'. The third digit for deeper subsurface soils represents the initial depth of a 1- or 1.5-foot interval, e.g., 3 would represent a soil sample taken between 3 and 4 feet. Ground-water samples are designated by site number and sampling point number.

d. Preliminary Remediation Goals (PRGs).

(1) A summary of PRGs, as suggested in this study, is included as Appendix D. These were derived from several sources. The TPH and BTEX were derived from State of Georgia guidance for underground storage tank corrective actions (reference 4). Other PRGs were derived from guidance published by Region III, U.S. Environmental Protection Agency (EPA) (reference 6). These encompassed the majority of the potential site contaminants and are based upon an industrial/commercial land use. The PRG for PCBs was derived from the PCB Spill Cleanup Policy (reference 7) and also assumes restricted site access.

(2) These PRGs were used to screen the analytical results of the soils and to determine which parameters may be contaminants of concern. With the exception of TPH, contaminants of concern were analyzed in a quantitative health risk assessment to determine if exposure to the site poses undue health risks to site workers. These PRGs do not serve as a substitute for a risk assessment as they don't consider any additive impacts of multiple contaminants. A health risk assessment was performed on Site 1 only.

(3) These PRGs will be used to develop recommended corrective actions for those contaminants that pose potential undue risks.

e. Data Evaluation.

(1) Site 1 Soils. Fifteen surface (0-6 inches), fifteen shallow subsurface samples (6-18 inches), and six deeper subsurface samples were selected at this site. The approach to evaluating the soil data at this site is as follows:

(a) TPH and BTEX. This data was evaluated using State of Georgia guidance (reference 4) for the cleanup of underground storage tanks. A TPH action level of 100 mg/kg and a total BTEX action level of 20 mg/kg should be used since the site in question is located within 3 miles of a public water system.

(b) Metals. Three surface and three shallow subsurface background samples were collected as a reference for naturally occurring contaminants (metals), and potential anthropogenic contaminant such as organics. It should be noted that both naturally occurring and anthropotenic metals and organics are possible. These background samples are identified as sample locations BG1, BG2, and BG3 on Figure 1. The geometric mean and standard deviation for each of the metals was obtained for background samples and for the Site 1 data. A one-tailed student t-test at the 90 percent confidence level was used to determine if the sample populations had significantly higher metal concentrations than those in background samples. The geometric mean was used for comparison instead of the more traditional arithmetic mean because environmental contaminant data typically follow a log-normal frequency distribution instead of a normal frequency distribution (reference 5). Metal concentrations statically above background were compared to PRGs (Appendix D). The PRGs for all detected parameters are presented in Appendix D.

(c) Other Analytical Parameters. Volatile organics, semivolatile organics, and pesticides concentrations were not averaged; instead, the highest concentration of each identified compound was compared to suggested EPA PRGs. The PCBs were similarly compared to the Toxic Substances Control Act (TSCA) requirements for decontaminating spills in restricted access areas. An action level of 25 parts per million (ppm) is indicated for restricted access areas, e.g., areas other than electrical substations that are at least 0.1 kilometers from a residential/ commercial area and where access is limited by a man-made barrier (reference 7).

(d) Health Risk Assessment. A health risk assessment was performed on the Site 1 soil data (Appendix E). The EPA methodology used for this assessment was developed for Comprehensive Environmental Response, Compensation and Liability Act sites. Its calculations result in a quantitative estimate of health risk based on the contaminant concentrations and the exposure characteristics. The specific details of the method are outlined in reference 10.

(2) Site 2-4 Soils. Surface and shallow subsurface soils at these sites were analyzed for TPH and BTEX. Deeper soil samples were analyzed for TPH using Method 418.1 (IR) and the Modified California Method (gasoline range). Action levels are the same as those in paragraph 5e(1)(a) above.

6. FINDINGS AND DISCUSSION.

a. Site 1 Soils. A summary of analytical data is presented in Table F-1, Appendix F.

(1) TPH/BTEX. The TPH concentrations at sample point 1-1 exceed the PRG. This sample point was within the bermed area containing large tanks of waste oil and JP-4. The average TPH concentration in the 0-6 inches composite was 12,000 mg/kg and in the 6-18 inches composite was 1,900 mg/kg. The average concentrations were based on duplicate samples taken next to each other. Composite samples at 0-6 inches and 6-18 inches taken near but outside the bermed area at sample points 1-2 and 1-15 exhibited concentrations of TPH slightly above 100 mg/kg. Deeper composites at sample point 1-15 exhibited no detectable TPH concentrations. This would suggest minimal lateral movement of contaminants from underneath the bermed area. The BTEX concentration at sample 1-1 averaged 11.7 mg/kg at 0-6 inches and 8.9 mg/kg at 6-18 inches. No other sample taken at this site exhibited a BTEX concentration greater than 1.1 mg/kg.

(2) Metals. Statistical analyses of metal concentrations are summarized in Appendix G and discussed in the following paragraphs:

(a) The mean surface sample concentrations from Site 1 exceeded background concentrations for cadmium, chromium, and barium. While the mean concentration of the above metals exceed background, the mean concentrations are relatively low when compared with the PRGs, presented in Appendix D, for commercial/industrial sites. The highest individual concentrations for these metals do not exceed these PRGs. The highest lead concentration, at sample point 1-14-0, was 880 mg/kg. This concentration falls within the accepted PRG range of 500-1,000 mg/kg (reference 8). It should be noted that arsenic, while it did not statically exceed background, exhibited an average concentration which exceeded the PRG of 1.6 mg/kg.

(b) The mean subsurface (0.5-1.5 foot) sample concentration from Site 1 exceeded background concentrations for arsenic, chromium, and lead. The mean concentrations and the highest individual concentrations of these metals do not exceed the PRGs in Appendix D with the exception of arsenic. Arsenic concentrations ranged from nondetectable to 42 mg/kg with a mean of 7.50 mg/kg. Higher concentrations were found at sample points 1-9-.5 to 1-13-.5, the area of the site where coal was observed in the subsurface soil. The PRG for arsenic is 1.6 mg/kg.

(3) Pesticides. Parts per billion (ppb) concentrations of DDE and DDT were identified in samples 1-1-.5, 1-2-0, and 1-4-0. These concentrations are well below the PRG of 8.4 mg/kg. No other pesticides were found.

(4) PCBs. The PCBs (specifically Aroclor® 1254) were detected at several locations. The highest concentration was 14.6 mg/kg at sample point 1-10-0. No other surface soil sample concentration exceeded 10 mg/kg and all subsurface sample concentrations ranged from 0.82 mg/kg to nondetectable. No sample concentrations exceeded the TSCA PRG of 25 ppm.

(5) VOCs. The following volatile organics were detected at low concentrations in some samples: xylene; ethylbenzene; toluene; benzene; 1,2,4-trimethylbenzene; 1,3,5-trimethylbenzene; undecane; dodecane; N-propylbenzene; isoproylbenzene; naphthalene; 2-methylnaphthalene; methylene chloride; and trichlorofluoromethane. All detected volatile compounds listed in Appendix F were below the PRGs. With the exception of methylene chloride, a common laboratory contaminant, and trichlorofluoromethane, a common refrigerant, the other volatile organic compounds are constituents of gasoline and kerosine. With the exception of sample point 1-1, which contained ppm concentrations of gasoline and kerosene constituents, all other Site 1 samples had these constituent concentrations ranging from nondetectable to low ppb.

® Aroclor is a registered trademark of E.I. duPont de Nemours & Co., Inc., Wilmington, Delaware. Use of company names does not imply endorsement by the U.S. Army but is intended only to assist in identification of a specific product.

(6) SVOCs. The following SVOCs were identified at low concentrations in some samples: acenaphthene; fluorene; pyrene; phenanthrene; fluoranthene; benzo(a)anthracene; chrysene; benzo(b)fluoranthene; benzo(k)fluoranthene; benzo(a)pyrene; indeno(1,2,3-cd)pyrene; dibenzo(a,h)anthracene; benzo(g,h,i)perylene; and bis(2-ethylhexyl)phthalate. With the exception of bis(2-ethylhexyl)phthalate, a plasticizer and common field and laboratory contaminant, the other compounds are coal tar constituents. Coal tar SVOCs are commonly found around coal yards as a residue from the coal. These compounds were detected mainly from sample points 1-9 to 1-13, which corresponds to the area of Site 1 that contained varying amounts of coal. This area is nearest to a coal pile located on the other side of the fence. Only benzo(a)pyrene at sample points 1-9, 1-10, 1-11, 1-12, and 1-15 and dibenzo(a,h)anthracene at sample points 1-9 and 1-15 exceeded PRGs.

(7) Health Risk Characterization.

(a) The calculations of the health affects are based on the results of sampling performed by this Agency for the HAAF. The sampling applicable to this assessment consisted of 15 surface soil sample. The chemicals of concern for risk calculation are silver, arsenic, barium, cadmium, chromium, mercury, selenium, ethylbenzene, methylene chloride, toluene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, o-xylene, M&P-xylene, undecane, dodecane, trichlorofluoromethane, naphthalene, 2-methylnaphthalene, fluorene, pyrene, bis-(2-ethylhexyl) phthalate, phenanthrene, fluoranthene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno (1,2,3cd) pyrene, dibenzo(ah)anthracene, benzo(ghi)perylene, DDT, DDE, and PCBs. Appendix E contains a discussion of the data results with respect to the risk assessment, the methodology for choosing the chemicals of concern, and the calculation of exposure concentrations. Annex E-3 contains a brief description of each chemical of concern and the toxicological properties of each of the chemicals of concern. Annex E-4 contains the calculations for the risk characterization.

(b) The hazard index (a measure of the noncarcinogenic risk) calculated for worker exposure did not exceed the EPA threshold value of unity (1.0) for both the dermal and the incidental soil ingestion exposures. The chemicals most significantly contributing to the hazard index are: PCB (Aroclor 1254), and cadmium. The carcinogenic risk level, also calculated for worker exposure, exceeded the study's threshold of $1 \text{ X } 10^{-6}$ (see Table E-1-3, Appendix E) for both the dermal and incidental soil ingestion exposures. The chemicals concentrations most significantly to these risks are: arsenic, benzo(a)pyrene, dibenzo(ah)anthracene, benzo(a)anthracene, indeno(1,2,3-cd)pyrene, and PCB (Aroclor 1254).

(c) The EPA guideline for lead does not indicate whether the comparison of the guideline to site data should be accomplished by a site average value or a point to point comparison. If the comparison is made between a site average or 95% UCL, lead in the surface soil would not be found to exceed the EPA guidelines of 500 ppm for residential children or 1000 ppm for an industrial setting. This essentially means that, with respect to the levels of lead in the surface soil, the use of the area by a 0-6 year old child is safe. However, if the comparison is suppose to be a point to point comparison, one soil sample exhibited a lead concentration which exceeded the guideline of 500 ppm for the residential child. Since it is unreasonable to assume that a child would spend the first six years of its life in that one spot, our comparison of site data to the guideline will be based on the site average.

(d) Because of the limitations and assumptions used in this assessment, this must not be used as an absolute determination of the probability of health effects from the possible contaminants at this site. This assessment should only be used as guidance for making decisions about using this facility.

(8) Suggested Remedial Actions.

(a) Three feet of soil should be removed from the bermed area corresponding to sample point 1-1. Prior to replacement with uncontaminated soil, sampling and analysis of exposed soil should be performed to ensure the remaining soil meets cleanup levels. This Agency can assist in the conformational sampling and analyses.

(b) Soil in the area bordered by sample points 1-9 to 1-13 contain levels of benzo(a)pyrene, dibenzo(a,h)anthracene, and arsenic above PRGs. Prior to a decision on the need for remediation of this area, a study to determine the relationship between contamination at the site to the coal pile situated near the site should be performed. Soil remediation may serve no practical purpose as long as potential external sources remain. This Agency can assist in this effort.

(c) All actions taken at this site should be coordinated with the Environmental Protection Division of the State of Georgia Department of Natural Resources. This includes the disposal of removed soil.

(9) Minimizing Worker Exposure. Dermal exposure can be minimized by ensuring site workers are properly clothed with coveralls, gloves, and hats. Incidental ingestion can be lowered by ensuring workers implement good hygiene practices, e.g., washing prior to eating.

b. Site 1 Ground Water.

(1) Geohydrology. Four direct push sample points were accomplished at Site 1 at locations shown on Figure 2. This site is underlain by fine to very fine grained sand with some silty zones. Drilling logs based on the Geoprobe direct push sampling are provided in Appendix H. Ground-water level measurements were taken at each screen implant location through the push sample rods. The depth to ground-water ranges from 4.73 to 9.35 feet below the ground surface. Subsequent ground-water level measurements cannot be taken from the screen implants and the tubing which is used to take ground-water samples. Based on ground-water elevations at the ground-water sample points, ground-water flow direction is to the northwest toward Lamar Canal.

(2) Ground-Water Quality. Ground-water samples were analyzed for the following parameters: nonmetals, metals, SVOCs, VOCs, TPH, pesticide, and PCBs. Tables I-1 and I-2, Appendix I, provide ground-water quality data for the four screen implants at this site. Drinking water MCLs and SMCLs were used as the basis to determine ground-water quality. None of the nonmetals exceeded an MCL or SMCL. Antimony concentrations were above the MCL in monitoring point 1-15 and the background monitoring point 1-16. Lead concentrations were also above the MCL in the background monitoring point 1-16. The concentrations of iron exceeded the SMCL at three monitoring points including the background monitoring point. Manganese concentrations exceed the SMCL for the ground-water sample from monitoring point 1-17. No pesticides or PCBs were detected in the ground-water samples at detection limits listed in Appendix C. From the SVOC analyses, bis(2-ethylhexyl)phthalate was detected in each of the samples and the blank. This compound is a common laboratory contaminant. Tetrachloroethene was detected in samples from screen implants 1-15, 1-16, and 1-17. Only the sample from 1-15 exceeded the MCL of 5 μg/L for tetrachloroethene. Trichloroethene was detected at an estimated concentration of 1 μg/L in the ground-water sample from 1-15 and the source may be a chemical breakdown of the tetrachloroethene at this sample point.

c. Site 2 Soils. The TPH (EPA Method 418.1) concentrations for this site were well below 100 mg/kg with the exception of a duplicate sample taken at sample point 2-2. This sample contained 250 mg/kg in the 0-0.5 feet composite and 540 mg/kg in the 0.5-1.5 feet composite. These higher concentrations are probably an isolated "hot spot." Deeper subsurface soil samples at 3-4.5 feet and 6-7.5 feet had concentrations of 10 mg/kg or less. All soils analyzed for BTEX and Gasoline Range TPH were below detection limits of 1.1 and 2.0 mg/kg, respectively. A summary of analytical data is presented in Table F-2, Appendix F.

d. Site 2 Ground Water.

(1) Geohydrology. Three soil probes were pushed at locations shown on Figure 3. A fourth soil probe location (2-4) could not be attempted due to the presence of underground utilities. The predominant subsurface material at Site 2 is fine to very fine grained sand. Screen implants were installed at 2-1 and 2-3. Ground-water levels ranged from 7.52 to 8.01 feet below ground surface. Elevations were surveyed and ground-water elevations were calculated. Based on combined ground-water elevations for Sites 2 and 3, the ground-water flow is toward the northwest.

(2) Ground-Water Quality. Ground-water samples from this site were analyzed for TPH using EPA Method 418.1 and the modified California Method for TPH as gasoline was used to determine the more volatile fuel components. Chemical analysis results for TPH using Method 418.1 showed concentrations of TPH were below the detection limit of 1.0 mg/L for all ground-water samples. Concentrations of TPH using the modified California Method were also below the detection limit of 0.1 mg/L for all ground-water samples.

e. Site 3 Soils. Two surface soil (0-0.5 feet) concentrations and one shallow subsurface (0.5-1.5 feet) concentration marginally exceeded the 100 mg/kg cleanup criteria for TPH. Deeper subsurface soils had concentrations ranging between nondetectable to 16 mg/kg. All soils analyzed for BTEX and Gasoline Range TPH were below detection limits of 1.1 and 2.0 mg/kg, respectively. A summary of analytical data is presented in Table F-2, Appendix F.

f. Site 3 Ground Water.

(1) Geohydrology. Four soil probes were pushed at locations shown on Figure 4. Fine to very fine grained sand was the predominant subsurface material at Site 3. Screen implants were installed at 3-1, 3-3, and 3-5. Depth to ground-water ranged from 6.53 to 6.93 feet below ground surface. Elevations at each screen implant were surveyed and ground-water elevations were calculated. Based on combined ground-water elevations for Sites 2 and 3, the ground-water flow is toward the northwest. Screen implant 3-5 is used as the background ground-water quality point.

(2) Ground-Water Quality. Ground-water samples from this site were analyzed for TPH using EPA Method 418.1 and the modified California Method for TPH as gasoline was used to determine the more volatile fuel components. Chemical analysis results for TPH using EPA Method 418.1 showed concentrations of TPH were below the detection limit of 1.0 mg/L for all ground-water samples. Concentrations of TPH using the modified California Method were also below the detection limit of 0.1 mg/L for all ground-water samples.

g. Site 4 Soils. A surface soil sample (4-1) taken below the grit chamber discharge pipe had a TPH concentration of 120 mg/kg, which is marginally above the cleanup criteria. A shallow subsurface soil sample, at this sampling point, had a TPH concentration of 42 mg/kg. Surface soil samples taken every 50 feet along the side of the ditch and downstream of the discharge pipe had TPH concentrations ranging from 18 to 70 mg/kg. One surface soil (4-7) was taken at the side of the ditch and 50 feet upstream of the discharge pipe. This soil had a TPH concentration of 60 mg/kg, which is within the range of concentrations found in the downstream soils. Deeper subsurface samples at sampling points 4-8 and 4-9 had TPH concentrations ranging from nondetectable to 35 mg/kg. All soils analyzed for BTEX and Gasoline Range TPH were below detection limits of 1.1 and 2.0 mg/kg, respectively. A summary of analytical data is presented in Table F-2, Appendix F.

h. Site 4 Ground Water.

(1) Geohydrology. Two direct push sample points were accomplished at Site 4 at locations shown on Figure 5. This site is underlain by coarse to very fine grained sand and silt. Drilling logs based on the Geoprobe direct push sampling are provided in Appendix H. A ground-water level measurement was taken at 4-8 through the push sample rods. The depth to ground-water was 3.77 feet below the ground surface at sample point 4-8. The apparent ground-water flow direction is to the adjacent drainage ditch.

(2) Ground-Water Quality. Ground-water samples from this site were analyzed for TPH using EPA Method 418.1 and the modified California Method for TPH as gasoline was used to determine the more volatile fuel components. Chemical analysis results for TPH using EPA Method 418.1 showed concentrations of TPH were below the detection limit of 1.0 mg/L for all ground-water samples. Concentrations of TPH using the modified California Method were also below the detection limit of 0.1 mg/L for all ground-water samples.

i. Background Soils. Three surface and three shallow subsurface background soils were taken in areas where industrial operations were believed to be at a minimum (Figure 1). The analytical data for the background soils are presented in Table F-3, Appendix F. The samples contained varying amounts of heavy metals, ppb concentrations of some gasoline constituents, and concentrations of TPH (EPA Method 418.1). The TPH concentration ranged from 44 to 110 mg/kg in the surface soils and ranged from 30 to 280 mg/kg in the shallow subsurface soils. Benzo(a)pyrene was estimated, i.e., below normal detection limits, in one surface soil at 0.43 mg/kg.

j. Suggested Remedial Actions, Soils, Sites 2-4. Based on the variability of TPH (EPA Method 418.1) concentration exhibited in the site samples and the background samples and the absence of BTEX in the site samples, no further action at these site appears justified.

Once plans are implemented to construct concrete containment slabs at site 2 and 3, some sampling and analysis of soils under the existing containment system should be performed to insure the absence of contaminants directly below the present storage area. This Agency can assist in this effort. Concurrence for this approach should be sought from the Environmental Protection Division of the State of Georgia Department of Natural Resources.

7. CONCLUSIONS.

a. Soil Study.

(1) Site 1.

(a) Three feet of soil should be removed from the bermed area corresponding to sample point 1-1. Prior to replacement with uncontaminated soil, sampling and analysis of exposed soil should be performed to ensure the remaining soil meets cleanup levels. This Agency can assist in the conformational sampling and analyses.

(b) Soil in the area bordered by sample points 1-9 to 1-13 contain levels of benzo(a)pyrene, dibenzo(a,h)anthracene, and arsenic above PRGs. Prior to a decision on the need for remediation of this area, a study to determine the relationship between contamination at the site to the coal pile situated near the site should be performed. Soil remediation may serve no practical purpose as long as potential external sources remain. This Agency can assist in this effort.

(c) Site 1 workers should use proper clothing and adequate hygiene practices to minimize exposure at this site.

(d) All actions taken at this site should be coordinated with the Environmental Protection Division of the State of Georgia Department of Natural Resources. This includes the disposal of removed soil.

(2) Sites 2-4. Based on the variability of TPH (EPA Method 418.1) concentration exhibited in the site samples and the background samples and the absence of BTEX in the site samples, no further action at these site appears justified. Once plans are implemented to construct concrete containment slabs at Sites 2 and 3, some sampling and analysis of soils under the existing containment system should be performed to ensure the absence of contaminants directly below the present storage area. This Agency can assist in this effort. Concurrence for this approach should be sought from the Environmental Protection Division of the State of Georgia Department of Natural Resources.

b. Ground-Water Study.

(1) Site 1. Ground water at this site is contaminated with tetrachloroethene at concentrations above the MCL for drinking water. Concentrations of antimony and lead are also above their respective MCLs at some monitoring points including the upgradient monitoring point, which indicates the Old PDO Yard is not the source of these metals.

(2) Sites 2 Through 4. Based on the TPH analysis results, ground water at these sites is not contaminated with waste fuel or waste oil from the suspected sources.

c. Health Risk Characterization, Site 1.

(1) The calculated carcinogenic risk level for worker exposure at the site exceeded the study's threshold of 1×10^{-6} (see Table E-1-3, Annex E-1, Appendix E).

(2) The calculated hazard index for workers at the site did not exceed the EPA established threshold of 1.0 adopted for this assessment.

(3) Both the carcinogenic risk and the noncarcinogenic risk are attributed to dermal absorption of chemicals and incidental ingestion of soil at the site.

(4) Because of the limitations and assumptions used, this assessment must not be used as an absolute determination of the probability of health effects from the possible contaminants at these sites. This assessment should only be used as guidance for making decisions about using this area.

8. RECOMMENDATIONS.

a. Soil Study.

(1) Initiate plans to remove soil from the Site 1 area corresponding to sample point 1-1.

(2) Investigate the impact of the coal pile near the Site 1 area defined by sample points 1-9 through 1-13.

(3) Ensure workers at Site 1 wear proper protective clothing and use adequate hygiene practices to minimize exposure to contaminants.

(4) Investigate possible soil contamination under existing POL storage at Sites 2 and 3 once new storage is established at these sites.

(5) Coordinate all actions taken at these sites with the Environmental Protection Division of the State of Georgia Department of Natural Resources. This includes the disposal of removed soil.

b. Ground-Water Study. Determine the rate and extent of ground-water contamination at Site 1. A study to implement this recommendation is planned for 18-22 April 1994 by this Agency.

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APPENDIX A

REFERENCES

1. Memorandum, U.S. Army Forces Command (FORSCOM), FCEN-CEE, 30 September 1993, subject: Characterization of Four Sites on Hunter Army Airfield.

2. Consent Order, State of Georgia Department of Natural Resources, 1 October 1993, Amended 17 February 1994.

3. USAEHA Site Visit by Mr. Murray Brown and Mr. Wayne Fox, this Agency, 12-14 October 1993, subject: Preliminary Assessment of the Four Potentially Contaminated Sites.

4. Georgia Department of Natural Resources Guidance on Closure of Underground Storage Tanks, March 1993.

5. Soil Sampling Quality Assurance User's Guide, Second Edition, U.S. Environmental Protection Agency (EPA) 600/8-89/046, March 1989.

6. Risked-Based Concentration Table, Third Quarter 1993, EPA, Region III, July 1993.

7. Title 40, Code of Federal Regulations (CFR), 1992 rev, Part 761.120, Polychlorinated Biphenyls (PCBs) Spill Cleanup.

8. Memorandum, EPA, Office of Solid Waste and Emergency Response, 29 August 1991, subject: Update on Soil Lead Cleanup Guidance.

9. SW-846, EPA, Test Methods for Evaluating Solid Waste - Laboratory Manual, Physical/Chemical Methods, 3d Ed., January 1990.

10. EPA 540/1-89/001, March 1989, Risk Assessment Guidance for Superfund, Volume II, Environmental Evaluation.

11. EPA, Superfund Exposure Assessment Manual, SEAM, April 1988.

12. EPA 540/1-86/060, May 1986, Superfund Public Health Manual.

13. EPA 600/8-89/043, March 1989, Exposure Factors Handbook.

14. EPA, Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual, OSWER Directive 9285.7-01a, 29 September 1989.

15. Final Guidelines for the Health Risk Assessment of Chemical Mixtures, Guidelines for the Health Risk Assessment of Chemical Mixtures, Federal Register (FR) 34014, 24 September 1986.

16. Final Guidelines for Estimating Exposure, Guidelines for Estimating Exposures, 51 FR, 34042, 24 September 1986.

17. EPA, Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites, OSWER Directive 9355.4-02, 7 September 1989.

18. Environmental Program Review No. 32-24-7038-89, 24th Infantry Division (Merchandized), Fort Stewart and Hunter Army Airfield, Fort Stewart, Georgia, prepared by USAEHA, August 1988.

19. Installation Assessment of Headquarters, 24th Infantry Division and Fort Stewart, Georgia, Report No. 334, Environmental Science and Engineering, Inc., October 1983.

20. EPA Publication 9285.7-081, May 1992, subject: Supplemental Guidance to RAGS: Calculating the Concentration Term.

APPENDIX B

SAMPLING PLAN

SAMPLING PLAN
HAZARDOUS WASTE STUDY NO. 37-24-J2KZ
HUNTER ARMY AIRFIELD

1. AUTHORITY. Memorandum, USAEHA, HSHB-ZA, 18 March 1993, subject: USAEHA Schedule of Field Services, FY 93.

2. REFERENCES.

a. Memorandum, U.S. Army Forces Command (FORSCOM), FCEN-CEE, 30 September 1993, subject: Characterization of Four Sites on Hunter Army Airfield.

b. Consent Order, State of Georgia Department of Natural Resources, 1 October 1993.

c. USAEHA Site Visit by Mr. Murray Brown, and Mr. Wayne Fox, this Agency, 12-14 October 1993, subject: Preliminary Assessment of the four potentially contaminated sites.

d. USEPA Soil Sampling Quality Assurance User's Guide, second edition, EPA/600/8-89/046, March 1989

e. SW-846, U.S. Environmental Protection Agency-Office of Solid Waste and Emergency Response, Test Methods for Evaluating Solid Waste - Laboratory Manual, Physical/Chemical Methods, 3rd Ed., January 1990.

3. PURPOSE. The purpose of this study is to assess four sites on Hunter Army Airfield (HAAF) for possible chemical contamination.

4. BACKGROUND. This Agency was requested by FORSCOM (reference 2a) to assist HAAF in assessing four sites identified in a Consent Order from the Georgia Department of Natural Resources (reference 2b). USAEHA personnel visited HAAF on 12-14 October (reference 2c) to inspect the four sites and develop strategies for the characterization of surface soil, subsurface soil, and groundwater at these sites.

5. GENERAL. The characterization of these sites will be performed in two phases. Phase 1 will be performed during the period 29 November to 3 December 1993 and Phase II will be accomplished 4-11 January 1994. Phase I will address the assessment of surface soils (0-6") and shallow subsurface soils (6-18") at the four sites. Phase 2 of the study will address the assessment of deeper subsurface soils and groundwater. The use of the Geoprobe system (Annex 1) is proposed for deep soils and ground-water investigations instead of installing conventional monitoring wells. If ground-water contamination is identified, permanent monitoring wells will be installed within 60 days. The sampling approach is presented below.

6. SITE DESCRIPTION.

a. Site 1, Old PDO Yard. This site is located near the Northwestern boundary of HAAF. The site is fenced and has the approximate dimensions of 136'x 300' (Figures 1, Annex 2). The yard is presently being used for the following purposes:

(1) An accumulation point for used oil and off-specification JP-4. The used oil is accumulated in 2-20,000 gallon above ground tanks placed inside earthen berms. The JP-4 is accumulated in an above ground 20,000 gallon tank located inside of one of the previously mentioned earthen berms.

(2) A 90-day hazardous waste (HW) storage facility. This facility, an open shed on a 1000 sq. ft. concrete slab, has been in operation for about 1.5 years.

(3) Scrap metal storage.

b. Site 2, Petroleum, oil, and Lubricant (POL) Storage near Hangar 850. This site is a 19'x 22' bermed and nylon reinforced butyl rubber lined storage area containing a 600 gallon above ground tank for used oil and a 1000 gallon above ground tank for off-specification JP-4 (Figure 2, Annex 2). There is approximately 6" of sand above the liner in the storage area. When POL spills occur within the bermed area, contaminated sand is removed and replaced with clean sand. Any accumulated rainwater has, in the past, been discharged outside the bermed area.

c. Site 3, POL Storage near Hangar 860. This site is a 15'x 26' bermed and nylon reinforced butyl rubber lined storage area containing a 250 gallon above ground tank for used oil and a 250 gallon above ground tank for off-specification JP-4 (Figure 2, Annex 2). There is approximately 6" of sand above the liner in the storage area. When POL spills occur within the bermed area, contaminated sand is removed and replaced with clean sand. Any accumulated rainwater has, in the past, been discharged outside the bermed area.

d. Site 4, Ditch near Building 1345. Stormwater from the area near several diesel fuel dispensing pumps and from a vehicle washrack discharged into a grit chamber near building 1345. Water from the grit chamber discharged into a ditch that runs parallel to building 1345 from Northeast to Southwest. The length of the 5' wide ditch from the point of discharge from the grit chamber to the point it passes under Tube Road is approximately 267'(Figure 3, Annex 2). The discharge pipe from the grit chamber has been plugged for approximately 6 months. At the time of the preliminary assessment, the ditch contained several inches of water flowing to the Southwest.

7. WORK PLAN.

a. Data Quality Objectives. The primary purpose of this investigation is to determine the presence of contamination in the soil and ground water at the four sites in question. A statistically-based soil sampling approach delineated in reference 2d will be used. This USEPA guidance suggests that a minimum of 4 samples be collected at sites 2, 3, and 4 from each stratum sampled. This conservative approach employs a confidence level of 80%, a power of 95%, a minimum detectable relative difference of 20%, and a coefficient of variation of 15%. A minimum of 15 samples will be collected from each stratum sampled at Site 1. This is based upon changing the coefficient of variation from 15% to 30%. The rationale for the larger sample size is the relatively larger area of site 1 and the uncertainty of past activities at this site. In the collection of environmental samples, the first two parameters (i.e., confidence level and power) are of particular concern. The confidence level addresses the analytical results which are false positive. The higher the confidence level, the lower the probability of a false positive. The higher the power value, the lower the degree of probability that a false negative will be identified in the data set. The preclusion of false negatives is especially important for the protection of human health, as people may be exposed to areas certified as "clean" when they may actually remain contaminated. Hence the use of the most conservative power value available when computing the number of samples required.

b. Sample locations.

(1) Site 1.

(a) Shallow Soils. One surface sample and one shallow subsurface soil sample will be taken approximately every 50′ parallel to the fence line and 25′-35′ inside the fence. This will include one set of samples within each of the bermed POL storage areas. The sampling configuration is chosen because storage of material is mostly in this area.

(b) Deep Soils and Ground Water. Deeper soil samples will be taken at the three monitoring point locations at depth intervals of 5 feet until the water table is encountered. One upgradient and two downgradient ground-water quality monitoring points will be installed near the site.

(2) Site 2 and 3.

(a) Shallow soils. Four surface and four shallow subsurface soil sample will be taken approximately 5′ outside of the bermed and lined POL storage areas.

(b) Deep Soils and Ground Water. Deeper soil samples will be taken at the two monitoring point locations at depth intervals of 5 feet until the water table is encountered. One upgradient and two downgradient ground-water quality monitoring points will be installed near each site.

(3) Site 4.

(a) Shallow Soils. One surface soil will be taken at the point where water from the grit chamber discharged to the ditch. One surface soil sample will be taken every 50′ along the ditch in a southwestern direction up to Tube Road. One surface sample will be taken up gradient of the point of discharge.

(b) Deep Soils and Ground Water. Since the potential contaminants at this site primarily affect the shallow soils, deeper soil and ground-water sampling should be contingent on finding contaminants in the shallow soils. If contamination is identified, deeper soil samples will be taken at the two monitoring point locations at depth intervals of 5 feet until the water table is encountered and one upgradient and one downgradient ground-water quality monitoring points will be installed near each site.

c. Analytical Parameters and Methodologies.

(1) Site 1. Soil and ground-water samples will be analyzed for the parameters of total metals, semivolatile organic compounds (SVOCs), volatile organic chemicals (VOCs), pesticide, and PCBs. The analyses will be accomplished using the basic protocols and procedures established in SW-846 (reference 2e) or other equivalent EPA methods. A total petroleum hydrocarbon (TPH) analysis will be performed on soil samples from the bermed POL areas of site 1. The TPH will be analyzed using EPA Method 418.1, an infra-red method. A USAEHA gas chromatographic method will be used to determine the more volatile gasoline and diesel components of TPH.

(2) Sites 2, 3, and 4. Soil and ground-water samples from these sites will be analyzed for TPH using EPA Method 418.1, an infra-red method. A USAEHA gas chromatographic method will be used to determine the more volatile fuel components of TPH.

d. Control Sites.

(1) Control sites are areas that are unaffected by any potential releases at the study site and provide background data for naturally occurring parameters at the study sites. Only metals will be considered as naturally occurring parameters for this study. The presence of any other analyzed parameters will be considered indicative of site induced contamination.

(2) Three background locations will be selected. The background samples will be collected from areas, outside the boundaries of the four sites, that are currently not showing signs of stressed vegetation and where no present or past industrial activities have occurred. Both surface and shallow subsurface background samples will be collected

e. Sampling Methods.

(1) Shallow Soils. Surface soils will be collected with either stainless steel scoops or bulb planters. Shallow subsurface soils will be collected with a hand auger. When necessary, soil samples will be composited in stainless steel bowls. All samples will be transferred to clean and labeled glass jars.

(2) Deeper Soils. Deeper soil samples will be collected in a 1-inch sample. Samples will be transferred to clean and labeled glass jars.

(3) Ground Water. At all monitoring points, the water level will be determined. After pumping three times the well volume of water from each monitoring point, the monitoring point will be sampled. Ground-water samples will be placed in appropriate containers. Purge water from the monitoring wells will be containerized and disposal decisions will be made after analytical results are available. Ground-water and deeper subsurface soil samples will be obtained using a Geoprobe System (See Enclossure 2).

f. Sample handling and Analysis.

(1) Field Procedures. Project personnel will place all samples in containers at the site. Labels will be affixed with installation name, project number, project officer, date sampled, sample identification, and analysis required marked with an indelible pen. Samples will immediately placed into coolers filled with ice to maintain a temperature of approximately 4 ^{O}C. The Project Officer will record appropriate field observations in a permanently bound field notebook.

(2) Shipment and Chain of Custody. All samples will be transported by Federal Express to the USAEHA Analytical Laboratory. Project personnel will ensure sample integrity and security by using the chain of custody procedures. A USAEHA chain of custody form will track the history of the samples from the time of collection to analysis and final disposition.

(3) Analytical Methods for Chemical Analysis. All analyses will be performed by the USAEHA Analytical Laboratory or contract laboratories. Typical test methods and detection limits for the parameters of interest are presented in the table below.

TABLE

ANALYTICAL METHODS

Parameter	EPA Method	Detection Limit* (mg/kg)
Arsenic	206.2	0.5
Barium	208.2	1.0
Cadmium	213.2	0.25
Chromium	218.2	0.5
Lead	239.2	0.5
Mercury	245.1	0.1
Selenium	270.2	0.5
Silver	272.2	0.5
Semivolatile organics	8270	0.3-1.0
Volatile organics	8260	0.005
Pesticides/PCBs	8081	0.01-
0.15		
TPH	418.1	10.0
TPH(gasoline range)**	8015/8020	5.0
TPH(diesel range)	USAEHA GC Method	4.0

*Detection limits vary with matrix interferences.
**This method can be used to simultaneously determine BTEX.

(4) Decontamination Procedures. Dedicated or disposable equipment will be used when possible to prevent the need for decontamination. All nondedicated sampling equipment will be decontaminated in a three stage process. Project personnel will first rinse the equipment in tap water to remove any remaining soil - brushing the equipment when necessary. This will be followed by washing the equipment in a soap and distilled water solution and finally rinsing with deionized water. All pumps and hoses will be flushed with potable water and all surfaces will be triple rinsed with lab grade detergent followed by a triple rinse with deionized water.

(5) Quality Control (QC)/Quality Assurance.

(a) Field QC. One duplicate shallow soil sample will be taken at Sites 2-4. Two duplicate shallow soil samples will be taken Site 1. A travel blank will accompany the samples.

(b) Laboratory QC. All analyses will be performed in accordance with EPA QC/QA standards.

8. SITE SAFETY PROCEDURES. A site safety and health plan is required for all environmental sampling projects. The plan summarizes the potential hazards and outlines precautions and safety procedures to be followed during sample collection.

9. SCHEDULE. The study team for Phase I is scheduled to travel to HAAF on 29 November 1993. The proposed sampling will occur on between 29 November and 3 December 1993. Samples will be delivered to the USAEHA Laboratory Customer Service Division (LCSD) on 1-3 December 1993. The Phase II study team is scheduled to travel to HAAF on 3 January 1994. The proposed sampling will occur on 4-9 January 1994. Samples will be delivered to the USAEHA LCSD on 6-9 January 1994. Analytical results should be available to the project officer 30 days after delivery to LCSD.

10. CLEANUP STANDARDS. For all constituents, cleanup standards relevant to this sampling plan are based on comparisons to background concentrations and determination of risk to human health and the environment. Representative background soil samples will be collected. Detections at or below the applicable background concentrations will require no further action, since there is either no indication of release from the site or the detected concentrations are pervasive at the installation. For concentrations detected above background levels, risk assessment methodology will be used to determine action levels and remediation requirements. Exceptions to the above include PCB contamination, which will be remediated to the acceptable levels defined in 40 CFR 761, Subpart G, and TPH, which will be remediated in accordance with State guidance.

10. TECHNICAL ASSISTANCE. All inquiries regarding this project may be directed to Mr. Murray Brown or Mr. Wayne Fox, DSN 584-3651 or Commercial (410) 671-3651.

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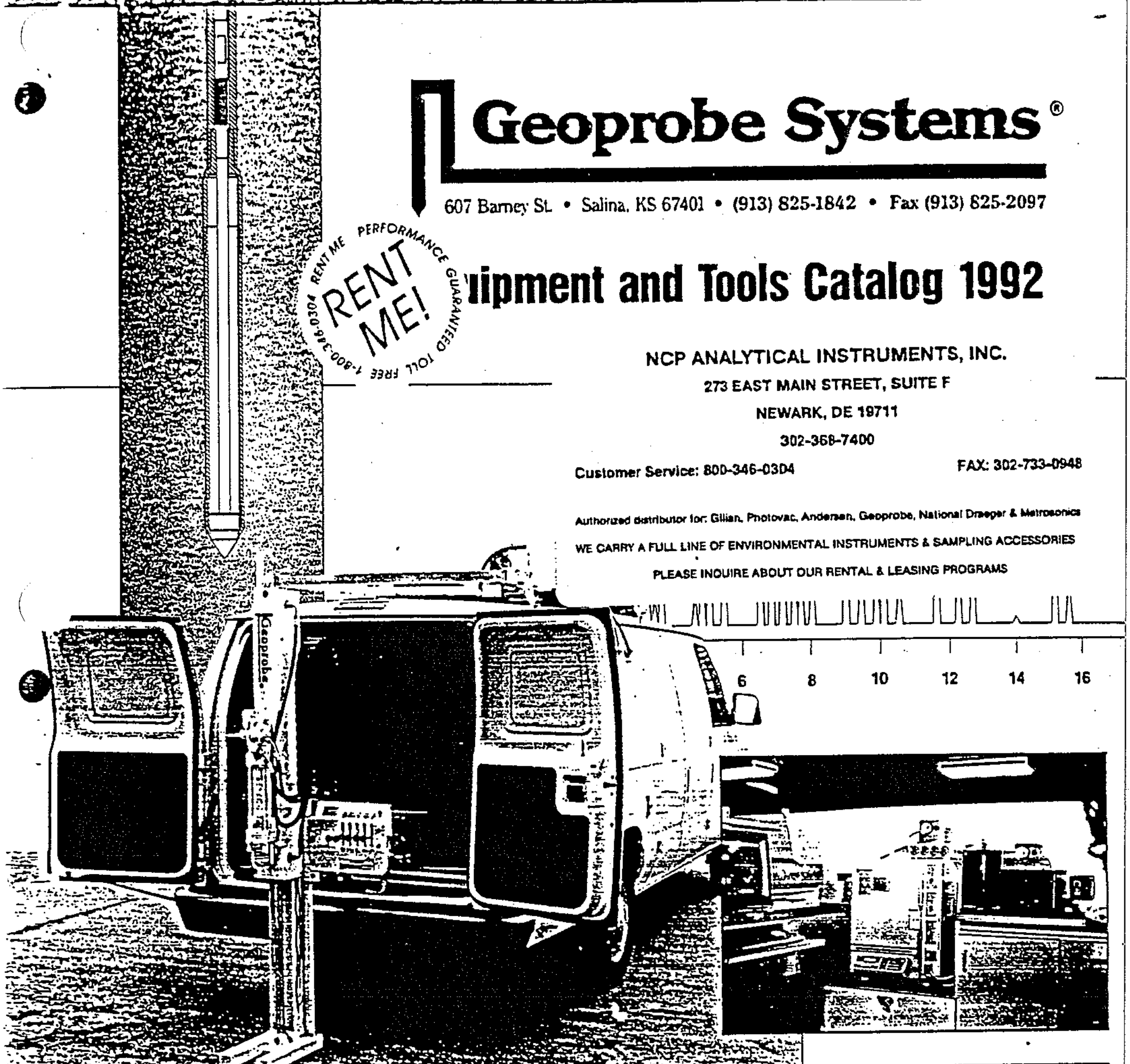

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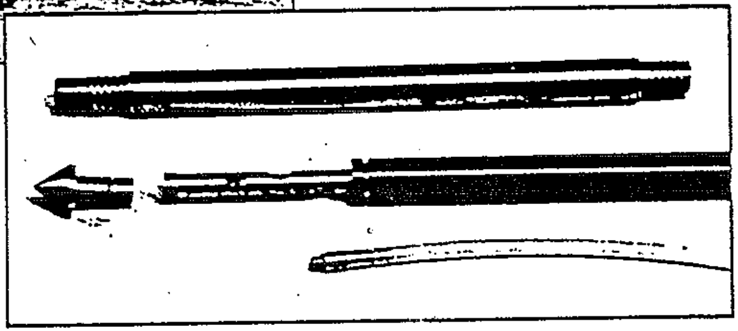

Annex 1

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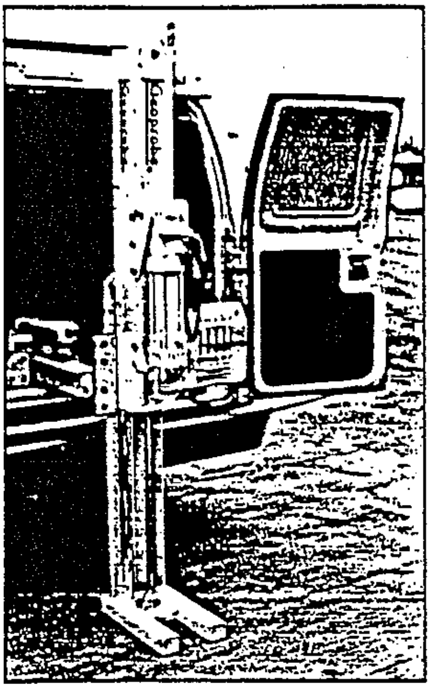
About Our Company:

1992 marks the beginning of the sixth year of production for the popular Geoprobe "8" Series Soil Probing Machines. Geoprobes now are seen on three continents and have visited a fourth. In the United States, they have been used in every state including Alaska and Hawaii. Their use is changing the definition of site investigation with fast, economical multiple depth sampling and real-time analysis.



Every year since 1987, Geoprobe Systems has tested and developed new tools and methods for collecting soil gas, soil core, and ground water samples. From the experience gained by having over seventy soil probes in the field and with the knowledge imparted to us by the men and women who use them in the field, we have developed some of the most innovative and reliable sampling tools on the market today.

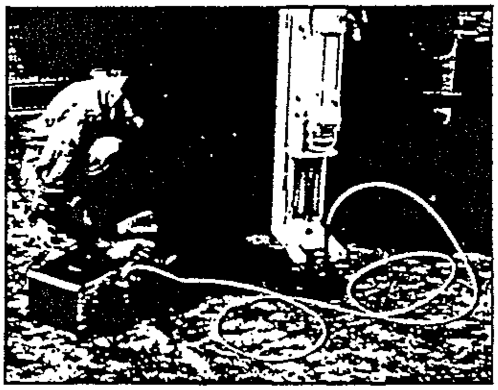
This catalog contains an overview of the field-proven equipment and sampling tools made by Geoprobe Systems. Our machines will get you to depth, and our tools will get you samples at depth. Our mobile laboratories will provide you with the real-time data that you need to make quick decisions in the field.

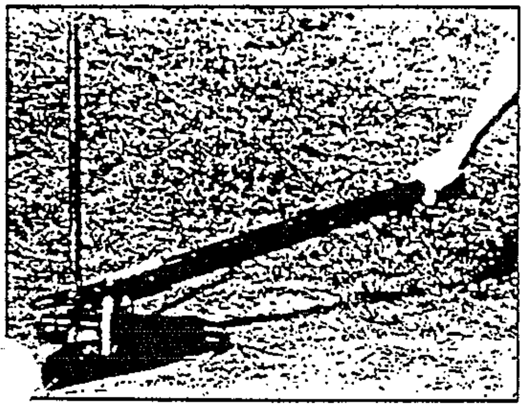
If this catalog does not answer your questions or you desire further information or price quotations, please call us. Our technical support staff is always ready to help.

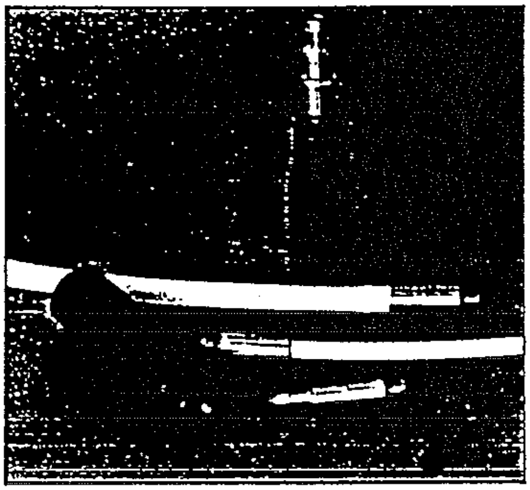
As we enter our sixth year, we pledge to continue to serve the industry and our clients by viding them with the tools for site investigation.

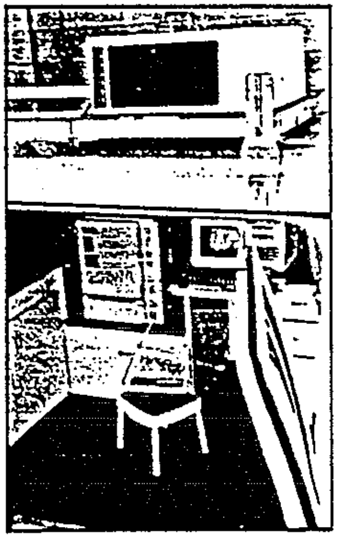
Melvin Kejr

M.P. Kejr
President



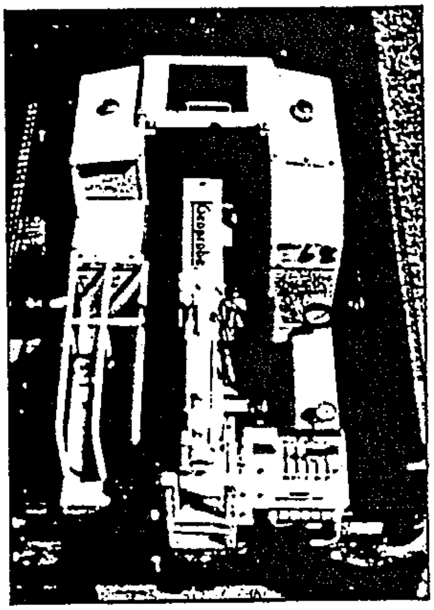






GEOPROBE 1992 CATALOG

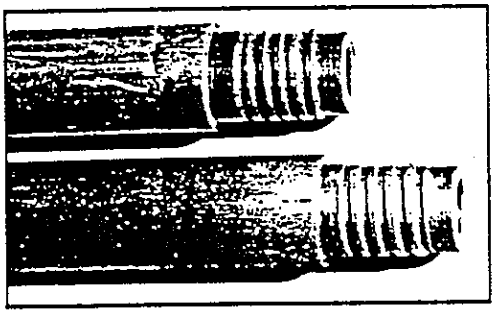
What's New In 1992


New 8 MU Skid Mount.

The 1992 Equipment and Tools Catalog features sections on Geoprobe "8-M" Series Hydraulic Soil Probes and Mobile Laboratories as well as accessory tools for sampling. It includes many new tools and most of the older tools that have become standard equipment for Geoprobe operators in the field.

Some tools that have appeared in our previous catalogs have been discontinued because of design improvements. For example, our improved "B" series thread which was introduced in 1991 is the only thread style featured in this catalog. However, most "A" style threaded tools are still available for operators who use them (see photo at right for identification of "A" and "B" style probe tool threads). It is important to specify the correct thread style when ordering parts. Likewise, drill bits and hammer replacement parts for earlier Geoprobe Model 8-A machines equipped with GHD-45 hammers are not listed but remain available.

New Tools for 1992 include the Kansas Sampler Manual Soil Extruder (AT-658) for extruding soil samples in the laboratory, Brass Liners (AT-666) for the Large Bore Soil Sampler, and the Geoprobe Screen Point Ground Water Sampler (AT-440K). Other tool lines have been expanded to provide a wider selection of options. In e Vapor Sampling Tools section you will want to check out the "New Gadgets".


"A" Style Threaded Probe Rod (top) and Rounded "B" Style (bottom).

Explanation of Part Numbering System

Tool Series Identification Number

Refers to Tool Classification — AT-123B — **Identification Extension**

AT – Accessory Tool
GW – Ground Water Tools
PR – Post Run Tubing System
RP – Replacement Parts

B – B Style Thread
K – Sold in Kit Form
R – "O"-Rings
S – Stainless Steel

Table of Contents

SECTION 1 – Major Equipment

SECTION 2 – Probing Tools

SECTION 3 – Ground Water Sampling Tools

SECTION 4 – Vapor Sampling Tools

SECTION 5 – Soil Sampling Tools

SECTION 6 – Manual Sampling Tools

SECTION 7 – Laboratory Accessories

SECTION 8 – Replacement Parts

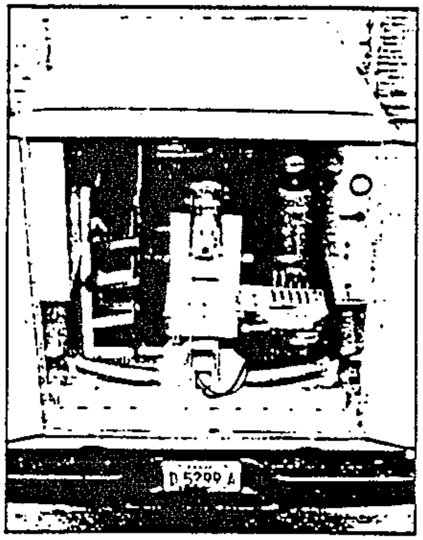
SECTION 9 – Index

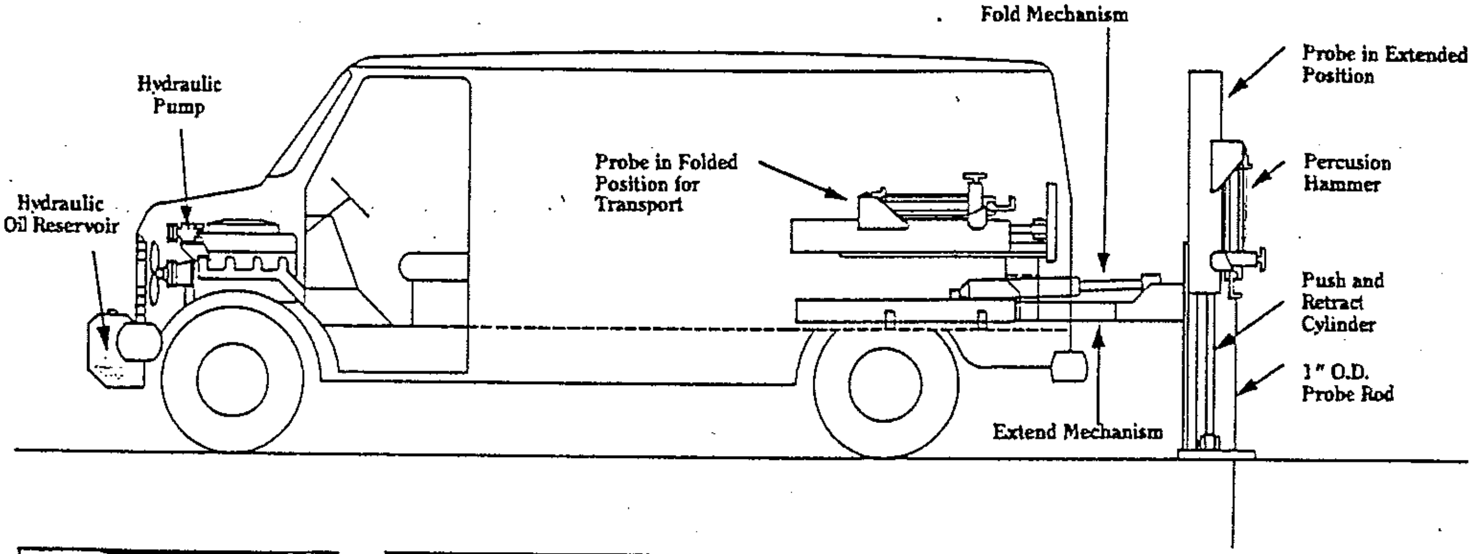
INTRODUCTION – Geoprobe Machines

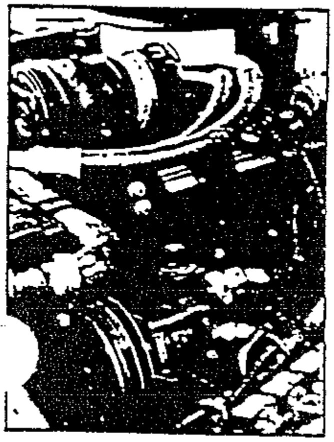
See Section 1 for Probe Unit Specifications

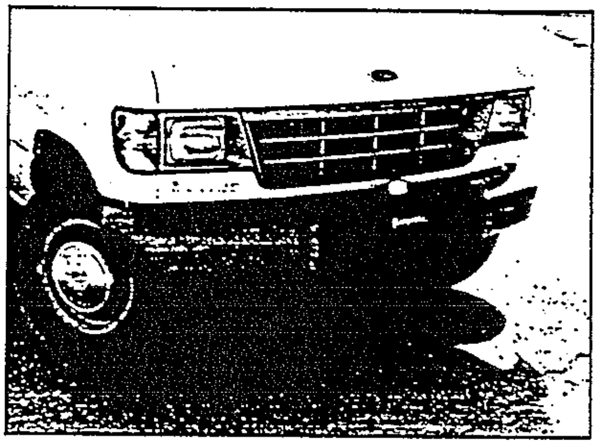
Basics

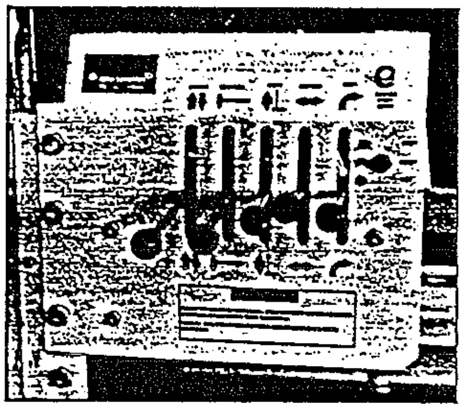
- Hydraulically powered probe operates from hydraulic system driven from the vehicle motor or an auxillary engine.
- Remote vehicle ignition allows operator to start vehicle engine from rear compartment.
- Belt driven hydraulic pump supplies 10 gpm at 2000 rpm, 2250 psi operating pressure.
- Probe unit folds for transport and sets up again in seconds.
- Utilizes static force (weight of vehicle) and percussion to advance probing tools.
- Powerful 8 horsepower hydraulic hammer delivers over 1800 blows per minute.
- Hammer features 0-300 rpm LH directional rotary function for drilling surface pavements.
- Probe has greater than 12,000 lbs. of pulling capability.
- Drives small diameter (1" O.D. - 1.6" O.D.) probing tools to depths limited only by soil type and depth to bedrock, typically to over thirty feet.


