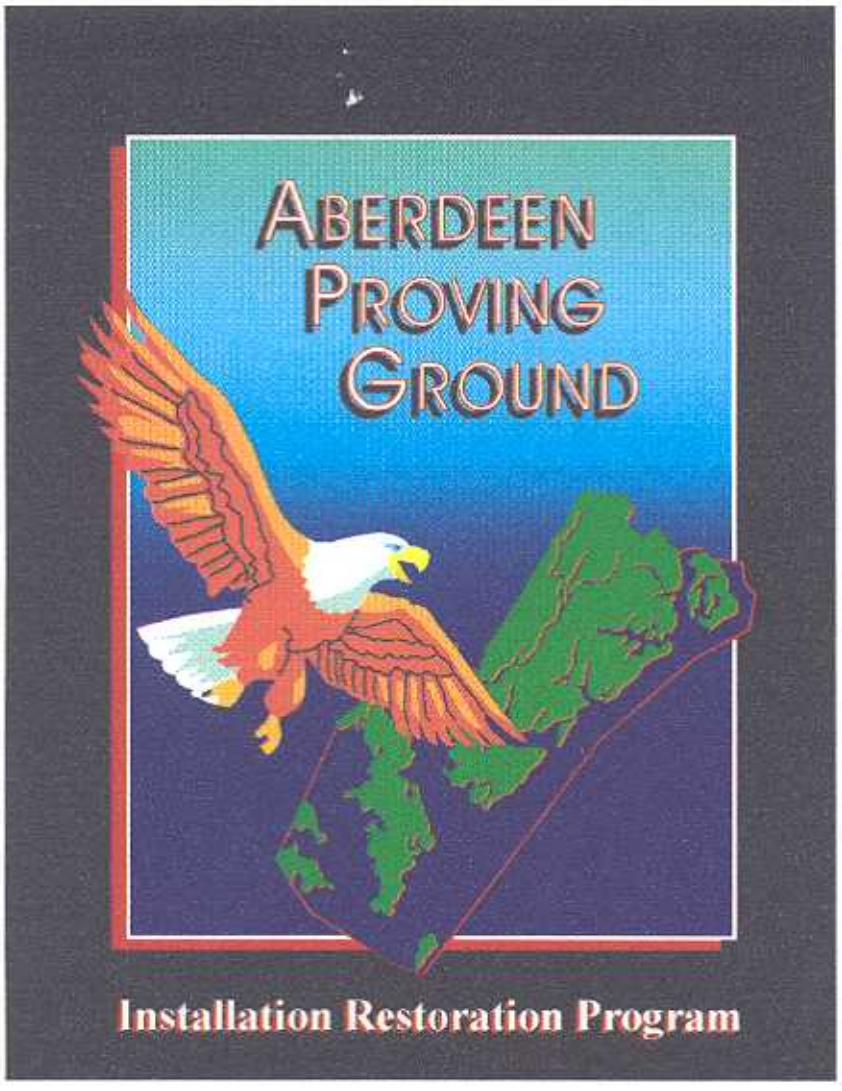

WORK PLAN FOR THE MID-GROWING SEASON SAMPLING PERIOD

J-FIELD PHYTOREMEDIATION STUDY

ABERDEEN PROVING GROUND, MARYLAND JULY 1998

1.0 OBJECTIVE

The Response Engineering and Analytical Contract (REAC) under the United States Environmental Protection Agency's Environmental Response Team Center (U.S. EPA/ERTC) will provide the requested sampling, monitoring and analytical analyses to evaluate pilot-scale phytoremediation at the J-Field Toxic Pits Site, Aberdeen Proving Ground (APG), Maryland.

The current objectives of this project are to:

1) compile groundwater data for the site and generate models of contaminant concentrations and water levels.

2) monitor water levels and contaminant concentrations in wells and lysimeters within the study area.

3) design, implement, and optimize an air sampling/monitoring device to capture volatile compounds and their degradation compounds in transpiration gas and condensate samples.

4) collect and analyze tree tissue samples for contaminants of concern.

5) monitor tree transpiration rates by measuring flow and correlate findings with meteorological data.

6) monitor soil flux emissions from established sampling locations for diurnal and seasonal changes.

7) utilize OP-FTIR to measure mass emissions of parent compounds from the phytoremediation study area.

8) maintain the phytoremediation study area by pruning, performing agronomic assessments, adding fertilizer / soil amendments, and clearing the drainage system.

9) use a geoprobe or similar machinery to collect groundwater samples as close to the surface of the water table as possible. Water samples will then be analyzed for volatile organic compounds.

