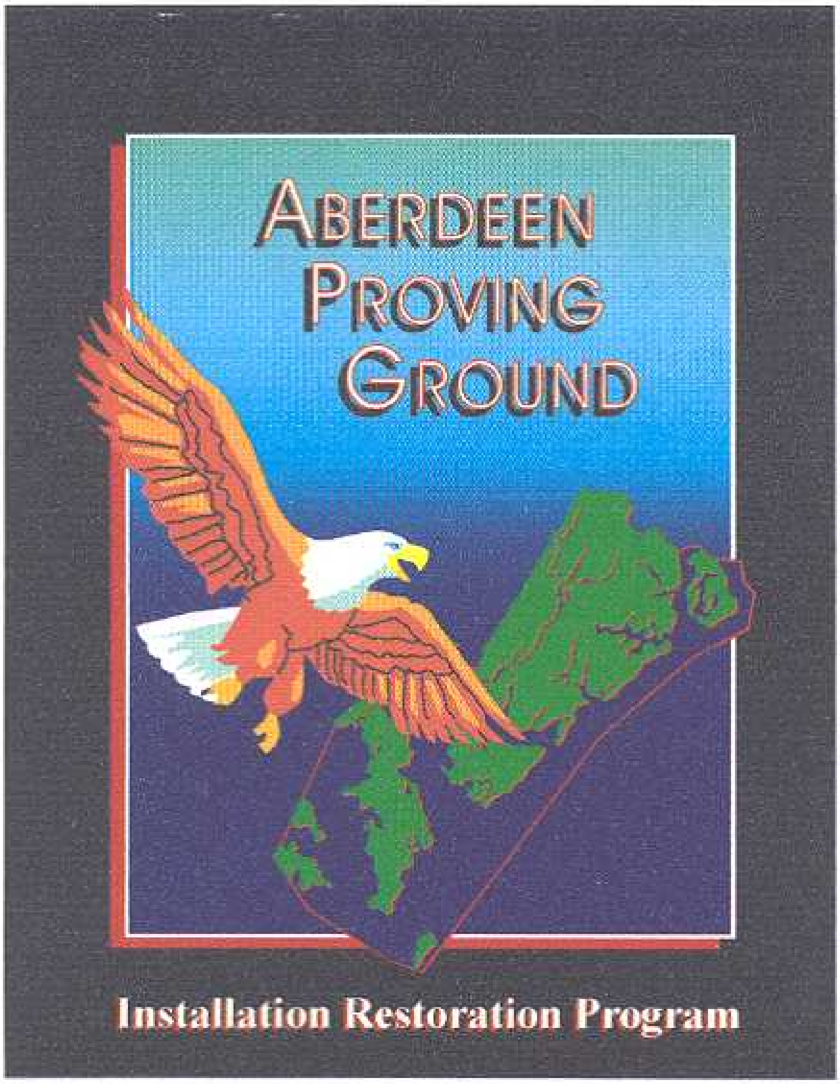

1997
PHYTOREMEDIATION STUDY
FINAL REPORT

ABERDEEN PROVING GROUND, MARYLAND
APRIL 1999

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THROUGH: Edward F. Gilardi, REAC Program Manager

FROM: Mark Finley, REAC Task Leader

SUBJECT: DOCUMENT TRANSMITTAL UNDER WORK ASSIGNMENT#3-173

Attached please find the following document prepared under this work assignment:

J-FIELD PHYTOREMEDIATION
1997 PHYTOREMEDIATION STUDY FINAL REPORT
ABERDEEN PROVING GROUND, EDGEWOOD, MARYLAND

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J-FIELD PHYTOREMEDIATION
1997 PHYTOREMEDIATION STUDY FINAL REPORT
ABERDEEN PROVING GROUND, EDGEWOOD, MARYLAND

Prepared by
Roy F. Weston, Inc.(WESTON)

April 1999

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1.0 INTRODUCTION

1.1 Site Background

The J-Field Phytoremediation site, hereafter referred to as J-Field, is located at the tip of the Gunpowder Neck, Edgewood Area of Aberdeen Proving Ground (APG) in Harford County, Maryland (Figure 1). The Toxic Pits area of J-Field was once the disposal site for chemical warfare agents, munitions, and industrial chemicals; this area consists of two parallel disposal pits that are approximately 10 feet deep by 15 feet wide by 200 feet long (Figure 2). Remnants of other pits extend into the marsh area to the east. All pits were used for open-pit burning and detonation from 1940 through 1980.

During open burning, wood was placed in one of the pits and the agents, munitions, and chemicals were placed on top. The pit was then flooded with fuel oil and ignited. After the first burn, a reburn of any remaining material was performed in the adjacent pit. Any remaining debris was then pushed into the marsh. The pits and surrounding land have been disturbed by the activities that took place on J-Field. The area to the northeast of the pits appears to be the main pushout area for the pits.

The materials handled at these pits included:

- High explosives
- Nerve agents
- Mustard agents
- Smoke materials
- Solvents

The contaminants of concern in the groundwater adjacent to the toxic pits are:

- 1,1,2,2-tetrachloroethane (1122)
- 1,1,1,2-tetrachloroethane (1112)
- 1,1,2-trichloroethane (TCA)
- trans-1,2-dichloroethene (t-DCE)
- cis-1,2-dichloroethene (c-DCE)
- trichloroethene (TCE)
- tetrachloroethene (PCE)

1.2 Study Background and Objectives

A pilot-scale phytoremediation study was implemented in the spring of 1996 as part of the remedial action selected for the site. One hundred eighty-three hybrid poplar (HP-510) trees (*Populus deltoides x trichocarpa*) were planted over approximately 1 acre of the site. This report presents phytoremediation monitoring data for the period February through October 1997. Well and lysimeter data for the same period can be found in the November 1997 *J-Field Phytoremediation Groundwater Well and Lysimeter Monitoring Report*. Background data can be found in the July 1997 *J-Field Phytoremediation Pilot Study Status Report Year 1.*

The objectives of the phytoremediation study are to examine whether or not the surficial aquifer in the area of the toxic pits can be intercepted and contained, and if volatile organic compounds (VOCs) in the groundwater and soil can be removed and/or destroyed through natural mechanisms. Other objectives of the study are to determine whether any aquifer drawdown occurs within the study area and the trees' zone of influence; to correlate findings from tree tissue and transpiration gas sampling with water quality data from the capillary fringe; and to determine the mechanisms responsible for VOC reduction.

These mechanisms include:

- Passive evaporation from groundwater through plant leaves without VOC degradation.
- Metabolism of VOCs in plant tissue leading to a release of degradation products through evapotranspiration.
- Incorporation, with or without modification, of VOC contaminants into plant tissue.
- Degradation of VOCs in soil by microbial populations. Root exudates may cause an increase in microbial populations in the rhizosphere.

These objectives will be met through field investigation involving the collection and analysis of plant tissue, roots, transpiration gas, soil, and groundwater contaminant concentration and elevation data over a five year period. The sap flow rate in trees will also be measured in an attempt to determine the volume of water being pumped by the trees. This report presents data from 1997 field investigations with results from seasonal sampling events in the spring (May), summer (July/August) and fall (September/October).

Possible outcomes of the pilot study are as follows:

A) Groundwater contamination remains the same or increases over time because:
  1) Trees are not reducing VOCs.
  2) Trees are reducing VOCs, but the contaminant source [soil or dense nonaqueous phase liquid (DNAPL)] is replenishing the groundwater.
  3) Trees are reducing VOCs at an undetectable rate.

B) Groundwater contamination decreases over time because:
  1) Trees are aiding in soil microbial biodegradation of VOCs in the rhizosphere.
  2) Trees are removing and metabolizing VOCs.
  3) Trees are removing and transpiring VOCs.
  4) Trees are removing and accumulating VOCs.

1.3 Monitor Well and Lysimeter Results

There are currently 14 wells and four lysimeters located near the phytoremediation area of J-Field. Five of the wells and the lysimeters were installed in the surficial aquifer near the phytoremediation study area to obtain additional data necessary to determine the effects of the study on the groundwater. The placement of these wells and lysimeters was determined based on monitoring objectives, site conditions, and accessibility. Two of lysimeters were placed at 4 feet below ground surface (bgs), and the other two were placed at 7.5 feet bgs. They will enable coverage of the capillary zone during seasonal highs and lows in the groundwater table level.

See REAC reports *J-Field Phytoremediation Well and Lysimeter Installation Report* April 1997 and *J-Field Well and Lysimeter Monitoring Report* November 1997 for additional information and data relating to the wells and lysimeters.

2.0 METHODOLOGY

2.1 Tree Tissue Preparation

2.1.1 VirTis® Handheld Homogenizer

In April 1997, a VirTis® handheld homogenizer with an open blade cutting assembly was used for the homogenization of tree buds and leaves. This method was developed to qualitatively determine the volatile contaminants in the tree leaves. Method development was necessary as no pre-established method existed and because it was difficult to find laboratories that would analyze for VOCs in leaf tissue. This new method involves the collection and immediate homogenization of leaf tissue in organic-free water. It was thought that any loss of volatile components during the homogenization procedure would be no worse than or equal to losses occurring during typical sample handling and transportation. The sampling procedure was as follows:

1. Buds and leaves were picked or cut from the tree.
2. 10 grams of buds or leaves were weighed and placed in a 200 milliliters (mL) glass VirTis® homogenization jar with an aerosol-free cap assembly.
3. 250 milliliters (mL) of organic-free water was measured and added to the jar.
4. The sample was homogenized for 1 minute on high speed.
5. A piece of aluminum window screen was placed over the top of the jar, and the extract was decanted into 40-mL volatile organic analysis (VOA) vials.
6. Samples were placed on ice, transported to the laboratory, and centrifuged before VOC analysis.

It is important to note that the VirTis® homogenizer proved to be ineffective at homogenizing the plant tissue. Additionally, the homogenizer heated the sample during mixing, potentially increasing volatilization of compounds.

2.1.2 Waring Blender®

In May 1997, a Waring blender® fitted with a stainless steel container and lid with a standard blade assembly was used to homogenize leaf tissue samples. Sixty grams of leaves or stems were homogenized in 500 mL of organic-free water. In July 1997, a rotor and stator blade assembly was used with the blender to yield better homogenization. The following procedure was determined to be the most effective:

1. Buds and leaves were picked or cut from the tree.
2. Immediately, 50 grams were weighed and placed directly in 500 mL of 4 degrees Celsius (^{0} C) organic-free water.
3. The sample was homogenized for 2.5 minutes.
4. A piece of aluminum window screen was placed over the top of the jar and the extract was poured into 40-mL VOA vials and/or 8 ounce (oz) glass jars.
5. Samples were placed on ice, transported to the laboratory, and analyzed for VOCs and haloacetic acids.

2.2 Tree Tissue Analysis

Tree tissue analysis was performed by REAC laboratories. Because the methods used by REAC were unproven, samples were sent to Phytokinetics, Inc., in North Logan, Utah for analysis to determine the volatile and semi-volatile organic content in the leaves.