Geoprobe Model 8-ML folded for transport.




Positive displacement hydraulic oil pump is belt driven by vehicle motor.

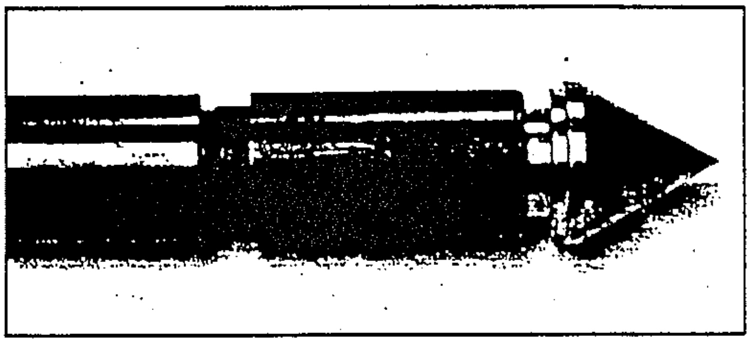

Hydraulic oil reservoir mounted on front bumper of 1992 Ford.


Control panel for operation of probe.

INTRODUCTION – Sampling Equipment

Geoprobe Equipment and Use

Geoprobe Systems supplies both the tools and the drivers to perform sampling. All tools fit our 1″ O.D. probe rods. Changing the sampling media is simply a matter of replacing the tip configuration of the leading probe rod.



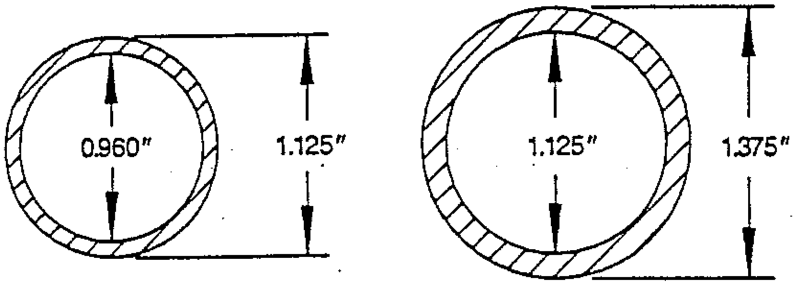
Typical point configuration for soil vapor sampling using expendable drive points.

Soil Vapor Sampling Tools

PRT System
Standard System
Permanent Vapor Implants
See also Vacuum/Volume System
See Section 4 for details.

Soil Sampling Tools

robe-Drive Soil Samplers:
andard Probe-Drive
ansas "Stainless"
Large Bore
Shelby Tubes
See Section 5 for details.

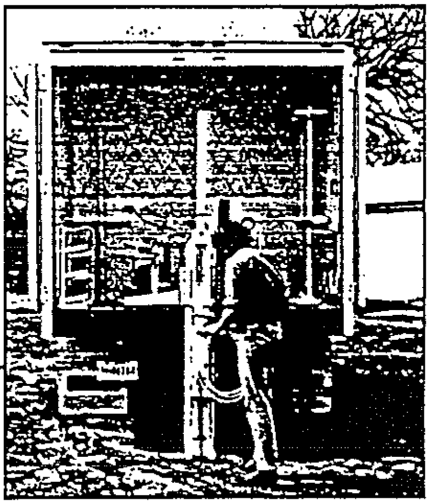


Actual sizes of Standard Sample Tube (left) and Large Bore Sample Tube (right).

Ground Water Sampling Tools

Mill Slotted Well Point
Screen Point Sampler
Mini-Bailer
Tubing Bottom Check Valve
See Section 3 for details.

Ground Water Sampling using the Geoprobe System with flexible tubing.



Mobile Laboratories

Geoprobe Systems also provides mobile laboratories compliment the probing units with in-field analysis.
e page 7 for more details on mobile laboratories.

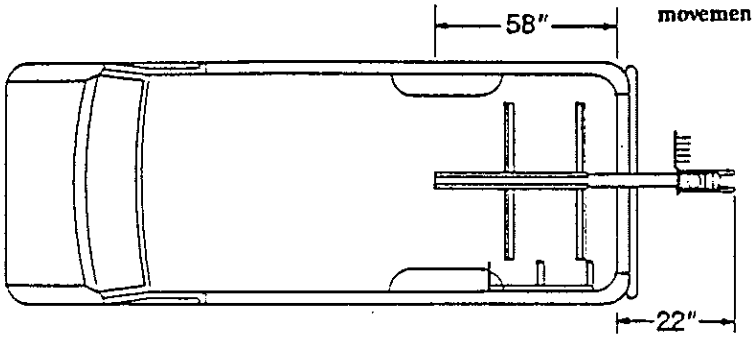
Geoprobe Mobile Lab.

MAJOR EQUIPMENT – Geoprobe Model 8-M

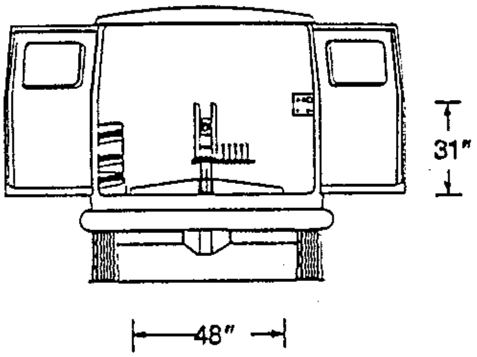
Specifications:

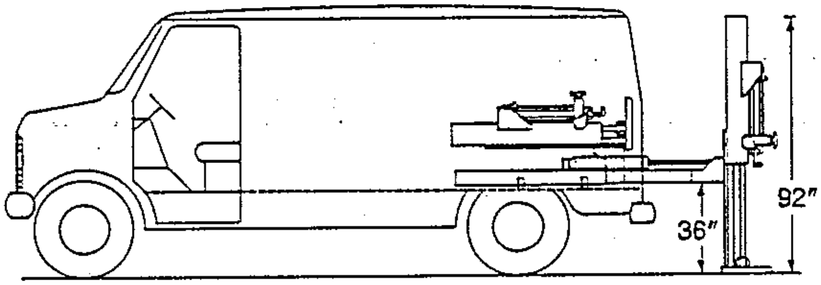
8-M Base occupies 58" from the inside of the rear door.

Probe has 22" of linear extension movement ability.



Folded unit is 31" high.
Base is 48" wide.
Door opening must be 46" high.





Maximum extended height with foot on ground is 92".

Foot can be deployed below vehicle bed up to 36". Higher vehicles require modified foot.

The Geoprobe 8-M can be mounted in a variety of carriers including vans, pick-ups, and four wheel drive vehicles.

00:10

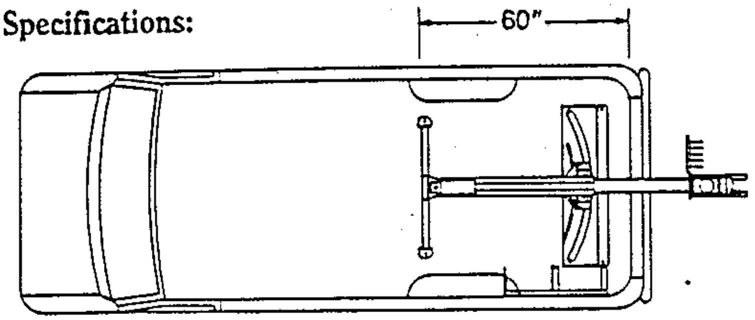
00:22

00:38

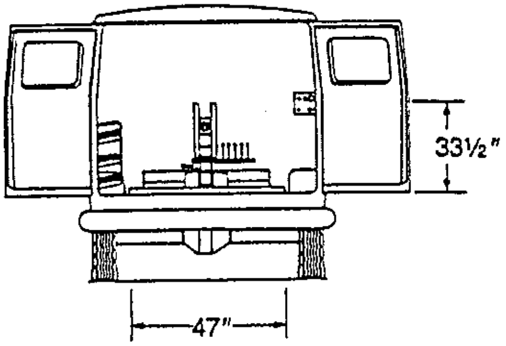
Geoprobe 8-M mounted in Chevrolet Suburban Carrier. Sequence shows deployment of the soil probe. The operation is complete in a matter of seconds.

MAJOR EQUIPMENT – Geoprobe Model 8-ML

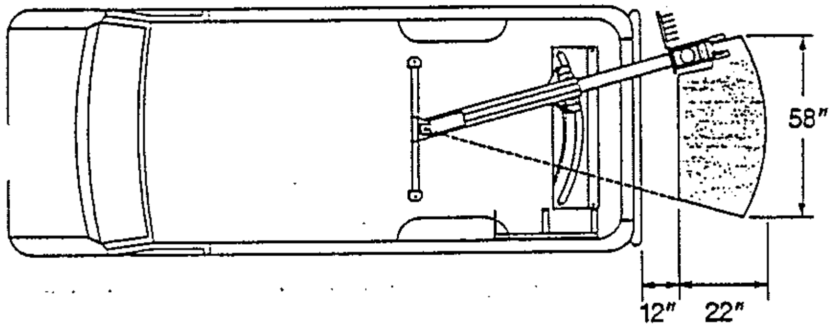
Specifications:



▲ 8-ML Base occupies 60″ from the inside of rear door.

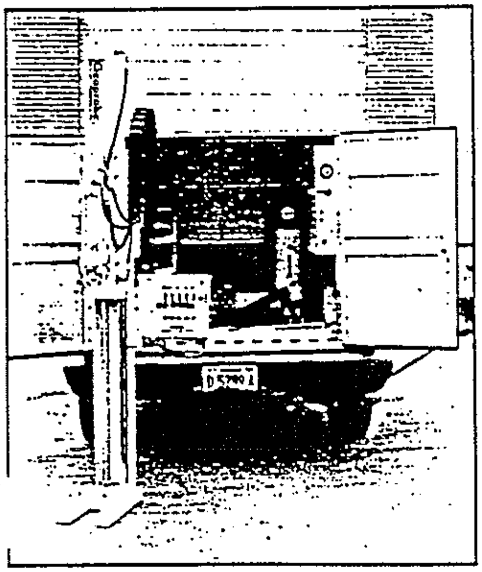


▲ Folded unit is 33½″ high.
Base is 47″ wide.
Door opening must be 46″ high.

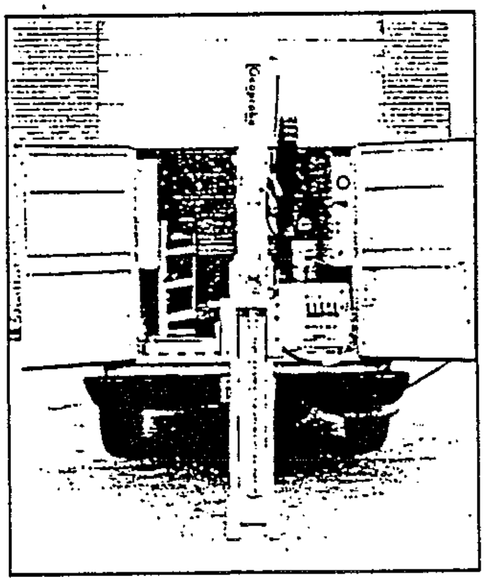


◄ Operating Area for Probe Placement using a Geoprobe 8-ML.

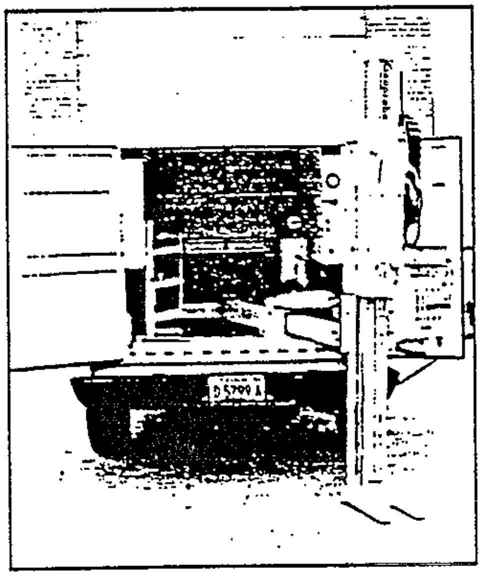
The 8-ML allows for multiple probe placements without moving the carrier vehicle. Roller bearing design allows the probing unit to slide easily from side to side.



Left Position



Center Position

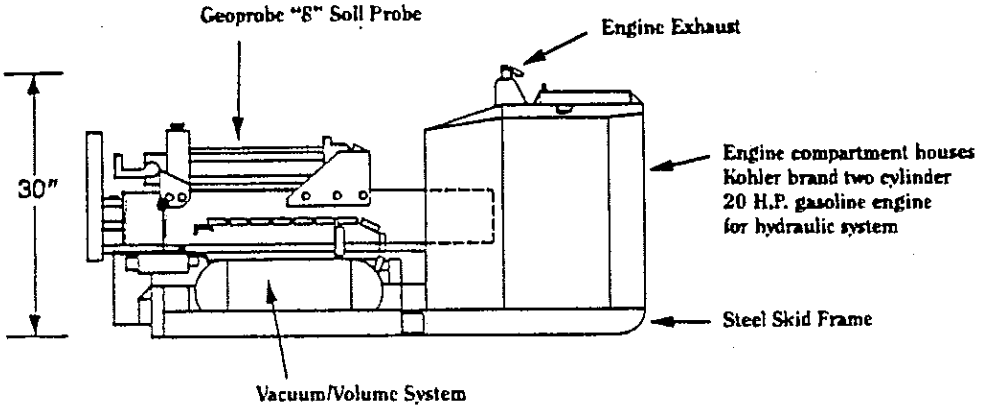


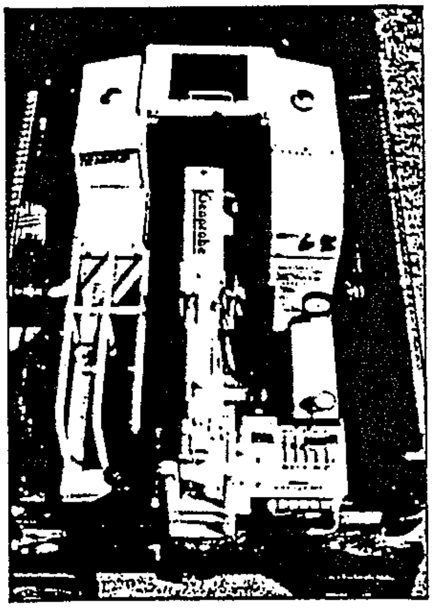
Right Position

- Place probe exactly on the location cleared for utilities.
- Move the unit aside while working over the hole.

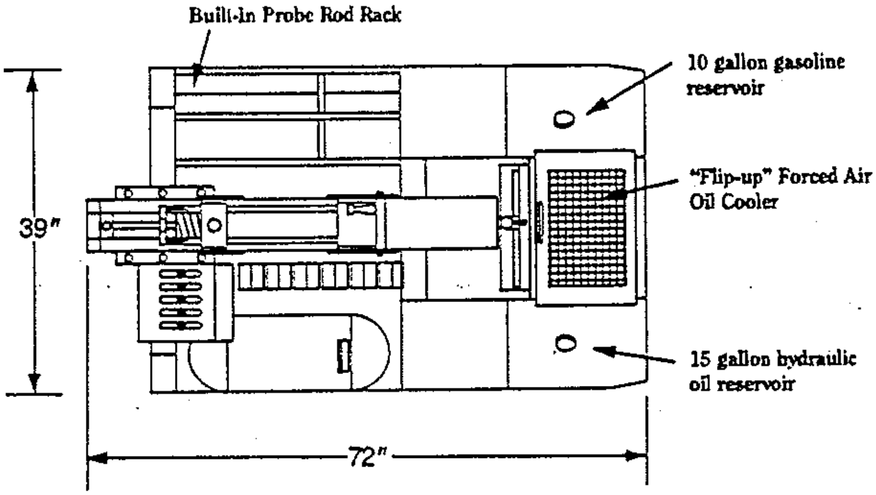
MAJOR EQUIPMENT – Geoprobe Model 8-MU

Specifications:

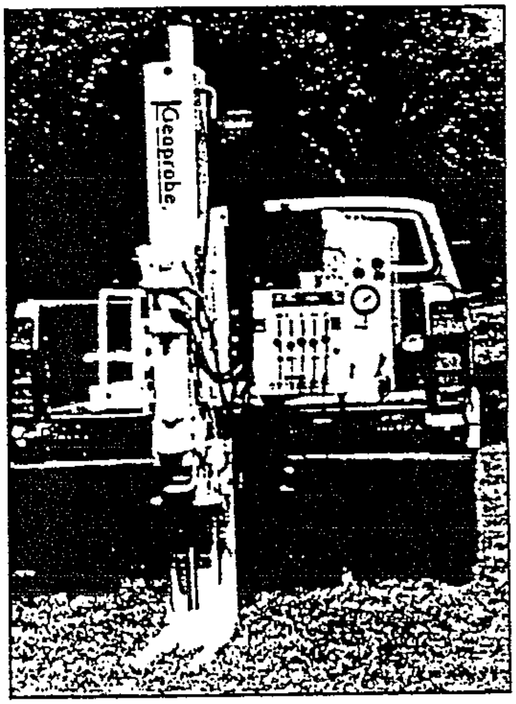




Compact Geoprobe Model 8-MU fits easily into the back of a pick-up truck. (Bolt down required).



Unit Weight: approximately 1200 pounds.
Fuel Consumption: 1.8 gallons per hour at full load.



Geoprobe Model 8-MU in operating position. Probe has the same capabilities as units powered from the vehicle engine.

- Same hammer and derrick system as Geoprobe Models 8-M and 8-ML.
- Completely self contained unit requires no auxillary power.
- Self loading and unloading from carrier vehicle using detachable legs.
- Can be mobilized in a variety of carrier vehicles.
- Easily transported or shipped to remote locations.
- Built in probing tools rack.
- Built in vacuum/volume system is optional.
- 10 gal. on board fuel capacity allows a full day of operation under normal conditions.
- 20 H.P. electric start gas engine with on-board 12 VDC battery.
- Probe unit extends 22" in and out from carrier vehicle.

MAJOR EQUIPMENT - Mobile Laboratories

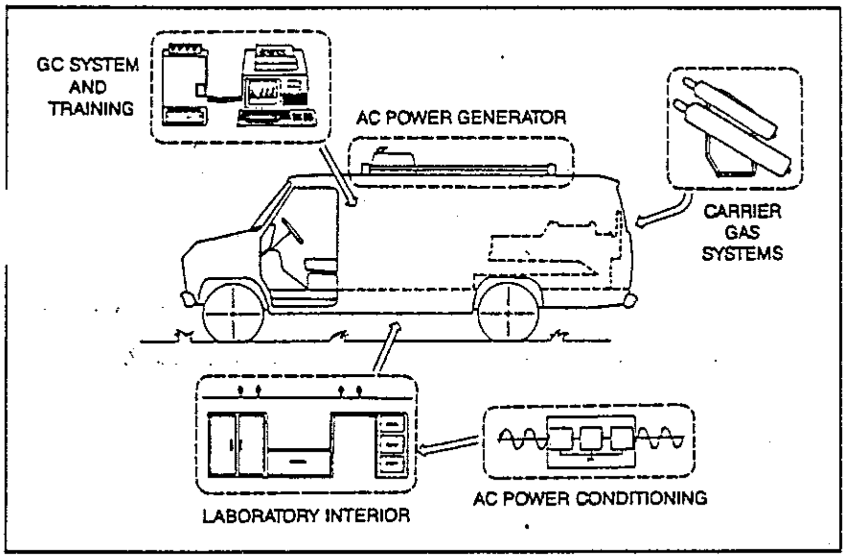
Geoprobe Mobile Laboratories

Geoprobe Systems can provide custom designed laboratories as complete systems to use in conjunction with the soil probe or as independently operating units.

Basic System Equipment:

- Laboratory interior with cabinets and countertops
- Dual or Single Electrical Generator System with line conditioning
- Compressed Gas Bottle Racks
- Gas Regulators and Plumbing
- Laboratory Grade Gas Chromatograph System with complete training

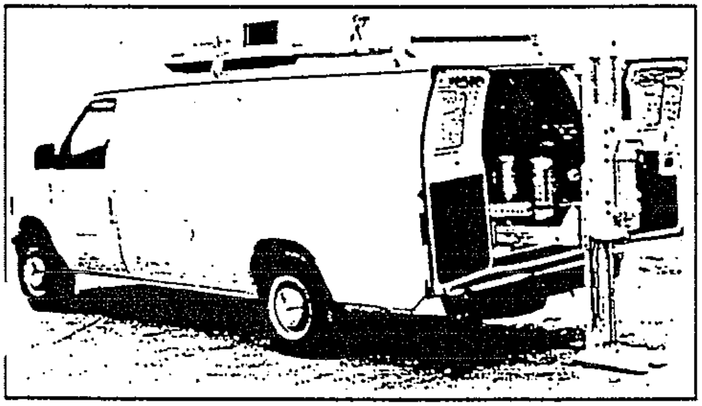
Geoprobe Mobile Laboratory interior with Shimadzu GC, purge and trap, and Epson PC based integrator.



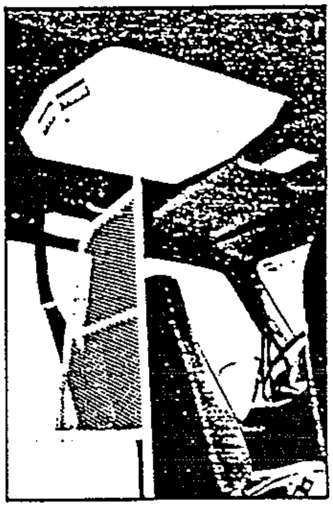
◄ Laboratory components added to a Probing/Analytical Unit

Optional Equipment:

- FID Compressed Air System
- Vapor Fume Hood
- Auxillary Air Conditioning
- Purge and Trap System



Complete Geoprobe Lab Unit with Soil Probe, Vac/Vol System, FID Compressed Air System (in rear compartment), Dual Electrical Generator System and Auxillary Air Conditioning (on roof).



Air conditioner/heater combination mounted in laboratory unit.

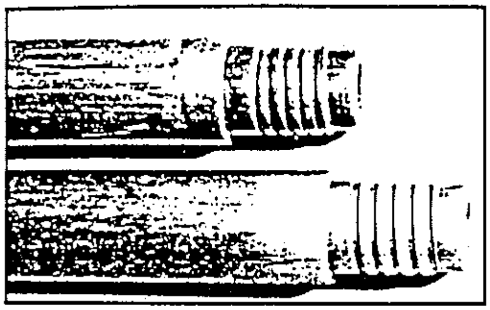
PROBING TOOLS – General Accessories

"B" Style Threaded Probe Rod

Part No. AT-10B (36″ length)
Part No. AT-105B (24″ length)
Part No. AT-106B (12″ length)

Geoprobe brand alloy steel, rounded profile thread that is heat treated and further improved by surface peening to inhibit fracturing and fatigue; 1″ O.D. x 0.5″ I.D. Introduced in 1991. Not compatible with A thread tools.

AT-10B Probe Rod



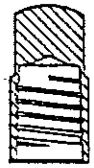
Older "A" style thread (top)
Improved "B" style thread (bottom)

Note to users: The internal diameter of probe rods produced by Geoprobe Systems will vary according to the stock provided to us by our suppliers. According to ASTM-A-519, this dimension could range from 0.470″ to 0.530″. For this reason, we cannot guarantee that the I.D. of our probe rods will be exactly 0.500 inches. But rather, the I.D. can be expected to vary within the above listed tolerances.

Geoprobe Drive Cap

Part No. AT-11B

Threaded top cap for driving Geoprobe brand probe rod.

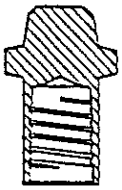


AT-11B

Geoprobe Pull Cap

Part No. AT-12B

Female threaded for pulling Geoprobe probe rods. Hammer latch fits over flanged top. Not required when using manual probe rod jack.

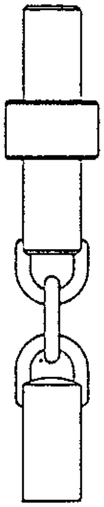


AT-12B

Chain Assisted Pull Cap

Part No. AT-120B

For pulling off-center probe rods, this tool is able to reach a 2″ radius area from the center of the hammer. The upper part fits into the hammer and latches, the lower part, connected by chain, threads onto the probe rod.

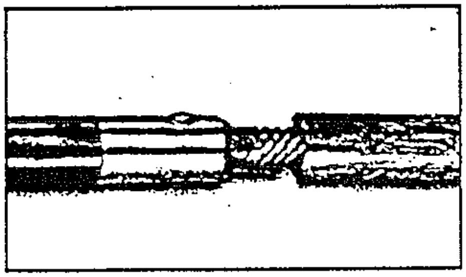


AT-120B

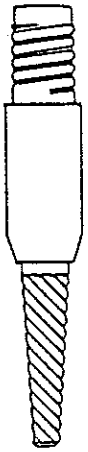
Rod Extractor (Fishing Tool)

Part No. AT-24B

Threads into Geoprobe rod. For retrieval of probe rods broken off down hole. Hammer blows drive tool into I.D. of broken rod for strong connection.



Broken Probe Rod recovered using AT-24B.



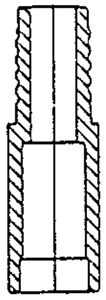
AT-24B

PROBING TOOLS – General Accessories

Expendable Point Holder

Part No. AT-13B

Threads into Geoprobe probe rods to drive expendable points. For soil gas or groundwater sampling through probe rods. The Geoprobe point system has been redesigned to minimize annular space between the point and holder.

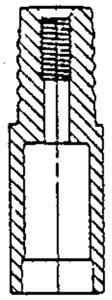


AT-13B

PRT Expendable Point Holder

Part No. PR-13B

Point Holder for use with PRT Soil Gas Sampling System. See page 20 for details on PRT System.

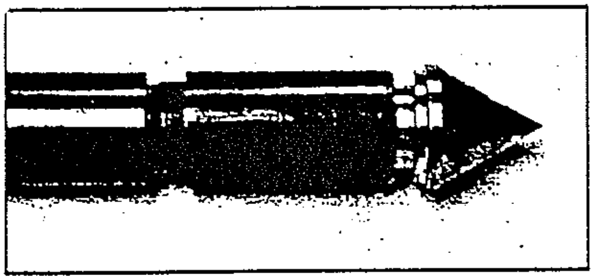


PR-13B

Machined Steel Expendable Drive Point

Part No. AT-14

1.1″ maximum O.D. machined steel drive point. Point remains in soil upon retraction of rods leaving an open cavity for soil gas sampling. Improved design utilizes minimum tolerances to inhibit intrusion from soil flow. Optional "O"-ring fits in groove for even tighter sealing. Fits Geoprobe Expendable Point Holders. May also be used with ¾″ NPT pipe.

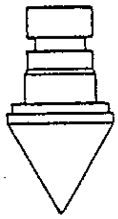


Typical Point Configuration

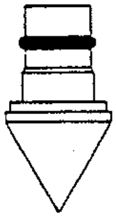
Neoprene "O"-Ring

Part No. AT-14R

Fits Expendable Point Part No. AT-14. Package of 25.



AT-14



AT-14 with O-ring

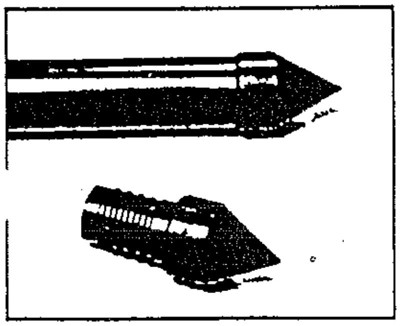
AT-14R

Solid Drive Point

Part No. AT-142B

Threads into leading Geoprobe rod. For pre-probing hole prior to gathering a soil sample. Also used for penetrating frost or asphalt layers prior to probing.

AT-142B

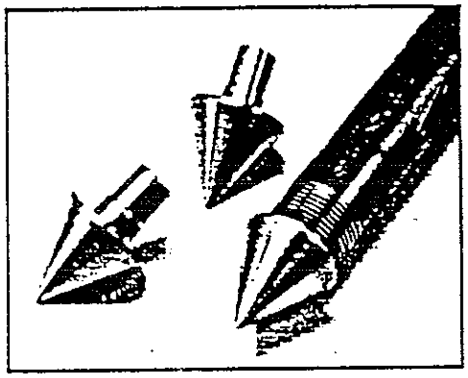


AT-142B

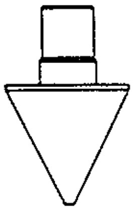
1.6″ Diameter Expendable Drive Point

Part No. AT-145

1.6″ maximum O.D. machined steel drive point. Fits Geoprobe Expendable Point Holders and 1″ or ¾″ NPT threaded pipe.



AT-145 on 1″ NPT pipe



AT-145

PROBING TOOLS – General Accessories

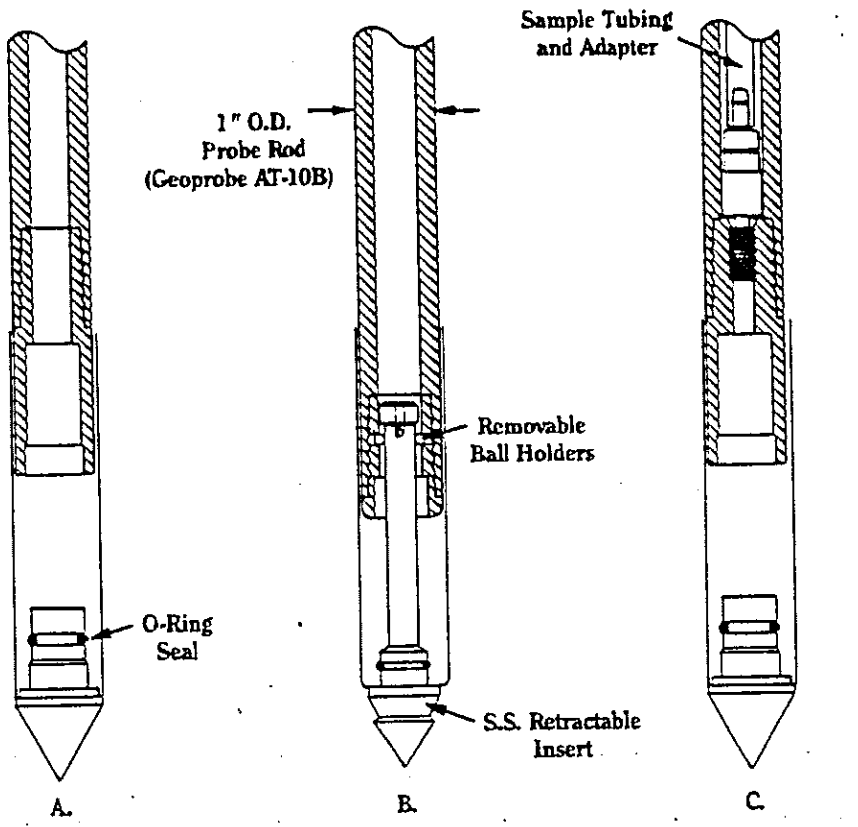
Tip Configurations

These tip configurations are available for your sampling requirements:

A. **Expendable Point System**
AT-13B Expendable Point Holder and AT-14 Expendable Point. See Page 9 for individual parts.

B. **Retractable Point System**
AT-21B Retractable Point Assembly. See Page 10 for individual parts.

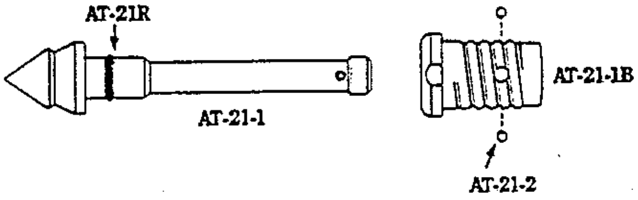
C. **Post-Run Tubing System**
PR-13B PRT Expendable Point Holder AT-14 Expendable Point; PRT Adapter and Tubing. See Page 20 for details.



Retractable Drive Point

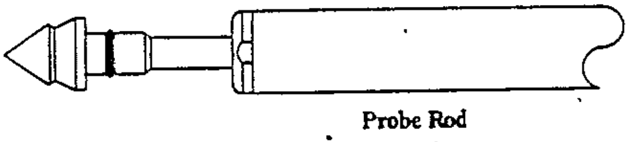
Part No. AT-21B

Stainless steel retractable point insert with Geoprobe threaded point holder and ball keepers. Point extends on pull back to allow gas sampling but remains attached to holder for further probing. Point extends 2" on pull back. Can be easily disassembled for cleaning.



Sub-Assembly Parts

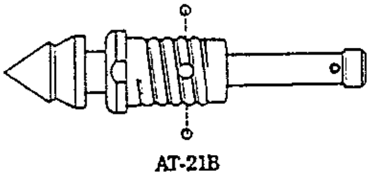
Retractable Point Housing **Part No. AT-21-1B**	**Retractable Point Ball Bearings** **Part No. AT-21-2** (package of 12)
Stainless Retractable Point Shaft **Part No. AT-21-1**	**Retractable Drive Point O-Rings** **Part No. AT-21R** (package of 25)



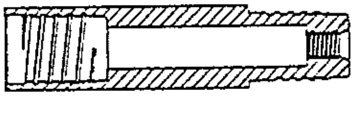
PRT Retractable Point Holder

t No. PR-21B

ractable Point Housing for use with PRT System. Requires AT-21B (Sold Separately).



AT-21B

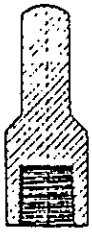


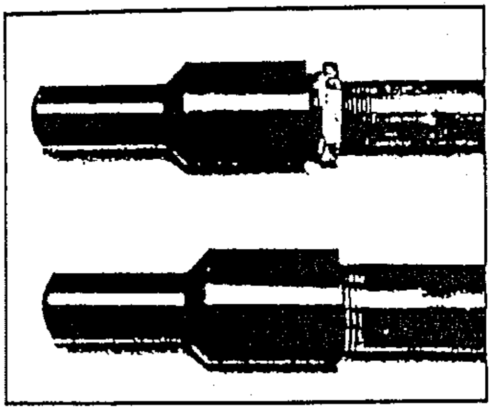
PR-21B

PROBING TOOLS – General Accessories

NPT Drive Cap (1″)

Part No. AT-18
For driving 1″ NPT threaded pipe. Can be used with a bushing to drive ¾″ NPT threaded pipe.

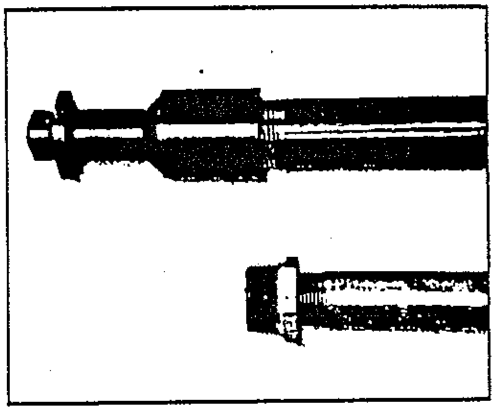

AT-18


AT-18 with 1″ NPT pipe (bottom)
AT-18 with bushing and ¾ NPT pipe (top)

NPT Pull Cap (1″)

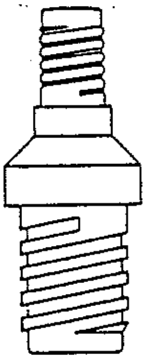
Part No. AT-20
For pulling 1″ NPT threaded pipe. Can be used with a bushing for pulling ¾″ NPT threaded pipe.


AT-20


AT-20 with 1″ NPT pipe. May also be used with bushing for ¾″ NPT pipe.

AW Drill Rod Sub

Part No. AT-16B
Allows standard AW drill rod to be driven by Geoprobe machine. Male Geoprobe thread x male AW. May also be used to drive 2″ diameter thin wall (shelby) tubes.


AT-16B

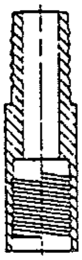
A to B Series Sub

Part No. AT-17A
For adapting B Series tools to A Series Probe Rods.
Male A, Female B.


AT-17A

B to A Series Sub

Part No. AT-17B
For adapting A Series tools to B Series Probe Rods.
Male B, Female A.


AT-17B

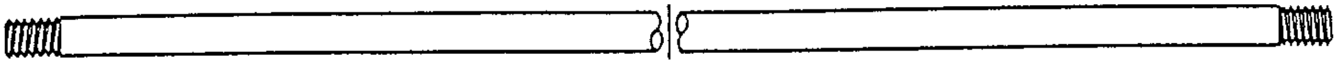
Note to users: These tools are only necessary for those operators still using "A" style threaded tools.

PROBING TOOLS – Cleaning Accessories

Extension Rod

Part No. AT-67

36″ Stainless Steel. Attaches to cleaning brush and adapter for cleaning probe rods.



AT-67

Extension Rod Coupler

Part No. AT-68

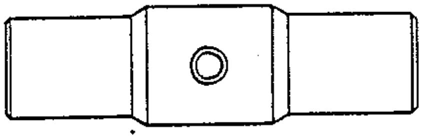
Stainless Steel. For joining extension rods together.

AT-68

Extension Rod Handle

Part No. AT-69

Machined steel. Threads onto extension rods.



AT-69

Brush Adapter

Part No. AT-101

Stainless Steel; threads onto cleaning brush (Part No. AT-100). Connects brush to extension rods.

AT-101

Cleaning Brush

Part No. AT-100

Threads into brush adapter (Part No. AT-101). ½″ diameter; stainless steel. For cleaning I.D. of probe rods.

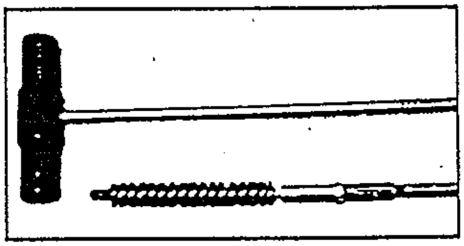
AT-100

Cleaning Kit

Part No. AT-100K

Includes the following parts:

1 – AT-67 1 – AT-101
1 – AT-69 1 – AT-100

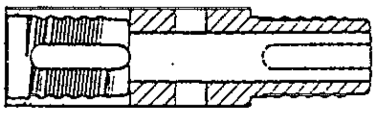


Cleaning Accessories AT-100K

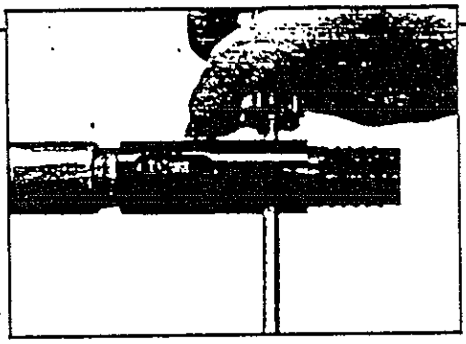
Geoprobe Thread Chaser

Part No. AT-160B

probe female x male threaded.
cleaning threads on
Geoprobe rods.



AT-160B



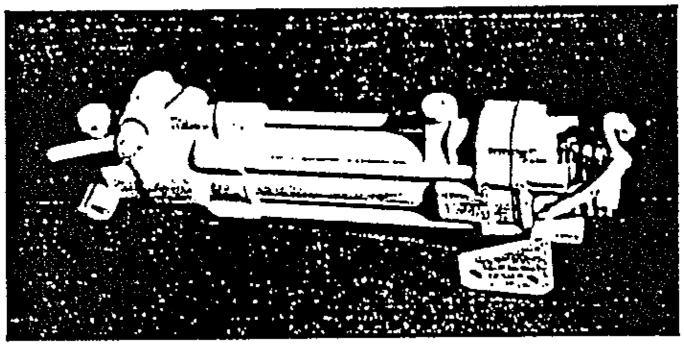
Using AT-160B to clean thread. ►

PROBING TOOLS – Hammer Accessories

GSK-58 Hydraulic Hammer

Part No. AT-5800

Percussion hammer for Geoprobe 8-M series machines. Delivers 1800 blows per minute for powerful penetration. Features rotary function for drilling surface pavements. Adaptable to earlier 8-A machines.

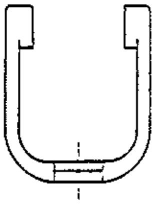


The GSK-58 Hydraulic Hammer is used on all Geoprobe 8-M Series Soil Probes.

GSK-58 Hammer Latch

Part No. RP-25

Replacement hammer latch. Fits GSK-58 Hammer on Geoprobe 8-M model machines.

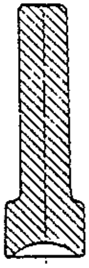


RP-25

GSK-58 Hammer Anvil

Part No. AT-220

Fits inside GSK-58 hammer to permit driving of probe rods. GSK-58 hammers are used on Geoprobe 8-M model machines.

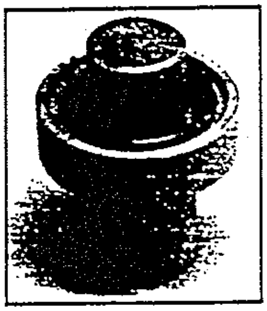


AT-220

Hammer Latch Tool

Part No. RP-251 (Pair)

Tool includes piston and compression collar for installing wire retaining ring on spring assembly for GSK-58 hammers on Geoprobe Model 8-M machines. Necessary for installation of hammer latch.



RP-251

Installing wire ring.

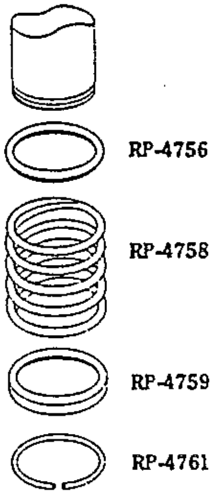
GSK-58 Replacement Parts

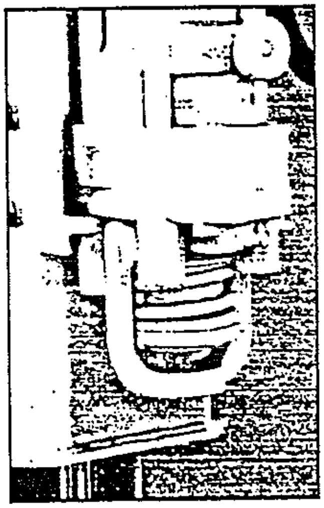
Latch Washer
Part No. RP-4756

Spring
Part No. RP-4758

Spring Back Up
art No. RP-4759

Wire Ring
Part No. RP-4761



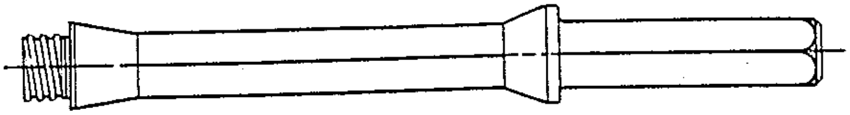


PROBING TOOLS - Pavement Drills

CSK-58 Drill Steels

Fits CSK-58 hammer on Geoprobe model 8-M machines.
For drilling surface pavements.

Part No.	Description
AT-32	Standard 18", drills 12" into surface
AT-33	24" length, drills 18" into surface
AT-34	30" length, drills 24" into surface
AT-35	36" length, drills 30" into surface

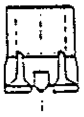


AT-32

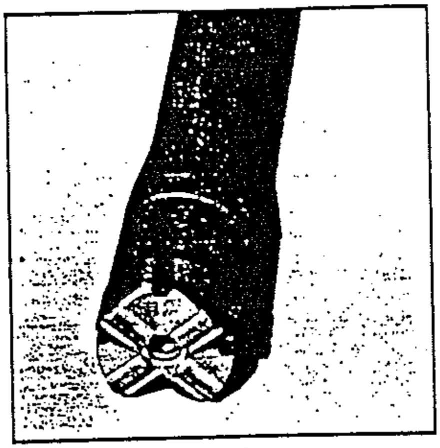
Carbide-Tipped Drill Bit

Part No. AT-36
1½" Diameter drill bit. Fits AT-32, AT-33, AT-34, and AT-35 drill steels.

Part No. AT-37
2" Diameter drill bit. Fits AT-32, AT-33, AT-34, and AT-35 drill steels.



AT-36



Drill Bit and Drill Steel

Fast-Drill Air System

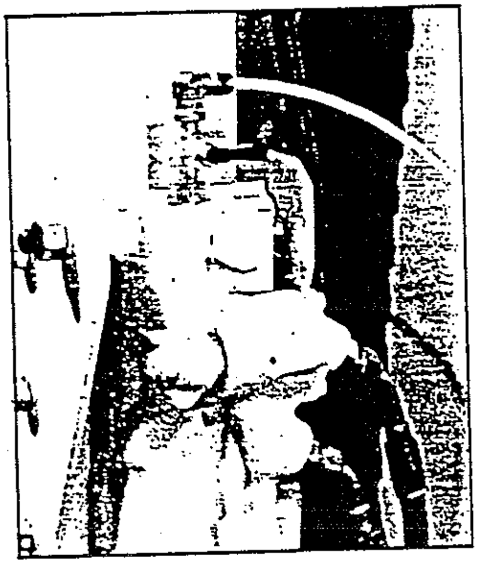
Part No. AT-1005

A Compressed Air System For Improved Pavement Drilling Performance.

Geoprobe 8-M hammers are equipped with a special port to allow the use of compressed air to blow cuttings from the drill hole. Removal of cuttings from the hole increases drilling rate and allows greater working depth. While the Geoprobe 8-M will normally penetrate 6" of concrete without the use of air, addition of the Fast-Drill system will allow drilling of 12 to 24 inch surface pavements or rock.

Fast-Drill includes a 12 VDC air compressor and storage tank. Compressed air at 60 PSI is applied to the hammer in quick bursts using a manual valve (supplied). System includes tank, compressor, automatic pump control, pressure gauge, and air supply tubing to hammer.

Use of Fast-Drill system does require the removal of threaded bore plugs from Geoprobe Drill Steels (Part No. AT-32, 33, 34, or 35).



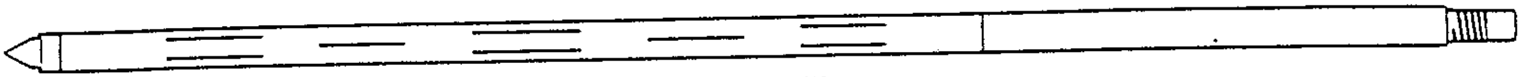
Manual Valve on GSK-58 Hammer supplies quick bursts of air for drilling.

GROUND WATER SAMPLING TOOLS

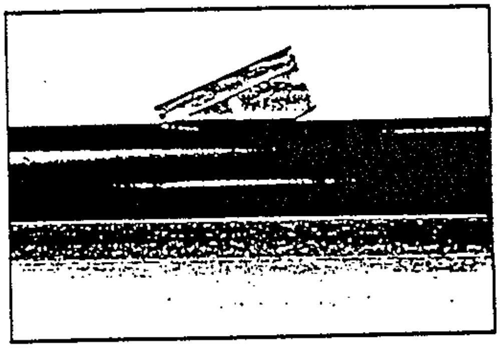
Mill-Slotted Well Point

Part No. GW-43K

Threads into leading Geoprobe probe rod. 3′ length x 1″ O.D.
Has 15 mill-cut slots, each 2″ in length x .020″ in width.



GW-43K
(Assembled Sampler)



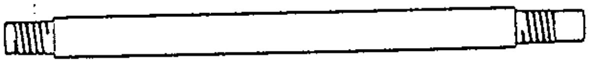
.020″ Mill Slot for Ground Water Sampling

Sub Assembly Parts

Solid Drive Point
Part No. AT-142B

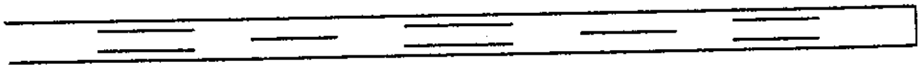
AT-142B

Mill Slot Drive Head
Part No. GW-43B



GW-43B

Mill-Slotted Rod Section
Part No. GW-44



GW-44

Well Mini-Bailer

Part No. GW-41

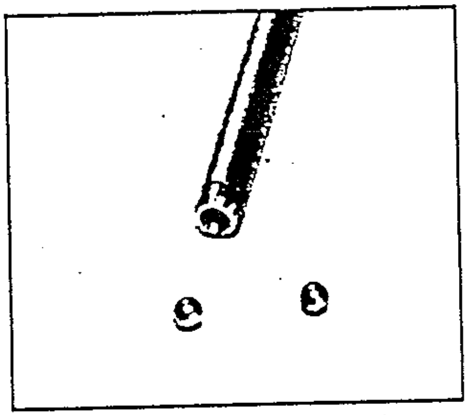
Stainless Steel; 20″ in length x 7/16″ O.D. Fits down I.D. of Geoprobe probe rods. Recovers up to 20ml of sample.

GW-41

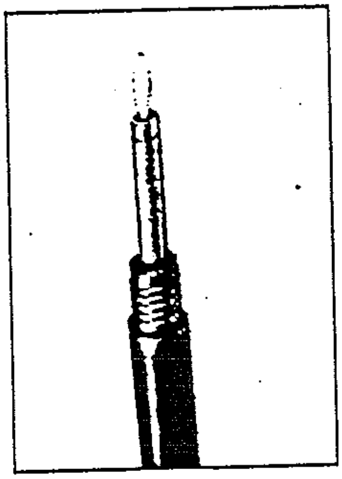
Mini-Bailer Check Ball

Part No. GW-41-1

Replacement check ball for mini-bailer, package of 5.



Replacement Check Ball for Mini-Bailer



Mini-Bailer Fits Down I.D. of Probe Rods.

GROUND WATER SAMPLING TOOLS

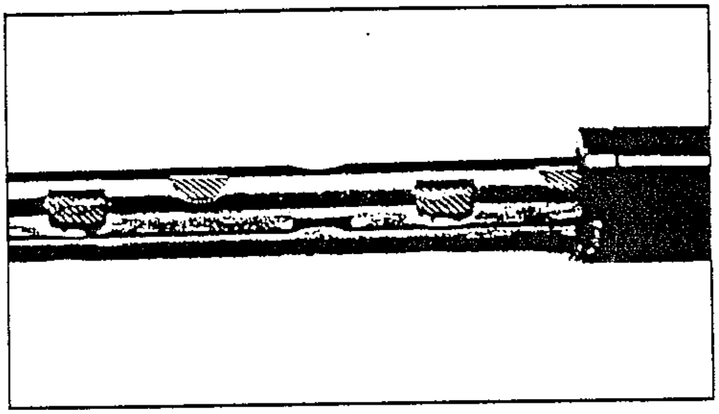
Geoprobe Screen Point Ground Water Sampler

GW-440 Series

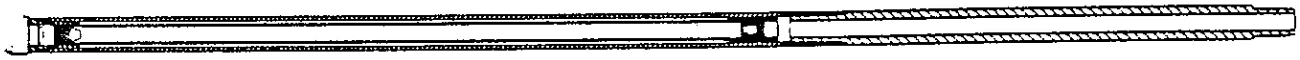
This sampler allows you to send a sealed stainless steel screen to depth, open the screen, and obtain a water sample via a tubing system to the surface. Features a 19″ screen encased in a perforated stainless sleeve. The screen remains totally enclosed in the sheath until it is pushed out into the formation at the desired depth. Flexible tubing can be connected to the top of the screen section using PRT adapters (Note: See the "PRT" section of this catalog for an explanation of available tubing and adapter sizes.) Water samples can be bailed from the rod bore or pumped directly from the screen section using a peristaltic pump.