2.0 PROJECT SCOPE

J-Field is located at the tip of Gunpowder Neck, Edgewood Area of APG in Harford County, Maryland. The Toxic Pits area of J-Field was once the disposal site for chemical warfare agents, munitions, and industrial chemicals. The Toxic Pits area consists of two parallel disposal pits that are approximately 10 feet deep by 15 feet wide by 200 feet long. Remnants of other pits extend into the marsh area to the southeast. The pits were used for open-pit burning and detonation from 1940 through 1980.

During open burning, wood was first placed in the pit 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 the material was performed in the adjacent pit. Any remaining debris was 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 push out area for the pits.

The types of materials handled at these pits included:

High explosives
Nerve agents
Mustard agents

Smoke materials
Solvents

The contaminants of concern are:

1,1,2,2-tetrachloroethane (1122)
1,1,2-trichloroethane (TCA)
trans-1,2-dichloroethene (DCE)
trichloroethene (TCE)
tetrachloroethene (PCE)
lead (Pb)

The ecosystem of concern is the Chesapeake Bay and surrounding waterways. Additional information/data may be found in: *Hydrology and Soil Gas at J-Field, Aberdeen Proving Ground, Maryland, U.S. Geological Survey, Water-Resources Investigations Report 92-4087, 1993.*

2.1 J-Field Phytoremediation

The J-Field Phytoremediation Sampling & Monitoring Pilot Study is being performed as an interim measure to prevent the migration of contaminants into the marsh area located to the east of the toxic pits. The feasibility of this type of process will be studied and evaluated for future full-scale use in remediating the site. Contaminant migration will be reduced either by depletion of the concentration of contaminants in the groundwater by means of transpiration and microbial degradation, by interception of the flow of groundwater by means of water uptake, or by reduction of the concentration of contaminants in the soil by means of microbial degradation and natural soil flushing.

The pilot-scale TreeMediation system was installed in March and April 1996 by ERTC as assisted by REAC and Applied Natural Sciences, Inc. (ANS) personnel. Since the time of the installation, site visits were made to monitor the progress of the trees, install a drainage system on the site, and collect samples.

Monitoring of the pilot system will involve the collection and analysis of leaves, stems, roots, soil, and groundwater over a five-year period. Sap flow rates and transpiration gases will also be measured.

Data from various agencies, companies, and APG will be compiled. Modeling of contaminant and water levels will be performed in order to establish a base for all subsequent sampling events. These data will be utilized to determine the effect the trees have on the groundwater system.

3.0 TECHNICAL APPROACH

3.1 Monitor Well/Lysimeter Sampling

Monitoring of the wells and lysimeters will include obtaining one round of samples per year to determine groundwater contaminant concentrations. Groundwater sampling for Volatile Organic Compounds (VOCs) and Target Analyte List (TAL) metals will be conducted on wells JF-53, JF-63, JF-73, JF-83, JF-183, JF-173, JF-203, JFP 1 through 5, and P-2 through 4. This data will be used to assess the effectiveness of the remediation project. Permanent water elevation monitors located at well JF-53, JF-63, JF-73 and JF-83 will record changes in groundwater levels. Additional groundwater level monitors may be installed.

Groundwater sampling of monitor wells will be performed in accordance with APG protocols (Appendix A) and any measurements will be recorded on Well Purge Forms along with the time of the reading and the cumulative volume extracted. Prior to purging, water depth will be recorded for each individual well. Each well will be purged prior to sampling using disposable bailers in accordance with the acceptable purge/sampling devices listed in the APG Standard Operating Procedure (SOP). Initially, after removing three Liters of water from the well while purging, a sample will be collected for pH, temperature, turbidity, conductivity and dissolved oxygen. These stabilization measurements will be collected using a Horiba water quality monitoring instrument, where an individual water sample will be poured from the bailer into a designated sampling cup. These measurements will be used to determine if conditions in the well have stabilized. Stabilization is achieved when three successive readings are within ± 0.1 for pH, $\pm 3\%$ for conductivity and $\pm 10\%$ for turbidity and dissolved oxygen (DO). Turbidity and DO are typically the last parameters to stabilize. If turbidity samples do not approach the range of natural groundwater (10 nephlometric turbidity units (NTU), both filtered and unfiltered samples will be collected for metals analysis. A sample will be collected when the total volume of water purged exceeds the water volume in the screened interval and the surrounding filter pack (the minimum purge volume for each well will be listed on the sampling form), and parameters stabilize to within over three consecutive readings. Lysimeters will be sampled in accordance with the TIMCO lysimeter manual (Appendix B).