2.2.1 Tissue Preparation and Haloacetic Acids Analysis

Tree tissue extract samples were analyzed for volatile organics as water samples using Gas Chromatography/Mass Spectrometry (GC/MS) following United States Environmental Protection Agency (EPA) standard methods (modified method 524.2). Sample foaming caused problems with the analysis of leaf tissue extracts. Antifoam agents were used to prevent these problems.

Haloacetic acids were analyzed using EPA method 552. Two subcontractor laboratories performed the analysis. Samples collected in April and July/August were sent to South West Research Institute (SWRI) laboratories, and samples collected in May were sent to Hampton Clark Laboratories.

2.2.2 Phytokinetics, Inc.

Samples were prepared on site by REAC personnel following Phytokinetics' instructions, and then shipped to Phytokinetics for analysis. Although Phytokinetics claimed they had a procedure for sampling and analysis of volatile organics in plant tissue, this procedure was still being developed the week the samples were collected. Approximately 5 grams of leaves were added to GC grade methanol in a 40-mL VOA vial. Borosilicate glass beads were added to the vial to aid in extraction. Samples were packed on ice and shipped to Phytokinetics. When the samples had cooled, the methanol contracted, and headspace was left in the vials. Approximately 28 grams of methanol were added to each sample. Each tissue sample was prepared in triplicate. In addition, a set of 12 extracts of one sample was prepared for Phytokinetics' use.

2.3 Transpiration Gas Sampling and Analysis

The objective of transpiration gas sampling was to determine whether the trees are remediating the volatile organics in the groundwater, and if so, to determine the types and levels of volatile contaminants being emitted from the leaves of the trees. Sampling was performed using a clear, 2 mil, 100 liter (30 x 36 inch) Tedlar® bag with dual stainless steel fittings, manufactured by SKC®, Inc. The valveless end of the bag was sliced open and placed over the ends of two or three branches. Branches were chosen for their location with respect to the sun and for their healthy appearance. Plastic wire ties, ceramic clay (Standard Clay Mines Dover White), and homemade mechanical clamps (wood and viton tubing) were used to form a tight seal between the bag and the branches. The following sampling and analytical methods were used to determine the levels of volatile organics in the gas and the effectiveness of the sampling method and analysis.

2.3.1 Summa® Canister

Evacuated 6-liter stainless steel Summa® canisters were used to collect a near-instantaneous gas sample from the Tedlar® bag. Teflon® tubing (0.25 inch) was used to connect the Summa® to the bag. Initial and final canister pressures were checked upon sampling. Samples were collected during all three seasonal sampling events (May, July/August, and September/October 1997). These samples were analyzed by GC/MS following method TO14 at the REAC laboratories. See Appendix A for copies of the Sampling Worksheets.

2.3.2 Tenax®/CMS® Tubes

Tenax®/Spherocarb® tube samples were collected in duplicate using a calibrated personal sampling pump. Teflon tubing (0.25 inch) was used to connect the tubes to the bags. Samples were collected at a flow rate of 40 cubic centimeters (cc) per minute for a total volume of 4.8 liters. Samples were collected during the May (Spring) 1997 sampling event only and samples were analyzed following methods TO1 and TO2 at the REAC laboratories. See Appendix A for copies of the Sampling Work Sheets.

2.3.3 Trace Atmospheric Gas Analyzer

A Sciex® (PE Sciex Ltd., Ontario, Canada) model 6000E Trace Atmospheric Gas Analyzer (TAGA) was used to perform ambient air monitoring, tree vent tube monitoring, and the monitoring of gases liberated from tree leaves collected in Tedlar gas bags (transpiration gas). The TAGA was used for the May (Spring) 1997 sampling event only. The following target compounds were monitored: vinyl chloride (VNCL), dichloroethene (DCE), 1122-tetrachloroethane (1122), trichloroethene (TCE), and tetrachloroethene (PCE). The TAGA mass spectrometer/mass spectrometer (MS/MS) is a direct air sampling instrument capable of detecting, in real time, trace levels of many organic compounds in ambient air. The technique of triple quadrupole MS/MS is used to differentiate and quantitate compounds.

Outside ambient air was continuously drawn into the inlet port in the TAGA system at a flow rate of approximately 1.5 liters per second. A 0.125-inch Teflon line was attached directly from the bag to the TAGA sample port. See the *TAGA Field Analytical Report* dated August 1997 in Appendix B for more information regarding the TAGA system.

During the planting of trees, corrugated vent tubes were placed in the ground alongside the trees to allow oxygen to reach the deeply planted root system. The TAGA was used to perform analysis of the gases in each vent tube in an effort to focus the transpiration gas sampling on those trees more likely to be uptaking the contaminants of concern. Tree vent tube monitoring was performed using a direct-air sampling system interfaced to a 200-foot length of corrugated Teflon sampling hose. Outside ambient air was continuously drawn through the Teflon hose and into the inlet port at a flow rate of approximately 1.5 liters per second. Background ambient air monitoring was also performed.

2.3.4 Viking® GC/MS

A Viking SpectraTrak 620 GC/MS was used in the field to provide quick turnaround analysis of the transpiration and flux chamber gas. The Viking was used during the July/August (Summer) 1997 sampling event only. A smaller 1-liter Tedlar bag was used to collect and transport a sample to the Viking. A vacuum box system connected via a 0.25-inch teflon line was used to collect a sample from the larger bag on the tree. The Viking was calibrated to analyze for three compounds (TCE, 1,1,2-trichloroethane (TCA), and 1122). See Appendix C, *Viking GC/MS Analytical Report* for more information regarding the system.

2.4 Condensate Collection and Analysis

Condensation formed in the Tedlar bag as a result of sealing the bag over the leaves of the tree. This water was sampled after the transpiration gas was sampled and before the bag was removed from the tree. To collect the sample, a small cut was made in one corner of the bag, and the condensate was transferred directly into 4- mL VOA vials with Teflon septas. Zero to three vials were collected from each bag, depending on the amount of condensation in the bag. The samples were placed on ice and transported to REAC for analysis by GC/MS. Samples were collected during all three seasonal sampling events.

2.5 Sap Flow Rate Measurement

A series of Dynamax Inc. Dynagage ™ sensors was used to collect continuous sap flow rates on selected trees in the phytoremediation plot. A data logger was used to record the sap flow measurements for the duration of each of the three sampling sessions in 1997. Each individual sensor consists of a series of thermopiles, a heating strip, and insulating separators. The thermopiles are arranged to measure conducted heat transfer (heat flux) up and down the stem and radial heat flux (heat lost to ambient). The heat added by the heat strip is precisely regulated at a fixed wattage and monitored by a separate sensor.

To calculate the sap flow in the stem, the individual parameters were used in the following thermodynamic equation:

$$F \bullet \frac{Pin - Qr - Qu - Qd}{Cp \bullet dT}$$

Where F = flow
Pin = power in watts applied to heater strip
Qr = radial heat flux
Qu = axial heat flux (upward component)
Qd = axial heat flux (downward component)
Cp = stem heat capacity constant
dT = temperature increase of the sap

The heat flux components of the thermodynamic equation are expressed in joules. The mass of sap passing through the sensor is calculated using the heat capacity of sap and the observed temperature increase. Since sap is over 99 percent water, the heat capacity constant of water (4.186 joules/gram ^{0}C) is used in the equation.

Each sensor installation was calibrated according to the manufacturers' instructions for the thermal conductance of the stem/sensor assembly by measuring all the thermopile outputs during a zero flow period. This was accomplished during the first pre-dawn period of the sampling session for each of the sensors. After calibration, the sensors record sap flow rates measured in gallons/hour at 5 minute intervals. During data processing, the calibration factor is used to adjust any uncalibrated data collected between sensor installation and sensor calibration.

2.6 Tree Health

Trees were examined to determine the status of their health since the initial planting. Pruning was performed as needed. Typically, trees were cut back to new growth if the tops of the trees had died. Insect damage, deer rutting damage, and leaf tip burn were recorded. Tree health was recorded as "healthy" (large unblemished leaves), "poor" (small or discolored leaves) or "significant or severe damage" (loss or devegitation of much of the tree). Tree heights were measured with a 25-foot surveyor's rod, and tree diameters were measured at breast height (1.4 meters from ground surface) with a tree diameter tape.

2.7 Flux Chambers

On 31 July 1997, eight flux samples were collected within the phytoremediation area. Stainless steel flux chambers were used to sample gases emanating from ground surface. Samples were designated F1 through F8, and were analyzed on site using the Viking GC/MS. See Figure 3 for the location of each flux chamber.

2.8 OP-FTIR Analysis

Ambient air sampling was performed to address concerns that high concentrations of volatile organics may be in the air within the phytoremediation area. An Open-path Fourier Transform Infrared (OP-FTIR) spectrometer manufactured by Environmental Technologies Group, Inc. (ETG) was used to monitor ambient concentrations of the target compounds within the phytoremediation area on 31 July and 1 August 1997. Specific target compounds were TCA, 1122, TCE, PCE and c-DCE.

Analysis of the ambient air within the tree area and outside the tree area (background) was performed on 31 July and 1 August 1997. Analysis within the tree area was performed near ground level (approximately one meter) and elevated (approximately 3 meters). For more information see Appendix E, *Summary of OP-FTIR Monitoring Results for J-Field Phytoremediation Site*.

3.0 RESULTS AND DISCUSSION

3.1 April 1997: Leaf Tissue Analysis

On 4 April 1997, the leaf buds on nine trees (eight poplar and one sweet gum) were sampled for haloacetic and VOA analysis. Due to problems with the VirTis homogenizer (Section 2.1.1), only the samples for haloacetic acid analysis (EPA method #552) were homogenized in the field.

On 29 April 1997, samples from 4 April 1997 were homogenized and submitted for volatile organic analysis. No volatile organic compounds of concern were detected in the leaf tissue samples (Appendix F). Haloacetic acid results are presented in micrograms per Liter (µg/L) in Table 1. Dichloroacetic acid was the only compound detected at greater than five times the detection limit, although high levels were also detected in the water blank (0.49 µg/L). Concentrations of dichloroacetic acid ranged from 0.34 to 0.88 µg/L in the extract. These concentrations may be from the water and not the leaves. Acetone was detected at concentrations less than 38 µg/L in nine of the samples. Chloroform (2.6 µg/L) was detected in one sample. It is believed that the presence of these compounds is the result of cross-contamination. Tentatively Identified Compounds (TICs) were detected in the poplar and sweet gum trees. Poplar trees contained unknowns, aldehydes, stearates, ketones and alcohols. The sweet gum contained only unknowns and alkenes (Appendix F).

3.2 May 1997: Spring Sampling Event

3.2.1 Leaf Tissue Analysis

Haloacetic acid analysis was performed on nine tissue samples in May 1997. Results were all non-detect (ND) due to high detection limits of 10 to 50 µg/L (Table 1.1 in Appendix G).