This sampler is easily disassembled for cleaning. The sampler screen section is inexpensive and easily replaced.

Assembled sampler is 1″ O.D. by 36″ overall length and threads onto the leading probe rod. This device is also useful for measurement of piezometric levels.



Screen Point Sampler in open position.



GW-440K
(Assembled Screen Point Sampler)

Sub-Assembly Parts

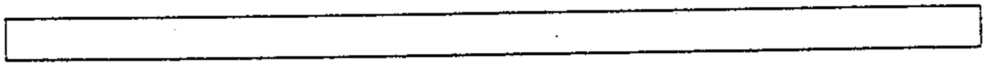
Mill-Slot Drive Head
Part No. GW-43B

GW-43B

Screen Point Sampler Sheath
Part No. GW-440

GW Drive Point Seat
Part No. GW-440-1

GW-440-1



GW-440

Screen Sleeve
Part No. GW-441

Screen Plug
Part No. GW-442

GW-442

GW-441

GW-443R

GW-443

Screen Connector
Part No. GW-443

Screen Connector "O"-Ring
t No. GW-443R

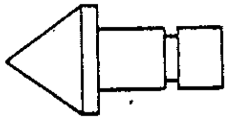
GW-443R

GW-444

Stainless Screen Insert
Part No. GW-444

GROUND WATER SAMPLING TOOLS

GW Expendable Drive Point
Part No. GW-445



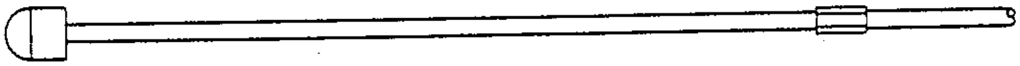
GW-445

GW Drive Point "O"-ring
Part No. GW-445R

GW-445R

Extension Rod Ram
Part No. GW-446

Fits Geoprobe Extension Rods (AT-67). Used for pushing screened section out of Sampler Sheath when sampling depth has been reached.



Other Required Parts:

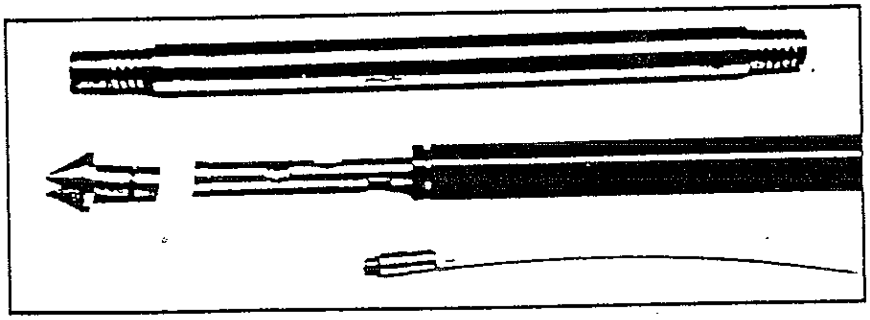
PR-25S	Post Run Tubing Adapter (fits into GW-443 Screen Connector). See page 23.
TB-25L	⅜" x ¼" Polyethylene Tubing. See page 18 or 23.
GW-41	Stainless Steel Mini-Bailer. See page 15.
GW-42	Tubing Bottom Check Valve. See page 18.

KITS

Assembled Screen Point Ground Water Sampler
Part No. GW-440K

Includes the following parts:

(1)	GW-43B	Mill Slot Drive Head
(1)	GW-440	Sampler Sheath
(1)	GW-440-1	Drive Point Seat
(1)	GW-441	Screen Sleeve
(1)	GW-442	Screen Plug
(1)	GW-443	Screen Connector
(1)	GW-443R	Screen Connector "O"-ring (pkg of 25)
(2)	GW-444	Stainless Screen Insert
(25)	GW-445	GW Expendable Drive Point
(1)	GW-445R	GW Drive Point "O"-ring (pkg of 25)
(1)	GW-446	Extension Rod Ram



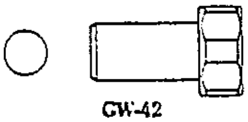
GW-440K Parts

GROUND WATER SAMPLING TOOLS

Tubing Bottom Check Valve

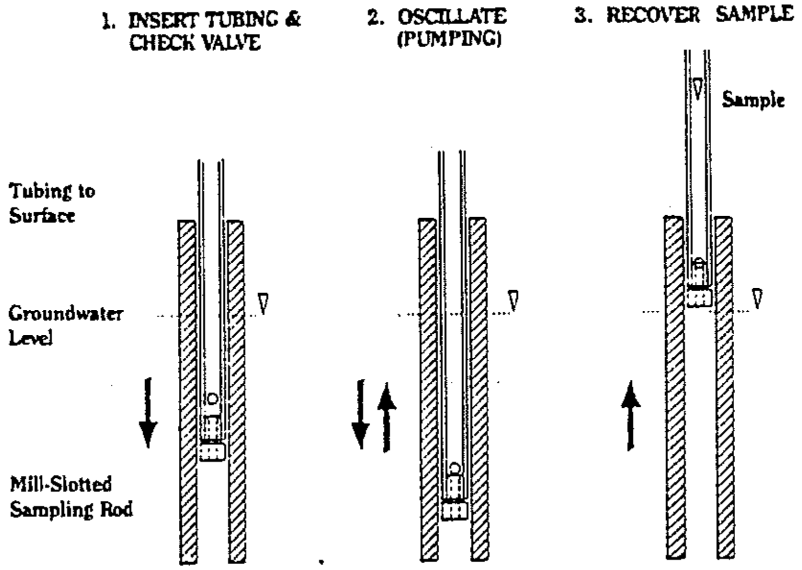
Part No. GW-42

Fits ¼" I.D. Tubing. Converts standard tubing into a mini-bailer. Oscillating motion pumps water column up into tubing. Can pump water to surface in some formations. Tubing recovers 9.65 ml per foot.



GW-42

Groundwater Sampling With Tubing Bottom Check Valve



Check Balls

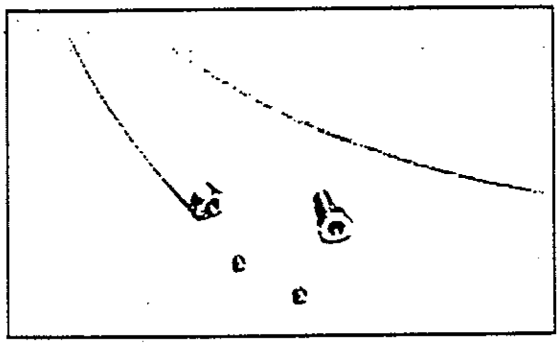
Part No. GW-42-1

cement check balls for GW-42. Package of 25.

¼" I.D. Polyethylene Tubing

Part No. TB-25L

⅜" O.D. x ¼" I.D. .060" wall tubing. For water sampling with GW-42 tubing bottom check valve. Discard tubing after each sample. 500 ft. roll.



Tubing Bottom Check Valve and ⅜" Polyethylene Tubing

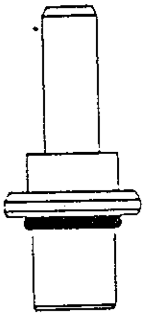
VAPOR SAMPLING TOOLS - Standard System

Gas Sampling Insert Adapter and Cap

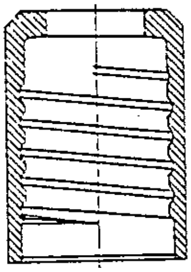
Part No. AT-153 (Insert Adapter)

Part No. AT-155B (Cap)

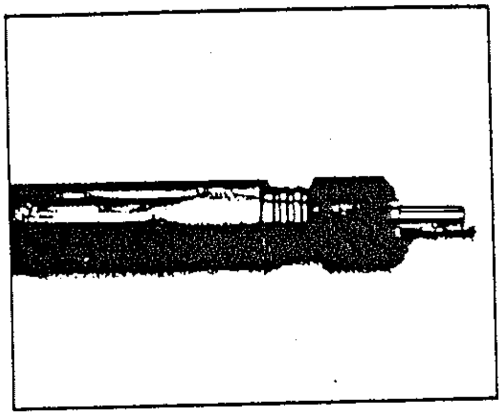
For sampling directly through probe rods. An "O"-ring design enables a vacuum-tight seal when cap is tightened onto probe rod compressing the "O"-ring at the base of the sampling adapter.



AT-153



AT-155B



Insert Adapter and Cap attached to probe rod.

Neoprene "O"-Ring

Part No. AT-153R

Fits Gas Sampling Adapter Part No. AT-153. Package of 25.

Gas Sampling Cap

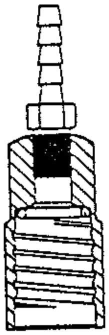
Part No. AT-15B

Geoprobe threaded top cap, supplied with 0.25 inch barbed hose fitting for connection to vacuum supply.

Neoprene "O"-Ring

Part No. AT-15R

Fits inside female end of AT-15B. Package of 25.



AT-15B

Silicone Tubing Adapter

Part No. AT-118

Silicone tubing fits over gas sampling adapters or PRT tubing and connects to Geoprobe Vacuum/Volume system. Syringe needle is inserted through silicone tubing for direct injection soil gas sampling.

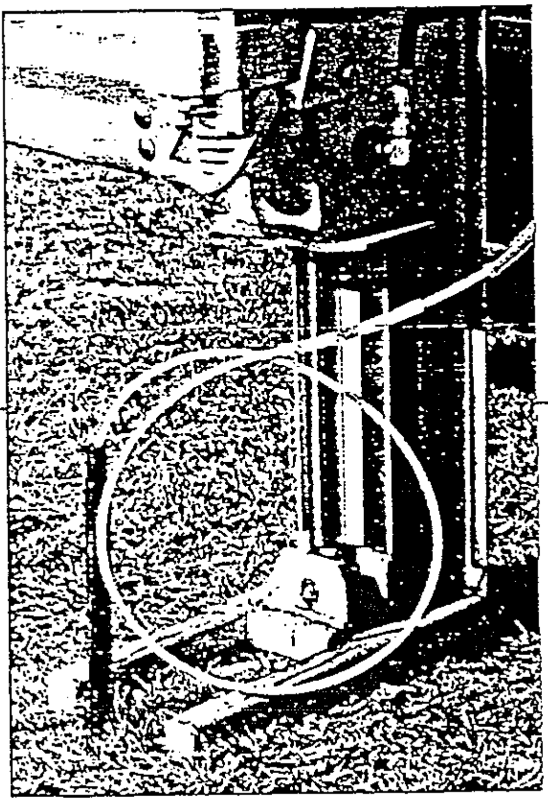
◄ Sample collection method for direct injection of soil gas sample into gas chromatograph.

The Post-Run Tubing System

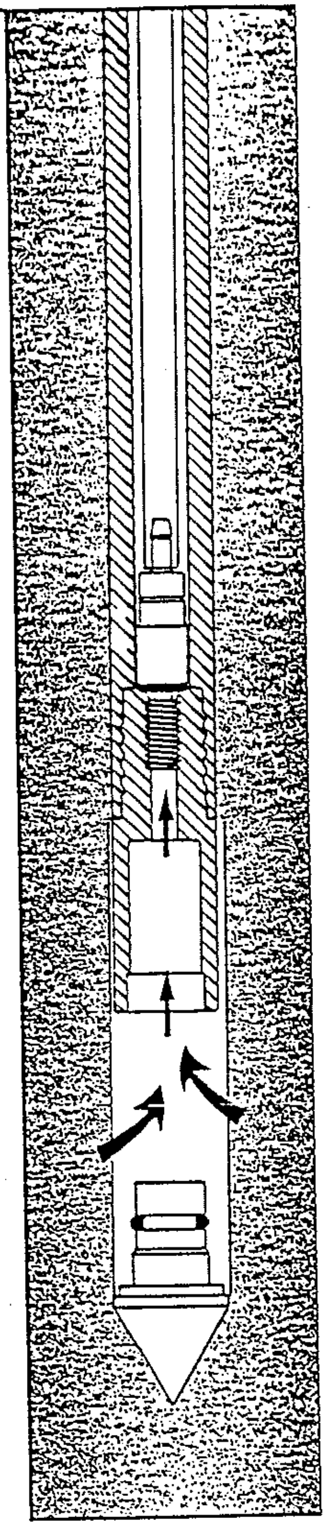
An Inner Tubing System inserted AFTER probe rods have been driven to depth...

- Increases speed and accuracy of soil vapor sampling.
- Eliminates problems associated with rod leakage and sample carryover.
- Reduces probe rod decontamination time.
- Utilizes simple design for ease of use and vacuum-tight sealing.
- Requires no management of inner tubing during probing.

The Post-Run Tubing System (PRT) allows the user to collect soil vapor samples quickly and easily at the desired sampling depth WITHOUT the usual time-consuming complications associated with rod leakage and contamination. "O"-ring connections enable the PRT system to deliver a vacuum-tight seal that prevents sample contamination from UP hole and assures that the sample is taken from the desired depth at the BOTTOM of the hole. The sample is drawn through the point holder, through the adapter, and into the sample tubing. The tubing can be replaced after each sample, thus eliminating sample carryover problems and the need to decontaminate probe rods. The resulting time-savings translates into a higher productivity rate for you and your client.



The PRT system inserted into the probe rods and connected to Geoprobe's vacuum/volume system.
◄



A cross-section of the PRT System showing how soil gas (arrows) is drawn through the inner tubing system.
►

Basics

Using the Post-Run Tubing (PRT) System, one can drive probe rods to the desired sampling depth, then insert and seal an internal tubing for soil gas sampling. The usual Geoprobe rods and driving accessories with the following tools are required:

- Expendable Point Holder for Post-Run Tubing (IMPORTANT: Replaces AT-13B)
- PRT Tubing Adapter
- Selected PRT Tubing

Probing operations remain unchanged from standard Geoprobe operations using expendable drive points.

Preparation

1. Clean all parts prior to use.
2. Inspect probe rods and clear them of all obstructions.

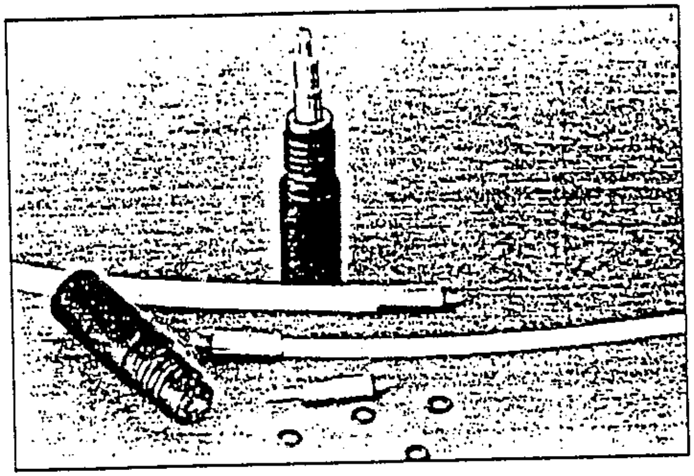
   TEST FIT the adapter with the expendable point holder to assure that threads are compatible and fit together smoothly.
4. Secure adapter to end of tubing. Taping may be necessary to prevent tubing from spinning freely around adapter during connection especially when using teflon tubing. **(Fig. 1)**

Probing

After the desired sampling depth has been reached, disengage the expendable point, remove the pull cap from the probe rods, and position the Geoprobe unit to allow room to work.

Connection

1. Insert the adapter end of the tubing down the inside diameter of the probe rods. **(Fig. 2)**
2. Feed the tubing down the hole until it hits bottom on the expendable point holder. Allow about 2 ft. of tubing to extend out of the hole before cutting it.
3. Grasp the excess tubing and apply some downward pressure while turning it in a counter-clockwise motion to engage the adapter threads with the expendable point holder. **(Fig. 3)**
4. Pull up lightly on the tubing to test engagement of threads. (Failure of adapter to thread could mean that intrusion of soil may have occurred during driving of probe rods or disengagement of drive point.)



PRT SYSTEM PARTS
PRT Expendable Point Holder, Tubing Adapters, Tubing, O-rings.

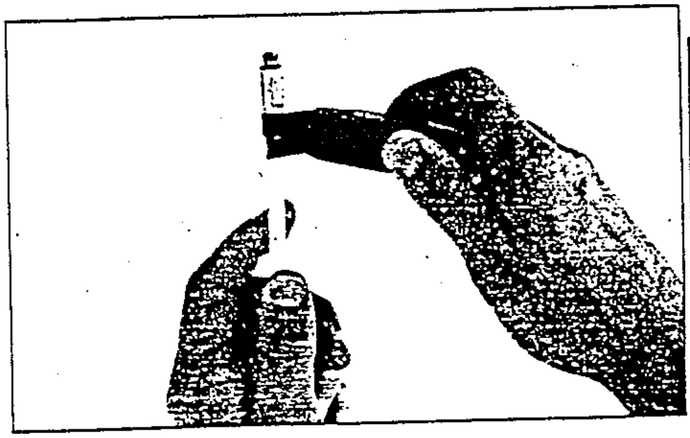


FIGURE 1
Securing adapter to tubing with tape.

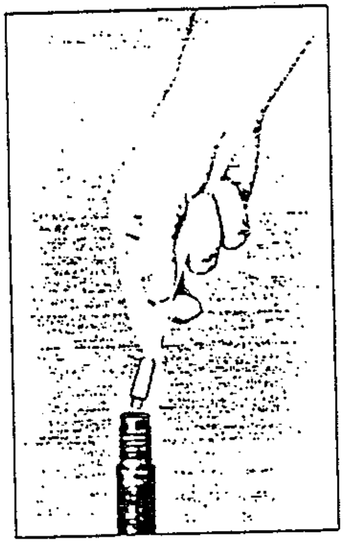


FIGURE 2
Insertion of tubing and PRT adapter.

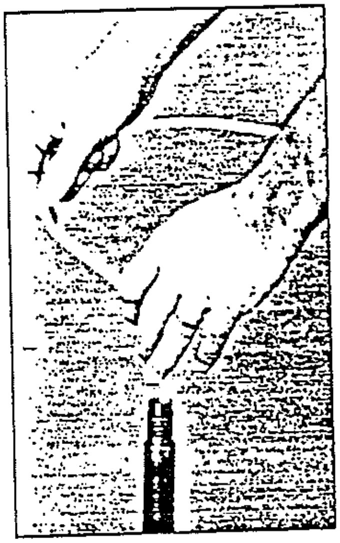
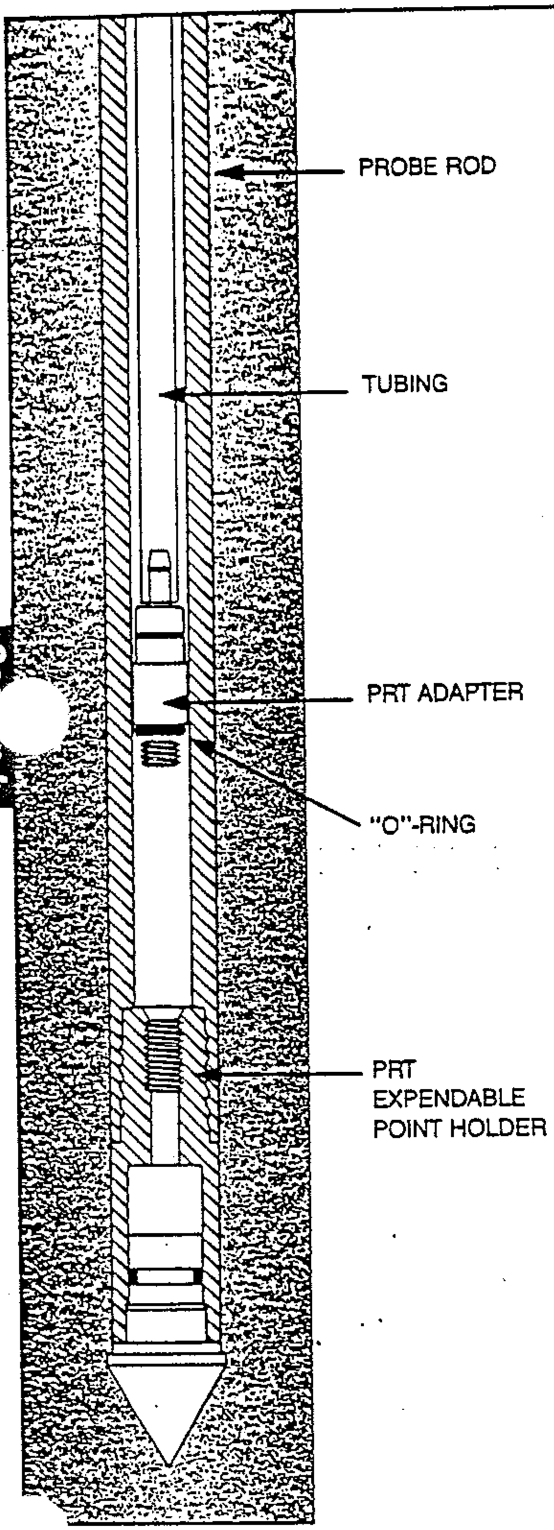


FIGURE 3
Engaging threads by rotating tubing.

VAPOR SAMPLING TOOLS - PRT System/Operation



▲ A cross-sectional view of probe rods driven to depth and then retracted to allow soil vapor sampling. The PRT adapter and tubing are now fed through the rods and rotated to form a vacuum-tight connection at the point holder. The result is a continuous run of tubing from the sample level to the surface.

FIGURE 4
Taking a soil gas sample with PRT system.

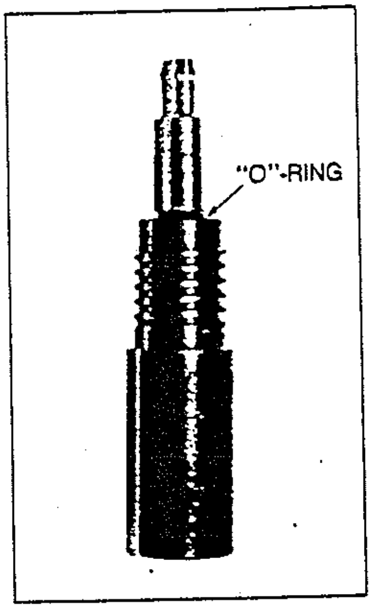


FIGURE 5
Visual inspection of the adapter/point holder connection. "O"-ring must be compressed for seal.

Sampling

1. Connect the outer end of the tubing to silicon tubing and vacuum hose (or other sampling apparatus).
2. Follow the appropriate sampling procedure to collect a soil gas sample. (Fig. 4)

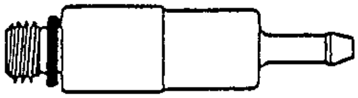
Removal

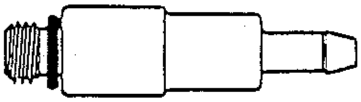
1. After collecting a sample, disconnect the tubing from the vacuum hose or sampling system.
2. Pull up firmly on the tubing until it releases from the adapter at the bottom of the hole. (Taped tubing requires a stronger pull.)
3. Remove the tubing from the probe rods. Dispose of polyethylene tubing or decontaminate teflon tubing for re-use.
4. Extract the probe rods from the ground and recover the expendable point holder with the attached adapter.
5. Inspect the "o"-ring at the base of the adapter to verify that proper sealing was achieved during sampling. "O"-ring should be compressed. (Fig. 5)
6. Prepare for next sample.

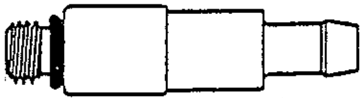
VAPOR SAMPLING TOOLS – PRT System

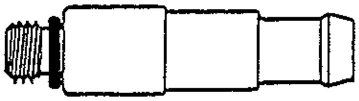
PRT System Parts List

Adapters


PR-12 S


PR-17 S


PR-25 S


PR-30 S

Tubing


TB-12T

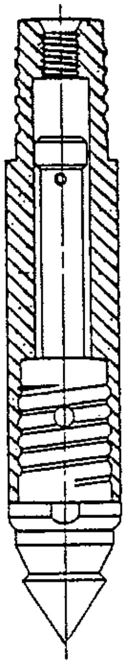

TB-17L


TB-17T

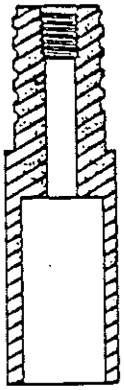

TB-25L


TB-30T

PRT Retractable Point Holder**


PR-21A/B

PRT Expendable Point Holder


PR-13A/B

Both point holders fit standard 1" O.D. Geoprobe Probe Rod

POST RUN TUBING SYSTEM PARTS LIST					
TUBING SIZE LD POLYETHYLENE*			PART NUMBER	INTERNAL VOLUME mL/FT	ADAPTER
O.D.	I.D.	WALL			STAINLESS
¼	.170	.040	TB-17L	4.46	PR-17S
⅜	¼	.060	TB-25L	9.65	PR-25S

* Available in 500 ft. length only

TEFLON (TFE) ★			NUMBER	VOLUME	STAINLESS
¼	⅛	.060	TB-12T	2.41	PR-12S
¼	3/16	.030	TB-17T	5.43	PR-17S
⅜	5/16	.030	TB-30T	15.08	PR-30S

★ Available in 50 ft. length only

POST-RUN EXPENDABLE POINT HOLDER	PR-13B
PRT RETRACTABLE POINT HOLDER	PR-21B
O-RINGS (PACKAGE OF 25)	PR-25R

Important: PR-13B replaces AT-13B

** Retractable Point Holder only, retractable point assembly (AT-21B) sold separately.

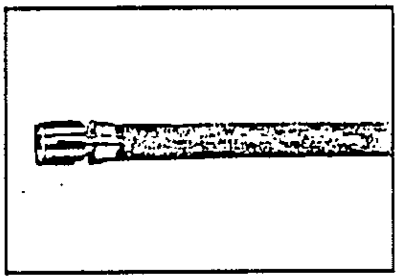
VAPOR SAMPLING TOOLS – Vapor Sampling Implants

Porous Implant

Part No. AT-80

Stainless Steel; 10 micron pore size. Fits down I.D. of probe rod and remains in the hole upon retraction of Geoprobe probe rods. For permanent vapor sampling point.

AT-80

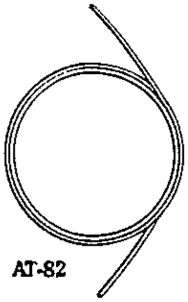


AT-80 Porous Stainless Implant

Coiled Tubing

Part No. AT-82

Stainless Steel; ⅛" in diameter. Connects to porous implant (Part No. AT-80) and vapor sampling implant (Part No. AT-81).

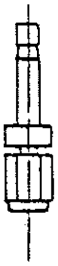


AT-82

Top Connector

Part No. AT-83

Connects ⅛" S.S. tubing to vacuum tubing. Used for surface connection of vapor sampling implants.



AT-83

Glass Beads

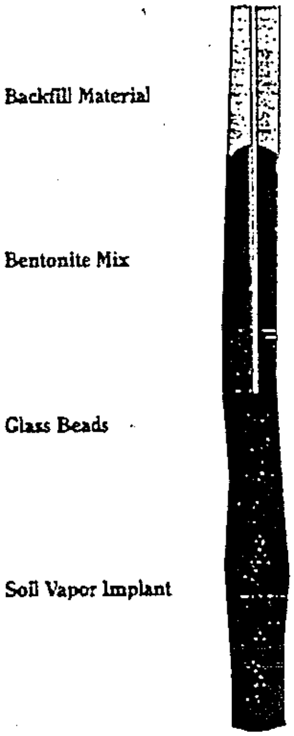
Part No. AT-84

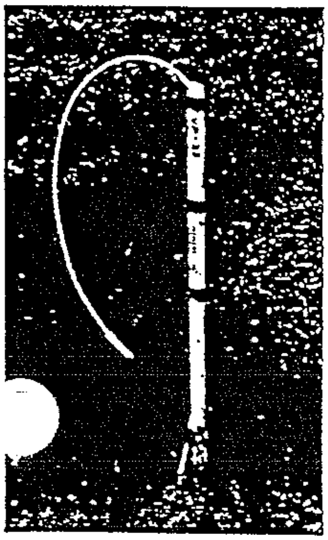
250 ml bag of 50-100 mesh rounded glass beads. For creating permeable layer around vapor implant.

Bentonite Mix

Part No. AT-85

250 ml bag of Bentonite/Glass Beads mixture. For sealing annulus above vapor implant.





A Vapor Implant Location

The Vapor Implant and stainless tubing are inserted down the inside diameter of the probe rods after the rods have been retracted about 1 foot. The Glass Beads are then poured down the inside diameter creating a permeable layer around the implant. The Bentonite/Glass Bead Mix follows to seal the annulus and the remainder of the hole is backfilled.

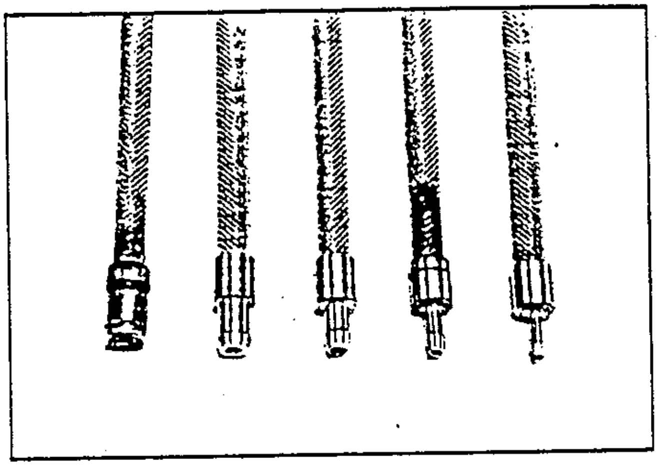
VAPOR SAMPLING TOOLS – Vapor Sampling Implants

Stainless Screen Implants

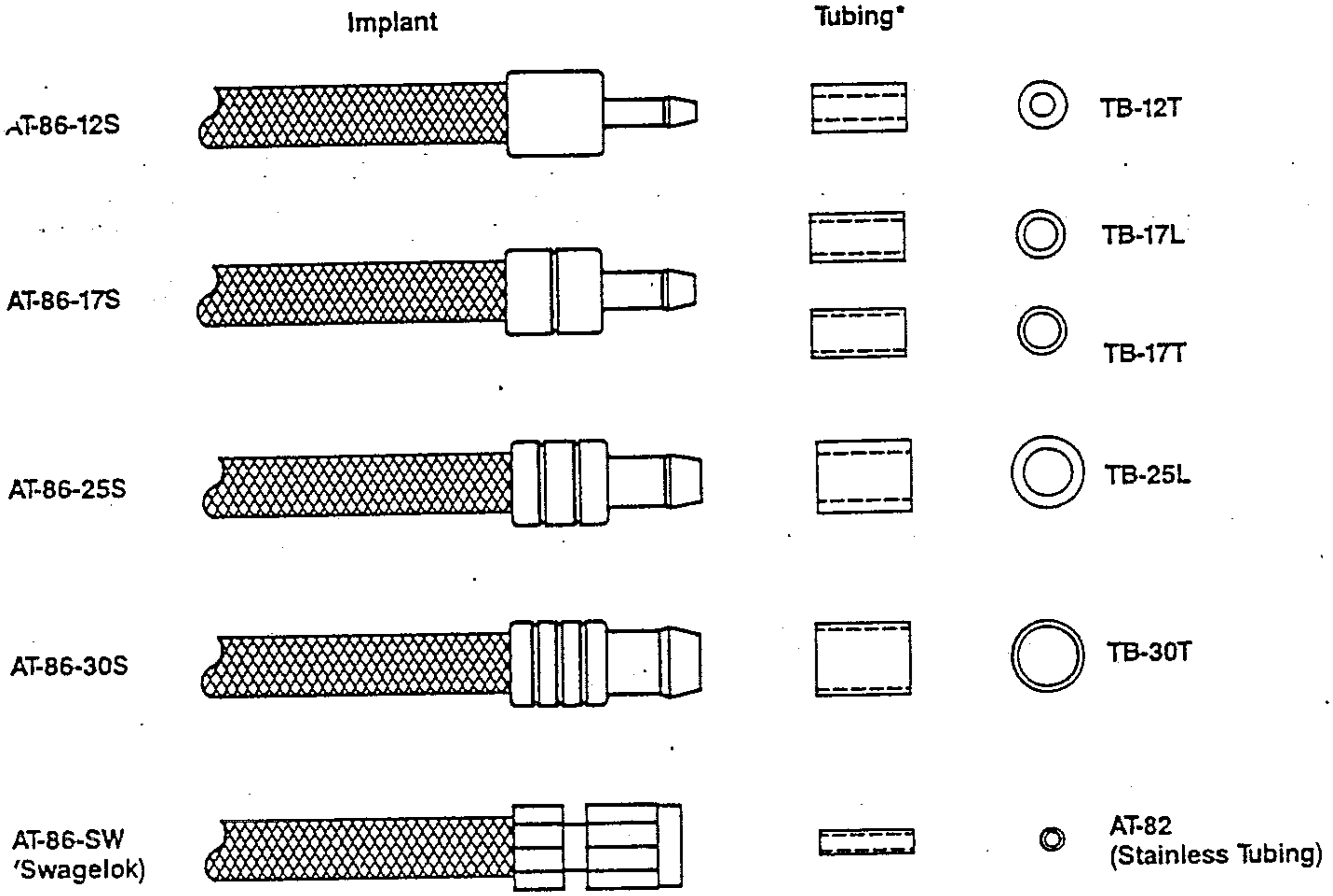
Part No. AT-86-12S
Part No. AT-86-17S
Part No. AT-86-25S
Part No. AT-86-30S
Part No. AT-86-SW

Stainless Steel Wire Screen Implants.

Double woven screen 6″ long x ¼″ I.D., with .0057″ openings. Connector heads have maximum O.D. of 7⁄16″ to fit down I.D. of probe rods. All stainless steel. Fit standard sizes of tubing.



AT-86 Series Wire Screen Implants (left to right, AT-86-SW, AT-86-30S, AT-86-25S, AT-17S, AT-86-12S).

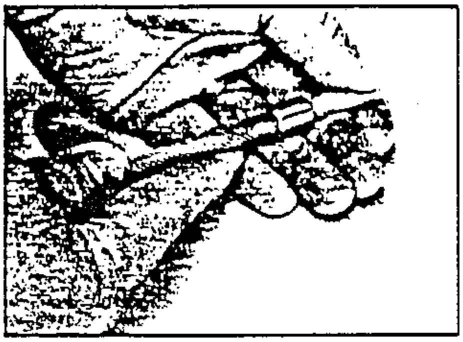


**See PRT Tubing Section on Page 23 for Complete Description of Tubing.*

VAPOR SAMPLING TOOLS - Vapor Sampling Implants - Operation

Instructions for installing permanent vapor implant:

1. Drive probe rods to desired depth using an AT-13B expendable point holder and an AT-14 expendable point.
2. Disengage the expendable point and retract the probe rods approximately twelve inches.
3. Attach appropriate tubing to vapor implant. If tubing is pre-cut, allow it to be approximately 48″ longer than the required depth of the implant. Use tape to close the upper end of the tubing.



Attaching tubing to vapor implant.

4. Insert the implant and tubing down the inside diameter of the probe rods until it stops. Note the length of the tubing inserted to assure that the desired depth has been reached by the implant (the implant must clear the end of the probe rods). Allow the excess tubing to extend out of the top of the probe rods.
5. Pour glass beads (AT-84) down the inside diameter of the probe rods using a funnel. Use the tubing to "stir" the glass beads into place around the implant. Do not lift up on the tubing while placing beads.
6. Pull the probe rods out of the hole an additional 18″-24″ using a manual jack or chain puller. (A regular pull cap cannot be used.) Exert downward pressure on the tubing while pulling to avoid pulling the tubing up with the rods.
7. Pour bentonite seal mixture (AT-85) down the inside diameter of the probe rods. Stir the mixture into place using the tubing as before. It may be desirable to "chase" the seal mixture with distilled water to initiate the seal.
8. Pull the remainder of the probe rods out of the hole in the same manner as in Step 6. Backfilling with sackrete (cement/sand) or bentonite sand mix may be done while removing the rods.

Pouring glass beads into probe rods to create permeable layer around implant.

Measuring carbon dioxide and methane level at vapor implant location.

9. Cut the tubing to the desired length at the surface and attach a tubing connector or plug.
10. Mark the sample location with a pin flag or stake. Point is ready for sampling now.

Uses:

- Landfill monitoring
- U.S.T. monitoring
- Remediation projects
- Radon gas monitoring

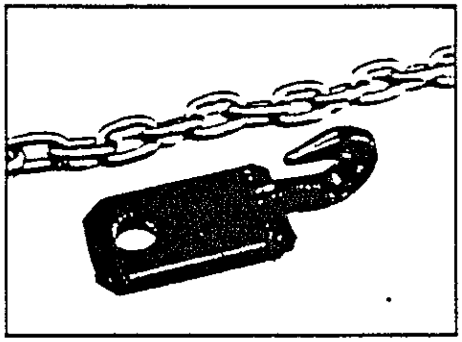
Pulling probe rods with chain puller with tubing in place.

VAPOR SAMPLING TOOLS – New Gadgets

Probe Rod Pull Plate

Part No. AT-122

Use this tool for pulling probe rods when a regular pull cap cannot be used such as when planting permanent vapor implants. A chain (not included) is required for operation.



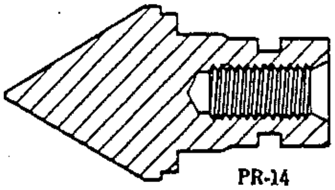
AT-122 Pull Plate

Using Pull Plate

PRT Implant Anchor

Part No. PR-14

Dual purpose drive point and anchor same as AT-14 except for tapped center that fits PRT adapters. Insert perforated teflon or polyethylene tubing with PRT "dummies" before disengaging point to create a mini monitoring point for water or vapor sampling. Use with regular AT-13B expendable point holder.

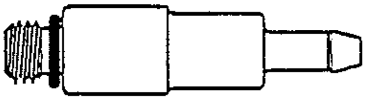


PR-14

PRT "Dummy Adapters"

Solid PRT Adapters (no bore) fit same sizes of tubing as regular PRT adapters. Stainless Steel. For use with PR-14 Implant Anchors and selected tubing.

PR-12D (fits 1/8" I.D. tubing)
PR-17D (fits 3/16" I.D. tubing)
PR-25D (fits 1/4" I.D. tubing)
PR-30D (fits 5/16" I.D. tubing)

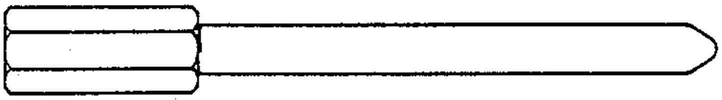


PR-17D

Post Run Point Popper

Part No. PR-15

Use in conjunction with extension rods to dislodge expendable points from point holder at the bottom of the hole. This is sometimes necessary when "O"-rings are used with drive points. Fits through PRT point holder adapter threads.



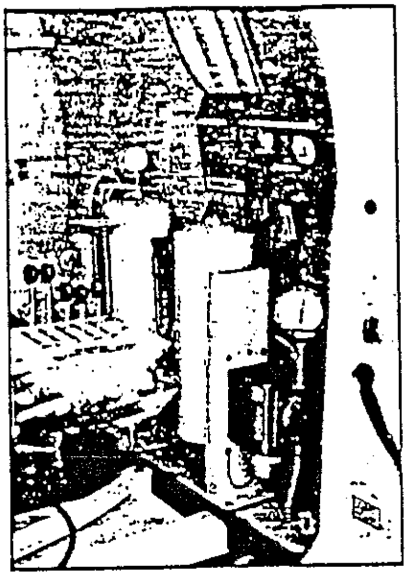
PR-15

VAPOR SAMPLING TOOLS – The Vacuum/Volume System

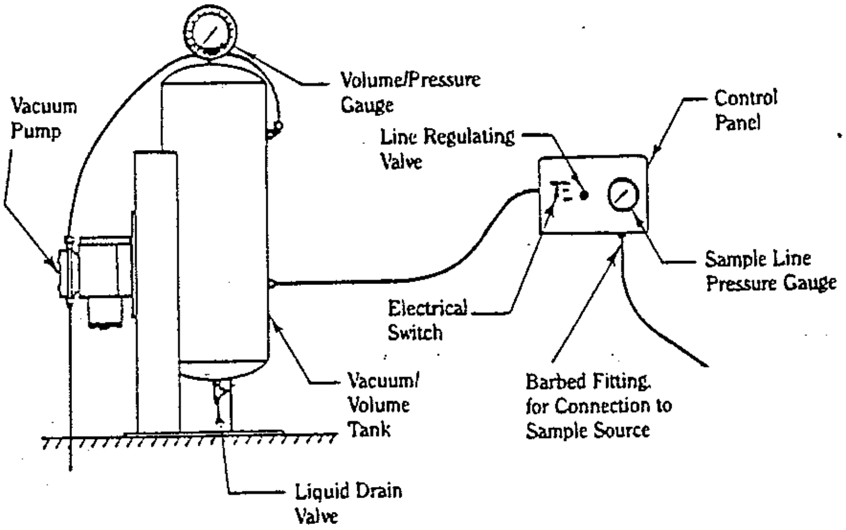
Mountable Vac/Vol System

Part No. AT-1001

Designed for programmed extraction of soil gas vapors from probe cavities. Eleven liter vacuum tank with 12 volt DC diaphragm pump and gauge calibrated in both tank volume and vacuum pressure. Capable of a vacuum up to 21" hg. Also includes a sampling valve, a line vacuum gauge, and a pump control switch. The vacuum tank gauge provides an accurate measurement of purge volume from the probed hole and allows regulation of the maximum applied vacuum. The line vacuum gauge indicates pressure at the probe head during vapor sampling. Weight: 35 lbs.



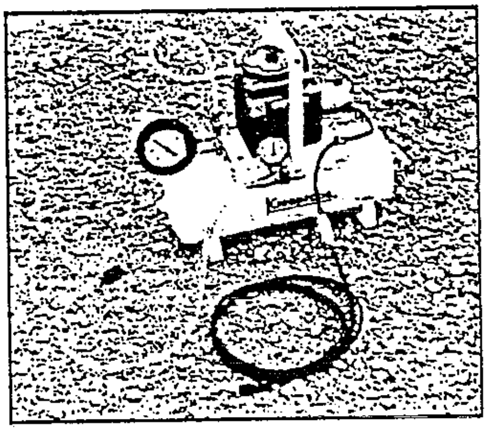
Vacuum / Volume System (front) mounted in a Geoprobe equipped van.



Portable Vac/Vol System

Part No. AT-1000

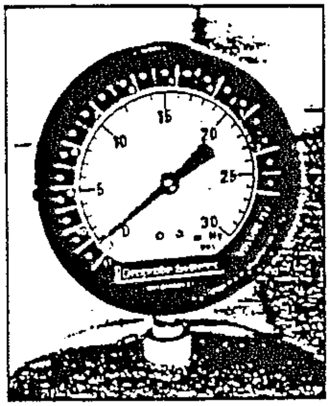
Portable version of vac/vol. system. 12 VDC.
Equipped with a cigarette lighter plug-in and 10 ft. of cord.
Weight: 40 lbs.



AT-1000 Portable Vaccum / Volume System

VAPOR SAMPLING TOOLS – Vacuum/Volume System – Operation

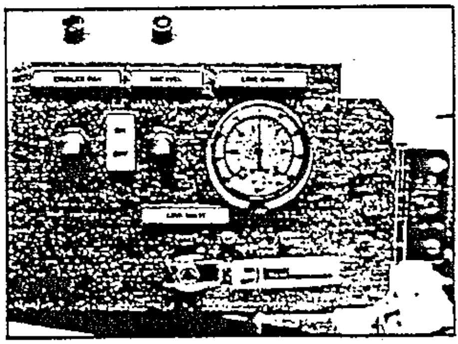
Operating Instructions for AT-1000 and AT-1001 Vacuum/Volume System



Vacuum gauge calibrated in inches Hg and volume in liters.

Follow these steps after probe rods have been driven to sampling depth and expendable or retractable point has been disengaged or after PRT tubing has been attached:

1. Turn the vacuum pump on and allow pressure to build in the vacuum tank. Make sure that the line valve is closed before starting the pump. The inside scale of the vacuum gauge is calibrated in inches Hg. The outside scale is calibrated for volume in liters (at standard temperature and pressure). Build the pressure to the desired vacuum and turn the switch off.
2. Attach the vacuum hose to the top of the soil vapor sampling train (i.e. to sampling cap on top of probe rods or to PRT tubing).
3. Open the line control valve. If sampling through probe rods, evacuate 100 ml of volume for each rod used. Some protocols may call for a minimum of 3 purge volumes to be evacuated before sampling (i.e. 9 foot depth = 3 rods x 100ml x 3 = 900ml). If using PRT tubing, evacuate the appropriate volume to purge the ambient air in the system. You may choose to purge a standard volume at each sample location.
4. After achieving sufficient purge volume, quickly close the line valve and allow sample line pressure to return to zero (0). This returns the sample train to atmospheric pressure. The sample can be collected at this time.



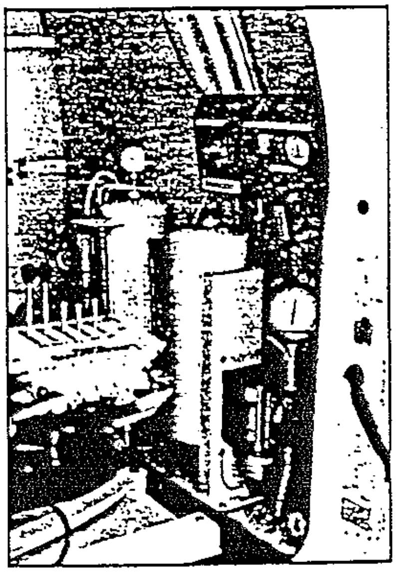
Control panel with line control valve and line pressure gauge.

Pointers

If the needle on the line valve does not move, it may indicate that the soil at the sampling depth is saturated or that the pore space is too tight to yield a sample. It could also indicate that the sampling train is plugged.

If the needle moves back to zero very quickly, it indicates that the soil at the sampling depth is very permeable or that there is a leak in the sampling train. You can check for leaks by laying out the sampling train and plugging the sampling end with a rubber stopper and applying a vacuum to it. You may want to do this before sampling.

In some soils the needle may return to zero very slowly. The time it takes for the needle to return to zero is called the "recovery" time. It should be noted for each sample taken. This information will allow relative comparison of soil permeability. Recovery times greater than 10 minutes should be considered suspect. The effect of any leakage in the sampling system is increased with longer recovery times. After 10 minutes, the operator should consider either changing the sampling depth, location, length of pull-back from the sampling tip, or switching entirely from soil-gas sampling to grab sampling and analysis of soil.

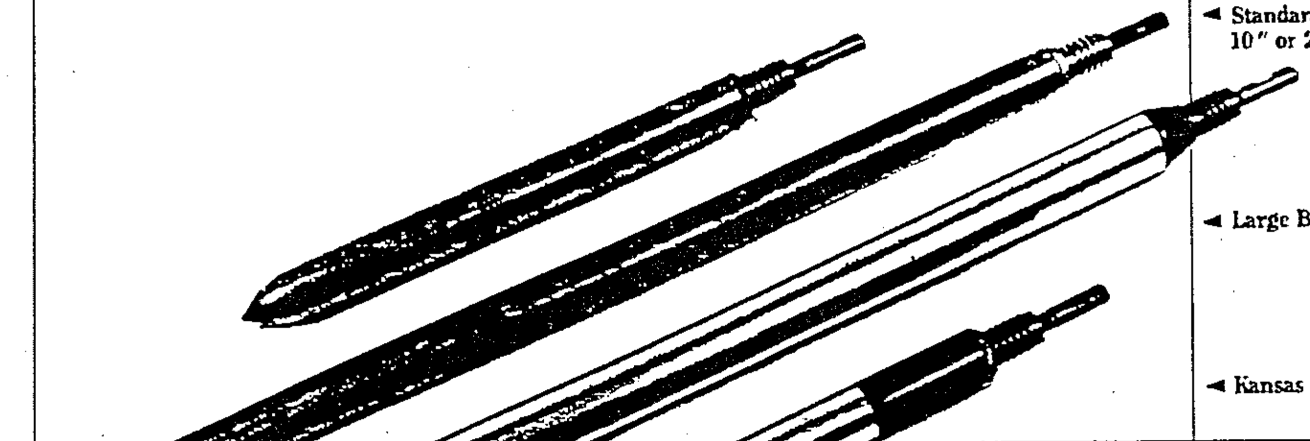


Vacuum volume system (right) mounted in Geoprobe lab van. FID compressed air system on left.

The Probe-Drive* Soil Sampling System

*Patent Pending

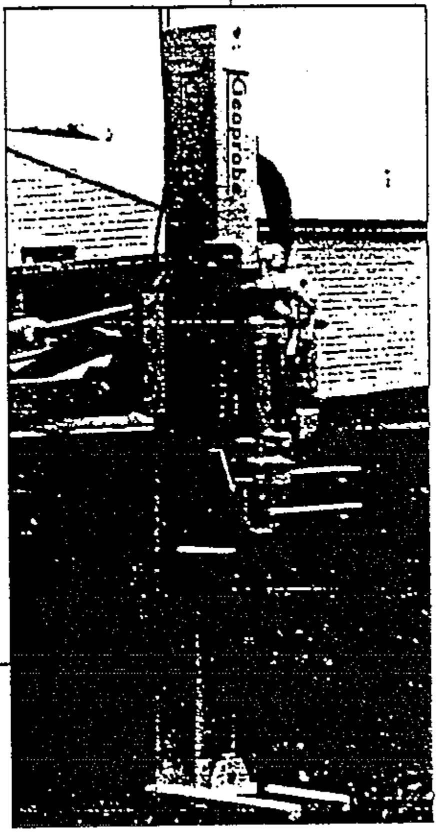
Soil Samplers that remain completely sealed while being pushed or driven to depth …



Typical Applications

Retrieval of Discrete Soil Samples at Depth Using Driven Probes

- Soil Sampling Beneath UST sites.
- Studies of chemical dissipation with soil depth.
- Pesticide studies.
- Hazardous waste site investigations.
- Property transaction surveys.
- Chemical carryover/residue studies.



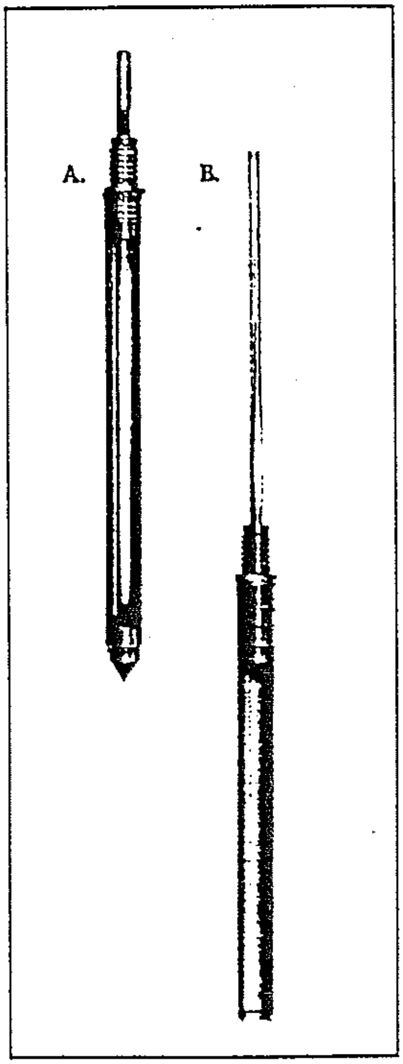
Using a truck mounted Geoprobe Model 8-M Hydraulic Probe to drive the Large Bore Soil Sampler. ►

SOIL SAMPLING TOOLS - Probe Drive System/Operation

Basics

The Probe-Drive System is a unique soil sampling system designed for use with Geoprobe sampling tools. They can be used with either manually driven probe rods or Geoprobe 8-series hydraulic soil probes.

Unlike split-spoon samplers, the Probe-Drive sampler remains completely sealed by a piston tip at the end of the sample tube while it is pushed or driven to the desired sampling depth. A piston stop-pin at the opposite end of the sampler is removed by means of extension rods inserted down the inside diameter of the probe rods after the sampler has been driven to depth. This enables the piston to retract into the sample tube while the sample is taken.



A Cross-Sectional View
A. Driving (Sealed) Position
B. Sampling Position, Stop-Pin Removed. (Soil pushes piston into tube).

Parts

The usual Geoprobe rods and driving accessories with the following tools are required to sample soil using the Probe-Drive System:

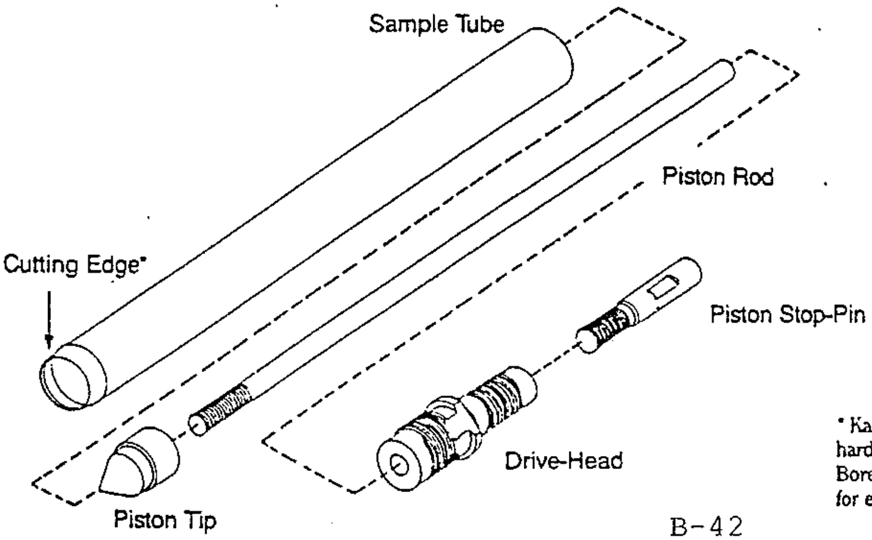
- Assembled Sampler
- Extension Rods
- Extension Rod Couplers
- Extension Rod Handle
- Extruder Rack*
- Extruder Piston*

* (except for Large Bore which uses an acetate liner for easy removal of sample)

See opposite page for parts and descriptions of individual samplers.