Other sampling events from only a portion of the wells and or lysimeters will be performed as necessary. Monthly water elevations will be collected to determine groundwater levels throughout the year. The data will be compared to weather parameters to determine the effect on fluctuations in the groundwater. The data will also be compared to groundwater contaminant modeling data to determine the impact of more highly contaminated groundwater on the trees.

3.2 Phytoremediation Monitoring

3.2.1 Plant Growth Measurements and Visual Observations

Plant growth will be measured during the mid-growing season sampling event (July). Measures of plant growth will include diameter at breast height (DBH) (1.4 meters above ground level) using tree girth diameter tape. Total height will be measured with a telescoping tree measuring pole. Observations of plant health will be conducted quarterly. Evidence of insect damage, chlorosis, wilting, and other visual symptoms of poor health will be recorded quarterly. Vegetation growing between the trees will be clipped annually to reduce competition with the trees.

3.2.2 Weather Monitoring

Weather parameter data will be collected from various sources. Parameters such as daily precipitation, wind speed/direction, solar radiation, and temperature will be recorded throughout the monitoring period. Weather and solar radiation data will be correlated with measures of transpiration.

3.2.3 Plant Tissue Sampling

Plant tissue samples (roots, shoots, leaves) will be collected from selected trees. Sample quantities will be determined by analytical methodology. Sampling will be conducted during the mid-growing season sampling event (July) to assess seasonal variability in the translocation of contaminants in plant tissues.

3.2.4 Soil-Flux Sampling / OP-FTIR

Soil flux samples will be taken from previously monitored sampling locations during both day and nighttime periods to measure emissions from the site. Additional monitoring of mass emissions of parent compounds from the plantation area will be conducted using open path-Fourier transform infrared (OP-FTIR) during the mid-growing season sampling event (July).

3.2.5 Plant Transpiration Measurements

Two methods of determining sap flow rates will be used. The heat balance technique, which has been used during previous monitoring events, uses the Dynamax Flow32^{tm} Sap Flow System to measure the transpiration rate in grams water/hour/tree. This method is non-invasive and does not injure the tree. The second method, Thermal Dissipation Sap Velocity (TDSV), uses small probes inserted into holes drilled in the tree trunk to measure sap flow rates. Transpiration rates will be recorded on eight trees or more over a one week period using the two sampling methods. This information will be correlated with measures of VOCs in transpiration gas and with meteorological data in order to estimate the quantity of VOCs being emitted from the trees over the course of the season.

3.2.6 Transpiration Gas Sampling

Transpiration gas will be measured on trees using the following method. A Tedlar bag will be placed over a three foot section of the end of a branch. The bag will be sealed around the stem using clay and a mechanical fastener. A cold trap attached to the system will remove condensate from the Tedlar bag enclosure. Air will be circulated through the enclosure and cold trap so that transpiration rates will not be substantially reduced in the affected branch due to increased relative humidity within the enclosure.

Transpiration gases and condensate from the enclosure will be sampled and analyzed for VOCs. Mean transpiration rates and mean contaminant concentrations in transpired gases and condensate will be used to estimate the quantity of transpired water and contaminants for the entire planting area.

3.2.7 Surficial Aquifer Sampling

A geoprobe or similar machinery will be used to collect discrete samples in the upper portion of the surficial aquifer in an attempt to determine if a concentration gradient exists in the vicinity of the tree root zone. This will be done at 5 trees to be chosen by EPA / ERTC and approximately 4 samples will be taken per tree.

3.3 Soil Sampling

Any soil sampling or boring will require a magnetometer sweep for UXO (unexploded ordnance) avoidance. An contractor to REAC will provide this service. This will ensure that no unexploded ordnance or munitions are present where sampling and/or boring is being performed. Soil samples may be collected from the root zone of the trees for chemical analysis. Any samples to be taken off base will be cleared of chemical agents through the CTF lab and Scitech Services of APG.

3.4 Standard Operating Procedures

A magnetometer sweep for UXO avoidance will be performed according to procedures set forth in the Site Health and Safety Plan before any intrusive activities are performed. ERTC/REAC and APG

SOPs will be utilized. The more stringent of the two SOPs will be utilized. Any discrepancies to these SOPs will be noted in a field logbook.