Results from VOC analyses detected 1122 (1.5 µg/L) in the leaf extract sample from Tree 174 (Table 2). This corresponds to a concentration of 15 µg/kg wet weight and 50 µg/kg dry weight.

3.2.2 Transpiration Condensate Analysis

1122 was detected in condensate samples from Tree 174 and Tree 19 (Table 2). Condensate concentrations of 1122 were 56 µg/L for Tree 174 and 11 µg/L for Tree 19. TCE (1.1 µg/L) was detected in condensate samples from Tree 19. Acetone and 2-butanone were also detected in condensate samples.

3.2.3 Transpiration Gas Analysis

Tenax/Spherocarb tubes, Summa canisters and the TAGA were used to sample target compounds in transpiration gas during the May 1997 sampling event. TCE, TCA, PCE, and 1122 were detected in the Tenax/Spherocarb tubes at concentrations above the method detection limit in the transpiration gas in five trees within the phytoremediation area (Table 3). TCE was detected in samples from Tree 174 (3.06 part per billion volume (ppbv)), Tree 175 (0.40 ppbv) and Tree 47 (1.12 ppbv) while TCA was only detected from Tree 174 (1.36 ppbv). PCE was detected in samples from Tree 19 (0.28 ppbv), Tree 174 (1.10 ppbv), Tree 175 (0.23 ppbv) and Tree 109 (1.94 ppbv) while 1122 was only detected in Tree 174 (5.54 ppbv) and Tree 175 (2.85 ppbv).

TCE and 1122 were also detected above the detection limit in the Summa canister samples (Table 4, Appendix H). TCE was detected at levels of 14.3 ppbv and 14.5 ppbv in Tree 174 while 1122 was only detected in Tree 174 with levels ranging from 11.3 to 172.9 ppbv. Other compounds detected in Summa samples include styrene, toluene, and ethylbenzene.

TCE and 1122 were also detected above the detection limits in transpiration gas samples during TAGA monitoring. TCE was detected in Tree 174 at 13.5 ppbv while 1122 was detected in all transpiration gas samples at levels above the daily quantitation limit (Table 5). The highest 1122 level was for Tree #174 at 170 ppbv, and the lowest level detected was Tree # 61 at 2.0 ppbv. The 1122 determinations via TAGA are considered suspect due to the possibility of interfering ions at the 83 and 85 m/z in the gases liberated from the J-Field trees. A natural product of plant respiration may be forming a protonated proponol water cluster, or similar compound which yields parent/daughter ion pairs similar to 1122.

3.2.4 Tree Vent Monitoring

The tree vent monitoring yielded high levels of TCE in Trees 11, 19, 43, 47, and 174, ranging from 142 to 885 ppbv. Tree 109 had PCE at a level of 1540 ppbv. Tree 11 had 1,2-DCE at 1771 ppbv, VNCL at 88 ppbv, and 1122 at 63 ppbv (Table 6, Appendix B). These compounds were also detected in samples from some of the other trees at lower quantitation limits.

3.2.5 Sap Flow Data

Eight trees were monitored during the first session from 13 May through 15 May 1997. Some of the sensors recorded erratic readings for short periods and some sensors recorded erratic readings for the entire session. During inspection of the raw data, one or more of the thermopile readouts was found to be not registering at that time. A complete search of the raw data was used to screen the affected data out of any subsequent evaluations. The data were summarized by averaging the flow rate for the active portion of the day (0600 to 1900 hours) for each tree and normalized by the trunk cross section area.

For the May sampling session, data are summarized from six sensors. The trees were installed on the data logger channels in the following order: 61,141,175,60,176, and 67. The maximum flow rate recorded for one tree in a 5 minute interval was 1.45 gallons/hour. The average flow rates for each tree ranged from 0.04 gal/hr to 0.13 gal/hr. The flow rate normalized by cross section area was 0.037gal/day x centimeter^2 (cm^2).

3.3 July/August 1997: Summer Sampling Event

3.3.1 Leaf Tissue Analysis

Haloacetic acid analysis for samples collected in July 1997 was performed on seven tree tissue samples and one *Phragmites spp.* sample from the adjacent marsh (Table 7). Results were "non-detect" (ND), with the exception of trichloroacetic acid (TCAA). TCAA was detected in Tree 148 (37 µg/kilogram (kg) wet weight of leaves), Tree 174 (150 µg/kg), and Tree 175 (51 µg/kg).

Results of analyses for VOCs in tree tissue detected 1122 in two leaf samples (Trees 139 and 174) at concentrations of 11 and 79 µg/L which corresponds to 110 and 790 µg/kg wet weight of leaves and 366 and 2630 µg/kg dry weight of leaves, respectively (Table 8).

Tissue analysis results from Phytokinetics Inc. for VOCs and semivolatile organics are presented in Table 9 and Appendix I . Concentrations of dichloroacetic acid (DCAA), dichloroethanol (DCEtOH), PCE, TCA and trichloroethanol (TCEtOH) were detected in leaf tissue samples. Tree 174 had the highest concentrations of DCAA (13600 ug/kg), DCEtOH (10700 ug/kg) , TCEtOH (7.64 ug/kg) and PCE (2.33 ug/kg). It was not possible to analyze for c-DCE, t-DCE and 1122, and the TCAA as results were deemed unreliable because of problems with the analytical procedure.

3.3.2 Transpiration Condensate Analysis

TCE, 1122 and TCA were detected in the transpiration condensate from trees 174 and 175 (Table 10). TCE was detected at a level of 2.5 µg/L in Tree 175 and at 4.8 and 6.3 µg/L in Tree 175. 1122 ranged from 100 to 640 µg/L for Trees 174 and 175, while TCA was detected only in Tree 174 and ranged from 1.2 to 2.2 µg/L (Table 10).

3.3.3 Transpiration Gas Analysis

TCE, 1122 and TCA were detected in summa canister samples in the transpiration gas from trees 148, 174 and 175 (Table 10). TCE ranged from 2.1(estimated) to 210 ppbv, 1122 ranged from 210 to 2000 ppbv, and TCA ranged from 2.6 (estimated) to 17 (J, estimated) ppbv (Table 10). 1122 and TCE were also detected by the Viking in tree 174, but 1122 was not detected because of high detection limits for this compound (Table 11).

3.3.4 Flux Chambers

Out of the eight locations sampled on 31 July 1997, two locations (F1 and F8) were resampled on 1 August because analyses could not be completed on 31 July. Results of the analyses are summarized in Table 12, and sample locations are presented in Figure 4. TCE was detected in three of the eight flux chamber samples. Concentrations ranged from 9.4 to

38 ppbv in flux F3, F7, and F8. TCA and 1122 were not detected in any sampling locations. See Appendix D for sampling work sheets and location sketches.

3.3.5 OP-FTIR Analysis

All monitoring events resulted in concentrations below the minimum detection limits (MDLs) for all the target compounds (TCA, 1122, TCE, PCE and c-DCE) . MDLs ranged from 1.6 to 53 parts per million-meter (ppm-m). See Appendix E for further details.

3.3.6 Sap Flow Data

Seven trees were monitored during the summer sampling session from 26 July through 1 August 1997. Some of the sensors recorded erratic readings for short periods, and some sensors recorded erratic readings for the entire session. During inspection of the raw data, one or more of the thermopile readouts was found to be not registering at that time. A complete search of the raw data was used to screen the affected data out of any subsequent evaluations. The data were summarized by averaging the flow rate for the active portion of the day (0600 to 1900 hours) for each tree and normalized by the trunk cross section area.

For the July sampling session, data was summarized from seven sensors. Tree 133 had two sensors installed to test repeatability, they were labeled numbers 133t (top) and 133b (bottom).The trees were installed on the individual data logger channels in the following order: 174, 175, 133t, 133b, 140, 148, and 139. The maximum flow rate recorded for one tree in a 5 minute interval was 1.2 gallons per hour (gal/hr). The average flow rates for each tree ranged from 0.20 gal/hr to 0.46 gal/hr. The flow rate normalized by cross section area was 0.16 gallons per day by centimeters^2 (gal/day x cm^2).

3.4 September/October 1997: Fall Sampling Event

3.4.1 Transpiration Condensate Analysis

Condensate was not collected from Tree 175 or the background sycamore located near the site due to a lack of condensate in the bag. TCE and 1122 were detected at concentrations above the MDL in the condensate from tree 174 while only 1122 was detected in Tree 196 (Table 13). The concentration of TCE in Tree 174 was 1.8 ug/L (Table 13). 1122 concentrations ranged from 17 ug/L in tree 196 to 160 ug/L in tree 174. A Tentatively Identified Compound (TIC) C_5H_8 (an alkyldiene) was also detected in condensate samples from Trees: 62, 69, 139, 147 and 175 (Table 13).

3.4.2 Transpiration Gas Analysis

TCE and 1122 were detected in transpiration gas samples at concentrations above the MDL in Trees: 147, 174, and the sycamore, and C_5H_8 was detected in all trees sampled. TCE concentrations ranged from 6.0 ppbv to 99.0 ppbv while concentrations of 1122 ranged from 54.0 to 919.0 ppbv (Table 13).

3.4.3 Sap Flow Data

Seven trees were monitored during the fall sampling session from 23 September through 16 October 1997. Some of the sensors recorded erratic readings for short periods, and some sensors recorded erratic readings for the entire session. During inspection of the raw data, one or more of the thermopile readouts was found to be not registering at that time. A complete search of the raw data was used to screen the affected data out of any subsequent evaluations. The data were summarized by averaging the flow rate for the active portion of the day (0600 to 1900 hours) for each tree and normalized by the trunk cross section area.

For the September sampling session, data are summarized from seven sensors. The trees were installed on the individual data logger channels in the following order: 98, 66, 96, 70, 101,105, and 75. The maximum flow rate recorded for one tree in a 5 minute interval was 1.14 gal/hr. The average flow rates for each tree ranged from 0.047 gal/hr to 0.24 gal/hr. The flow rate normalized by cross section area was 0.048 gal/day x cm^2.

3.5 Tree Health

Tree health and growth data (height and diameter at breast height) for the 183 trees planted are presented in (Table 14), respectively. Since November 1996, 8 trees have died (6%), 35 are doing poorly (19%), and the other 137 are healthy. Of the 11 dead trees, two were healthy, five had deer rub damage, three had been cut back, and one was a replant. Nineteen trees had been replanted in November 1996, of these, 18 are doing poorly.

The diameter of 13 trees increased by more than 100% from April through November 1996. Between November 1996 and October 1997, the diameter of 26 trees increased by more than 100%. No trees showed height growth greater than 100% between April and November 1996, whereas eight trees did the following year. From April through November 1996, 34 trees showed diameter growth of less than 10% and 138 trees showed height growth of less than 10%. From November 1996 to October 1997, 35 trees showed diameter growth of less than 10% and only 36 trees showed height growth of less than 10%.

4.0 CONCLUSIONS

Based on the results of the 1997 sampling season, the data indicate that the site objectives, (examining whether or not the surficial aquifer in the area of the toxic pits can be intercepted and contained, and if volatile organic compounds in the groundwater can be removed and/or destroyed through natural mechanisms) are being met.