Assembly

After cleaning parts thoroughly, assemble as shown below. All parts must fit tightly. Stop-Pin is reverse threaded and should be tightened with a wrench so that it exerts pressure against the piston rod. Damage could occur during probing if pin is not tight.



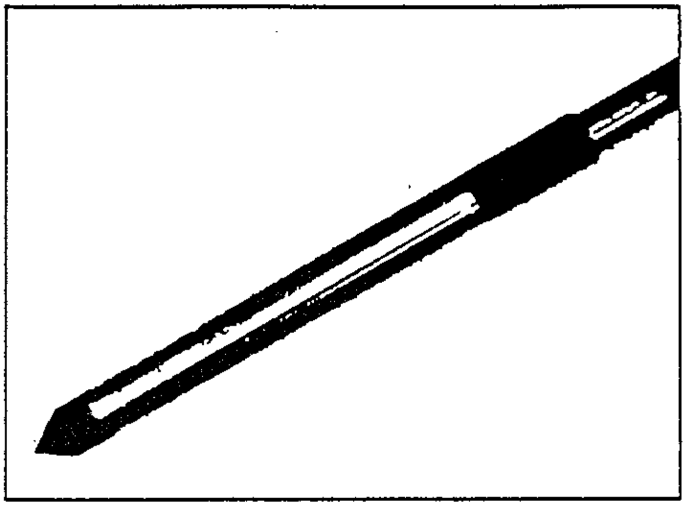
◄ Standard Soil Sampler Assembly

* Kansas Stainless and Large Bore Samplers feature removable hardened cutting shoes that thread onto the sample tube. Large Bore Sampler also utilizes an acetate liner inside of the sample tube for easy removal of soil sample.

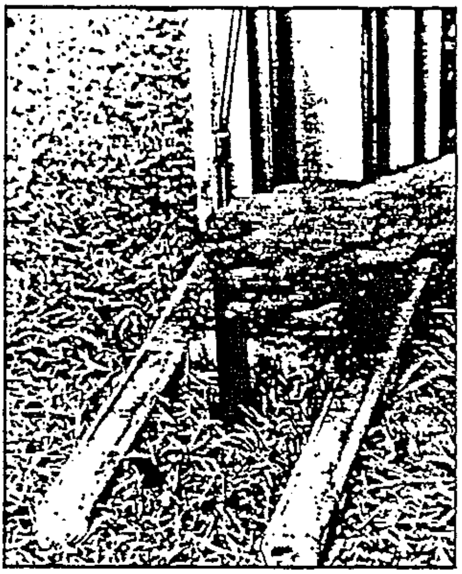
Probing

1. Attach assembled sampler onto leading Geoprobe probe rod. (A 12" probe rod is recommended to start the Standard 24" and Large Bore Samplers. Replace the 12" rod with a 36" rod as soon as sampler is driven below the surface.)
2. Drive the sampler with the attached probe rods to the top of the interval to be sampled using manual probe rod driver or hydraulically powered Geoprobe unit.

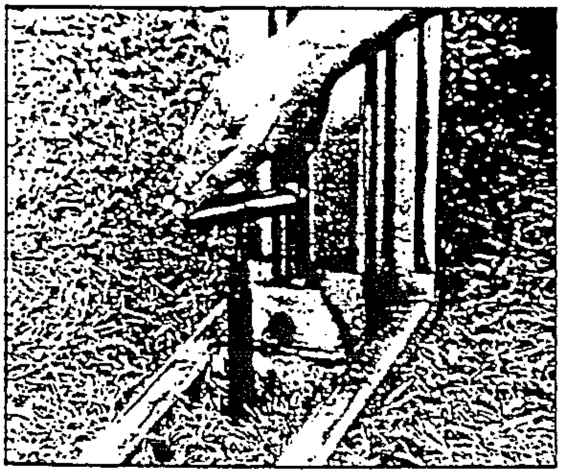
IMPORTANT: Some soil conditions may warrant using a retractable or solid drive point to pre-probe the hole to the desired sampling depth. Do not drive the sampler into bedrock or other impenetrable layer.



▲ **Assembled Kansas Sampler attached to Geoprobe 1" O.D. Standard Probe Rod.**



▲ FIGURE 1
Joining extension rods together with couplers.



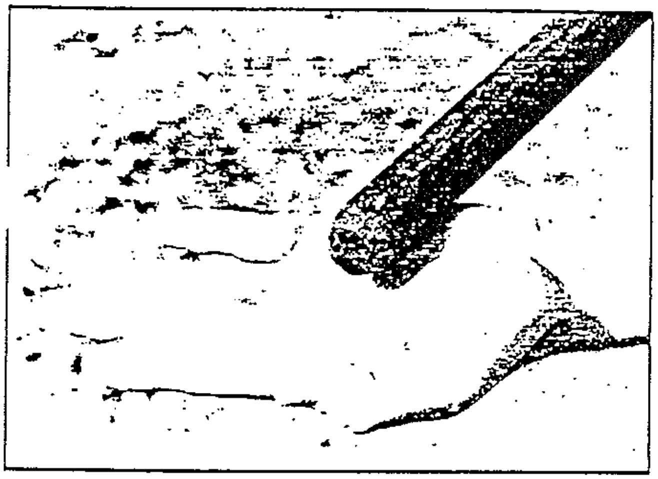
▲ FIGURE 2
Rotating extension rod handle clockwise to disengage stop-pin.

Stop-Pin Removal

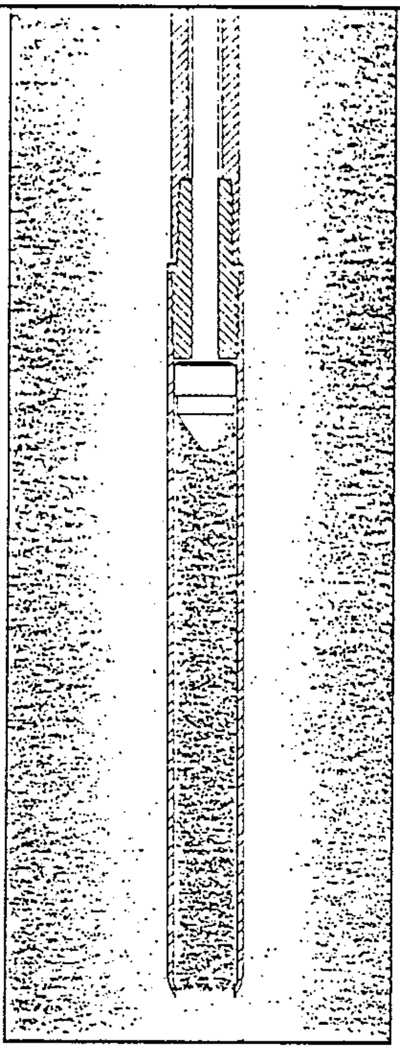
1. If using Geoprobe, move probe unit back from top of probe rods to allow room to work.
2. Remove drive cap and lower extension rods into inside diameter of probe rods using couplers to join rods together. (Fig. 1)
3. Attach extension rod handle to top extension rod.
4. Rotate extension rod handle clockwise until the leading extension rod is screwed into the piston stop-pin downhole. (Fig. 2)
5. Continue to rotate handle clockwise until reverse-threaded stop-pin has disengaged from the drive head.
6. Remove extension rods and attached stop-pin from the probe rods.

Sampling

1. Replace drive cap onto top probe rod. (If top of probe rod is already in lowest driving position, it will be necessary to attach another probe rod before driving.)
2. Mark the top probe rod with a marker or tape at the appropriate distance above the ground surface. (i.e. 10" for Standard Sampler, 12" for Kansas Sampler, and 24" for Large Bore Sampler.)
3. Drive probe rods and sampler the designated distance. Be careful not to over-drive the sampler which could compact the soil sample in the tube making it difficult to extrude.
4. Retract probe rods from the hole and recover the sampler. Inspect the sampler to confirm that a sample was recovered.



▲ A recovered standard soil sampler.



Soil Sampling at depth using a probe-drive soil sampler. Piston tip and rod retract during sampling. ►

Machine Extrusion

(Standard and Kansas Samplers)

1. Disassemble sampler. Remove all parts.
2. Position extruder rack on the foot of the Geoprobe derrick as shown. (Fig. 3)
3. Insert sample tube into extruder rack with the cutting end up.
4. Position the extruder piston and push sample out of tube using the "probe" function on the Geoprobe. Catch the sample as it is extruded beneath the extruder.

CAUTION: Use care when performing this task. Apply down pressure gradually. Use of excessive force could result in injury to operator or damage to tools.

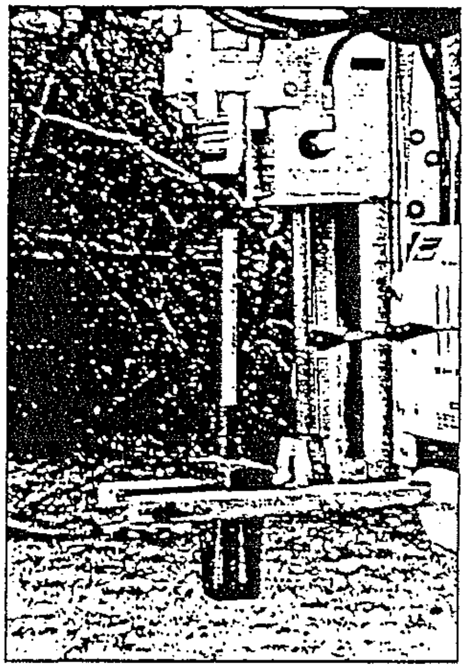


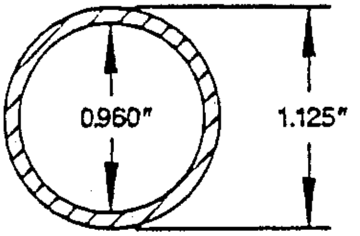
FIGURE 3
Using Geoprobe to extrude soil samples. ►

SOIL SAMPLING TOOLS – Probe Drive System/Standard Sampler

Standard Probe-Drive Sampler

AT-60 Series

The original probe drive sampler, featuring a single piece thin wall tube with a built-in cutting edge. Recovers discrete soil samples 8.75" long x .96" diameter (106 ml). Can sample to working depth of soil probe. The twenty-four inch model recovers 21.25" long core (257 ml). The easiest driving sampler of the Probe Drive family.

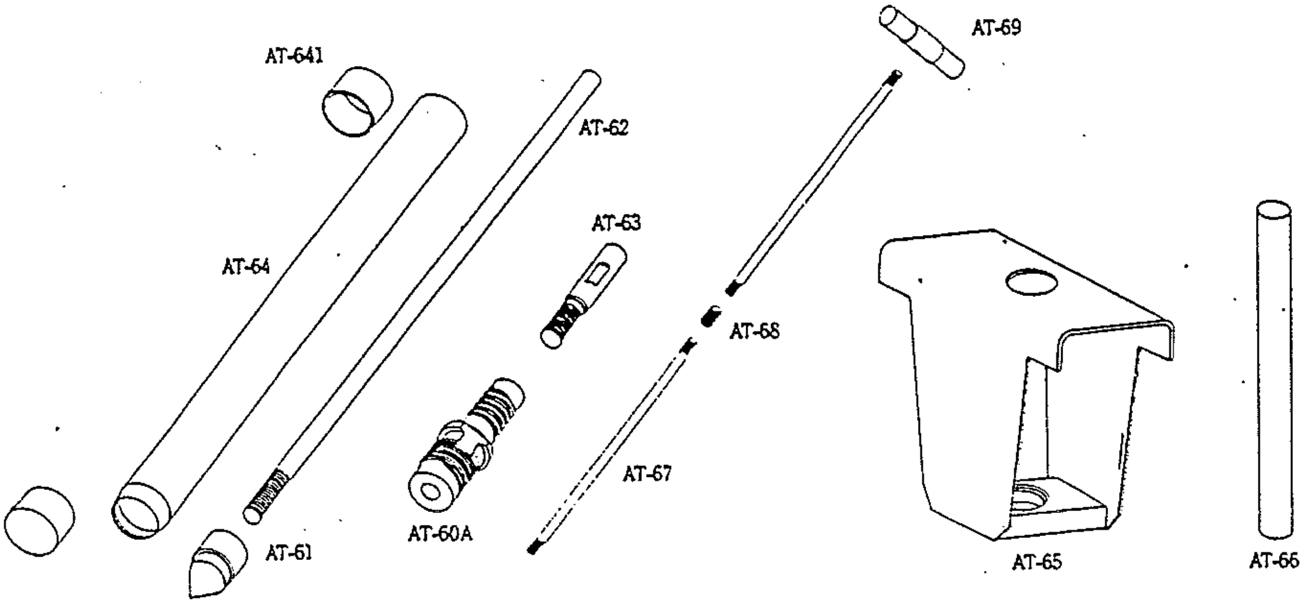


Actual size of sample tube

PARTS	
Standard (10") Sampler Parts	
AT-60B	STD Drive Head
AT-61	STD Piston Tip
AT-62	STD Piston Rod
AT-63	STD Piston Stop-Pin
AT-64	STD Sample Tube
AT-641	STD Tube Vinyl End Caps
AT-65	STD Sample Extruder Rack
AT-66	STD Extruder Piston
Standard (24") Sampler Parts*	
AT-621	STD 24" Piston Rod
AT-645	STD 24" Sample Tube
*Uses all other STD parts	

PARTS	
Parts used with all Probe-Drive Samplers	
AT-63	STD Piston Stop-Pin
AT-67	Extension Rod (Stainless)
AT-68	Extension Rod Couplers
AT-69	Extension Rod Handle

Standard Probe Drive Sampler Parts

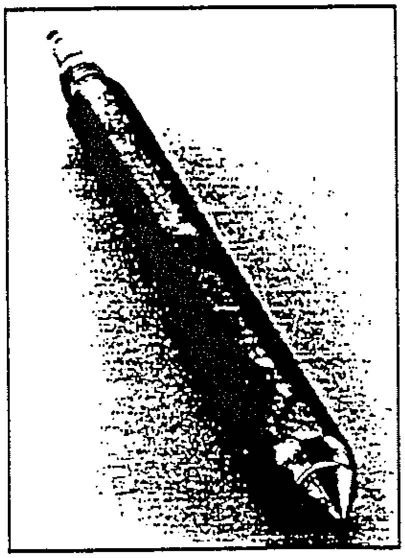


SOIL SAMPLING TOOLS – Probe Drive System/Standard Sampler

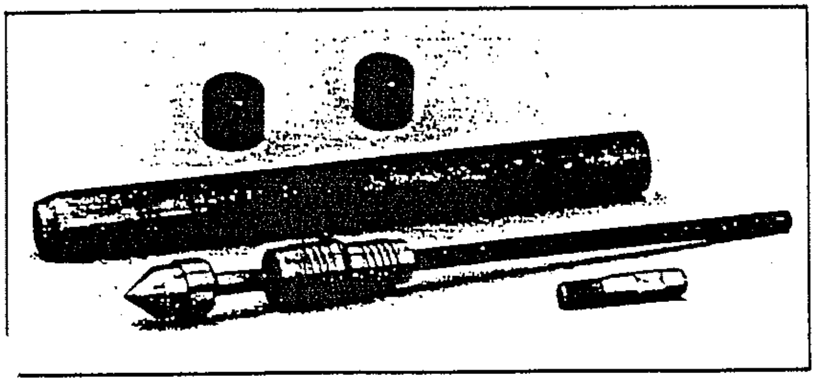
PARTS

Standard Probe Drive Sampler Kit
Part No. AT-60K
Includes the following parts:

(2) AT-60B	(2) AT-63	(1) AT-65	(8) AT-67
(2) AT-61	(12) AT-64	(4) AT-66	(8) AT-68
(2) AT-62	(24) AT-641		(1) AT-69



Assembled Standard Sampler



Standard Sampler Parts

Discounts

The following parts are replaced frequently. Geoprobe offers a discount on these pre-packaged parts.

PARTS

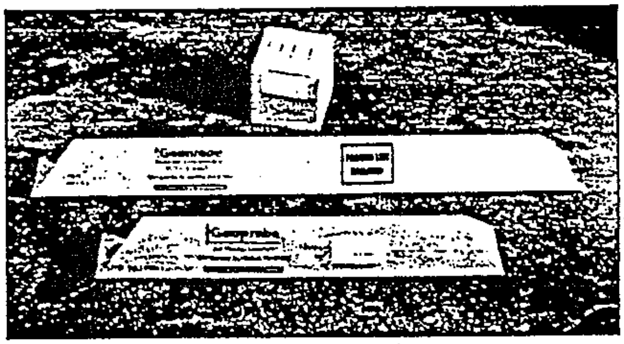
12 Standard Sample Tubes
Part No. AT-64K
Includes the following parts:

(12)	AT-64	STD Sample Tubes
(24)	AT-641	STD Vinyl End Caps

6 – 24" Samples Tubes
Part No. AT-645K
Includes the following parts:

(6)	AT-645	STD 24" Sample Tubes
(12)	AT-641	STD Vinyl End Caps

100 Vinyl End Caps
Part No. AT-641K



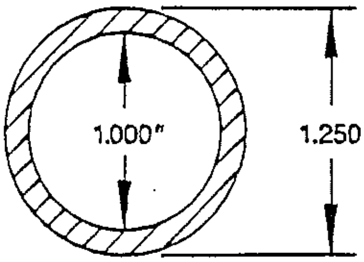
Pre-packaged parts available for fast shipment.

SOIL SAMPLING TOOLS – Probe Drive System/Kansas Sampler

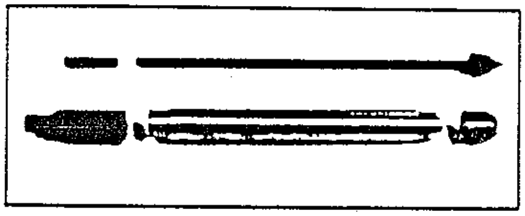
Kansas Stainless Sampler

AT-650 Series

Features a stainless steel sample tube and replaceable hardened cutting shoe. Specially designed to recover sample cores a full 12" long x 1" diameter (158 ml). Able to sample to working depth of soil probe unit. Uses STD Sample Extruder Rack and STD Piston Stop-Pin. Hardened cutting shoe makes this a good sampler for rocky soil.



Actual size of sample tube



AT-650 Kansas Stainless Sampler

PARTS

Kansas Stainless Sampler Parts

AT-650	KS Cutting Shoe	AT-653	KS Piston Tip
AT-651	KS Drive Head	AT-654	KS Piston Rod
AT-652	KS Stainless Tube	AT-656	KS Extruder Piston

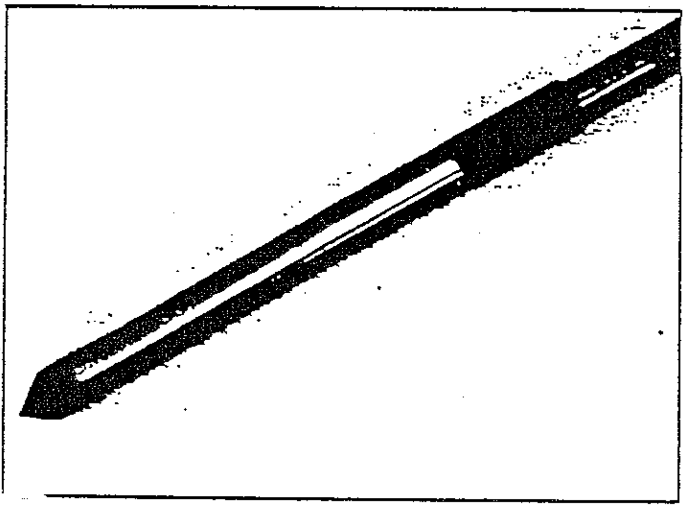
Kansas Sampler Alloy Steel Tube

Replaces stainless sample tube for Kansas Sampler. Made of heavy alloy steel with black corrosion resistant finish. This tube should be used in rockier soils.

PARTS

Kansas Sampler Steel Alloy Tube

AT-657	KS Steel Tube



bled Kansas Sampler attached to Geoprobe 1" O.D.
ard Probe Rod.

KITS

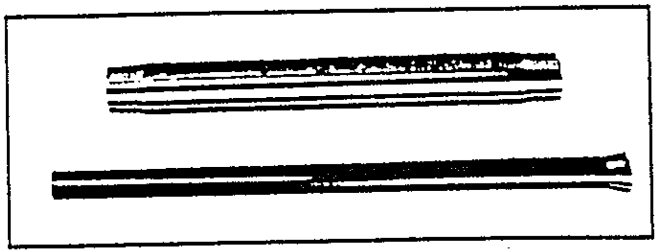
Assembled Kansas Stainless Sampler
Part No. AT-650K
Includes the following parts:
(2) AT-650 (1) AT-652 (1) AT-654
(1) AT-651 (1) AT-653 (1) AT-63

Assembled Kansas Steel Sampler
Part No. AT-657K
Includes the following parts:
(2) AT-650 (1) AT-657 (1) AT-654
(1) AT-651 (1) AT-653 (1) AT-653

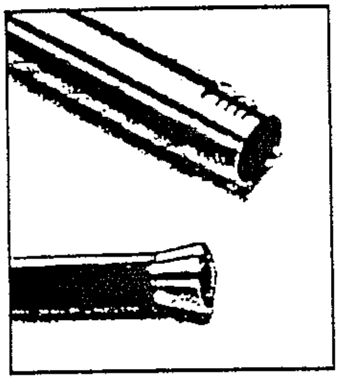
Kansas Sampler Extruder Assembly

Part No. AT-656

Features steel rod with replaceable stainless steel piston. For use with AT-65 extruder rack and hydraulic probe. For use with Kansas sample tubes only.



Kansas sample tube (top) and extruder assembly AT-656



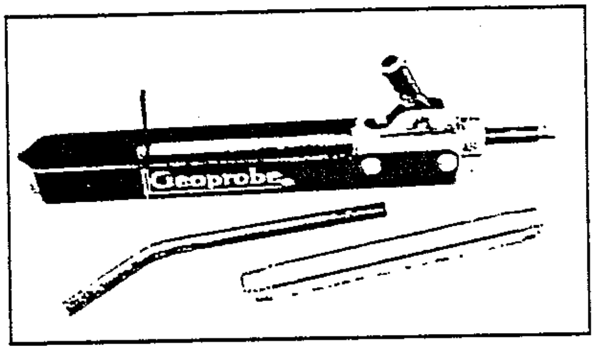
Kansas Sampler Extruder Assembly

PARTS	
Kansas Sampler Extruder Parts	
AT-656-1	KS Steel Extruder Rod
AT-656-2	KS Stainless Extruder Piston

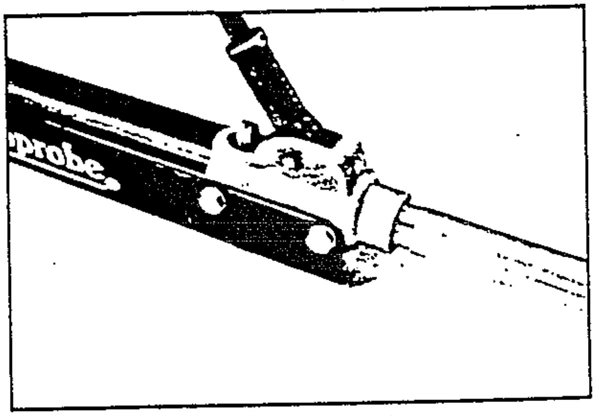
Kansas Sampler Manual Extruder

Part No. AT-658

For extruding soil samples from Kansas style sample tubes. Tube screws into end of extruder. Ratchet action advances piston to extrude soil samples. Ideal for laboratory use.



Kansas Sampler Manual Extruder



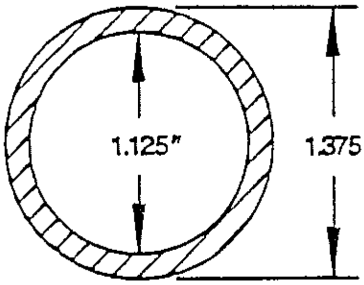
Sample tubes screw into end of extruder.

SOIL SAMPLING TOOLS – Probe Drive System/Large Bore

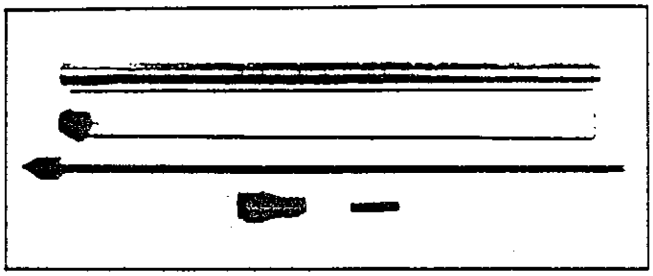
Large Bore Sampler

AT-660 Series

Features nickel plated sample tube, replaceable hardened cutting shoe, and removable acetate liner. Recovers cores 24" long x 1⅛" diameter (400 ml). Recommended for sampling depths up to 12 feet. Uses STD Piston Stop-Pin. Use where larger sample volume and visual examination of intact core is desired.



Actual size of sample tube



**Note:* *Acetate liner snaps over interior end of cutting shoe.*

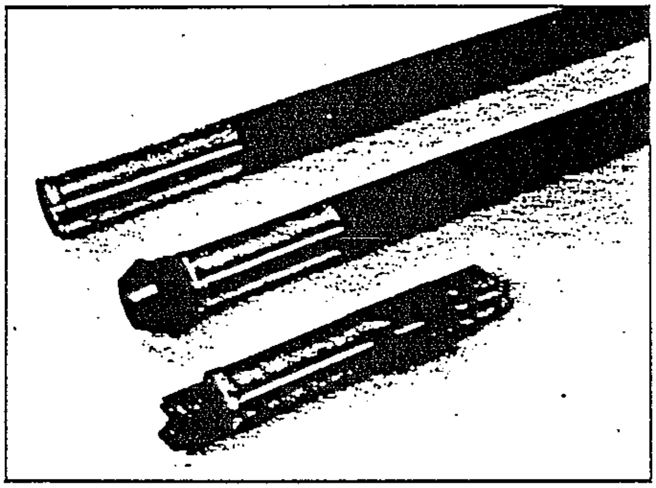
PARTS

Large Bore Sampler Parts

AT-660	LB Cutting Shoe	AT-663	LB Piston Tip
AT-661	LB Drive Head	AT-664	LB Piston Rod
AT-662	LB Sample Tube	AT-665	LB Acetate Liner

rge Bore Sampler Brass Liner

Brass liner comes in 4 – six inch sections aligned in an outer plastic sleeve. End piece is flared to fit over interior end of cutting shoe. Weight 10 oz. each.



AT-666 Brass Liner. Easily separated for removal of soil samples.

PARTS

AT-666	LB Brass Liner

KITS

Large Bore Assembled Kit
Part No. AT-660K
Includes the following parts:

(2) AT-660	(1) AT-662	(1) AT-664	(1) AT-63
(1) AT-661	(1) AT-663	(10) AT-665	

Note to users: A 12" section of probe rod (AT-106B) should be used to initially drive this sampler into the ground.

Discounts

following parts are replaced frequently. Geoprobe offers a ount on these pre-packaged parts.

PARTS

130 LB Acetate Liners
Part No. AT-665K

SOIL SAMPLING TOOLS – Shelby Tubes

Shelby Tube Sampling Kit

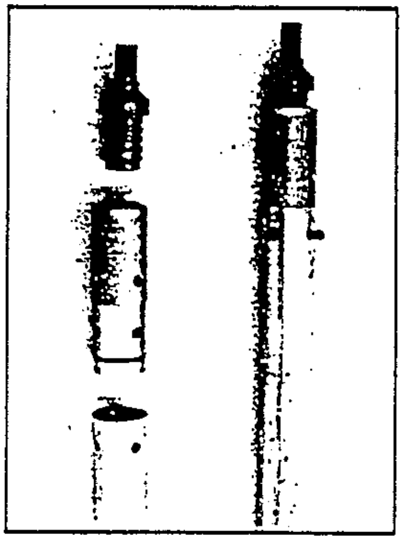
AT-70 Series

Allows use of Geoprobe machine to push 2″ diameter thin wall (shelby) tubes. These tools have been successfully used to sample to depths in excess of 5′ in cohesive soils. The Extruder Bracket (Part No. AT-71) allows the use of the hydraulic system on the Geoprobe Machine for extrusion of soil samples from 2″ diameter Shelby Tubes.

PARTS

Shelby Tube Sampler Parts

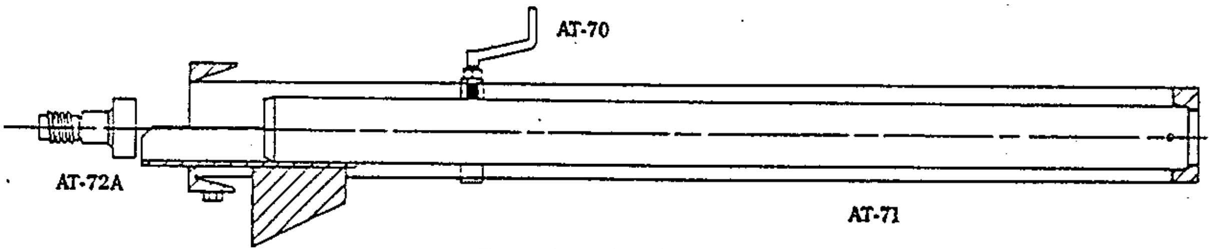
AT-710	Tube Sampler Head
AT-73	2″ Diameter x 30″ Sample Tube
AT-16B	Sampler Sub (Geoprobe Male x AW)



Shelby Tube Sampler Parts AT-16B (top), AT-710 (middle), AT-73 (bottom). Sample tube attaches to sampler head with hex bolts.

Shelby Tube Extruder

Extruder Rack (AT-71) fits onto foot of Geoprobe in horizontal position. Latch (AT-70) secures sample tube against rack to hold tube in place. Piston (AT-72B) threads into end of AT-10B probe rod. Geoprobe machine is put into lateral position and uses probe as ram to push out soil sample.



Extrusion of Soil Sample

PARTS

Shelby Tube Extruder Parts

AT-70	Extruder Latch
AT-71	Shelby Extruder Rack
AT-72B	Extruder Piston

KITS

Shelby Tube Sampler Kit

Part No. AT-70K

Includes the following parts:

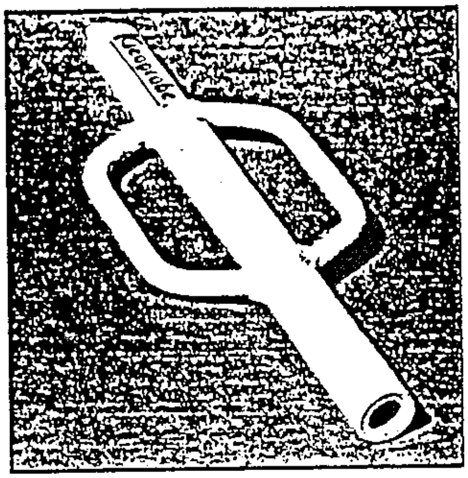
(1) AT-710
(1) AT-70
(1) AT-71
(1) AT-71B
(15) AT-73
(1) AT-16B

MANUAL SAMPLING TOOLS

Manual Probe Rod Driver

Part No. AT-23

All steel construction with no moving parts. This traditional-style driver has been used to effectively drive rods to over 18 ft. Weighs over 30 lbs. Must be used in conjunction with probe rod jack for removing rods.

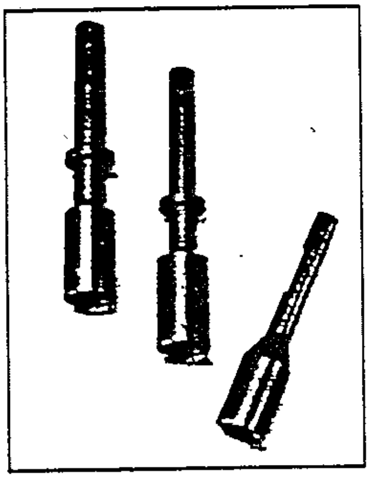


AT-23 Manual Driver

Hammer Anvil Adapters

Part No. AT-221 7/8" x 4 1/4" shank (fits Wacker)
rt No. AT-222 1" x 4 1/4" shank (fits Wacker)
rt No. AT-223 3/4" x 4" shank (fits Bosch)

Allows user to drive Geoprobe brand probe rods with popular gas or electric hammer drills/breakers. Hardened steel with corrosion resistant finish.



Wacker Anvils (left)
and Bosch Anvil (right)

Probe Rod Jack

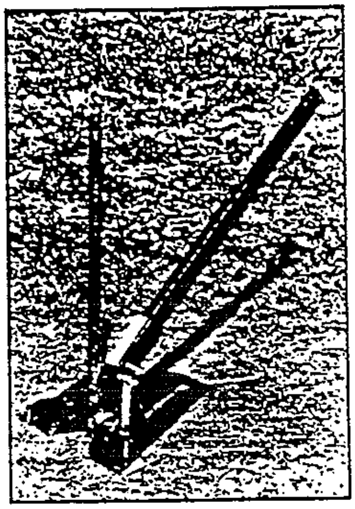
Part No. AT-99

Specially designed jack for manually removing Geoprobe 1" probe rods. Jack handle is collapsible and attaches to base for easy storage and transport. Ideal for pulling manually driven probe rods or as a back-up tool for the Geoprobe. Lift capability is over 4500 lbs. Chuck piece is interchangeable so jack may be used to pull other sizes of rods and pipe. Will work on slide hammers.

Chuck Piece

Part No. AT-98

Replaces chuck piece on AT-99 Probe Rod Jack. A 3 in 1 tool for pulling 1/2", 5/8", or 7/8" slide-hammer rods or pipe.



AT-99 Probe Rod Jack pulling probe rod.

Probe Rod Jack with AT-98 Chuck Piece removing slide hammer.

MANUAL TOOLS - KITS

Basic Manual Tool Kit

Includes the basic tools needed to use Geoprobe sampling attachments.
Comes with 12′ of probe rods for 10′ depth capability.
Purchase additional sampling kits for a complete sampling system.

KIT

Basic Manual Tool Kit
Part No. AT-10K
Includes the following parts:

(1)	AT-23	Manual Probe Rod Driver
(1)	AT-99	Probe Rod Jack
(4)	AT-10B	Probe Rods
(2)	AT-11B	Drive Cap

Soil Gas Sampling Kits

KIT

PRT Soil Gas Sampling Kit
Part No. PR-13K
Includes the following parts:

(2)	PR-13B	PRT Expendable Point Holder
(4)	PR-17S	PRT Adapter
(1)	PR-25R	PRT "O"-rings (pkg of 25)
(100)	AT-14	Expendable Drive Points
(1)	TB-17L	500′ ¼″ Polyethylene Tubing

Soil Sampling Kits (See Section 5)

AT-60K	Standard Probe Drive Sampler Kit – pg. 35
AT-650K	Kansas Sampler Assembled Kit – pg. 36
AT-660K	Large Bore Sampler Assembled Kit – pg. 38

Ground Water Sampling Kits (See Section 3)

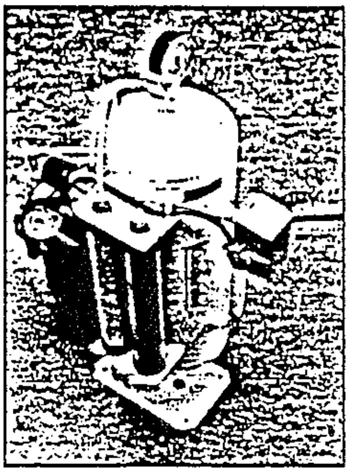
GW-43K	Mill Slotted Assembly – pg. 15
GW-440K	Screen Point Sampler Assembly – pg. 16

LABORATORY ACCESSORIES

FID Compressed Air System

Part No. AT-1004

An air compressor/storage system with dessicant and organic removal capability used to provide hydrocarbon free air for flame ionization detector operation. This system includes an oilless air compressor, 2 gal. air storage tank, pressure switch for automatic operation of compressor, single stage pressure regulator, drierite/mole sieve gas purification cartridge, and activated carbon gas purifier cartridge. Compressor will operate approximately 1 minute every 15 minutes for typical FID operation.

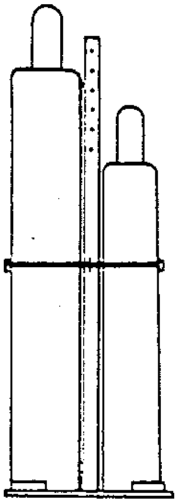


AT-1004 FID Compressed Air System.

Vertical Gas Bottle Rack

Part No. AT-1002

Used for securing compressed gas cylinders in mobile boratories. Holds two "Q" size (35″ length) gas bottles. imum clearance is 45″. Tie-down strap is included. bolts to the floor and wall of a cargo van or pickup truck.

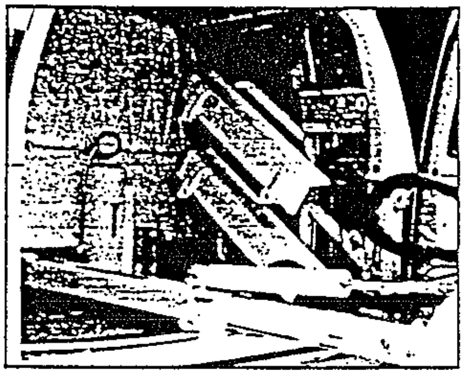


AT-1002

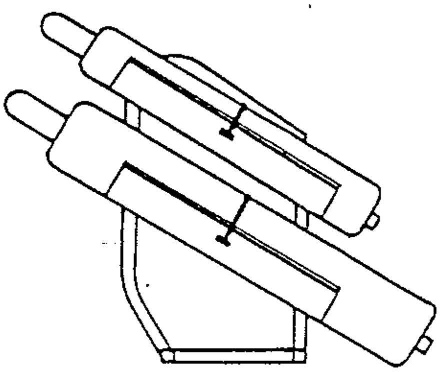
Horizontal Gas Bottle Rack

Part No. AT-1003

Holds two compressed gas bottles of variable length up to "T" size (60″ length). Two tie-down straps are included. Equipped with cylinder cradles for easy loading and unloading of compressed gas bottles from carrier vehicle, and to allow for use of universal size gas bottles. Common gases used ultra-pure nitrogen, hydrogen, and pressed air. Must be bolted to the oor and wall of a cargo van or pickup truck.



AT-1003 mounted in Geoprobe Lab Van.



AT-1003

REPLACEMENT PARTS

Hydraulic Cylinder Seal Kits

When hydraulic cylinders require maintenance, these seal kits are readily available from Geoprobe Systems.

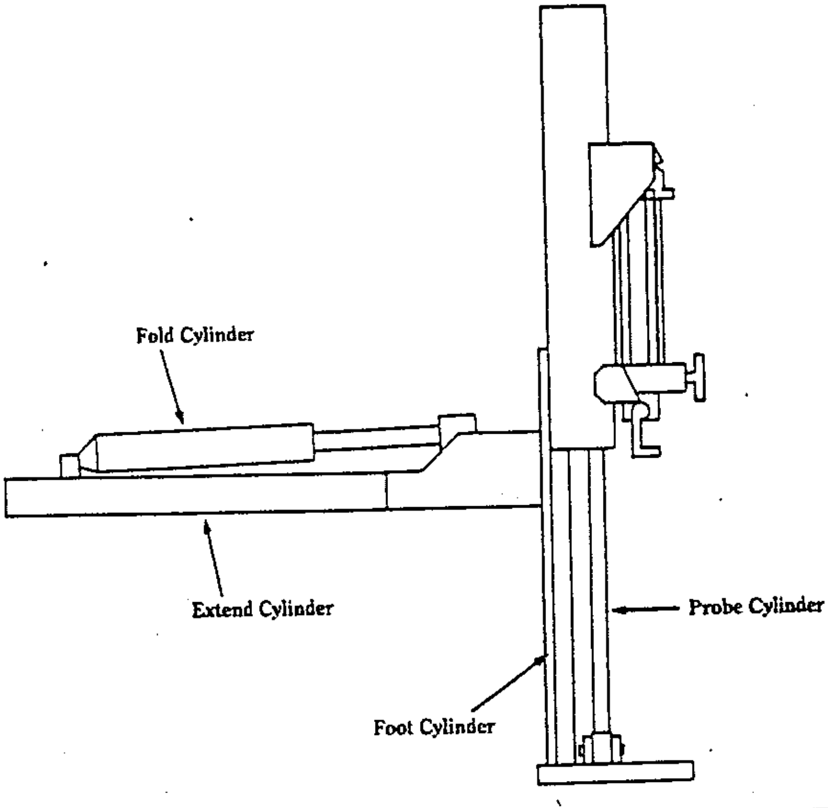
Fold Cylinder Seal Kit
Part No. RP-2376

Extend Cylinder Seal Kit
Part No. RP-2367

Foot Cylinder Seal Kit
Part No. RP-2378

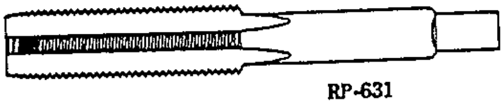
Probe Cylinder Seal Kit
Part No. RP-2368
(For Geoprobe Units with Serial No. 9208R1 and lower manufactured before 4/1/1992)

Probe Cylinder Seal Kit
Part No. RP-2772
or Geoprobe Units with Serial No. 9209R1 and higher manufactured after 4/1/1992)



Reverse Threaded Die Tap

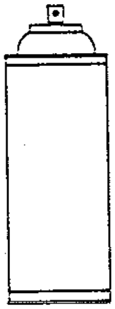
Part No. RP-631
Die Tap for repairing damaged reverse-threaded fittings for AT-63 stop-pin on probe drive soil sampler drive heads (AT-60B, AT-651, and AT-661).



RP-631

"Geoprobe" White Touch-Up Paint

Part No. RP-1583
Matches finish on most Geoprobe machines, probe rod racks, and vacuum/volume tanks.
11 oz. Spray Can



RP-1583

For other Geoprobe parts and components, please call us and have the following information ready:

Geoprobe Serial Number (found on control panel)
Year, Make, and Model of Carrier Vehicle

TOOL INDEX

Part No.	Description	Page
AT-10B	Probe Rod (36″)	8
AT-10K	Basic Manual Tool Kit	41
AT-100	Cleaning Brush	12
AT-101	Cleaning Brush Adapter	12
AT-150B	Probe Rod (24″)	8
AT-106B	Probe Rod (12″)	8
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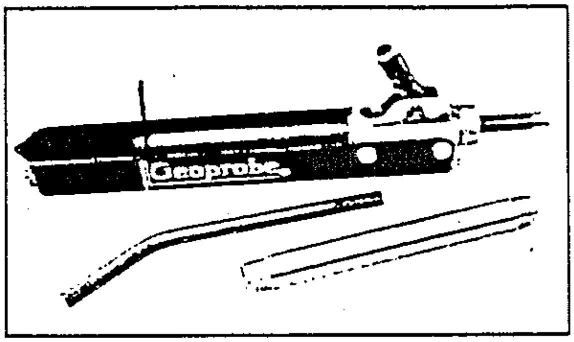
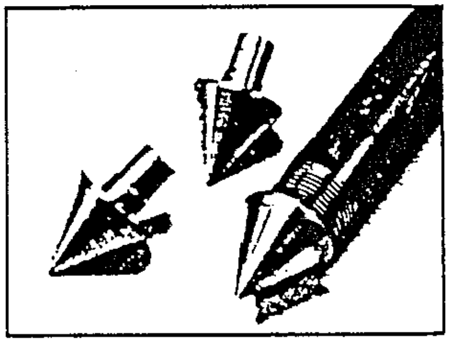
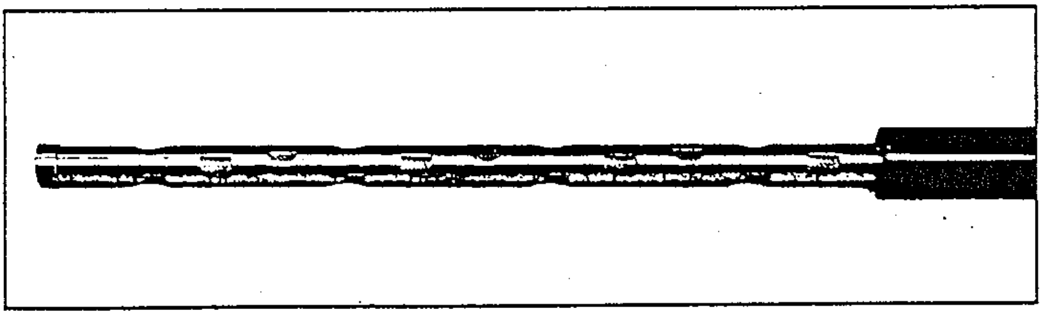


Kansas Sampler Manual Extruder. See page 37.

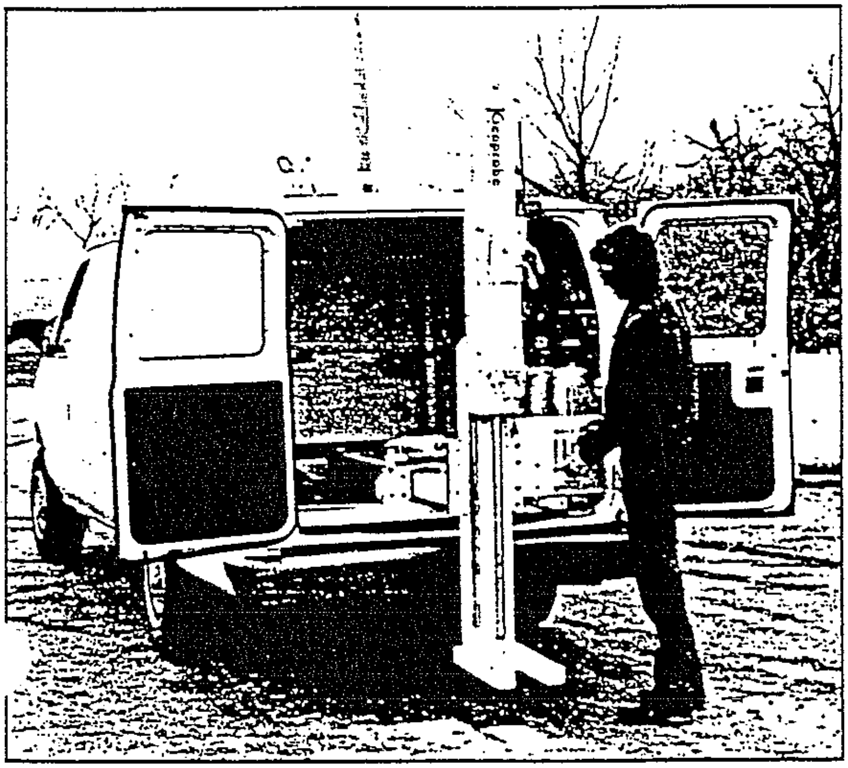


1.6″ Diameter Expendable Drive Point. See page 9.

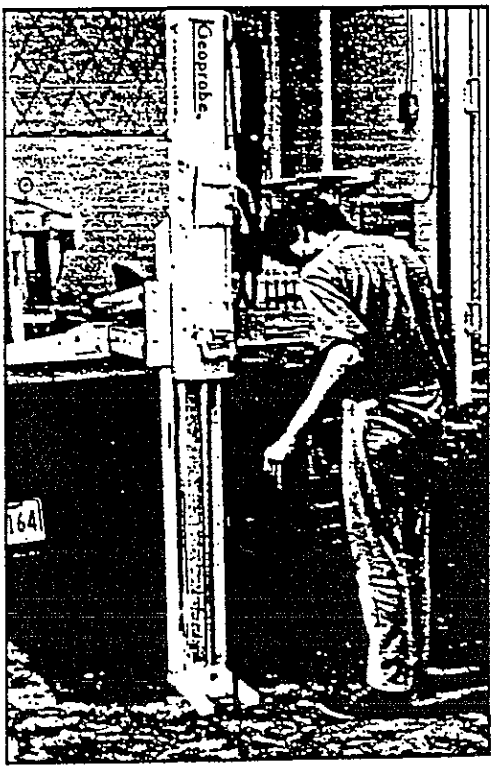
Vapor Sampling Implants. See page 26.



Screen Point Sampler. See page 17.



Geoprobe Model 8-ML. See page 5.



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See Ground Water Sampling Tools, Section 3, pages 15-18.