3.4.1 Sample Documentation

Sample documentation will be completed as per the following Standard Operating Procedures (SOPs):

- ERTC/REAC SOP #2002, *Sample Documentation*
- ERTC/REAC SOP #4005, *Chain of Custody Procedures*
- ERTC/REAC SOP #4021, *Preparation of Final Reports*

3.4.2 Sample Packaging and Shipment

Sample packaging and shipment will be conducted in accordance with the following SOP:

- ERTC/REAC SOP #2004, *Sample Packaging and Shipment*

3.4.3 Sampling Techniques

- ERTC/REAC SOP #2007, *Groundwater Well Sampling*
- ERTC/REAC SOP #2012, *Soil Sampling*
- ERTC/REAC SOP #2001, *General Field Sampling Guidelines*
- ERTC/REAC SOP #2003, *Sample Storage, Preservation, and Handling*
- ERTC/REAC SOP #2013, *Surface Water Sampling*
- ERTC/REAC SOP #2041, *Operation of the Hydrolab Surveyor II Water Quality Management System*
- ERTC/REAC SOP #2016, *Sediment Sampling*
- ERTC/REAC SOP #2043, *Water Level Measurement*
- APG SOP # 013, *Collection of Monitoring Well Samples*

Other ERTC/REAC SOPs will be followed where appropriate for the various phases of the project.

3.5 Equipment Decontamination

The following equipment decontamination procedure will be employed prior and subsequent to boring holes and/or for large equipment:

- physical removal
- high pressure nonphosphate detergent wash
- potable water rinse

The following sample equipment decontamination procedure will be employed prior to collection of environmental samples with nondedicated sampling equipment:

- physical removal
- nonphosphate detergent wash
- deionized water rinse
- 10% nitric acid wash
- deionized water rinse
- acetone wash

- deionized water rinse
- air dry

3.6 Waste/Sample Disposal

3.6.1 Investigation-Derived Waste (IDW) Disposal

RCRA Hazardous IDW:

- Any waste generated from the analytical procedures will be disposed through the appropriate hazardous waste disposal contractors in accordance with applicable regulations.

Other IDW:

- Waste generated on site will remain on site and be disposed through the appropriate hazardous waste disposal contractors in accordance with applicable regulations.

3.6.2 Sample Residuals Disposal

All of the treated and untreated samples will be maintained for 60 days after the issuance of the final report. If no additional testing is requested at the end of the 60 days, arrangements will be made for disposal.

APPENDIX A
WORK PLAN
PHYTOREMEDIATION SAMPLING & MONITORING PILOT STUDY
J-FIELD, ABERDEEN PROVING GROUND, MARYLAND
JULY 1998

APPENDIX B
WORK PLAN
PHYTOREMEDIATION SAMPLING & MONITORING PILOT STUDY
J-FIELD, ABERDEEN PROVING GROUND, MARYLAND
JULY 1998

Proposed Sampling Schedule

Monday - July 13
Mobilization Day
FTIR - Amy, Ken, Michelle
Flow32 - Mark, Dale, Jen
Viking - Chuck, Larry
Geoprobe - McKenna
Weather Station - Ken

Extra People - Tim, Nicole

How often Sample
GP – Data Logger

Tuesday - July 14
Daytime Flux - Ken, Nicole
Op-FTIR - Amy, Ken, Michelle
Well Sampling - Tim, Nicole and other available people
Flow 32 (check) - Mark, Dale
Weather Station (check) - Ken
Transpiration Gas Sampling - Larry, Ken, Harry, Dale, Jen
Geoprobe - McKenna
Sample Management - Jen, Michelle, Nicole (includes filetering water samples)
Tree Tissue Sampling - Mark, Harry, Dale

Tuesday - July 14 (Night)
Nighttime Flux - Ken, Nicole, Amy, Mark, Dale

Wednesday - July 15
Flow 32 (check) - Mark, Dale
Weather Station (check) - Ken
Transpiration Gas Sampling - Larry, Ken, Harry, Dale, Jen
Well Sampling - Tim, Nicole and other available people
Geoprobe - McKenna
Tree Maintenance/Health/Height - Dale, Nicole, Jen, Michelle?
(Includes cleaning drainage system)
Tree Tissue Sampling - Mark, Harry, Dale
Sample Management - Jen, Michelle, Nicole (includes filetering water samples)

Thursday - July 16 - EPA VISIT
1. OP-FTIR Explanation - Amy (flux explanantion - Ken)
2. Flow 32 / Transpiration Gas Explanation - Mark, Larry (Viking - Chuck)
3. Recirculating Well Explanation - John W.
4. Abbey Point / Geophysics - George P., Noel, Mark F.?

Flow 32 (check) - Mark, Dale
Weather Station (check) - Ken
Transpiration Gas Sampling - Larry, Ken, Harry, Dale, Jen
Finish Well Sampling if necessary - Tim, Nicole, Jen, Michelle
Geoprobe - McKenna (if not finished)
Sample Management - Jen, Michelle, Nicole (includes filetering water samples)

Friday - July 17
De-mobilization