Results of leaf tissue analyses revealed that VOCs and their breakdown products are present in leaf tissue (Sections 3.1, 3.2.1, 3.3.1). However, given the lack of precise analytical methods for detecting VOCs in tissue, leaf tissue sampling should not be considered further until better methodologies are developed.

Transpiration gas and condensate samples indicated that site parent and breakdown compounds of concern are being transpired from the trees (Sections 3.2.2, 3.2.3, 3.3.2, 3.3.3, 3.4.1 and 3.4.2). These data support the site objective of removing and/or destroying site VOCs.

Sap flow analyses revealed a seasonal trend in transpiration rate with seasonal averages of 0.04 to 0.13 gal/hr in the spring (Section 3.2.5); 0.20 to 0.46 gal/hr in the summer (Section 3.3.6); and 0.047 to 0.24 gal/hr in the fall (Section 3.4.3). Future sampling objectives for the site include continued seasonal sap flow monitoring for the purposes of estimating transpiration rates.

Flux chamber sampling (Sections 3.3.4) indicated the TCE is off gassing from the soil under natural conditions. This information may be useful should future monitoring of mass emissions be undertaken. OP-FTIR results (Section 3.3.5) revealed that no measurable concentrations of contaminants of concern were detected in and around the phytoremediation area. Given this information, there is little concern that VOCs off gassing from the trees pose risk to ecological or human receptors.

TABLE 1
Haloacetic Acid in Leaf Tissue Results - April 1997
J-Field Phytoremediation Study
Aberdeen Proving Ground, Edgewood, MD
April 1999

(Reported in ug/L)

Sample	MCAA	DCAA	MBAA	TCAA	BCAA	DBAA
Tree 99	0.15	0.81	ND	ND	ND	ND
Tree 46	ND	0.82	ND	0.081	ND	ND
Tree 19	ND	0.65	ND	ND	ND	ND
Tree 57	ND	0.69	ND	ND	ND	ND
Tree 113	0.16	0.34	ND	ND	ND	ND
Tree 147	ND	0.67	ND	0.07	ND	ND
Tree 188	0.13	0.88	ND	ND	ND	ND
Tree 200	ND	0.84	ND	0.073	ND	ND
Sweet Gum	ND	0.67	ND	0.082	ND	ND
Water Blank	ND	0.49	ND	ND	ND	ND

MCAA - monochloroacetic acid
DCAA - dichloroacetic acid
MBAA - monobromoacetic acid
TCAA - trichloroacetic acid
BCAA - bromochloroacetic acid
DBAA - dibromoacetic acid
ug/L - micrograms per Liter
ND - not detected (detection limit equals 0.063 ug/L)
To convert to ug/kg wet weight multiply by 25.
To convert to ug/kg dry weight multiply by 83.

Table 2
Leaf Condensate and Tissue Extract VOC Results - Spring (May) 1997
J-Field Phytoremediation Study
Aberdeen Proving Ground, Edgewood, MD
April 1999

(Reported in ug/L)

Location Sample #	Tree 174 condensate 10195	Tree 19 condensate 10196	Tree 174 extract 10206	Blank for tree extract 10207
Acetone	33	48	ND	ND
1122	56	11	1.5	ND
2-Butanone	ND	14	ND	ND
TCE	ND	1.1	ND	ND
TIC (C5H8)	100	ND	ND	ND

ND - non detect
TIC - Tentatively Identified Compound
For Sample # 10206, to convert to ug/kg wet weight multiply by 10.
For Sample # 10206, to convert to ug/kg dry weight multiply by 33.

TABLE 3

[illegible] Targe[illegible] [illegible]nd Resu[illegible] [illegible]ax/Sphe[illegible] [illegible] Sam[illegible] [illegible]ring (Ma[illegible]

J-Field Phytoremediatio[illegible]

Aberdeen Proving Ground, [illegible] D

April 1999

(Reported in ppbv)

Method Detection Limit (ppbv) = 0.2

Sample Location	Method Blank	Field Blank	Tree 174	Tree 175	Tree 47	Tree 19	Tree 109	System Blank	Field Blank	Method Blank	Ambient
Sample Number	N/A	09403	09401	09406	09411	09412	09413	N/A	09414	N/A	09425
Date Sampled	05/14/97	05/14/97	05/14/97	05/14/97	05/14/97	05/14/97	05/14/97	N/A	05/14/97	N/A	05/16/97
Date Analyzed	05/20/97	05/20/97	05/20/97	05/20/97	05/20/97	05/20/97	05/20/97	05/20/97	05/20/97	05/28/97	05/28/97
Chloromethane	0.21 J	0.37 JB	0.21 U	0.14 JB	0.21 U	0.53 JB	0.37 JB	0.04 JB	0.28 JB	0.08 J	0.18 JB
Vinyl Chloride	0.21	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U
Chloroethane	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U
Trichlorofluoromethane	0.21 U	0.24	0.05 J	0.21 U	0.21 U	0.53	0.07 J	0.21 U	0.21 U	0.21 U	0.52
1,1-Dichloroethene	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U
Methylene Chloride	0.17 J	0.16 JB	0.22 JB	0.15 JB	0.21 U	0.17 JB	0.21 U	0.11 JB	0.15 JB	0.08 J	0.16 JB
trans-1,2-Dichloroethene	0.21 U	0.21 U	0.20 J	0.21 U	0.21 U	0.04 J	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U
1,1-Dichloroethane	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U
Trichloromethane	0.21 U	0.21 U	0.21 U	0.01 J	0.21 U	0.04 J	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U
1,1,1-Trichloroethane	0.21 U	0.21 U	0.07 J	0.07 J	0.06 J	0.13 J	0.04 J	0.21 U	0.21 U	0.21 U	0.16 J
1,2-Dichloroethane	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U
Benzene	0.11 J	0.09 JB	0.71	0.62	0.71	0.72	1.08	0.08 JB	0.12 JB	0.08 J	0.41
Carbon Tetrachloride	0.21 U	0.21 U	0.08 J	0.07 J	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.14 J
Trichloroethene (TCE)	0.21 U	0.21 U	3.08	0.40	1.12	0.04 J	0.03 J	0.21 U	0.21 U	0.21 U	0.04 J
Dibromomethane	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.08 J	0.08 J	0.07 J	0.05 JB
Bromodichloromethane	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U
Toluene	0.04 J	0.07 JB	3.69	2.61	0.98	0.25	0.32	0.21 U	0.07 J	0.02 J	0.53
1,1,2-Trichloroethane (TCA)	0.21 U	0.21 U	1.38	0.04 J	0.10 J	0.07 J	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U
Tetrachloroethene (PCE)	0.21 U	0.21 U	1.10	0.23	0.11 J	0.28	1.94	0.21 U	0.21 U	0.21 U	0.28
Ethylbenzene	0.01 J	0.21 U	2.47	1.83	3.43	1.97	0.99 J	0.21 U	0.21 U	0.21 U	0.11 J
m & p-Xylenes	0.21 U	0.06 JB	0.90	0.45	0.21 U	0.56	0.14 J	0.21 U	0.21 U	0.21 U	0.36
Styrene	0.04 J	0.03 J	3.43	1.55	0.33	3.62	0.08 J	0.21 U	0.21 U	0.21 U	0.08 J
o-Xylene	0.21 U	0.21 U	0.35	0.15 J	0.01 J	0.21 J	0.21 U	0.21 U	0.21 U	0.21 U	0.14 J
1,1,2,2-Tetrachloroethane (1122	0.17 J	0.21 U	5.54 E	2.85	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U
Meta-Ethyltoluene	0.21 U	0.21 U	0.38	0.21 U	0.21 U	0.08 J	0.21 U	0.21 U	0.21 U	0.21 U	0.13 J

U - not detected

J - below 1.00 nL quantitation Limit

B - <3 times blank value

E - exceeds calibration range

ppbv - part per billion volume

TAL Con

Air Toxic Target Compound Results for a Canister Samples - Spring (May) 1997

J-Field Phyto diation Study

Aberdeen Proving Ground, Edgewood, MD

April 1999

(Reported in ppbv)

Sample Location	Tree 11		Tree 109		Sweet Gum		Tree 178		Tree 73		Tree 19		Ambient	
Sample Number	09422		09421		09420		09419		09418		09417		09423	
Date Sampled	05/15/97		05/15/97		05/15/97		05/15/97		05/15/97		05/15/97		05/15/97	
Method Detection Limit (ppbv)	4		4		4		4		4		4		4	
Chloromethane	4	U	4	U	0.5	J	.6	J	2.4	J	1.2	J	1.0	J
Vinyl Chloride	4	U	4	U	4	U	4	U	4	U	4	U	4	U
Chloroethane	4	U	4	U	4	U	4	U	4	U	4	U	4	U
Trichlorofluoromethane	4	U	4	U	4	U	4	U	4	U	4	U	4	U
1,1-Dichloroethene	4	U	4	U	4	U	4	U	4	U	4	U	4	U
Methylene Chloride	4	U	4	U	4	U	4	U	4	U	4	U	4	U
trans-1,2-Dichloroethene	4	U	4	U	4	U	4	U	4	U	4	U	4	U
1,1-Dichloroethane	4	U	4	U	4	U	4	U	4	U	4	U	4	U
Trichloromethane	4	U	4	U	4	U	4	U	4	U	4	U	4	U
1,1,1-Trichloroethane	4	U	4	U	4	U	4	U	4	U	4	U	4	U
1,2-Dichloroethane	4	U	4	U	4	U	4	U	4	U	4	U	4	U
Benzene	0.9	J	0.6	J	4	U	1.3	J	1.0	J	1.5	J	4	U
Carbon Tetrachloride	4	U	4	U	4	U	4	U	4	U	4	U	4	U
Trichloroethene (TCE)	4	U	4	U	4	U	4	U	4	U	4	U	4	U
Dibromomethane	4	U	4	U	4	U	4	U	4	U	4	U	4	U
Bromodichloromethane	4	U	4	U	4	U	4	U	4	U	4	U	4	U
Toluene	2.4	J	2.0	J	0.5	J	4.4		3.0	J	7.7		.4	J
1,1,2-Trichloroethane (TCA)	4	U	4	U	4	U	4	U	4	U	4	U	4	U
Tetrachloroethene (PCE)	4	U	0.4	J	4	U	4	U	4	U	0.6	J	4	U
Ethylbenzene	1.9	J	1.4	J	4	U	4.9		3.2	J	3.8	J	4	U
m & p-Xylenes	4	U	4	U	4	U	0.8	J	1.2	J	5.0		4	U
Styrene	13.0		8.7		4	U	35.9		21.7	U	19.5		4	U
o-Xylene	4	U	4	U	4	U	4	U	4	U	2.2	J	4	U
1,1,2,2-Tetrachloroethane (1122)	4	U	4	U	1.1	J	4	U	4	U	0.5	J	4	U
Meta-Ethyltoluene	4	U	4	U	4	U	4	U	4	U	4	J	4	J