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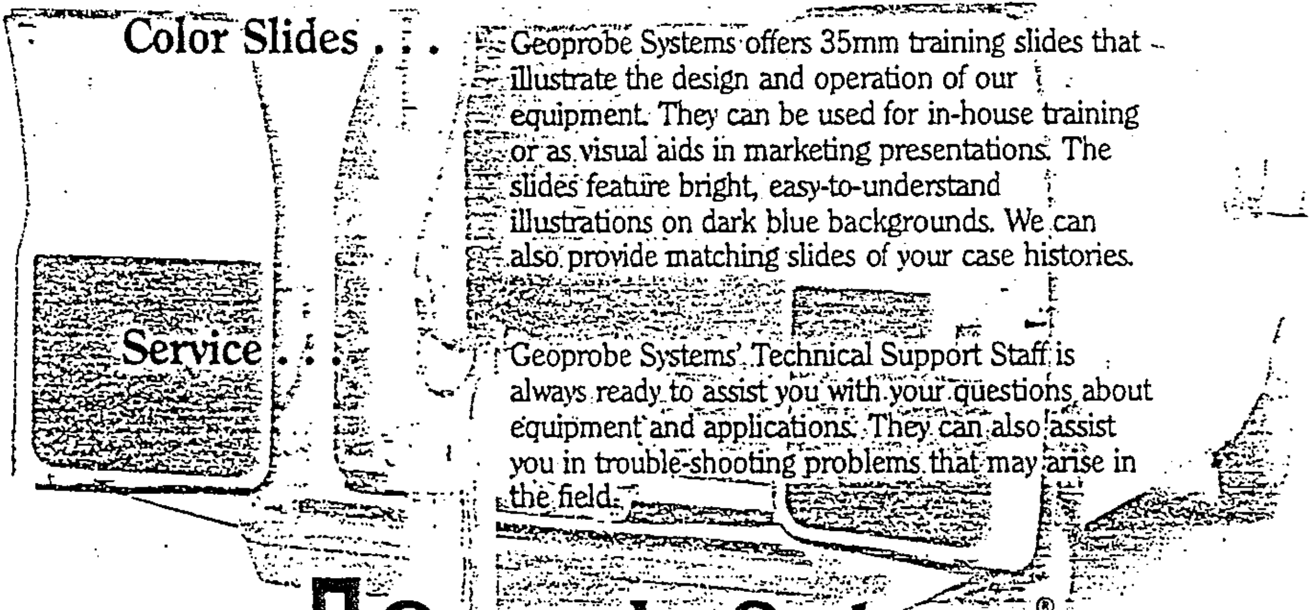

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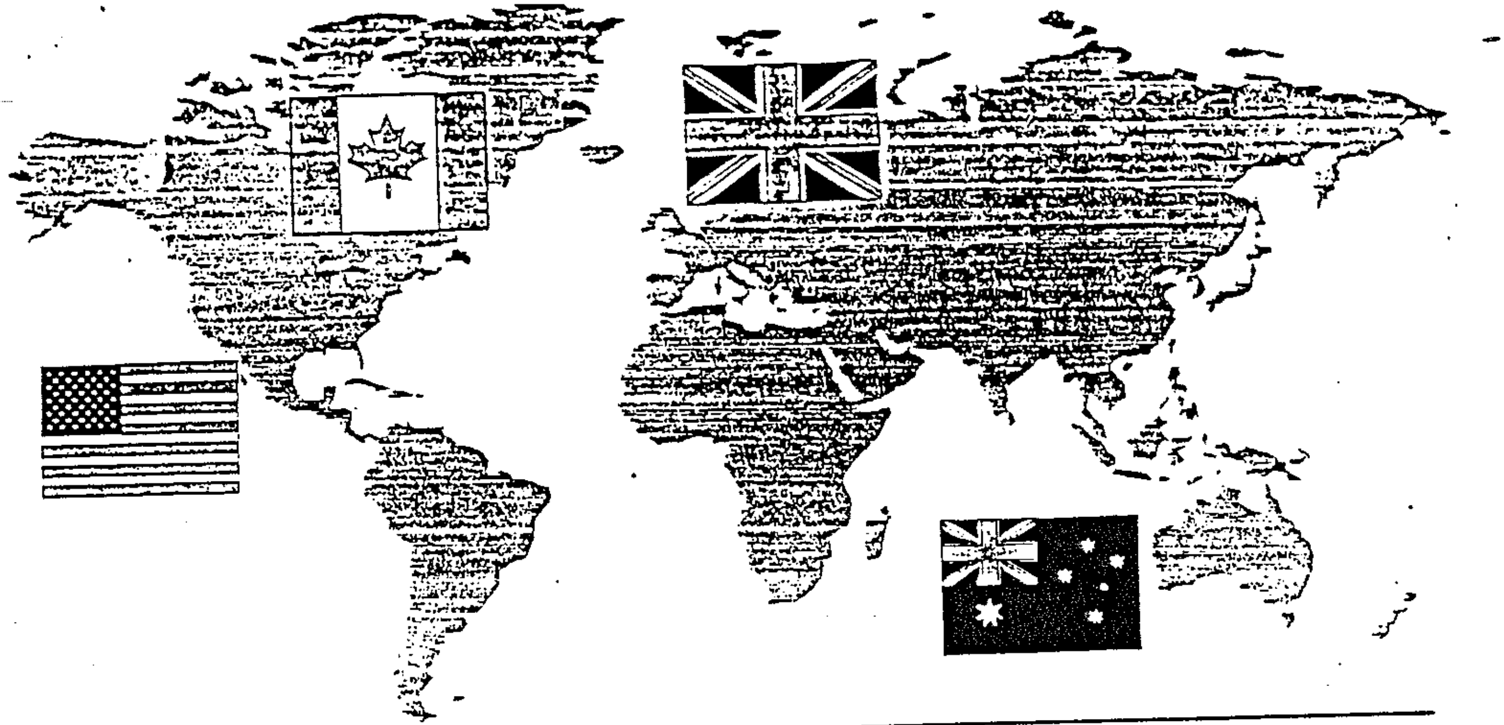

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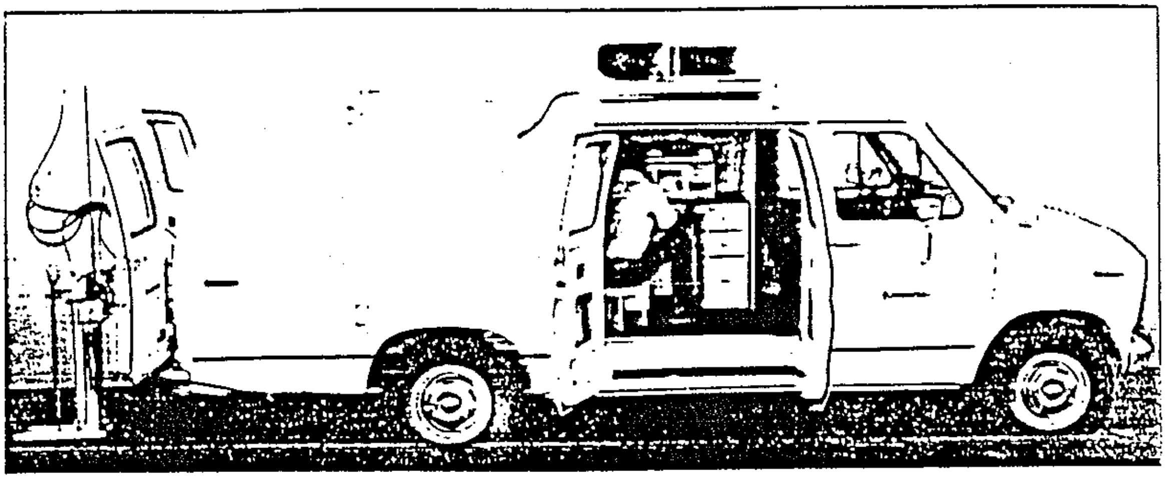

Versatility: Sample soil, groundwater and soil vapor

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---

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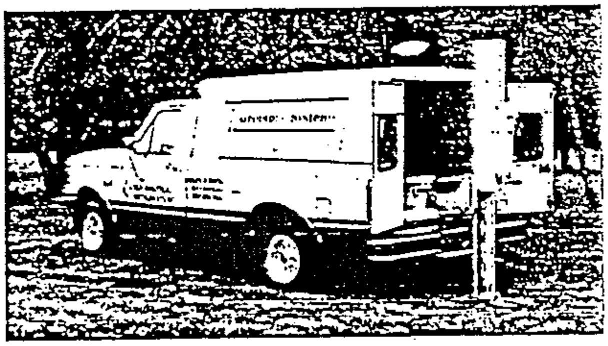

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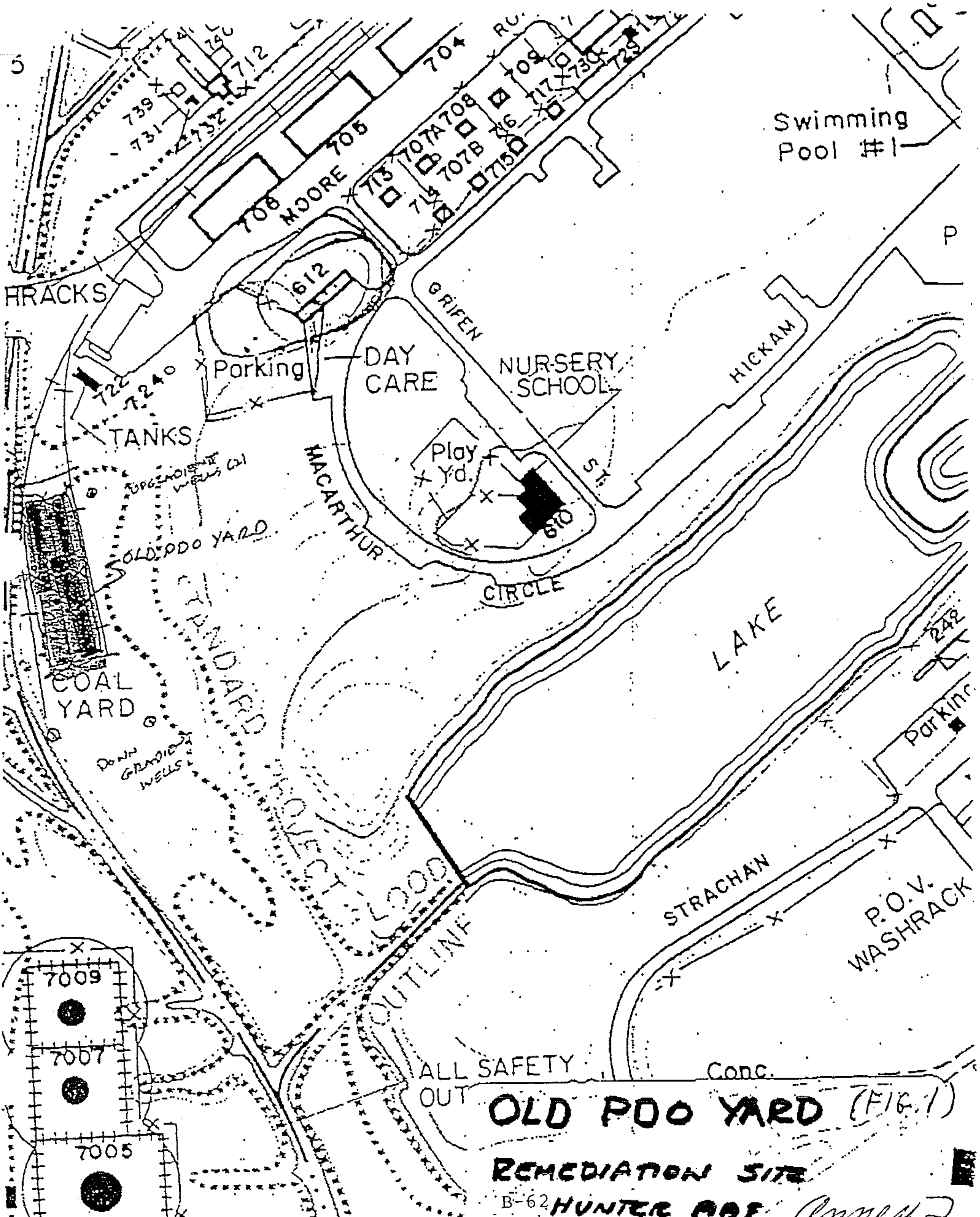
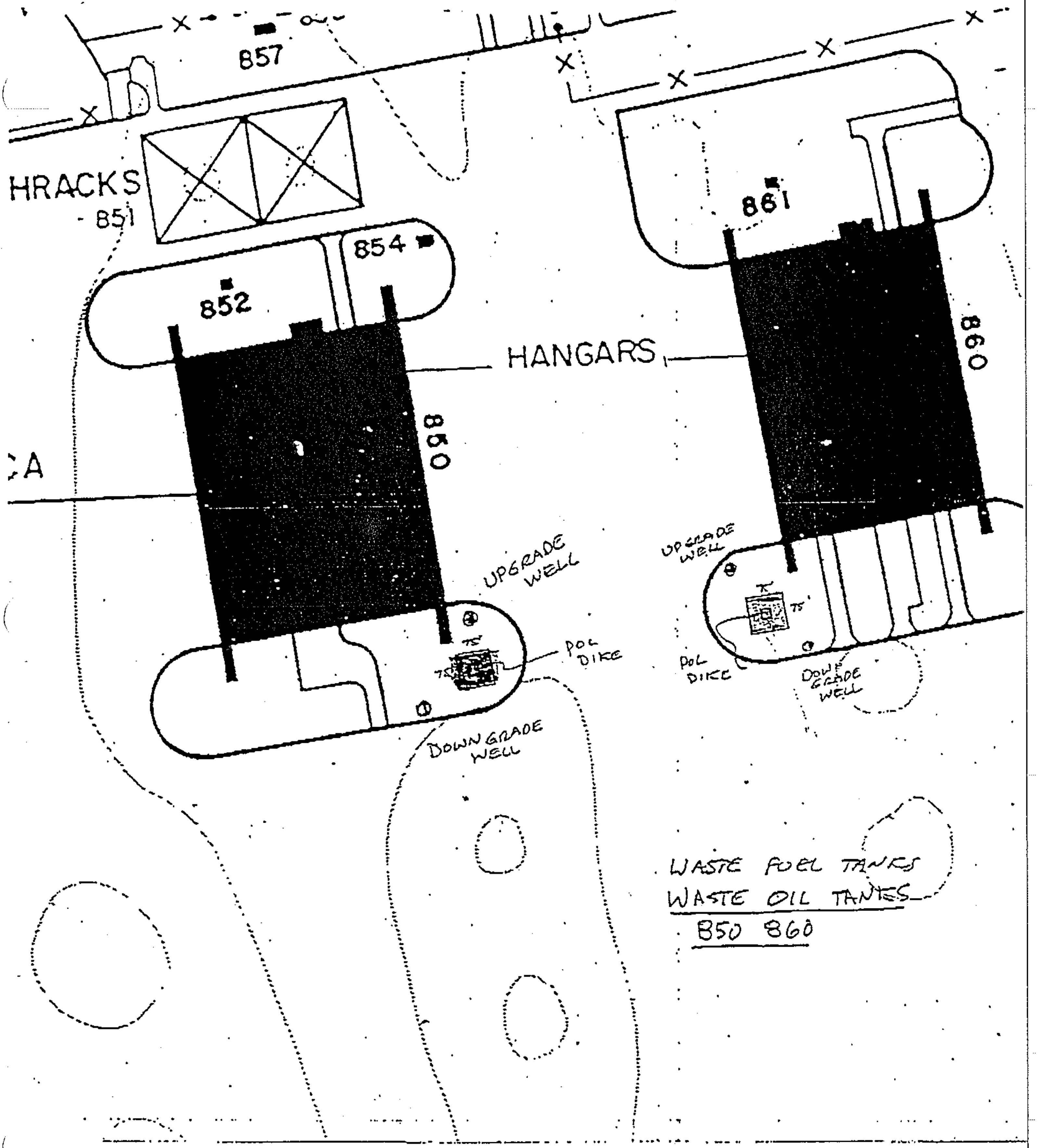


OLD POO YARD (FIG. 1)

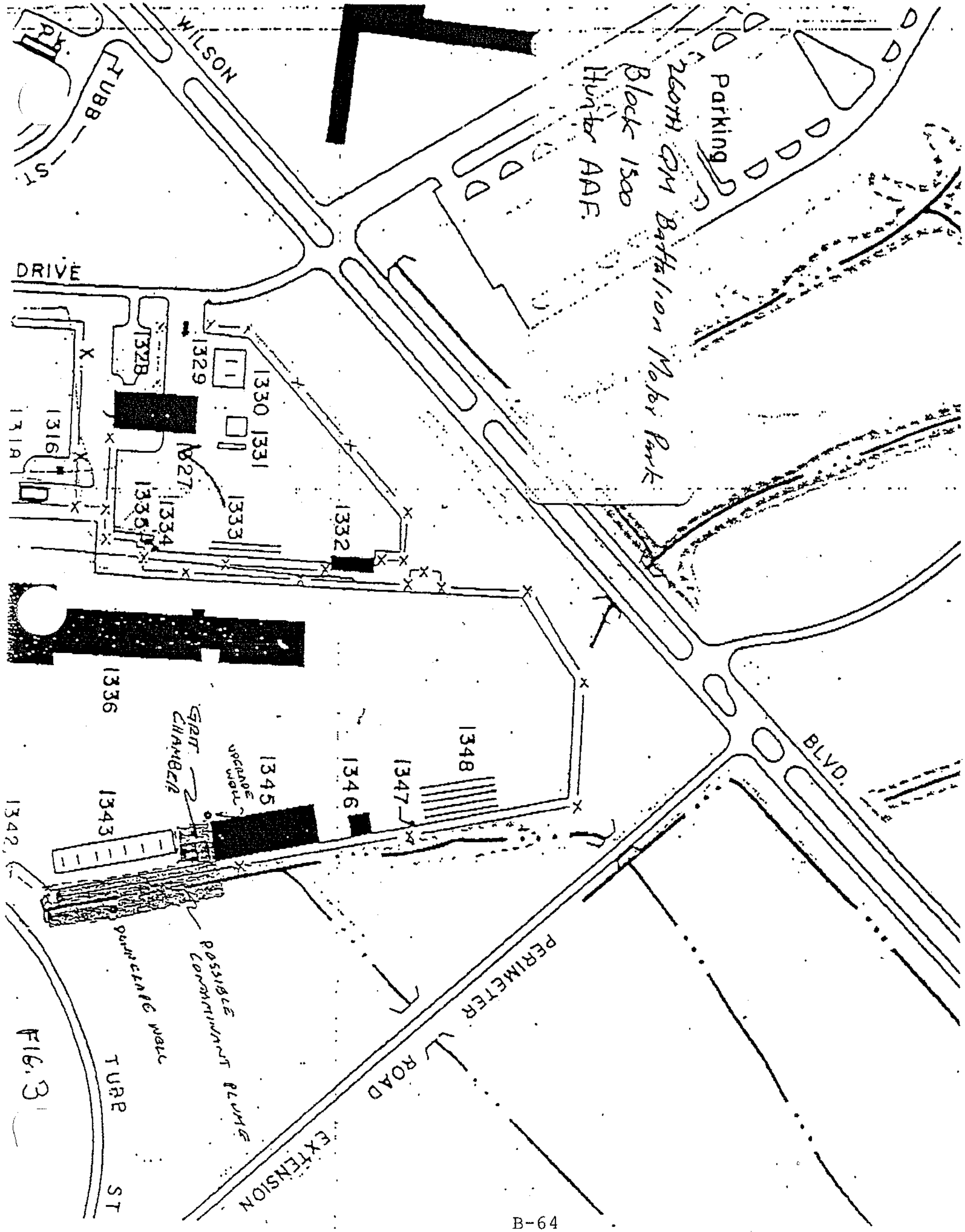
REMEDIATION SITE

B-62 HUNTER AAF



WASTE FUEL TANKS
WASTE OIL TANKS
850 860

FIG. 2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STUBB ST
DRIVE
Parking
260th QM Battalion Motor Park
Block 1300
Hunter AAF
1328
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1316A
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1342
UPGRADE WELL
GRIT CHAMBER
POSSIBLE CONTAMINANT PLUME
DOWNGRADE WELL
BLVD.
PERIMETER ROAD EXTENSION
TURF ST

FIG. 3

APPENDIX C

LIST OF PARAMETERS ANALYZED
AND
THE ANALYTICAL METHODS AND DETECTION LIMITS USED FOR ANALYSES

TABLE C-1. VOLATILE ORGANIC COMPOUNDS IN SOIL

Parameter	Detection Limit (μg/kg)
Benzene	5.0
Bromobenzene	5.0
Bromochloromethane	5.0
Bromodichloromethane	5.0
Bromoform	5.0
Bromomethane	5.0
n-Butylbenzene	5.0
sec-Butylbenzene	5.0
tert-Butylbenzene	5.0
Carbon tetrachloride	5.0
Chlorobenzene	5.0
Chloroethane	5.0
Chloroform	5.0
Chloromethane	5.0
2-Chlorotoluene	5.0
4-Chlorotoluene	5.0
Dibromochloromethane	5.0
1,2-Dibromo-3-chloropropane	5.0
1,2-Dibromoethane	5.0
Dibromomethane	5.0
1,2-Dichlorobenzene	5.0
1,3-Dichlorobenzene	5.0
1,4-Dichlorobenzene	5.0
Dichlorodifluoromethane	5.0
1,1-Dichloroethane	5.0
1,2-Dichloroethane	5.0
1,1-Dichloroethene	5.0
c-1,2-Dichloroethene	5.0
t-1,2-Dichloroethene	5.0
1,2-Dichloropropane	5.0
1,3-Dichloropropane	5.0
2,2-Dichloropropane	5.0
1,1-Dichloropropene	5.0

See footnotes on page C-3.

TABLE C-1. VOLATILE ORGANIC COMPOUNDS IN SOIL (Cont.)

Parameter	Detection Limit (μg/kg)
c-1,3-Dichloropropene	5.0
t-1,3-Dichloropropene	5.0
Ethylbenzene	5.0
Hexachlorobutadiene	5.0
Isopropylbenzene	5.0
p-Isopropyltoluene	5.0
Methylene chloride	5.0
Naphthalene	5.0
n-Propylbenzene	5.0
Styrene	5.0
1,1,1,2-Tetrachloroethane	5.0
1,1,2,2-Tetrachloroethane	5.0
Tetrachloroethene	5.0
Toluene	5.0
1,2,3-Trichlorobenzene	5.0
1,2,4-Trichlorobenzene	5.0
1,1,1-Trichloroethane	5.0
1,1,2-Trichloroethane	5.0
Trichloroethene	5.0
Trichlorofluoromethane	5.0
1,2,3-Trichloropropane	5.0
1,2,4-Trimethylbenzene	5.0
1,3,5-Trimethylbenzene	5.0
Vinyl chloride	5.0
o-Xylene	5.0
m&p-Xylene	5.0

Samples were analyzed using EPA Method 8260.
Detection limits for samples 1-1, 1-1S, 1-1D, and 1-1SD are 200X greater than above because of matrix effects.

TABLE C-2. SEMIVOLATILE ORGANIC COMPOUNDS IN SOIL

Parameter	Detection Limit (μg/kg)
Pyridine	720-990
N-nitrosodimethylamine	720-990
Phenol	720-990
bis(-2-Chloroethyl)Ether	720-990
2-Chlorophenol	720-990
1,3-Dichlorobenzene	720-990
1,4-Dichlorobenzene	720-990
Benzyl alcohol	720-990
1,2-Dichlorobenzene	720-990
2-Methylphenol	720-990
4-Methylphenol	720-990
bis(2-chloroisopropyl)ether	720-990
N-Nitroso-Di-n-propylamine	720-990
Hexachloroethane	720-990
Nitrobenzene	720-990
Isophorone	720-990
2-Nitrophenol	720-990
2,4-Dimethylphenol	720-990
bis(-2-Chloroethoxy)methane	720-990
2,4-Dichlorophenol	720-990
1,2,4-Trichlorobenzene	720-990
Naphthalene	720-990
4-Chloroaniline	720-990
Hexachlorobutadiene	720-990
4-Chloro-3-methylphenol	720-990
2-Methylnaphthalene	720-990
Hexachlorocyclopentadiene	720-990
2,4,6-Trichlorophenol	720-990
2,4,5-Trichlorophenol	720-990
2-Chloronaphthalene	720-990
2-Nitroaniline	720-990
Dimethyl Phthalate	720-990
Acenaphthylene	720-990
2,6-Dinitrotoluene	720-990
3-Nitroaniline	720-990

See footnotes on page C-5.

TABLE C-2. SEMIVOLATILE ORGANIC COMPOUNDS IN SOIL (Cont.)

Parameter	Detection Limit (μg/kg)
Acenaphthene	720-990
2,4-Dinitrophenol	1400-2000
4-Nitrophenol	720-990
Dibenzofuran	720-990
2,4-Dinitrotoluene	720-990
Diethylphthalate	720-990
4-Chlorophenyl-phenylether	720-990
Fluorene	720-990
4-Nitroaniline	720-990
2-Methyl-4,6-dinitrophenol	720-990
N-Nitrosodiphenylamine	720-990
4-Bromophenyl-phenylether	720-990
Hexachlorobenzene	720-990
Pentachlorophenol	1400-2000
Phenanthrene	720-990
Anthracene	720-990
Di-n-butylphthalate	720-990
Fluoranthene	720-990
Pyrene	720-990
Butylbenzylphthalate	720-990
3,3'-Dichlorobenzidine	720-990
Benzo(a)anthracene	720-990
Chrysene	720-990
bis(2-Ethylhexyl)phthalate	720-990
Di-n-octyl Phthalate	720-990
Benzo(b)fluoranthene	720-990
Benzo(k)fluoranthene	720-990
Benzo(a)pyrene	720-990
Indeno(1,2,3-cd)pyrene	720-990
Dibenzo(a,h)anthracene	720-990
Benzo(g,h,i)perylene	720-990

Samples were analyzed using EPA method 8270.
Because of matrix interferences, the detection limits for samples varied within a narrow range of concentrations.

TABLE C-3. GENERAL PARAMETER IN SOIL

Parameter	EPA Method	Detection Limit (mg/kg)
Total Petroleum hydrocarbon(TPH)	418.1	10
TPH as gasoline	*	2.0
BTEX (Site 1)	8270	0.025
BTEX (Sites 2-4)	8020	1.1

---

* The gas chromatographic method used was the modified California Method. A four point calibration curve, ranging from 2.0 mg/kg to 25 mg/kg, was generated, using a ten component gasoline standard purchased commercially. All BTEX constituents are contained in the ten component standard.

TABLE C-4. INSECTICIDES AND PCBs IN SOIL

Parameter	Detection Limit (μg/kg)
Aldrin	0.010
BHC-alpha	0.010
BHC-beta	0.010
BHC-delta	0.010
Chlordane (technical)	0.050
Chlordane-cis	0.010
Chlordane-trans	0.010
DDD-o,p'	0.010
DDD-p,p'	0.010
DDE-o,p'	0.010
DDE-p,p'	0.010
DDT-o,p'	0.010
DDT-p,p'	0.010
Dieldrin	0.010
Endosulfan Cyclic Sulfate	0.010
Endosulfan I	0.010
Endosulfan II	0.010
Endrin	0.010
Endrin Aldehyde	0.010
Heptachlor	0.010
Heptachlor Epoxide	0.010
Lindane	0.010
Methoxychlor	0.010
Toxaphene	0.125
PCB (Aroclor 1016)	0.100
PCB (Aroclor 1221)	0.100
PCB (Aroclor 1232)	0.100
PCB (Aroclor 1242)	0.100
PCB (Aroclor 1248)	0.100
PCB (Aroclor 1254)	0.100
PCB (Aroclor 1260)	0.100

These samples were analyzed by EPA Methods 3550 and 8081.

TABLE C-5. METALS IN SOIL

Parameter	EPA Method	Detection Limit (mg/kg)
Arsenic	7060	0.50
Barium	6010	0.50
Cadmium	6010A	0.25
Chromium	6010A	0.50
Lead	6010A	1.0
Mercury	7471	0.10
Selenium	7740	0.50
Silver	6010	0.50

TABLE C-6. VOLATILE ORGANIC COMPOUNDS IN GROUND WATER

Parameter	Detection Limit (μg/kg)
Benzene	2.
Bromobenzene	2.
Bromochloromethane	2.
Bromodichloromethane	2.
Bromoform	2.
Bromomethane	2.
n-Butylbenzene	2.
sec-Butylbenzene	2.
tert-Butylbenzene	2.
Carbon tetrachloride	2.
Chlorobenzene	2.
Chloroethane	2.
Chloroform	2.
Chloromethane	2.
2-Chlorotoluene	2.
4-Chlorotoluene	2.
Dibromochloromethane	2.
1,2-Dibromo-3-chloropropane	2.
1,2-Dibromoethane	2.
Dibromomethane	2.
1,2-Dichlorobenzene	2.
1,3-Dichlorobenzene	2.
1,4-Dichlorobenzene	2.
Dichlorodifluoromethane	2.
1,1-Dichloroethane	2.
1,2-Dichloroethane	2.
1,1-Dichloroethene	2.
c-1,2-Dichloroethene	2.
t-1,2-Dichloroethene	2.
1,2-Dichloropropane	2.
1,3-Dichloropropane	2.
2,2-Dichloropropane	2.
1,1-Dichloropropene	2.
c-1,3-Dichloropropene	2.

See footnote on page C-10.

TABLE C-6. VOLATILE ORGANIC COMPOUNDS IN GROUND WATER (Cont.)

Parameter	Detection Limit (μg/kg)
t-1,3-Dichloropropene	2.
Ethylbenzene	2.
Hexachlorobutadiene	2.
Isopropylbenzene	2.
p-Isopropyltoluene	2.
Methylene chloride	2.
Naphthalene	2.
n-Propylbenzene	2.
Styrene	2.
1,1,1,2-Tetrachloroethane	2.
1,1,2,2-Tetrachloroethane	2.
Tetrachloroethene	2.
Toluene	2.
1,2,3-Trichlorobenzene	2.
1,2,4-Trichlorobenzene	2.
1,1,1-Trichloroethane	2.
1,1,2-Trichloroethane	2.
Trichloroethene	2.
Trichlorofluoromethane	2.
1,2,3-Trichloropropane	2.
1,2,4-Trimethylbenzene	2.
1,3,5-Trimethylbenzene	2.
Vinyl chloride	2.
o-Xylene	2.
m&p-Xylene	2.

Samples were analyzed using EPA Method 8260.

TABLE C-7. SEMIVOLATILE ORGANIC COMPOUNDS IN GROUND WATER

Parameter	Detection Limit (μg/kg)
Pyridine	10.
N-nitrosodimethylamine	10.
Phenol	10.
bis(-2-Chloroethyl)Ether	10.
2-Chlorophenol	10.
1,3-Dichlorobenzene	10.
1,4-Dichlorobenzene	10.
Benzyl alcohol	10.
1,2-Dichlorobenzene	10.
2-Methylphenol	10.
4-Methylphenol	10.
bis(2-chloroisopropyl)ether	10.
N-Nitroso-Di-n-propylamine	10.
Hexachloroethane	10.
Nitrobenzene	10.
Isophorone	10.
2-Nitrophenol	10.
2,4-Dimethylphenol	10.
bis(-2-Chloroethoxy)methane	10.
2,4-Dichlorophenol	10.
1,2,4-Trichlorobenzene	10.
Naphthalene	10.
4-Chloroaniline	10.
Hexachlorobutadiene	10.
4-Chloro-3-methylphenol	10.
2-Methylnaphthalene	10.
Hexachlorocyclopentadiene	10.
2,4,6-Trichlorophenol	10.
2,4,5-Trichlorophenol	10.
2-Chloronaphthalene	10.
2-Nitroaniline	10.
Dimethyl Phthalate	10.
Acenaphthylene	10.
2,6-Dinitrotoluene	10.

See footnotes on page C-12.

TABLE C-7. SEMIVOLATILE ORGANIC COMPOUNDS IN GROUND WATER (Cont.)

Parameter	Detection Limit (μg/kg)
3-Nitroaniline	10.
Acenaphthene	10.
2,4-Dinitrophenol	20.
4-Nitrophenol	10.
Dibenzofuran	10.
2,4-Dinitrotoluene	10.
Diethylphthalate	10.
4-Chlorophenyl-phenylether	10.
Fluorene	10.
4-Nitroaniline	10.
2-Methyl-4,6-dinitrophenol	20.
N-Nitrosodiphenylamine*	10.
4-Bromophenyl-phenylether	10.
Hexachlorobenzene	10.
Pentachlorophenol	20.
Phenanthrene	10.
Anthracene	10.
Di-n-butylphthalate	10.
Fluoranthene	10.
Pyrene	10.
Butylbenzylphthalate	10.
3,3'-Dichlorobenzidine	20.
Benzo(a)anthracene	10.
Chrysene	10.
bis(2-Ethylhexyl)phthalate	10.
Di-n-octyl Phthalate	10.
Benzo(b)fluoranthene	10.
Benzo(k)fluoranthene	10.
Benzo(a)pyrene	10.
Indeno(1,2,3-cd)pyrene	10.
Dibenzo(a,h)anthracene	10.
Benzo(g,h,i)perylene	10.

Samples were analyzed using EPA Method 8270.
* Cannot be separated from diphenylamine

TABLE C-8. ANALYTE LIST REPORTING LIMITS FOR PRIMARY PESTICIDES AND PCBs IN WATER SAMPLES

Compounds	Reporting Limits μg/L (ppb)*
ALDRIN	0.05
BHC-alpha	0.05
BHC-beta	0.05
BHC-delta	0.06
CHLORDANCE (Technical)	0.40
CHLORDANCE-cis	0.06
CHLORDANE-trans	0.06
CHLORPYRIFOS	0.30
DDD-o,p'	0.06
DDD-p,p'	0.06
DDE-o,p'	0.06
DDE-p,p'	0.06
DDT-o,p'	0.10
DDT-p,p'	0.10
DIAZINON	0.60
DIELDRIN	0.06
ENDOSULFAN CYCLIC SULFATE	0.30
ENDOSULFAN I	0.10
ENDOSULFAN II	0.20
ENDRIN	0.04
ENDRIN ALDEHYDE	0.10
HCB	0.02
HEPTACHLOR	0.05
HEPTACHLOR EPOXIDE	0.05
LINDANE	0.05
MALATHION	2.00
METHOXYCHLOR	0.40
METHYL PARATHION	0.60
MIREX	0.10
OXYCHLORDANE	0.05
PARATHION	0.60
PCB (Aroclor 1016)	0.80
PCB (Aroclor 1221)	0.80
PCB (Aroclor 1032)	0.80
PCB (Aroclor 1242)	0.80
PCB (Aroclor 1248)	0.80
PCB (Aroclor 1054)	0.80
PCB (Aroclor 1260)	0.80
TOXAPHENE	1.00

* Based on electron-capture detection

TABLE C-9. METALS, NONMETALS, AND TOTAL PETROLEUM HYDROCARBONS IN GROUND WATER

Parameter	EPA Method	Detection Limit* (μg/L)
Metals		
Antimony	204.2	1.0
Arsenic	206.2	1.0
Barium	200.8	10.
Beryllium	200.8	0.5
Cadmium	200.8	0.5
Chromium	200.8	0.5
Copper	220.1	100
Iron	200.7	50
Lead	200.8	0.5
Manganese	200.7	10
Mercury	245.1	0.5
Nickel	200.8	0.5
Selenium	270.2	1.0
Silver	200.8	0.5
Thallium	200.8	0.5
Zinc	200.8	1.0
Nonmetals		
Chloride	300.0	1000
Cyanide	335.2	10
Nitrate/nitrite (N)	353.2	50
Sulfate	300.0	1000
Total dissolved solids	160.1	1000
Total Petroleum Hydrocarbons		
TPH	418.1	1000
TPH(gasoline range)	Modified California	100

APPENDIX D
PRELIMINARY REMEDIATION GOALS

Parameter	PRG (mg/kg) Reference 6*
Silver	5100
Arsenic	1.6
Barium	72000
Cadmium	510
Chromium	5100
Mercury	310
Lead†	NL‡
Selenium	5100
Ethylbenzene	100000
Methylene chloride	380
Toluene	200000
1,2,4-Trimethylbenzene	NL
1,3,5-Trimethylbenzene	NL
Xylene (Mixed)	1000000
Undecane	NL
Dodecane	NL
Benzene	99
n-Propylbenzene	NL
Trichlorofluoromethane	310000
Naphthalene	41000
Isopropylbenzene	NL
2-Methylnaphthalene	NL
Acenaphthene	61000
Fluorene	41000
Pyrene	31000
bis(2-Ethylhexyl-phthalate)	200
Phenanthrene	NL
Fluoranthene	41000
Benzo(a)anthracene	3.9

See footnotes on page C-15.

PRELIMINARY REMEDIATION GOALS (Cont.)

Parameter	PRG (mg/kg) Reference 6*
Chrysene	39000
Benzo(b)fluoranthene	3.9
Benzo(k)fluoranthene	39
Benzo(a)pyrene	0.39
Indeno(1,2,3-cd)pyrene	3.9
Dibenzo(a,h)anthracene	0.39
Benzo(g,h,i)perylene	NL
p,p-DDT	8.4
p,p-DDE	8.4
TPH§	100
BTEX§	20
PCBs**	25

* PRGs are based on commercial/industrial soils.

† A cleanup level for lead of 500-1000 mg/kg is identified in USEPA guidance (reference 8).

‡ NL- Not listed.

§ PRGs based on guidance in reference 4.

** PRG based on guidance in reference 7.

APPENDIX E

HEALTH RISK ASSESSMENT

ANNEX E-1

RISK CHARACTERIZATION

1. Introduction.

a. We calculated a health based risk assessment by the EPA methods used for CERCLA sites. The CERCLA method uses the concentrations found in the environment to calculate a level of risk to the population using the environment.

b. To quantitatively assess the potential risks to human health, the concentrations of chemicals in the affected pathways at the points of potential exposure are used to calculate the average intake of the chemical by the receptor. In other words, the amounts of chemicals a person at the site is exposed to are used to determine how much chemical actually gets into the body. These intake values are expressed as the amount of a substance taken into the body per unit body weight per unit time, or mg/kg/day (reference 11).

c. Upper bound excess lifetime cancer risks may be estimated by multiplying intake rate at the exposure point of the contaminant under consideration by its cancer slope factor. Under the Superfund Program, the EPA has determined the acceptable range of excess cancer risk to be 1 X 10^{-4} to 1 X 10^{-6} (i.e., the probability of one excess cancer in a population of 10,000 to one excess cancer in a population of 1,000,000, respectively, under the conditions of exposure) (reference 11). The upper bound is a conservative probable maximum estimate of a range that can be as low as zero. A risk level of 1 X 10^{-6}, representing an upper bound probability of one in 1,000,000 that an individual could develop cancer due to an exposure to potential carcinogens at a site, is often used as the point of departure by regulatory agencies. For this assessment, we will use the 1 X 10^{-6} risk level as our point of departure to determine whether or not the potential concern exists.

d. Chronic noncancer hazards may be quantified by dividing each chemical's daily intake by its chronic reference dose, then summing these quotients by receptor. This sum is the Hazard Index and assumes that the chemicals act adversely in the human body in an additive fashion. Under the Superfund Program, the EPA considers a hazard index of unity (1) to be the threshold of concern. For this assessment, we will also use a hazard index of unity as our threshold. The chronic reference doses were used because of the more conservative nature of the chronic reference doses and that the only exposure is expected to exist for greater than seven years.

e. Due to the limited number of background samples, all of the chemicals detected were considered possible chemicals of concern for the risk assessment with the exception of lead. The EPA is currently re-evaluating the safe levels of lead exposures. Since these values are needed in the risk assessment calculations, evaluation of lead in the quantitative risk calculations will not be performed. However, the EPA has published a guideline for lead evaluations. This guideline is aimed at being protective of a residential setting for 0-6 year old children. While a residential child scenario is not expected at this site, we will use the EPA guideline for lead evaluation in this report. The EPA guideline for lead does not indicate whether the comparison of the guideline to site data should be accomplished by a site average value or a point to point comparison. If the comparison is made between a site average or 95% UCL, lead in the surface soil would not be found to exceed the EPA guidelines of 500 ppm for residential children or 1000 ppm for an industrial setting. This essentially means that, with respect to the levels of lead in the surface soil, the use of the area by a 0-6 year old child is safe. However, if the comparison is suppose to be a point to point comparison, one soil sample exhibited a lead concentration which exceeded the guideline of 500 ppm for the residential child. Since it is unreasonable to assume that a child would spend the first six years of its life in that one spot, our comparison of site data to the guideline will be based on the site average.

2. Exposures. The exposures evaluated in this report involve a worker's exposure to chemical contamination during normal duties. As such, the only complete pathways involve contact with the surface soil. Potential surface soil exposure routes include direct contact with and incidental ingestion of soil particles. The areas surrounding this site are heavily vegetated with the actual yard being devoid of vegetation. Vegetative cover essentially eliminates regeneration of fugitive dust from the site soils. The lack of such cover can result in airborne contamination from the site soils; however, the denuded area at this site is small and is surrounded by tall trees and secondary (understory) shrubs. Thus, the possible pathway of inhalation of soil particles is considered incomplete at these sites. The complete pathways consists of incidental soil ingestion and dermal contact. The only potential receptors at these sites are adult workers. The assumptions generated from this exposure scenario are presented in Table E-1-1.

3. Chemicals of Concern/Assumptions. The contaminants of concern for this study were chosen from the site data. The list of chemicals of concern consisted of silver, arsenic, barium, cadmium, chromium, mercury, selenium, ethylbenzene, methylene chloride, toluene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, o-xylene, M&P-xylene, trichlorofluoromethane, naphthalene, 2-methylnaphthalene, fluorene, pyrene, bis(2 ethylhexyl)phthalate, fluoranthene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3cd)pyrene, dibenzo(ah)anthracene, benzo(ghi)perylene, DDT, DDE, and PCB's. For a discussion of the reasoning behind the selection of these contaminants of concern, the reader is referred to the Annex E-2. The analysis for chromium was for total chromium content. Chromium can exist in one of three valence states: +2, +3, or +6. Because each of these valence states exhibit different toxicological properties, the toxic responses to chromium and its compounds can vary widely. Since the analysis suite did not include a breakdown between Chromium (+2), Chromium (+3), and Chromium (+6), this assessment will assume that all of the Chromium detected is the more toxic Chromium (+6).

4. Data Reduction. Assessment of a site requires that risk be evaluated using a reasonable maximum contaminant concentration. The EPA defines this value as the upper 95th percentile concentration calculated from the arithmetic mean of the sample data. As the site data adheres more to log-normal distribution, these values are actually the arithmetic mean of a log-normal distribution (reference 20). These values are used as the exposure concentrations for the risk characterization. These values are summarized in Table E-1-2.

TABLE E-1-1. ASSUMPTIONS USED IN THE RISK CHARACTERIZATION

	Worker	
Reasonable worst -case Soil Ingestion Rate[a]	480	mg/day
Exposure[a]	~~8~~	~~hrs/week~~ 4hrs/day
	50	weeks/year 2Days/wk
	25	year usage
Body Weight[a]	70	Kg
Lifetime[a]	25550	days
Soil to Skin Adherence[a]	1.0	mg/cm^2
Dermal Absorption Factor[b]		1% metals/6% PCBs
Intestinal Absorption Factor		100%
Exposed Skin Area[a]	4300	cm^2 (arms, hands and head)

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[a] EPA Exposure Factors Handbook.

[b] Personal Communication with Ms. Susan Griffin, EPA Office of the Toxics Integration Branch, 18 November 1991.

TABLE E-1-2. SUMMARY OF THE CHEMICALS OF CONCERN AND THE EXPOSURE CONCENTRATION

Chemical	Exposure Concentration 95th upper Confidence Limit (UCL)	
Silver	6.2	mg/kg
Arsenic	5.6	mg/kg
Barium	46.3	mg/kg
Cadmium	174.0	mg/kg
Chromium	34.9	mg/kg
Mercury	0.067	mg/kg
Lead	457.0	mg/kg
Selenium	0.411	mg/kg
Ethylbenzene	3.35	μg/kg
Methylene Chloride	11.3	μg/kg
Toluene	102.0	μg/kg
1,2,4 Trimethylbenzene	2785.0	μg/kg
1,3,5 Trimethylbenzene	682.2	μg/kg
O-xylene	299.0	μg/kg
M&P-xylene	593.0	μg/kg
Undecane	939.0	μg/kg
Dodecane	3.83	μg/kg
Trichlorofluoromethane	4.60	μg/kg
Naphthalene	525.0	μg/kg
2 Methylnaphthalene	824.0	μg/kg
Fluorene	573.0	μg/kg
Pyrene	726.0	μg/kg
Bis (2 Ethylhexyl) phthalate	770.0	μg/kg
Phenanthrene	570.0	μg/kg
Fluoranthene	1021.0	μg/kg
Benzo(a)anthracene	690.0	μg/kg
Chrysene	752.0	μg/kg
Benzo(b)fluoranthene	826.0	μg/kg
Benzo(k)fluoranthene	801.0	μg/kg
Benzo(a)pyrene	742.0	μg/kg
Indeno 1,2,3(cd) pyrene	591.0	μg/kg
Dibenzo(ah)anthracene	380.0	μg/kg
Benzo(ghi)perylene	494.0	μg/kg
DDT	21.2	μg/kg
DDE	7.13	μg/kg
PCB Aroclor 1254	10.1	mg/kg

5. Calculations.

a. Annex E-4 contains the overall equations used to calculate the exposure and risk along with the calculations of the chemical intakes and the risks. The results of these calculations are contained in Table E-1-3.

TABLE E-1-3. SUMMARY OF THE HEALTH ASSESSMENT RESULTS

Pathway	Hazard Index	Cancer Risk
Oral	6.0E-1	3E-5
Dermal	2.4E-1	2.7E-6
Total	8.4E-1	3.3E-5

All values are unitless

b. The calculated carcinogenic risk level for worker exposure at the site exceeded the study's threshold of 1 X 10^{-6} (see Table E-4-4, Annex E-4). The calculated carcinogenic risk for this exposure is due to the dermal absorption and the incidental soil ingestion of Arsenic, Dibenzo(ah)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Indeno(1,2,3cd)pyrene and PCB (Aroclor 1254) on the soil particles.

c. The calculated hazard index for workers at the site did not exceed the EPA established threshold of 1.0 adopted for this assessment. The calculated noncarcinogenic hazard for this exposure is due to the dermal absorption and the incidental soil ingestion of PCB (Aroclor 1254) and Cadmium on the soil particles;

d. Because of the limitations and assumptions used in this assessment, this must not be used as an absolute determination of the probability of health effects from the possible contaminants at these sites. This assessment should only be used as guidance for making decisions about working at the scrap metal storage yard.

6. Uncertainties in the Assessment.

a. As in any risk assessment, the estimates of risk for the sites have many associated uncertainties. Some of the uncertainties associated with this assessment (such as restricted scope of sampling) can be addressed by additional sampling and analysis; others are more related to inherent limitations in the available toxicological literature or in the risk assessment process, itself.

b. There were also several uncertainties associated with the exposure scenarios evaluated in this assessment.

(1) One of the underlying assumptions in this assessment was that the chemical concentrations found in the sampled media remained constant during the period of exposure. This assumption may result in over-estimates of risk because chemical concentrations may decrease over time due to various chemical degradation pathways and migration of the chemicals from the site.

(2) Another source of uncertainty was the EPA standard assumptions used in the exposure models. These assumptions are based on research studies of plausible maximum cases or averages. They are based on assumptions and scenarios chosen for the research study that created them which may or may not be representative of the scenario in the present risk assessment.

(3) Also, uncertainties exist associated with the exposure estimates of how often, if at all, an individual would come in contact with the chemicals of concern and the period of time over which such exposures would occur. While we tried to model the average working day, the assumptions were estimates and could be different in reality.

c. The toxicity data used for this report also contributes to uncertainty. As the EPA notes in its Guidelines for Carcinogenic Risk Assessment: There are major uncertainties in extrapolating both from animals to humans and from high to low doses. There are important species differences in uptake, metabolism, and organ distribution of carcinogens, as well as species and strain differences in target site susceptibility. Human populations are variable with respect to genetic constitution, diet, occupation and home environment, activity patterns and other cultural factors. Another uncertainty for this study is the use of oral toxicity data for the dermal exposure. Dermal toxicity values do not exist and many medical professionals (doctors and toxicologist) believe that the only result of dermal exposure to metals is contact dermatitis (skin rash).

d. Table E-1-4 is a summary of the statistical parameters for the site data. A statistical analysis of samples collected from the site resulted the following observations.

TABLE E-1-4. SUMMARY OF STATISTICAL DATA, SURFACE SOIL, SITE 1

Chemical	Mean	Std Deviation mg/kg	95% confidence precision on the mean
Silver	2.75	5.34	2.76
Arsenic	3.54	2.30	1.19
Barium	35.7	20.0	10.3
Cadmium	22.0	54.4	28.1
Chromium	19.7	22.5	11.6
Mercury	0.0587	0.0228	0.0118
Lead	163.0	224.0	116.0
Selenium	0.340	0.191	0.0985
Ethylbenzene	0.00293	0.00162	0.000837
Methylene Chloride	0.00676	0.00978	0.00505
Toluene	0.117	0.423	0.218
1,2,4 Trimethylbenzene	1.87	6.98	3.61
1,3,5 Trimethylbenzene	0.937	3.49	1.80
O-xylene	0.343	1.27	0.656
M&P-xylene	0.506	1.87	0.965
Undecane	0.945	3.51	1.82
Dodecane	0.00327	0.00287	0.00148
Trichlorofluoromethane	0.0037	0.00319	0.00165
Naphthalene	0.444	0.318	0.164
2 Methylnaphthalene	0.680	1.13	0.584
Fluorene	0.479	0.463	0.239
Pyrene	0.564	0.355	0.184
Bis(2Ethylhexyl)phthalate	0.654	1.14	0.586
Phenanthrene	0.473	0.285	0.147
Fluoranthene	0.701	0.547	0.282
Benzo(a)anthracene	0.541	0.369	0.190
Chrysene	0.577	0.396	0.204
Benzo(b)fluoranthene	0.614	0.488	0.252
Benzo(k)fluoranthene	0.600	0.467	0.241
Benzo(a)pyrene	0.573	0.414	0.214
Indeno 1,2,3(cd) pyrene	0.357	0.0649	0.0335
Dibenzo(ah)anthracene	0.426	0.184	0.0951
DDT	0.0163	0.0342	0.0177
DDE	0.00613	0.00424	0.00219
PCB Aroclor 1254	1.65	3.88	2.00

(1) The number of samples collected to determine the background level of chemicals was insufficient to characterize the natural or anthropogenic surface soil condition. Under statistical analysis, the data from the background soil sampling was too variable to provide a usable database for comparison with the site data. As such, no chemicals of concern were deleted because of a comparison of the site data with background. This could lead to an overestimation of risks if the level of chemicals in the background soil were high enough to delete chemicals from the list of chemicals of concern.

(2) Two duplicates were collected for this data set. This number is too small to allow for an adequate statistical analysis of the data precision. Normally, this would not allow the data set to be validated for use in risk assessment. However, since the regulatory suspense date on the determination of health effects from this site is short, the data was use in a calculation of human health risk. It is impossible to determine if this uncertainty will over- or under-estimate risk.

(3) A statistical analysis of the data from the site showed that the confidence interval around the mean varied from 9 percent of the mean to 193 percent. While some variability is inherent in the analysis of natural systems, a variability greater than 100 percent should be reason to suspect that the data set was too small to be representative. The representative nature of the data should draw special concern if the chemicals showing the largest variability are also those resulting in the largest risk. Chemicals whose data resulted in variability greater than 100 percent in this report are: PCB (Aroclor 1254) (121%); DDT ((108%); Undecane (192%); M & P Xylene (190%); O-Xylene (191%); 1,3,5 Trimethylbenzene (192%); 1,2,4 Trimethylbenzene (193%); Toluene (187%); and Cadmium (128%). This list contains two of the five chemicals significantly contributing to risk: Cadmium and PCB (Aroclor 1254).

e. The sampling and analytical methods used in this study could lead to unknown inconsistency of the data. Another source of uncertainty stems from the possibility of other sources of the contaminants of concern in the area around the Hunter Army Airfield.

f. As a result of the uncertainties described above, this risk assessment should not be construed as presenting an absolute estimate of health affects to the receptors. Rather it is an estimate intended to indicate the potential at which adverse impact might occur.

ANNEX E-2

RESULTS OF ANALYSIS
CHOICE OF CHEMICALS OF CONCERN, AND CALCULATION OF EXPOSURE CONCENTRATIONS

1. RESULTS OF ANALYSIS.

a. The field quality control was evaluated by use of duplicate samples. Two duplicate samples were collected from this site for analysis by statistical methods. Unfortunately, two samples does not allow for the use of a statistical approach. As such, we have no confidence in the validity of this data set. Since the regulatory suspense for the evaluation of this site is too short to allow resampling the site, we will assume that the quality of data is adequate for use in this risk assessment even though we can not validate the data.

b. A statistical analysis of samples collected from the site showed that the confidence interval around the mean varied from 9 percent of the mean to 193 percent. While some variability is inherent in the analysis of natural systems, a variability greater than 100 percent should be reason to suspect that the data set was too small to be representative. The representative nature of the data should be draw special concern if the chemicals showing the largest variability are also those resulting in the largest risk. Chemicals whose data resulted in variability greater than 100 percent in this report are: PCB aroclor 1244 (121%); DDT ((108%); Undecane (192%); M & P Xylene (190%); O-Xylene (191%); 1,3,5 Trimethylbenzene (192%); 1,2,4 Trimethylbenzene (193%); Toluene (187%); and Cadmium (128%). This list contains two of the four chemicals significantly contributing to risk: Cadmium and PCB aroclor 1254.

c. The number of samples collected to determine the background level of chemicals was insufficient to characterize the natural or anthropogenic surface soil condition. Under statistical analysis, the data from the background soil sampling was too variable to provide a usable database for comparison with the site data. As such, no chemicals of concern were deleted because of a comparison of the site data with background. This could lead to an overestimation of risks if the level of chemicals in the background soil were high enough to delete chemicals from the list of chemicals of concern.

2. CHOICE OF CHEMICALS OF CONCERN.

a. Comparison to Background. A comparison to the background levels of chemicals was not performed because of the limited number of samples collected for background. As such, no chemicals were deleted from the risk assessment because of a comparison of site data to background.

b. Frequency of Detection. The criteria suggested in the EPA guidance (reference 10) that chemicals found in less than 5 percent of the samples of any one media can be dropped from consideration of being a chemical of concern for that media. Since the site data consists of 15 samples, any single detected would constitute greater than 5 percent frequency of detection. Therefore, this criteria was not used to eliminate chemicals from the risk assessment. However, chemicals which were not detected during the sampling were deleted from the list of chemicals of concern. Benzene, N-Propylbenzene, Isopropylbenzene, and Acenaphthalene were eliminated for this reason.

c. Lack of Toxicological Data. Risk assessment is a mathematical evaluation which uses toxicological data as numerical criteria to determine if a health effect has a possibility to exist. The lack of appropriate toxicological information for any one chemical makes the calculations difficult. In some cases, data for a similar chemical can be used as a surrogate. Other chemicals are deleted from the calculations. In this assessment, the toxicological data for 1,3,5 trimethylbenzene was used as a surrogate for 1,2,4 trimethylbenzene; the toxicological data for Naphthalene was used as a surrogate for 2 Methylnaphthalene; and the toxicological data for generalized PCB was used as a surrogate for Aroclor 1254. Chemicals which were deleted from the risk assessment because of the lack of toxicological data were Phenanthrene, Undecane and Dodecane.

d. Chemicals of Concern. The resulting chemicals of concern for this study consisted of Silver, Arsenic, Barium, Cadmium, Chromium, Mercury, Selenium, Ethylbenzene, Methylene Chloride, Toluene, 1,2,4 Trimethylbenzene, 1,3,5 Trimethylbenzene, O-xylene, M&P-xylene, Trichlorofluoromethane, Naphthalene, 2 Methylnaphthalene, Fluorene, Pyrene, Bis (2 Ethylhexyl) phthalate, Fluoranthene, benzo-a-anthracene, Chrysene, Benzo-b-fluoranthene, Benzo-k-fluoranthene, Benzo-a-pyrene, Indeno 1,2,3cd pyrene, Dibenzo-ah-anthracene, Benzo-ghi-perylene, DDT, DDE, and PCB's.

3. EXPOSURE CONCENTRATIONS.

a. Statistical methods were used to calculate the arithmetic mean and upper 95th percentile value for each chemical assuming a log-normal distribution. Table E-1-2 is a summary of the chemicals of concern with their respective 95th UCL value.

ANNEX E-3

TOXICOLOGICAL ASSESSMENT

Toxicological Profiles

1. Toxicity profiles have been prepared for the chemicals of concern for the Hunter Army Airfield Risk Assessment. Enclosed are toxicity profiles for: Arsenic, Cadmium, Chromium, Lead, Mercury, Silver.

2. The following summaries are intended to express primary toxic effects of the contaminants in this document. These summaries are not intended to be comprehensive literature reviews—but rather general human toxicological effects, with supporting values.

ARSENIC

Naturally occurring deposits of arsenic are found throughout The environment in water and soil. Inorganic arsenic is also released daily into the environment through use of fossil fuels. Low levels of arsenic are even found in cigarette smoke. (ref. 1)

Human exposure to inorganic arsenic usually occurs through ingestion and inhalation, it is not readily absorbed through the skin. Ingestion of high levels of inorganic arsenic can cause gastrointestinal tract irritation, adverse CNS and cardiovascular effects, and damage to the liver and kidney. Ingestion can also produce skin abnormalities which could lead to skin cancers. It is possible, however unlikely, that inhalation may produce similar effects. The main concern of inorganic arsenic inhalation is the potential for cancer. Direct contact with arsenic can cause skin irritation. Atmospheric levels of 200 ug/m3 can cause irritation to the eyes and throat. (ref. 1)

The EPA has classified inorganic arsenic as a category A (human) carcinogen. This was based on observations of increased lung cancer mortality in populations exposed primarily through inhalation and increased skin cancer incidence in populations consuming drinking water with high arsenic concentrations. (ref. 2) There has not been consistent demonstration of carcinogenicity in test animals for various arsenic forms. Tests have been conducted in several species by various routes of administration. However the potential for carcinogenicity has been supported by studies in which sodium arsenate has been shown to transform Syrian hamster embryo cells. Arsenic has not been shown to be mutagenic to bacteria. For inhalation exposure the slope factor is 5 E+1 (mg/kg/d)-1. (ref. 2) The Maximum Contaminant Level (MCL) for drinking water is 0.05 mg/l. Based on a unit risk of 5E-1 (ug/l)-1 an oral slope factor of 1.75E+0 (mg/kg-day)-1 can be derived. (ref. 2) The recommended water quality criteria for water and fish consumption is [illegible] ug/l. Arsenic has the ability to bioaccumulate in tissues of aquatic and marine organisms and can potentially concentrate in the food chain. (ref. 3)

References:

1. Toxicological Profile for Arsenic. Agency for Toxic Substances and Disease Registry U.S. Public Health Service.

2. U.S.E.P.A. 1991. Health Effects Assessment Summary Tables. Environmental Criteria and Assessment Office, Cincinnati, Ohio.

3. U.S.E.P.A., 1990. Integrated Risk Information System (IRIS). Online. Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati. Ohio.