J - below 1.00 nL quantitation Limit
U - not detected
B - <3 times blank value
E - exceeds calibration range
ppvb - part per billion volume

TABLE 4
Air Toxic Target Compound Results for Summa C[illegible] Samples - Spring (May) 1997
J-Field Phytoremediat[illegible]
Aberdeen Proving Ground , [illegible]d, MD
April 1999

(Reported in ppbv)

Sample Location	Trip Blank		Tree 174		Tree 174		Tree 174 Rep		Tree 175		Tree 47		Ambient		Method Blank		Blank	
Sample Number	09409		09407		09410		09410		09415		09416		09408		N/A		09424	
Date Sampled	05/13/97		05/13/97		05/14/97		05/14/97		05/14/97		05/14/97		05/13/97		N/A			
Method Detection Limit (ppbv)	4		4		13.3		13.3		4		4		4		4		4	
Chloromethane	4	U	.7	J	13.3	U	13.3	U	0.7	J	0.6	J	0.6	J	4	U	4	U
Vinyl Chloride	4	U	4	U	13.3	U	13.0	U	4	U	4	U	4	U	4	U	4	U
Chloroethane	4	U	4	U	13.3	U	13.0	U	4	U	4	U	4	U	4	U	4	U
Trichlorofluoromethane	4	U	4	U	13.3	U	13.0	U	4	U	4	U	4	U	4	U	4	U
1,1-Dichloroethene	4	U	4	U	13.3	U	13.0	U	4	U	4	U	4	U	4	U	4	U
Methylene Chloride	4	U	4	U	13.3	U	13.0	U	4	U	4	U	4	U	4	U	4	U
trans-1,2-Dichloroethene	4	U	4	U	13.3	U	13.0	U	4	U	4	U	4	U	4	U	4	U
1,1-Dichloroethane	4	U	4	U	13.3	U	13.0	U	4	U	4	U	4	U	4	U	4	U
Trichloromethane	4	U	4	U	13.3	U	13.0	U	4	U	4	U	4	U	4	U	4	U
1,1,1-Trichloroethane	4	U	4	U	13.3	U	13.0	U	4	U	4	U	4	U	4	U	4	U
1,2-Dichloroethane	4	U	4	U	13.3	U	13.0	U	4	U	4	U	4	U	4	U	4	U
Benzene	4	U	4	U	13.3	U	1.5	J	0.8	J	0.7	J	4	U	4	U	4	U
Carbon Tetrachloride	4	U	4	U	13.3	U	13.0	U	4	U	4	U	4	U	4	U	4	U
Trichloroethene (TCE)	4	U	1.5	J	14.3		14.5		0.7	J	3.2	J	4	U	4	U	4	U
Dibromomethane	4	U	4	U	13.3	U	13.0	U	4	U	4	U	4	U	4	U	4	U
Bromodichloromethane	4	U	4	U	13.3	U	13.0	U	4	U	4	U	4	U	4	U	4	U
Toluene	4	U	0.9	J	3.1	J	2.9	J	2.4	J	2.2	J	4	U	4	U	4	U
1,1,2-Trichloroethane (TCA)	4	U	0.5	J	1.5	J	13.0	U	4	U	2.0	J	4	U	4	U	4	U
Tetrachloroethene (PCE)	4	U	0.4	J	13.3	U	13.0	U	4	U	4	U	4	U	4	U	4	U
Ethylbenzene	.6	J	1.0	J	2.3	J	2.0	J	1.6	J	1.6	J	4	U	4	U	4	U
m & p-Xylenes	4	U	1.2	J	13.3	U	13.3	U	0.5	J	4	U	4	U	4	U	4	U
Styrene	4	U	1.4	J	6.1	J	5.2	J	2.8	J	2.2	J	4	U	4	U	4	U
o-Xylene	0.6	J	0.8	J	13.3	U	13.3	U	4	U	4	U	4	U	4	U	4	U
1,1,2,2-Tetrachloroethane (1122)	4	U	11.3		172.9		150.1		2.7	J	1.6	J	4	U	4	U	4	U
Meta-Ethyltoluene	4	U	1.6	J	13.3	J	13.3	J	4	U	4	U	4	U	4	U	4	U

J - below 1.00 nL quantitation Limit
U - not detected
B - <3 times blank value
E - exceeds calibration range
ppvb - part per billion volume

TABLE 5
TAGA Monitoring of Transpiration Gases - Spring (May) 1997
J-Field Phytoremediation Study
Aberdeen Proving Ground, Edgewood, MD
April 1999

DATE	TREE#	1122	1,2-DCE	PCE	TCE	VNCL
05/13	61	2.0	DL=5.1	DL=3.3	DL=2.4	DL=17.0
05/13	131	6.4	DL=5.1	DL=3.3	DL=2.4	DL=17.0
05/13	174	12	DL=5.1	DL=3.3	3.4J	DL=17.0
05/14	174	170	6.8J	DL=3.3	13.5	DL=10.0
05/14	175	80	DL=4.4	DL=3.3	DL=3.0	DL=10.0
05/15	11	52	DL=4.5	DL=2.9	DL=3.3	DL=3.7
05/15	19	64	DL=4.5	DL=2.9	DL=3.3	DL=3.7
05/15	73	98	DL=4.5	DL=2.9	DL=3.3	DL=3.7
05/15	109	20	DL=4.5	DL=2.9	DL=3.3	DL=3.7
05/15	178	100	DL=4.5	DL=2.9	DL=3.3	DL=3.7
05/15	Sweet gum	14	DL=4.5	DL=2.9	DL=3.3	DL=3.7

All results in parts per billion by volume (ppbv).

DL - at or below detection limits (DLs given in ppbv)
J - above DLs below quantitation limits
1122 - 1,1,2,2- tetrachloroethane
1,2-DCE - trans-1,2-dichlorethene
PCE - tetrachlorethene
TCE - trichlorethene
VNCL - vinyl chloride

TABLE 6
TAGA Tree Vent Monitoring - Spring (May) 1997
J-Field Phytoremediation Study
Aberdeen Proving Ground, Edgewood, MD
April 1999

DATE	TREE#	1122	1,2-DCE	PCE	TCE	VNCL
14 MAY	1	DL=11.2	6.7J	DL=3.3	13.4	DL=10.0
14 MAY	2	DL=11.2	DL=4.4	DL=3.3	6.0J	DL=10.0
14 MAY	4	DL=11.2	5.0J	DL=3.3	3.9J	DL=10.0
14 MAY	5	DL=11.2	DL=4.4	DL=3.3	3.0J	DL=10.0
14 MAY	8	DL=11.2	9.4J	DL=3.3	25.6	DL=10.0
14 MAY	9	DL=11.2	60.4	DL=3.3	52.2	DL=10.0
14 MAY	10	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	11	62.7	1771	9.4J	884.7	87.5
14 MAY	12	DL=11.2	DL=4.4	DL=3.3	11.2	DL=10.0
14 MAY	14	DL=11.2	DL=4.4	DL=3.3	9.0J	DL=10.0
14 MAY	15	DL=11.2	83.2	DL=3.3	121.5	10.2J
14 MAY	17	DL=11.2	4.6J	DL=3.3	15.6	DL=10.0
14 MAY	18	DL=11.2	6.3J	DL=3.3	21.9	DL=10.0
14 MAY	19	24.3J	163.1	8.6J	633.2	16.4J
14 MAY	20	DL=11.2	DL=4.4	DL=3.3	3.8J	DL=10.0
14 MAY	22	DL=11.2	6.7J	DL=3.3	11.8	DL=10.0
14 MAY	24	DL=11.2	DL=4.4	DL=3.3	5.5J	DL=10.0
14 MAY	40	DL=11.2	11.1J	DL=3.3	19.7	DL=10.0
14 MAY	41	DL=11.2	DL=4.4	8.1J	4.6J	DL=10.0

All results in parts per billion by volume (ppbv).

DL - at or below detection limits (DLs given in ppbv)
J - above DLs below quantitation limits
1122 - 1,1,2,2- tetrachloroethane
1,2-DCE - trans-1,2-dichlorethene
PCE - tetrachlorethene
TCE - trichlorethene
VNCL - vinyl chloride

TABLE 6 Cont' d
TAGA Tree Vent Monitoring - Spring (May) 1997
J-Field Phytoremediation Study
Aberdeen Proving Ground, Edgewood, MD
April 1999

DATE	TREE#	1122	1,2-DCE	PCE	TCE	VNCL
14 MAY	42	DL=11.2	DL=4.4	DL=3.3	15.9	DL=10.0
14 MAY	43	42.1	3.8,8	7.5J	472.5	DL=10.0
14 MAY	44	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	46	DL=11.2	14.5J	DL=3.3	3.3J	DL=10.0
14 MAY	47	36.5J	DL=4.4	3.6J	465.6	DL=10.0
14 MAY	48	DL=11.2	5.7J	DL=3.3	3.6J	DL=10.0
14 MAY	50	DL=11.2	28.4	12.0	66	DL=10.0
14 MAY	51	DL=11.2	DL=4.4	DL=3.3	71.1	DL=10.0
14 MAY	52	DL=11.2	DL=4.4	5.0J	80.J	DL=10.0
14 MAY	53	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	54	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	55	DL=11.2	DL=4.4	DL=3.3	5.3J	DL=10.0
14 MAY	56	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	57	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	58	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	58	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	59	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
12 MAY	60	DL=15.9	DL=4.2	DL=4.2	DL=5.6	DL=16.0

All results in parts per billion by volume (ppbv).

DL - at or below detection limits (DLs given in ppbv)
J - above DLs below quantitation limits
1122 - 1,1,2,2- tetrachloroethane
1,2-DCE - trans-1,2-dichlorethene
PCE - tetrachlorethene
TCE - trichlorethene
VNCL - vinyl chloride

TABLE 6 Cont' d
TAGA Tree Vent Monitoring - Spring (May) 1997
J-Field Phytoremediation Study
Aberdeen Proving Ground, Edgewood, MD
April 1999

DATE	TREE#	1122	1,2-DCE	PCE	TCE	VNCL
14 MAY	60	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
12 MAY	61	DL=15.9	DL=4.2	DL=4.2	DL=5.6	DL=16.0
14 MAY	61	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
12 MAY	62	DL=15.9	DL=4.2	DL=4.2	DL=5.6	DL=16.0
14 MAY	62	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
12 MAY	63	DL=15.9	DL=4.2	DL=4.2	DL=5.6	DL=16.0
14 MAY	63	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
12 MAY	64	DL=15.9	DL=4.2	DL=4.2	DL=5.6	DL=16.0
14 MAY	64	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	65	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	65	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	66	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	66	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
12 MAY	67	DL=15.9	DL=4.2	DL=4.2	DL=5.6	DL=16.0
14 MAY	67	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	68	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	68	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	69	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0

All results in parts per billion by volume (ppbv).

DL - at or below detection limits (DLs given in ppbv)
J - above DLs below quantitation limits
1122 - 1,1,2,2- tetrachloroethane
1,2-DCE - trans-1,2-dichlorethene
PCE - tetrachlorethene
TCE - trichlorethene
VNCL - vinyl chloride

TABLE 6 Cont' d
TAGA Tree Vent Monitoring - Spring (May) 1997
J-Field Phytoremediation Study
Aberdeen Proving Ground, Edgewood, MD
April 1999

DATE	TREE#	1122	1,2-DCE	PCE	TCE	VNCL
14 MAY	70	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	71	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	72	DL=11.2	DL=4.4	DL=3.3	7.1J	DL=10.0
14 MAY	73	DL=11.2	DL=4.4	11.1	20.1	DL=10.0
14 MAY	74	DL=11.2	DL=4.4	DL=3.3	23.0	DL=10.0
14 MAY	75	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	76	DL=11.2	DL=4.4	DL=3.3	3.9J	DL=10.0
14 MAY	77	DL=11.2	DL=4.4	DL=3.3	6.1J	DL=10.0
14 MAY	78	DL=11.2	DL=4.4	DL=3.3	3.0J	DL=10.0
14 MAY	79	DL=11.2	DL=4.4	DL=3.3	17.5	DL=10.0
14 MAY	80	DL=11.2	DL=4.4	DL=3.3	4.6J	DL=10.0
14 MAY	81	DL=11.2	4.5J	DL=3.3	36.5	DL=10.0
14 MAY	82	DL=11.2	DL=4.4	3.8J	9.5J	DL=10.0
14 MAY	83	DL=11.2	8.3J	DL=3.3	57.3	DL=10.0
14 MAY	84	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	85	DL=11.2	5.4J	4.3J	36.6	DL=10.0
14 MAY	87	DL=11.2	DL=4.4	DL=3.3	7.7J	DL=10.0
14 MAY	88	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0

All results in parts per billion by volume (ppbv).

DL - at or below detection limits (DLs given in ppbv)
J - above DLs below quantitation limits
1122 - 1,1,2,2- tetrachloroethane
1,2-DCE - trans-1,2-dichlorethene
PCE - tetrachlorethene
TCE - trichlorethene
VNCL - vinyl chloride

TABLE 6 Cont' d
TAGA Tree Vent Monitoring - Spring (May) 1997
J-Field Phytoremediation Study
Aberdeen Proving Ground, Edgewood, MD
April 1999

DATE	TREE#	1122	1,2-DCE	PCE	TCE	VNCL
14 MAY	89	DL=11.2	DL=4.4	DL-3.3	DL=3.0	DL=10.0
14 MAY	90	DL=11.2	DL=4.4	DL-3.3	DL=3.0	DL=10.0
14 MAY	91	DL=11.2	DL=4.4	DL-3.3	DL=3.0	DL=10.0
14 MAY	92	DL=11.2	DL=4.4	DL-3.3	DL=3.0	DL=10.0
14 MAY	93	DL=11.2	DL=4.4	DL-3.3	DL=3.0	DL=10.0
14 MAY	94	DL=11.2	DL=4.4	DL-3.3	DL=3.0	DL=10.0
14 MAY	95	DL=11.2	DL=4.4	3.7J	DL=3.0	DL=10.0
14 MAY	96	DL=11.2	DL=4.4	DL-3.3	DL=3.0	DL=10.0
14 MAY	97	DL=11.2	DL=4.4	5.1J	8.8J	DL=10.0
14 MAY	98	DL=15.9	DL=4.2	DL-4.2	DL=5.6	DL=10.0
14 MAY	98	DL=11.2	DL=4.4	3.7J	DL=3.0	DL=10.0
14 MAY	99	DL=11.2	DL=4.4	5.6J	DL=3.0	DL=10.0
14 MAY	100	DL=11.2	DL=4.4	58.7	4.7J	DL=10.0
14 MAY	101	DL=11.2	DL=4.4	7.1J	DL=3.0	DL=10.0
14 MAY	103	DL=11.2	DL=4.4	11.7	3.1J	DL=10.0
14 MAY	107	DL=11.2	DL=4.4	36.8	3.5J	DL=10.0
14 MAY	109	20.5J	5.0J	1540.3	22.2	DL=10.0
14 MAY	124	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0

All results in parts per billion by volume (ppbv).

DL - at or below detection limits (DLs given in ppbv)
J - above DLs below quantitation limits
1122 - 1,1,2,2- tetrachloroethane
1,2-DCE - trans-1,2-dichlorethene
PCE - tetrachlorethene
TCE - trichlorethene
VNCL - vinyl chloride

TABLE 6 Cont' d
TAGA Tree Vent Monitoring - Spring (May) 1997
J-Field Phytoremediation Study
Aberdeen Proving Ground, Edgewood, MD
April 1999

DATE	TREE#	1122	1,2-DCE	PCE	TCE	VNCL
14 MAY	126	DL=11.2	DL=4.4	DL=3.3	18.1	DL=10.0
14 MAY	128	DL=11.2	DL=4.4	DL=3.3	6.1J	DL=10.0
14 MAY	130	DL=11.2	DL=4.4	DL=3.3	4.3J	DL=10.0
14 MAY	131	DL=15.9	6.1J	DL=4.2	107.1	DL=10.0
14 MAY	131	DL=11.2	6.9J	DL=3.3	115.6	DL=10.0
14 MAY	132	DL=11.2	DL=4.4	5.9J	4.0J	DL=10.0
14 MAY	133	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	134	DL=11.2	DL=4.4	6.1J	10.6	DL=10.0
14 MAY	135	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	136	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	137	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	138	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	139	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	140	DL=11.2	DL=4.4	DL=3.3	5.0J	DL=10.0
12 MAY	141	DL=15.9	DL=4.2	DL=4.2	14.9J	DL=10.0
14 MAY	141	DL=11.2	DL=4.4	DL=3.3	16	DL=10.0
14 MAY	142	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	143	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0

All results in parts per billion by volume (ppbv).

DL - at or below detection limits (DLs given in ppbv)
J - above DLs below quantitation limits
1122 - 1,1,2,2- tetrachloroethane
1,2-DCE - trans-1,2-dichlorethene
PCE - tetrachlorethene
TCE - trichlorethene
VNCL - vinyl chloride

TABLE 6 Cont' d
TAGA Tree Vent Monitoring - Spring (May) 1997
J-Field Phytoremediation Study
Aberdeen Proving Ground, Edgewood, MD
April 1999

DATE	TREE#	1122	1,2-DCE	PCE	TCE	VNCL
14 MAY	144	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	145	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	147	DL=11.2	DL=4.4	5.1J	16.4	DL=10.0
12 MAY	148	DL=15.9	DL=4.2	DL=4.2	DL=5.6	DL=16.0
14 MAY	148	DL=11.2	DL=4.4	DL=3.3	5.7J	DL=10.0
14 MAY	149	DL=15.9	DL=4.2	DL=4.2	8.4J	DL=16.0
14 MAY	149	DL=11.2	DL=4.4	DL=3.3	12.7	DL=10.0
14 MAY	150	DL=11.2	DL=4.4	DL=3.3	22	DL=10.0
14 MAY	168	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	169	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	170	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	171	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	172	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
12 MAY	173	DL=15.9	DL=4.2	DL=4.2	DL=5.6	DL=16.0
14 MAY	173	22.7J	DL=4.4	DL=3.3	DL=3.0	DL=10.0
12 MAY	174	DL=15.9	DL=4.2	7.5J	37.5	DL=16.0
14 MAY	174	34.2J	8.3J	24.6	141.7	DL=10.0
12 MAY	175	DL=15.9	DL=4.2	DL=4.2	6.9J	DL=16.0

All results in parts per billion by volume (ppbv).

DL - at or below detection limits (DLs given in ppbv)
J - above DLs below quantitation limits
1122 - 1,1,2,2- tetrachloroethane
1,2-DCE - trans-1,2-dichlorethene
PCE - tetrachlorethene
TCE - trichlorethene
VNCL - vinyl chloride

TABLE 6 Cont' d
TAGA Tree Vent Monitoring - Spring (May) 1997
J-Field Phytoremediation Study
Aberdeen Proving Ground, Edgewood, MD
April 1999

DATE	TREE#	1122	1,2-DCE	PCE	TCE	VNCL
14 MAY	175	DL=11.2	DL=4.4	5.7J	11.0	DL=10.0
12 MAY	176	DL=15.9	DL=4.2	DL=4.2	DL=5.6	DL=16.0
14 MAY	176	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	177	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	178	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	180	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	181	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	182	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	183	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	184	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	185	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	186	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	187	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	188	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	189	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	190	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	191	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	192	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	193	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	194	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	196	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	197	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	198	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	199	DL=11.2	DL=4.4	DL=3.3	DL=3.0	DL=10.0
14 MAY	200	DL=11.2	DL=4.4	3.6J	18.5	DL=10.0

All results in parts per billion by volume (ppbv).

DL - at or below detection limits (DLs given in ppbv)
J - above DLs below quantitation limits
1122 - 1,1,2,2- tetrachloroethane
1,2-DCE - trans-1,2-dichlorethene
PCE - tetrachlorethene
TCE - trichlorethene
VNCL - vinyl chloride

TABLE 7
Haloacetic Acid Results in Tree Tissue - Summer (July/August) 1997
J-Field Phytoremediation Study
Aberdeen Proving Ground, Edgewood, MD
April 1999

(Reported in ug/L)

Sample	MCAA	DCAA	MBAA	TCAA	BCAA	DBAA
Phragamites spp.	ND	ND	ND	ND	ND	ND
Tree 148	ND	ND	ND	3.7	ND	ND
Tree 170	ND	ND	ND	ND	ND	ND
Tree 102	ND	ND	ND	ND	ND	ND
Tree 174	ND	ND	ND	15	ND	ND
Tree 175	ND	ND	ND	5.1	ND	ND
Tree 139	ND	ND	ND	ND	ND	ND
Tree 65	ND	ND	ND	ND	ND	ND
Water Blank	ND	ND	ND	ND	ND	ND

MCAA - monochloroacetic acid
DCAA - dichloroacetic acid
MBAA - monobromoacetic acid
TCAA - trichloroacetic acid
BCAA - bromochloroacetic acid
DBAA - dibromoacetic acid
ug/L - micrograms per Liter
ND - not detected (detection limit equals 0.31 ug/L)
Multiply ug/L by 10 to get ug/kg wet weight of leaves and by 33.3 to get ug/kg dry weight of leaves.

TABLE 8
Tree Tissue Extract Results - Summer (July / August) 1997
J-Field Phytoremediation Study
Aberdeen Proving Ground, Edgewood, MD
April 1999

(Reported in ug/L)

Sampling Date Sample # Compound	Tree 148 08/01/97 11838	Tree 174 08/01/97 11841	Tree 175 08/01/97 11842	Tree 139 08/01/97 11843
Acetone	5.8	ND	5.4	7.9
1122	ND	79	ND	11

ND - non detect (detection limit equals 1 ug/L)
Multiply ug/L by 10 to get ug/kg wet weight of leaves and by 33.3 to get ug/kg dry weight of leaves.