CADMIUM

Cadmium exists in nature in small quantities having no known nutritive value. It is a general cytotoxic agent and a potent inhibitor of some enzyme systems. Mineral loss from bone and renal damage result from chronic cadmium poisoning. Excretion occurs in narrow limits and each increase in intake results in an increased accumulation. (ref. 1) The oral RfD for water is 0.0005 mg Cd/kg/day. RfDs are based on the highest level of cadmium in the renal cortex not associated with significant proteinuria. No RfDs for inhalation have been established. (ref. 2) Cadmium has been classified as a B1 probable human carcinogen through inhalation. This is based on several studies of workers exposed to cadmium. Rats exposed to cadmium chloride developed lung tumors and cadmium oxide produced tumors at multiple sites. Mutagenicity tests in bacteria and yeast have been inconclusive. Mutation assays in hamster cells, mouse lymphoma cells and chicken embryos have been positive. Insufficient data exist to classify cadmium as carcinogenic to humans by the oral route. The inhalation slope factor is 6.1 E+0 /mg/kg/day for air concentrations not exceeding 6 ug/cu. m.(ref. 1)

References:

1. U.S.E.P.A., 1990. Integrated Risk Information System (IRIS). Online. Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, Ohio.

2. U.S.E.P.A. 1990. Health Effects Assessment Summary Tables. Environmental Criteria and Assessment Office, Cincinnati, Ohio.

CHROMIUM

Chromium is a hard, brittle gray metal. Low concentrations of chromium are found in urban air, water, and a variety of foods. The primary use of chromium in industry is for plating. It is desirable for this purpose because of the non-corrosive, shiny, decorative finish it gives to automotive parts, household appliances, tools and machinery. Small amounts of chromium are essential to humans and animals to maintain glucose tolerance (ref. 1).

The toxicity of chromium varies with the valance state of the compound. Due to high solubility the hexavalent form of chromium (Cr+6) is readily absorbed by the lungs and gastrointestinal tract (ref. 1).

Ingestion of Chromium can cause nausea, vomiting and potential death due to uremic poisoning. Dermal exposure may result in a contact dermatitis. Acute exposure to high atmospheric concentrations of chromium may cause eye irritation, respiratory irritation with nosebleeds, cough and congestion. Chronic inhalation exposure can lead to ulcerations, bleeding, and erosion of the nasal septum. Inhalation exposure may induce coughing, chest pain, shortness of breath, asthma and lung cancer (ref. 1).

Toxic hematological effects were observed in animal studies using Cr+3. In bacterial systems Cr+6 is mutagenic; Cr+3 is not mutagenic. Cr+3 is not a carcinogen. Due to a lack of data, there is an uncertainty with regard to oral carcinogenic risk of Cr+6 (ref. 1). the EPA has set the MCL for total chromium in drinking water at 0.050 mg/L. The EPA has classified Cr+6 as class A, human carcinogen, by the inhalation route with a slope factor of 4.1E+1 (mg/kg-d)-1. the slope factor is based on a number of epidemiological studies in chromate facilities. The EPA has also given Cr+6 a chronic oral RfD of 5E-3 (mg/kg-d), and a chronic inhalation RfD of 6E-7 (mg/kg-d) (ref. 3).

Urine chromium levels greater than 5ug/g may be an indication of exposure (ref. 1).

References: (Chromium)

1. LaDou, Joseph; Occupational Medicine. Appleton and Lange, East Norwalk, Connecticut, 1990.

2. U.S. Air Force, 1985. The Installation Restoration Program Toxicology Guide.

3. USEPA. 1991. Health Effects Assessment Summary Tables. Environmental Criteria and Assessment Office, Cincinnati, Ohio.

LEAD

The absorption of lead from the gastrointestinal tract is dependant on a number of factors including age and nutritional state. Adults absorb between 5-15% of an ingested dose and retain less than 5% of the absorbed dose. Children may absorb and retain as much as 42% of an ingested dose. Absorption of inhaled lead is relatively complete (ref. 1).

Target organs for the toxic actions of lead include the central nervous system, blood forming tissues, the gastrointestinal system and the reproductive system. Of these, the CNS effects are of most concern (ref. 1). Blood lead concentrations have been used as an indicator of exposure and a number of toxic endpoints have been correlated with blood lead levels.

Children appear to be particularly susceptible to the neurotoxic effects of lead. A number of the neurobehavioral development endpoints occur at such low blood lead levels that there may not be a threshold for these effects (ref. 2).

Several of the soluble lead salts have been shown to produce renal tumors in rodent bioassays. Epidemiological evidence from human occupational exposures was inadequate to demonstrate a clear association between lead exposures and cancer. Based on these data, the EPA has classified lead as a B2 carcinogen (ref.2). Because of the uncertainties associated with the lead carcinogen risk assessment, the EPA recommended that numerical estimates of risk from lead exposure be avoided (ref.2).

The EPA is currently developing guidelines for performing environmental risk assessments involving lead. As an interim measure, they are suggesting the use of a Centers for Disease Control (CDC) document which recommended that soil lead levels between 500 ppm - 1000 ppm were safe levels, protective of the neurological effects in children (ref. 3). This value only addresses exposures from soil ingestion; probably the most important pathway when dealing with contaminated soil (ref.3). In terms of air lead, the EPA promulgated a NAAQS of 1.5 ug/m3. This level is also undergoing extensive review. In the absence of toxicity values, the CDC recommendations concerning soil lead concentrations and the NAAQ primary air standard will be used to partially quantify health risks in the current evaluation.

References:

1. Casarett and Doulls Toxicology The Basic Science of Poisons, 3rd edition, C. Klaassen, M. Amdur and J. Doull, 1986.

2. IRIS, Integrated Risk Information System, On-Line.

7. OSWER 9355. 4-02. Establishing Lead Cleanup Levels, EPA 1989.

MERCURY

Mercury is a silvery white metal which is ubiquitous in nature as it is found in many different classes of rock. The major use of mercury is in the manufacturing of control instruments, thermometers, barometers, etc. (ref. 1)

Inorganic mercury salts are poorly absorbed from the gastrointestinal tract (ref. 2). The kidneys show the highest concentration of mercury following exposure to inorganic salts and mercury vapor. In contrast, the CNS is the primary target for organic mercury compounds (ref. 2). Chronic occupational exposures to mercury compounds have been associated with mental disturbances, tremors and gingivitis (ref. 3).

The EPA has established an oral RfD of 3E-4 for methyl mercury. This value was based on several human studies and includes an uncertainty factor of 10 (ref. 4). Mercury was classified by the EPA as category D, not classifiable as to human carcinogenicity (ref. 4).

The OSHA has recommended a workplace exposure level of 0.1 mg/m3 for both aryl and inorganic mercury compounds, and an 8 hour TWA of 0.01 mg/m3 for alkyl mercury compounds (ref. 5).

References:

1. LaDou, Joseph; Occupational Medicine. Appleton and Lange, East Norwalk, Connecticut, 1990.

2. Klassen, C.D., Amour, M.O., Doull, J. 1986. Cassarett and Doull's Toxicology the Basic Science of Poisons, Third Edition: MacMillin Publishing Co., New York.

3. U.S.E.P.A., 1984. Health Effects Assessment. Final Draft. Environmental Criteria and Assessment Office, Cincinnati, Ohio, September 1984.

4. U.S.E.P.A., 1990. Integrated Risk Information System (IRIS). Online. Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, Ohio.

5. OSHA, Jan. 1989. Federal Register Part III, vol. 54, no. 12.

SILVER

Silver is a naturally occurring soft, silver colored metal. Uses for silver include the production of jewelry, coins and eating utensils. Silver salts are used for medicinal purposes. Industry utilizes silver halide in the manufacture of photographic plates.

Silver can be absorbed through the lungs and gastrointestinal tracts and be accumulated in the liver. Silver has the potential to impregnate tissue and remain there as silver sulfide resulting in a condition known as argyria. Argyria can localize in the formation of gray-blue patches on skin or manifest in the eye conjunctiva. Argyria can be generalized where pigmentation is widespread, vision is disturbed, and the respiratory tract can be adversely affected. Arteriosclerosis and lesions of the lung and kidney have been attributed to industrial and medicinal exposures. Chronic bronchitis has been associated with medicinal use of colloidal silver (Reference 1).

Silver has been categorized in Class D, not classifiable as a human carcinogen. This classification is based on the inconclusive data from animal studies and the lack of evidence in humans (Reference 2). Silver has an oral RfD of 5E-3 (Reference 2).

References: (Silver)

1. Klaassen, C.D., Amour, M.O., Doull, J. 1986. Cassarett and Doull's Toxicology the Basic Science of Poisons, Third Edition: MacMillin Publishing Co., New York.

2. USEPA. Integrated Risk Information System (IRIS). Online. Office of Health and Environmental Assessment, Environmental Cirteria and Assessment Office, Cincinnati, Ohio.

BARIUM

CAS NUMBER

7440-39-3

COMMON SYNONYMS

None.

ANALYTICAL CLASSIFICATION

Inorganic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: decomposes [1]
Vapor Pressure: insignificant at 25°C [1]
Henry's Law Constant: Not Applicable
Specific Gravity: 3.51 at 20/20°C [1]
Organic Carbon Partition Coefficient: NA

BACKGROUND CONCENTRATIONS

Barium is a naturally-occurring element. The concentration of barium in minimally disturbed soils varies tremendously. A collection of 1,319 soil samples from across the conterminous U.S. determined that 86 percent were less than or equal to 700 ppm, with a geometric mean of 440 ppm, but with a maximum value as high as 3,000 ppm [2].

FATE AND TRANSPORT

Barium is a highly reactive metal that occurs naturally only in the combined state. Most barium released to the environment from industrial sources is in forms that do not become widely dispersed. In the atmosphere, barium is likely to be present in the particulate form. Environmental fate processes may transform one barium compound to another; however, barium itself is not degraded. It is removed from the atmosphere primarily by wet or dry deposition [1].

In aquatic media, barium is likely to precipitate out of solution as an insoluble salt, or adsorb to suspended particulate matter. Sedimentation of suspended solids removes a large portion of the barium from surface waters. Barium in sediments is found largely in the form of barium sulfate. Bioconcentration in freshwater aquatic organisms is minimal [1].

Barium in soil may either be taken up to a small extent by vegetation, or transported through soil with precipitation. Barium is not very mobile in most soil systems. The higher the level of organic matter, the greater the adsorption. The presence of calcium carbonate will also limit mobility. Mobility is increased in the presence of high chloride concentrations. Barium complexes with fatty acids, for example, in acidic landfill leachate, will be much more mobile [1].

HUMAN TOXICITY

General. The primary target of barium toxicity is the cardiovascular system [1]. Information regarding the genotoxicity of barium are equivocal. Barium has not been placed in a weight-of-evidence cancer group by the USEPA [3].

Oral Exposure. A chronic oral RfD of 0.07 mg Ba/kg/day is based on a NOAEL of 0.21 mg Ba/kg/day for increased blood pressure in a long-term drinking water study in humans [3]. Barium is poorly absorbed following oral exposure (about 5%) [1]. In rats, acute oral LD_{50} values range from 132 to 277 mg/kg [1]. In humans, ingestion of very large amounts of barium (doses not reported) over a short period may cause paralysis or death. Ingestion of lower doses of barium over a short period may result in difficulties in breathing, increased blood pressure, changes in heart rhythm, stomach irritation, minor changes in blood, muscle weakness, changes in nerve reflexes, swelling of the brain, and damage to the liver, kidney, heart, and spleen [1]. Studies in animals report effects similar to those found in humans. Barium sulfate is sometimes given orally or rectally for the purpose of making X rays. This has not been shown to be harmful [1]. There is no evidence that oral exposure to barium affects human reproduction or development and developmental and reproduction studies in animals are inconclusive [1]. Barium has not been shown to cause cancer in humans or animals following oral exposure, therefore, an oral slope factor is not available [1,3].

Inhalation Exposure. The chronic inhalation RfC for barium of 5×10^{-4} mg/m^3 is based on a NOEL of 0.8 mg/m^3 for fetal toxicity in rats [4]. Approximately 65% of an inhaled concentration of barium is absorbed following inhalation exposure [1]. Barium has not been reported to be fatal to humans or animals following inhalation exposure [1]. Studies examining the toxicity of inhaled barium in humans and animals are extremely limited but suggest that exposure results in effects on the respiratory, cardiovascular, and gastrointestinal systems [1]. There is no evidence that inhaled barium affects human reproduction or development, but studies in animals suggest that barium may have adverse effects on these processes [1]. Barium is not known to cause cancer in humans or animals following inhalation exposure, therefore, an inhalation unit risk is not available [1,3].

Dermal Exposure. Dermal exposure to barium has not been reported to be fatal in humans or animals. Limited animal studies indicate that barium is a dermal and ocular irritant, but the results of this study are inconclusive [1].

ECOLOGICAL TOXICITY

General. Barium compounds are generally insoluble making them relatively unavailable for biological uptake [5]. All water- or acid-soluble barium compounds are poisonous. Barium is considered a nonessential element for plants and animals.

Vegetation. There are very few reports of barium toxicity to plants, except under conditions of acidic soils or with highly concentrated soil solutions where the bioavailable fractions are excessive (e.g., 2 mg/L soluble barium). Some authors report that concentrations of barium need to be extreme before toxicity occurs. Barium accumulation in plants is unusual except when the barium concentration exceeds calcium and magnesium concentrations in the soil, a condition which may occur when sulfate is depleted [6].

Aquatic Life. Barium ions in general are rapidly precipitated or removed from solution by chemical bonding, adsorption, and sedimentation. In most natural water, there is sufficient sulfate or carbonate to precipitate soluble barium present in the water, converting it to an insoluble nontoxic compound [6]. Experimental data indicate that soluble barium concentrations would have to exceed 50,000 μg/L before toxic effects to aquatic life might be observed [5]. Other data show the concentrations of barium lethal to half the test population of fish range from 150 to 10,000 mg/L [7]. Because barium represents little hazard under natural conditions, there are no federal aquatic life water quality standards [8].

Wildlife. Soluble barium compounds such as barium chloride, barium carbonate, barium sulfide, and barium oxide are highly toxic to animals when injested [9], although it is unlikely that suitable conditions would exist under natural conditions to accommodate exposure to these compounds. No reports of barium toxicity to wildlife under natural conditions were identified.

REFERENCES

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2. USGS, 1984. Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States. United States Geological Survey Professional Paper 1270.
3. USEPA, 1992. Integrated Risk Information System (IRIS). Data base. Online. August 3, 1992.
4. USEPA, 1992. Health Effects Assessment Summary Tables (HEAST). Office of Emergency and Remedial Response. OHEA ECAO-CIN-821. March 1992.
5. CH2M Hill, Inc., 1989. Preliminary Endangerment Assessment for Lowry Landfill. Denver, Colorado.

6. U.S. Environmental Protection Agency. 1983. Hazardous Waste Land Treatment (revised edition). Office of Solid Waste and Emergency Response. SW-874. Washington, D.C.
7. Snyder, Bruce D. and Janet L. Snyder. 1984. Feasibility of Using Oil Shale Wastewater for Waterfowl Wetlands. U.S. Fish and Wildlife Service. FWS/OBS-84/01.
8. U.S. Environmental Protection Agency. 1991. Water Quality Criteria Summary. Washington, D.C.
9. U.S. Fish and Wildlife Service. 1978. Impacts of Coal-Fired Power Plants on Fish, Wildlife, and their Habitats. FWS/OBS-78/29.

BIS(2-ETHYLHEXYL)PHTHALATE

CAS NUMBER

117-81-7

COMMON SYNONYMS

1,2-Benzenedicarboxylic acid bis(2-ethylhexyl)ester; di(2-ethylhexyl) phthalate; dioctylphthalate.

ANALYTICAL CLASSIFICATION

Semi-volatile organic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: 0.3 mg/L at 25°C [1]
Vapor Pressure: 6.45 x 10^{-6} mm Hg at 25°C [1]
Henry's Law Constant: 1.1 x 10^{-5} atm-m^3/mole [1]
Specific Gravity: 0.99 at 20/20°C [2]
Organic Carbon Partition Coefficient: 10,000 - 100,000 [1]

FATE DATA: HALF-LIVES

Soil: 5 - 23 days [3]
Air: 2.9 - 29 hours [3]
Surface Water: 5 - 23 days [3]
Groundwater: 10 - 389 days [3]

NATURAL SOURCES

Possible product of animal and/or plant life.

ARTIFICIAL SOURCES

Plasticizer for polyvinylchloride and other polymers; disposal/incineration of plastic(s)/polymer(s) [1].

FATE AND TRANSPORT

Bis(2-ethylhexyl)phthalate (hereafter, BEHP) has a strong tendency to adsorb to soils and sediments, suggesting low likelihood of leaching to groundwaters. Given the very low vapor pressure and Henry's Law constant of BEHP, volatilization from soils and waters is very unlikely. This compound does show a tendency to bioconcentrate in aquatic organisms. Hydrolysis (from aquatic systems), photolysis (in the water and atmosphere), and photo-oxidation (in atmospheric systems) are not predicted to be important removal processes. In aquatic environments, aerobic biodegradation occurs rapidly following acclimation; no anaerobic biodegradation occurs. Some slight biodegradation in soils is expected. In the atmosphere, the primary removal mechanism is via rainfall washout [1].

HUMAN TOXICITY

General. There is currently no evidence that BEHP causes adverse effects in humans, but animal studies indicate that the liver, kidneys and testes are targets of oral exposure [4]. Information regarding the genotoxicity of BEHP are equivocal but indicate that BEHP may act as a co-carcinogen in rodents [4]. The USEPA has placed BEHP in weight-of-evidence cancer Group B2, indicating that it is a probable human carcinogen [5].

Oral Exposure. A chronic oral RfD of 0.02 mg/kg/day is based on a LOAEL of 19 mg/kg/day for increased relative liver weight in a chronic oral study in guinea pigs [5]. BEHP is readily absorbed following oral exposure. Acute oral LD_{50} values of 30,600 mg/kg and 33,900 mg/kg have been defined for rats and rabbits, respectively [4]. BEHP has not been found to be fatal to humans at doses up to 143 mg/kg; mild abdominal pain and diarrhea were the only effects reported at this dose [4]. Oral studies in animals reported effects on the liver (morphological changes, nodules, tumors), kidneys (effects on kidney cells), thyroid and pancreas (changes in the acinar cells of both organs), and testes (atrophy and degeneration). Animal studies indicated that monkeys are less susceptible to the toxic effects of BEHP than are mice and rats [4]. The relative susceptibility of humans is not known. Effects on fetal development (reduced survival, malformations) were reported in rodents following oral exposure [4]. There is no evidence that BEHP causes cancer in humans, but studies in animals suggest that oral exposure results in liver cancer [4]. An oral slope factor of 0.014 $(mg/kg/day)^{-1}$ is based on the incidence of liver tumors in mice [5].

Inhalation Exposure. An inhalation RfC is not available for BEHP [5]. Information regarding the toxicity of inhaled BEHP in humans are not available and data in animals are limited to one developmental study [4]. In the developmental study, no adverse effects were reported in rats following exposure to up to 300 mg/m^3 during gestation [4]. There is no evidence that inhaled BEHP causes cancer in humans or animals, therefore, an inhalation unit risk for cancer is not available for BEHP [5].

Dermal Exposure. An acute dermal LD_{50} value of 24,750 mg/kg was reported for rabbits [4]. Dermal exposure of both humans and animals indicate that BEHP is neither an irritant nor a sensitizer [4].

ECOLOGICAL TOXICITY

General. Bis(2-ethylhexyl)phthalate (BEHP) is the most well studied of the phthalate esters. Most information reported in the technical literature dealt with phthalate esters as a group. Autian [6] suggests there is evidence phthalate esters are degraded by microbiota and metabolized by fish and animals. As a result, phthalate esters are not likeley to biomagnify. According to Arthur D. Little, Inc. [7], phthalate esters readily complex with natural organic substances (e.g., fulvic acid) to form complexes which are very soluble in water. BEHP is nonvolatile, strongly adsorbed, and has a high potential for bioaccumulation.

Vegetation. Review of the technical literature did not produce information regarding the phototoxic effects of BEHP.

Aquatic Life. Bioconcentration factors (BCFs) for fish and aquatic invertebrates range from 54 to 2,680. Fathead minnows accumulated levels of BEHP 1,380 times the water concentration of 2.5 μg/L after 28 days. Residue half-life was 7 days. Invertebrates accumulated BEHP up to 13,400 times when exposed to water concentrations ranging from 0.08 to 0.3 μg/L. Over 90 percent of the residues were lost within 10 days [8]. The 96-hour LC_{50} of bluegill is more than 770,000 μg/L [9]. The LC_{50} of *Daphnia magna* exposed to BEHP was 11,000 μg/L. There are no USEPA acute or chronic aquatic life criteria for BEHP [10,11].

Wildlife. The only information available on wildlife toxicity to BEHP concerns laboratory animals. The oral LD_{50} values for rats is 31,000 mg/kg, 30,000 mg/kg, for mice, and 34,000 mg/kg for rabbit [12].

REFERENCES

1. Howard, P.H., 1989. Handbook of Environmental Fate and Exposure Data For Organic Chemicals, Vol. I: Large Production and Priority Pollutants. Lewis Publishers, Inc. Chelsea, MI. 574 pp.
2. Verschueren, K., 1983. Handbook of Environmental Data on Organic Chemicals. Second Edition. Van Nostrand Reinhold Company, New York.
3. Howard, P.H.; Boethling, R.S.; Jarvis, W.F.; Meylan, W.M.; and Michalenko, E.M.; 1991. Handbook of Environmental Degradation Rates. Lewis Publishers, Inc. Chelsea, MI. 725 pp.
4. ATSDR, 1991. Toxicological Profile for Di(2-Ethylhexyl)Phthalate. Draft. Agency for Toxic Substances and Disease Registry. USPHS/USEPA. October 1991.
5. USEPA, 1992. Integrated Risk Information System (IRIS). Data base. Online. August 3, 1992.
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4,4'-DDE

CAS NUMBER

72-55-9

COMMON SYNONYMS

p,p' - DDE; 4,4-Dichlorodiphenylchloroethane; 1,1-Dichloro-2,2-bis(p-ethylphenyl) ethane; 1,1'-(2,2-Dichloroethylidene)bis[4-ethylbenzene] [1]

ANALYTICAL CLASSIFICATION

Pesticide (organic).

PHYSICAL AND CHEMICAL DATA

Water Solubility: 0.12 mg/L at 25°C [2]
Vapor Pressure: $6.50 \times 10E^{-6}$ mm Hg at 20°C [2]
Henry's Law Constant: 6.8×10^{-5} atm-m^3/mole [2]
Specific Gravity: ND [2]
Organic Carbon Partition Coefficient: 4,400,000 [2]

FATE DATA: HALF-LIVES

Soil: 2 - 15.6 years [3]
Air: 17.7 hours - 7.4 days [3]
Surface Water: 15 hours - 6.1 days [3]
Groundwater: 16 days - 31.3 years [3]

NATURAL SOURCES

None noted [1].

ARTIFICIAL SOURCES

Insecticide [1].

FATE AND TRANSPORT

Like 4,4-DDD and 4,4-DDT, 4,4-DDE is a highly stable compound. Generally, it is resistant to photodegradation and/or oxidation [1]. Given the high K_{oc} value, 4,4-DDE is expected to adsorb tightly to soils and sediments/suspended solids in waters. In addition to the high K_{oc} value, the low level of solubility suggests little probability of groundwater infiltration via leaching through soils. The low vapor pressure and Henry's Law constant values suggest little tendency to volatilize from soils and/or waters. 4,4-DDE has a high bioconcentration factor (51,000), indicating that it is expected to readily bioconcentrate in aquatic organisms [4]. Biodegradation, aerobic or anaerobic, is expected to be slow.

HUMAN TOXICITY

General. Typically, individuals are exposed to a mixture of 4,4-DDT, 4,4-DDE and 4,4-DDD, and not to the compounds individually. Both 4,4-DDE and 4,4-DDD are contaminants, as well as degradation and metabolic products, of 4,4-DDT [2]. Most of the available toxicity data deal with 4,4-DDT. The major targets of the three compounds are the central nervous system (CNS) and the liver [2]. Data regarding the genotoxicity of the compounds are equivocal, but chromosomal damage has been observed in exposed individuals [2]. The USEPA placed 4,4-DDT, 4,4-DDE and 4,4-DDD in weight-of-evidence Group B2, indicating that they are probable human carcinogens [6].

Oral Exposure. A chronic oral RfD is currently not available for 4,4-DDE [6]. 4,4-DDE is readily absorbed following oral exposure [2]. Acute oral LD_{50} values of 880 to 1240 mg/kg were reported for male and female rats, respectively, and a range of 700 to 1000 mg/kg was reported in mice [5]. Symptoms of acute exposure were not reported, but toxic effects on the liver (necrosis) and CNS (tremors, ataxia, loss of equilibrium) have resulted in animals following long-term oral exposure [5]. In one study in humans, no adverse effects were noted in an individual given 5 mg (0.07 mg/kg/day) 4,4-DDE orally for 92 days [5]. Limited animal studies indicate that 4,4-DDE is not likely to affect reproduction or development. There is no evidence that 4,4-DDE causes cancer in humans, but studies in animals suggest that oral exposure may result in liver cancer [5]. The USEPA derived an oral slope factor of 0.34 $(mg/kg/day)^{-1}$ based on the incidence of liver tumors in animals [6].

Inhalation Exposure. A chronic inhalation RfC is not available for 4,4-DDE [6]. Inhalation of 4,4-DDE is considered to be a minor route of entry because 4,4-DDE is a large particle and, when inhaled, is trapped in the upper regions of the respiratory tract and eventually swallowed [2]. Data are not available regarding the toxicity of inhaled 4,4-DDE in humans or animals [2].

Dermal Exposure. No useful information was located regarding dermal exposure to 4,4-DDE.

ECOLOGICAL TOXICITY

General. 4,4-DDE is an impurity in 4,4-DDT and also is formed as a degradation product of 4,4-DDT [7]. It is not manufactured as a commercial product [8]. As would be expected from this class of compounds, 4,4-DDE has a high environmental toxicity to invertebrates and is also quite toxic to fish, birds, and mammals. However, the primary concerns related to 4,4-DDE are its persistence in the environment, its ability to bioconcentrate in almost all classes of biota, and its capacity to biomagnify through the food chain. These problems are particularly serious because, unlike 4,4-DDT and 4,4-DDD, 4,4-DDE in biota appears to be a stable end product incapable of being further degraded by biotransformation [8]. This characteristic results in 4,4-DDE being detected in 90 to 100 percent of fish and bird samples collected throughout the United States at least 11 years after the use of 4,4-DDT was banned [7].

Vegetation. Although no data were found on the phytotoxicity of DDE, the risk of this compound to plants is probably low. According to Micromedex, Inc. [7], enough 4,4-DDT was produced to cover all of the arable land in the world with this compound and its metabolites, 4,4-DDD and 4,4-DDE, at a rate of 1.5 pounds per acre. Despite the abundance of these chemicals, the scientific literature is virtually devoid of information on phytotoxicity. This implies that 4,4-DDE has low toxicity to plants.

Like 4,4-DDT, 4,4-DDE bioconcentrates in aquatic plants. Studies summarized by the USEPA [8] and Micromedex, Inc. [7] show bioconcentration factors in algae of 10^3 to 10^4. Tissue concentrations in aquatic vascular plants of 2 μg/kg dry weight were found in Finnish lakes. Although in-tissue concentrations of 4,4-DDE may not be toxic to the plants, they are important as sources of 4,4-DDE in higher trophic levels. Concerning the structurally similar compound 4,4-DDT, Johnson and Finley [9] state that "Food seems to be more important than water as a source of body residues," while a study on DDE summarized by the USEPA [8] found concentration factors of 10^4 in mosquito larvae and fish exposed in a food-chain microcosm, but only 10^2 through aquatic exposure where a food chain did not exist.

Aquatic Life. The USEPA has not established a criterion for 4,4-DDE for the chronic protection of freshwater aquatic life. However, because of the chemical similarities between 4,4-DDE and 4,4-DDT, it is assumed that the 4,4-DDT criteria would provide adequate protection if applied to 4,4-DDE. The federal aquatic life criterion for 4,4-DDT for the chronic protection of freshwater aquatic life is 0.001 μg/L [10].

4,4-DDE appears to be slightly less toxic to fish than 4,4-DDT. Acute toxicities (96-hour LC_{50}s) from 4,4-DDE for freshwater fish summarized by Micromedex, Inc. [7] ranged from 32 μg/L to 240 μg/L. Acute toxicities for 4,4-DDT for fish seldom exceeded 10 μg/L. No data were found concerning acute toxicities of 4,4-DDE to aquatic invertebrates.

A major concern to aquatic life is the bioconcentration of 4,4-DDE. Studies reported by the USEPA [8] and Micromedex, Inc. [7] show bioconcentration factors for invertebrates and fish generally ranging from 10^3 to 10^5. Bioaccumulation of 4,4-DDE is important both because the chemical can build up to toxic concentrations in the animal's tissues and because it serves as a source of toxic levels of 4,4-DDE to higher trophic levels. In fish collected from Great Lakes watersheds in the early 1980's, 94 percent were positive, with 4,4-DDE concentrations ranging from 15 to 5,800 ppb [7]. More than 30 percent of snapping turtles from waters in New York had 4,4-DDE concentrations of greater than 5 ppm [7].

Wildlife. Toxicity of 4,4-DDE to non-human mammals is indicated by the human toxicity information presented earlier, which was based on studies of rodents. In the body, 4,4-DDE accumulates chiefly in the adipose tissue, but is also found in significant concentrations in liver, brain, and muscle tissues [11].

Birds are also susceptible to 4,4-DDE poisoning. Studies summarized by Micromedex, Inc. [7] showed that mallards, ring-necked pheasant, bobwhite quail, and Japanese quail had 5-day LD_{50}'s for ingestion of 4,4-DDE ranging from 825 to 3,572 ppm. Bioaccumulation also occurs in birds. In other studies summarized by Micromedex, Inc. [7], 100 percent of 293 dead or moribund bald eagles collected in the United States from 1978 through 1981 tested positive for 4,4-DDE and had median carcass concentrations of 4,4-DDE each year of 2.4 to 3.3 ppm. Mean 4,4-DDE concentrations in Pacific black ducks were 331 ppm in fat, 42 ppm in wings, 10 ppm in liver, and 2.1 ppm in brain [7]. However, the greatest environmental threat to birds from 4,4-DDE is associated with eggshell thinning and related reproduction failure. Studies cited by Micromedex, Inc. [7] showed 100 percent of black-crowned night heron eggs collected from Colorado and Wyoming in 1979 contained concentration of 4,4-DDE ranging from 0.33 to 44 ppm (wet weight) as did 98 percent of colonial waterbirds eggs collected from Green Bay and Lake Michigan between 1975 and 1980 (0.30 to 44 ppm wet weight). Steep declines in populations of birds such as eagles, peregrine falcons, ospreys, and brown pelicans that occupy upper trophic levels prompted the United States and many other developed countries to ban the use of 4,4-DDT in the early 1970's.

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4,4'-DDT

CAS NUMBER

50-29-3

COMMON SYNONYMS

p,p' - DDT; 4,4-Dichlorodiphenyltrichloroethane, 1,1-(2,2,2-Trichloroethylidene)bis[4-chlorobenzene]

ANALYTICAL CLASSIFICATION

Pesticide (organic).

PHYSICAL AND CHEMICAL DATA

Water Solubility: insoluble (maximum 0.0034 mg/L at 25°C) [1]
Vapor Pressure: 5.5×10^{-6} mm Hg at 20°C [1]
Henry's Law Constant: 5.13×10^{-4} atm-m^3/mole [1]
Specific Gravity: 0.98 - 0.99 gm/ml at 20°C [2]
Organic Carbon Partition Coefficient: 243,000 [1]

FATE DATA: HALF-LIVES

Soil: 2 - 15.6 years [3]
Air: 17.7 hours - 7.4 days [3]
Surface Water: 7 - 350 days [3]
Groundwater: 16 days - 31.3 years [3]

NATURAL SOURCES

None.

ARTIFICIAL SOURCES

Contact insecticide, pesticide [2].

FATE AND TRANSPORT

Like 4,4-DDD and 4,4-DDE, 4,4-DDT is a highly stable compound and is considered a persistent pollutant in soils and waters. It is generally resistant to photodegradation and/or oxidative processes [4]. Given the high K_{oc} value, 4,4-DDT is expected to adsorb very tightly to soils, sediments and suspended solids in waters. In addition to the high K_{oc} value, the low level of solubility suggests little probability of groundwater infiltration via leaching. The low values associated with this compound for vapor pressure and Henry's Law constant suggest little tendency to volatilize from soils or waters. The bioconcentration factor (54,000) associated with this compound suggests a readiness to bioconcentrate in aquatic organisms [5]. Biodegradation, aerobic or anaerobic, is expected to be slow [1].

HUMAN TOXICITY

General. Typically, individuals are exposed to a mixture of 4,4-DDT, 4,4-DDE and 4,4-DDD, and not to the compounds individually. Both 4,4-DDE and 4,4-DDD are contaminants, as well as degradation and metabolic products, of 4,4-DDT [1]. Most of the available toxicity data deal with 4,4-DDT. The major targets of the three compounds are the central nervous system and the liver [1]. Data regarding the genotoxicity of the compounds are equivocal [1,2]. The USEPA placed 4,4-DDT, 4,4-DDE and 4,4-DDD in weight-of-evidence Group B2, indicating that they are probable human carcinogens [6].

Oral Exposure. A chronic oral RfD of 0.0005 mg/kg/day is based on a NOEL of 0.05 mg/kg/day for liver lesions in a subchronic oral study in rats [6]. 4,4-DDT is readily absorbed following oral exposure [1]. Oral LD_{50} values in animals ranged from 87 mg/kg in rats to 400 mg/kg in guinea pigs [1,2]. The human oral LD_{50} value has been estimated at 250 mg/kg [2]. The initial symptoms of oral poisoning include a burning or prickling sensation of the mouth and face, tremor of the extremities, confusion, malaise, headache, fatigue and delayed vomiting [2]. These symptoms can occur as soon as 30 minutes after the ingestion of a large dose or as long as 6 hours after the ingestion of a small dose. Recovery is usually complete within 24 hours after poisoning. Several longer-term studies have been conducted in humans [2]; no adverse effects were observed following treatment with up to 35 mg daily (0.5 mg/kg/day) for 21.5 months. Pathological lesions of the liver and kidneys were reported in chronic studies in animals [2]. There is no evidence that 4,4-DDT affects reproduction or development in humans [1]. There is no evidence that 4,4-DDT causes cancer in humans, but studies in animals suggest that oral exposure results in liver cancer [1]. The USEPA derived an oral slope factor of 0.34 $(mg/kg/day)^{-1}$ based on the incidence of liver tumors in mice [6].

Inhalation Exposure. A chronic inhalation RfC is not available for 4,4-DDT [6]. Inhalation of 4,4-DDT is considered to be a minor route of entry because 4,4-DDT is a large particle and, when inhaled, is trapped in the upper regions of the respiratory tract and eventually swallowed [1]. In occupationally exposed workers, no overt symptoms of exposure were reported, although an increase in neurological effects was suggested [2]. Daily intake in workers was estimated to be approximately 18 mg/man (0.25 mg/kg/day) [2]. Limited, short-term inhalation studies in animals indicate that the central nervous system is the target of 4,4-DDT toxicity [2]. An inhalation unit risk of 9.7 x 10^{-5} was calculated from the oral slope factor [6].

Dermal Exposure. Dermal LD_{50} values ranged from 300 mg/kg in rabbits to 3000 mg/kg in rats [1,2]. Dermal contact with 4,4-DDT does not appear to cause irritation or systemic effects [2].

ECOLOGICAL TOXICITY

General. 4,4-DDT was widely used as an insecticide until 1972, when its use in the United States was banned. However, it is still manufactured and used elsewhere in the world. As would be expected from this class of compounds, 4,4-DDT has a high environmental toxicity to invertebrates and is also quite toxic to fish, birds, and mammals. However, the primary concerns related to 4,4-DDT are its persistence in the environment, its ability to bioconcentrate in almost all classes of biota, and its capacity to biomagnify through the food chain.

Vegetation. Although no data were found on the phytotoxicity of 4,4-DDT, the toxicity of this compound to plants is probably low. Since the 1940's, more than 3.5 billion pounds of 4,4-DDT have been produced, which is an amount sufficient to cover all of the arable land in the world at the rate of 1.5 pounds per acre [7]. Because of the environmental persistence of DDT and its metabolities, this application rate would have resulted in a concentration of 4,4-DDT, 4,4-DDD, and/or 4,4-DDE of approximately 750 μg/kg in arable surface soils worldwide. Despite the abundance of these chemicals, the scientific literature is virtually devoid of information on phytotoxicity. This implies that 4,4-DDT, 4,4-DDD, and 4,4-DDE have low toxcicities to plants.

4,4-DDT bioconcentrates in many species of aquatic plants. Studies summarized by Micromedex, Inc. [7] show a bioconcentration factor in *Cladophora* (a green algae) of more than 21,000. Bioconcentration factors in aquatic vasuclar plants range from approximately 500 to 14,000. Although in-tissue concentrations of 4,4-DDT may not be toxic to the plants, they are important as sources of 4,4-DDT in higher trophic levels. Johnson and Finley [8] state that "Food seems to be more important than water as a source of body residues," while a study on DDE (a metabolite of 4,4-DDT with a similar chemical structure) summarized by the USEPA [9] found concentration factors of 10^4 in mosquito larvae and fish exposed in a food-chain microcosm, but only 10^2 through aquatic exposure where a food chain did not exist.

Aquatic Life. The federal aquatic life criterion for 4,4-DDT for the chronic protection of freshwater aquatic life is 0.001 μg/L [10].

These standards derive from the high toxicity of 4,4-DDT to aquatic invertebrates and fish. For example, studies cited in Johnson and Finley [8] and Micromedex, Inc. [7] show most 96-hour LC_{50}s (acute toxicities) for both invertebrates and fish between 1 and 10 μg/L.

Generally, an application factor of 0.01 is used to convert acute toxicities to criteria that provide for the chronic protection of aquatic life [11].

A major concern to aquatic life is the bioconcentration of 4,4-DDT. Numerous studies reported by the USEPA [9] and Micromedex, Inc. [7] show bioconcentration factors for invertebrates and fish generally ranging from 10^3 to 10^5. Residue accumulations in fish of up to 2 million have been reported [11]. Bioaccmulation of 4,4-DDT is important both because the chemical can build up to toxic concentrations in the animal's tissues and because it serves as a source of toxic levels of 4,4-DDT to higher trophic levels.

Wildlife. Toxicity of 4,4-DDT to non-human mammals is indicated by the human toxicity information presented earlier, which was based on studies of rodents and rabbits. In the body, 4,4-DDT and its metabolites accumulate chiefly in the adipose tissue, but are also found in significant concentrations in the liver, brain, and muscle tissues [12]. Cattle and swine fed 25 ppm in the diet for 28 days had 4,4-DDT levels in fat of 22 ppm and 10 ppm, respectively [12].

Birds are also susceptible to 4,4-DDT poisoning. Studies summarized by Micromedex, Inc. [7] showed that mallards, ring-necked pheasant, bobwhite quail, and Japanese quail had 5-day LD_{50}s for ingestion of 4,4-DDT ranging from 300 ppm to 4800 ppm. Bioaccumulation also occurs in birds, with mean wet weight concentrations in muscle tissue from gamebirds (goose, quail, and woodcock) in several Tennessee counties ranging from 2.9 mg/kg to 9.9 mg/kg [13]. Bald eagle carcasses showed 4,4-DDT concentrations as high as 25 ppm (lipid basis), while ospreys accumulated 4,4-DDT up to 5.7 ppm (wet weight) [7]. However, the greatest environmental threat to birds from 4,4-DDT and its metabolities is associated with eggshell thinning and associated reproductive failure. Studies cited by the USEPA [11] showed that dietary intake of 4,4-DDT at more than 3 mg/kg wet weight in natural food adversely affected reproduction in captive waterfowl. By the late 1960's, populations of birds occupying upper trophic levels, such as eagles, peregrine falcons, ospreys, and brown pelicans, had declined sharply because of eggshell thinning caused by 4,4-DDT and its metabolities in the natural diet. Concerned about these declining populations lead the United States and many other developed countries to ban to use of 4,4-DDT in the early 1970's.

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METHYLENE CHLORIDE

CAS NUMBER

75-09-2

COMMON SYNONYMS

Dichloromethane [1]

ANALYTICAL CLASSIFICATION

Volatile Organic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: 13,000 mg/L at 25°C [1]
Vapor Pressure: 434.9 mm Hg at 25°C [1]
Henry's Law Constant: 2.68×10^{-3} atm-m^3/mole [1]
Specific Gravity: 1.3255 at 20/4°C [2]
Organic Carbon Partition Coefficient: 47.86 [1]

FATE DATA: HALF-LIVES

Soil: 1 - 4 weeks [3]
Air: 19.1 - 191 days [3]
Surface Water: 1 - 4 weeks [3]
Groundwater: 2 - 8 weeks [3]

NATURAL SOURCES

None noted [1].

ARTIFICIAL SOURCES

Aerosol propellant; paint remover; metal degreaser; urethane foam blowing agent; paint/ink industries; aluminum forming; coal mining; photographic equipment; pharmaceutical, organic chemicals/plastics, and rubber processing industries; foundries; and laundries [1,2].

FATE AND TRANSPORT

Methylene chloride released to soil will evaporate quickly from near-surface soils, given its high vapor pressure. That which does not volatilize can be expected to leach through soils to groundwater not protected by a confining layer. Under normal environmental conditions, hydrolysis in soils and/or groundwaters is not predicted. Aerobic biodegredation of methylene chloride is reported to be complete (within 6 hours to 7 days), and anaerobic biodegradation will proceed after a variable-length acclimation period. The primary removal process of methylene chloride from surface waters is volatilization. Biodegredation of methylene chloride is possible in natural waters, but will be a slow process relative to volatilization. Hydrolysis in surface waters, under normal environmental conditions, is not to be expected. The greater portion of atmospheric methylene chloride will degrade by reaction with hydroxyl radicals; photolysis is not expected. A small portion of the methylene chloride will diffuse to the stratosphere and will subsequently undergo rapid photolytic degradation and reaction with chlorine radicals. The moderate solubility of methylene chloride suggests the probability of atmospheric washout via rainfall.

Given its low, estimated bioconcentration factor of 5 (calculated from the octanol/water partition coefficient [1]), methylene chloride is not expected to bioconcentrate in aquatic biota.

HUMAN TOXICITY

General. The major targets of methylene chloride toxicity are the central nervous system, the liver and the kidneys [4]. Information regarding the mutagenicity of methylene chloride are equivocal. The USEPA has placed methylene chloride in weight-of-evidence cancer Class B2, indicating that it is a probable human carcinogen [5].

Oral Exposure. The chronic oral RfD of 0.06 mg/kg/day is based on a NOAEL of 6 mg/kg/day for liver toxicity in a chronic oral study in rats [5]. Methylene chloride is readily absorbed following oral exposure. An acute oral LD_{50} of 2100 mg/kg was reported for rats [4]. Human fatalities resulting from oral exposure to methylene chloride have not been reported. Limited animal data indicates that effects on the liver and kidneys occur at doses above 55 mg/kg/day [4]. There is no evidence to suggest that methylene chloride affects reproduction or development. There is no evidence that methylene chloride causes cancer in humans, but studies in animals suggest that oral exposure results in liver cancer [4]. An oral slope factor of 7.5×10^{-3} $(mg/kg/day)^{-1}$ was derived based on the incidence of liver cancer in mice [5].

Inhalation Exposure. A chronic inhalation RfC of 3 mg/m^3 is based on a NOAEL of 694.8 mg/m^3 for liver toxicity in a chronic study in rats [6]. Methylene chloride is readily absorbed following inhalation exposure. An acute LC_{50} of 16,189 ppm was reported for mice [4]. The odor threshold is approximately 200 ppm. Case studies have demonstrated that inhaled methylene chloride can be fatal to humans, but exposure levels were not reported [4]. Acute (3-4 hours) exposure to concentrations of 300 ppm or greater results in adverse effects on vision and hearing, while exposure to 800 ppm or greater results in impairment of psychomotor performance (reaction time, hand precision, steadiness) [4]. In most cases, effects will disappear when exposure ceases. Animal studies indicate that exposure to higher concentrations (1000 ppm) results in unconsciousness or death [4]. Animal studies indicate that methylene chloride is not likely to produce adverse effects on reproduction or development in humans [4]. There is no evidence that methylene chloride causes cancer in humans, but studies in animals suggest that inhalation exposure results in liver cancer [4]. An inhalation unit risk of 4.7×10^{-7} $(\mu g/m^3)^{-1}$ was derived based on the incidence of liver cancer in mice [5].

Dermal Exposure. No information is available regarding the effects of dermal exposure to methylene chloride in humans. Limited animal studies report adverse effects on the eye of rabbits following exposure. The effects were reversed within a few days [4].

ECOLOGICAL TOXICITY

General. Methylene chloride is highly volatile, is weakly absorbed to soil, and has no significant potential for bioaccumulation. It is highly mobile in the soil/ground water system [7]. No information was found regarding biomagnification of methylene chloride.

Vegetation. The sorption of methylene chloride is not well documented. Transformation processes such as hydrolysis and biodegradation are not expected to be important in natural soil systems [7]. Review of the technical literature did not produce information regarding the phytotoxic effects of methylene chloride.

Aquatic Life. CH2M Hill, Inc. [8] states that acute values for fathead minnows and bluegill are 193,000 μg/L and 224,000 μg/L, respectively. The 96-hour LC_{50} of green sunfish is 550 ppm [9]. According to Arthur D. Little, Inc. [7], there is no criterion for acute toxicity in freshwater species, but the LOEL occurs at 11,000 μg/L halomethanes. There are no USEPA aquatic life water quality standards for methylene chloride [10].

Wildlife. Methylene chloride is slightly toxic to mammals. CH2M Hill, Inc. [8] states the oral LD_{50} for rats is 2,136 mg/kg and for mice is 1,987 mg/kg. The lowest lethal dose for rabbits is 1,900 mg/kg. Methylene chloride has a low to moderate acute oral toxicity in lab animals. The LD_{50} value for rats and rabbits fed undiluted methylene chloride is about 2,000 mg/kg [7].

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NAPHTHALENE
2-METHYLNAPHTHALENE

GENERAL

There is relatively little information available on 2-methylnaphthalene as compared to naphthalene. Therefore, all information below refers to naphthalene unless explicitly stated otherwise.

CAS NUMBERS

Naphthalene	91-20-3
2-Methylnaphthalene	91-57-6

COMMON SYNONYMS

Naphthalene: Naphthene, Tar Camphor.
2-Methylnaphthalene: Beta-methylnaphthalene

ANALYTICAL CLASSIFICATION

Semi-Volatile Organic.

PHYSICAL AND CHEMICAL DATA

	Naphthalene	2-Methylnaphthalene
Water Solubility (mg/L at 20°C) [1]	31.7	ND
Vapor Pressure (mm Hg at 25°C) [1]	0.087	ND
Henry's Law Constant (atm-m^3/mole) [1]	4.6×10^{-4}	ND
Specific Gravity (20/4°C) [1]	1.145	1.0058
Organic Carbon Partition Coefficient [1]	933	ND

FATE DATA: HALF-LIVES (HRS)

Soil: 16.6 to 48 days [2]
Air: 2.96 to 29.6 hours [2]
Surface Water: 12 hours to 20 days [2]
Groundwater: 1 to 288 days [2]

NATURAL SOURCES

Crude oil; natural, uncontrolled combustion (i.e., forest fires) [3,4].

ARTIFICIAL SOURCES

Naphthalene: Petroleum refining, mothball use and manufacture, coal tar distillation, pitch fumes, chemical intermediate (i.e., phthalic anhydride manufacture), vehicle emissions, combustion processes (i.e., refuse combustion), tobacco smoke, and oil spillage [3,4].

2-Methylnaphthalene: Synthesis of organic compounds such as insecticides, and release from gasoline due to its use as an additive [1,5].

FATE AND TRANSPORT

Naphthalene's sorption to soil ranges from low to moderate, depending upon the organic carbon content of the soil, and will leach rapidly through sandy soils. Volatilization from the uppermost soil layer will be important, but will lessen in importance with soil depth. In addition, volatilization from moisture-saturated soil is not expected to be important. Biodegradation is expected to be rapid in soils previously contacted with other polycyclic aromatic hydrocarbons (PAHs), but slow in "virgin" soils [3].

Volatilization, photolysis, sorption (to suspended solids, sediments, etc.), and biodegradation are the primary removal mechanisms for naphthalene in waters. The actual predominant mechanisms change with variations in several factors (i.e., water flow rate, level of sediments/suspended soils, water clarity, etc.) In addition, biodegradation rates of naphthalene in water vary with changes in concentration of naphthalene (higher concentrations yield higher rates), "virgin" versus oil-polluted water (quicker in oil-polluted waters), actual pollution site (more rapid biodegradation in sediments than waters), aerobic versus anaerobic conditions (no biodegradation in anaerobic conditions), and so on. Bioconcentration in aquatic organisms is expected to be moderate, except for accelerated bioconcentration in organisms lacking an aryl hydroxylase enzyme system (i.e. phytoplankton, snails, mussels). Naphthalene in the atmosphere reacts during daylight hours with hydroxyl radicals, and during nighttime hours with nitrate radicals. Photolysis is also expected in the atmosphere [3].

HUMAN TOXICITY

General. The breakdown of red blood cells is the primary health concern for humans exposed to naphthalene. Human deaths following ingestion have occurred [1]. The USEPA has placed naphthalene in weight-of-evidence Group D, indicating that it is not classifiable as to human carcinogenicity [6]. The USEPA does not currently provide any toxicity values for 2-methylnaphthalene [7,8].

Oral Exposure. Both the chronic and subchronic RfDs for naphthalene of 0.04 mg/kg/day are based on a NOEL of 50 mg/kg/day for decreased body weight observed in a subchronic oral (gavage) study in rats [7]. Clinical evidence indicates that naphthalene is absorbed by humans in significant quantities via the oral route. The oral LD_{50} reported for naphthalene in rats ranges from 2,200 to 2,400 mg/kg in rats [1]. The oral LD_{50} reported for 2-methylnaphthalene in rats is 1,630 mg/kg [5]. Lethal doses of naphthalene in humans have ranged from as low as 74 mg/kg to as high as 574 mg/kg [1,8]. Ocular damage has been documented in humans and animals following oral exposure [1]. Symptoms of intoxication include: nausea, vomiting, headache, diaphoresis, hematuria, hemolytic anemia, fever, central nervous system depression, hepatic necrosis, jaundice, convulsions, and coma [1,2,9]. Administration of 300 mg/kg/day to pregnant mice resulted in a decrease in the number of live pups per litter [1].

Inhalation Exposure. An inhalation RfC was not reported for naphthalene [6,7]. Clinical reports suggest that inhaled naphthalene may be absorbed in sufficient quantity to produce adverse health effects in humans; however, no quantitative absorption data were located for humans or animals. One study, on rats, reported a NOAEL of 78 ppm for a 4-hour exposure. Symptoms and effects of inhalation exposure in humans include: headache, nausea, vomiting, abdominal pain, malaise, confusion, anemia, jaundice, and renal disease. No information was found regarding developmental and reproductive effects [1].

Dermal Exposure. Limited evidence in human infants indicated that hemolytic anemia may have resulted from dermal exposure to an unknown quantity of naphthalene. A NOAEL of 2,500 mg/kg was reported for rats. Naphthalene is a mild dermal and ocular irritant [1].

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POLYCHLORINATED BIPHENYLS
(PCBS)

GENERAL

Polychlorinated biphenyls (PCBs) represent a class of chlorinated aromatic compounds which, until they were banned in 1979, had widespread industrial application because of their stability, inertness, excellent dielectric properties, and excellent solvent characteristics [1]. There are 209 possible PCB congeners when biphenyl is chlorinated. Monsanto Corporation marketed mixtures of PCBs under the trade name Aroclor. The Aroclors are identified by a four-digit numbering code in which the first two digits indicate biphenyl (12 carbon atoms), and the last two digits indicate the average chlorine content by weight percent. For example, Aroclor 1260 has an average chlorine content of 60%. An exception to this system is Aroclor 1016, with an average chlorine content of 41% [2]. Given their extensive past usage history, PCBs may be expected to be found throughout the environment. This profile addresses four Aroclors and PCBs collectively, as listed below.

CAS NUMBERS

Aroclor 1242	53469-21-9
Aroclor 1248	12672-29-6
Aroclor 1254	11097-69-1
Aroclor 1260	11096-82-5
PCBs	1336-36-3

COMMON SYNONYMS

PCBs, Aroclors

ANALYTICAL CLASSIFICATION

Semivolatile organic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: 6.00×10^{-3} to 2.40×10^{-1} mg/L at 24 to 25°C [3]
Vapor Pressure: 7.71×10^{-5} to 4.06×10^{-4} mm Hg at 25°C [3]
Henry's Law Constant: 5.60×10^{-4} to 2.70×10^{-3} atm-m^3/mole [3]
Specific Gravity: 1.38 to 1.62 at 25°C [2]
Organic Carbon Partition Coefficient: 5.13×10^{3} to 2.63×10^{6} [3]

FATE DATA: HALF-LIVES

Soil: 6 to > 365 days [1]
Air: 2 days to 4.7 years [1]
Surface Water: 9.5 hours to > 365 days [1]
Groundwater: persistent

NATURAL SOURCES

None noted.

ARTIFICIAL SOURCES

Electrical transformers; dielectric fluids; solvents.

FATE AND TRANSPORT

As a class of compounds, polychlorinated biphenyls exhibit a tendency to sorb strongly to soils and suspended solids/sediments in waters. PCB releases to the environment, then, will be expected to show very limited mobility and present only a slight danger of leaching to unprotected groundwaters. There is a wide distribution of a variety of microorganisms capable of degrading PCBs, mainly through dechlorination actions. The degradation rate/action of these microorganisms is lowered, however, as the number of chlorine ion substitutions on the biphenyl parent compound increases. In addition, biodegradation rates are slowed by the tight sorptive ability of PCBs, low ambient temperatures, low moisture content, extremes in pH, and available oxygen content (with no biodegradation evidenced under anaerobic conditions). The number of chlorine ion substitutions also affects volatilization and photoionization rates; as chlorine ion substitutions increase, so do these rates. PCBs volatilized to the atmosphere undergo two major modes of degradation: reaction with hydroxyl radicals and/or reaction with ozone. Reaction with hydroxyl radicals (resulting in substitution of OH^- for Cl^- on the biphenyl parent compounds) is the more important of these two processes. Hydrolysis and/or oxidative reactions are not considered to be important fate processes for PCBs. Generally, PCBs having a higher chlorine content exhibit greater persistency in the environment than do PCBs with lower chlorine content. Bioconcentration of PCBs in aquatic organisms is expected to be an important process for all PCBs, and shows an increase as the chlorine content increases [1].