TABLE 9
Tree Tissue Extract Results - Summer (July / August) 1997
J-Field Phytoremediation Study
Aberdeen Proving Ground, Edgewood, MD
April 1999

based on wet weight

Sample	*Phragmites spp.*	Tree 174	Tree 175	Tree 139
TCAA *	ND	325	66.9	ND
DCAA	86.6	13600	7740	ND
TCEtOH	ND	ND	ND	ND
DCEtOH	ND	10700	6380	5640
1,1,1,2-PCA	ND	ND	ND	ND
TCA**	1	ND	ND	34
PCE	ND	2.33	1.66	1.14
TCEtOH	ND	7.64	1.47	1.45
c-DCE	Unable to achieve resolution or a dose response			
t-DCE	Unable to achieve resolution or a dose response			
1122	Unable to achieve resolution or a dose response			

results in ug/kg based on wet weight
* - results are unreliable and are therefore estimated
** - 23 ug/L measured in blank - this amount has been subtracted from results
TCAA - trichloroacetic acid
DCAA - dichloroacetic acid
TCEtOH - trichloroethanol
DCEtOH - dichloroethanol
ND - below detection limit

TABLE 10

Tree Condensate and Transpiration Gas VOC Results - Summer (July / August) 1997

J-Field Phytoremediation Study

Aberdeen Proving Ground, Edgewood, MD

April 1999

Sample	Condensate (ug/L)				Gas* (ppbv)			
	TCE	1122	TCA	TIC C_5H_8	TCE	1122	TCA	TIC C_5H_8
Tree 174 North	4.8	340	1.2	19	210	2000	17J	8821
Tree 174 East	6.3	640	2.2	5	160	2000	14J	7247
Tree 175	2.5	100	ND	100	59	210	2.6J	684
Tree 139	ND	ND	ND	36	NS	NS	NS	NS
Tree 102	ND	ND	ND	96	NS	NS	NS	NS
Tree 170	ND	ND	ND	110	NS	NS	NS	NS
Tree 148	ND	ND	ND	64	2.1J	ND	ND	ND
Tree 55	ND	ND	ND	91	NS	NS	NS	NS
Tree 65	ND	ND	ND	100	NS	NS	NS	NS
Tree 140	ND	ND	ND	24	NS	NS	NS	NS

*Gas samples collected with Summa canisters

TIC - tentatively identified compound

NS - no sample collected due to low volume

ND - non detect (detection limit equals 1 ug/L)

J - Estimated

ug/L - micrograms per liter

ppbv - parts per billion by volume

Field Blank was non detect for all compounds.

Note - Acetone and/or 2-butanone was detected in the condensate but not in any field, trip, or lab blanks.

TABLE 11
Transpiration Gas VOC Results - Summer (July/August) 1997
J-Field Phytoremediation Study
Aberdeen Proving Ground, Edgewood, MD
April 1999

Sampling Location	TCE	1122	TCA
Tree 174 North	200	ND (200)	1100
Tree 174 East	ND (500)	ND (500)	1000
Tree 174 - ambient	ND	ND	19
Tree 175	ND (500)	ND (500)	ND (500)
Tree 140	ND	ND	ND
Tree 139	ND	ND	ND
Tree 148	ND	ND	ND
Tree 170	ND	ND	ND
Tree 65	ND	ND	ND
Tree 102	ND	ND	ND
Tree 55	ND	ND	ND

All results are reported in parts-per-billion volume/volume (ppb v/v).
ND - non detect (detection limit equal to 4 ppb v/v unless noted in parenthesis)

TABLE 12
Flux Chamber Results - Summer (July/August) 1997
J-Field Phytoremediation Study
Aberdeen Proving Ground, Edgewood, MD
April 1999

Sampling Location	Sample ID	TCE	1122	TCA
F1	12659	ND	ND	ND
F2	12650	ND	ND	ND
F3	12651	9.4	ND	ND
F4	12652	ND	ND	ND
F5	12653	ND	ND	ND
F6	12654	ND	ND	ND
F7	12655	38	ND	ND
F8	12658	38	ND	ND

All results are reported in parts-per-billion volume/volume (ppb v/v).
ND - non detect, (detection limit is 4 ppb v/v)
Analysis performed by on-site Viking GC/MS.
GC/MS - gas chromatography/mass spectrometry

TABLE 13
Tree Condensate and Transpiration Gas VOC Results - Fall (September/October) 1997
J-Field Phytoremediation Study
Aberdeen Proving Ground, Edgewood, MD
April 1999

	Condensate (ug/L)			Gas (ppbv)		
Sample	TCE	1122	TIC C_5H_8	TCE	1122	TIC C_5H_8
Tree 69	ND	ND	34	ND	ND	340
Tree 174	1.8	160	ND	99	919	2389
Tree 196	ND	17	ND	ND	0.7J	496
Tree 147	ND	ND	17	6.0	54	703
Tree 139	ND	ND	21	ND	1J	527
Tree 62	ND	ND	10	0.8J	2J	788
Tree 175	ND	ND	7	1J	2J	237
Contaminated sycamore	NS	NS	NS	7	71	366
Background sycamore	NS	NS	NS	ND	ND	133

TIC - tentatively identified compound
NS - no sample collected due to low volume
ND - non detect
J - Estimated
ug/L - micrograms per liter
ppbv - parts per billion by volume

TABLE 14
Tree Health Data
J-Field Phytoremediation Study
Aberdeen Proving Ground, Edgewood, MD
April 1999

Tree Number	22-May-96	06-Jun-96	20-Aug-96	08-Nov-96	03-Oct-97
1	CB	SD	D	RP	P, TB
2	SD	NG	H	H	P, TB
3	H	H	TB	H	P, B
4	SD	SD	H	CB	D
5	SD	SD	H	H	P, B
6	SD (1)	NG (2)	TB	RP	P, B
7	SD	CB	D	RP	P, TB
8	SD	NG	H	DR	P, B
9	H	H	H	H	P, TB
10	H	H	TB	H	P, B
11	CB	SD	D	RP	P, B
12	H (1)	H	H	DR	P, TB
13	CB	NC	H	DR	
14	SD (1)	SD (2)	TB	SD	P
15	H	H	TB	H	H, TB
16	H	H	H	H	P, TB
17	H	H	TB	H	P, TB
18	H	H	TB	H	P, TB
19	H	H	TB	H	H
20	SD (1)	CB (2)	D	RP	P, B
21					
22	H (1)	H	H	DR	
23					
24					P, TB
25					
26					
27					
28					
29					
30					
31					
32					
33					
34					

B - bare
CB - damaged and cut back to growth
D - dead
DR - deer rub
H - healthy
NC - no change
NG - new growth
P - poor
RP - replanted
SD - significant and/or severe damage
TB - tip burn
(1) - caterpiller infestation
(2) - no caterpillers

TABLE 14 Cont'd.
Tree Health Data
J-Field Phytoremediation Study
Aberdeen Proving Ground, Edgewood, MD
April 1999

Tree Number	22-May-96	06-Jun-96	20-Aug-96	08-Nov-96	03-Oct-97
35					
36					
37					
38	SD	SD	SD	RP	P, TB
39	CB	NG	H	DR	D
40	CB	SD	D	RP	P, TB
41	H	H	H	H	H
42	H	CB	D	RP	P, TB
43	H	H	TB	CB	D
44	SD	NG	H	RP	P, TB
45	H	H	TB	H	P, B
46	H	H	H	H	H, TB
47	H	H	TB	H	P, B
48	H	H	H	H	H
49	H	H	TB	CB	D
50	SD	SD	CB	H	H, TB
51	H	H	TB	H	P, TB
52	H	H	H	DR	H
53	H	H	H	H	H, TB
54	H	H	H	H	H
55	H	H	H	H	H
56	H	H	H	H	H
57	H	H	H	H	H
58	H	H	H	H	H
59	H	H	H	H	H
60	H	H	H	H	H
61	H	H	H	H	H
62	H	H	H	H	H
63	H	H	H	DR	H
64	H	H	H	H	H
65	H	H	H	H	H
66	H	H	H	H	H
67	H	H	H	H	H
68	H	H	H	H	H

B - bare
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H - healthy
NC - no change
NG - new growth
P - poor
RP - replanted
SD - significant and/or severe damage
TB - tip burn
(1) - caterpiller infestation
(2) - no caterpillers

TABLE 14 Cont'd.
Tree Health Data
J-Field Phytoremediation Study
Aberdeen Proving Ground, Edgewood, MD
April 1999

Tree Number	22-May-96	06-Jun-96	20-Aug-96	08-Nov-96	03-Oct-97
69	H	H	H	H	H
70	H	H	H	H	H
71	H	H	H	H	H
72	H	H	H	H	H
73	H	H	H	H	H
74	H	H	H	H	H
75	H	H	H	H	H, TB
76	H	H	H	H	H
77	CB	SD	D	RP	D
78	H	H	D	RP	P
79	SD	SD	H	H	H
80	H	CB	D	RP	P
81	H	H	H	H	H, TB
82	SD	SD	H	H	H
83	H	H	H	H	H, TB
84	SD	CB	H	H	H
85	SD	NG	H	H	H, TB
86	SD	SD	H	H	
87	H	H	H	DR	H
88	H	H	H	H	H
89	H	H	H	H	H
90	H	H	H	H	H
91	SD	CB	H	H	H
92	H	H	H	H	H
93	H	H	H	DR	H
94	H	H	H	H	H
95	H	H	H	H	H
96	H	H	H	H	H
97	H	H	H	H	H
98	H	H	H	H	H
99	H	H	H	H	H
100	H	H	H	H	H

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TABLE 14 Cont'd.
Tree Health Data
J-Field Phytoremediation Study
Aberdeen Proving Ground, Edgewood, MD
April 1999

Tree Number	22-May-96	06-Jun-96	20-Aug-96	08-Nov-96	03-Oct-97
101	H	H	H	H	H
102	H	H	H	H	H
103	H	H	H	H	H
104	H	H	H	DR	H
105	CB	SD	D	RP	P
106	H	H	H	H	H
107	H	H	H	H	H
108	H	H	H	H	H
109	SD	SD	H	H	H
110	CB	SD	D	RP	P, TB
111	H	H	H	H	H
112	CB	SD	D	RP	P
113	H	H	H	H	H
114	CB	SD	D	RP	P, TB
115	H	H	H	H	H
116	H	H	H	H	H
117	H	H	H	H	H
118	H	H	H	DR	H
119	SD	SD	H	H	H
120	SD	NG, CB	H	H	H
121	H	H	H	H	H
122	SD	NG	H	H	H
123	H	H	H	H	H
124	SD	SD	H	H	H
125	H	H	H	H	H
126	H	H	H	H	H
127	SD	NG	H	H	H
128	H	H	H	H	H
129	CB	SD	H	H	H
130	H	H	H	H	H
131	H	H	H	H	H
132	H	H	H	H	P
133	H	H	H	H	H
134	H	H	H	DR	H
135	CB	NG	D	RP	P
136	H	H	H	H	H
137	H	H	H	H	H
138	H	H	H	H	H
139	H	H	H	H	H

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TABLE 14 Cont'd.
Tree Health Data
J-Field Phytoremediation Study
Aberdeen Proving Ground, Edgewood, MD
April 1999

Tree Number	22-May-96	06-Jun-96	20-Aug-96	08-Nov-96	03-Oct-97
140	SD	NG	H	H	H
141	H	H	H	H	H
142	SD	NG	H	H	H
143	H	H	H	H	H
144	H	H	H	H	H
145	H	H	H	H	H
146	CB	SD	D	DR	D
147	H	H	H	H	H
148	H	H	H	H	H
149	H	H	H	H	H
150	H	H	H	H	H
151	H	H	H	H	H
152	H	H	H	H	H
153	H	H	H	H	H
154	SD	NG	H	H	H
155	H	H	H	CB	H
156	H	H	H	H	H
157	H	H	H	H	H
158	H	H	H	DR	H
159	H	H	H	DR	H
160	H	H	H	H	H
161	CB	NG	H	H	H
162	CB	NG	H	H	D
163	H	H	H	H	H
164	SD	SD	H	H	H
165	SD	NG	H	H	H
166	CB	NG	H	DR	D
167	CB	NG	D	RP	P
168	H	H	H	H	H
169	H	H	H	H	H
170	H	H	H	H	H
171	H	H	H	H	H
172	H	H	H	DR	H
173	H	H	H	H	H
174	H	H	H	H	H
175	H	H	H	H	H
176	SD	NG	H	H	H
177	H	H	H	H	H
178	H	H	H	H	P

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TABLE 14 Cont'd.
Tree Health Data
J-Field Phytoremediation Study
Aberdeen Proving Ground, Edgewood, MD
April 1999

Tree Number	22-May-96	06-Jun-96	20-Aug-96	08-Nov-96	03-Oct-97
179					
180	H	H	H	H	H
181	H	H	H	H	H
182	H	H	H	H	H
183	CB	SD	D	RP	P
184	H	H	H	H	H
185	H	H	H	H	H
186	H	H	H	H	H
187	H	H	H	H	H
188	H	H	H	H	H
189	H	H	H	H	H
190	H	H	H	H	H
191	H	H	H	H	H
192	H	H	H	H	H
193	H	H	H	H	H
194	H	H	H	H	H
195					
196	H	H	H	H	H
197	H	H	H	DR	H
198	H	H	H	DR	H
199	H	H	H	H	H
200	H	H	H	H	H

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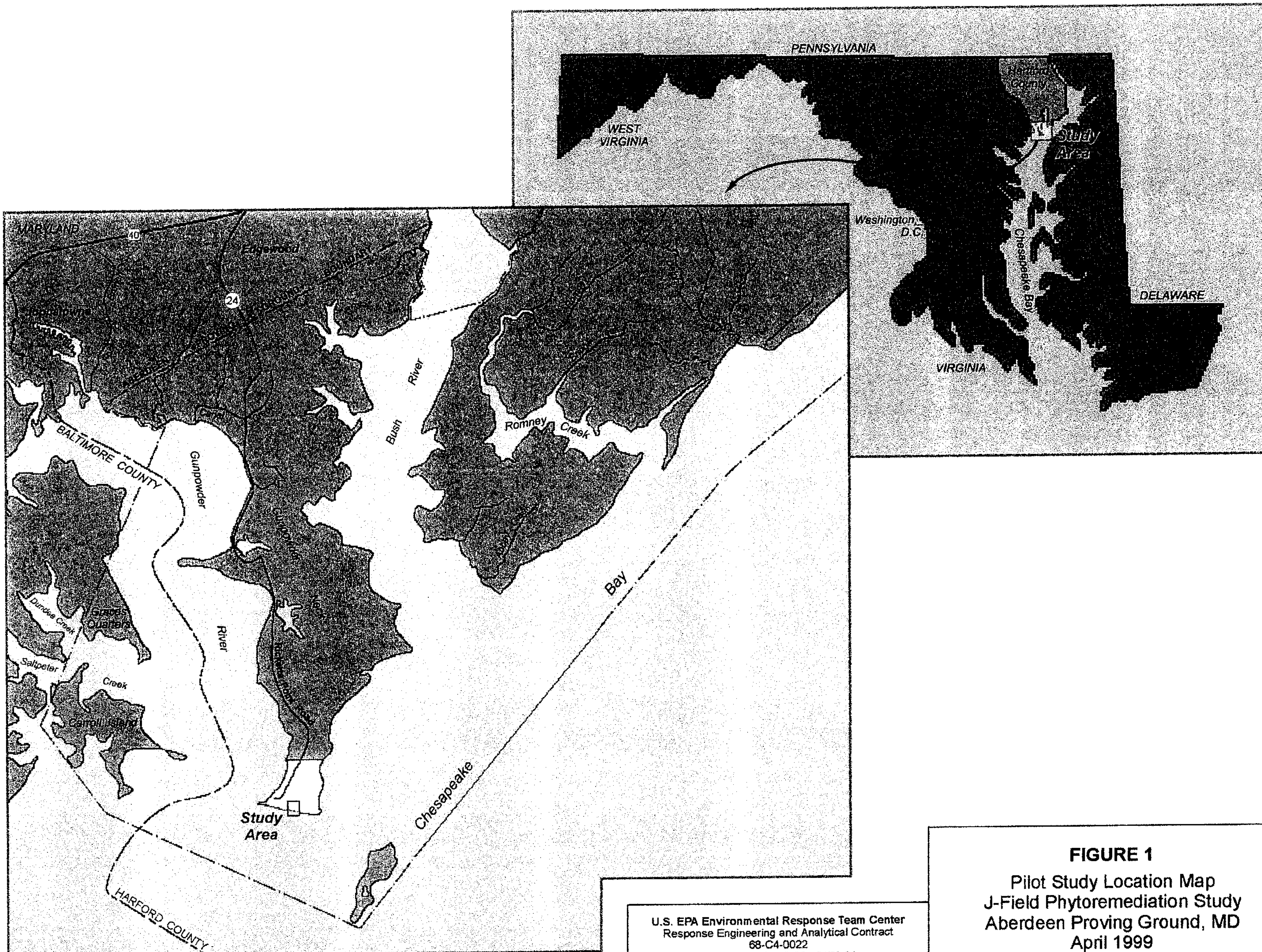
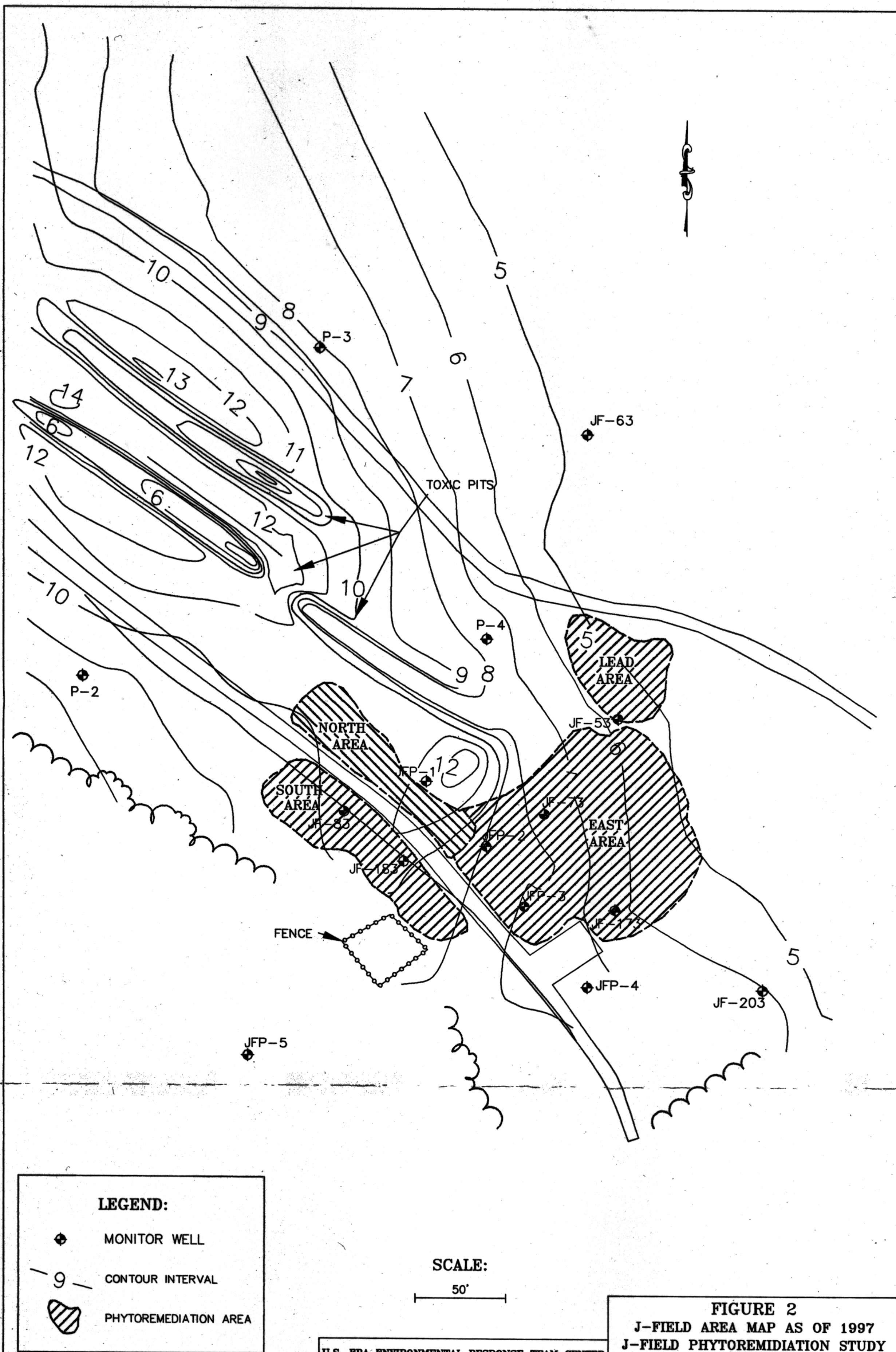


U.S. EPA Environmental Response Team Center
Response Engineering and Analytical Contract
68-C4-0022
W.O. # 03347-143-001-3173-01

FIGURE 1
Pilot Study Location Map
J-Field Phytoremediation Study
Aberdeen Proving Ground, MD
April 1999

1173maps.cdr



U.S. EPA ENVIRONMENTAL RESPONSE TEAM CENTER
RESPONSE ENGINEERING AND ANALYTICAL CONTRACT
68-C4-0022
W.O.# 03347-143-001-3173-01

FIGURE 2
J-FIELD AREA MAP AS OF 1997
J-FIELD PHYTOREMIDIATION STUDY
ABERDEEN PROVING GROUND, MD
APRIL 1999

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