HUMAN TOXICITY

General. PCBs are known to cause skin irritations, such as acne and rashes, in humans. Young children of women who ate foods containing high levels of PCBs, such as fish, before and during their pregnancies may experience learning difficulties. Consumption of contaminated food is presumed to be the major route of exposure for the general population

[2]. The USEPA has placed PCBs in weight-of-evidence Group B2, indicating that they are probable human carcinogens [4].

Oral Exposure. The USEPA does not currently provide an oral RfD for PCBs [4,5]. PCBs are readily absorbed by humans via the oral route. Absorption in rats reportedly ranges from 75% to 90% of the administered dose. Single-dose LD_{50} values determined for rats ranged from 1,010 mg/kg for Aroclor 1254 to 4,250 mg/kg for Aroclor 1242 [2].

Numerous studies have been done on human children born to mothers who consumed large quantities of PCB-contaminated fish while pregnant. In one such study, the concentrations in the fish consumed ranged from 168 ppb to 3,012 ppb. Overall consumption of fish and levels of total PCBs in cord serum were positively correlated with lower birth weight, smaller head circumference, and shorter gestational age. By 7 months of age the infants with the highest levels of PCBs in cord serum scored significantly lower on neurobehavioral tests. By 4 years of age the children with the highest levels of PCBs in cord serum exhibited poorer performance on tests involving short-term memory [2].

Occupational studies have indicated possible PCB-related cancers of the liver, gastrointestinal tract, hematopoietic system, and skin [2]. An oral slope factor of 7.7 $(mg/kg/day)^{-1}$ is based on hepatocellular carcinomas observed in rodents [4].

Inhalation Exposure. The USEPA does not currently provide an inhalation RfC for PCBs [4,5]. Qualitative evidence exists that PCBs are absorbed via inhalation in humans and rats. NOAELs in rats, rabbits, guinea pigs, and mice exposed for up to 121 days ranged from 5.4 to 8.6 mg/m^3. A LOAEL of 1.5 mg/m^3 for liver and kidney degeneration was determined for rats exposed for 213 days. Upper respiratory tract and eye irritation, cough, and tightness of the chest were symptoms noted in humans exposed to 0.007 to 11 mg/m^3. Low birth weight and shortened gestational age has been correlated with occupational exposure of pregnant women to PCBs; however, confounding factors make these studies suspect [2]. The USEPA does not currently provide an inhalation slope factor or unit risk for PCBs [4,5].

Dermal Exposure. Hard data on dermal absorption of PCBs by humans and animals are lacking. Absorption efficiency in rhesus monkeys and guinea pigs ranged from about 15% to 34%. Median lethal doses for single dermal applications of PCBs to rabbits were as follows (mg/kg): <1,269 for Aroclors 1242 and 1248, <3,169 for Aroclors 1221 and 1262, and <2,000 for Aroclors 1232 and 1260. Liver and kidney damage were noted in rabbits treated dermally 5 days/week for up to 38 days with up to 44 mg/kg/day Aroclor 1260 [2].

ECOLOGICAL TOXICITY

General. Aroclor 1254 and Aroclor 1260 are the only two PCB cogeners of ecological concern at the OB Grounds. Therefore, this discussion is limited to these two compounds.

Environmental persistence of PCBs is determined by the degree of chlorination. Higher chlorobiphenyls, i.e., those with five or more chlorine atoms, are more persistent in the environment than those with three or fewer chlorine atoms. Aroclor 1254 has five chlorine atoms per moleclue, and Aroclor 1260 has six or more, making them among the most stable compounds in this chemical class [6].

Since 1979, the manufacture, processing, distribution, and use of PCB's has been banned in the United States [6]. However, because these chemicals are so stable, the major source of Aroclor 1254 and Aroclor 1260 release to the environment is an enviromental cycling process of these compounds previously introduced into the environment. The cycle involves volatilization from water and soil into the atmosphere with subsequent removal from the atmosphere via wet or dry deposition, followed by revolatilization [7]. Although biodegradation of Aroclor 1254 and Arolclor 1260 may occur very slowly in the environment, no other degradation mechanisms have been shown to be important in natural systems. Therefore, biodegradation may be the ultimate fate process [7].

PCBs have a significant environmental toxicity to invertebrates, fish, birds, and mammals. PCB toxicity is further enhanced by their ability to bioaccumulate and biomagnify in the food chain [6]. Their persistence in the environment, their ability to bioconcentrate in almost all classes of biota, and their ability to bioconcentrate and biomagnify through the food chain make PCBs a potentially significant hazard to fish, wildlife, and invertebrate resources [6].

Vegetation. CH2M Hill [8] summarized data that show that PCBs are not very toxic to terrestrial plants. Beets grown in soils with PCBs at a concentration of 100 mg/kg (dry weight) had no significant reduction in growth, while a significant reduction in growth of corn was noted at this concentration. Ostrich ferns growing on sediments with PCB residues of 26 mg/kg (mostly Aroclor 1254) showed five-fold increases in somatic mutations (genetic damage), but other plants in the contaminated area were not genetically damaged. While one source states that PCBs in the soil at concentrations of 100 mg/kg (dry weight) had no significant effect on growth of soybeans, another source identifies a 27 percent reduction in growth of soybean plants at this soil concentration and states that the NOEL is 2 to 3 mg/kg. Regardless, all of these values show low phytotoxicities for this class of compounds.

PCBs have been shown to bioconcentrate in both terrestrial and aquatic plants. Studies summarized in Eisler [6] showed dry-weight concentrations in foliage, grasses, aspen leaves, and goldenrod leaves of up to 0.29 ppm, 0.14 ppm, 0.12 ppm, and 0.32 ppm dry weight, respectively. Some of these values exceed the FDA limit of 0.2 ppm for PCBs in feeds for livestock [6]. Crop leaves (soybeans, string beans, and corn) grown on a contaminated site had PCB levels of 30 ppb to 50 ppb [7] BCFs of 10^4 to 10^5 were reported in various species of algae [6]. Although in-tissue concentrations of PCBs may not be toxic to the plants, they could be important as sources of PCBs in higher trophic levels.

Aquatic Life. The federal aquatic life criterion for PCBs for the chronic protection of freshwater aquatic life is 0.014 μg/L [9].

The chronic aquatic life standards derive in part from the toxicity of PCBs to aquatic invertebrates and fish. Studies show 96-hour LC_{50}s (acute toxicities) for freshwater invertebrates are usually between 50 μg/L and 800 μg/L. Most 96-hour LC_{50}s for warm water fish are between 100 μg/L and 600 μg/L [6,7,10,11]. Generally, an application factor of 0.01 is used to convert acute toxicities to criteria that provide for the chronic protection of aquatic life [10]. However, because of the extent to which PCBs bioaccumulate, more stringent criteria are appropriate [10].

A major concern to aquatic life is the bioconcentration of PCBs. Studies cited in virtually every summary article on PCBs showed concentration factors ranging from 10^3 to 10^5 in freshwater invertebrates and fish [6,7,10,11,12]. PCBs with the highest chlorination (which would include Aroclor 1254 and Aroclor 1260) were accumulated most readily [6]. This ability to bioaccumulate further enhances the toxicity of these compounds [6]. Diet contributes most of the total PCB body burdens of upper-level aquatic carnivores, with diet accounting for 90 percent of the total PCB body burden in brown trout and 51 to 83 percent in striped bass [6]. Elimination of accumulated PCBs is slow, with no elimination by codfish larvae after 12 days and 97.8 percent retention by chironomid (an invertebrate) larvae after 7 days [6].

Wildlife. Because of their ability to bioaccumulate, PCBs have been studied more extensively in wildlife than have most other chemicals. Studies summarized by Eisler [6] show that effects vary among PCB compounds. For example, tissues from cattle that had been dosed with Aroclor 1254 and fed to mink at levels as low as 0.64 ppm fresh weight of diet caused severe reproductive effects. However, Aroclors 1016 and 1221 at dietary concentrations of 2 ppm produced no adverse reproductive effects in mink over a 9-month period, nor did Aroclor 1242 at 5 ppm during a similar period.

Aroclor 1260 has relatively low oral toxicity, at least to rats. Micromedex, Inc. [7] cites several studies in which laboratory rats were fed Aroclor 1260 at concentrations of 100 ppm to 1,250 ppm in the diet for periods ranging from 2 months to 21 months. Although sublethal effects such as reduced reproductive success, liver tumors, and retarded growth were noted, these concentrations did not cause large-scale mortality.

Aroclor 1254 has been tested in a number of species of wildlife. LD_{50} data for dietary intake of Aroclor 1254 that were summarized in Eisler [6] and Micromedex, Inc. [7] are presented below.

Raccoon	>50 mg/kg, 8 days
Cottontail rabbit	>10 mg/kg, 12 weeks
Mink	4 mg/kg, no time given
Mink	6.7 mg/kg, 9 months
White-footed mouse	>100 mg/kg, 3 weeks
Norway rat	>75 mg/kg, 6 days
Mouse, PCB-resistant	>250 mg/kg, 18 weeks

Aroclor 1254 apparently is more toxic to rats than is Aroclor 1260. Rats fed Aroclor 1254 at the rate of 1,000 mg/kg in the diet all died in 53 days; mortality started at day 28 [6]. These and other feeding studies suggest that a total intake of about 500 to 2,000 mg of Aroclor 1254 per kg body weight is the lethal level in rats for dietary exposures of 1 to 7 weeks [6].

In the body, PCBs are accumulated primarily in the adipose tissue, skin, and liver [6,12]. More highly chlorinated congeners have longer half-lives, with a half-life of Aroclor 1260 in humans of 33 to 34 months [7].

Birds are generally more resistant to acutely toxic effects of PCBs than mammals [6]. Studies summarized in Eisler [6] and Micromedex Inc. [7] showed that mallards, ring-necked pheasants, bobwhite quail, and Japanese quail had 5-day LD_{50}s for ingestion of Aroclor 1254 and Aroclor 1260 ranging from 600 ppm to more than 2,000 ppm in the diet. Acute LD_{50}s for European starlings, red-winged blackbirds, and brown-headed cowbirds were all 1,500 mg/kg in the diet [6]. However, sublethal effects can occur at much lower concentrations. For example, 20 ppm in the diet of chickens caused a significant decrease both in the hatchability of eggs and in the viability of the surviving chicks [10]. Delayed reproduction and decreased numbers of eggs occurred in mourning doves fed 10 ppm Aroclor 1254 for 28 days [8].

Bioaccumulation also occurs in birds. Diet is an important route of PCB accumulation, with highest liver concentrations of PCBs in birds that fed on fish, followed by species that feed on small birds and mammals; and on worms and insects. Concentrations were lowest in herbivorous bird species [6]. In general, PCB accumulation is rapid and elimination is slow. For example, in common grackles, the biological half-life of Aroclor 1254 was calculated to be 89 days [6].

The Red Book [10] states, "Evidence is accumulating that PCBs do not contribute to shell thinning of bird eggs." However, this statement was contradicted by Prager [12] and Micromedex, Inc. [7], who indicate that PCBs cause eggshell thinning and reduced reproductive ability. Although Eisler [6] cited several PCB-related instances of eggshell thinning and associated reproductive failure in cormorants, peregrine falcons, bald eagles, and black-crowned night herons, he states, "At present, the evidence implicating PCBs as a major source of eggshell thinning is inconclusive."

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POLYCYCLIC AROMATIC HYDROCARBONS

GENERAL

Polycyclic aromatic hydrocarbons (PAHs) are a large group of chemicals formed during the incomplete combustion of organic materials. There are over one hundred PAHs, and they are found throughout the environment in air, water, and soil. Seven of the 15 PAHs addressed in this profile are classified as probable human carcinogens [1,2].

CAS NUMBERS

Acenaphthene	83-32-9	Chrysene	218-01-9
Acenaphthylene	208-96-8	Dibenzo(a,h)anthracene	53-70-3
Anthracene	120-12-7	Fluoranthene	206-44-0
Benzo(a)anthracene	56-55-3	Fluorene	86-73-7
Benzo(a)pyrene	50-32-8	Indeno(1,2,3-cd)pyrene	193-39-5
Benzo(b)fluoranthene	205-99-2	Phenanthrene	85-01-8
Benzo(g,h,i)perylene	191-24-2	Pyrene	129-00-00
Benzo(k)fluoranthene	207-08-9		

COMMON SYNONYMS

Polynuclear aromatic hydrocarbons, PNAs, PAHs.

ANALYTICAL CLASSIFICATION

Semivolatile organic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: insoluble to 3.93 mg/L [1]
Vapor Pressure: negligible to very low at 25°C [1]
Henry's Law Constant: 6.95×10^{-8} to 1.45×10^{-3} atm-m^3/mole [1]
Specific Gravity: approximately 0.9 to 1.4 at 0 to 27°C [1]
Organic Carbon Partition Coefficient (K_{oc}): 2.5×10^3 to 5.5×10^6 [1]

FATE DATA: HALF-LIVES

Soil: 12.3 days to 5.86 years [3]
Air: 0.191 hours to 2.8 days [3]
Surface Water: 0.37 hours to 1.78 years [3]
Groundwater: 24.6 days to 10.4 years [3]

NATURAL SOURCES

Volcanoes, forest fires, crude oil, and oil shale [1].

ARTIFICIAL SOURCES

Motor vehicles and other petroleum fuel engines, wood-burning stoves and fireplaces, furnaces, cigarette smoke, industrial smoke or soot, and charcoal-broiled foods [1].

FATE AND TRANSPORT

Because the physical and chemical properties of PAHs vary substantially depending on the specific compounds in question, the fate and transport characteristics vary. Thus, the following discussion is presented in very general terms. Some fate characteristics are roughly correlated with molecular weight; so the compounds are grouped as follows [1]:

- Low molecular weight: acenaphthene, acenaphthylene, anthracene, fluorene, and phenanthrene;
- Medium molecular weight: fluoranthene and pyrene; and
- High molecular weight: benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene.

PAHs are present in the atmosphere in the gaseous phase and sorbed to particulates. They may be transported great distances, and are subject to photodegradation as well as wet or dry deposition [1].

PAHs in surface water are removed by volatilization, binding to particulates and sediments, bioaccumulation, and sorption onto aquatic biota. The low molecular weight PAHs have Henry's Law constants in the range of 10^{-3} to 10^{-5} atm-m^3/mole, and would therefore be expected to undergo significant volatilization; medium molecular weight PAHs have constants in the 10^{-6} range; and high molecular weight PAHs have constants in the range of 10^{-5} to 10^{-8}. Half-lives for volatilization of benzo(a)anthracene and benzo(a)pyrene from water have been estimated to be greater than 100 hours. It has been reported that lower molecular weight PAHs could be substantially removed by volatilization under conditions of high temperature, shallow depth, and high wind. For example, anthracene was found to have a half-life for volatilization of 18 hours in a stream with moderate current and wind. In an estuary, volatilization and adsorption are the primary removal mechanisms for medium and high molecular weight PAHs, whereas volatilization and biodegradation are the major mechanisms for low molecular weight compounds. PAHs can bioaccumulate in plants and animals, but are subject to extensive metabolism by high-trophic-level consumers, indicating that biomagnification is not significant [1].

Potential mobility in soil is related to the organic carbon partition coefficient (K_{oc}). The low molecular weight PAHs have K_{oc} values in the range of 10^3 to 10^4, which indicates a moderate potential to be adsorbed to organic material. Medium molecular weight compounds have values on the order of 10^4, while high molecular weight compounds have values in the 10^5 to 10^6 range. The latter compounds, then, have a much greater tendency to adsorb and resist movement through soil. Volatilization of the lower molecular weight compounds from soil may be substantial. However, some portion of PAHs in soil may be transported to groundwater, and then move laterally in the aquifer, depending on soil/water conditions [1].

HUMAN TOXICITY

General. Ingestion of, inhalation of, or dermal contact with PAHs by laboratory animals has been shown to produce tumors. Reports in humans show that individuals exposed by inhalation or dermal contact for long periods of time to mixtures of PAHs and other compounds can also develop cancer. However, the relationship of exposure to any individual PAH with the onset of cancer in humans is not clear [1]. The available slope factors are presented below. No other toxicity values were available [2,4].

Oral Exposure. Indirect evidence suggests that benzo(a)pyrene may not be readily absorbed following oral exposure in humans. On the other hand, absorption in rats appears to be rapid and efficient. Whether or not there is actually a significant difference between humans and rats in the capacity to absorb benzo(a)pyrene is questionable. It should be noted that the degree of uptake is highly dependent on the vehicle of administration. A NOAEL of 150 mg/kg/day was determined for gastrointestinal, hepatic, and renal effects in rats following acute oral exposure to benzo(a)pyrene or benzo(a)anthracene. LOAELs in the range of 40 to 160 mg/kg/day were determined for developmental and reproductive effects in mice following acute oral exposure to benzo(a)pyrene [1]. An oral slope factor of 7.3 $(mg/kg/day)^{-1}$ for benzo(a)pyrene is based on tumors detected in the forestomachs of rats and mice in various diet studies [2].

Inhalation Exposure. The USEPA does not currently provide inhalation RfCs for any of the PAHs [2,4]. Pure PAH aerosols appear to be well absorbed from the lungs of animals. However, PAHs adsorbed to various particles appear to be poorly absorbed, if at all. The latter are most likely to be removed from the lungs by mucociliary clearance and subsequent ingestion. Lung cancer in humans has been strongly associated with long-term inhalation of coke-oven emissions, roofing-tar emissions, and cigarette smoke, all of which contain mixtures of carcinogenic PAHs. It has been estimated that the 8-hour time-weighted average exposure to PAHs in older coke plants was approximately 22 to 33 mg/m^3 [1]. An inhalation slope factor of 6.1 $(mg/kg/day)^{-1}$ for benzo(a)pyrene is based on tumors detected in the respiratory tracts of hamsters in a chronic intermittent inhalation study [4].

Dermal Exposure. Limited *in vivo* evidence exists that PAHs are at least partially absorbed by human skin. An *in vitro* study with human skin indicated that 3% of an applied dose of benzo(a)pyrene was absorbed after 24 hours. Studies in mice indicated that at least 40% of an applied dose of benzo(a)pyrene was absorbed after 24 hours. The carcinogenic PAHs as a group cause various noncancerous skin disorders in humans and animals. Substances containing mixtures of PAHs have been linked to skin cancers in humans. Studies in laboratory animals have demonstrated the ability of benz(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene to induce skin tumors [1].

ECOLOGICAL TOXICITY

General. The molecular weight of the individual PAHs affects their mobility and solubility in the environment, with lower weight compounds generally being more volatile and soluble than higher weight compounds, which have strong sorption properties. In aquatic environments, PAH partitioning in sediments occurs in an equilibrium process, with a potential for localized occurrences of high levels of dissolved PAHs [5,6]. PAHs can bioaccumulate in plants and animals, but do not biomagnify in food chains. Inter- and intraspecies responses to carcinogenic PAHs are variable, and some PAHs tend to inhibit the carcinogenicity of other compounds in mammals [7]. A variety of adverse effects on aquatic and terrestrial animals has been observed.

Vegetation. Plants absorb PAHs from soils through their root systems, and can translocate them to above ground parts. Lower weight PAHs are absorbed more readily than other PAHs [7]. Airborne deposition of particulate PAHs, and the subsequent adsorption to the skins of fruits and vegetables, accounts for reported higher PAH concentrations in aboveground versus underground plant parts. Soil concentrations of benzo(a)pyrene typically may reach 1,000 mg/kg; concentrations for total PAHs typically exceed benzo(a)pyrene concentrations by at least one order of magnitude. PAH concentrations in vegetation typically range from 20 to 1,000 μg/kg [6]. Some plants biocentrate PAHs in their oily parts (e.g., seeds) above levels in surrounding soils, but this does not appear to be typical [6]. In limited studies on PAHs in plants, phytotoxic effects were rare; photosynthetic inhibition in algae has been documented [6,7]. Some vascular plants catabolize benzo(a)pyrene [6], and PAHs synthesized by plants may act as growth hormones [7,8]. Plants may serve as a pathway for exposure of higher-order consumers to toxic levels of PAHs.

Aquatic Life. Most PAHs in aquatic environments tend to sorb to sediments, and sediment-associated PAHs have accounted for up to 77 percent of the steady-state body burden in benthic amphipods [7]. Absorption and assimilation of PAHs vary widely among species and according to the specific compound. Crustaceans and fish appear better able to assimilate, metabolize, and eliminate PAHs than do molluscs and polychaetes [7,8]. Fish appeared to detoxify benzo(a)pyrene as quickly as it was absorbed in water-only exposures [9]. Little potential for biomagnification through aquatic food chains exists, and bioconcentration factors range widely. A 2- to 3-day exposure BCF of 485 was reported for anthracene in fathead minnows, and a 24-hour BCF of 12 was reported for benzo(a)pyrene in bluegill [7].

Toxic effects of PAHs in fish include liver, thyroid, gonad, and skin tumors. Phenanthene has an LC_{50} of 370 μg/L in grass shrimp, and benz(a)anthracene has an LC_{87} of 1,000 μg/L in bluegill [7]. In the Black River, Ohio, where sediment PAH levels were 10,000 times those in a control location, brown bullheads showed elevated concentrations of lower molecular weight PAHs in their livers and a higher incidence of liver tumors [5,7,8]. Dissolved fluorene introduced into pond waters resulted in reduced growth in bluegill at 0.12 mg/L, and in increased vulnerability to predation at 1.0 mg/L [7].

There are no promulgated federal aquatic life water quality criteria for any of the PAHs, though the USEPA has proposed a chronic criterion of 6.3 μg/L and an acute criterion of 30 μg/L for phenanthrene in fresh waters [10].

<u>Wildlife.</u> PAH toxicity studies in animals are mostly confined to laboratory experiments. Many PAHs can produce tumors in skin and epithelia tissues in all animal species tested, with malignancies induced by microgram acute exposures. Some carcinogenic PAHs can pass across skin, lungs, intestines, and placenta in mammals. Target organs are diverse, and the tissue affected is dependent on the compound and method of exposure. For example, dietary benzo(a)pyrene caused leukemia, lung adenoma, and stomach tumors in mice. Ancillary tissue damage may accompany carcinomas [7]. Selective effects based on age and gender of the receptor have also been observed [8,9,11,12]. Mammals do not tend to accumulate PAHs, which is likely due to the rapid metabolism of these compounds. For example, the biological half-life of benzo(a)pyrene in rat blood and liver was 5 to 10 minutes [7].

There is a scarcity of data on PAHs that are not carcinogenic [13]. Many chemicals, including other PAHs, modify the carcinogenic actions of PAHs in laboratory animals. Inhibitors of PAH-induced tumors include selenium, vitamins A and E, flavones, and ascorbic acid [7]. LD_{50} values also range widely: acute oral LD_{50} values for rodents range from 50 mg/kg body weight for benzo(a)pyrene to 700 mg/kg for phenanthrene, to 2,000 mg/kg for fluoranthene. Chronic oral carcinogenicity values for rodents include 40 mg/kg for benzo(b)fluoranthene, 72 mg/kg for benzo(k)fluoranthene, and 99 mg/kg for chrysene [7].

In a study on mallards, no mortality or visible toxic effects were observed over 7 months during which birds were fed diets containing 4,000 mg/kg PAHs, though heptatic changes were observed. Sax [9] reports that single oral doses of 250 ppm benzo(a)pyrene were not acutely toxic to ducks or chickens.

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SELENIUM

CAS NUMBER

7782-49-2

COMMON SYNONYMS

Vandex; CI77805; selenium base; selenium dust; colloidal selenium; selenium homopolymer [1].

ANALYTICAL CLASSIFICATION

Metal.

PHYSICAL AND CHEMICAL DATA

Water Solubility: Insoluble [1]
Vapor Pressure: Insignificant at 25°C [1]
Henry's Law Constant: Not Applicable
Specific Gravity: 4.81 at 20°C [2]
Organic Carbon Partition Coefficient: NA

BACKGROUND CONCENTRATIONS

Selenium is a naturally-occurring element. The concentration of selenium in minimally disturbed soils varies tremendously. A collection of 1,267 soil samples from across the conterminous U.S. determined that 80 percent were less than or equal to 0.5 ppm, with a geometric mean of 0.26 ppm, but with a maximum of 5 ppm [3].

FATE AND TRANSPORT

The behavior of selenium in the environment is dependent upon its oxidation state, and the behavior of the chemical compounds formed as a result of the differing oxidation states. In addition, the oxidation state of selenium in the environment is dependent upon a number of environmental factors, including pH, Eh, and biological activity, etc. For releases of selenium to soils, pH and Eh will be the primary determining factors for its fate and transport. Elemental and/or inorganic selenium may undergo microbial methylation (to dimethyl selenide and dimethyl deselenide), ultimately being volatilized to the atmosphere. Temperature, however, will moderate the methylation of selenium; reductions in temperature from 20°C to 4°C resulted in a methylation rate reduction of 90%. Acidic soil conditions favor the predominance of selenides. Selenides are insoluble and are expected to be immobile in the soils. Neutral to alkaline soil conditions favor the predominance of selenates. Selenates are expected to be very mobile in soils, given their high solubility and low sorption potential, and represent a potential for leaching to unprotected groundwaters. For water-soluble selenium compounds (i.e., selenates), terrestrial plant uptake represents a removal/transport mechanism of concern, but will be influenced by a variety of environmental factors (e.g., pH, soil type, reduction oxidation (redox) potentials, etc.) [1].

Selenium released to surface waters is expected to be found in the form of salts of selenic and selenious acids. Salts of selenic acid (such as sodium selenate) are generally found in aerobic, alkaline waters, and are expected to be highly mobile in the aquatic environment. Salts of selenious acid (selenite salts) are found in neutral to acidic waters, and show less environmental mobility than do selenate salts. Under acidic conditions, however, selenite is readily reduced to elemental selenium; selenate, as well, is converted to elemental selenium, but more slowly. Elemental selenium will be stable over a wide range of pH and redox conditions. Aquatic organisms, however, will convert selenium to selenoamino acids and, subsequently, methylated selenium compounds. Neither metabolic product is expected to exist long in the aquatic environment, with the methylated forms volatilizing rapidly to the atmosphere. Selenium in the aquatic environment has been demonstrated to bioaccumulate ($\log_{BAF} = 3.60$), bioconcentrate ($\log_{BCF} = 3.27$), and, potentially, biomagnify in aquatic organisms [1].

Atmospheric concentrations of selenium are generally found as inorganic compounds such as selenium dioxide and hydrogen selenide, and organic compounds such as dimethyl selenide and dimethyl diselenide. Dry and/or wet deposition of selenium compounds is expected to account for some removal of these materials from the atmosphere [1].

HUMAN TOXICITY

General. Selenium is considered an essential element. Toxic effects may occur, however, when too much selenium is taken into the body. The major target of selenium toxicity is the lungs, with the heart, liver and kidneys also being affected. Selenium is considered to be genotoxic [1]. The USEPA placed selenium in weight-of-evidence cancer Group D, indicating that it is not classifiable as to human carcinogenicity [4].

Oral Exposure. A chronic oral RfD of 0.005 mg/kg/day is based on a NOAEL of 0.015 mg/kg/day for clinical selenosis in a human epidemiology study [4]. Selenium is readily absorbed following oral exposure. Acute oral LD_{50} values of 4.8 - 7 mg/kg in rats, 3.2 - 3.5 mg/kg in mice, 2.3 mg/kg in guinea pigs and 1.0 mg/kg in rabbits have been reported for selenium [1]. In humans, selenium exposure has resulted in death, but the fatal dose is not known. Following accidental ingestion of selenium, effects on the lungs (pulmonary edema, breathing difficulties), upset stomachs and muscular weakness have been noted. The dose resulting in these effects is not known. Symptoms reported in people who ingested selenium over a long period of time include loss of hair, loss of and poorly formed nails, problems with walking, reduced reflexes and some paralysis. These effects occurred at doses greater than or equal to 0.053 mg/kg/day [1]. Selenium has not been found to cause developmental effects in humans or mammals, but birth defects have been found in birds [1]. Most epidemiological studies indicate that selenium is not carcinogenic to humans. In fact, some animal studies suggest that oral selenium may inhibit cancer. An oral Slope Factor for cancer is not available for selenium [4].

Inhalation Exposure. A chronic inhalation RfC is not available for selenium [4]. Selenium is readily absorbed following inhalation exposure. Acute inhalation LC_{50} values in guinea pigs ranged from 1-12.7 mg/m^3 for 2 to 8 hours [1]. Inhaled selenium has not been reported to be fatal in humans. In both humans and animals, the respiratory system is the primary target of inhaled selenium because selenium is an irritant when it comes in contact with water. Short-term exposure to high concentrations of selenium (exact levels not known) results in pulmonary edema, bronchial spasms, symptoms of asphyxiation, and persistent bronchitis [1]. Neurological effects (headaches, dizziness, malaise) have also been noted following short-term inhalation of selenium. Occupational exposure to low concentrations (0.007-0.05 mg/m^3) has resulted in slight tracheobronchitis [1]. Information regarding the potential effects of inhaled selenium on reproduction and development are not available. Inhaled selenium has not been reported to cause cancer in humans or animals, therefore, an inhalation Unit Risk is not available [4].

Dermal Exposure. Contact dermatitis and skin rashes have been reported following both acute and chronic exposure to selenium [1]. This is due to the irritative properties of selenium. Other information regarding the toxicity of selenium following dermal exposure are not available.

ECOLOGICAL TOXICITY

General. Selenium is considered a non-essential trace element for most plants and a required trace element or micronutrient for most animals. Selenium has a comparatively short biological life in various species of organisms for which data are available: 10 days in pheasant; 13 days in voles; 15 days in ants; 28 days in leeches; and 64 days in earthworms [5]. Recent studies suggest that selenium biomagnifies in aquatic and terrestrial food chains. It usually magnifies from two to six times in aquatic food chains [6].

Vegetation. Selenium is readily absorbed in high quantities in some plants, apparently without injury. Selenium bioaccumulation is typically associated with arid and semi-arid soil regions of the western United States where selenium-containing geologic deposits are abundant and alkaline soils are common. Because soil parent materials are low in selenium most forage and grain crops would typically contain <0.05 ppm selenium in their tissues [7]. A suggested maximum concentration value of selenium in plants is given at 3 to 10 ppm to avoid animal health problems [8]. Selenium in soil is more soluble under alkaline conditions. Selenium accumulators can tolerate extremely high selenium concentrations without injury. The primary indication of selenium injury in nontolerant plants is growth inhibition. A symptom of selenium toxicity in grains is white chlorosis of some or all of the leaves [7].

Aquatic Life. Impacts of selenium in surface waters on aquatic animal species have been noted at concentrations of 0.8 mg/L [8]. The lowest concentration of selenium that results in the impairment of mature fish is 0.25 mg/L and selenium at 0.003 mg/L has harmful effects on fish fry [9]. Field and laboratory data suggest that selenium at concentrations greater than 0.002 to 0.005 mg/L can be bioconcentrated in food chains and cause toxicity and reproductive failure in fish [6]. Two- to 4-day LC_{50}s for fish range from 2.0 to 80.0 mg/L [10]. Selenium toxicity of fathead minnows has LC_{50} values of 0.37 to 1.0 mg/L and at 20 mg/L 100 percent mortality occurred [8]. The 48-day LC_{50} for bluegill larvae was 0.4 mg/L at a water hardness of 330 mg/L [6], whereas 100 percent mortality of juvenile bluegills was achieved with a dietary exposure equivalent to 45 ppm selenium (hardness was 18 mg/L). The 96-hour LC_{50} for fathead minnow fry was 2.9 mg/L, and for bluegill juveniles was 40.0 mg/L [7]. Selenium accumulation is affected by water temperature, age of organism, organ or tissue specificity, mode of administration, and other factors [5]. It is noteworthy that selenium in the diet is known to exert a protective influence against mercury poisoning [11]. The federal aquatic life chronic freshwater quality criterion are 5.0 μg/L for warmwater and modified warmwater habitats [12].

Wildlife. Selenium protects mammals and some birds against the toxic affects of mercury, cadmium, arsenic, thallium, and the herbicide paraquat [5]. There is a danger of selenium toxicity in the diets of terrestrial animals at concentrations in excess of 5 ppm [8]. In terrestrial systems, Byers [13] suggested 4 ppm (dry weight) of selenium in plants as a tolerance limit for animals that consume them and reported 5 ppm to be potentially dangerous. Lemly and Smith [6] suggested that environmental exposures to waterfowl from water, diet, and sediments should not exceed 0.005 ppm in water and 3 ppm (dry weight) in food and sediments to protect waterfowl from reproductive failures and/or mortality through food chain biomagnification effects. Studies with adult mallards indicated that 100 ppm dietary selenium (as sodium selenite) was fatal within 1 month, but that survival was high at 25 ppm after 3 months. Poor egg hatchability was recorded at 25 ppm, but not at 10 ppm [5].

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TOLUENE

CAS NUMBER

108-43-2

COMMON SYNONYMS

Methylbenzene.

ANALYTICAL CLASSIFICATION

Volatile organic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: 534.8 mg/L at 25°C [1]
Vapor Pressure: 28.4 mm Hg at 25°C [1]
Henry's Law Constant: 5.94×10^{-3} atm-m^3/mole [1]
Specific Gravity: 0.866 at 20/4°C [2]
Organic Carbon Partition Coefficient: 37 to 178 [1]

FATE DATA: HALF-LIVES

Soil: 4 to 22 days [3]
Air: 10 hours to 4.3 days [3]
Surface Water: 4 to 22 days [3]
Groundwater: 1 to 4 weeks [3]

NATURAL SOURCES

Volcanoes, forest fires, and crude oil [1].

ARTIFICIAL SOURCES

Gasoline, fuel oils, automobile exhaust, chemical industry, paints and lacquers [1].

FATE AND TRANSPORT

Much of the toluene released to surface soil will be lost to volatilization. It is mobile in soils and will leach to groundwater. Biodegradation occurs slowly in soil and groundwater, but is inhibited by high concentrations. Under ideal conditions of low concentration and acclimated microbial populations, rapid biodegradation may occur. Losses from surface water occur due to volatilization and biodegradation. It will not significantly adsorb to sediment or bioconcentrate in aquatic organisms. In the atmosphere it will degrade or be washed out with rain [1].

HUMAN TOXICITY

General. Toluene acts primarily on the central nervous system [4]. The USEPA has placed toluene in weight-of-evidence Group D; that is, it is not classifiable as to human carcinogenicity [5].

Oral Exposure. A chronic RfD of 0.2 mg/kg/day is based on a NOAEL of 223 mg/kg/day for changes in liver and kidney weights in a subchronic oral study in rats. The LOAEL in this study was a dose of 446 mg/kg/day [5]. Toluene is absorbed more slowly from the gastrointestinal tract than from the lungs [6]. The acute oral LD_{50} for adult rats is in the range of 5,000 to 7,300 mg/kg [4,6]. Brain damage was noted in mice receiving 1,250 mg/kg/day by gavage for 13 weeks [6].

Inhalation Exposure. The RfC of 0.4 mg/m^3 is based on a LOAEL of 88 ppm for central nervous system effects observed in humans following inhalation exposure [7]. Toluene is rapidly absorbed following inhalation by humans and animals [6]. The inhalation LC_{50} in mice is 5,300 ppm for an 8-hour exposure. Exposure of humans by inhalation to 200 ppm for 8 hours produced mild fatigue, weakness, confusion, lacrimation, and tingling of the skin. At 600 ppm, additional effects included euphoria, headache, dizziness, dilated pupils, convulsions, and nausea. After 8 hours at 800 ppm, symptoms were more pronounced; effects included nervousness, muscular fatigue, and insomnia persisting for several days. Exposure to concentrations of 10,000 to 30,000 ppm could lead to narcosis and death. Chronic abusive inhalation of toluene vapors by humans produces central nervous system impairment and emotional and intellectual disturbances. Uptake in the various brain regions is widespread due to the high lipid solubility of toluene and the high lipid content of the brain. Effects on animals following high levels of exposure include hearing loss, kidney effects, and lung lesions. High level oral intake by animals has resulted in weight increases in the liver and kidney, and brain tissue damage [4].

Dermal Exposure. The absorption of toluene through human skin is slow, falling within the range of 14 to 23 mg/cm^2/hour. Dermal contact with toluene by humans may cause skin damage. Application of toluene to the eyes of rabbits reportedly resulted in moderately severe injury [6].

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XYLENES

CAS NUMBER

1330-20-7

COMMON SYNONYMS

Xylene.

Note: There are three isomers (forms) of xylene: ortho, meta, and para, also known as 1,2-, 1,3-, and 1,4-xylene, respectively.

ANALYTICAL CLASSIFICATION

Volatile organic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: 146 - 175 mg/L at 25°C [1]
Vapor Pressure: 6.6 - 8.7 mm Hg at 25°C [1]
Henry's Law Constant: 5.1×10^{-3} to 7.7×10^{-3} atm-m^3/mole [1]
Specific Gravity: 0.880 at 20/4°C (*o*-xylene) [2]
Organic Carbon Partition Coefficient: 25.4 - 204 [1]

FATE DATA: HALF-LIVES

Soil: 1 - 4 weeks [3]
Air: 2.6 hours - 1.8 days [3]
Surface Water: 1 - 4 weeks [3]
Groundwater: 2 weeks - 1 year [3]

NATURAL SOURCES

All three isomers of xylene occur in petroleum. 1,2-Xylene is found additionally in coal tar, forest fire products, and plants [1].

ARTIFICIAL SOURCES

Gasoline, fuel oils, and their combustion products. Petroleum refining, chemical industry; aerosols of paints, varnishes, and shellacs. Wood-burning stoves and fireplaces [1].

FATE AND TRANSPORT

Xylenes are moderately mobile in soil and may leach to groundwater where they are known to persist for several years despite evidence of biodegradation in both soil and groundwater. The dominant removal process in surface water is volatilization, but this is not a rapid process. Some adsorption to sediment will occur. Once released to the atmosphere, xylenes will undergo photochemical degradation at a moderate rate [1].

HUMAN TOXICITY

General. The primary target of xylenes toxicity is the central nervous system [4,5]. Xylenes are considered to be nongenotoxic. The USEPA has placed xylenes in weight-of-evidence cancer Group D, indicating that they are not classifiable as to human carcinogenicity [6].

Oral Exposure. A chronic oral RfD of 2 mg/kg/day is based on a NOAEL of 250 mg/kg/day for hyperactivity, decreased body weight and increased male mortality in a chronic study in rats [6]. Acute oral LD_{50} values for xylenes ranged from 3523 to 8600 mg/kg in rats and 5251 to 5627 mg/kg in mice [4,5]. Death in humans has been reported following the ingestion of xylenes, but the fatal dose is not known [4]. Reports of the ingestion of xylenes in humans are generally lacking. In animals, oral exposure to xylenes results in effects on the liver (increased liver enzymes and weight), the kidenys (increased kidney weight), and the nervous system (impairment of visual function, hyperactivity) [4]. Information is not available regarding the effects of ingested xylene on reproduction or development in humans, and the results of developmental studies in animals are inconclusive [4]. There is no conclusive evidence that oral exposure to xylenes causes cancer in humans or animals, therefore, an oral slope factor is not available [6].

Inhalation Exposure. An inhalation RfC for mixed xylenes is considered non-verifiable by the USEPA [7]. Xylenes are readily absorbed following inhalation exposure. Acute inhalation LC_{50} values of 6350 to 6700 ppm (4-hour exposure) were reported in rats for mixed xylenes [4]. LC_{50} values for the separate isomers are comparable to the mixture. Cause of death was usually respiratory failure and/or sudden ventricular fibrillation. In humans, inhalation of approximately 10,000 ppm xylenes has been fatal [4]. Exposure of humans to 90 ppm xylene has produced impairment of reaction time, manual coordination and body balance [5]. Brief exposure to concentrations of 200 ppm has caused irritation of the eyes, nose and throat. and exposure to concentrations above 200 ppm has resulted in nausea, vomiting, abdominal pain and loss of appetite [5]. Long-term high-level occupational exposure to xylenes ($>$ 200 ppm) has resulted in central nervous system effects, incoordination, nausea, vomiting, and abdominal pain [5]. Studies in laboratory animals suggest that xylenes have a relatively low chronic toxicity. Some data in animals suggest possible kidney and liver impairment with high level inhalation exposures ($>$1000 ppm) [5]. Information regarding the effects of xylenes on human reproduction and development are not available, but teratogenicity, fetotoxicity, and maternal toxicity have been observed in animals [4,5]. Xylenes have been found to cross the human placenta, therefore, there is sufficient reason for concern for pregnant women who are exposed to xylenes [4,5]. It is not known whether inhaled xylenes cause cancer in humans or animals, therefore, an inhalation unit risk is not available [6].

Dermal Exposure. Acute dermal LD_{50} values in rabbits of 14.1 ml/kg and greater than 5.0 ml/kg are reported for m-xylene and mixed xylenes, respectively [5]. Xylene is a skin irritant and causes redness, defatting and dryness. Vesicles may form following prolonged skin contact [4,5].

ECOLOGICAL TOXICITY

General. Xylenes are not a priority pollutant because they have low acute and chronic toxicity. Xylenes move through the soil/groundwater system when present at low concentrations, dissolved in water and adsorbed on soil, or as a separate organic phase resulting from a spill of significant quantities. Xylenes readily volatilize from water, are moderately adsorbed on soil, and have a moderate potential for bioccumulation [8]. No information on biomagnification of xylenes was available in the technical literature.

Vegetation. Nearly all xylenes (98.8 percent) are expected to be sorbed into the soil. For the portion of xylenes in the gaseous phase of soil (0.5 percent), diffusion through the soil/air pores up to the ground surface and removal by wind will be a significant loss pathway [8]. Review of the technical literature did not produce information regarding the phytotoxic effects of xylenes.

Aquatic Life. The half-life of xylenes in surface water has been calculated as 2.6 to 11.2 days [9]. Under normal environmental conditions, xylenes are not expected to undergo hydrolysis because they contain no hydrolyzable functional groups [8]. The LC_{50} value for freshwater fish was approximately 30 mg/L [9]. The 96-hour LC_{50} values for fathead minnows were 26.7 mg/L in soft water and 28.8 mg/L in hard water [10]. The 96-hour LC_{50} for bluegills was 20.9 mg/L in soft water [10]. There are no federal water quality standards established to protect aquatic life [11].

Wildlife. Xylenes are considered to be of low acute and chronic toxicity to birds and mammals [12]. No changes were found in rats, guinea pigs, dogs, and monkeys continuously exposed to 80 ppm for 127 days, nor in rats exposed to 700 ppm for 130 days [8]. Japanese quail showed no signs of toxicity at oral concentrations of 5,000 to 20,000 ppm (approximately 600 to 2,400 mg/kg body weight) [9]. Mallard eggs were immersed in xylene (10%) for 30 seconds and no significant effects on embryonic weight and length were observed when compared to controls [13]. Arthur D. Little, Inc. [8] reported an oral LD_{50} for rats at 4,300 mg/kg.

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ETHYLBENZENE

Ethylbenzene is a colorless liquid which occurs naturally in coal tar and petroleum. It has a gasoline odor which is detectable at 2 ppm. Ethylbenzene is also found in paints, ink, insecticides, gasoline, household cleaning supplies and tobacco products. (ref. 1) Ethylbenzene is used primarily as an intermediate in the manufacture of styrene (ref. 2).

Ethylbenzene is a common air contaminate in urban areas due to engine exhaust, burning of fossil fuels and industrial contamination. The average ethylbenzene air levels range from 0.01 ppb (parts per billion) in rural areas, 0.62 in the suburbs, and 0.66 ppb in the city. Levels as high as 20 ppb have been measured in some urban areas (ref. 1 and 3).

Exposure to ethylbenzene can occur via inhalation, ingestion of contaminated food or water and absorption through skin in contact directly with liquid ethylbenzene. The body can metabolize, and excrete, absorbed ethylbenzene within 48 hours of exposure. These metabolites, mandelic acid and phenylglyoxide acid, are excreted in the urine and serve as a good biological marker of ethylbenzene exposure (ref. 1 and 2). Currently these metabolites only confirm ethylbenzene exposure and do not correlate with actual health effects (ref. 1).

Acute low levels of ethylbenzene have reportedly caused eye, skin and respiratory irritation in humans. High doses can produce dizziness and CNS depression. There is limited data regarding the effects of chronic exposure to ethylbenzene. Animal studies suggest the potential of death from high level exposure, while there are no reports of fatal ethylbenzene exposure in humans (ref. 1).

Studies indicate adverse liver, kidney, CNS effects and blood changes in animals exposed to ethylbenzene. Animal studies also suggest teratogenic effects, which appear to be dose related. Animal data with regard to reproductive effects and carcinogenic potential are inconclusive (ref. 1).

The EPA has established oral and inhalation RfD's (reference doses) for ethylbenzene. The oral subchronic and chronic RfD's are 1E+0 (mg/kg-d) and 1E-1 (mg/kg-d). The inhalation subchronic, and chronic, RfC (reference concentration) is 1E+0 mg/cu. m. These values are based on liver, kidney and teratogenic effects in rodents (ref. 4).

References: (ethylbenzene)

1. Toxicological Profile for Ethylbenzene. Agency for Toxic Substances and Disease Registry U.S. Public Health Service.

2. LaDou, Joseph; Occupational Medicine. Appleton and Lange, East Norwalk, Connecticut, 1990.

3. Klassen, C.D., Amour, M.O., Doull, J. 1986. Cassarett and Doull's Toxicology the Basic Science of Poisons, Third Edition: MacMillin Publishing Co., New York.

4. U.S.E.P.A. 1991. Health Effects Assessment Summary Tables. Environmental Criteria and Assessment Office, Cincinnati, Ohio.

TRICHLOROFLUOROMETHANE:

Trichlorofluoromethane (freon 11) is a colorless liquid at temperatures below 23.7^{oC}. It is also odorless at concentrations below 20%. This compound is used as a propellant in aerosols, blowing agent in production of polyurethane foams and as an electrical insulation . Freon 11 is also used in refrigerants and in fire extinguishers (ref. 1).

Freons are severely cardiotoxic sensitizing the heart to arrhythmogenic effects at inhaled high doses. The cardiotoxicity may originate from irritation of the respiratory tract which in turn influences the heart rate even prior to complete absorption of the fluorocarbon. This compound also may be a CNS depressant (ref.1).

Populations at risk include those with cardiovascular disease and those with impaired pulmonary function. Exposure may exacerbate the symptoms (ref. 1).

The oral reference dose was based on a study with rats measuring mortality following gavage over 78 weeks. A LOEL of 488 mg/kg/day was determined and an uncertainty factor of 1000 was applied to determine the oral RfD. The EPA has established to oral RfD at 0.3 mg/kg/day. Currently, this compound has not been evaluated by the EPA for evidence of human carcinogenicity potential (ref. 2).

References:

1. Hazardous Substances Database, National Library of Medicine, 1994. TOMES, Micromedex, Inc.

2. Integrated Risk Information Systems, National Library of Medicine, 1994. TOMES, Micromedex, Inc.

DODECANE and UNDECANE

Both dodecane and undecane are aliphatic hydrocarbons. Dodecane is a colorless liquid used as a solvent (distillation chaser) in jet fuel research, and in the rubber and paper processing industry. Dodecane also serves as a chemical intermediate for oil additives (ref. 1). Undecane is a component of gasoline and used as a distillation chaser in petroleum research (ref. 1).

The toxicity of hydrocarbons is generally indirectly proportional to the agent's viscosity, with product's having high viscosity (150-250) such as heavy greases and oils considered to have only limited toxicity (ref. 2). Oral ingestion of hydrocarbons is often associated with symptoms of mucous membrane irritation, vomiting, and CNS depression (ref. 2). Direct aspiration of undecane into the lungs may cause chemical pneumonitis, pulmonary edema, and hemorrhaging (ref. 2).

Currently, there are no toxicity values for dodecane and undecane.

References:

1. Hazardous Substance Database, National Library of Medicine 1994. TOMES, Micromedex Inc.

2. Amdur, M.O., Doull, J., Klaassen, C.D., 1991. Cassarett and Doull's Toxicology: the Basic Science of Poisons, Fourth Edition: Pergamon Press, Inc., New York.

1,2,4-TRIMETHYLBENZENE

1,2,4-trimethylbenzene is a colorless liquid used as a solvent (fleet-x-dv-99) and paint thinner. It is also used in the manufacturing of dyes, perfumes, and resins (ref. 1).

In the solvent form, 1,2,4-trimethylbenzene is a primary skin irritant. Deposition into the lungs causes chemical pneumonitis at the site of contact. High concentrations of vapors (5000-9000 ppm) causes CNS depression. An incidence involving 27 persons who worked for a number of years with the solvent "fleet-x-dv-99" experienced nervousness, tension, anxiety, and asthmatic bronchitis (ref. 1).

Rats exposed to 1700 ppm for 10-21 days showed no adverse effects; however, rats exposed for 4 months showed signs of decreased weight gain, progressive lymphopenia and neutrophilia, and marked CNS depression (ref. 1).

Currently, there are no EPA toxicity values for this compound.

References:

1. Hazardous Substance Database, National Library of Medicine, 1994. TOMES, Micromedex Inc.

1,3,5-TRIMETHYLBENZENE:

1,3,5-trimethylbenzene (mestilyene) is a colorless liquid with a peculiar odor used in as a dyestuff intermediate, solvent, paint thinner and plastic stabilizer (ref 1).

1,3,5-trimethylbenzene is a primary skin irritant and deposition of the liquid into the lungs causes chemical pneumonitis at the site of contact. High concentrations of vapors (5000 to 9000 ppm) causes CNS depression. Workers exposed for years to the solvent "fleet-x-ov-99" at 10-60 ppm vapor concentration had symptoms of nervousness, tension, anxiety, and asthmatic bronchitis.

In animals subjected to acute lethal intoxication, death was preceded by CNS depression and respiratory failure. During a single continuous 24-hour exposure at 2400 ppm, 4 out of 16 rats died of respiratory failure. Rats exposed at 1700 ppm for 10-21 days showed no adverse effects; however, rats exposed for 4 months showed decreased weight gain and increase lymphopenia and neutrophilia. Marked CNS depression was also observed (ref 1).

Currently, there are no EPA toxicity values for this compound.

References:

1. Hazardous Substances Database, National Library of Medicine, 1994. TOMES, Micromedex Inc.

ANNEX E-4

CALCULATIONS OF INTAKE, HAZARD, AND RISK

1. The general equation for intake, hazard, and risk follows:

a. Oral Intake

$$\text{Oral Intake} = \frac{CS \times IR \times CF \times IA \times FI \times ED \times EF}{BW \times AT}$$

Where:

CS = Concentration of the Specific Chemical in the Soil (mg/Kg)
Intake = Contaminant intake (mg/Kg/day),
IR = ingestion rate (mg/day),
CF = Conversion Factor (10^{-6} Kg/mg),
IA = Intestinal Absorption Factor (unitless),
FI = Fraction Ingested from Contaminated Source (unitless),
ED = Exposure Duration (years),
EF = Exposure Frequency (days/year)
BW = Body Weight (Kg), and
AT = Averaging Time (Lifespan or exposure)(days).

b. Dermal Intake

$$\text{Dermal Intake} = \frac{CS \times DCR \times FI \times AF \times ED \times EF}{BW \times AT}$$

Where:

CS = Concentration of the Specific Chemical in the Soil (mg/Kg)
Intake = Contaminant intake (mg/Kg/day),
DCR = Dermal Contact Rate (Kg/day)(equals exposed skin area X soil adherence rate X 10^{-6}),
AF = Dermal Absorption Factor,
FI = Fraction Contacted from Contaminated Source
ED = Exposure Duration (years),
EF = Exposure Frequency (days/year)
BW = Body Weight (Kg), and
AT = Averaging Time (Lifespan or exposure)(days).

c. Hazard Quotient = Intake/Rfd

This is summed over all the contaminants one receptor is exposed to and will equal the hazard index.

Where:
Intake = Contaminant intake (mg/Kg/day),
Rfd = Reference Dose (mg/Kg/day)

d. Risk = Intake * q_1

Where:
Intake = Contaminant intake (mg/Kg/day),
q_1 = Cancer Slope Factor $(\text{mg/Kg/day})^{-1}$

2. Examples.

a. Oral Route

(1) Non-Carcinogenic Exposure

$$\text{Intake} = \frac{(\text{CS})480\ \text{mg/day}(50\ \text{days/yr})(25\ \text{yrs})10^{-6}}{(70\ \text{Kg})\ \ 7500\ \text{days}}$$

Intake (non-carc) = (CS) $1.14 \times 10^{-6}\ \text{day}^{-1}$

(2) Carcinogenic Exposure

$$\text{Intake} = \frac{(\text{CS})480\ \text{mg/day}(50\ \text{days/yr})(25\ \text{yrs})10^{-6}}{(70\ \text{Kg})\ 25550\ \text{days}}$$

Intake (carc) = (CS) $3.35 \times 10^{-7}\ \text{day}^{-1}$

b. Dermal Route (Metals).

(1) Non-Carcinogenic Exposure

$$\text{Intake} = \frac{(\text{CS})0.0043\ \text{Kg/day}(100\ \text{days/yr})1.0(25\ \text{yrs}).01}{(70\ \text{Kg})\ \ 7500\ \text{days}}$$

Intake (non-carc) = (CS) 2×10^{-7} day^{-1}

(2) Carcinogenic Exposure

$$\text{Intake} = \frac{(\text{CS})0.0043\ \text{kg/day}(100\ \text{days/yr})1.0(25\ \text{yrs}).01}{(70\ \text{Kg})\ \ 25550\ \text{days}}$$

Intake (carc) = (CS) 6×10^{-8} day^{-1}

TABLE E-4-1. CHEMICAL INTAKE VALUES BY CHEMICAL AND EXPOSURE ROUTE (NONCARCINOGENIC HAZARD)

Route	Chemical	Intake Values based on 95th UCL
Oral	Silver	7.1E-6 mg/kg/day
	Arsenic	6.4E-6 mg/kg/day
	Barium	5.4E-5 mg/kg/day
	Cadmium	2.0E-4 mg/kg/day
	Chromium	4.0E-5 mg/kg/day
	Mercury	7.6E-8 mg/kg/day
	Lead	5.2E-4 mg/kg/day
	Selenium	4.6E-7 mg/kg/day
	Ethylbenzene	3.8E-9 mg/kg/day
	Methylene Chloride	1.3E-8 mg/kg/day
	Toluene	1.2E-7 mg/kg/day
	1,2,4 Trimethylbenzene	3.2E-6 mg/kg/day
	1,3,5 Trimethylbenzene	7.8E-7 mg/kg/day
	O-xylene	3.4E-7 mg/kg/day
	M&P-xylene	6.8E-7 mg/kg/day
	Undecane	1.1E-6 mg/kg/day
	Dodecane	4.4E-9 mg/kg/day
	Trichlorofluoromethane	5.2E-9 mg/kg/day
	Naphthalene	6.0E-7 mg/kg/day
	2 Methylnaphthalene	9.4E-7 mg/kg/day
	Fluorene	6.5E-7 mg/kg/day
	Pyrene	8.3E-7 mg/kg/day
	Bis (2 Ethylhexyl) phthalate	8.8E-7 mg/kg/day
	Phenanthrene	6.5E-7 mg/kg/day
	Fluoranthene	1.2E-6 mg/kg/day
	Benzo(a)anthracene	7.9E-7 mg/kg/day
	Chrysene	8.6E-7 mg/kg/day
	Benzo(b)fluoranthene	9.4E-7 mg/kg/day
	Benzo(k)fluoranthene	9.1E-7 mg/kg/day
	Benzo(a)pyrene	8.5E-7 mg/kg/day
	Indeno 1,2,3(cd) pyrene	6.7E-7 mg/kg/day
	Dibenzo(ah)anthracene	4.3E-7 mg/kg/day
	Benzo(ghi)perylene	5.6E-7 mg/kg/day
	DDT	2.4E-8 mg/kg/day
	DDE	8.1E-9 mg/kg/day
	PCB Aroclor 1254	1.2E-5 mg/kg/day

TABLE E-4-1. CHEMICAL INTAKE VALUES BY CHEMICAL AND EXPOSURE ROUTE (NONCARCINOGENIC HAZARD) (Cont.)

Route	Chemical	Intake Values based on 95th UCL
Dermal	Cadmium	1.1E-3 mg/kg/day
	PCB Aroclor 1254	3.7E-5 mg/kg/day

TABLE E-4-2. CHEMICAL INTAKE VALUES BY CHEMICAL AND EXPOSURE ROUTE (CARCINOGENIC RISK)

Route	Chemical	Intake Values based on 95th UCL
Oral	Silver	2.1E-6 mg/kg/day
	Arsenic	1.9E-6 mg/kg/day
	Barium	1.5E-5 mg/kg/day
	Cadmium	5.8E-5 mg/kg/day
	Chromium	1.2E-5 mg/kg/day
	Mercury	2.2E-8 mg/kg/day
	Lead	1.5E-4 mg/kg/day
	Selenium	1.4E-7 mg/kg/day
	Ethylbenzene	1.1E-9 mg/kg/day
	Methylene Chloride	3.8E-9 mg/kg/day
	Toluene	3.4E-8 mg/kg/day
	1,2,4 Trimethylbenzene	9.3E-7 mg/kg/day
	1,3,5 Trimethylbenzene	2.3E-7 mg/kg/day
	O-xylene	1.0E-7 mg/kg/day
	M&P-xylene	2.0E-7 mg/kg/day
	Undecane	3.1E-7 mg/kg/day
	Dodecane	1.3E-9 mg/kg/day
	Trichlorofluoromethane	1.5E-9 mg/kg/day
	Naphthalene	1.8E-7 mg/kg/day
	2 Methylnaphthalene	2.8E-7 mg/kg/day
	Fluorene	1.9E-7 mg/kg/day
	Pyrene	2.4E-7 mg/kg/day
	Bis (2 Ethylhexyl) phthalate	2.6E-7 mg/kg/day
	Phenanthrene	1.9E-7 mg/kg/day
	Fluoranthene	3.4E-7 mg/kg/day
	Benzo(a)anthracene	2.3E-7 mg/kg/day
	Chrysene	2.5E-7 mg/kg/day
	Benzo(b)fluoranthene	2.8E-7 mg/kg/day
	Benzo(k)fluoranthene	2.7E-7 mg/kg/day
	Benzo(a)pyrene	2.5E-7 mg/kg/day
	Indeno 1,2,3(cd) pyrene	2.0E-7 mg/kg/day
	Dibenzo(ah)anthracene	1.3E-7 mg/kg/day
	Benzo(ghi)perylene	1.7E-7 mg/kg/day
	DDT	7.1E-9 mg/kg/day
	DDE	2.4E-9 mg/kg/day
	PCB Aroclor 1254	4.0E-6 mg/kg/day

TABLE E-4-2. CHEMICAL INTAKE VALUES BY CHEMICAL AND EXPOSURE ROUTE (CARCINOGENIC RISK) (Cont.)

Route	Chemical	Intake Values based on 95th UCL

Dermal	Cadmium	5.2E-5 mg/kg/day
	PCB Aroclor 1254	1.8E-6 mg/kg/day

TABLE E-4-3. SUMMARY OF TOXICOLOGICAL RISK ASSESSMENT DATA BY CHEMICAL

Chemical	Chronic Rfd	Slope Factor	EPA W.O.E*.
	Oral	Oral	
Silver	5E-3	NA	-
Arsenic	3E-4	1.75	A
Barium	7E-2	NA	-
Cadmium	5E-4	NA	B1
Chromium(+6)	5E-3	NA	A
Mercury	3E-4+	NA	D
Lead	UR	UR	B2
Selenium	5E-3	NA	D
Ethylbenzene	1E-1	NA	D
Methylene Chloride	6E-2	7.5E-3	B2
Toluene	2E-1	NA	D
1,2,4 Trimethylbenzene	5E-4	NA	-
1,3,5 Trimethylbenzene	4E-4	NA	-
O-xylene	2E-0+	NA	D
M&P-xylene	2E-0+	NA	D
Undecane	NA	NA	-
Dodecane	NA	NA	-
Trichlorofluoromethane	3E-1	NA	-
Naphthalene	4E-2	NA	D
2 Methylnaphthalene	NA	NA	-
Fluorene	4E-2	NA	D
Pyrene	3E-2	NA	D
Bis(2Ethylhexyl)phthalate	2E-2	1.4E-2	B2
Phenanthrene	NA	NA	D
Fluoranthene	4E-2	NA	D
Benzo(a)anthracene	NA	7.3E-1+	B2
Chrysene	NA	7.3E-3+	B2
Benzo(b)fluoranthene	NA	7.3E-1+	B2
Benzo(k)fluoranthene	NA	7.3E-2+	B2
Benzo(a)pyrene	NA	7.3E-0	B2
Indeno 1,2,3(cd) pyrene	NA	7.3E-1+	B2
Dibenzo(ah)anthracene	NA	7.3E-0	B2

See footnotes on page E-4-9.

TABLE E-4-3. SUMMARY OF TOXICOLOGICAL RISK ASSESSMENT DATA BY CHEMICAL (Cont.)

Chemical	Chronic Rfd	Slope Factor	EPA W.O.E*.
	Oral	Oral	
Benzo(ghi)perylene	NA	NA+	D
DDT	5E-4	3.4E-1	B2
DDE	NA	3.4E-1	B2
PCB Aroclor 1254	7E-5	7.7E-0	B2

UR - Under Review by the EPA, no current values available
NA - Not Applicable
* W.O.E. - EPA's Weight of Evidence notation
References:
1. USEPA Integrated Risk Information System (IRIS). On line data base.
2. USEPA Health Effects Assessment Summary Tables (HEAST). 1991.

+ Source is Health Effects Assessment Summary Tables (HEAST), all others are USEPA Integrated Risk Information System (IRIS).

TABLE E-4-4. CARCINOGENIC RISK AND HAZARD QUOTIENT VALUES BY CHEMICAL AND EXPOSURE ROUTE (Chemicals exhibiting no hazard quotient or risk were omitted from this table.)

Route	Chemical	Hazard Quotient	Carcinogen Risk
Oral			
	Silver	1.4E-3	
	Arsenic	2.1E-2	3E-6
	Barium	7.5E-4	
	Cadmium	4.0E-1	
	Chromium	8.0E-3	
	Mercury	2.5E-4	
	Selenium	9.3E-5	
	Ethylbenzene	1.1E-7	
	Methylene Chloride	6.4E-7	3E-11
	Toluene	1.7E-6	
	1,2,4 Trimethylbenzene	6.3E-3	
	1,3,5 Trimethylbenzene	1.9E-9	
	O-xylene	5.1E-7	
	M&P-xylene	1.0E-6	
	Trichlorofluoromethane	5.2E-8	
	Naphthalene	1.4E-5	
	Fluorene	1.6E-5	
	Pyrene	2.7E-5	
	Bis(2Ethylhexyl) phthalate	4.3E-5	4E-8
	Fluoranthene	2.9E-5	
	Benzo(a)anthracene		2E-7
	Chrysene		2E-9
	Benzo(b)fluoranthene		2E-7
	Benzo(k)fluoranthene		2E-8
	Benzo(a)pyrene		2E-7
	Indeno 1,2,3(cd) pyrene		1E-7
	Dibenzo(ah)anthracene		9E-7
	DDT	4.8E-5	2E-9
	DDE		8E-10
	PCB Aroclor 1254	1.7E-1	3E-5

Total Oral		6.0E-1	3E-5

TABLE E-4-4. CARCINOGENIC RISK AND HAZARD QUOTIENT VALUES BY CHEMICAL AND EXPOSURE ROUTE (Chemicals exhibiting no hazard quotient or risk were omitted from this table.) (Cont.)

Route	Chemical	Hazard Quotient	Carcinogen Risk

Dermal			
	Cadmium	7E-2	
	PCB Aroclor 1254	1.7E-1	2.7E-6

Total Dermal		2.4E-1	2.7E-6

Total		8.4E-1	3.3E-5

APPENDIX F

ANALYTICAL RESULTS - SOIL

TABLE F-1. CHEMICAL ANALYSIS RESULTS - SITE 1

Sample ID	1-1-0	1-1-.5	1-1D-0	1-1D-.5
Lab #	C6986	C6987	C6988	C6989
GENERAL PARAMETERS (mg/kg)				
TPH Method 418.1)	9000	1600	15000	2200
TOTAL METALS (mg/kg)				
Silver	2.4	1.4	1.8	1.6
Arsenic	2.2	1.8	2.8	1.2
Barium	41	31	54	28
Cadmium	17	8.7	6.1	0.56
Chromium	22	8.6	27	7.8
Mercury	0.13	0.22	0.12	<0.10
Lead	240	140	410	220
Selenium	<0.50	<0.50	<0.50	<0.50
ORGANIC COMPOUNDS				
<u>Volatile Organic Compounds</u> (mg/kg)				
Ethylbenzene	ND	0.54	ND	1.1
Methylene chloride	ND	ND	ND	ND
Toluene	1.4	1.0	1.7	1.3
1,2,4-Trimethylbenzene	12	7.6	28	12
1,3,5-Trimethylbenzene	9	3.2	14	3.6
O-Xylene	3.9	2.1	5.1	3.0
M&P Xylene	3.7	3.1	7.5	5.8
Undecane	11.9	21	14.1	14.5
Dodecane	ND	11.0	ND	6.2
Benzene	ND	ND	ND	ND
N-Propylbenzene	ND	ND	ND	1.3
Trichlorofluoromethane	ND	ND	ND	ND
Naphthalene	ND	ND	ND	ND
Isopropylbenzene	ND	ND	ND	ND
BTEX	9.0	6.7	14.3	11.2
<u>Semivolatile Organic Compounds</u> (mg/kg)				
Naphthalene	1.3	0.51	1.6	1.1
2-Methylnaphthalene	4.3	2.1	4.9	3.8
Acenaphthene	ND	ND	ND	ND
Fluorene	0.48	ND	0.56	ND
Pyrene	0.63	ND	0.61	ND
bis2-Ethylhexylphthalate)	1.5	0.58	4.9	ND
Phenanthrene	ND	ND	0.62	ND
Fluoranthene	ND	ND	ND	ND
Benzoa)anthracene	ND	ND	ND	ND
Chrysene	ND	ND	ND	ND
Benzob)fluoranthene	ND	ND	ND	ND
Benzok)fluoranthene	ND	ND	ND	ND
Benzoa)pyrene	ND	ND	ND	ND
Indenol,2,3-cd)pyrene	ND	ND	ND	ND
Dibenzoa,h)anthracene	ND	ND	ND	ND
Benzog,h,i)perylene	ND	ND	ND	ND
<u>Pesticides/PCBs</u> (mg/kg)				
p,p-DDE	<0.25	0.021	<0.05	0.034
Aroclor 1254	<2.5	0.10	<0.5	<0.1

TABLE F-1. CHEMICAL ANALYSIS RESULTS - SITE 1 (Cont.)

Sample ID Lab #	1-2-0 C6990	1-2-.5 C6991	1-3-0 C6992	1-3-.5 C6993
GENERAL PARAMETERS (mg/kg)				
TPH Method 418.1)	99	130	75	67
TOTAL METALS (mg/kg)				
Silver	<0.5	<0.5	0.7	<0.5
Arsenic	2.2	1.0	3.5	1.9
Barium	22	9.4	35	26
Cadmium	210	6.3	0.30	<0.25
Chromium	23	2.2	9.2	7.0
Mercury	<0.10	<0.10	<0.10	<0.10
Lead	280	160	11	10.3
Selenium	<0.50	<0.50	<0.50	<0.50
ORGANIC COMPOUNDS				
<u>Volatile Organic Compounds</u> (mg/kg)				
Ethylbenzene	ND	ND	ND	ND
Methylene chloride	ND	0.006	ND	ND
Toluene	ND	ND	ND	ND
1,2,4-Trimethylbenzene	ND	ND	ND	ND
1,3,5-Trimethylbenzene	ND	ND	ND	ND
O-Xylene	ND	ND	ND	ND
M&P Xylene	ND	0.006	ND	ND
Undecane	ND	ND	ND	ND
Dodecane	ND	ND	ND	ND
Benzene	ND	ND	ND	ND
n-Propylbenzene	ND	ND	ND	ND
Trichlorofluoromethane	ND	ND	ND	ND
Naphthalene	ND	ND	ND	ND
Isopropylbenzene	ND	ND	ND	ND
BTEX	ND	0.006	ND	ND
<u>Semivolatile Organic Compounds</u> (mg/kg)				
Naphthalene	ND	ND	ND	ND
2-Methylnaphthalene	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND
Pyrene	ND	ND	ND	0.59
bis2-Ethylhexyl-phthalate)	ND	ND	0.39	ND
Phenanthrene	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	0.45
Benzoa)anthracene	ND	ND	ND	0.86
Chrysene	ND	ND	ND	1.0
Benzob)fluoranthene	ND	ND	ND	1.3
Benzok)fluoranthene	ND	ND	ND	1.7
Benzoa)pyrene	ND	ND	0.38	2.8
Indeno1,2,3-cd)pyrene	ND	ND	ND	1.9
Dibenzoa,h)anthracene	ND	ND	ND	ND
Benzog,h,i)perylene	ND	ND	ND	1.5
<u>Pesticides/PCBs</u> (mg/kg)				
p,p-DDT	0.14	ND	ND	ND

TABLE F-1. CHEMICAL ANALYSIS RESULTS - SITE 1 (Cont.)

Sample ID	1-4-0	1-4-.5	1-5-0	1-5-.5
Lab #	C6994	C6995	C6996	C6997
GENERAL PARAMETERS (mg/kg)				
TPH Method 418.1)	NA	NA	NA	NA
TOTAL METALS (mg/kg)				
Silver	<0.5	<0.5	<0.5	<0.5
Arsenic	0.75	<0.5	1.7	2.3
Barium	13	11	23	16
Cadmium	0.69	<0.25	0.54	<0.25
Chromium	6.5	4.5	14	17
Mercury	<0.10	<0.10	<0.10	<0.10
Lead	25	9.6	33	11
Selenium	<0.50	<0.50	<0.50	<0.50
ORGANIC COMPOUNDS				
<u>Volatile Organic Compounds</u> (mg/kg)				
Ethylbenzene	ND	ND	ND	ND
Methylene chloride	ND	ND	ND	ND
Toluene	ND	ND	ND	ND
1,2,4-Trimethylbenzene	ND	ND	ND	ND
1,3,5-Trimethylbenzene	ND	ND	ND	ND
O-Xylene	ND	ND	ND	ND
M&P Xylene	ND	ND	ND	ND
Undecane	ND	ND	ND	ND
Dodecane	ND	ND	ND	ND
Benzene	ND	ND	ND	ND
n-Propylbenzene	ND	ND	ND	ND
Trichlorofluoromethane	ND	ND	ND	ND
Naphthalene	ND	ND	ND	ND
Isopropylbenzene	ND	ND	ND	ND
BTEX	ND	ND	ND	ND
<u>Semivolatile Organic Compounds</u> (mg/kg)				
Naphthalene	ND	ND	ND	ND
2-Methylnaphthalene	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND
bis2-Ethylhexyl-phthalate)	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND
Benzoa)anthracene	ND	ND	ND	ND
Chrysene	ND	ND	ND	ND
Benzob)fluoranthene	ND	ND	ND	ND
Benzok)fluoranthene	ND	ND	ND	ND
Benzoa)pyrene	ND	ND	ND	ND
Indeno1,2,3-cd)pyrene	ND	ND	ND	ND
Dibenzoa,h)anthracene	ND	ND	ND	ND
Benzog,h,i)perylene	ND	ND	ND	ND
<u>Pesticides/PCBs</u> (mg/kg)				
p,p-DDT	0.040	ND	ND	ND
p,p-DDE	0.022	ND	ND	ND
Aroclor 1254	0.169	ND	0.295	ND

TABLE F-1. CHEMICAL ANALYSIS RESULTS - SITE 1 (Cont.)

Sample ID Lab #	1-6-0 C6998	1-6-.5 C6999	1-6D-0 C7000	1-6D-.5 C7001
GENERAL PARAMETERS (mg/kg)				
TPH Method 418.1)	NA	NA	NA	NA
TOTAL METALS (mg/kg)				
Silver	<0.5	<0.5	1.1	<0.5
Arsenic	0.85	1.2	1.1	4.5
Barium	25	21	21	17
Cadmium	0.40	<0.25	0.57	<0.25
Chromium	4.6	8.6	5.8	9.6
Mercury	<0.10	<0.10	<0.10	<0.10
Lead	54	7.6	80	22
Selenium	<0.50	<0.50	<0.50	0.60
ORGANIC COMPOUNDS				
<u>Volatile Organic Compounds</u> (mg/kg)				
Ethylbenzene	ND	ND	ND	ND
Methylene chloride	ND	ND	ND	ND
Toluene	ND	ND	ND	ND
1,2,4-Trimethylbenzene	ND	ND	ND	ND
1,3,5-Trimethylbenzene	ND	ND	ND	ND
O-Xylene	ND	ND	ND	ND
M&P Xylene	ND	ND	ND	ND
Undecane	ND	ND	ND	ND
Dodecane	ND	ND	ND	ND
Benzene	ND	ND	ND	ND
n-Propylbenzene	ND	ND	ND	ND
Trichlorofluoromethane	ND	ND	ND	ND
Naphthalene	ND	ND	ND	ND
Isopropylbenzene	ND	ND	ND	ND
BTEX	ND	ND	ND	ND
<u>Semivolatile Organic Compounds</u> (mg/kg)				
Naphthalene	ND	ND	ND	ND
2-Methylnaphthalene	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND
bis2-Ethylhexyl-phthalate)	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND
Benzoa)anthracene	ND	ND	ND	ND
Chrysene	ND	ND	ND	ND
Benzob)fluoranthene	ND	ND	ND	ND
Benzok)fluoranthene	ND	ND	ND	ND
Benzoa)pyrene	ND	ND	ND	ND
Indeno1,2,3-cd)pyrene	ND	ND	ND	ND
Dibenzoa,h)anthracene	ND	ND	ND	ND
Benzog,h,i)perylene	ND	ND	ND	ND
<u>Pesticides/PCBs</u> (mg/kg)				
p,p-DDT	ND	ND	ND	ND
p,p-DDE	ND	ND	ND	ND
Aroclor 1254	ND	ND	ND	ND

TABLE F-1. CHEMICAL ANALYSIS RESULTS - SITE 1 (Cont.)

Sample ID Lab #	1-7-0 C7002	1-7-.5 C7003	1-8-0 C7004	1-8-.5 C7005
GENERAL PARAMETERS (mg/kg)				
TPH Method 418.1)	NA	NA	NA	NA
TOTAL METALS (mg/kg)				
Silver	<0.5	<0.5	<0.5	<0.5
Arsenic	2.4	1.6	1.4	0.65
Barium	22	17	28	10
Cadmium	0.69	<0.25	1.4	<0.25
Chromium	8.8	4.8	11	14
Mercury	<0.10	<0.10	<0.10	<0.10
Lead	18	13.6	47	6.2
Selenium	<0.50	<0.50	<0.50	<0.50
ORGANIC COMPOUNDS				
Volatile Organic Compounds (mg/kg)				
Ethylbenzene	ND	ND	ND	ND
Methylene chloride	ND	ND	ND	ND
Toluene	ND	ND	ND	ND
1,2,4-Trimethylbenzene	ND	ND	ND	ND
1,3,5-Trimethylbenzene	ND	ND	ND	ND
O-Xylene	ND	ND	ND	ND
M&P Xylene	ND	ND	ND	ND
Undecane	ND	ND	ND	ND
Dodecane	ND	ND	ND	ND
Benzene	ND	ND	ND	ND
n-Propylbenzene	ND	ND	ND	ND
Trichlorofluoromethane	ND	ND	ND	ND
Naphthalene	ND	ND	ND	ND
Isopropylbenzene	ND	ND	ND	ND
BTEX	ND	ND	ND	ND
Semivolatile Organic Compounds (mg/kg)				
Naphthalene	ND	ND	ND	ND
2-Methylnaphthalene	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND
Pyrene	ND	ND	0.42	ND
bis2-Ethylhexyl-phthalate)	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND
Benzoa)anthracene	ND	ND	ND	ND
Chrysene	ND	ND	ND	ND
Benzob)fluoranthene	ND	ND	ND	ND
Benzok)fluoranthene	ND	ND	ND	ND
Benzoa)pyrene	ND	ND	ND	ND
Indeno1,2,3-cd)pyrene	ND	ND	ND	ND
Dibenzoa,h)anthracene	ND	ND	ND	ND
Benzog,h,i)perylene	ND	ND	ND	ND
Pesticides/PCBs (mg/kg)				
p,p-DDT	ND	ND	ND	ND
p,p-DDE	ND	ND	ND	ND
Aroclor 1254	0.113	ND	ND	ND

TABLE F-1. CHEMICAL ANALYSIS RESULTS - SITE 1 (Cont.)

Sample ID Lab #	1-9-0 C7006	1-9-.5 C7007	1-11-0 C7009	1-11-.5 C7010	1-10-0 C7008
GENERAL PARAMETERS (mg/kg)					
TPH Method 418.1)	NA	NA	NA	NA	NA
TOTAL METALS (mg/kg)					
Silver	<0.5	<0.5	0.85	<0.5	0.97
Arsenic	3.4	5.6	6.1	41	5.6
Barium	96	40	44	47	40
Cadmium	5.1	0.82	6.3	<0.25	0.82
Chromium	32	7.2	6.5	5.0	7.2
Mercury	<0.10	<0.10	<0.10	<0.10	<0.10
Lead	240	35	91	9.8	35
Selenium	<0.50	<0.50	0.60	1.2	<0.50
ORGANIC COMPOUNDS					
<u>Volatile Organic Compounds</u> (mg/kg)					
Ethylbenzene	ND	0.002	ND	0.010	ND
Methylene chloride	ND	0.011	0.020	0.031	0.009
Toluene	ND	0.004	ND	0.066	ND
1,2,4-Trimethylbenzene	ND	0.007	ND	0.11	ND
1,3,5-Trimethylbenzene	ND	ND	ND	0.049	ND
O-Xylene	ND	0.005	ND	0.024	ND
M&P Xylene	ND	0.010	ND	0.048	ND
Undecane	ND	ND	0.016	0.043	ND
Dodecane	ND	ND	0.014	ND	ND
Benzene	ND	ND	ND	0.045	ND
n-Propylbenzene	ND	ND	ND	0.085	ND
Trichlorofluoromethane	ND	ND	ND	0.030	ND
Naphthalene	ND	ND	ND	ND	ND
Isopropylbenzene	ND	ND	ND	ND	ND
BTEX	ND	0.021	ND	0.19	ND
<u>Semivolatile Organic Compounds</u> (mg/kg)					
Naphthalene	ND	ND	0.64	ND	ND
2-Methylnaphthalene	ND	ND	0.64	0.51	ND
Acenaphthene	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND
Pyrene	0.68	1.9	1.4	ND	1.3
bis2-Ethylhexyl-phthalate)	ND	ND	ND	ND	0.42
Phenanthrene	0.37	1.0	1.4	0.31	0.33
Fluoranthene	0.82	2.2	1.7	ND	1.6
Benzoa)anthracene	0.42	1.7	0.89	ND	1.3
Chrysene	0.50	1.8	1.0	ND	1.4
Benzob)fluoranthene	0.49	2.1	0.95	ND	1.9
Benzok)fluoranthene	0.49	1.9	0.95	ND	1.6
Benzoa)pyrene	0.44	2.0	0.81	ND	1.5
Indeno1,2,3-cd)pyrene	ND	1.0	ND	ND	0.77
Dibenzoa,h)anthracene	ND	0.44	ND	ND	ND
Benzog,h,i)perylene	ND	0.91	0.36	ND	0.73
<u>Pesticides/PCBs</u> (mg/kg)					
p,p-DDT	ND	ND	ND	ND	ND
p,p-DDE	ND	ND	ND	ND	ND
Aroclor 1254	1.23	0.54	0.82	ND	14.6

TABLE F-1. CHEMICAL ANALYSIS RESULTS - SITE 1 (Cont.)

Sample ID	1-12-0	1-12-.5	1-13-0	1-13-.5
Lab #	C7011	C7012	C7013	C7014
GENERAL PARAMETERS (mg/kg)				
TPH Method 418.1)	NA	NA	NA	NA
TOTAL METALS (mg/kg)				
Silver	19	<0.5	0.85	<0.5
Arsenic	7.9	13	6.3	42
Barium	49	44	43	60
Cadmium	85	2.7	1.3	1.2
Chromium	51	7.5	5.1	4.0
Mercury	0.10	<0.10	<0.10	<0.10
Lead	230	26	18	19
Selenium	0.60	0.80	0.90	1.1
ORGANIC COMPOUNDS				
<u>Volatile Organic Compounds</u> (mg/kg)				
Ethylbenzene	ND	0.008	0.009	0.011
Methylene chloride	0.029	0.023	0.033	0.034
Toluene	ND	0.020	0.018	0.040
1,2,4-Trimethylbenzene	ND	0.028	0.029	0.057
1,3,5-Trimethylbenzene	ND	0.016	0.016	0.031
O-Xylene	ND	0.015	0.017	0.026
M&P Xylene	0.006	0.035	0.041	0.054
Undecane	0.034	ND	ND	ND
Dodecane	ND	ND	ND	ND
Benzene	ND	0.006	ND	ND
n-Propylbenzene	ND	ND	ND	ND
Trichlorofluoromethane	0.009	0.023	0.014	0.035
Naphthalene	ND	ND	ND	0.010
Isopropylbenzene	ND	ND	ND	0.007
BTEX	0.006	0.084	0.085	0.13
<u>Semivolatile Organic Compounds</u> (mg/kg)				
Naphthalene	ND	ND	ND	0.26
2-Methylnaphthalene	ND	ND	0.58	0.66
Acenaphthene	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND
Pyrene	0.97	ND	ND	ND
bis2-Ethylhexyl-phthalate)	0.36	ND	ND	ND
Phenanthrene	0.86	ND	0.45	0.32
Fluoranthene	1.3	ND	ND	ND
Benzoa)anthracene	0.60	ND	ND	ND
Chrysene	0.85	ND	ND	ND
Benzob)fluoranthene	0.87	ND	ND	ND
Benzok)fluoranthene	0.76	ND	ND	ND
Benzoa)pyrene	0.81	ND	ND	ND
Indeno1,2,3-cd)pyrene	0.60	ND	ND	ND
Dibenzoa,h)anthracene	ND	ND	ND	ND
Benzog,h,i)perylene	0.58	ND	ND	ND
<u>Pesticides/PCBs</u> (mg/kg)				
p,p-DDT	ND	ND	ND	ND
p,p-DDE	ND	ND	ND	ND
Aroclor 1254	7.18	0.267	ND	ND

TABLE F-1. CHEMICAL ANALYSIS RESULTS - SITE 1 (Cont.)

Sample ID	1-14-0	1-14-.5	1-15-0	1-15-.5
Lab #	C7015	C7016	C7017	C7018
GENERAL PARAMETERS (mg/kg)				
TPH Method 418.1)	NA	NA	140	80
TOTAL METALS (mg/kg)				
Silver	13	<0.5	0.85	<0.5
Arsenic	6.8	0.84	1.4	1.4
Barium	16	15	25	13
Cadmium	0.66	<0.25	<0.25	<0.25
Chromium	4.1	1.8	3.6	2.8
Mercury	<0.10	<0.10	<0.10	<0.10
Lead	880	67	48	160
Selenium	<0.50	<0.50	<0.50	<0.50
ORGANIC COMPOUNDS				
<u>Volatile Organic Compounds</u> (mg/kg)				
Ethylbenzene	ND	ND	ND	ND
Methylene chloride	ND	ND	ND	ND
Toluene	ND	ND	ND	ND
1,2,4-Trimethylbenzene	0.006	0.011	0.007	0.009
1,3,5-Trimethylbenzene	ND	0.007	ND	ND
O-Xylene	ND	0.007	0.005	0.005
M&P Xylene	0.007	0.012	0.014	0.013
Undecane	ND	ND	ND	ND
Dodecane	ND	ND	ND	ND
Benzene	ND	ND	ND	ND
n-Propylbenzene	ND	ND	ND	ND
Trichlorofluoromethane	ND	ND	ND	ND
Naphthalene	ND	ND	ND	ND
Isopropylbenzene	ND	ND	ND	ND
BTEX	0.007	0.019	0.019	0.018
<u>Semivolatile Organic Compounds</u> (mg/kg)				
Naphthalene	ND	ND	ND	ND
2-Methylnaphthalene	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND
Fluorene	ND	ND	2.2	ND
Pyrene	ND	ND	ND	ND
bis2-Ethylhexylphthalate)	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND
Fluoranthene	ND	ND	1.7	ND
Benzoa)anthracene	ND	ND	1.5	ND
Chrysene	ND	ND	1.5	ND
Benzob)fluoranthene	ND	ND	1.6	ND
Benzok)fluoranthene	ND	ND	1.8	ND
Benzoa)pyrene	ND	ND	1.6	ND
Indeno1,2,3-cd)pyrene	ND	ND	1.8	ND
Dibenzoa,h)anthracene	ND	ND	0.60	ND
Benzog,h,i)perylene	ND	ND	0.98	ND
<u>Pesticides/PCBs</u> (mg/kg)				
p,p-DDT	ND	ND	ND	ND
p,p-DDE	ND	ND	ND	ND
Aroclor 1254	ND	ND	ND	ND

TABLE F-1. CHEMICAL ANALYSIS RESULTS - SITE 1 (Cont.)

Sample ID	1-15-4	1-15-8	1-17-4
Lab #	C7224	C7225	C7220
GENERAL PARAMETERS (mg/kg)			
TPH Method 418.1)	<10	<10	11
TPH Gas Range)	<2.0	<2.0	<2.0
BTEX	NA	NA	NA

Sample ID	1-17-8	1-18-5	1-18-10
Lab #	C7221	C7222	C7223
GENERAL PARAMETERS (mg/kg)			
TPH Method 418.1)	13	15	<10
TPH Gas Range)	<2.0	<2.0	<2.0
	NA	NA	NA

TABLE F-2. CHEMICAL ANALYSIS RESULTS - SITES 2-4

Sample ID	Lab#	TPH (418.1)	TPH (Gas Range)	BTEX
<u>Site 2</u>				
2-1-0	C6948	55	<2.0	<1.1
2-1-.5	C6949	29	<2.0	<1.1
2-1-3	C7226	<10	<2.0	NA
2-1-6	C7227	17	<2.0	NA
2-2-0	C6950	54	<2.0	<1.1
2-2D-0	C6951	250	<2.0	<1.1
2-2-.5	C6952	58	<2.0	<1.1
2-2D-.5	C6953	540	<2.0	<1.1
2-2-3	C7230	10	<2.0	NA
2-2-6	C7231	<10	<2.0	NA
2-3-0	C6954	48	<2.0	<1.1
2-3-.5	C6955	40	<2.0	<1.1
2-3-3	C7228	10	<2.0	NA
2-3-6	C7229	<10	<2.0	NA
2-4-0	C6956	52	<2.0	<1.1
2-4-.5	C6957	23	<2.0	<1.1
<u>Site 3</u>				
3-1-0	C6958	35	<2.0	<1.1
3-1D-0	C6959	37	<2.0	<1.1
3-1-.5	C6960	63	<2.0	<1.1
3-1D-.5	C6961	74	<2.0	<1.1
3-1-5	C7234	<10	<2.0	NA
3-1-10	C7235	<10	<2.0	NA
3-2-0	C6962	26	<2.0	<1.1
3-2-.5	C6963	54	<2.0	<1.1
3-2-3	C7238	16	<2.0	NA
3-2-6	C7239	<10	<2.0	NA
3-3-0	C6964	110	<2.0	<1.1
3-3-.5	C6965	17	<2.0	<1.1
3-3-3	C7236	<10	<2.0	NA
3-3-6	C7237	<10	<2.0	NA
3-4-0	C6966	120	<2.0	<1.1
3-4-.5	C6967	130	<2.0	<1.1
3-4-3	C7232	13	<2.0	NA
3-4-6	C7233	<10	<2.0	NA
<u>Site 4</u>				
4-1-0	C6968	120	<2.0	<1.1
4-1-.5	C6969	42	<2.0	<1.1
4-2-0	C6970	70	<2.0	<1.1
4-2D-0	C6971	18	<2.0	<1.1
4-3-0	C6972	77	<2.0	<1.1
4-4-0	C6973	47	<2.0*	<1.1*
4-5-0	C6974	58	<2.0*	<1.1*
4-6-0	C6975	69	<2.0	<1.1
4-7-0	C6976	60	<2.0*	<1.1*
4-8-3	C7242	10	<2.0	NA
4-8-6	C7243	<10	<2.0	NA
4-9-3	C7240	35	<2.0	NA
4-9-6	C7241	30	<2.0	NA

* Low surrogate recovery.
ND- Below detection limit.
NA- Not analyzed.

TABLE F-3. CHEMICAL ANALYSIS RESULTS - BACKGROUND SAMPLES

Sample ID Lab #	BG1-0 C7019	BG1-.5 C7020	BG2-0 C7021	BG2-.5 C7022
GENERAL PARAMETERS (mg/kg)				
TPH Method 418.1)	63	280	110	50
TPH-Gasoline Range	<2.0	<2.0	<2.0	<2.0
BTEX	<1.1	<1.1	<1.1	<1.1
TOTAL METALS (mg/kg)				
Silver	<0.50	<0.50	<0.50	<0.50
Arsenic	<0.50	<0.50	0.60	<0.50
Barium	9.9	6.6	6.2	13
Cadmium	<0.25	<0.25	<0.25	<0.25
Chromium	3.3	1.9	7.8	2.4
Mercury	<0.10	<0.10	<0.10	<0.10
Lead	12	2.8	160	6.3
Selenium	0.90	<0.50	1.1	<0.50
ORGANIC COMPOUNDS				
<u>Volatile Organic Compounds</u> (mg/kg)				
Ethylbenzene	ND	0.007	ND	ND
1,2,4-Trimethylbenzene	0.008	0.011	0.017	0.006
1,3,5-Trimethylbenzene	ND	0.006	0.008	ND
O-Xylene	0.008	0.014	0.007	0.007
M&P Xylene	0.019	0.035	0.020	0.016
BTEX	0.027	0.056	0.027	0.023
<u>Semivolatile Organic Compounds</u> (mg/kg)				
Pyrene	ND	ND	0.65	ND
Fluoranthene	ND	ND	0.59	ND
Benzoa)anthracene	ND	ND	0.34	ND
Chrysene	ND	ND	0.48	ND
Benzob)fluoranthene	ND	ND	0.47	ND
Benzok)fluoranthene	ND	ND	0.38	ND
Benzoa)pyrene	ND	ND	0.43	ND
Indeno1,2,3-cd)pyrene	ND	ND	0.41	ND
<u>Pesticides/Herbicides/PCBs</u> (mg/kg)				
p,p-DDT	ND	ND	ND	ND
p,p-DDE	ND	ND	0.05	ND
Aroclor 1254	ND	ND	ND	ND

Sample ID Lab #	BG3-0 C7024	BG3-.5 C7023
GENERAL PARAMETERS (mg/kg)		
TPH Method 418.1)	44	30
TPH-Gasoline Range	<2.0	<2.0
BTEX	<1.1	<1.1
TOTAL METALS (mg/kg)		
Silver	<0.50	<0.50
Arsenic	1.1	<0.50
Barium	31.4	39
Cadmium	<0.25	<0.25
Chromium	2.4	3.9

TABLE F-3. CHEMICAL ANALYSIS RESULTS - BACKGROUND SAMPLES (Cont.)

Sample ID Lab #	BG3-0 C7024	BG3-.5 C7023
TOTAL METALS (mg/kg) (Cont.)		
Mercury	<0.10	<0.10
Lead	72.4	39.0
Selenium	<0.50	<0.50
ORGANIC COMPOUNDS		
Volatile Organic Compounds (mg/kg)		
Ethylbenzene	ND	ND
1,2,4-Trimethylbenzene	ND	0.005
1,3,5-Trimethylbenzene	ND	ND
O-Xylene	ND	0.005
M&P Xylene	0.007	0.012
BTEX	0.007	0.017
Semivolatile Organic Compounds (mg/kg)		
Pyrene	ND	ND
Fluoranthene	ND	ND
Benzoa)anthracene	ND	ND
Chrysene	ND	ND
Benzob)fluoranthene	ND	ND
Benzok)fluoranthene	ND	ND
Benzoa)pyrene	ND	ND
Indeno1,2,3-cd)pyrene	ND	ND
Pesticides/Herbicides/PCBs (mg/kg)		
p,p-DDT	ND	ND
p,p-DDE	ND	ND
Aroclor 1254	ND	ND

APPENDIX G

STATISTICAL DATA
METAL CONCENTRATIONS IN SOIL

TABLE G-1.

Parameter*	Geo Mean	Geo STD	t-geo+	t-0.1
SURFACE SAMPLES, SITE 1				
Arsenic	2.55	0.335	1.225	1.330
Barium	31.6	0.217	2.728	
Cadmium	2.48	0.873	2.354	
Chromium	11.7	0.378	2.056	
Lead	87.5	0.534	0.670	
Mercury	0.108	0.094	0.641	
Selenium	0.51	0.066	-3.655	
Silver	0.99	0.490	1.003	
SUBSURFACE SOIL (0.5'-1.5'), SITE 1				
Arsenic	2.59	0.602	2.006	1.333
Barium	18.1	0.250	0.475	
Cadmium	0.55	0.480	1.218	
Chromium	5.9	0.268	2.200	
Lead	27.9	0.533	1.475	
Mercury	0.105	0.086	0.417	
Selenium	0.57	0.129	0.821	
Silver	0.59	0.161	0.779	

* All concentrations are in mg/kg.

\+ Parameter exceeds background if t-geo>t.10.

TABLE G-2.

Parameter*	Geo Mean	Geo STD
SURFACE BACKGROUND SAMPLES		
Arsenic	0.69	0.179
Barium	12.4	0.361
Cadmium	0.25	0.000
Chromium	4.0	0.255
Lead	51.8	0.574
Mercury	0.100	0.000
Selenium	0.79	0.179
Silver	0.50	0.000
SUBSURFACE BACKGROUND SAMPLES		
Arsenic	0.50	0.000
Barium	15.0	0.387
Cadmium	0.25	0.000
Chromium	2.6	0.158
Lead	8.8	0.583
Mercury	0.100	0.000
Selenium	0.50	0.000
Silver	0.50	0.000

* All concentrations are in mg/kg.

APPENDIX H

DRILLING LOGS

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

INSTALLATION Hunter AAF
PROJECT NUMBER 38-26-K2KZ-94
LOCATION Old PDO Yard
DATE 4 Jan 94
GEOLOGIST Fox, Butoryak
DRILLERS Spradlin, Kestner
BORE HOLE 1-15
WATER LEVEL 5.20 feet
DRILL RIG Geoprobe 5400

DEPTH (ft)	SAMPLE NUMBER	DESCRIPTION	REMARKS
5	1-15-4	Sand, fine to very fine grained, and silt light gray-brown	Faint fuel odor
	1-15-8	Same as above	No fuel odor
10		Bottom of Hole	
		Note: Screen implant set at 8.25 to 10.0 feet below ground surface	
15			

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

INSTALLATION Hunter AAF
PROJECT NUMBER 38-26-K2KZ-94
LOCATION Old PDO Yard
DATE 3 Jan 94
GEOLOGIST Fox, Butoryak
DRILLERS Spradlin, Kestner
BORE HOLE 1-16
DRILL RIG Geoprobe 5400
WATER LEVEL 9.35 feet

DEPTH (ft)	SAMPLE NUMBER	DESCRIPTION	REMARKS
0			
5	1-16-5	Sand, fine to very fine grained, and silt, mottled gray and red-brown	No fuel odor
10	1-16-10	Sand, very fine grained, light gray	No fuel odor
		— Bottom of Hole —	
15		Note: Screen implant set at 10.5 to 12.25 feet below ground surface	

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

INSTALLATION Hunter AAF
PROJECT NUMBER 38-26-K2KZ-94
LOCATION Old PDO Yark
DATE 4 Jan 94
GEOLOGIST Fox, Butoryak
DRILLERS Spradlin, Kestner
BORE HOLE 1-17
DRILL RIG Geoprobe 5400
WATER LEVEL 4.73 feet

DEPTH (ft)	SAMPLE NUMBER	DESCRIPTION	REMARKS
0			
	1-17-4	Sand, fine grained, silt, light brown	No fuel odor
5		Silt and clay	
	1-17-8	Sand, medium to very fine grained, light gray	No fuel odor
10		—— Bottom of Hole —— Note: Screen implant set at 8.25 to 10.0 feet below ground surface	
15			

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

INSTALLATION Hunter AAF
PROJECT NUMBER 38-26-K2KZ-94
LOCATION Old PDO Yard
DATE 4 Jan 94
GEOLOGIST Fox, Butoryak
DRILLERS Spradlin, Kestner
BORE HOLE 1-18
DRILL RIG Geoprobe 5400
WATER LEVEL 6.86 feet

DEPTH (ft)	SAMPLE NUMBER	DESCRIPTION	REMARKS
0			
5	1-18-5	Sand, fine to very fine grained, tan to light gray	No fuel odor
10	1-18-10	Same as above	No fuel odor
		Bottom of Hole	
		Note: Screen implant set at 8.25 to 10.0 feet below ground surface	

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

INSTALLATION Hunter AAF
PROJECT NUMBER 38-26-K2KZ-94
LOCATION Hanger 850
DATE 5 Jan 94
GEOLOGIST Fox, Butoryak
DRILLERS Spradlin, Kestner
BORE HOLE 2-1
DRILL RIG Geoprobe 5400
WATER LEVEL 7.52 feet

DEPTH (ft)	SAMPLE NUMBER	DESCRIPTION	REMARKS
0			
	2-1-3	Sand, fine to very fine grained, light gray-tan	Faint fuel odor
5			
	2-1-6	Same as above	Faint fuel odor
10		Bottom of Hole	Note: No fuel odor in ground water
		Note: Screen implant set at 8.25 to 10.0 feet below ground surface	

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

INSTALLATION Hunter AAF
PROJECT NUMBER 38-26-K2KZ-94
LOCATION Hanger 850
DRILL RIG Geoprobe 5400

DATE 5 Jan 94
GEOLOGIST Fox, Butoryak
DRILLERS Spradlin, Kestner
BORE HOLE 2-2
WATER LEVEL -

DEPTH (ft)	SAMPLE NUMBER	DESCRIPTION	REMARKS
0			
	2-2-3	Sand, fine to very fine grained, light gray-tan	No fuel odor
5			
	2-2-6	Same as above	No fuel odor
		Bottom of Hole	
10			

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

INSTALLATION Hunter AAF
PROJECT NUMBER 38-26-K2KZ-94
LOCATION Hanger 850
DRILL RIG Geoprobe 5400

DATE 5 Jan 94
GEOLOGIST Fox, Butoryak
DRILLERS Spradlin, Kestner
BORE HOLE 2-3
WATER LEVEL 8.01 feet

DEPTH (ft)	SAMPLE NUMBER	DESCRIPTION	REMARKS
0			
	2-3-3	Sand, fine to very fine grained, light gray-tan	No fuel odor
5			
	2-3-6	Same as above	No fuel odor
10		Bottom of Hole	
		Note: Screen implant set at 8.25 to 10.0 feet below ground surface	

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

INSTALLATION Hunter AAF
PROJECT NUMBER 38-26-K2KZ-94
LOCATION Hanger 860
DATE 4 Jan 94
GEOLOGIST Fox, Butoryak
DRILLERS Spradlin, Kestner
BORE HOLE 3-1
DRILL RIG Geoprobe 5400
WATER LEVEL 6.92 feet

DEPTH (ft)	SAMPLE NUMBER	DESCRIPTION	REMARKS
0			
5	3-1-5	Sand, fine grained, light gray	No fuel odor
10	3-1-10	Sand, fine to very fine grained, light gray-tan	
		Bottom of Hole	No fuel odor
		Note: Screen implant set at 8.25 to 10 feet below ground surface	
15			

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

INSTALLATION Hunter AAF
PROJECT NUMBER 38-26-K2KZ-94
LOCATION Hanger 860
DATE 5 Jan 94
GEOLOGIST Fox, Butoryak
DRILLERS Spradlin, Kestner
BORE HOLE 3-2
DRILL RIG Geoprobe 5400
WATER LEVEL -

DEPTH (ft)	SAMPLE NUMBER	DESCRIPTION	REMARKS
0		Sand, fine to very fine grained, tan	
	3-2-3	Sand, fine to very fine grained, light gray-tan	No fuel odor
5			
	3-2-6	Same as above	No fuel odor
		Bottom of Hole	
10			

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

INSTALLATION Hunter AAF
PROJECT NUMBER 38-26-K2KZ-94
LOCATION Hanger 860
DRILL RIG Geoprobe 5400

DATE 5 Jan 94
GEOLOGIST Fox, Butoryak
DRILLERS Spradlin, Kestner
BORE HOLE 3-3
WATER LEVEL 6.93 feet

DEPTH (ft)	SAMPLE NUMBER	DESCRIPTION	REMARKS
0			
		Sand, fine grained, light gray-tan	
	3-3-3		No fuel odor
5			
	3-3-6	Same as above	Faint fuel odor
10		Bottom of Hole	
		Note: Screen implant set at 8.25 to 10.0 feet below ground surface	Note: Faint fuel odor in purge ground water
15			

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

INSTALLATION Hunter AAF
PROJECT NUMBER 38-26-K2KZ-94
LOCATION Hanger 860
DATE 5 Jan 94
GEOLOGIST Fox, Butoryak
DRILLERS Spradlin, Kestner
BORE HOLE 3-4
DRILL RIG Geoprobe 5400
WATER LEVEL -

DEPTH (ft)	SAMPLE NUMBER	DESCRIPTION	REMARKS
0			
	3-4-3	Sand, very fine grained, light gray-tan	Faint fuel odor
5			
	3-4-6	Same as above	
		Bottom of Hole	
10			

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

INSTALLATION Hunter AAF
PROJECT NUMBER 38-26-K2KZ-94
LOCATION Hanger 860
DATE 5 Jan 94
GEOLOGIST Fox, Butoryak
DRILLERS Spradlin, Kestner
BORE HOLE 3-5
DRILL RIG Geoprobe 5400
WATER LEVEL 6.53 feet

DEPTH (ft)	SAMPLE NUMBER	DESCRIPTION	REMARKS
0		Sand, fine grained, light gray-tan	
5			
10		Bottom of Hole Note: Screen implant set at 8.25 to 10.0 feet below ground surface	
15			

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

INSTALLATION Hunter AAF
PROJECT NUMBER 38-26-K2KZ-94
LOCATION Consolidated Motor Pool
DRILL RIG Geoprobe 5400
DATE 6 Jan 94
GEOLOGIST Fox, Butoryak
DRILLERS Spradlin, Kestner
BORE HOLE 4-8
WATER LEVEL 3.77 feet

DEPTH (ft)	SAMPLE NUMBER	DESCRIPTION	REMARKS
0			
		Sand, coarse to fine grained, medium brown	
	4-8-3	Silt and sand, fine grained, dark brown	Organic odor
5			
	4-8-6	Same as above	Sewage odor
10		Bottom of Hole	
		Note: Screen implant set at 8.25 to 10.0 feet below ground surface	Note: Sewage odor in ground water

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

INSTALLATION Hunter AAF
PROJECT NUMBER 38-26-K2KZ-94
LOCATION Consolidated Motor Pool
DRILL RIG Geoprobe 5400

DATE 6 Jan 94
GEOLOGIST Fox, Butoryak
DRILLERS Spradlin, Kestner
BORE HOLE 4-9
WATER LEVEL -

DEPTH (ft)	SAMPLE NUMBER	DESCRIPTION	REMARKS
0		Asphalt	
		Gravel, road base	
	4-9-3	Sand, medium grained, trace fine gravel, medium gray-brown	Sewage odor
5			
			Sewage odor
	4-9-6	Same as above	
			Bottom of temporary screen set at 10’
10		Bottom of Hole	

APPENDIX I

ANALYTICAL RESULTS - GROUND WATER

TABLE I-1.

CHEMICAL ANALYSIS RESULTS - METALS AND NONMETALS

Old PDO Yard (Site 1)
Ground-Water Samples

Hunter Army Airfield
Project 38-26-K2KZ-94

Monitoring Point Number			1-15	1-16*	1-17	1-18
Sampling Date	MCL	SMCL	5 Jan 94	5 Jan 94	5 Jan 94	5 Jan 94
			Concentrations in µg/L			
DISSOLVED METALS						
Silver		100	<0.500	<0.500	<0.500	<0.500
Arsenic	50		<1.0	<1.0	<1.0	11.0
Barium	2000		97.5	42.8	27.4	30.4
Beryllium	4		<0.500	<0.500	0.700	<0.500
Cadmium	5		<0.500	<0.500	0.670	<0.500
Chromium	100		<0.500	<0.500	0.680	0.580
Copper		1000	<100	<100	<100	<100
Iron		300	142	412**	1,000**	11,400**
Mercury	2		<0.500	<0.500	<0.500	<0.500
Manganese		50	11	15	128**	24
Nickel	100		<0.500	14.4	24.0	34.1
Lead	15		0.545	16.9†	0.890	1.25
Antimony	6		9.4†	9.4†	<1.0	5.4
Selenium	50		1.4	<1.0	<1.0	<1.0
Thallium	2		<0.500	<0.500	<0.500	<0.500
Zinc		5,000	10.1	34.1	111	129
			Concentrations in mg/L			
NON-METALS						
Chloride		250	15	11	5.4	6.5
Cyanide	0.2		<0.01	<0.01	<0.01	<0.01
Nitrite + Nitrate as N	10.		0.06	<0.05	<0.05	0.17
Sulfate		250	25	4.2	77	39
Total Dissolved Solids		500	78	47	115	72

* Background screen implant
† Exceeds the MCL
** Exceeds the SMCL

TABLE I-2.

CHEMICAL ANALYSIS RESULTS - ORGANIC COMPOUNDS

Hunter Army Airfield
Project 38-26-K2KZ-94

Old PDO Yard (Site 1)
Ground-Water Samples

Monitoring Point Number Sampling Date	MCL	SMCL	1-15 5 Jan 94	1-16* 5 Jan 94	1-17 5 Jan 94	1-18 5 Jan 94
			Concentrations in µg/L			
Volatile Organic Compounds						
Trichloroethene	5	-	1(est)	<2	<2	<2
Tetrachloroethene	5	-	53†	3	1(est)	<2
No other target compound was detected. See Appendix for a list of analytes and detection limits.						
Semivolatile Organic Compounds						
Bis(2-ethylhexyl)phthalate**	-	-	30	61	99	62
No other target compound was detected. See Appendix C for a list of analytes and detection limits.						
Pesticides and PCB						
None of the pesticide or PCB compounds were detected. See Appendix C for a list of analytes and detection limits.						
TPH (EPA Method 418.1)			<1000	<1000	<1000	<1000
TPH (Modified California Method)			<100	<100	<100	<100

* Background screen implant
** Analyte was found in the associated blank as well as in the sample.
† Exceeds the MCL

TABLE. ACCREDITATION AND CERTIFICATIONS OF USAEHA

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1. American Industrial Hygiene Association.

2. American Association for Laboratory Accreditation (includes USAEHA-S and USAEHA-W).

3. National Institute of Standards and Technology/National Voluntary Laboratory Accreditation Program (NIST/NVLAP).

4. American Association for Accreditation of Laboratory Animal Care.

5. State of Maryland (supported by EPA for radiochemistry).

6. Certification by other states and EPA Regional Offices:

Alabama
California
Colorado
Delaware
Georgia
Idaho
Iowa
Kansas
Maine
Michigan
Kentucky

New Hampshire
North Dakota

Pennsylvania
Rhode Island
Rhode Island
Tennessee
Virginia
Washington
Maine
Michigan

EPA Region III
Philadelphia,
Pennsylvania

EPA Region V
Chicago, Illinois

EPA Region VI
Dallas, Texas

EPA Region VII
Kansas City, Missouri

7. Other Activities Coordinated.

a. Participation by the Toxicology Division in a Proficiency Testing Program of College of American Pathologists for blood and serum analyses.

b. Participation by WDED in NIST/NVLAP's Soil Measurement Proficiency Testing Program.

c. Participation by DLS in NIOSH Proficiency Testing Studies.

d. Participation by DLS in EPA Radiochemistry Intercomparison Studies.
